MuPDF Documentation

Release 1.25.0

Artifex

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USER GUIDE

MuPDF is a lightweight *PDF*, *XPS*, and *E-book* viewer. It is available under either the GNU GPL Affero license or licensed for commercial use from Artifex Software, Inc.

MuPDF consists of a software library, command line tools, and viewers for various platforms. To get started with *MuPDF* a developer should *acquire the source code* and *build the library*.

CHAPTER

ONE

QUICK START GUIDE

1.1 Get the *MuPDF* source code

There are a few options for acquiring the source code as follows:

- Download an official *MuPDF* release here: MuPDF Releases.
- Check out the *Github* repository here: MuPDF on Github.
- Or check out the latest development source directly from our canonical git repository: `git clone --recursive git://git.ghostscript.com/mupdf.git`.

Note: If you have checked out a *git repo* then in the "mupdf" directory, update the third party libraries with: `git submodule update --init`.

1.2 Building the library

1.2.1 *Windows*

On *Windows* there is a *Visual Studio* solution file in `platform/win32/mupdf.sln`.

Using Microsoft Visual Studio

To build the required DLLs, load `platform/win32/mupdf.sln` into *Visual Studio*, and select the required architecture from the drop down - then right click on `libmupdf` in the solution explorer and choose "Build".

1.2.2 *macOS*

Build for *macOS* with the following *Terminal* command:

```
make prefix=/usr/local install
```

This will then install the viewer, command line tools, libraries, and header files on your system.

1.2.3 *Linux*

You will also need the X11 headers and libraries if you're building on *Linux*. These can typically be found in the xorg-dev package.

Alternatively, if you only want the command line tools, you can build with `HAVE_X11=no`.

The new *OpenGL* based viewer also needs *OpenGL* headers and libraries. If you're building on *Linux*, install the `mesa-common-dev`, `libgl1-mesa-dev` packages, and `libglu1-mesa-dev` packages. You'll also need several X11 development packages: `xorg-dev`, `libxcursor-dev`, `libxrandr-dev`, and `libxinerama-dev`. To skip building the *OpenGL* viewer, build with `HAVE_GLUT=no`.

To install the viewer, command line tools, libraries, and header files on your system:

```
make prefix=/usr/local install
```

To install only the command line tools, libraries, and headers invoke `make` like this:

```
make HAVE_X11=no HAVE_GLUT=no prefix=/usr/local install
```

Note: Results of the build can be found in `build/release` in your "mupdf" folder.

1.3 Validating your installation

From the command line you should now have the following *MuPDF* commands available:

- *mupdf-gl* A handy viewer UI.
- *muraster* Can be used to convert PDF pages to raster images.
- *mutool* An all purpose tool for dealing with PDF files.

1.4 Supported file formats

MuPDF supports the following file formats:

`pdf`, `epub`, `xps`, `cbz`, `mobi`, `fb2`, `svg`

And a suite of image types, e.g. `png`, `jpg`, `bmp` etc.

CHAPTER

TWO

USING *MUPDF* WITH *C*

This intends to be an introductory guide into how to use *MuPDF* with your *C* code and as such assumes at least an intermediate knowledge of programming with *C*.

2.1 Basic *MuPDF* usage example

For an example of how to use *MuPDF* in the most basic way, see `docs/examples/example.c`.

Listing 1: docs/examples/example.c

```c
/*
How to use MuPDF to render a single page and print the result as
a PPM to stdout.

To build this example in a source tree and render first page at
100% zoom with no rotation, run:
make examples
./build/debug/example document.pdf 1 100 0 > page1.ppm

To build from installed sources, and render the same document, run:
gcc -I/usr/local/include -o example \
        /usr/local/share/doc/mupdf/examples/example.c \
        /usr/local/lib/libmupdf.a \
        /usr/local/lib/libmupdfthird.a \
        -lm
./example document.pdf 1 100 0 > page1.ppm
*/

#include <mupdf/fitz.h>

#include <stdio.h>
#include <stdlib.h>

int main(int argc, char **argv)
{
        char *input;
        float zoom, rotate;
        int page_number, page_count;
        fz_context *ctx;
        fz_document *doc;
```

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```
        fz_pixmap *pix;
        fz_matrix ctm;
        int x, y;

        if (argc < 3)
        {
                fprintf(stderr, "usage: example input-file page-number [ zoom [ rotate ]␣
↪]\n");
                fprintf(stderr, "\tinput-file: path of PDF, XPS, CBZ or EPUB document to␣
↪open\n");
                fprintf(stderr, "\tPage numbering starts from one.\n");
                fprintf(stderr, "\tZoom level is in percent (100 percent is 72 dpi).\n");
                fprintf(stderr, "\tRotation is in degrees clockwise.\n");
                return EXIT_FAILURE;
        }

        input = argv[1];
        page_number = atoi(argv[2]) - 1;
        zoom = argc > 3 ? atof(argv[3]) : 100;
        rotate = argc > 4 ? atof(argv[4]) : 0;

        /* Create a context to hold the exception stack and various caches. */
        ctx = fz_new_context(NULL, NULL, FZ_STORE_UNLIMITED);
        if (!ctx)
        {
                fprintf(stderr, "cannot create mupdf context\n");
                return EXIT_FAILURE;
        }

        /* Register the default file types to handle. */
        fz_try(ctx)
                fz_register_document_handlers(ctx);
        fz_catch(ctx)
        {
                fz_report_error(ctx);
                fprintf(stderr, "cannot register document handlers\n");
                fz_drop_context(ctx);
                return EXIT_FAILURE;
        }

        /* Open the document. */
        fz_try(ctx)
                doc = fz_open_document(ctx, input);
        fz_catch(ctx)
        {
                fz_report_error(ctx);
                fprintf(stderr, "cannot open document\n");
                fz_drop_context(ctx);
                return EXIT_FAILURE;
        }

        /* Count the number of pages. */
```

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```
	fz_try(ctx)
		page_count = fz_count_pages(ctx, doc);
	fz_catch(ctx)
	{
		fz_report_error(ctx);
		fprintf(stderr, "cannot count number of pages\n");
		fz_drop_document(ctx, doc);
		fz_drop_context(ctx);
		return EXIT_FAILURE;
	}

	if (page_number < 0 || page_number >= page_count)
	{
		fprintf(stderr, "page number out of range: %d (page count %d)\n", page_
↪number + 1, page_count);
		fz_drop_document(ctx, doc);
		fz_drop_context(ctx);
		return EXIT_FAILURE;
	}

	/* Compute a transformation matrix for the zoom and rotation desired. */
	/* The default resolution without scaling is 72 dpi. */
	ctm = fz_scale(zoom / 100, zoom / 100);
	ctm = fz_pre_rotate(ctm, rotate);

	/* Render page to an RGB pixmap. */
	fz_try(ctx)
		pix = fz_new_pixmap_from_page_number(ctx, doc, page_number, ctm, fz_
↪device_rgb(ctx), 0);
	fz_catch(ctx)
	{
		fz_report_error(ctx);
		fprintf(stderr, "cannot render page\n");
		fz_drop_document(ctx, doc);
		fz_drop_context(ctx);
		return EXIT_FAILURE;
	}

	/* Print image data in ascii PPM format. */
	printf("P3\n");
	printf("%d %d\n", pix->w, pix->h);
	printf("255\n");
	for (y = 0; y < pix->h; ++y)
	{
		unsigned char *p = &pix->samples[y * pix->stride];
		for (x = 0; x < pix->w; ++x)
		{
			if (x > 0)
				printf("  ");
			printf("%3d %3d %3d", p[0], p[1], p[2]);
			p += pix->n;
		}
```

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```
                printf("\n");
        }

        /* Clean up. */
        fz_drop_pixmap(ctx, pix);
        fz_drop_document(ctx, doc);
        fz_drop_context(ctx);
        return EXIT_SUCCESS;
}
```

To limit the complexity and give an easier introduction this code has no error handling at all, but any serious piece of code using *MuPDF* should use *error handling strategies*.

2.2 Common function arguments

Most functions in *MuPDF's* interface take a context argument.

A context contains global state used by *MuPDF* inside functions when parsing or rendering pages of the document. It contains for example:

- an exception stack (see error handling below),
- a memory allocator (allowing for custom allocators)
- a resource store (for caching of images, fonts, etc.)
- a set of locks and (un-)locking functions (for multi-threading)

Without the set of locks and accompanying functions the context and its proxies may only be used in a single-threaded application.

2.3 Error handling

MuPDF uses a set of exception handling macros to simplify error return and cleanup. Conceptually, they work a lot like *C++'s* try/catch system, but do not require any special compiler support.

The basic formulation is as follows:

```
fz_try(ctx)
{
   // Try to perform a task. Never 'return', 'goto' or
   // 'longjmp' out of here. 'break' may be used to
   // safely exit (just) the try block scope.
}
fz_always(ctx)
{
   // Any code here is always executed, regardless of
   // whether an exception was thrown within the try or
   // not. Never 'return', 'goto' or longjmp out from
   // here. 'break' may be used to safely exit (just) the
   // always block scope.
}
```

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```
fz_catch(ctx)
{
   // This code is called (after any always block) only
   // if something within the fz_try block (including any
   // functions it called) threw an exception. The code
   // here is expected to handle the exception (maybe
   // record/report the error, cleanup any stray state
   // etc) and can then either exit the block, or pass on
   // the exception to a higher level (enclosing) fz_try
   // block (using fz_throw, or fz_rethrow).
}
```

The `fz_always` block is optional, and can safely be omitted.

The macro based nature of this system has 3 main limitations:

Never return from within try (or 'goto' or `longjmp` out of it). This upsets the internal housekeeping of the macros and will cause problems later on. The code will detect such things happening, but by then it is too late to give a helpful error report as to where the original infraction occurred.

The `fz_try(ctx) { ... } fz_always(ctx) { ... } fz_catch(ctx) { ... }` is not one atomic *C* statement. That is to say, if you do:

```
if (condition)
   fz_try(ctx) { ... }
   fz_catch(ctx) { ... }
```

then you will not get what you want. Use the following instead:

```
if (condition) {
   fz_try(ctx) { ... }
   fz_catch(ctx) { ... }
}
```

The macros are implemented using `setjmp` and `longjmp`, and so the standard *C* restrictions on the use of those functions apply to `fz_try` / `fz_catch` too. In particular, any "truly local" variable that is set between the start of `fz_try` and something in `fz_try` throwing an exception may become undefined as part of the process of throwing that exception.

As a way of mitigating this problem, we provide a `fz_var()` macro that tells the compiler to ensure that that variable is not unset by the act of throwing the exception.

A model piece of code using these macros then might be:

```
house build_house(plans *p)
{
   material m = NULL;
   walls w = NULL;
   roof r = NULL;
   house h = NULL;
   tiles t = make_tiles();

   fz_var(w);
   fz_var(r);
   fz_var(h);
```

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```
    fz_try(ctx)
    {
        fz_try(ctx)
        {
            m = make_bricks();
        }
        fz_catch(ctx)
        {
            // No bricks available, make do with straw?
            m = make_straw();
        }
        w = make_walls(m, p);
        r = make_roof(m, t);
        // Note, NOT: return combine(w,r);
        h = combine(w, r);
    }
    fz_always(ctx)
    {
        drop_walls(w);
        drop_roof(r);
        drop_material(m);
        drop_tiles(t);
    }
    fz_catch(ctx)
    {
        fz_throw(ctx, "build_house failed");
    }
    return h;
}
```

Things to note about this:

If `make_tiles` throws an exception, this will immediately be handled by some higher level exception handler. If it succeeds, `t` will be set before `fz_try` starts, so there is no need to `fz_var(t);`.

We try first off to make some bricks as our building material. If this fails, we fall back to straw. If this fails, we'll end up in the `fz_catch`, and the process will fail neatly.

We assume in this code that combine takes new reference to both the walls and the roof it uses, and therefore that `w` and `r` need to be cleaned up in all cases.

We assume the standard *C* convention that it is safe to destroy `NULL` things.

2.4 Multi-threading

First off, study the basic usage example in *docs/examples/example.c* and make sure you understand how it works as the data structures manipulated there will be referred to in this section too.

MuPDF can usefully be built into a multi-threaded application without the library needing to know anything about threading at all. If the library opens a document in one thread, and then sits there as a 'server' requesting pages and rendering them for other threads that need them, then the library is only ever being called from this one thread.

Other threads can still be used to handle UI requests etc, but as far as *MuPDF* is concerned it is only being used in a single threaded way. In this instance, there are no threading issues with *MuPDF* at all, and it can safely be used without any locking, as described in the previous sections.

This section will attempt to explain how to use *MuPDF* in the more complex case; where we genuinely want to call the *MuPDF* library concurrently from multiple threads within a single application.

MuPDF can be invoked with a user supplied set of locking functions. It uses these to take mutexes around operations that would conflict if performed concurrently in multiple threads. By leaving the exact implementation of locks to the caller *MuPDF* remains threading library agnostic.

The following simple rules should be followed to ensure that multi-threaded operations run smoothly:

1. **"No simultaneous calls to MuPDF in different threads are allowed to use the same context."**

   Most of the time it is simplest to just use a different context for every thread; just create a new context at the same time as you create the thread. For more details see "Cloning the context" below.

2. **"No simultaneous calls to MuPDF in different threads are allowed to use the same document."**

   Only one thread can be accessing a document at a time, but once display lists are created from that document, multiple threads at a time can operate on them.

   The document can be used from several different threads as long as there are safeguards in place to prevent the usages being simultaneous.

3. **"No simultaneous calls to MuPDF in different threads are allowed to use the same device."**

   Calling a device simultaneously from different threads will cause it to get confused and may crash. Calling a device from several different threads is perfectly acceptable as long as there are safeguards in place to prevent the calls being simultaneous.

4. **"An fz_locks_context must be supplied at context creation time, unless MuPDF is to be used purely in a single thread at a time."**

   MuPDF needs to protect against unsafe access to certain structures/resources/libraries from multiple threads. It does this by using the user supplied locking functions. This holds true even when using completely separate instances of *MuPDF*.

5. **"All contexts in use must share the same fz_locks_context (or the underlying locks thereof)."**

   We strongly recommend that `fz_new_context` is called just once, and `fz_clone_context` is called to generate new contexts from that. This will automatically ensure that the same locking mechanism is used in all *MuPDF* instances. For now, we do support multiple completely independent contexts being created using repeated calls to `fz_new_context`, but these MUST share the same `fz_locks_context` (or at least depend upon the same underlying locks). The facility to create different independent contexts may be removed in future.

So, how does a multi-threaded example differ from a non-multithreaded one?

Firstly, when we create the first context, we call `fz_new_context` as before, but the second argument should be a pointer to a set of locking functions.

The calling code should provide `FZ_LOCK_MAX` mutexes, which will be locked/unlocked by *MuPDF* calling the lock/unlock function pointers in the supplied structure with the user pointer from the structure and the lock number, `i` (`0 <= i < FZ_LOCK_MAX`). These mutexes can safely be recursive or non-recursive as *MuPDF* only calls in a non-recursive style.

To make subsequent contexts, the user should **not** call `fz_new_context` again (as this will fail to share important resources such as the store and glyph cache), but should rather call `fz_clone_context`. Each of these cloned contexts can be freed by `fz_free_context` as usual. They will share the important data structures (like store, glyph cache etc.) with the original context, but will have their own exception stacks.

To open a document, call `fz_open_document` as usual, passing a context and a filename. It is important to realise that only one thread at a time can be accessing the documents itself.

This means that only one thread at a time can perform operations such as fetching a page, or rendering that page to a display list. Once a display list has been obtained however, it can be rendered from any other thread (or even from several threads simultaneously, giving banded rendering).

This means that an implementer has 2 basic choices when constructing an application to use *MuPDF* in multi-threaded mode. Either they can construct it so that a single nominated thread opens the document and then acts as a 'server' creating display lists for other threads to render, or they can add their own mutex around calls to *MuPDF* that use the document. The former is likely to be far more efficient in the long run.

For an example of how to do multi-threading see below which has a main thread and one rendering thread per page.

Listing 2: docs/examples/multi-threaded.c

```
/*
Multi-threaded rendering of all pages in a document to PNG images.

First look at docs/example.c and make sure you understand it.
Then, before coming back here to see an example of multi-threading,
please read the multi-threading section in:
https://mupdf.readthedocs.io/en/latest/using-mupdf.html#multi-threading

This example will create one main thread for reading pages from the
document, and one thread per page for rendering. After rendering
the main thread will wait for each rendering thread to complete before
writing that thread's rendered image to a PNG image. There is
nothing in MuPDF requiring a rendering thread to only render a
single page, this is just a design decision taken for this example.

To build this example in a source tree and render every page as a
separate PNG, run:
make examples
./build/debug/multi-threaded document.pdf

To build from installed sources, and render the same document, run:
gcc -I/usr/local/include -o multi-threaded \
        /usr/local/share/doc/mupdf/examples/multi-threaded.c \
        /usr/local/lib/libmupdf.a \
        /usr/local/lib/libmupdfthird.a \
        -lpthread -lm
./multi-threaded document.pdf

Caution! As all pages are rendered simultaneously, please choose a
file with just a few pages to avoid stressing your machine too
```

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```
much. Also you may run in to a limitation on the number of threads
depending on your environment.
*/

//Include the MuPDF header file, and pthread's header file.
#include <mupdf/fitz.h>
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>

// A convenience function for dying abruptly on pthread errors.

void
fail(const char *msg)
{
        fprintf(stderr, "%s\n", msg);
        abort();
}

// The data structure passed between the requesting main thread and
// each rendering thread.

struct thread_data {
        // A pointer to the original context in the main thread sent
        // from main to rendering thread. It will be used to create
        // each rendering thread's context clone.
        fz_context *ctx;

        // Page number sent from main to rendering thread for printing
        int pagenumber;

        // The display list as obtained by the main thread and sent
        // from main to rendering thread. This contains the drawing
        // commands (text, images, etc.) for the page that should be
        // rendered.
        fz_display_list *list;

        // The area of the page to render as obtained by the main
        // thread and sent from main to rendering thread.
        fz_rect bbox;

        // This is the result, a pixmap containing the rendered page.
        // It is passed first from main thread to the rendering
        // thread, then its samples are changed by the rendering
        // thread, and then back from the rendering thread to the main
        // thread.
        fz_pixmap *pix;

        // This is a note of whether a given thread failed or not.
        int failed;
};
```

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```
// This is the function run by each rendering function. It takes
// pointer to an instance of the data structure described above and
// renders the display list into the pixmap before exiting.

void *
renderer(void *data_)
{
        struct thread_data *data = (struct thread_data *)data_;
        int pagenumber = data->pagenumber;
        fz_context *ctx = data->ctx;
        fz_display_list *list = data->list;
        fz_rect bbox = data->bbox;
        fz_device *dev = NULL;

        fprintf(stderr, "thread at page %d loading!\n", pagenumber);

        // The context pointer is pointing to the main thread's
        // context, so here we create a new context based on it for
        // use in this thread.
        ctx = fz_clone_context(ctx);

        // Next we run the display list through the draw device which
        // will render the request area of the page to the pixmap.

        fz_var(dev);

        fprintf(stderr, "thread at page %d rendering!\n", pagenumber);
        fz_try(ctx)
        {
                // Create a white pixmap using the correct dimensions.
                data->pix = fz_new_pixmap_with_bbox(ctx, fz_device_rgb(ctx), fz_round_
↪rect(bbox), NULL, 0);
                fz_clear_pixmap_with_value(ctx, data->pix, 0xff);

                // Do the actual rendering.
                dev = fz_new_draw_device(ctx, fz_identity, data->pix);
                fz_run_display_list(ctx, list, dev, fz_identity, bbox, NULL);
                fz_close_device(ctx, dev);
        }
        fz_always(ctx)
                fz_drop_device(ctx, dev);
        fz_catch(ctx)
                data->failed = 1;

        // Free this thread's context.
        fz_drop_context(ctx);

        fprintf(stderr, "thread at page %d done!\n", pagenumber);

        return data;
}
```

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```
// These are the two locking functions required by MuPDF when
// operating in a multi-threaded environment. They each take a user
// argument that can be used to transfer some state, in this case a
// pointer to the array of mutexes.

void lock_mutex(void *user, int lock)
{
        pthread_mutex_t *mutex = (pthread_mutex_t *) user;

        if (pthread_mutex_lock(&mutex[lock]) != 0)
                fail("pthread_mutex_lock()");
}

void unlock_mutex(void *user, int lock)
{
        pthread_mutex_t *mutex = (pthread_mutex_t *) user;

        if (pthread_mutex_unlock(&mutex[lock]) != 0)
                fail("pthread_mutex_unlock()");
}

int main(int argc, char **argv)
{
        char *filename = argc >= 2 ? argv[1] : "";
        pthread_t *thread = NULL;
        fz_locks_context locks;
        pthread_mutex_t mutex[FZ_LOCK_MAX];
        fz_context *ctx;
        fz_document *doc = NULL;
        int threads;
        int i;

        // Initialize FZ_LOCK_MAX number of non-recursive mutexes.
        for (i = 0; i < FZ_LOCK_MAX; i++)
        {
                if (pthread_mutex_init(&mutex[i], NULL) != 0)
                        fail("pthread_mutex_init()");
        }

        // Initialize the locking structure with function pointers to
        // the locking functions and to the user data. In this case
        // the user data is a pointer to the array of mutexes so the
        // locking functions can find the relevant lock to change when
        // they are called. This way we avoid global variables.
        locks.user = mutex;
        locks.lock = lock_mutex;
        locks.unlock = unlock_mutex;

        // This is the main thread's context function, so supply the
        // locking structure. This context will be used to parse all
        // the pages from the document.
        ctx = fz_new_context(NULL, &locks, FZ_STORE_UNLIMITED);
```

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```
	fz_var(thread);
	fz_var(doc);

	fz_try(ctx)
	{
		// Register default file types.
		fz_register_document_handlers(ctx);

		// Open the PDF, XPS or CBZ document.
		doc = fz_open_document(ctx, filename);

		// Retrieve the number of pages, which translates to the
		// number of threads used for rendering pages.
		threads = fz_count_pages(ctx, doc);
		fprintf(stderr, "spawning %d threads, one per page...\n", threads);

		thread = malloc(threads * sizeof (*thread));

		for (i = 0; i < threads; i++)
		{
			fz_page *page;
			fz_rect bbox;
			fz_display_list *list;
			fz_device *dev = NULL;
			fz_pixmap *pix;
			struct thread_data *data;

			fz_var(dev);

			fz_try(ctx)
			{
				// Load the relevant page for each thread. Note, that this
				// cannot be done on the worker threads, as only one thread
				// at a time can ever be accessing the document.
				page = fz_load_page(ctx, doc, i);

				// Compute the bounding box for each page.
				bbox = fz_bound_page(ctx, page);

				// Create a display list that will hold the drawing
				// commands for the page. Once we have the display list
				// this can safely be used on any other thread.
				list = fz_new_display_list(ctx, bbox);

				// Create a display list device to populate the page's display list.
				dev = fz_new_list_device(ctx, list);

				// Run the page to that device.
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```
                                fz_run_page(ctx, page, dev, fz_identity, NULL);

                                // Close the device neatly, so everything is flushed to␣
↪the list.
                                fz_close_device(ctx, dev);
                        }
                        fz_always(ctx)
                        {
                                // Throw away the device.
                                fz_drop_device(ctx, dev);

                                // The page is no longer needed, all drawing commands
                                // are now in the display list.
                                fz_drop_page(ctx, page);
                        }
                        fz_catch(ctx)
                                fz_rethrow(ctx);

                        // Populate the data structure to be sent to the
                        // rendering thread for this page.
                        data = malloc(sizeof (*data));

                        data->pagenumber = i + 1;
                        data->ctx = ctx;
                        data->list = list;
                        data->bbox = bbox;
                        data->pix = NULL;
                        data->failed = 0;

                        // Create the thread and pass it the data structure.
                        if (pthread_create(&thread[i], NULL, renderer, data) != 0)
                                fail("pthread_create()");
                }

                // Now each thread is rendering pages, so wait for each thread
                // to complete its rendering.
                fprintf(stderr, "joining %d threads...\n", threads);
                for (i = 0; i < threads; i++)
                {
                        char filename[42];
                        struct thread_data *data;

                        if (pthread_join(thread[i], (void **) &data) != 0)
                                fail("pthread_join");

                        if (data->failed)
                        {
                                fprintf(stderr, "\tRendering for page %d failed\n", i +␣
↪1);
                        }
                        else
                        {
```

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```
                                sprintf(filename, "out%04d.png", i);
                                fprintf(stderr, "\tSaving %s...\n", filename);

                                // Write the rendered image to a PNG file
                                fz_save_pixmap_as_png(ctx, data->pix, filename);
                        }

                        // Free the thread's pixmap and display list.
                        fz_drop_pixmap(ctx, data->pix);
                        fz_drop_display_list(ctx, data->list);

                        // Free the data structure passed back and forth
                        // between the main thread and rendering thread.
                        free(data);
                }
        }
        fz_always(ctx)
        {
                // Free the thread structure
                free(thread);

                // Drop the document
                fz_drop_document(ctx, doc);
        }
        fz_catch(ctx)
        {
                fz_report_error(ctx);
                fail("error");
        }

        // Finally the main thread's context is freed.
        fz_drop_context(ctx);

        fprintf(stderr, "finally!\n");
        fflush(NULL);

        return 0;
}
```

2.5 Cloning the context

As described above, every context contains an exception stack which is manipulated during the course of nested `fz_try` / `fz_catches`. For obvious reasons the same exception stack cannot be used from more than one thread at a time.

If, however, we simply created a new context (using `fz_new_context`) for every thread, we would end up with separate stores/glyph caches etc., which is not (generally) what is desired. *MuPDF* therefore provides a mechanism for "cloning" a context. This creates a new context that shares everything with the given context, except for the exception stack.

A commonly used general scheme is therefore to create a 'base' context at program start up, and to clone this repeatedly to get new contexts that can be used on new threads.

2.6 Coding Style

2.6.1 Names

Functions should be named according to one of the following schemes:

- **verb_noun**.
- **verb_noun_with_noun**.
- **noun_attribute**.
- **set_noun_attribute**.
- **noun_from_noun** - convert from one type to another (avoid **noun_to_noun**).

Prefixes are mandatory for exported functions, macros, enums, globals and types:

- `fz` for common code.
- `pdf`, `xps`, etc., for interpreter specific code.

Prefixes are optional (but encouraged) for private functions and types.

Avoid using 'get' as this is a meaningless and redundant filler word.

These words are reserved for reference counting schemes:

- **new**, **create**, **find**, **load**, **open**, **keep** - return objects that you are responsible for freeing.
- **drop** - relinquish ownership of the object passed in.

When searching for an object or value, the name used depends on whether returning the value is passing ownership:

- **lookup** - return a value or borrowed pointer.
- **find** - return an object that the caller is responsible for freeing.

2.6.2 Types

Various different integer types are used throughout *MuPDF*.

In general:

- `int` is assumed to be 32bit at least.
- `short` is assumed to be exactly 16 bits.
- `char` is assumed to be exactly 8 bits.
- Array sizes, string lengths, and allocations are measured using `size_t`. `size_t` is 32bit in 32bit builds, and 64bit on all 64bit builds.
- Buffers of data use unsigned chars (or `uint8_t`).
- Offsets within files/streams are represented using `int64_t`.

In addition, we use floats (and avoid doubles when possible), assumed to be IEEE compliant.

2.6.3 Reference counting

Reference counting uses special words in functions to make it easy to remember and follow the rules.

Words that take ownership: `new`, `find`, `load`, `open`, `keep`.

Words that release ownership: `drop`.

If an object is returned by a function with one of the special words that take ownership, you are responsible for freeing it by calling `drop` or `free`, or `close` before you return. You may pass ownership of an owned object by return it only if you name the function using one of the special words.

Any objects returned by functions that do not have any of these special words, are borrowed and have a limited life time. Do not hold on to them past the duration of the current function, or stow them away inside structs. If you need to keep the object for longer than that, you have to either `keep` it or make your own copy.

CHAPTER

THREE

USING *MUPDF WASM*

3.1 Installing

- From the command line, select the folder you want to work from and do:

  ```
  npm install mupdf
  ```

- To verify your installation you can then create a *JavaScript* file as such:

  ```
  const mupdf = require("mupdf");
  console.log(mupdf);
  ```

- Save this file as "test.js".
- Then run:

  ```
  node test.js
  ```

- It should print the `mupdf` object along with details on the internal objects.

3.2 Loading a Document

The following *JavaScript* sample demonstrates how to load a local document and then print out the page count. Ensure you have a valid *PDF* for "my_document.pdf" file alongside this *JavaScript* sample before trying it.

```
const fs = require("fs");
const mupdf = require("mupdf");

var input = fs.readFileSync("my_document.pdf");
var doc = mupdf.Document.openDocument(input, "application/pdf");
console.log(doc.countPages());
```

3.3 Creating a PDF

The following *JavaScript* sample demonstrates how to create a blank *PDF* file with an assortment of annotations.

```
var fs = require("fs")
var mupdf = require("mupdf")

function createBlankPDF() {
    var doc = new mupdf.PDFDocument()
    doc.insertPage(0, doc.addPage([0, 0, 595, 842], 0, null, ""))
    return doc
}

function savePDF(doc, path, opts) {
    fs.writeFileSync(path, doc.saveToBuffer(opts).asUint8Array())
}

try {
    var doc = createBlankPDF()
    var page = doc.loadPage(0)
    var annot

    annot = page.createAnnotation("Text")
    annot.setRect([200, 10, 250, 50])
    annot.setContents("This is a Text annotation!")
    annot.setColor([0,0.5,1])

    annot = page.createAnnotation("FreeText")
    annot.setRect([10, 10, 200, 50])
    annot.setContents("This is a FreeText annotation!")
    annot.setDefaultAppearance("TiRo", 18, [0])

    annot = page.createAnnotation("Circle")
    annot.setRect([100, 100, 300, 300])
    annot.setColor([0, 1, 1])
    annot.setInteriorColor([0.5, 0, 0])
    annot.setBorderEffect("Cloudy")
    annot.setBorderEffectIntensity(4)
    annot.setBorderWidth(10)

    annot = page.createAnnotation("Polygon")
    annot.setColor([1, 0, 0])
    annot.setInteriorColor([1, 1, 0])
    annot.addVertex([10, 100])
    annot.addVertex([200, 200])
    annot.addVertex([30, 300])

    annot = page.createAnnotation("Line")
    annot.setColor([1, 0, 0])
    annot.setInteriorColor([0, 0, 1])
    annot.setLine([10, 300], [200, 500])
    annot.setLineEndingStyles("None", "ClosedArrow")
```

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```
    annot = page.createAnnotation("Highlight")
    annot.setColor([1, 1, 0])
    annot.setQuadPoints([
        [
            80, 70,
            190, 70,
            80, 90,
            190, 90,
        ]
    ])

    annot = page.createAnnotation("Stamp")
    annot.setRect([10, 600, 200, 700])
    annot.setAppearance(null, null, mupdf.Matrix.identity, [ 0, 0, 100, 100 ],
↪{}, "0 1 0 rg 10 10 50 50 re f")

    annot = page.createAnnotation("Stamp")
    annot.setRect([10, 750, 200, 850])
    annot.setIcon("TOP SECRET")

    annot = page.createAnnotation("FileAttachment")
    annot.setRect([300, 10, 350, 60])
    annot.setFileSpec(
        doc.addEmbeddedFile (
            "readme.txt",
            "text/plain",
            "Lorem ipsum dolor...",
            new Date(),
            new Date(),
            false
        )
    )

    annot = page.createAnnotation("Ink")
    annot.setColor([0.5])
    annot.setBorderWidth(5)
    annot.addInkListStroke()
    for (let i = 0; i < 360; i += 5) {
        let y = Math.sin(i * Math.PI / 180)
        annot.addInkListStrokeVertex([ 200 + i, 700 + y * 50 ])
    }

    page.createLink([ 500, 20, 590, 40 ], "https://mupdf.com/")
    page.createLink([ 500, 40, 590, 60 ], doc.formatLinkURI({ type: "Fit",␣
↪page: 0 }))

    page.update()

    savePDF(doc, "out.pdf", "")

} catch (err) {
    console.error(err)
```

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```
    process.exit(1)
}
```

3.4 Trying the Viewer

From the previous installation step you should have a folder called `node_modules`. From `node_modules/mupdf/lib` copy the 3 files `mupdf-wasm.js`, `mupdf-wasm.wasm` & `mupdf.js` into `platform/wasm/lib` in your local checkout of mupdf.git. Then you can open `platform/wasm/viewer/mupdf-view.html` to try it out.

Note: You need to run this HTML viewer page within a suitable *Development Environment* in order to load and view *PDFs*, if you see the error message "TypeError: this.mupdfWorker.openDocumentFromBuffer is not a function", please read that section.

If running locally you can append `?file=my_file.pdf` to the browser URL to automatically load the *PDF* you need without using the "Open File" option from the GUI.

3.5 Development Environment

3.5.1 Browser setup

If you developing a *WASM* webpage it is important to note the following pre-requisites for local development:

- You should run the webpage in a localhost environment, or:
- Run the webpage locally in a browser which allows for a less strict origin policy allowing for local file loads - see below for how to do this in *Firefox*.

Artifex recommends *Firefox* as the browser of choice for local development due to its feature set of highly configurable developer options.

Firefox - enabling local files loads

If you are not running in a local host environment then this is required for local JS files to load & execute into the webpage without hindrance. It also allows for local *PDF* files to be chosen and loaded via the File JS interface.

By default *Firefox* is set to *not* allow local files to be loaded into the browser environment.

You can enable local file loads in *Firefox* by setting `security.fileuri.strict_origin_policy` in the `about:config` menu to `false`.

Steps to do this:

- Type `about:config` into a *Firefox* tab.
- Click "Accept the Risk and Continue".
- Search for `security.fileuri.strict_origin_policy`.
- Click on the value to toggle it to `false`.

Note: If you do this you should probably use an entirely separate browser for development use - e.g. Firefox Developer Edition. Or reset the origin policy back to default at a later time.

3.5.2 JavaScript methodology

Due to the asynchronous nature of a *WASM* web application *Web Workers* and *Promises* should be used within your application to handle the life-cycle and document events.

Web Workers

By utilizing *Web Workers* your webpage will be able to run scripts on background threads which will not interfere with the user interface. As there may be a fair amount of file I/O and page rendering occurring the *Web Worker* solution will allow for this whilst not hanging or slowing down (or seemingly crashing) your webpage.

See *Mozilla's* page on Using Web Workers for more.

Promises

By utilizing *Promises* your *JavaScript* code will be better equipped to manage asynchronous operations. Code should be easier to follow and maintain as you develop your *WASM* application.

See Mozilla's page on Using Promises for more.

CHAPTER

FOUR

MUPDF ON THE COMMAND LINE

MuPDF has few command line options available:

- *mupdf-gl* A handy viewer UI.
- *muraster* Can be used to convert *PDF* pages to raster images.
- *mutool* An all purpose tool for dealing with *PDF* files. Used in conjunction with the *mutool JavaScript API*

4.1 *mupdf-gl*

The *OpenGL* based viewer can read *PDF*, *XPS*, *CBZ*, *EPUB*, & *FB2* documents as well as typical image formats including *SVG*. It compiles on any platform that has a GLUT library. The latest release builds on *Linux*, *Windows*, and *MacOS*.

4.1.1 Command Line Options

```
mupdf-gl [options] document [page]
```

`[options]`

`-p` password
The password needed to open a password protected *PDF* file.

`-c` profile.cc
Load an ICC profile to use for display (default is sRGB).

`-r` resolution
Set the initial zoom level, specified as DPI. The default value is `72`.

`-W` width
Set the page width in points for *EPUB* layout.

`-H` height
Set the page height in points for *EPUB* layout.

`-S` size
Set the default font size in points for *EPUB* layout.

`-U` stylesheet
Specify a *CSS* file containing user styles to load for *EPUB* layout.

`-X`
Ignore publisher styles for *EPUB* layout.

`-J`
: Disable *JavaScript* in *PDF* forms.

`-A level`
: Set anti-aliasing level or pixel rendering rule.

- `0`: off.
- `2`: 4 levels.
- `4`: 16 levels.
- `8`: 256 levels.
- `9`: using centre of pixel rule.
- `10`: using any part of a pixel rule.

`-I`
: Start in inverted color mode.

`-B hex-color`
: Set black tint color (default `303030`).

`-C hex-color`
: Set white tint color (default `FFFFF0`).

`-Y factor`
: Set UI scaling factor (default calculated from screen DPI).

`[page]`
: The initial page number to show.

Example usage #1:

This will open the viewer with a file browser which allows you to choose the file you need.

```
mupdf-gl
```

Example usage #1:

This will open a specific file, in inverted color mode, on page 10.

```
mupdf-gl -I mupdf_explored.pdf 10
```

4.1.2 Mouse Bindings

The middle mouse button (scroll wheel button) pans the document view.

The right mouse button selects a region and copies the marked text to the clipboard.

4.1.3 Key Bindings

Several commands can take a number argument entered before the key, to modify the command. For example, to zoom to 150 dpi, type "150z".

F1	Display help.
i	Show document information.
o	Show document outline.
L	Highlight links.
F	Highlight form fields.
a	Show annotation editor.
r	Reload document.
S	Save document (only for *PDF*).
q	Quit viewer.

<	Decrease E-book font size.
>	Increase E-book font size.
I	Toggle inverted color mode.
C	Toggle tinted color mode.
E	Toggle ICC color management.
e	Toggle spot color emulation.
A	Toggle anti-aliasing.

f	Toggle fullscreen.
w	Shrinkwrap window to fit page.
W	Fit page width to window.
H	Fit page height to window.
Z	Fit page size to window.
[number] z	Set zoom resolution in DPI.
+	Zoom in.
-	Zoom out.
[	Rotate counter-clockwise.
]	Rotate clockwise.
or **h**, **j**, **k**, **l**	Pan page in small increments.

b	Smart move one screenful backward.
[space]	Smart move one screenful forward.
[comma] or **[page up]**	Go one page backward.
[period] or **[page down]**	Go one page forward.
[number] g	Go to page number.
G	Go to last page.

m	Save current page to navigation history.
t	Go back in navigation history.
T	Go forward in navigation history.
[number] m	Save current page in numbered bookmark.
[number] t	Go to numbered bookmark.

/	Start searching forward.
?	Start searching backward.
n	Continue searching forward.
N	Continue searching backward.

4.2 *muraster*

This is a much simpler version of `mutool draw` command. As such it can be used to quickly rasterize an input file with a set of options.

4.2.1 Command Line Options

```
muraster [options] file [pages]
```

`[options]`

`-p` password
The password needed to open a password protected *PDF* file.

`-o` filename
The output file name.

`-F` format
The output format (default inferred from output file name), e.g. `pam`, `pbm`, `pgm`, `pkm`, `ppm`.

`-s` information
Show extra information: - `m`: show memory use. - `t`: show timings.

`-R` rotation
Set a rotation for the output (default `auto`): - `auto`. - `0`. - `90`. - `180`. - `270`. - `clockwise`.

`-r` x,y
Comma separated x and y resolution in DPI (default: 300,300).

`-w` width
Printable width (in inches) (default: 8.27).

`-h` height
Printable height (in inches) (default: 11.69).

`-f`
Fit file to page if too large.

`-B` height
Set the minimum band height (e.g. 32).

`-M` memory
Sets the maximum band memory (e.g. 655360).

`-W` width
Page width for EPUB layout.

`-H` height
Page height for EPUB layout.

`-S` size
Font size for EPUB layout.

-U filename
File name of user stylesheet for EPUB layout

-X
Disable document styles for EPUB layout

-A level
Set anti-aliasing level.

- 0: off.
- 2: 4 levels.
- 4: 16 levels.
- 8: 256 levels.

-A graphics level / text level
Independently set the anti-aliasing levels for graphics and text.

e.g. `-A 0/4`.

[pages]
A comma separated list of page numbers and ranges.

Example usage #1:

This will render a raster file from page one of the input file "mupdf_explored.pdf". The output file will be called "test.ppm", have a clockwise rotation and specific graphics/text anti-aliasing applied.

```
muraster -o test.ppm -R clockwise -A 0/8 mupdf_explored.pdf 1
```

4.3 *mutool*

Note: It is advised to use rlwrap with `mutool` for command line history and cursor navigation (this can be also installed via *Homebrew* or *MacPorts*).

Note: Use `mutool -help` for summary usage.

For rendering and converting documents there are three commands available:

4.3.1 *mutool draw*

The `draw` command will render a document to image files, convert to another vector format, or extract the text content.

- The supported input document formats are: `pdf`, `xps`, `cbz`, and `epub`.
- The supported output image formats are: `pbm`, `pgm`, `ppm`, `pam`, `png`, `pwg`, `pcl` and `ps`.
- The supported output vector formats are: `svg`, `pdf`, and `debug trace` (as `xml`).
- The supported output text formats are: `plain text`, `html`, and structured text (as `xml` or `json`).

```
mutool draw [options] file [pages]
```

Note: Command line parameters within square brackets `[]` are optional.

`[options]`

Options are as follows:

`-p` password
Use the specified password if the file is encrypted.

`-o` output
The output file name. The output format is inferred from the output filename. Embed `%d` in the name to indicate the page number (for example: "page%d.png"). Printf modifiers are supported, for example "%03d". If no output is specified, the output will go to `stdout`.

`-F` format
Enforce a specific output format. Only necessary when outputting to `stdout` since normally the output filename is used to infer the output format.

`-R` angle
Rotate clockwise by given number of degrees.

`-r` resolution
Render the page at the specified resolution. The default resolution is 72 dpi.

`-w` width
Render the page at the specified width (or, if the `-r` flag is used, render with a maximum width).

`-h` height
Render the page at the specified height (or, if the `-r` flag is used, render with a maximum height).

`-f`
Fit exactly; ignore the aspect ratio when matching specified width/heights.

`-B` bandheight
Render in banded mode with each band no taller than the given height. This uses less memory during rendering. Only compatible with `pam`, `pgm`, `ppm`, `pnm` and `png` output formats. Banded rendering and md5 checksumming may not be used at the same time.

`-W` width
Page width in points for *EPUB* layout.

`-H` height
Page height in points for *EPUB* layout.

`-S` size
Font size in points for *EPUB* layout.

`-U` filename
User CSS stylesheet for *EPUB* layout.

`-X`
Disable document styles for *EPUB* layout.

`-c` colorspace
Render in the specified colorspace. Supported colorspaces are: `mono`, `gray`, `grayalpha`, `rgb`, `rgbalpha`, `cmyk`, `cmykalpha`. Some abbreviations are allowed: `m`, `g`, `ga`, `rgba`, `cmyka`. The default is chosen based on the output format.

`-G` gamma
Apply gamma correction. Some typical values are 0.7 or 1.4 to thin or darken text rendering.

-I
Invert colors.

-s [mft5]
Show various bits of information: `m` for glyph cache and total memory usage, `f` for page features such as whether the page is grayscale or color, `t` for per page rendering times as well statistics, and `5` for md5 checksums of rendered images that can be used to check if rendering has changed.

-A bits
Specify how many bits of anti-aliasing to use. The default is `8`. `0` means no anti-aliasing, `9` means no anti-aliasing, centre-of-pixel rule, `10` means no anti-aliasing, any-part-of-a-pixel rule.

-D
Disable use of display lists. May cause slowdowns, but should reduce the amount of memory used.

-i
Ignore errors.

-L
Low memory mode (avoid caching objects by clearing cache after each page).

-P
Run interpretation and rendering at the same time.

---

file
Input file name. The input can be any of the *document formats supported by MuPDF*.

[pages]
Comma separated list of page ranges. The first page is "1", and the last page is "N". The default is "1-N".

This is the more customizable tool, but also has a more difficult set of command line options. It is primarily used for rendering a document to image files.

4.3.2 *mutool convert*

The `convert` command converts an input file into another format.

```
mutool convert [options] file [pages]
```

Note: Command line parameters within square brackets `[]` are optional.

[options]
Options are as follows:

-p password
Use the specified password if the file is encrypted.

-o output
The output file name. The output format is inferred from the output filename. Embed `%d` in the name to indicate the page number (for example: "page%d.png"). Printf modifiers are supported, for example "%03d". If no output is specified, the output will go to `stdout`.

-F output format (default inferred from output file name)

- raster: `cbz`, `png`, `pnm`, `pgm`, `ppm`, `pam`, `pbm`, `pkm`.
- print-raster: `pcl`, `pclm`, `ps`, `pwg`.
- vector: `pdf`, `svg`.
- text: `html`, `xhtml`, `text`, `stext`.

-A bits
Specify how many bits of anti-aliasing to use. The default is `8`.

-W width
Page width in points for *EPUB* layout.

-H height
Page height in points for *EPUB* layout.

-S size
Font size in points for *EPUB* layout.

-U filename
User CSS stylesheet for *EPUB* layout.

-X
Disable document styles for *EPUB* layout.

`-O` comma separated list of options for output format.

Raster output options:

- `rotate=N` Rotate rendered pages N degrees counterclockwise.
- `resolution=N` Set both X and Y resolution in pixels per inch.
- `x-resolution=N` X resolution of rendered pages in pixels per inch.
- `y-resolution=N` Y resolution of rendered pages in pixels per inch.
- `width=N` Render pages to fit N pixels wide (ignore resolution option).
- `height=N` Render pages to fit N pixels tall (ignore resolution option).
- `colorspace=(gray|rgb|cmyk)` Render using specified colorspace.
- `alpha` Render pages with alpha channel and transparent background.
- `graphics=(aaN|cop|app)` Set the rasterizer to use for graphics.
  - `aaN` Antialias with N bits (0 to 8).
  - `cop` Center of pixel.
  - `app` Any part of pixel.
- `text=(aaN|cop|app)` Set the rasterizer to use for text.
  - `aaN` Antialias with N bits (0 to 8).
  - `cop` Center of pixel.
  - `app` Any part of pixel.

PCL output options:

- `colorspace=mono` Render 1-bit black and white page.
- `colorspace=rgb` Render full color page.

- preset=generic|ljet4|dj500|fs600|lj|lj2|lj3|lj3d|lj4|lj4pl|lj4d|lp2563b|oce9050.
- spacing=0 No vertical spacing capability.
- spacing=1 PCL 3 spacing (<ESC>*p+<n>Y).
- spacing=2 PCL 4 spacing (<ESC>*b<n>Y).
- spacing=3 PCL 5 spacing (<ESC>*b<n>Y and clear seed row).
- mode2 Enable mode 2 graphics compression.
- mode3 Enable mode 3 graphics compression.
- eog_reset End of graphics (<ESC>*rB) resets all parameters.
- has_duplex Duplex supported (<ESC>&l<duplex>S).
- has_papersize Papersize setting supported (<ESC>&l<sizecode>A).
- has_copies Number of copies supported (<ESC>&l<copies>X).
- is_ljet4pjl Disable/Enable HP 4PJL model-specific output.
- is_oce9050 Disable/Enable Oce 9050 model-specific output.

PCLm output options:

- compression=none No compression (default).
- compression=flate Flate compression.
- strip-height=N Strip height (default 16).

PWG output options:

- media_class= Set the media_class field.
- media_color= Set the media_color field.
- media_type= Set the media_type field.
- output_type= Set the output_type field.
- rendering_intent= Set the rendering_intent field.
- page_size_name= Set the page_size_name field.
- advance_distance= Set the advance_distance field.
- advance_media= Set the advance_media field.
- collate= Set the collate field.
- cut_media= Set the cut_media field.
- duplex= Set the duplex field.
- insert_sheet= Set the insert_sheet field.
- jog= Set the jog field.
- leading_edge= Set the leading_edge field.
- manual_feed= Set the manual_feed field.
- media_position= Set the media_position field.
- media_weight= Set the media_weight field.
- mirror_print= Set the mirror_print field.

- negative_print= Set the negative_print field.
- num_copies= Set the num_copies field.
- orientation= Set the orientation field.
- output_face_up= Set the output_face_up field.
- page_size_x= Set the page_size_x field.
- page_size_y= Set the page_size_y field.
- separations= Set the separations field.
- tray_switch= Set the tray_switch field.
- tumble= Set the tumble field.
- media_type_num= Set the media_type_num field.
- compression= Set the compression field.
- row_count= Set the row_count field.
- row_feed= Set the row_feed field.
- row_step= Set the row_step field.

Text output options:

- inhibit-spaces Don't add spaces between gaps in the text.
- preserve-images Keep images in output.
- preserve-ligatures Do not expand ligatures into constituent characters.
- preserve-whitespace Do not convert all whitespace into space characters.
- preserve-spans Do not merge spans on the same line.
- dehyphenate Attempt to join up hyphenated words.
- mediabox-clip=no Include characters outside mediabox.

PDF output options:

- decompress Decompress all streams (except compress-fonts/images).
- compress Compress all streams.
- compress-fonts Compress embedded fonts.
- compress-images Compress images.
- ascii ASCII hex encode binary streams.
- pretty Pretty-print objects with indentation.
- linearize Optimize for web browsers.
- clean Pretty-print graphics commands in content streams.
- sanitize Sanitize graphics commands in content streams.
- incremental Write changes as incremental update.
- continue-on-error Continue saving the document even if there is an error.
- garbage Garbage collect unused objects.

or `garbage=compact` ... and compact cross reference table.

or `garbage=deduplicate` ... and remove duplicate objects.

- `decrypt` Write unencrypted document.
- `encrypt=rc4-40|rc4-128|aes-128|aes-256` Write encrypted document.
- `permissions=NUMBER` Document permissions to grant when encrypting.
- `user-password=PASSWORD` Password required to read document.
- `owner-password=PASSWORD` Password required to edit document.
- `regenerate-id` Regenerate document id (default yes).

SVG output options:

- `text=text` Emit text as <text> elements (inaccurate fonts).
- `text=path` Emit text as <path> elements (accurate fonts).
- `no-reuse-images` Do not reuse images using <symbol> definitions.

`file`
Input file name. The input can be any of the *document formats supported by MuPDF*.

`[pages]`
Comma separated list of page ranges. The first page is "1", and the last page is "N". The default is "1-N".

This tool is used for converting documents into other formats, and is easier to use.

4.3.3 *mutool trace*

The `trace` command prints a trace of device calls needed to render a page.

```
mutool trace [options] file [pages]
```

Note: Command line parameters within square brackets `[]` are optional.

`[options]`
Options are as follows:

`-p` password
Use the specified password if the file is encrypted.

`-W` width
Page width in points for *EPUB* layout.

`-H` height
Page height in points for *EPUB* layout.

`-S` size
Font size in points for *EPUB* layout.

-U filename
User CSS stylesheet for *EPUB* layout.

-X
Disable document styles for *EPUB* layout.

-d
Use display list.

---

file
Input file name. The input can be any of the *document formats supported by MuPDF*.

[pages]
Comma separated list of page ranges. The first page is "1", and the last page is "N". The default is "1-N".

The trace takes the form of an XML document, with the root element being the document, its children each page, and one page child element for each device call on that page.

An example trace:

```
<document filename="hello.pdf">
<page number="1" mediabox="0 0 595 842">
<fill_path winding="nonzero" colorspace="DeviceRGB" color="1 0 0" transform="1␣
↪0 0 -1 0 842">
<moveto x="50" y="50"/>
<lineto x="100" y="200"/>
<lineto x="200" y="50"/>
</fill_path>
<fill_text colorspace="DeviceRGB" color="0" transform="1 0 0 -1 0 842">
<span font="Times-Roman" wmode="0" trm="100 0 0 100">
<g unicode="H" glyph="H" x="50" y="500" />
<g unicode="e" glyph="e" x="122.2" y="500" />
<g unicode="l" glyph="l" x="166.6" y="500" />
<g unicode="l" glyph="l" x="194.4" y="500" />
<g unicode="o" glyph="o" x="222.2" y="500" />
<g unicode="!" glyph="exclam" x="272.2" y="500" />
</span>
</fill_text>
</page>
</document>
```

This is a debugging tool used for printing a trace of the graphics device calls on a page.

There are also several tools specifically for working with *PDF* files:

4.3.4 *mutool show*

The `show` command will print the specified objects and streams to `stdout`. Streams are decoded and non-printable characters are represented with a period by default.

```
mutool show [options] input.pdf ( trailer | xref | pages | grep | outline | js␣
↪| form | <path> ) *
```

Note: Command line parameters within square brackets `[]` are optional.

[options]
Options are as follows:

-p password
Use the specified password if the file is encrypted.

-o output
The output file name instead of using `stdout`. Should be a plain text file format.

-e
Leave stream contents in their original form.

-b
Print only stream contents, as raw binary data.

-g
Print only object, one line per object, suitable for grep.

---

input.pdf
Input file name. Must be a *PDF* file.

(trailer | xref | pages | grep | outline | js | form | <path>) *
Specify what to show by using one of the following keywords, or specify a path to an object:

trailer
Print the trailer dictionary.

xref
Print the cross reference table.

pages
List the object numbers for every page.

grep
Print all the objects in the file in a compact one-line format suitable for piping to grep.

outline
Print the outline (also known as "table of contents" or "bookmarks").

js
Print document level *JavaScript*.

form
Print form objects.

<path>
A path starts with either an object number, a property in the trailer dictionary, or the keyword "trailer" or "pages". Separate elements with a period '.' or slash '/'. Select a page object by using pages/N where N is the page number. The first page is number 1.

*****
You can use * as an element to iterate over all array indices or dictionary properties in an object. Thus you can have multiple keywords with for your `mutool show` query.

Examples:

Find the number of pages in a document:

```
mutool show $FILE trailer/Root/Pages/Count
```

Print the raw content stream of the first page:

```
mutool show -b $FILE pages/1/Contents
```

Print the raw content stream of the first page & second page & the PDF outline (demonstrates use of the * element):

```
mutool show -b $FILE pages/1/Contents pages/2/Contents outline
```

Show all *JPEG* compressed stream objects:

```
mutool show $FILE grep | grep '/Filter/DCTDecode'
```

A tool for displaying the internal objects in a *PDF* file.

4.3.5 *mutool extract*

The `extract` command can be used to extract images and font files from a *PDF* file. The image and font files will be saved out to the same folder which the file originates from.

```
mutool extract [options] input.pdf [object numbers]
```

Note: Command line parameters within square brackets `[]` are optional.

[options]
Options are as follows:

-p password
Use the specified password if the file is encrypted.

-r
Convert images to RGB when extracting them.

-a
Embed SMasks as alpha channel.

-N
Do not use ICC color conversions.

`input.pdf`
Input file name. Must be a *PDF* file.

`[object numbers]`
An array of object ids to extract from. If no object numbers are given on the command line, all images and fonts will be extracted from the file.

Extract images and embedded font resources.

4.3.6 *mutool clean*

The `clean` command pretty prints and rewrites the syntax of a *PDF* file. It can be used to repair broken files, expand compressed streams, filter out a range of pages, etc.

```
mutool clean [options] input.pdf [output.pdf] [pages]
```

Note: Command line parameters within square brackets `[]` are optional.

`[options]`
Options are as follows:

`-p` password
Use the specified password if the file is encrypted.

`-g`
Garbage collect unused objects.

`-gg`
In addition to `-g` compact xref table.

`-ggg`
In addition to `-gg` merge duplicate objects.

`-gggg`
In addition to `-ggg` check streams for duplication.

`-l`
Linearize PDF.

`-D`
Save file without encryption.

`-E` encryption
Save file with new encryption (`rc4-40`, `rc4-128`, `aes-128`, or `aes-256`).

`-O` owner_password
Owner password (only if encrypting).

`-U` user_password
User password (only if encrypting).

`-P` permission
Permission flags (only if encrypting).

-a
ASCII hex encode binary streams.

-d
Decompress streams.

-z
Deflate uncompressed streams.

-f
Compress font streams.

-i
Compress image streams.

-c
Clean content streams.

-s
Sanitize content streams.

-A
Create appearance streams for annotations.

-AA
Recreate appearance streams for annotations.

-m
Preserve metadata.

---

input.pdf
Input file name. Must be a *PDF* file.

[output.pdf]
The output file. Must be a *PDF* file.

> **Note:** If no output file is specified, it will write the cleaned *PDF* to "out.pdf" in the current directory.

[pages]
Comma separated list of page numbers and ranges. If no pages are supplied then all document pages will be considered for the output file.

Rewrite *PDF* files. Used to fix broken files, or to make a *PDF* file human editable.

4.3.7 *mutool merge*

The `merge` command is used to pick out pages from two or more files and merge them into a new output file.

```
mutool merge [-o output.pdf] [-O options] input.pdf [pages] [input2.pdf]␣
↪[pages2] ...
```

Note: Command line parameters within square brackets `[]` are optional.

[-o output.pdf]
The output filename. Defaults to "out.pdf" if not supplied.

[-O options]
Comma separated list of output options.

- `decompress` Decompress all streams (except compress-fonts/images).
- `compress` Compress all streams.
- `compress-fonts` Compress embedded fonts.
- `compress-images` Compress images.
- `ascii` ASCII hex encode binary streams.
- `pretty` Pretty-print objects with indentation.
- `linearize` Optimize for web browsers.
- `clean` Pretty-print graphics commands in content streams.
- `sanitize` Sanitize graphics commands in content streams.
- `incremental` Write changes as incremental update.
- `continue-on-error` Continue saving the document even if there is an error.
- `garbage` Garbage collect unused objects.

  or `garbage=compact` ... and compact cross reference table.

  or `garbage=deduplicate` ... and remove duplicate objects.
- `decrypt` Write unencrypted document.
- `encrypt=rc4-40|rc4-128|aes-128|aes-256` Write encrypted document.
- `permissions=NUMBER` Document permissions to grant when encrypting.
- `user-password=PASSWORD` Password required to read document.
- `owner-password=PASSWORD` Password required to edit document.
- `regenerate-id` Regenerate document id (default yes).

input.pdf
The first document.

`[pages]`
: Comma separated list of page ranges for the first document (`input.pdf`). The first page is "1", and the last page is "N". The default is "1-N".

`[input2.pdf]`
: The second document.

`[pages2]`
: Comma separated list of page ranges for the second document (`input2.pdf`). The first page is "1", and the last page is "N". The default is "1-N".

`...`
: Indicates that we add as many additional `[input]` & `[pages]` pairs as required to merge multiple documents.

Merge pages from multiple input files into a new *PDF*.

4.3.8 *mutool poster*

The `poster` command reads the input PDF file and for each page chops it up into `x` by `y` pieces. Each piece becomes its own page in the output *PDF* file. This makes it possible for each page to be printed upscaled and can then be merged into a large poster.

```
mutool poster [options] input.pdf [output.pdf]
```

Note: Command line parameters within square brackets `[]` are optional.

`[options]`
: Options are as follows:

  `-p password`
  : Use the specified password if the file is encrypted.

  `-x x decimation factor`
  : Pieces to horizontally divide each page into.

  `-y y decimation factor`
  : Pieces to vertically divide each page into.

  `-r`
  : Split horizontally from right to left (default splits from left to right).

`input.pdf`
: The input *PDF* document.

`[output.pdf]`
: The output filename. Defaults to "out.pdf" if not supplied.

Divide pages of a *PDF* into pieces that can be printed and merged into a large poster.

4.3.9 *mutool create*

The `create` command creates a new *PDF* file with the contents created from one or more input files containing graphics commands.

```
mutool create [-o output.pdf] [-O options] page.txt [page2.txt ...]
```

Note: Command line parameters within square brackets `[]` are optional.

[-o output.pdf]
The output filename. Defaults to "out.pdf" if not supplied.

[-O options]
The `-O` argument is a comma separated list of options for writing the *PDF* file:

- `decompress` Decompress all streams (except compress-fonts/images).
- `compress` Compress all streams.
- `compress-fonts` Compress embedded fonts.
- `compress-images` Compress images.
- `ascii` ASCII hex encode binary streams.
- `pretty` Pretty-print objects with indentation.
- `linearize` Optimize for web browsers.
- `clean` Pretty-print graphics commands in content streams.
- `sanitize` Sanitize graphics commands in content streams.
- `incremental` Write changes as incremental update.
- `continue-on-error` Continue saving the document even if there is an error.
- `garbage` Garbage collect unused objects.

  or `garbage=compact` ... and compact cross reference table.

  or `garbage=deduplicate` ... and remove duplicate objects.
- `decrypt` Write unencrypted document.
- `encrypt=rc4-40|rc4-128|aes-128|aes-256` Write encrypted document.
- `permissions=NUMBER` Document permissions to grant when encrypting.
- `user-password=PASSWORD` Password required to read document.
- `owner-password=PASSWORD` Password required to edit document.
- `regenerate-id` Regenerate document id (default yes).

page.txt
: *Page content stream* with annotations for creating resources.

[page2.txt ...]
: Define multiple *page content streams* as required.

Page content streams

A page is created for each input file, with the contents of the file copied into the content stream. Special comments in the input files are parsed to define the page dimensions and font and image resources.

Example #1

Define an image:

```
%%MediaBox 0 0 500 800
%%Rotate 90
%%Image Im0 path/to/image.png
```

Example #2

Font resources can be created by either giving the name of a standard *PDF* font, or by giving the path to a font file. If a third argument is present and either "Greek" or "Cyrillic" the font will be encoded using ISO 8859-7 or KOI8-U, respectively:

```
%%Font Tm Times-Roman
%%Font TmG Times-Roman Greek
%%Font TmC Times-Roman Cyrillic
%%Font Fn0 path/to/font/file.ttf
%%Font Fn1 path/to/font/file.ttf Cyrillic
```

Example #3

CJK fonts can be created by passing a language tag for one of the 4 CID orderings: zh-Hant, zh-Hans, ja, or ko (Traditional Chinese, Simplified Chinese, Japanese, Korean). The CJK font will use the UTF-16 encoding. A font file will not be embedded, so a *PDF* viewer will use a substitute font:

```
%%CJKFont Batang ko
%%CJKFont Mincho ja
%%CJKFont Ming zh-Hant
%%CJKFont Song zh-Hans
```

Example #4

An example input file, which adds an image, a triangle and some text:

```
%%MediaBox 0 0 595 842
%%Font TmRm Times-Roman
%%Font Helv-C Helvetica Cyrillic
%%Font Helv-G Helvetica Greek
%%CJKFont Song zh-Hant
%%CJKFont Mincho ja
%%CJKFont Batang ko
```

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```
%%Image I0 logo/mupdf-simplified-logo.png

% Draw an image.
q
480 0 0 480 50 250 cm
/I0 Do
Q

% Draw a triangle.
q
1 0 0 rg
50 50 m
100 200 l
200 50 l
f
Q

% Show some text.
q
0 0 1 rg
BT /TmRm 24 Tf 50 760 Td (Hello, world!) Tj ET
BT /Helv-C 24 Tf 50 730 Td <fac4d2c1d7d3d4d7d5cad4c521> Tj ET
BT /Helv-G 24 Tf 50 700 Td <eae1ebe7ecddf1e1> Tj ET
BT /Song 24 Tf 50 670 Td <4F60 597D> Tj ET
BT /Mincho 24 Tf 50 640 Td <3053 3093 306b 3061 306f> Tj ET
BT /Batang 24 Tf 50 610 Td <c548 b155 d558 c138 c694> Tj ET
Q
```

Create a new *PDF* file from a text file with graphics commands.

4.3.10 *mutool sign*

The `sign` command reads an input *PDF* file and by default prints information about each signature field object. The command applies to the signature field objects given, or every signature field if none are specified. Given suitable option signature fields can be verified, cleared or signed using a given certificate and certificate password.

```
mutool sign [options] input.pdf [signature object numbers]
```

Note: Command line parameters within square brackets `[]` are optional.

`[options]`
Options are as follows:

`-p password`
Use the specified password if the file is encrypted.

`-v`
Verify each signature field and check whether the document has changed since signing.

`-c`
Revert each signed signature field back to its unsigned state.

`-s certificate file`
Sign each signature field with the certificate in the given file.

`-P certificate password`
The password used together with the certificate to sign a signature field.

`-o filename`
Output *PDF* file name.

`input.pdf`
The input *PDF* document.

`[signature object numbers]`
Can be used to specify a particular set of signature field objects to apply the `sign` command to.

Signing certificates

Signing digital signatures in *MuPDF* requires that you have a PFX certificate. You can create a self-signed certificate using *OpenSSL* by following these steps:

1) Generate a self-signed certificate and private key:

```
$ openssl req -x509 -days 365 -newkey rsa:2048 -keyout cert.pem -out cert.pem
```

2) Convert to PFX format:

```
$ openssl pkcs12 -export -in cert.pem -out cert.pfx
```

List, verify, and sign digital signatures in *PDF* files.

4.3.11 *mutool info*

The `info` command shows info about the objects on pages in an input file. For each page the page object number is shown, and then detailed information about the desired objects.

```
mutool info [options] file [pages]
```

Note: Command line parameters within square brackets `[]` are optional.

`[options]`
Options are as follows:

`-p password`
Use the specified password if the file is encrypted.

`-F`
List fonts.

-I
List images.

-M
List dimensions.

-P
List patterns.

-S
List shadings.

-X
List form and postscript xobjects.

---

file
The input file.

[pages]
Comma separated list of page numbers and ranges. If no pages are supplied then all document pages will be considered for the output file.

Prints details about objects on each page in a *PDF* file.

4.3.12 *mutool pages*

The `pages` command prints out *MediaBox*, *CropBox*, etc. as well as `Rotation` and `UserUnit` for each page given (or all if not specified).

```
mutool pages [options] input.pdf [pages]
```

Note: Command line parameters within square brackets `[]` are optional.

[options]
Options are as follows:

-p password
Use the specified password if the file is encrypted.

---

input.pdf
Input file name. Must be a *PDF* file.

[pages]
Comma separated list of page numbers and ranges. If no pages are supplied then all document pages will be considered for the output file.

Prints the size and rotation of each page in a PDF. Provides information about *MediaBox*, *ArtBox*, etc. for each page in a *PDF* file.

4.3.13 *mutool trim*

This command allows you to make a modified version of a *PDF* with content that falls inside or outside of *defined boxes* removed.

See *mutool pages* to get information on the box elements in a *PDF*.

```
mutool trim [options] input.pdf
```

[options]
Options are as follows:

-b box
Which box to trim to (`mediabox` (default), `cropbox`, `bleedbox`, `trimbox`, `artbox`).

-m margins
Add margins to box (positive for inwards, negative for outwards).

<All> or *<V>,<H>* or *<T>,<R>,<B>,<L>*

-e
Exclude contents of box, rather than include them.

-f
Fallback to `mediabox` if specified box not available.

-o filename
Output file.

Note: Command line parameters within square brackets `[]` are optional.

Examples:

Trim a document by trimming the *MediaBox* elements with a margin of 200 points inwards:

```
mutool trim -b mediabox -m 200 -o out.pdf in.pdf
```

Trim a document by trimming the *MediaBox* elements with a margin of 20 points from the top & bottom (vertical) and 30 points from the left & right (horizontal):

```
mutool trim -b mediabox -m 20,30 -o out.pdf in.pdf
```

Trim a document by trimming the *MediaBox* elements to a box offset 10 points from the top & right, 50 points from the bottom and 20 points in from the left:

```
mutool trim -b mediabox -m 10,10,50,20 -o out.pdf in.pdf
```

Exclude the contents of the *ArtBox* element:

```
mutool trim -b artbox -e -o out.pdf in.pdf
```

MediaBox

The MediaBox is for complete pages including items that will be physically trimmed from the final product like crop marks, registration marks, etc.

CropBox

The CropBox defines the region that a *PDF* is expected to display or print.

BleedBox

The BleedBox determines the region to which the page contents expect to be clipped.

TrimBox

The TrimBox defines the intended dimensions of the finished page.

ArtBox

The ArtBox can be used to denote areas where it is considered "safe" to place graphical elements.

This command allows you to make a modified version of a *PDF* with content that falls inside or outside of *defined boxes* removed.

4.3.14 *mutool run*

The `run` command executes a *JavaScript* program, which has access to most of the features of the *MuPDF* library. The command supports *ECMAScript* 5 syntax in strict mode. All of the *MuPDF* constructors and functions live in the global object, and the command line arguments are accessible from the global `scriptArgs` object. The name of the script is in the global `scriptPath` variable.

See the mutool JavaScript API for more.

```
mutool run script.js [ arguments ... ]
```

Note: Command line parameters within square brackets `[]` are optional.

`script.js`
The *JavaScript* file which you would like to run.

Note: See the mutool JavaScript API for more.

`[ arguments ... ]`
If invoked without any arguments, it will drop you into an interactive *REPL* (read-eval-print-loop). To exit this loop type `quit()` (same as pressing *ctrl-C* two times).

JavaScript Shell

Several global functions that are common for command line shells are available:

`gc(report)`
Run the garbage collector to free up memory. Optionally report statistics on the garbage collection.

`load(fileName)`
Load and execute script in "fileName".

`print(...)`
Print arguments to `stdout`, separated by spaces and followed by a newline.

quit()
Exit the shell.

read(fileName)
Read the contents of a file and return them as a *UTF-8* decoded string.

readline()
Read one line of input from `stdin` and return it as a string.

require(module)
Load a *JavaScript* module.

write(...)
Print arguments to `stdout`, separated by spaces.

Example scripts

Create and edit *PDF* documents

Create PDF document from scratch using only low level functions

Listing 1: docs/examples/pdf-create-lowlevel.js

```
// Create a PDF from scratch.

// This example creates a new PDF file from scratch, using only the low level␣
↪APIs.
// This assumes a basic working knowledge of the PDF file format.

// Create a new empty document with no pages.
var pdf = new PDFDocument()

// Create and add a font resource.
var font = pdf.addObject({
        Type: "Font",
        Subtype: "Type1",
        Encoding: "WinAnsiEncoding",
        BaseFont: "Times-Roman",
})

// Create and add an image resource:
var image = pdf.addRawStream(
        // The raw stream contents, hex encoded to match the Filter entry:
        "004488CCEEBB7733>",
        // The image object dictionary:
        {
                Type: "XObject",
                Subtype: "Image",
                Width: 4,
                Height: 2,
                BitsPerComponent: 8,
                ColorSpace: "DeviceGray",
                Filter: "ASCIIHexDecode",
        }
```

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```
);

// Create resource dictionary.
var resources = pdf.addObject({
        Font: { Tm: font },
        XObject: { Im0: image },
})

// Create content stream.
var buffer = new Buffer()
buffer.writeLine("10 10 280 330 re s")
buffer.writeLine("q 200 0 0 200 50 100 cm /Im0 Do Q")
buffer.writeLine("BT /Tm 16 Tf 50 50 TD (Hello, world!) Tj ET")
var contents = pdf.addStream(buffer)

// Create page object.
var page = pdf.addObject({
        Type: "Page",
        MediaBox: [0,0,300,350],
        Contents: contents,
        Resources: resources,
})

// Insert page object into page tree.
var pagetree = pdf.getTrailer().Root.Pages
pagetree.Count = 1
pagetree.Kids = [ page ]
page.Parent = pagetree

// Save the document.
pdf.save("out.pdf")
```

Create PDF document from scratch, using helper functions

Listing 2: docs/examples/pdf-create.js

```
// Create a PDF from scratch using helper functions.

// This example creates a new PDF file from scratch, using helper
// functions to create resources and page objects.
// This assumes a basic working knowledge of the PDF file format.

// Create a new empty document with no pages.
var pdf = new PDFDocument()

// Load built-in font and create WinAnsi encoded simple font resource.
var font = pdf.addSimpleFont(new Font("Times-Roman"))

// Load PNG file and create image resource.
var image = pdf.addImage(new Image("example.png"))
```

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```
// Create resource dictionary.
var resources = pdf.addObject({
        Font: { Tm: font },
        XObject: { Im0: image },
})

// Create content stream data.
var contents =
        "10 10 280 330 re s\n" +
        "q 200 0 0 200 50 100 cm /Im0 Do Q\n" +
        "BT /Tm 16 Tf 50 50 TD (Hello, world!) Tj ET\n"

// Create a new page object.
var page = pdf.addPage([0,0,300,350], 0, resources, contents)

// Insert page object at the end of the document.
pdf.insertPage(-1, page)

// Save the document to file.
pdf.save("out.pdf", "pretty,ascii,compress-images,compress-fonts")
```

Merge pages from multiple PDF documents into one PDF file

Listing 3: docs/examples/pdf-merge.js

```
// A re-implementation of "mutool merge" in JavaScript.

function copyPage(dstDoc, srcDoc, pageNumber, dstFromSrc) {
        var srcPage, dstPage
        srcPage = srcDoc.findPage(pageNumber)
        dstPage = dstDoc.newDictionary()
        dstPage.Type = dstDoc.newName("Page")
        if (srcPage.MediaBox) dstPage.MediaBox = dstFromSrc.
↪graftObject(srcPage.MediaBox)
        if (srcPage.Rotate) dstPage.Rotate = dstFromSrc.graftObject(srcPage.
↪Rotate)
        if (srcPage.Resources) dstPage.Resources = dstFromSrc.
↪graftObject(srcPage.Resources)
        if (srcPage.Contents) dstPage.Contents = dstFromSrc.
↪graftObject(srcPage.Contents)
        dstDoc.insertPage(-1, dstDoc.addObject(dstPage))
}

function copyAllPages(dstDoc, srcDoc) {
        var dstFromSrc = dstDoc.newGraftMap()
        var k, n = srcDoc.countPages()
        for (k = 0; k < n; ++k)
                copyPage(dstDoc, srcDoc, k, dstFromSrc)
}

function pdfmerge() {
```

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```
        var srcDoc, dstDoc, i

        dstDoc = new PDFDocument()
        for (i = 1; i < scriptArgs.length; ++i) {
                srcDoc = Document.openDocument(scriptArgs[i])
                copyAllPages(dstDoc, srcDoc)
        }
        dstDoc.save(scriptArgs[0], "compress")
}

if (scriptArgs.length < 2)
        print("usage: mutool run pdf-merge.js output.pdf input1.pdf input2.pdf␣
↪...")
else
        pdfmerge()
```

Graphics and the device interface

Draw all pages in a document to PNG files

Listing 4: docs/examples/draw-document.js

```
// Draw all pages in a document and save them as PNG files.

var doc = Document.openDocument(scriptArgs[0]);
var n = doc.countPages();
for (var i = 0; i < n; ++i) {
        var page = doc.loadPage(i);
        var pixmap = page.toPixmap(Matrix.identity, ColorSpace.DeviceRGB);
        pixmap.saveAsPNG("out" + (i+1) + ".png");
}
```

Use device API to draw graphics and save as a PNG file

Listing 5: docs/examples/draw-device.js

```
// Use device interface to draw some graphics and save as a PNG.

var font = new Font("Times-Roman");
var image = new Image("huntingofthesnark.png");
var path, text;

var pixmap = new Pixmap(ColorSpace.DeviceRGB, [0,0,500,600], false);
pixmap.clear(255);
var device = new DrawDevice(Matrix.identity, pixmap);
var transform = [2,0,0,2,0,0]
{
        text = new Text();
        {
                text.showString(font, [16,0,0,-16,100,30], "Hello, world!");
```

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```
                text.showString(font, [0,16,16,0,15,100], "Hello, world!");
        }
        device.fillText(text, transform, ColorSpace.DeviceGray, [0], 1);

        path = new Path();
        {
                path.moveTo(10, 10);
                path.lineTo(90, 10);
                path.lineTo(90, 90);
                path.lineTo(10, 90);
                path.closePath();
        }
        device.fillPath(path, false, transform, ColorSpace.DeviceRGB, [1,0,0],␣
↪1);
        device.strokePath(path, {dashes:[5,10], lineWidth:3, lineCap:'Round'},␣
↪transform, ColorSpace.DeviceRGB, [0,0,0], 1);

        path = new Path();
        {
                path.moveTo(100,100);
                path.curveTo(150,100, 200,150, 200,200);
                path.curveTo(200,300, 0,300, 100,100);
                path.closePath();
        }
        device.clipPath(path, true, transform);
        {
                device.fillImage(image, Matrix.concat(transform, [300,0,0,300,
↪0,0]), 1);
        }
        device.popClip();
}
device.close();

pixmap.saveAsPNG("out.png");
```

Implement a device in JavaScript

Listing 6: docs/examples/trace-device.js

```
var Q = JSON.stringify

var pathPrinter = {
        moveTo: function (x,y) { print("moveTo", x, y) },
        lineTo: function (x,y) { print("lineTo", x, y) },
        curveTo: function (x1,y1,x2,y2,x3,y3) { print("curveTo", x1, y1, x2,␣
↪y2, x3, y3) },
        closePath: function () { print("closePath") },
}

var textPrinter = {
        beginSpan: function (f,m,wmode, bidi, dir, lang) {
```

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```
                print("beginSpan",f,m,wmode,bidi,dir,repr(lang));
        },
        showGlyph: function (f,m,g,u,v,b) { print("glyph",f,m,g,u,v,b) },
        endSpan: function () { print("endSpan"); }
}

var traceDevice = {
        fillPath: function (path, evenOdd, ctm, colorSpace, color, alpha) {
                print("fillPath", evenOdd, ctm, colorSpace, color, alpha)
                path.walk(pathPrinter)
        },
        clipPath: function (path, evenOdd, ctm) {
                print("clipPath", evenOdd, ctm)
                path.walk(pathPrinter)
        },
        strokePath: function (path, stroke, ctm, colorSpace, color, alpha) {
                print("strokePath", Q(stroke), ctm, colorSpace, color, alpha)
                path.walk(pathPrinter)
        },
        clipStrokePath: function (path, stroke, ctm) {
                print("clipStrokePath", Q(stroke), ctm)
                path.walk(pathPrinter)
        },

        fillText: function (text, ctm, colorSpace, color, alpha) {
                print("fillText", ctm, colorSpace, color, alpha)
                text.walk(textPrinter)
        },
        clipText: function (text, ctm) {
                print("clipText", ctm)
                text.walk(textPrinter)
        },
        strokeText: function (text, stroke, ctm, colorSpace, color, alpha) {
                print("strokeText", Q(stroke), ctm, colorSpace, color, alpha)
                text.walk(textPrinter)
        },
        clipStrokeText: function (text, stroke, ctm) {
                print("clipStrokeText", Q(stroke), ctm)
                text.walk(textPrinter)
        },
        ignoreText: function (text, ctm) {
                print("ignoreText", ctm)
                text.walk(textPrinter)
        },

        fillShade: function (shade, ctm, alpha) {
                print("fillShade", shade, ctm, alpha)
        },
        fillImage: function (image, ctm, alpha) {
                print("fillImage", image, ctm, alpha)
        },
        fillImageMask: function (image, ctm, colorSpace, color, alpha) {
```

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```
                print("fillImageMask", image, ctm, colorSpace, color, alpha)
        },
        clipImageMask: function (image, ctm) {
                print("clipImageMask", image, ctm)
        },

        beginMask: function (area, luminosity, colorspace, color) {
                print("beginMask", area, luminosity, colorspace, color)
        },
        endMask: function () {
                print("endMask")
        },

        popClip: function () {
                print("popClip")
        },

        beginGroup: function (area, isolated, knockout, blendmode, alpha) {
                print("beginGroup", area, isolated, knockout, blendmode, alpha)
        },
        endGroup: function () {
                print("endGroup")
        },
        beginTile: function (area, view, xstep, ystep, ctm, id) {
                print("beginTile", area, view, xstep, ystep, ctm, id)
                return 0
        },
        endTile: function () {
                print("endTile")
        },
        beginLayer: function (name) {
                print("beginLayer", name)
        },
        endLayer: function () {
                print("endLayer")
        },
        beginStructure: function (structure, raw, uid) {
                print("beginStructure", structure, raw, uiw)
        },
        endStructure: function () {
                print("endStructure")
        },
        beginMetatext: function (meta, metatext) {
                print("beginMetatext", meta, metatext)
        },
        endMetatext: function () {
                print("endMetatext")
        },

        renderFlags: function (set, clear) {
                print("renderFlags", set, clear)
        },
```

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```
        setDefaultColorSpaces: function (colorSpaces) {
                print("setDefaultColorSpaces", colorSpaces.getDefaultGray(),
                colorSpaces.getDefaultRGB(), colorSpaces.getDefaultCMYK(),
                colorSpaces.getOutputIntent())
        },

        close: function () {
                print("close")
        },
}

if (scriptArgs.length != 2)
        print("usage: mutool run trace-device.js document.pdf pageNumber")
else {
        var doc = Document.openDocument(scriptArgs[0]);
        var page = doc.loadPage(parseInt(scriptArgs[1])-1);
        page.run(traceDevice, Matrix.identity);
}
```

Advanced examples

Create a PDF from rendered page thumbnails

Listing 7: docs/examples/create-thumbnail.js

```
// Create a PDF containing thumbnails of pages rendered from another PDF.

var pdf = new PDFDocument()

var subdoc = Document.openDocument("pdfref17.pdf")

var resources = { XObject: {} }

var contents = new Buffer()
for (var i=0; i < 5; ++i) {
        var pixmap = subdoc.loadPage(1140+i).toPixmap([0.2,0,0,0.2,0,0],␣
↪ColorSpace.DeviceRGB, true)
        resources.XObject["Im" + i] = pdf.addImage(new Image(pixmap))
        contents.writeLine("q 100 0 0 150 " + (50+100*i) + " 50 cm /Im" + i +
↪" Do Q")
}

var page = pdf.addPage([0,0,100+i*100,250], 0, resources, contents)
pdf.insertPage(-1, page)

pdf.save("out.pdf")
```

A tool for running *JavaScript* programs with access to the *MuPDF* library functions.

See the JavaScript API for more.

CHAPTER

FIVE

C API

This is the *MuPDF C* API guide for developers. In this document we will guide you through the public and stable bits of the *MuPDF* library. This is intended to both provide an introduction to new developers wanting to use low level features of *MuPDF*, and as a reference guide to the public interface.

We will be explaining the basics, enough to get you started on a single threaded application. There are more functions and data structures used internally, and there are also ways to use *MuPDF* from multiple threads, but those are beyond the scope of this document.

The functions and structures documented in this document are what we consider stable *APIs*. They will rarely change, and if they do, any such changes will be noted in the "api-changes" document along with instructions for how to update your code.

5.1 *MuPDF* modules

MuPDF is separated into several modules.

5.1.1 Core API

The core module contains the runtime context, exception handling, and various string manipulation, math, hash table, binary tree, and other useful functions.

Core API

Almost all functions in the *MuPDF* library take a `fz_context` structure as their first argument. The context is used for many things; primarily it holds the exception stack for our `setjmp` based exception handling. It also holds various caches and auxiliary contexts for font rendering and color management.

The *Fitz* Context

Note: If you wonder where the prefix "fz" and name *Fitz* come from, *MuPDF* originally started out as a prototype of a new rendering library architecture for *Ghostscript*. It was to be a fusion of *libart* and *Ghostscript*. History turned out differently, and the project mutated into a standalone *PDF* renderer now called *MuPDF*. The "fz" prefix for the graphics library and core modules remains to this day.

Here is the code to create a *Fitz* context. The first two arguments are used if you need to use a custom memory allocator, and the third argument is a hint to much memory the various caches should be allowed to grow. The limit is only a soft

limit. We may exceed it, but will start clearing out stale data to try to stay below the limit when possible. Setting it to a lower value will prevent the caches from growing out of hand if you are tight on memory.

```
#include <mupdf/fitz.h>

main()
{
    fz_context *ctx;

    ctx = fz_new_context(NULL, NULL, FZ_STORE_UNLIMITED);
    if (!ctx)
        die("Failed to create a new Fitz context!");

    ... do stuff ...

    fz_drop_context(ctx);
}
```

Error Handling

MuPDF uses a `setjmp` based exception handling system. This is encapsulated by the use of three macros: `fz_try`, `fz_always`, and `fz_catch`. When an error is raised by `fz_throw`, or re-raised by `fz_rethrow`, execution will jump to the enclosing always/catch block.

All functions you call should be guarded by a `fz_try` block to catch the errors, or the program will call `exit()` on errors. You don't want that.

The `fz_always` block is optional. It is typically used to free memory or release resources unconditionally, in both the case when the execution of the try block succeeds, and when an error occurs.

```
fz_try(ctx) {
    // Do stuff that may throw an exception.
}
fz_always(ctx) {
    // This (optional) block is always executed.
}
fz_catch(ctx) {
    // This block is only executed when recovering from an exception.
}
```

Since the `fz_try` macro is based on `setjmp`, the same conditions that apply to local variables in the presence of `setjmp` apply. Any locals written to inside the try block may be restored to their pre-try state when an error occurs. We provide a `fz_var()` macro to guard against this.

In the following example, if we don't guard `buf` with `fz_var`, then when an error occurs the `buf` local variable might have be reset to its pre-try value (`NULL`) and we would leak the memory.

```
char *buf = NULL;
fz_var(buf);
fz_try(ctx) {
    buf = fz_malloc(ctx, 100);
    // Do stuff with buf that may throw an exception.
}
fz_always(ctx) {
```

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```
    fz_free(ctx, buf);
}
fz_catch(ctx) {
    fz_rethrow(ctx);
}
```

Carefully note that you should **never** return from within a `fz_try` or `fz_always block`! Doing so will unbalance the exception stack, and things will go catastrophically wrong. Instead, it is possible to break out of the `fz_try` and `fz_always` block by using a break statement if you want to exit the block early without throwing an exception.

Throwing a new exception can be done with `fz_throw`. Passing an exception along after having cleaned up in the `fz_catch` block can be done with `fz_rethrow`. `fz_throw` takes a `printf`-like formatting string.

```
enum {
    FZ_ERROR_SYSTEM, // fatal out of memory or syscall error
    FZ_ERROR_LIBRARY, // unclassified error from third-party library
    FZ_ERROR_ARGUMENT, // invalid or out-of-range arguments to functions
    FZ_ERROR_LIMIT, // failed because of resource or other hard limits
    FZ_ERROR_UNSUPPORTED, // tried to use an unsupported feature
    FZ_ERROR_FORMAT, // syntax or format errors that are unrecoverable
    FZ_ERROR_SYNTAX, // syntax errors that should be diagnosed and ignored
};
void fz_throw(fz_context *ctx, int error_code, const char *fmt, ...);
void fz_rethrow(fz_context *ctx);
```

Memory Allocation

You should not need to do raw memory allocation using the *Fitz* context, but if you do, here are the functions you need. These work just like the regular *C* functions, but take a *Fitz* context and throw an exception if the allocation fails. They will **not** return `NULL`; either they will succeed or they will throw an exception.

```
void *fz_malloc(fz_context *ctx, size_t size);
void *fz_realloc(fz_context *ctx, void *old, size_t size);
void *fz_calloc(fz_context *ctx, size_t count, size_t size);
void fz_free(fz_context *ctx, void *ptr);
```

There are also some macros that allocate structures and arrays, together with a type cast to catch typing errors.

```
T *fz_malloc_struct(fz_context *ctx, T); // Allocate and zero the memory.
T *fz_malloc_array(fz_context *ctx, size_t count, T); // Allocate uninitialized memory!
T *fz_realloc_array(fz_context *ctx, T *old, size_t count, T);
```

In the rare case that you need an allocation that returns `NULL` on failure, there are variants for that too: `fz_malloc_no_throw`, etc.

Pool Allocator

The pool allocator is used for allocating many small objects that live and die together. All objects allocated from the pool will be freed when the pool is freed.

```
typedef struct { opaque } fz_pool;

fz_pool *fz_new_pool(fz_context *ctx);
void *fz_pool_alloc(fz_context *ctx, fz_pool *pool, size_t size);
char *fz_pool_strdup(fz_context *ctx, fz_pool *pool, const char *s);
void fz_drop_pool(fz_context *ctx, fz_pool *pool);
```

Reference Counting

Most objects in *MuPDF* use reference counting to keep track of when they are no longer used and can be freed. We use the verbs "keep" and "drop" to increment and decrement the reference count. For simplicity, we also use the word "drop" for non-reference counted objects (so that in case we change our minds and decide to add reference counting to an object, the code that uses it need not change).

Hash Table

We have a generic hash table structure with fixed length keys.

The keys and values are not reference counted by the hash table. Callers are responsible for manually taking care of reference counting when inserting and removing values from the table, should that be desired.

```
typedef struct { opaque } fz_hash_table;
```

fz_hash_table *fz_new_hash_table(fz_context *ctx, int initial_size, int key_length, int lock, void (*drop_value)(fz_context *ctx, void *value));
The lock parameter should be zero, any other value will result in unpredictable behavior. The `drop_value` callback function to the constructor is only used to release values when the hash table is destroyed.

void fz_drop_hash_table(fz_context *ctx, fz_hash_table *table);
Free the hash table and call the `drop_value` function on all the values in the table.

void *fz_hash_find(fz_context *ctx, fz_hash_table *table, const void *key);
Find the value associated with the key. Returns `NULL` if not found.

void *fz_hash_insert(fz_context *ctx, fz_hash_table *table, const void *key, void *value);
Insert the value into the hash table. Inserting a duplicate entry will **not** overwrite the old value, it will return the old value instead. Return `NULL` if the value was inserted for the first time. Does not reference count the value!

void fz_hash_remove(fz_context *ctx, fz_hash_table *table, const void *key);
Remove the associated value from the hash table. This will not reference count the value!

void fz_hash_for_each(fz_context *ctx, fz_hash_table *table, void *state, void (*callback)(fz_context *ctx, void *state, void *key, int key_length, void *value);
Iterate and call a function for each key-value pair in the table.

Binary Tree

The `fz_tree` structure is a self-balancing binary tree that maps text strings to values.

`typedef struct { opaque } fz_tree;`

`void *fz_tree_lookup(fz_context *ctx, fz_tree *node, const char *key);`
Look up an entry in the tree. Returns `NULL` if not found.

`fz_tree *fz_tree_insert(fz_context *ctx, fz_tree *root, const char *key, void *value);`
Insert a new entry into the tree. Do not insert duplicate entries. Returns the new root object.

`void fz_drop_tree(fz_context *ctx, fz_tree *node, void (*dropfunc)(fz_context *ctx, void *value));`
Free the tree and all the values in it.

There is no constructor for this structure, since there is no containing root structure. Instead, the insert function returns the new root node. Use `NULL` for the initial empty tree.

```
fz_tree *tree = NULL;
tree = fz_tree_insert(ctx, tree, "A", my_a_obj);
tree = fz_tree_insert(ctx, tree, "B", my_b_obj);
tree = fz_tree_insert(ctx, tree, "C", my_c_obj);
assert(fz_tree_lookup(ctx, tree, "B") == my_b_obj);
```

XML Parser

We have a rudimentary *XML* parser that handles well formed *XML*. It does not do any namespace processing, and it does not validate the *XML* syntax.

The parser supports `UTF-8`, `UTF-16`, `iso-8859-1`, `iso-8859-7`, `koi8`, `windows-1250`, `windows-1251`, and `windows-1252` encoded input.

If `preserve_white` is *false*, we will discard all *whitespace-only* text elements. This is useful for parsing non-text documents such as *XPS* and *SVG*. Preserving whitespace is useful for parsing *XHTML*.

```
typedef struct { opaque } fz_xml_doc;
typedef struct { opaque } fz_xml;

fz_xml_doc *fz_parse_xml(fz_context *ctx, fz_buffer *buf, int preserve_white);
void fz_drop_xml(fz_context *ctx, fz_xml_doc *xml);
fz_xml *fz_xml_root(fz_xml_doc *xml);

fz_xml *fz_xml_prev(fz_xml *item);
fz_xml *fz_xml_next(fz_xml *item);
fz_xml *fz_xml_up(fz_xml *item);
fz_xml *fz_xml_down(fz_xml *item);
```

`int fz_xml_is_tag(fz_xml *item, const char *name);`
Returns *true* if the element is a tag with the given name.

`char *fz_xml_tag(fz_xml *item);`
Returns the tag name if the element is a tag, otherwise `NULL`.

`char *fz_xml_att(fz_xml *item, const char *att);`
Returns the value of the tag element's attribute, or `NULL` if not a tag or missing.

char *fz_xml_text(fz_xml *item);
Returns the UTF-8 text of the text element, or NULL if not a text element.

fz_xml *fz_xml_find(fz_xml *item, const char *tag);
Find the next element with the given tag name. Returns the element itself if it matches, or the first sibling if it doesn't. Returns NULL if there is no sibling with that tag name.

fz_xml *fz_xml_find_next(fz_xml *item, const char *tag);
Find the next sibling element with the given tag name, or NULL if none.

fz_xml *fz_xml_find_down(fz_xml *item, const char *tag);
Find the first child element with the given tag name, or NULL if none.

String Functions

All text strings in *MuPDF* use the UTF-8 encoding. The following functions encode and decode UTF-8 characters, and return the number of bytes used by the UTF-8 character (at most FZ_UTFMAX).

```
enum { FZ_UTFMAX=4 };
int fz_chartorune(int *rune, const char *str);
int fz_runetochar(char *str, int rune);
```

Since many of the *C* string functions are locale dependent, we also provide our own locale independent versions of these functions. We also have a couple of semi-standard functions like strsep and strlcpy that we can't rely on the system providing. These should be pretty self explanatory:

```
char *fz_strdup(fz_context *ctx, const char *s);
float fz_strtof(const char *s, char **es);
char *fz_strsep(char **stringp, const char *delim);
size_t fz_strlcpy(char *dst, const char *src, size_t n);
size_t fz_strlcat(char *dst, const char *src, size_t n);
void *fz_memmem(const void *haystack, size_t haystacklen, const void *needle, size_t␣
↪needlelen);
int fz_strcasecmp(const char *a, const char *b);
```

There are also a couple of functions to process filenames and *URLs*:

char *fz_cleanname(char *path);
Rewrite path in-place to the shortest string that names the same path. Eliminates multiple and trailing slashes, and interprets "." and "..".

void fz_dirname(char *dir, const char *path, size_t dir_size);
Extract the directory component from a path.

char *fz_urldecode(char *url);
Decode *URL* escapes in-place.

String Formatting

Our `printf` family handles the common `printf` formatting characters, with a few minor differences. We also support several non-standard formatting characters. The same `printf` syntax is used in the `printf` functions in the *I/O* module as well.

```
size_t fz_vsnprintf(char *buffer, size_t space, const char *fmt, va_list args);
size_t fz_snprintf(char *buffer, size_t space, const char *fmt, ...);
char *fz_asprintf(fz_context *ctx, const char *fmt, ...);
```

%%, %c, %e, %f, %p, %x, %d, %u, %s
: These behave as usual, but only take padding (+,0,space), width, and precision arguments.

%g float
: Prints the `float` in the shortest possible format that won't lose precision, except `NaN` to `0`, `+Inf` to `FLT_MAX`, `-Inf` to `-FLT_MAX`.

%M fz_matrix*
: Prints all 6 coefficients in the matrix as `%g` separated by spaces.

%R fz_rect*
: Prints all `x0`, `y0`, `x1`, `y1` in the rectangle as `%g` separated by spaces.

%P fz_point*
: Prints `x`, `y` in the point as `%g` separated by spaces.

%C int
: Formats character as `UTF-8`. Useful to print unicode text.

%q char*
: Formats string using double quotes and C escapes.

%(char*
: Formats string using parenthesis quotes and *Postscript* escapes.

%n char*
: Formats string using prefix `/` and *PDF* name hex-escapes.

Math Functions

We obviously need to deal with lots of points, rectangles, and transformations in *MuPDF*.

Points are fairly self evident. The `fz_make_point` utility function is for use with *Visual Studio* that doesn't yet support the *C99* struct initializer syntax.

```
typedef struct {
    float x, y;
} fz_point;

fz_point fz_make_point(float x, float y);
```

Rectangles are represented by two pairs of coordinates. The `x0`, `y0` pair have the smallest values, and in the normal coordinate space used by *MuPDF* that is the upper left corner. The `x1`, `y1` pair have the largest values, typically the lower right corner.

In order to represent an infinite unbounded area, we use an `x0` that is larger than the `x1`.

```
typedef struct {
    float x0, y0;
    float x1, y1;
} fz_rect;

const fz_rect fz_infinite_rect = { 1, 1, -1, -1 };
const fz_rect fz_empty_rect = { 0, 0, 0, 0 };
const fz_rect fz_unit_rect = { 0, 0, 1, 1 };

fz_rect fz_make_rect(float x0, float y0, float x1, float y1);
```

Our matrix structure is a row-major 3x3 matrix with the last column always `[ 0 0 1 ]`. This is represented as a struct with six fields, in the same order as in *PDF* and *Postscript*. The identity matrix is a global constant, for easy access.

```
/ a b 0 \
| c d 0 |
\ e f 1 /
```

```
typedef struct {
    float a, b, c, d, e, f;
} fz_matrix;

const fz_matrix fz_identity = { 1, 0, 0, 1, 0, 0 };

fz_matrix fz_make_matrix(float a, float b, float c, float d, float e, float f);
```

Sometimes we need to represent a non-axis aligned rectangular-ish area, such as the area covered by some rotated text. For this we use a quad representation, using a points for each of the upper/lower/left/right corners as seen from the reading direction of the text represented.

```
typedef struct {
    fz_point ul, ur, ll, lr;
} fz_quad;
```

List of math functions

These are simple mathematical operations that can not throw errors, so do not need a context argument.

`float fz_abs(float f);`
Abs for float.

`float fz_min(float a, float b);`
Min for float.

`float fz_max(float a, float b);`
Max for float.

`float fz_clamp(float f, float min, float max);`
Clamp for float.

`int fz_absi(int i);`
Abs for integer.

`int fz_mini(int a, int b);`
Min for integer.

`int fz_maxi(int a, int b);`
Max for integer.

`int fz_clampi(int i, int min, int max);`
Clamp for integer.

`int fz_is_empty_rect(fz_rect r);`
Returns whether the supplied `fz_rect` is empty.

`int fz_is_infinite_rect(fz_rect r);`
Returns whether the supplied `fz_rect` is infinite.

`fz_matrix fz_concat(fz_matrix left, fz_matrix right);`
Concat two matrices and returns a new matrix.

`fz_matrix fz_scale(float sx, float sy);`
Scale.

`fz_matrix fz_shear(float sx, float sy);`
Shear.

`fz_matrix fz_rotate(float degrees);`
Rotate.

`fz_matrix fz_translate(float tx, float ty);`
Translate.

`fz_matrix fz_invert_matrix(fz_matrix matrix);`
Invert a matrix.

`fz_point fz_transform_point(fz_point point, fz_matrix m);`
Transform a point according to the given matrix.

`fz_point fz_transform_vector(fz_point vector, fz_matrix m);`
Transform a vector according to the given matrix (ignores translation).

`fz_rect fz_transform_rect(fz_rect rect, fz_matrix m);`
Transform a `fz_rect` according to the given matrix.

`fz_quad fz_transform_quad(fz_quad q, fz_matrix m);`
Transform a `fz_quad` according to the given matrix.

`int fz_is_point_inside_rect(fz_point p, fz_rect r);`
Returns whether the point is inside the supplied `fz_rect`.

`int fz_is_point_inside_quad(fz_point p, fz_quad q);`
Returns whether the point is inside the supplied `fz_quad`.

`fz_matrix fz_transform_page(fz_rect mediabox, float resolution, float rotate);`
Create a transform matrix to draw a page at a given resolution and rotation. The scaling factors are adjusted so that the page covers a whole number of pixels. Resolution is given in dots per inch. Rotation is expressed in degrees (`0`, `90`, `180`, and `270` are valid values).

5.1.2 I/O

The I/O module contains structures and functions for buffers of data, reading and writing to streams, compression, and encryption.

I/O API

Buffers

In order to represent a generic chunks of data we use the `fz_buffer` structure.

```
typedef struct {
    unsigned char *data;
    size_t len; // current length
    size_t cap; // total capacity
    ... reserved internal fields ...
} fz_buffer;

fz_buffer *fz_keep_buffer(fz_context *ctx, fz_buffer *buf);
void fz_drop_buffer(fz_context *ctx, fz_buffer *buf);
```

There are many ways to create a buffer. Some create a buffer shared immutable data, others with data you can edit, and others by copying or decoding other data.

fz_buffer *fz_new_buffer(fz_context *ctx, size_t capacity);
Create a new empty buffer, with the given initial capacity.

fz_buffer *fz_new_buffer_from_shared_data(fz_context *ctx, const unsigned char *data, size_t size);
Create a new buffer wrapping the given data pointer. The data is only referenced, and will not be freed when the buffer is destroyed. The data pointer must **not** change or disappear while the buffer lives.

fz_buffer *fz_new_buffer_from_copied_data(fz_context *ctx, const unsigned char *data, size_t size);
Create a buffer containing a copy of the data pointed to.

fz_buffer *fz_new_buffer_from_base64(fz_context *ctx, const char *data, size_t size);
Create a buffer containing the decoded `BASE64` data.

Sometimes you want to create buffers piece by piece by appending strings or other data to it, while dynamically growing the underlying storage.

```
void fz_append_data(fz_context *ctx, fz_buffer *buf, const void *data, size_t len);
void fz_append_string(fz_context *ctx, fz_buffer *buf, const char *string);
void fz_append_byte(fz_context *ctx, fz_buffer *buf, int byte);
void fz_append_rune(fz_context *ctx, fz_buffer *buf, int rune);
void fz_append_int16_be(fz_context *ctx, fz_buffer *buf, int x);
void fz_append_int16_le(fz_context *ctx, fz_buffer *buf, int x);
void fz_append_int32_be(fz_context *ctx, fz_buffer *buf, int x);
void fz_append_int32_le(fz_context *ctx, fz_buffer *buf, int x);
void fz_append_printf(fz_context *ctx, fz_buffer *buffer, const char *fmt, ...);
void fz_append_vprintf(fz_context *ctx, fz_buffer *buffer, const char *fmt, va_list␣
↪args);
```

You can also write a bit stream with the following functions. The buffer length always covers all the bits in the buffer, including any unused ones in the last byte, which will always be zero.

void fz_append_bits(fz_context *ctx, fz_buffer *buf, int value, int count);
Write the lower count bits from value into the buffer.

void fz_append_bits_pad(fz_context *ctx, fz_buffer *buf);
Write enough zero bits to be byte aligned.

You can use the buffer data as a zero-terminated C string by calling the following function. This will ensure that there is a zero terminator after the last byte and return a pointer to the first byte. This pointer is only borrowed, and should only be used briefly, before the buffer is changed again (which may reallocate or free the data).

const char *fz_string_from_buffer(fz_context *ctx, fz_buffer *buf);
You can also read and write the contents of a buffer to file.

fz_buffer *fz_read_file(fz_context *ctx, const char *filename);
Read the contents of a file into a buffer.

void fz_save_buffer(fz_context *ctx, fz_buffer *buf, const char *filename);
Save the contents of a buffer to a file.

Input Streams and Filters

An input stream reads data from a source. Some stream types can decompress and decrypt data, and these streams can be chained together in a pipeline.

```
typedef struct { internal } fz_stream;

fz_stream *fz_keep_stream(fz_context *ctx, fz_stream *stm);
void fz_drop_stream(fz_context *ctx, fz_stream *stm);
```

fz_stream *fz_open_file(fz_context *ctx, const char *filename);
Open a stream reading the contents of a file.

fz_stream *fz_open_memory(fz_context *ctx, const unsigned char *data, size_t len);
Open a stream reading from the data pointer.

fz_stream *fz_open_buffer(fz_context *ctx, fz_buffer *buf);
Open a stream reading from a buffer.

The basic stream operations you expect are available.

```
int64_t fz_tell(fz_context *ctx, fz_stream *stm);
void fz_seek(fz_context *ctx, fz_stream *stm, int64_t offset, int whence);
size_t fz_read(fz_context *ctx, fz_stream *stm, unsigned char *data, size_t len);
size_t fz_skip(fz_context *ctx, fz_stream *stm, size_t len);
```

fz_buffer *fz_read_all(fz_context *ctx, fz_stream *stm, size_t initial);
Read the remaining data into a new buffer.

char *fz_read_line(fz_context *ctx, fz_stream *stm, char *buf, size_t n);
Behaves like `fgets()`.

```
int fz_read_byte(fz_context *ctx, fz_stream *stm);
int fz_peek_byte(fz_context *ctx, fz_stream *stm);
int fz_is_eof(fz_context *ctx, fz_stream *stm);
```

You can read binary data one integer at a time. The default is big endian, but *LE* versions are also provided.

```
uint16_t fz_read_uint16(fz_context *ctx, fz_stream *stm);
uint32_t fz_read_uint24(fz_context *ctx, fz_stream *stm);
uint32_t fz_read_uint32(fz_context *ctx, fz_stream *stm);
uint64_t fz_read_uint64(fz_context *ctx, fz_stream *stm);

uint16_t fz_read_uint16_le(fz_context *ctx, fz_stream *stm);
```

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```
uint32_t fz_read_uint24_le(fz_context *ctx, fz_stream *stm);
uint32_t fz_read_uint32_le(fz_context *ctx, fz_stream *stm);
uint64_t fz_read_uint64_le(fz_context *ctx, fz_stream *stm);

int16_t fz_read_int16(fz_context *ctx, fz_stream *stm);
int32_t fz_read_int32(fz_context *ctx, fz_stream *stm);
int64_t fz_read_int64(fz_context *ctx, fz_stream *stm);

int16_t fz_read_int16_le(fz_context *ctx, fz_stream *stm);
int32_t fz_read_int32_le(fz_context *ctx, fz_stream *stm);
int64_t fz_read_int64_le(fz_context *ctx, fz_stream *stm);
```

Reading bit streams is also possible:

```
unsigned int fz_read_bits(fz_context *ctx, fz_stream *stm, int n);
unsigned int fz_read_rbits(fz_context *ctx, fz_stream *stm, int n);
void fz_sync_bits(fz_context *ctx, fz_stream *stm);
int fz_is_eof_bits(fz_context *ctx, fz_stream *stm);
```

Various decoding, decompression, and decryption filters can be chained together.

```
fz_stream *fz_open_null_filter(fz_context *ctx, fz_stream *chain, int len, int64_t␣
↪offset);
fz_stream *fz_open_arc4(fz_context *ctx, fz_stream *chain, unsigned char *key, unsigned␣
↪keylen);
fz_stream *fz_open_aesd(fz_context *ctx, fz_stream *chain, unsigned char *key, unsigned␣
↪keylen);
fz_stream *fz_open_a85d(fz_context *ctx, fz_stream *chain);
fz_stream *fz_open_ahxd(fz_context *ctx, fz_stream *chain);
fz_stream *fz_open_rld(fz_context *ctx, fz_stream *chain);
fz_stream *fz_open_flated(fz_context *ctx, fz_stream *chain, int window_bits);

fz_stream *fz_open_dctd(fz_context *ctx, fz_stream *chain,
    int color_transform,
    int invert_cmyk,
    int l2factor,
    fz_stream *jpegtables);

fz_stream *fz_open_faxd(fz_context *ctx, fz_stream *chain,
    int k,
    int end_of_line,
    int encoded_byte_align,
    int columns,
    int rows,
    int end_of_block,
    int black_is_1);

fz_stream *fz_open_lzwd(fz_context *ctx, fz_stream *chain,
    int early_change,
    int min_bits,
    int reverse_bits,
    int old_tiff);
```

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```
fz_stream *fz_open_predict(fz_context *ctx, fz_stream *chain,
    int predictor,
    int columns,
    int colors,
    int bpc);
```

Output Streams and Filters

Output streams let us write data to a sink, usually a file on disk or a buffer. As with the input streams, output streams can be chained together to compress, encrypt, and encode data.

```
typedef struct { internal } fz_output;
```

Because output may be buffered in the writer, we need a separate close function to ensure that an output stream is properly flushed and any end of data markers are written. This is separate to the drop function, which just frees data. If a writing operation has succeeded, you need to call close on the output stream before dropping it. If you encounter an error while writing data, you can just drop the stream directly, since we couldn't finish writing it and closing it properly would be irrelevant.

```
void fz_close_output(fz_context *ctx, fz_output *out);
void fz_drop_output(fz_context *ctx, fz_output *out);
```

Outputs can be created to write to files or buffers. You can also implement your own data sink by providing a state pointer and callback functions.

```
fz_output *fz_new_output_with_path(fz_context *, const char *filename, int append);
fz_output *fz_new_output_with_buffer(fz_context *ctx, fz_buffer *buf);

fz_output *fz_new_output(fz_context *ctx,
    int buffer_size,
    void *state,
    void (*write)(fz_context *ctx, void *state, const void *data, size_t n),
    void (*close)(fz_context *ctx, void *state),
    void (*drop)(fz_context *ctx, void *state));
```

The usual suspects are available, as well as functions to write integers of various sizes and byte orders.

void fz_seek_output(fz_context *ctx, fz_output *out, int64_t off, int whence);
Seek to a location in the output. This is not available for all output types.

int64_t fz_tell_output(fz_context *ctx, fz_output *out);
Tell the current write location of the output stream.

```
void fz_write_data(fz_context *ctx, fz_output *out, const void *data, size_t size);
void fz_write_string(fz_context *ctx, fz_output *out, const char *s);
void fz_write_byte(fz_context *ctx, fz_output *out, unsigned char x);
void fz_write_rune(fz_context *ctx, fz_output *out, int rune);
void fz_write_int16_be(fz_context *ctx, fz_output *out, int x);
void fz_write_int16_le(fz_context *ctx, fz_output *out, int x);
void fz_write_int32_be(fz_context *ctx, fz_output *out, int x);
void fz_write_int32_le(fz_context *ctx, fz_output *out, int x);
void fz_write_printf(fz_context *ctx, fz_output *out, const char *fmt, ...);
```

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```
void fz_write_vprintf(fz_context *ctx, fz_output *out, const char *fmt, va_list ap);
void fz_write_base64(fz_context *ctx, fz_output *out, const unsigned char *data, size_t␣
↪size, int newline);
```

Output streams can be chained together to add encryption, compression, and encoding. Note that these do not take ownership of the chained stream, they only write to it. For example, you can write a header, create a compression filter stream, write some data to the filter to compress the data, close the filter and then keep writing more data to the original stream.

```
fz_output *fz_new_arc4_output(fz_context *ctx, fz_output *chain, unsigned char *key,␣
↪size_t keylen);
fz_output *fz_new_ascii85_output(fz_context *ctx, fz_output *chain);
fz_output *fz_new_asciihex_output(fz_context *ctx, fz_output *chain);
fz_output *fz_new_deflate_output(fz_context *ctx, fz_output *chain, int effort, int no_
↪header);
fz_output *fz_new_rle_output(fz_context *ctx, fz_output *chain);
```

File Archives

The archive structure is a read-only collection of files. This is typically a *Zip* file or directory on disk, but other formats are also supported.

```
typedef struct { internal } fz_archive;

void fz_drop_archive(fz_context *ctx, fz_archive *arch);

int fz_is_directory(fz_context *ctx, const char *path);

fz_archive *fz_open_directory(fz_context *ctx, const char *path);
fz_archive *fz_open_archive(fz_context *ctx, const char *filename);
fz_archive *fz_open_archive_with_stream(fz_context *ctx, fz_stream *file);

int fz_count_archive_entries(fz_context *ctx, fz_archive *arch);
const char *fz_list_archive_entry(fz_context *ctx, fz_archive *arch, int idx);

int fz_has_archive_entry(fz_context *ctx, fz_archive *arch, const char *name);
fz_stream *fz_open_archive_entry(fz_context *ctx, fz_archive *arch, const char *name);
fz_buffer *fz_read_archive_entry(fz_context *ctx, fz_archive *arch, const char *name);
```

We can also create new *Zip* archives.

```
typedef struct { internal } fz_zip_writer;

fz_zip_writer *fz_new_zip_writer(fz_context *ctx, const char *filename);
fz_zip_writer *fz_new_zip_writer_with_output(fz_context *ctx, fz_output *out);
void fz_write_zip_entry(fz_context *ctx, fz_zip_writer *zip, const char *name, fz_buffer␣
↪*buf, int compress);
void fz_close_zip_writer(fz_context *ctx, fz_zip_writer *zip);
void fz_drop_zip_writer(fz_context *ctx, fz_zip_writer *zip);
```

5.1.3 Graphics

The graphics module contains graphic resource objects like colors, fonts, shadings, and images.

Graphics API

This module is a grab bag of various graphics related objects and functions.

Colors

Colors throughout *MuPDF* are represented as a float vector associated with a `colorspace` object. `Colorspaces` come in many variants, the most common of which are *Gray*, *RGB*, and *CMYK*. We also support *Indexed* (palette), *L*a*b**, *Separation*, *DeviceN*, and *ICC* based colorspaces.

```
enum { FZ_MAX_COLORS = 32 };

enum fz_colorspace_type {
   FZ_COLORSPACE_NONE,
   FZ_COLORSPACE_GRAY,
   FZ_COLORSPACE_RGB,
   FZ_COLORSPACE_BGR,
   FZ_COLORSPACE_CMYK,
   FZ_COLORSPACE_LAB,
   FZ_COLORSPACE_INDEXED,
   FZ_COLORSPACE_SEPARATION,
};

struct fz_colorspace_s {
   enum fz_colorspace_type type;
   int n;
   char *name;
   private internal fields
};

fz_colorspace *fz_keep_colorspace(fz_context *ctx, fz_colorspace *colorspace);
void fz_drop_colorspace(fz_context *ctx, fz_colorspace *colorspace);
```

Most colorspace` have color components between `0` and `1`. The number of components a color uses is given by the 'n' field of the colorspace. This is at most `FZ_MAX_COLORS`.

*L*a*b** colors have a range of `0..100` for the *L** and `-128..127` for *a** and *b**.

CMYK, *Separation*, and *DeviceN* colorspaces are subtractive colorspaces. *Separation* and *DeviceN* colorspaces also have a tint transform function and a base colorspace used to represent the colors when rendering to a device that does not have these specific colorants.

Color management engine

MuPDF is usually built with a color management engine, but this can be turned off at runtime if you need faster performance at the cost of much more inaccurate color conversions.

```
int fz_enable_icc(fz_context *ctx);
int fz_disable_icc(fz_context *ctx);
```

The various color conversion functions also take certain parameters that the color management engine uses, such as rendering intent and overprint control.

```
enum {
   FZ_RI_PERCEPTUAL,
   FZ_RI_RELATIVE_COLORIMETRIC,
   FZ_RI_SATURATION,
   FZ_RI_ABSOLUTE_COLORIMETRIC,
};

typedef struct {
   int ri; // Rendering intent
   int bp; // Black point compensation
   int op;
   int opm;
} fz_color_params;

const fz_color_params fz_default_color_params = { FZ_RI_RELATIVE_COLORIMETRIC, 1, 0, 0 };
```

Device colorspaces

When you need to define a color, and don't care too much about the calibration, you can use the *Device* colorspaces. When *MuPDF* is built with a color management engine and *ICC* is enabled the *Gray* and *RGB* colorspaces use an *sRGB ICC* profile.

```
fz_colorspace *fz_device_gray(fz_context *ctx);
fz_colorspace *fz_device_rgb(fz_context *ctx);
fz_colorspace *fz_device_bgr(fz_context *ctx);
fz_colorspace *fz_device_cmyk(fz_context *ctx);
fz_colorspace *fz_device_lab(fz_context *ctx);
```

BGR is present to allow you to render to pixmaps that have the *RGB* components in a different order, so that the data can be passed directly to the operating system for drawing without needing yet another conversion step.

Indexed colorspaces

Indexed colors have a range of `0..N` where `N` is one less than the number of colors in the palette. An indexed colorspace also has a base colorspace, which is used to define the palette of colors used.

```
fz_colorspace *fz_new_indexed_colorspace(fz_context *ctx,
   fz_colorspace *base,
   int high,
   unsigned char *lookup);
```

High is the maximum value in the palette; i.e. one less than the number of colors.

The lookup argument is a packed array of color values in the base colorspace, represented as bytes mapped to the range of `0..255`.

ICC colorspaces

You can create *ICC* colorspaces from a buffer containing the *ICC* profile.

```
fz_colorspace *fz_new_icc_colorspace(fz_context *ctx,
   enum fz_colorspace_type type,
   int flags,
   const char *name,
   fz_buffer *buf);
```

The `type` argument can be `NONE` if you want to automatically infer the colorspace type from the profile data. If the type is anything else, then an error will be thrown if the profile does not match the type.

Color converters

There are several ways to convert colors. The easiest is to call a function, but if you are converting many colors at once, it will be faster to use a color converter object.

```
void fz_convert_color(fz_context *ctx,
fz_colorspace *src_colorspace,
const float *src_color,
fz_colorspace *dst_colorspace,
float *dst_color,
fz_colorspace *proof_colorspace,
const fz_color_params params);
typedef struct {
void (*convert)(fz_context *ctx, fz_color_converter *cc, const float *src, float *dst);
private internal fields
} fz_color_converter;

void fz_find_color_converter(fz_context *ctx, fz_color_converter *cc,
fz_colorspace *src_colorspace,
fz_colorspace *dst_colorspace,
fz_colorspace *proof_colorspace,
fz_color_params params);
void fz_drop_color_converter(fz_context *ctx, fz_color_converter *cc);
```

Here is some sample code to do a one-off *CMYK* to *RGB* color conversion.

```
float cmyk[4] = { 1, 0, 0, 0 };
float rgb[3];
fz_convert_color(ctx, fz_device_cmyk(ctx), cmyk, fz_device_rgb(ctx), rgb, NULL, fz_
↪default_color_params(ctx));
```

Here is some sample code to do repeated *CMYK* to *RGB* color conversions on many colors using a color converter object.

```
float cmyk[100][4] = { {1,0,0,0}, ...
float rgb[100][3];
int i;
fz_color_converter cc;
fz_find_color_converter(ctx, &cc, fz_device_cmyk(ctx), fz_device_rgb(ctx), NULL, fz_
↪default_color_params(ctx));
for (i = 0; i < 100; ++i)
   cc.convert(ctx, &cc, cmyk[i], rgb[i]);
fz_drop_color_converter(ctx, &cc);
```

Pixmaps

A pixmap is an 8-bit per component raster image. Each pixel is packed with process colorants, spot colors, and alpha channel in that order. If an alpha channel is present, the process colorants are pre-multiplied with the alpha value.

```
typedef struct {
   int w, h; // Width and height
   int x, y; // X and Y offset
   int n; // Number of components in total (colors + spots + alpha)
   int s; // Number of components that are spot colors
   int alpha; // True if alpha channel is present
   int stride; // Number of bytes per row
   int xres, yres; // Resolution in dots per inch.
   fz_colorspace *colorspace; // Colorspace of samples, or NULL if alpha only pixmap.
   unsigned char *samples;
   private internal fields
} fz_pixmap;

fz_pixmap *fz_keep_pixmap(fz_context *ctx, fz_pixmap *pix);
void fz_drop_pixmap(fz_context *ctx, fz_pixmap *pix);
```

There are too many pixmap constructors. Here is the only one you should need.

```
fz_pixmap *fz_new_pixmap(fz_context *ctx, fz_colorspace *cs, int w, int h, fz_
↪separations *seps, int alpha);
```

A newly created pixmap has uninitialized data. The samples must either be cleared or overwritten with existing data before the pixmap can be safely used.

void fz_clear_pixmap(fz_context *ctx, fz_pixmap *pix);
Clear the pixmap to black.

void fz_clear_pixmap_with_value(fz_context *ctx, fz_pixmap *pix, int value);
Clear the pixmap to a grayscale value `0..255`, where `0` is black and `255` is white. The value is automatically inverted for subtractive colorspaces.

void fz_fill_pixmap_with_color(fz_context *ctx, fz_pixmap *pix, fz_colorspace *colorspace, float *color, fz_color_params color_params);
Fill the pixmap with a solid color.

void fz_unpack_tile(fz_context *ctx, fz_pixmap *dst, unsigned char *src, int n, int depth, size_t stride, int scale);
Unpack pixel values from source data to fill in the pixmap samples. `n` is the number of samples per pixel, `depth` is the bit depth (`1`, `2`, `4`, `8`, `16`, `24`, or `32`), `stride` is the number of bytes per row. If *`scale`* is non-zero, it is the scaling factor to apply to the input samples to map them to the 8-bpc pixmap range. Pass 1 to the scale for

indexed images, and 0 for everything else. If there are more components in the source data than the destination, they will be dropped. If there are fewer components in the source data, the pixmap will be padded with 255.

Some functions can create a pixmap and initialize its samples in one go:

```
fz_pixmap *fz_new_pixmap_from_8bpp_data(fz_context *ctx, int x, int y, int w, int h,␣
↪unsigned char *data, int stride);
fz_pixmap *fz_new_pixmap_from_1bpp_data(fz_context *ctx, int x, int y, int w, int h,␣
↪unsigned char *data, int stride);
```

Pixmaps can be tinted, inverted, scaled, gamma corrected, and converted to other colorspaces.

void fz_invert_pixmap(fz_context *ctx, fz_pixmap *pix);
Invert the pixmap samples.

void fz_tint_pixmap(fz_context *ctx, fz_pixmap *pix, int black, int white);
Map black to black and white to white. The black and white colors are represented as a packed *RGB* integer. 0xFFFFFF is white, 0xFF0000 is red, and 0x000000 is black.

void fz_gamma_pixmap(fz_context *ctx, fz_pixmap *pix, float gamma);
Apply a gamma correction curve on the samples. A typical use is to adjust the gamma curve on an inverted image by applying a correction factor of 1/1.4.

fz_pixmap *fz_convert_pixmap(fz_context *ctx, fz_pixmap *source_pixmap, fz_colorspace *destination_colorspace, fz_colorspace *proof_colorspace, fz_default_colorspaces *default_cs, fz_color_params color_params, int keep_alpha);
Convert the source pixmap into the destination colorspace. Pass NULL for the default_cs parameter.

fz_pixmap *fz_scale_pixmap(fz_context *ctx, fz_pixmap *src, float x, float y, float w, float h, const fz_irect *clip);
Scale the pixmap up or down in size to fit the rectangle. Will return NULL if the scaling factors are out of range. This applies fancy filtering and will anti-alias the edges for subpixel positioning if using non-integer coordinates. If the clip rectangle is set, the returned pixmap may be subset to fit the clip rectangle. Pass NULL to the clip if you want the whole pixmap scaled.

5.1.4 Device

The device interface is how we provide access to the contents of a document. A device is a callback structure, that gets called for each piece of text, line art, and image on a page. There are several device implementations. The most important one renders the contents to a raster image, and another one gathers all the text into a structure that can be used to select and copy and search the text content on a page.

5.1.5 Document

The document module handles reading and writing documents in various formats, and ties together all the preceding modules to provide rendering, format conversion, and search functionality for the document types we support.

5.1.6 PDF

The PDF module provides access to the low level PDF structure, letting you query, modify, and create PDF objects and streams. It allows you to create new documents, modify existing documents, or examine features, extract data, or do almost anything you could want at the PDF object and stream level that we don't provide with the higher level APIs.

CHAPTER

SIX

MUPDF & JAVASCRIPT

MuPDF can be used in two ways with *Javascript* as follows:

- With `mutool run`.
- With mupdf.js package for *Node* and browsers.

Both usages are, in fact, very similar and here we show code samples and the API for both.

APIs generally work for both environments, however if an API is specific to only one usage, then it is marked with the or .

Note:

- In the code examples, if you are developing for `mutool run` then the `mupdf` prefix is optional.
- `mutool run` supports *ECMAScript 5* syntax in strict mode, but not *ECMAScript 6* and above.

6.1 Class A-Z Index

- Archive
- Buffer
- ColorSpace
- Device
- Document
- DocumentWriter
- DisplayList
- DisplayListDevice
- DrawDevice
- Image
- Font
- Link
- OutlineIterator
- Page
- Path

- PDFAnnotation
- PDFDocument
- PDFGraftMap
- PDFObject
- PDFPage
- PDFWidget
- Pixmap
- Story
- StrokeState
- StructuredText
- Text
- XML

6.2 Matrices and Rectangles

These objects are not instantiated as such. All dimensions are in points unless otherwise specified.

6.2.1 Matrices

Matrices are simply 6-element arrays representing a 3-by-3 transformation matrix as:

```
/ a b 0 \
| c d 0 |
\ e f 1 /
```

This matrix is represented in *JavaScript* as `[a,b,c,d,e,f]`.

Matrix

Properties

`identity`

The identity matrix, short hand for `[1,0,0,1,0,0]`.

```
var m = mupdf.Matrix.identity;
```

Methods

`scale`(*sx*, *sy*)

Returns a scaling matrix, short hand for `[sx,0,0,sy,0,0]`.

Arguments

- **sx** – X scale as a floating point number.
- **sy** – Y scale as a floating point number.

Returns
[a,b,c,d,e,f].

```
var m = mupdf.Matrix.scale(2,2);
```

translate(*tx*, *ty*)

Return a translation matrix, short hand for [1,0,0,1,tx,ty].

Arguments

- **tx** – X translation as a floating point number.
- **ty** – Y translation as a floating point number.

Returns
[a,b,c,d,e,f].

```
var m = mupdf.Matrix.translate(2,2);
```

rotate(*theta*)

Return a rotation matrix, short hand for [cos(theta),sin(theta),-sin(theta),cos(theta),0,0].

Arguments

- **theta** – Rotation value.

Returns
[a,b,c,d,e,f].

```
var m = mupdf.Matrix.rotate(90);
```

concat(*a*, *b*)

Concatenate matrices a and b. Bear in mind that matrix multiplication is not commutative.

Arguments

- **a** – Matrix "a".
- **b** – Matrix "b".

Returns
[a,b,c,d,e,f].

```
var m = mupdf.Matrix.concat([1,1,1,1,1,1], [2,2,2,2,2,2]);
```

invert(*matrix*)

Inverts the supplied matrix and returns the result.

Arguments

- **matrix** – Matrix array.

Returns
[a,b,c,d,e,f].

```
var m = mupdf.Matrix.invert([1,0.5,1,1,1,1]);
```

6.2.2 Rectangles

Rectangles are 4-element arrays, specifying the minimum and maximum corners (typically upper left and lower right, in a coordinate space with the origin at the top left with descending y): `[ulx,uly,lrx,lry]`. Rectangles are always X- and Y-axis aligned.

If the minimum x coordinate is bigger than the maximum x coordinate, *MuPDF* treats the rectangle as infinite in size.

Rect

Methods

isEmpty(*rect*)

Returns a boolean indicating if the rectangle is empty or not.

Arguments

- **rect** – Rectangle array.

Returns

Boolean.

```
var isEmpty = mupdf.Rect.isEmpty([0,0,0,0]); // true
var isEmpty = mupdf.Rect.isEmpty([0,0,100,100]); // false
```

isValid(*rect*)

Returns a boolean indicating if the rectangle is valid or not. Rectangles are considered "invalid" if `lrx < ulx` and/or if `lry < uly`.

Arguments

- **rect** – Rectangle array.

Returns

Boolean.

```
var isValid = mupdf.Rect.isValid([0,0,100,100]); // true
var isValid = mupdf.Rect.isValid([0,0,-100,100]); // false
```

isInfinite(*rect*)

Returns a boolean indicating if the rectangle is infinite or not.

Arguments

- **rect** – Rectangle array.

Returns

Boolean.

```
var isInfinite = mupdf.Rect.isInfinite([0x80000000,0x80000000,0x7fffff80,
↪0x7fffff80]); //true
var isInfinite = mupdf.Rect.isInfinite([0,0,100,100]); // false
```

transform(*rect*, *matrix*)

Returns a rectangle generated by transforming the supplied `rect` by the `matrix`.

Arguments

- **rect** – Rectangle array.
- **matrix** – Matrix array.

Returns

`[ulx,uly,lrx,lry]`.

```
var m = mupdf.Rect.transform([0,0,100,100], [1,0.5,1,1,1,1]);
```

6.3 Colors

Colors are specified as arrays with the appropriate number of components for the color space. Each number is a floating point between `0` and `1` for the component value.

Therefore colors are represented as an array of up to 4 component values.

For example:

- In the `DeviceCMYK` color space a color would be `[Cyan,Magenta,Yellow,Black]`. A full magenta color would therefore be `[0,1,0,0]`.
- In the `DeviceRGB` color space a color would be `[Red,Green,Blue]`. A full green color would therefore be `[0,1,0]`.
- In the `DeviceGray` color space a color would be `[Black]`. A full black color would therefore be `[0]`.

6.3.1 Color parameters

This object is a dictionary with keys for:

renderingIntent
Either of "Perceptual", "RelativeColorimetric", "Saturation" or "AbsoluteColorimetric".

blackPointCompensation
True if black point compensation is activated.

overPrinting
True if overprint is activated.

overPrintMode
The overprint mode. Can be either `0` or `1`.

6.3.2 Alpha

Alpha values are floats between `0` and `1`, whereby `0` denotes full transparency & `1` denotes full opacity.

6.4 Object Protocols

The following objects are standard *JavaScript* objects with assumed properties (i.e. they follow their outlined protocol). They are used throughout the *mutool API* to support object types for various methods.

6.4.1 Link Destination Object

A link destination points to a location within a document and how a document viewer should show that destination.

It consists of a dictionary with keys for:

`chapter`
: The chapter within the document.

`page`
: The page within the document.

`type`
: Either “Fit”, “FitB”, “FitH”, “FitBH”, “FitV”, “FitBV”, “FitR” or “XYZ”, controlling which of the keys below exist.

`x`
: The left coordinate, valid for “FitV”, “FitBV”, “FitR” and “XYZ”.

`y`
: The top coordinate, valid for “FitH”, “FitBH”, “FitR” and “XYZ”.

`width`
: The width of the zoomed in region, valid for “XYZ”.

`height`
: The height of the zoomed in region, valid for “XYZ”.

`zoom`
: The zoom factor, valid for “XYZ”.

6.4.2 File Specification Object

This object is used to represent a file.

In order to retrieve information from this object see methods described within Embedded files in PDFs.

6.4.3 Embedded File Object

This `Object` contains metadata about an embedded file, it has properties for:

filename
The name of the embedded file.

mimetype
The *MIME* type of the embedded file, or `undefined` if none exists.

size
The size in bytes of the embedded file contents.

creationDate
The creation date of the embedded file.

modificationDate
The modification date of the embedded file.

6.4.4 PDF Journal Object

This `Object` contains a numbered array of operations and a reference into this list indicating the current position.

position
The current position in the journal.

steps
An array containing the name of each step in the journal.

6.4.5 Stroking State Object

The stroking state is a dictionary with keys for:

- **startCap, dashCap, endCap**
  "Butt", "Round", "Square", or "Triangle".
- **lineCap**
  Set `startCap`, `dashCap`, and `endCap` all at once.
- **lineJoin**
  "Miter", "Round", "Bevel", or "MiterXPS".
- **lineWidth**
  Thickness of the line.
- **miterLimit**
  Maximum ratio of the miter length to line width, before beveling the join instead.
- **dashPhase**
  Starting offset for dash pattern.
- **dashes**
  Array of on/off dash lengths.

```
{dashes:[5,10], lineWidth:3, lineCap:'Round'}
```

6.4.6 Outline Iterator Object

This `Object` has properties for:

`title`
The title of the item.

`uri`
A *URI* pointing to the destination. Likely to be a document internal link that can be resolved by Document.resolveLink(), otherwise a link to a web page.

`open`
True if the item should be opened when shown in a tree view.

6.4.7 Text Layout Object

A description of layouted text value from a text widget with keys:

`matrix`
Normal transform matrix for the layouted text.

`invMatrix`
Inverted transform matrix for the layouted text.

`lines`
An array of text lines belonging to the layouted text, a `lines` object contains:

- `x` The X coordinate for the text line.
- `y` The Y coordinate for the text line.
- `fontSize` The text size used for the layouted text line.
- `index` The index of the beginning of the line in the text string.
- `rect` The bounding rectangle for the text line.
- `chars` An array of characters in the text line.

  A `chars` object contains:

  - `x` The position of the character.
  - `advance` The advance of the character.
  - `index` The index of the character in the text string.
  - `rect` The bounding Rectangle for the character.

6.4.8 Signature Configuration Object

A signature configuration object has properties with `Boolean` values as follows:

`showLabels`
Whether to include both labels and values or just values on the right hand side.

`showDN`
Whether to include the distinguished name on the right hand side.

`showTextName`
Whether to include the name of the signatory on the right hand side.

showDate
Whether to include the date of signing on the right hand side.

showGraphicName
Whether to include the signatory name on the left hand side.

showLogo
Whether to include the *MuPDF* logo in the background.

6.4.9 Placement Result Object

filled
The rectangle of the actual area that was used.

more
True if more content remains to be placed, otherwise *false* if all content fits in the `Story`.

6.4.10 Default Appearance Text Object

font
String representing the font.

size
Integer representing the size of the font.

color
Array representing the color value.

6.5 Buffer

`Buffer` objects are used for working with binary data. They can be used much like arrays, but are much more efficient since they only store bytes.

new Buffer()

Constructor method.

Create a new empty buffer.

Returns
`Buffer`.

```
var buffer = new mupdf.Buffer();
```

new Buffer(*original***)**

Constructor method.

Create a new buffer with a copy of the data from the original buffer.

Arguments

- **original** – `Buffer`.

Returns
Buffer.

```
var buffer = new mupdf.Buffer(buffer);
```

readFile(*fileName*)

Constructor method.

Create a new buffer with the contents of a file.

Arguments

- **fileName** – The path to the file to read.

Returns
Buffer.

```
var buffer = mupdf.readFile("my_file.pdf");
```

length

The number of bytes in the buffer. Read-only.

[n]

Read/write the byte at index 'n'. Will throw exceptions on out of bounds accesses.

```
var byte = buffer[0];
```

getLength()

Returns the number of bytes in the buffer. Read-only.

Returns
Integer.

```
var length = buffer.getLength();
```

writeByte(*b*)

Append a single byte to the end of the buffer.

Arguments

- **b** – The byte value. Only the least significant 8 bits of the value are appended to the buffer.

```
buffer.writeByte(0x2a);
```

readByte(*at*)

Read the byte at the supplied index.

Arguments

- **at** – Integer.

```
buffer.readByte(0);
```

writeRune(*c*)

Encode a unicode character as UTF-8 and append to the end of the buffer.

Arguments

- **c** – The character unicode codepoint.

```
buffer.writeRune(0x4f60); // To append U+4f60
buffer.writeRune(0x597d); // To append U+597d
buffer.writeRune(0xff01); // To append U+ff01
```

writeLine(...)

Append arguments to the end of the buffer, separated by spaces, ending with a newline.

Arguments

- **...** – List of arguments.

```
buffer.writeLine("a line");
```

write(...)

Append arguments to the end of the buffer, separated by spaces.

Arguments

- **...** – List of arguments.

```
buffer.write("hello", "world");
```

writeBuffer(*data*)

Append the contents of the `data` buffer to the end of the buffer.

Arguments

- **data** – Data buffer.

```
buffer.writeBuffer(anotherBuffer);
```

slice(*start end*)

Create a new buffer containing a (subset of) the data in this buffer. Start and end are offsets from the beginning of this buffer, and if negative from the end of this buffer.

Arguments

- **start** – Start index.
- **end** – End index.

Returns
Buffer.

```
var buffer = new Buffer();
buffer.write("hello", "world"); // buffer contains "hello world"
var newBuffer = buffer.slice(1, -1); // newBuffer contains "ello worl"
```

save(*fileName*)

Write the contents of the buffer to a file.

Arguments

- **fileName** – Filename to save to.

```
buffer.save("my_buffer_filename");
```

asUint8Array()

Returns the buffer as a Uint8Array.

Returns
Uint8Array.

```
var arr = buffer.asUint8Array();
```

asString()

Returns the buffer as a String.

Returns
String.

```
var str = buffer.asString();
```

6.6 Document

MuPDF can open many document types (*PDF*, *XPS*, *CBZ*, *EPUB*, *FB2* and a handful of image formats).

new Document.**openDocument**(*fileName*, *fileType*)

Constructor method.

Open the named document.

Arguments

- **fileName** – File name to open.
- **fileType** – File type.

Returns

Document.

```
var document = new mupdf.Document.openDocument("my_pdf.pdf", "application/pdf");
```

needsPassword()

Returns *true* if a password is required to open a password protected PDF.

Returns

Boolean.

```
var needsPassword = document.needsPassword();
```

authenticatePassword(*password*)

Returns a bitfield value against the password authentication result.

Arguments

- **password** – The password to attempt authentication with.

Returns

Integer.

Bitfield value	Description
0	Failed
1	No password needed
2	Is User password and is okay
4	Is Owner password and is okay
6	Is both User & Owner password and is okay

```
var auth = document.authenticatePassword("abracadabra");
```

hasPermission(*permission*)

Returns *true* if the document has permission for the supplied permission String parameter.

Arguments

- **permission** – String The permission to seek for, e.g. "edit".

Returns
Boolean.

String	Description
print	Can print
edit	Can edit
copy	Can copy
annotate	Can annotate
form	Can fill out forms
accessibility	Can copy for accessibility
assemble	Can manage document pages
print-hq	Can print high-quality

```
var canEdit = document.hasPermission("edit");
```

getMetaData(*key*)

Return various meta data information. The common keys are: format, encryption, info:ModDate, and info:Title.

Arguments

- **key** – String.

Returns
String.

```
var format = document.getMetaData("format");
var modificationDate = doc.getMetaData("info:ModDate");
var author = doc.getMetaData("info:Author");
```

setMetaData(*key*, *value*)

Set document meta data information field to a new value.

Arguments

- **key** – String.
- **value** – String.

```
document.setMetaData("info:Author", "My Name");
```

isReflowable()

Returns true if the document is reflowable, such as *EPUB*, *FB2* or *XHTML*.

Returns
Boolean.

```
var isReflowable = document.isReflowable();
```

Note: This will always return `false` in the *WASM* context as there is no *HTML/EPUB* support in *WASM*.

layout(*pageWidth*, *pageHeight*, *fontSize*)

Layout a reflowable document (*EPUB*, *FB2*, or *XHTML*) to fit the specified page and font size.

Arguments

- **pageWidth** – Int.
- **pageHeight** – Int.
- **fontSize** – Int.

```
document.layout(300,300,16);
```

countPages()

Count the number of pages in the document. This may change if you call the layout function with different parameters.

Returns
Int.

```
var numPages = document.countPages();
```

loadPage(*number*)

Returns a *Page* (or *PDFPage*) object for the given page number. Page number zero (0) is the first page in the document.

Returns
Page or PDFPage.

```
var page = document.loadPage(0); // loads the 1st page of the document
```

loadOutline()

Returns an array with the outline (also known as "table of contents" or "bookmarks"). In the array is an object for each heading with the property 'title', and a property 'page' containing the page number. If the object has a 'down' property, it contains an array with all the sub-headings for that entry.

Returns
[...].

```
var outline = document.loadOutline();
```

outlineIterator()

Returns an OutlineIterator for the document outline.

Returns
OutlineIterator.

```
var obj = document.outlineIterator();
```

resolveLink(*uri*)

Resolve a document internal link *URI* to a link destination.

Arguments

- **uri** – String.

Returns

Link destination.

```
var linkDestination = document.resolveLink(my_link);
```

isPDF()

Returns *true* if the document is a *PDF* document.

Returns

Boolean.

```
var isPDF = document.isPDF();
```

formatLinkURI(*linkDestination*)

Format a document internal link destination object to a *URI* string suitable for createLink().

Arguments

- **linkDestination** – Link destination.

Returns

String.

```
var uri = document.formatLinkURI({chapter:0, page:42,
        type:"FitV", x:0, y:0, width:100, height:50, zoom:1});
document.createLink([0,0,100,100], uri);
```

6.7 Page

The base class for a PDF Page.

getBounds()

Returns a rectangle containing the page dimensions.

Returns

[ulx,uly,lrx,lry].

```
var rect = page.getBounds();
```

run(*device*, *matrix*)

Calls device functions for all the contents on the page, using the specified transform matrix. The `device` can be one of the built-in devices or a *JavaScript* object with methods for the device calls. The `matrix` maps from user space points to device space pixels.

Arguments

- **device** – The device object.
- **matrix** – `[a,b,c,d,e,f]`. The transform matrix.

```
page.run(obj, mupdf.Matrix.identity);
```

runPageContents(*device*, *matrix*)

This is the same as the run method above but it only considers the page itself and omits annotations and widgets.

Arguments

- **device** – The device object.
- **matrix** – `[a,b,c,d,e,f]`. The transform matrix.

```
page.runPageContents(obj, mupdf.Matrix.identity);
```

runPageAnnots(*device*, *matrix*)

This is the same as the run method above but it only considers the page annotations.

Arguments

- **device** – The device object.
- **matrix** – `[a,b,c,d,e,f]`. The transform matrix.

```
page.runPageAnnots(obj, mupdf.Matrix.identity);
```

runPageWidgets(*device*, *matrix*)

This is the same as the run method above but it only considers the page widgets.

Arguments

- **device** – The device object.
- **matrix** – `[a,b,c,d,e,f]`. The transform matrix.

```
page.runPageWidgets(obj, mupdf.Matrix.identity);
```

toPixmap(*matrix*, *colorspace*, *alpha*, *showExtras*)

Render the page into a Pixmap, using the specified transform matrix and `colorspace`. If `alpha` is *true*, the page will be drawn on a transparent background, otherwise white. If `showExtras` is *true* then the operation will include any page annotations and/or widgets.

Arguments

- **matrix** – `[a,b,c,d,e,f]`. The transform matrix.
- **colorspace** – `ColorSpace`.
- **alpha** – `Boolean`.
- **showExtras** – `Boolean`.

Returns
`Pixmap`.

Note: In *MuPDF WASM* `alpha` & `showExtras` default to *true* unless otherwise specified. In *mutool run* `alpha` defaults to *false* and `showExtras` defaults to *true* unless otherwise specified.

```
var pixmap = page.toPixmap(mupdf.Matrix.identity, mupdf.ColorSpace.DeviceRGB, true,␣
↪true);
```

`toDisplayList`(*showExtras*)

Record the contents on the page into a DisplayList. If `showExtras` is *true* then the operation will include any page annotations and/or widgets.

Arguments

- **showExtras** – `Boolean`.

Returns
`DisplayList`.

Note: In both *MuPDF WASM* and *mutool run* `showExtras` defaults to *true* unless otherwise specified.

```
var displayList = page.toDisplayList(true);
```

`toStructuredText`(*options*)

Extract the text on the page into a `StructuredText` object. The options argument is a comma separated list of flags: "preserve-ligatures", "preserve-whitespace", "preserve-spans", and "preserve-images".

Arguments

- **options** – `String`.

Returns
`StructuredText`.

```
var sText = page.toStructuredText("preserve-whitespace");
```

`search`(*needle*, *max_hits*)

Search the page text for all instances of the `needle` value, and return an array of search hits. Each search hit is an array of rectangles corresponding to all characters in the search hit.

Arguments

- **needle** – `String`.

- **max_hits** – Integer Defaults to 500 unless otherwise specified.

Returns
[...].

```
var results = page.search("my search phrase");
```

Note: The numbers are [ulx, uly, urx, ury, llx, lly, lrx, lry] for each rectangle against each result. These type of rectangles are know as "Quads" or "QuadPoints" in the *PDF* specification.

getLinks()

Return an array of all the links on the page. Each link is an object with a 'bounds' property, and either a 'page' or 'uri' property, depending on whether it's an internal or external link. See: Link.

Returns
[...].

```
var links = page.getLinks();
var link = links[0];
var linkDestination = doc.resolveLink(link)
```

Note: If there are no links then an empty array is returned.

createLink(*rect*, *destinationUri*)

Create a new link within the rectangle on the page, linking to the destination URI string.

Arguments

- **rect** – Rectangle for the link.
- **destinationUri** – String containing URI.

Returns
Link.

```
var link = page.createLink([0,0,100,100], "https://example.com");
```

deleteLink(*link*)

Delete the link from the page.

Arguments

- **link** – Link.

```
page.deleteLink(link_obj);
```

getLabel()

Returns the page number as a string using the numbering scheme of the document.

Returns
String.

```
var label = page.getLabel();
```

isPDF()

Returns *true* if the page is from a *PDF* document.

Returns
Boolean.

```
var isPDF = page.isPDF();
```

Note: As PDFPage extends Page this method will return **false**. It is only if we actually have an instance of a PDFPage when this method is overridden to return **true**.

6.8 Link

Link objects contain information about page links.

getBounds()

Returns a rectangle describing the link's location on the page.

Returns
[ulx,uly,lrx,lry].

```
var rect = link.getBounds();
```

getURI()

Returns a string URI describing the link's destination. If isExternal returns *true*, this is a URI for a suitable browser, if it returns *false* pass it to resolveLink to access to the destination page in the document.

Returns
String.

```
var uri = link.getURI();
```

isExternal()

Returns a boolean indicating if the link is external or not. If the link URI has a valid scheme followed by : then it considered to be external, e.g. https://example.com.

Returns
Boolean.

```
var isExternal = link.isExternal();
```

6.9 StructuredText

`StructuredText` objects hold text from a page that has been analyzed and grouped into blocks, lines and spans. To obtain a `StructuredText` instance use Page toStructuredText().

search(*needle*)

Search the text for all instances of `needle`, and return an array with all matches found on the page.

Each match in the result is an array containing one or more QuadPoints that cover the matching text.

Arguments

- **needle** – `String`.

Returns

`[...]`.

```
var result = sText.search("Hello World!");
```

highlight(*p*, *q*)

Return an array with rectangles needed to highlight a selection defined by the start and end points.

Arguments

- **p** – Start point in format `[x,y]`.
- **q** – End point in format `[x,y]`.

Returns

`[...]`.

```
var result = sText.highlight([100,100], [200,100]);
```

copy(*p*, *q*)

Return the text from the selection defined by the start and end points.

Arguments

- **p** – Start point in format `[x,y]`.
- **q** – End point in format `[x,y]`.

Returns

`String`.

```
var result = sText.copy([100,100], [200,100]);
```

walk(*walker*)

Arguments

- **walker** – Function with protocol methods, see example below for details.

Walk through the blocks (images or text blocks) of the structured text. For each text block walk over its lines of text, and for each line each of its characters. For each block, line or character the walker will have a method called.

```
var stext = pdfPage.toStructuredText();
stext.walk({
    beginLine: function (bbox, wmode, direction) {
        console.log("beginLine", bbox, wmode, direction);
    },
    beginTextBlock: function (bbox) {
        console.log("beginTextBlock", bbox);
    },
    endLine: function () {
        console.log("endLine");
    },
    endTextBlock: function () {
        console.log("endTextBlock");
    },
    onChar: function (utf, origin, font, size, quad, color) {
        console.log("onChar", utf, origin, font, size, quad, color);
    },
    onImageBlock: function (bbox, transform, image) {
        console.log("onImageBlock", bbox, transform, image);
    },
});
```

Note: On `beginLine` the direction parameter is a vector (e.g. `[0, 1]`) and can you can calculate the rotation as an angle with some trigonometry on the vector.

asJSON(*scale*)

Returns the instance in *JSON* format.

Arguments

- **scale** – `Float` Default: 1. Multiply all the coordinates by this

factor to get the coordinates at another resolution. :return: `String`.

```
var json = sText.asJSON();
```

6.10 ColorSpace

Properties

`DeviceGray`

The default grayscale colorspace.

`DeviceRGB`

The default RGB colorspace.

`DeviceBGR`

The default RGB colorspace, but with components in reverse order.

`DeviceCMYK`

The default CMYK colorspace.

`DeviceLab`

The default Lab colorspace.

Methods

new ColorSpace(*from*, *name*)

Constructor method.

Create a new `ColorSpace`.

Arguments

- **from** – A buffer containing an ICC profile.
- **name** – A user descriptive name.

Returns
`ColorSpace`.

```
var icc_colorspace = new mupdf.ColorSpace(fs.readFileSync("SWOP.icc"), "SWOP");
```

getNumberOfComponents()

A grayscale colorspace has one component, RGB has 3, CMYK has 4, and DeviceN may have any number of components.

```
var cs = mupdf.ColorSpace.DeviceRGB;
var num = cs.getNumberOfComponents(); // 3
```

toString()

Return name of `ColorSpace`.

Returns
`String`.

```
var cs = mupdf.ColorSpace.DeviceRGB;
var num = cs.toString(); // "DeviceRGB"
```

isGray()

Returns true if the object is a gray color space.

Returns
Boolean.

```
var bool = colorSpace.isGray();
```

isRGB()

Returns true if the object is an RGB color space.

Returns
Boolean.

```
var bool = colorSpace.isRGB();
```

isCMYK()

Returns true if the object is a CMYK color space.

Returns
Boolean.

```
var bool = colorSpace.isCMYK();
```

isIndexed()

Returns true if the object is an Indexed color space.

Returns
Boolean.

```
var bool = colorSpace.isIndexed();
```

isLab()

Returns true if the object is a Lab color space.

Returns
Boolean.

```
var bool = colorSpace.isLab();
```

isDeviceN()

Returns true if the object is a Device N color space.

Returns
Boolean.

```
var bool = colorSpace.isDeviceN();
```

isSubtractive()

Returns true if the object is a subtractive color space.

Returns
Boolean.

```
var bool = colorSpace.isSubtractive();
```

getType()

Returns a string indicating the type.

Returns
`String` One of "None", "Gray", "RGB", "BGR", "CMYK", "Lab", "Indexed", "Separation".

6.11 DefaultColorSpaces

`DefaultColorSpaces` is an object with keys for:

getDefaultGray()

Get the default gray colorspace.

Returns
`ColorSpace`.

getDefaultRGB()

Get the default RGB colorspace.

Returns
`ColorSpace`.

getDefaultCMYK()

Get the default CMYK colorspace.

Returns
`ColorSpace`.

getOutputIntent()

Get the output intent.

Returns
`ColorSpace`.

setDefaultGray(*colorspace*)

Arguments

- **colorspace** – `ColorSpace`.

setDefaultRGB(*colorspace*)

Arguments

- **colorspace** – `ColorSpace`.

setDefaultCMYK(*colorspace*)

Arguments

- **colorspace** – `ColorSpace`.

setOutputIntent(*colorspace*)

Arguments

- **colorspace** – `ColorSpace`.

6.12 Pixmap

A Pixmap object contains a color raster image (short for pixel map). The components in a pixel in the Pixmap are all byte values, with the transparency as the last component. A Pixmap also has a location (x, y) in addition to its size; so that they can easily be used to represent tiles of a page.

new Pixmap(*colorspace*, *bounds*, *alpha*)

Constructor method.

Create a new pixmap. The pixel data is **not** initialized; and will contain garbage.

Arguments

- **colorspace** – ColorSpace.
- **bounds** – [ulx,uly,lrx,lry] Rectangle.
- **alpha** – Boolean.

Returns

Pixmap.

```
var pixmap = new mupdf.Pixmap(mupdf.ColorSpace.DeviceRGB, [0,0,100,100], true);
```

clear(*value*)

Clear the pixels to the specified value. Pass 255 for white, or omit for transparent.

Arguments

- **value** – Pixel value.

```
pixmap.clear(255);
pixmap.clear();
```

getBounds()

Return the pixmap bounds.

Returns

[ulx,uly,lrx,lry] Rectangle.

```
var rect = pixmap.getBounds();
```

getWidth()

Returns

Int The width value.

```
var w = pixmap.getWidth();
```

getHeight()

Returns
Int The height value.

```
var h = pixmap.getHeight();
```

getNumberOfComponents()

Number of colors; plus one if an alpha channel is present.

Returns
Int Number of color components.

```
var num = pixmap.getNumberOfComponents();
```

getAlpha()

True if alpha channel is present.

Returns
Boolean.

```
var alpha = pixmap.getAlpha();
```

getStride()

Number of bytes per row.

Returns
Int.

```
var stride = pixmap.getStride();
```

getColorSpace()

Returns the ColorSpace for the Pixmap.

Returns
ColorSpace.

```
var cs = pixmap.getColorSpace();
```

setResolution(*xRes*, *yRes*)

Set x & y resolution.

Arguments

- **xRes** – Int X resolution in dots per inch.
- **yRes** – Int Y resolution in dots per inch.

```
pixmap.setResolution(300, 300);
```

getXResolution()

Returns the `x` resolution for the `Pixmap`.

Returns
`Int` Resolution in dots per inch.

```
var xRes = pixmap.getXResolution();
```

getYResolution()

Returns the `y` resolution for the `Pixmap`.

Returns
`Int` Resolution in dots per inch.

```
var yRes = pixmap.getYResolution();
```

getSample(*x*, *y*, *index*)

Get the value of component `index` at position `x`, `y` (relative to the image origin: 0, 0 is the top left pixel).

Arguments

- **x** – X co-ordinate.
- **y** – Y co-ordinate.
- **index** – Component index. i.e. For CMYK ColorSpaces 0 = Cyan, for RGB 0 = Red etc.

Returns
`Int`.

```
var sample = pixmap.getSample(0,0,0);
```

saveAsPNG(*fileName*)

Save the `Pixmap` as a *PNG*. Only works for *Gray* and *RGB* images.

Arguments

- **fileName** – `String`.

```
pixmap.saveAsPNG("fileName.png");
```

saveAsJPEG(*fileName*, *quality*)

Save the `Pixmap` as a *JPEG*. Only works for *Gray*, *RGB* and *CMYK* images.

Arguments

- **fileName** – `String`.
- **quality** – `Int`.

```
pixmap.saveAsJPEG("fileName.jpg", 80);
```

saveAsPAM(*fileName*)

Save the Pixmap as a *PAM*.

Arguments

- **fileName** – String.

```
pixmap.saveAsPAM("fileName.pam");
```

saveAsPNM(*fileName*)

Save the Pixmap as a *PNM*. Only works for *Gray* and *RGB* images without alpha.

Arguments

- **fileName** – String.

```
pixmap.saveAsPNM("fileName.pnm");
```

saveAsPBM(*fileName*)

Save the Pixmap as a *PBM*. Only works for *Gray* and *RGB* images without alpha.

Arguments

- **fileName** – String.

```
pixmap.saveAsPBM("fileName.pbm");
```

saveAsPKM(*fileName*)

Save the Pixmap as a *PKM*. Only works for *Gray* and *RGB* images without alpha.

Arguments

- **fileName** – String.

```
pixmap.saveAsPKM("fileName.pkm");
```

invert()

Invert all pixels. All components are processed, except alpha which is unchanged.

```
pixmap.invert();
```

invertLuminance()

Transform all pixels so that luminance of each pixel is inverted, and the chrominance remains as unchanged as possible. All components are processed, except alpha which is unchanged.

```
pixmap.invertLuminance();
```

gamma(*gamma*)

Apply gamma correction to Pixmap. All components are processed, except alpha which is unchanged.

Values >= 0.1 & < 1 = darken, > 1 & < 10 = lighten.

Arguments

- **gamma** – Float.

```
pixmap.gamma(3);
```

tint(*black*, *white*)

Tint all pixels in a *RGB*, *BGR* or *Gray* Pixmap.
Map black and white respectively to the given hex *RGB* values.

Arguments

- **black** – Integer.
- **white** – Integer.

```
pixmap.tint(0xffff00, 0xffff00);
```

warp(*points*, *width*, *height*)

Return a warped subsection of the Pixmap, where the result has the requested dimensions.

Arguments

- **points** – [x0, y0, x1, y1, x2, y2, x3, y3, x4, y4]

Points give the corner points of a convex quadrilateral within the Pixmap to be warped. :arg width: Int. :arg height: Int.

Returns
Pixmap.

```
var warpedPixmap = pixmap.warp([0,0,100,0,0,100,100,100],200,200);
```

convertToColorSpace(*colorspace*, *proof*, *defaultColorSpaces*, *colorParams*, *keepAlpha*)

Convert pixmap into a new pixmap of a desired colorspace. A proofing colorspace, a set of default colorspaces and color parameters used during conversion may be specified. Finally a boolean indicates if alpha should be preserved (default is to not preserve alpha).

Arguments

- **colorspace** – Colorspace.

- **proof** – Colorspace.
- **defaultColorSpaces** – DefaultColorSpaces.
- **colorParams** – [].
- **keepAlpha** – Boolean.

Returns
Pixmap.

getPixels()

Returns an array of pixels for the Pixmap.

Returns
[...].

```
var pixels = pixmap.getPixels();
```

asPNG()

Returns a buffer of the Pixmap as a *PNG*.

Returns
Buffer.

```
var buffer = pixmap.asPNG();
```

asPSD()

Returns a buffer of the Pixmap as a *PSD*.

Returns
Buffer.

```
var buffer = pixmap.asPSD();
```

asPAM()

Returns a buffer of the Pixmap as a *PAM*.

Returns
Buffer.

```
var buffer = pixmap.asPAM();
```

asJPEG(*quality*)

Returns a buffer of the Pixmap as a *JPEG*. Note, if the Pixmap has an alpha channel then an exception will be thrown.

Returns
Buffer.

```
var buffer = pixmap.asJPEG(80);
```

6.13 DrawDevice

The DrawDevice can be used to render to a Pixmap; either by running a Page with it or by calling its methods directly.

new DrawDevice(*transform*, *pixmap*)

Constructor method.

Create a device for drawing into a Pixmap. The Pixmap bounds used should match the transformed page bounds, or you can adjust them to only draw a part of the page.

Arguments

- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **pixmap** – Pixmap.

Returns

DrawDevice.

```
var drawDevice = new mupdf.DrawDevice(mupdf.Matrix.identity, pixmap);
```

6.14 DisplayList

A display list records all the device calls for playback later. If you want to run a page through several devices, or run it multiple times for any other reason, recording the page to a display list and replaying the display list may be a performance gain since then you can avoid reinterpreting the page each time. Be aware though, that a display list will keep all the graphics required in memory, so will increase the amount of memory required.

new DisplayList(*mediabox*)

Constructor method.

Create an empty display list. The mediabox rectangle should be the bounds of the page.

Arguments

- **mediabox** – [ulx,uly,lrx,lry] Rectangle.

Returns

DisplayList.

```
var displayList = new mupdf.DisplayList([0,0,100,100]);
```

run(*device*, *transform*)

Play back the recorded device calls onto the device.

Arguments

- **device** – Device.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

```
displayList.run(device, mupdf.Matrix.identity);
```

getBounds()

Returns a rectangle containing the dimensions of the display list contents.

Returns

[ulx,uly,lrx,lry] Rectangle.

```
var bounds = displayList.getBounds();
```

toPixmap(*transform*, *colorspace*, *alpha*)

Render display list to a Pixmap.

Arguments

- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **colorspace** – ColorSpace.
- **alpha** – Boolean. If alpha is *true*, a transparent background, otherwise white.

Returns

Pixmap.

```
var pixmap = displayList.toPixmap(mupdf.Matrix.identity, mupdf.ColorSpace.DeviceRGB,
↪ false);
```

toStructuredText(*options*)

Extract the text on the page into a StructuredText object. The options argument is a comma separated list of flags: "preserve-ligatures", "preserve-whitespace", "preserve-spans", and "preserve-images".

Arguments

- **options** – String.

Returns

StructuredText.

```
var sText = displayList.toStructuredText("preserve-whitespace");
```

search(*needle*, *max_hits*)

Search the display list text for all instances of the needle value, and return an array of search hits. Each search hit is an array of rectangles corresponding to all characters in the search hit.

Arguments

- **needle** – String.
- **max_hits** – Integer Use to limit number of results, defaults to 500.

Returns
[[Quad, Quad, ...], [Quad, Quad, ...], ...].

```
var results = displayList.search("my search phrase");
```

6.15 DisplayListDevice

new DisplayListDevice(*displayList*)

Constructor method.

Create a device for recording onto a display list.

Arguments

- **displayList** – DisplayList.

Returns
DisplayListDevice.

```
var my_display_list = new mupdf.DisplayList([0,0,100,100]);
console.log("my_display_list="+my_display_list);
var displayListDevice = new mupdf.DisplayListDevice(my_display_list);
```

6.16 Device

All built-in devices have the methods listed below. Any function that accepts a device will also accept a *JavaScript* object with the same methods. Any missing methods are simply ignored, so you only need to create methods for the device calls you care about.

Many of the methods take graphics objects as arguments: Path, Text, Image and Shade.

Colors are specified as arrays with the appropriate number of components for the color space.

The methods that clip graphics must be balanced with a corresponding popClip.

fillPath(*path*, *evenOdd*, *transform*, *colorspace*, *color*, *alpha*, *colorParams*)

Fill a path.

Arguments

- **path** – Path object.
- **evenOdd** – The even odd rule to use.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

- **colorspace** – The ColorSpace.
- **color** – The color value.
- **alpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.fillPath(path, false, mupdf.Matrix.identity, mupdf.ColorSpace.DeviceRGB, [1,
↪0,0], true);
```

strokePath(*path*, *stroke*, *transform*, *colorspace*, *color*, *alpha*, *colorParams*)

Stroke a path.

Arguments

- **path** – Path object.
- **stroke** – StrokeState The stroke state object.
- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **colorspace** – The ColorSpace.
- **color** – The color value.
- **alpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.strokePath(path,
                  {dashes:[5,10], lineWidth:3, lineCap:'Round'},
                  mupdf.Matrix.identity,
                  mupdf.ColorSpace.DeviceRGB,
                  [0,1,0],
                  0.5);
```

clipPath(*path*, *evenOdd*, *transform*)

Clip a path.

Arguments

- **path** – Path object.
- **evenOdd** – The even odd rule to use.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

```
device.clipPath(path, true, mupdf.Matrix.identity);
```

clipStrokePath(*path*, *stroke*, *transform*)

Clip & stroke a path.

Arguments

- **path** – Path object.
- **stroke** – StrokeState The stroke state object.

- **transform** – `[a,b,c,d,e,f]`. The transform matrix.

```
device.clipStrokePath(path, true, mupdf.Matrix.identity);
```

fillText(*text*, *transform*, *colorspace*, *color*, *alpha*, *colorParams*)

Fill a text object.

Arguments

- **text** – `Text` object.
- **transform** – `[a,b,c,d,e,f]`. The transform matrix.
- **colorspace** – The ColorSpace.
- **color** – The color value.
- **alpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.fillText(text, mupdf.Matrix.identity, mupdf.ColorSpace.DeviceRGB, [1,0,0],␣
↪1);
```

strokeText(*text*, *stroke*, *transform*, *colorspace*, *color*, *alpha*, *colorParams*)

Stroke a text object.

Arguments

- **text** – `Text` object.
- **stroke** – `StrokeState` The stroke state object.
- **transform** – `[a,b,c,d,e,f]`. The transform matrix.
- **colorspace** – The ColorSpace.
- **color** – The color value.
- **alpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.strokeText(text,
                  {dashes:[5,10], lineWidth:3, lineCap:'Round'},
                  mupdf.Matrix.identity, mupdf.ColorSpace.DeviceRGB,
                  [1,0,0],
                  1);
```

clipText(*text*, *transform*)

Clip a text object.

Arguments

- **text** – `Text` object.
- **transform** – `[a,b,c,d,e,f]`. The transform matrix.

```
device.clipText(text, mupdf.Matrix.identity);
```

clipStrokeText(*text*, *stroke*, *transform*)

Clip & stroke a text object.

Arguments

- **text** – Text object.
- **stroke** – StrokeState The stroke state object.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

```
device.clipStrokeText(text, {dashes:[5,10], lineWidth:3, lineCap:'Round'},  mupdf.
↪Matrix.identity);
```

ignoreText(*text*, *transform*)

Invisible text that can be searched but should not be visible, such as for overlaying a scanned OCR image.

Arguments

- **text** – Text object.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

```
device.ignoreText(text, mupdf.Matrix.identity);
```

fillShade(*shade*, *transform*, *alpha*, *colorParams*)

Fill a shade (a.k.a. gradient).

Note: The details of gradient fills are not exposed to *JavaScript* yet.

Arguments

- **shade** – The gradient.
- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **alpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.fillShade(shade, mupdf.Matrix.identity, true, {overPrinting:true});
```

fillImage(*image*, *transform*, *alpha*, *colorParams*)

Draw an image. An image always fills a unit rectangle [0,0,1,1], so must be transformed to be placed and drawn at the appropriate size.

Arguments

- **image** – Image object.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

- **alpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.fillImage(image, mupdf.Matrix.identity, false, {overPrinting:true});
```

fillImageMask(*image*, *transform*, *colorspace*, *color*, *alpha*, *colorParams*)

An image mask is an image without color. Fill with the color where the image is opaque.

Arguments

- **image** – Image object.
- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **colorspace** – The ColorSpace.
- **color** – The color value.
- **alpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.fillImageMask(image, mupdf.Matrix.identity, mupdf.ColorSpace.DeviceRGB,␣
↪0xff00ff, true, {});
```

clipImageMask(*image*, *transform*)

Clip graphics using the image to mask the areas to be drawn.

Arguments

- **image** – Image object.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

```
device.clipImageMask(image, mupdf.Matrix.identity);
```

popClip()

Pop the clip mask installed by the last clipping operation.

```
device.popClip();
```

beginMask(*area*, *luminosity*, *backdropColorspace*, *backdropColor*, *backdropAlpha*, *colorParams*)

Create a soft mask. Any drawing commands between beginMask and endMask are grouped and used as a clip mask.

Arguments

- **area** – Path Mask area.
- **luminosity** – Boolean If luminosity is *true*, the mask is derived from the luminosity (grayscale value) of the graphics drawn; otherwise the color is ignored completely and the mask is derived from the alpha of the group.
- **backdropColorspace** – The ColorSpace.

- **backdropColor** – The color value.
- **backdropAlpha** – The alpha value.
- **colorParams** – The color parameters object.

```
device.beginMask(path, true, mupdf.ColorSpace.DeviceRGB, 0xff00ff, false, {});
```

endMask()

Ends the mask.

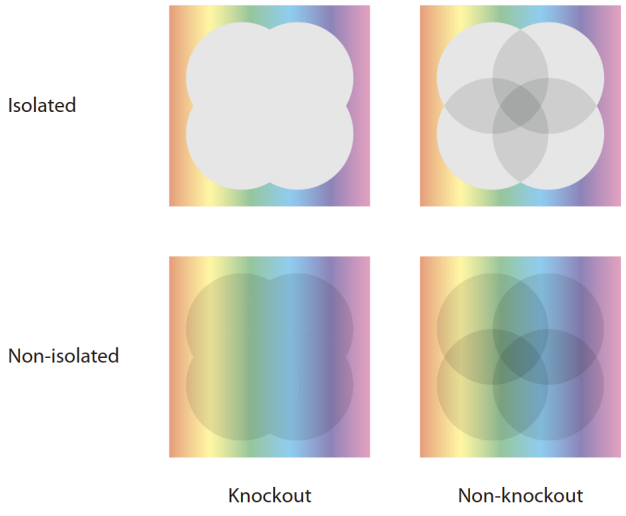
```
device.endMask();
```

beginGroup(*area*, *colorspace*, *isolated*, *knockout*, *blendmode*, *alpha*)

Push/pop a transparency blending group. See the PDF reference for details on `isolated` and `knockout`.

Arguments

- **area** – `[ulx,uly,lrx,lry]` Rectangle. The blend area.
- **colorspace** – ColorSpace.
- **isolated** – `Boolean`.
- **knockout** – `Boolean`.
- **blendmode** – Blendmode is one of the standard *PDF* blend modes: "Normal", "Multiply", "Screen", etc.
- **alpha** – The alpha value.




```
device.beginGroup([0,0,100,100], mupdf.ColorSpace.DeviceRGB, true, true, "Multiply",
↪ 0.5);
```

endGroup()

Ends the blending group.

```
device.endGroup();
```

beginTile(*areaRect*, *viewRect*, *xStep*, *yStep*, *transform*, *id*)

Draw a tiling pattern. Any drawing commands between `beginTile` and `endTile` are grouped and then repeated across the whole page. Apply a clip mask to restrict the pattern to the desired shape.

Arguments

- **areaRect** – `[ulx,uly,lrx,lry]` Rectangle.
- **viewRect** – `[ulx,uly,lrx,lry]` Rectangle.
- **xStep** – `Integer` representing `x` step.
- **yStep** – `Integer` representing `y` step.
- **transform** – `[a,b,c,d,e,f]`. The transform matrix.
- **id** – `Integer` The purpose of `id` is to allow for efficient caching of rendered tiles. If `id` is `0`, then no caching is performed. If it is non-zero, then it assumed to uniquely identify this tile.

```
device.beginTile([0,0,100,100], [100,100,200,200], 10, 10, mupdf.Matrix.identity,␣
↪0);
```

endTile()

Ends the tiling pattern.

```
device.endTile();
```

beginLayer(*tag*)

Begin a marked-content layer with the given tag.

Arguments

- **tag** – `String`.

```
device.beginLayer("my tag");
```

endLayer()

End a marked-content layer.

```
device.endLayer();
```

renderFlags(*set*, *clear*)

Set/clear device rendering flags. Both set and clear are arrays where each element is a flag name:

"mask", "color", "uncacheable", "fillcolor-undefined", "strokecolor-undefined", "startcap-undefined", "dashcap-undefined", "endcap-undefined", "linejoin-undefined", "miterlimit-undefined", "linewidth-undefined", "bbox-defined", or "gridfit-as-tiled".

Arguments

- **set** – [].
- **clear** – [].

```
device.renderFlags(["mask","startcap-undefined"], []);
```

setDefaultColorSpaces(*defaults*)

Change the set of default colorspaces for the device. See the DefaultColorSpaces object.

Arguments

- **defaults** – Object.

```

```

beginStructure(*standard*, *raw*, *uid*)

Begin a standard structure element, the raw tag name and a unique identifier.

Arguments

- **standard** – String. One of the standard *PDF* structure names: "Document", "Part", "BlockQuote", etc.
- **raw** – String. The tag name.
- **uid** – Integer. A unique identifier.

```
device.beginStructure("Document", "my_tag_name", 123);
```

endStructure()

End a standard structure element.

```
device.endStructure();
```

beginMetatext(*type*, *text*)

Begin meta text information.

Arguments

- **type** – String. The type (either of "ActualText", "Alt", "Abbreviation", or "Title")
- **text** – String. The text value.

```
device.beginMetatext("Title", "My title");
```

endMetatext()

End meta text information.

```
device.endMetatext();
```

close()

Tell the device that we are done, and flush any pending output. Ensure that no items are left on the stack before closing.

```
device.close();
```

6.17 Path

A Path object represents vector graphics as drawn by a pen. A path can be either stroked or filled, or used as a clip mask.

new Path()

Constructor method.

Create a new empty path.

Returns

Path.

```
var path = new mupdf.Path();
```

getBounds(*stroke*, *transform*)

Return a bounding rectangle for the path.

Arguments

- **stroke** – Float The stroke for the path.
- **transform** – [a,b,c,d,e,f]. The transform matrix for the path.

Returns

[ulx,uly,lrx,lry] Rectangle.

```
var rect = path.getBounds(1.0, mupdf.Matrix.identity);
```

moveTo(*x*, *y*)

Lift and move the pen to the coordinate.

Arguments

- **x** – X coordinate.
- **y** – Y coordinate.

```
path.moveTo(10, 10);
```

lineTo(*x*, *y*)

Draw a line to the coordinate.

Arguments

- **x** – X coordinate.
- **y** – Y coordinate.

```
path.lineTo(20,20);
```

curveTo(*x1*, *y1*, *x2*, *y2*, *x3*, *y3*)

Draw a cubic bezier curve to (x3, y3) using (x1, y1) and (x2, y2) as control points.

Arguments

- **x1** – X1 coordinate.
- **y1** – Y1 coordinate.
- **x2** – X2 coordinate.
- **y2** – Y2 coordinate.
- **x3** – X3 coordinate.
- **y3** – Y3 coordinate.

```
path.curveTo(0, 0, 10, 10, 100, 100);
```

curveToV(*cx*, *cy*, *ex*, *ey*)

Draw a cubic bezier curve to (ex, ey) using the start point and (cx, cy) as control points.

Arguments

- **cx** – CX coordinate.
- **cy** – CY coordinate.
- **ex** – EX coordinate.
- **ey** – EY coordinate.

```
path.curveToV(0, 0, 100, 100);
```

curveToY(*cx*, *cy*, *ex*, *ey*)

Draw a cubic bezier curve to (ex, ey) using the (cx, cy) and (ex, ey) as control points.

Arguments

- **cx** – CX coordinate.
- **cy** – CY coordinate.
- **ex** – EX coordinate.
- **ey** – EY coordinate.

```
path.curveToY(0, 0, 100, 100);
```

closePath()

Close the path by drawing a line to the last moveTo.

```
path.closePath();
```

rect(*x1*, *y1*, *x2*, *y2*)

Shorthand for moveTo, lineTo, lineTo, lineTo, closePath to draw a rectangle.

Arguments

- **x1** – X1 coordinate.
- **y1** – Y1 coordinate.
- **x2** – X2 coordinate.
- **y2** – Y2 coordinate.

```
path.rect(0,0,100,100);
```

walk(*pathWalker*)

Call moveTo, lineTo, curveTo and closePath methods on the pathWalker object to replay the path.

Arguments

- **pathWalker** – The path walker object. A user definable *JavaScript* object which can be used to trigger your own functions on the path methods.

Note: A path walker object has callback methods that are called when walk() walks over moveTo, lineTo, curveTo and closePath operators in a Path.

```
var myPathWalker = {
    moveTo: function (x, y) {
        //... do whatever ...
    },
    lineTo: function (x, y) {
```

(continues on next page)

(continued from previous page)

```
        //... do whatever ...
    },
}
```

transform(*transform*)

Transform path by the given transform matrix.

Arguments

- **transform** – `[a,b,c,d,e,f]`. The transform matrix for the path.

```
path.transform(mupdf.Matrix.scale(2,2));
```

6.18 Text

A `Text` object contains text.

new Text()

Constructor method.

Create a new empty text object.

Returns

`Text`.

```
var text = new mupdf.Text();
```

showGlyph(*font*, *transform*, *glyph*, *unicode*, *wmode*)

Add a glyph to the text object.

Transform is the text matrix, specifying font size and glyph location. For example: `[size,0,0,-size,x,y]`.

Glyph and unicode may be `-1` for n-to-m cluster mappings. For example, the "fi" ligature would be added in two steps: first the glyph for the 'fi' ligature and the unicode value for 'f'; then glyph `-1` and the unicode value for 'i'.

Arguments

- **font** – `Font` object.
- **transform** – `[a,b,c,d,e,f]`. The transform matrix.
- **glyph** – `Integer`.
- **unicode** – `Integer`.
- **wmode** – `0` for horizontal writing, and `1` for vertical writing.

```
text.showGlyph(new mupdf.Font("Times-Roman"), mupdf.Matrix.identity, 21, 0x66, 0);
text.showGlyph(new mupdf.Font("Times-Roman"), mupdf.Matrix.identity, -1, 0x69, 0);
```

showString(*font*, *transform*, *string*)

Add a simple string to the `Text` object. Will do font substitution if the font does not have all the unicode characters required.

Arguments

- **font** – `Font` object.
- **transform** – `[a,b,c,d,e,f]`. The transform matrix.
- **string** – String content for `Text` object.

```
text.showString(new mupdf.Font("Times-Roman"), mupdf.Matrix.identity, "Hello");
```

walk(*textWalker*)

Call the `showGlyph` method on the `textWalker` object for each glyph in the text object.

Arguments

- **textWalker** – The text walker object. A user definable *JavaScript* object which can be used to trigger your own functions on the text methods.

```
text.walk({
    beginSpan: function (font, transform, wmode, bidilevel, markupdirection,␣
↪language) {
        // ... do whatever ...
    },
    showGlyph: function (font, transform, glyph, unicode, wmode, bidilevel) {
        // ... do whatever ...
    },
    endSpan: function () {
        // ... do whatever ...
    },
});
```

6.19 Font

`Font` objects can be created from *TrueType*, *OpenType*, *Type1* or *CFF* fonts. In *PDF* there are also special *Type3* fonts.

new Font(*ref*)

Constructor method.

Create a new font, either using a built-in font name or a file name.

The built-in standard *PDF* fonts are:

- *Times-Roman*.
- *Times-Italic*.
- *Times-Bold*.
- *Times-BoldItalic*.

- *Helvetica*.
- *Helvetica-Oblique*.
- *Helvetica-Bold*.
- *Helvetica-BoldOblique*.
- *Courier*.
- *Courier-Oblique*.
- *Courier-Bold*.
- *Courier-BoldOblique*.
- *Symbol*.
- *ZapfDingbats*.

The built-in CJK fonts are referenced by language code: `zh-Hant`, `zh-Hans`, `ja`, `ko`.

Arguments

- **ref** – Font name or file name.

Returns
`Font`.

```
var font = new mupdf.Font("Times-Roman");
```

getName()

Get the font name.

Returns
`String`.

```
var name = font.getName();
```

encodeCharacter(*unicode*)

Get the glyph index for a unicode character. Glyph zero (.notdef) is returned if the font does not have a glyph for the character.

Arguments

- **unicode** – The unicode character.

Returns
Glyph index.

```
var index = font.encodeCharacter(0x42);
```

advanceGlyph(*glyph*, *wmode*)

Return advance width for a glyph in either horizontal or vertical writing mode.

Arguments

- **glyph** – The glyph as unicode character.
- **wmode** – 0 for horizontal writing, and 1 for vertical writing.

Returns
Width for the glyph.

```
var width = font.advanceGlyph(0x42, 0);
```

isBold()

Returns *true* if font is bold.

Returns
Boolean.

```
var isBold = font.isBold();
```

isItalic()

Returns *true* if font is italic.

Returns
Boolean.

```
var isItalic = font.isItalic();
```

isMono()

Returns *true* if font is monospaced.

Returns
Boolean.

```
var isMono = font.isMono();
```

isSerif()

Returns *true* if font is serif.

Returns
Boolean.

```
var isSerif = font.isSerif();
```

6.20 Image

Image objects are similar to Pixmaps, but can contain compressed data.

new Image(*ref*)

Constructor method.

Create a new image from a Pixmap data, or load an image file data.

Returns
Image.

```
var imageFromPixmap = new mupdf.Image(pixmap);
var imageFromBuffer = new mupdf.Image(buffer);
```

getWidth()

Get the image width in pixels.

Returns
The width value.

```
var width = image.getWidth();
```

getHeight()

Get the image height in pixels.

Returns
The height value.

```
var height = image.getHeight();
```

getXResolution()

Returns the x resolution for the Image.

Returns
Int Image resolution in dots per inch.

```
var xRes = image.getXResolution();
```

getYResolution()

Returns the y resolution for the Image.

Returns
Int Image resolution in dots per inch.

```
var yRes = image.getYResolution();
```

getColorSpace()

Returns the ColorSpace for the Image.

Returns
ColorSpace.

```
var cs = image.getColorSpace();
```

getNumberOfComponents()

Number of colors; plus one if an alpha channel is present.

Returns
Integer.

```
var num = image.getNumberOfComponents();
```

getBitsPerComponent()

Returns the number of bits per component.

Returns
Integer.

```
var bits = image.getBitsPerComponent();
```

getInterpolate()

Returns *true* if interpolated was used during decoding.

Returns
Boolean.

```
var interpolate = image.getInterpolate();
```

getColorKey()

Returns an array with 2 * N integers for an N component image with color key masking, or null if masking is not used. Each pair of integers define an interval, and component values within that interval are not painted.

Returns
[...] or null.

```
var result = image.getColorKey();
```

getDecode()

Returns an array with 2 * N numbers for an N component image with color mapping, or null if mapping is not used. Each pair of numbers define the lower and upper values to which the component values are mapped linearly.

Returns
[...] or null.

```
var arr = image.getDecode();
```

getOrientation()

Returns the orientation of the image.

Returns
Integer.

```
var orientation = image.getOrientation();
```

setOrientation(*orientation*)

Set the image orientation to the given orientation.

Arguments

- **orientation** – Integer Orientation value from the table below:

0	Undefined
1	0 degree ccw rotation. (Exif = 1)
2	90 degree ccw rotation. (Exif = 8)
3	180 degree ccw rotation. (Exif = 3)
4	270 degree ccw rotation. (Exif = 6)
5	flip on X. (Exif = 2)
6	flip on X, then rotate ccw by 90 degrees. (Exif = 5)
7	flip on X, then rotate ccw by 180 degrees. (Exif = 4)
8	flip on X, then rotate ccw by 270 degrees. (Exif = 7)

```
var orientation = image.setOrientation(4);
```

getImageMask()

Returns *true* if this image is an image mask.

Returns
Boolean.

```
var mask = image.getImageMask();
```

getMask()

Get another Image used as a mask for this one.

Returns
Image (or null).

```
var img = image.getMask();
```

toPixmap(*scaledWidth*, *scaledHeight*)

Create a Pixmap from the image. The scaledWidth and scaledHeight arguments are optional, but may be used to decode a down-scaled Pixmap.

Arguments

- **scaledWidth** – Float.
- **scaledHeight** – Float.

Returns

Pixmap.

```
var pixmap = image.toPixmap();
var scaledPixmap = image.toPixmap(100, 100);
```

6.21 DocumentWriter

DocumentWriter objects are used to create new documents in several formats.

new DocumentWriter(*filename*, *format*, *options*)

Constructor method.

Create a new document writer to create a document with the specified format and output options. If format is null it is inferred from the filename extension. The options argument is a comma separated list of flags and key-value pairs.

The output format & options are the same as in the *mutool convert* command.

Arguments

- **filename** – The file name to output to.
- **format** – The file format.
- **options** – The options as key-value pairs.

Returns

DocumentWriter.

```
var writer = new mupdf.DocumentWriter("out.pdf", "PDF", "");
```

new DocumentWriter(*buffer*, *format*, *options*)

Constructor method.

Create a new document writer to create a document with the specified format and output options. The options argument is a comma separated list of flags and key-value pairs.

The output format & options are the same as in the *mutool convert* command.

Arguments

- **buffer** – The buffer to output to.
- **format** – The file format.
- **options** – The options as key-value pairs.

Returns
DocumentWriter.

```
var writer = new mupdf.DocumentWriter(buffer, "PDF", "");
```

beginPage(*mediabox*)

Begin rendering a new page. Returns a Device that can be used to render the page graphics.

Arguments

- **mediabox** – [ulx,uly,lrx,lry] Rectangle.

Returns
Device.

```
var device = writer.beginPage([0,0,100,100]);
```

endPage(*device*)

Finish the page rendering. The argument must be the same Device object that was returned by the beginPage method.

Arguments

- **device** – Device.

```
writer.endPage(device);
```

close()

Finish the document and flush any pending output.

```
writer.close();
```

6.22 PDFDocument

With *MuPDF* it is also possible to create, edit and manipulate *PDF* documents using low level access to the objects and streams contained in a *PDF* file. A PDFDocument object is also a Document object. You can test a Document object to see if it is safe to use as a PDFDocument by calling document.isPDF().

new PDFDocument()

Constructor method.

Create a new empty *PDF* document.

Returns
PDFDocument.

```
var pdfDocument = new mupdf.PDFDocument();
```

new PDFDocument(*fileName*)

Constructor method.

Load a *PDF* document from file.

Returns
PDFDocument.

```
var pdfDocument = new mupdf.PDFDocument("my-file.pdf");
```

getVersion()

Returns the *PDF* document version as an integer multiplied by 10, so e.g. a PDF-1.4 document would return 14.

Returns
Integer.

```
var version = pdfDocument.getVersion();
```

setLanguage(*lang*)

Sets the language for the document.

Arguments

- **lang** – String.

```
pdfDocument.setLanguage("en");
```

getLanguage()

Gets the language for the document.

Returns
String.

```
var lang = pdfDocument.getLanguage();
```

rearrangePages(*pages*)

Rearrange (re-order and/or delete) pages in the PDFDocument.

The pages in the document will be rearranged according to the input list. Any pages not listed will be removed, and pages may be duplicated by listing them multiple times.

The PDF objects describing removed pages will remain in the file and take up space (and can be recovered by forensic tools) unless you save with the garbage option.

N.B. the PDFDocument should not be used for anything except saving after rearranging the pages (FIXME).

Arguments

- **pages** – An array of page numbers (0-based).

```
var document = new Document.openDocument("my_pdf.pdf");
pdfDocument.rearrangePages([3,2]);
pdfDocument.save("fewer_pages.pdf", "garbage");
```

save(*fileName*, *options*)

Write the PDFDocument to file. The options are a string of comma separated options (see the *mutool convert options*).

Arguments

- **fileName** – The name of the file to save to.
- **options** – The options.

```
pdfDocument.save("my_fileName.pdf", "compress,compress-images,garbage=compact");
```

saveToBuffer(*options*)

Saves the document to a buffer. The options are a string of comma separated options (see the *mutool convert options*).

Arguments

- **options** – The options.

Returns

Buffer.

```
var buffer = pdfDocument.saveToBuffer({"compress-images":true});
```

canBeSavedIncrementally()

Returns *true* if the document can be saved incrementally, e.g. repaired documents or applying redactions prevents incremental saves.

Returns

Boolean.

```
var canBeSavedIncrementally = pdfDocument.canBeSavedIncrementally();
```

countVersions()

Returns the number of versions of the document in a *PDF* file, typically 1 + the number of updates.

Returns

Integer.

```
var versionNum = pdfDocument.countVersions();
```

countUnsavedVersions()

Returns the number of unsaved updates to the document.

Returns
Integer.

```
var unsavedVersionNum = pdfDocument.countUnsavedVersions();
```

validateChangeHistory()

Check the history of the document, return the last version that checks out OK. Returns 0 if the entire history is OK, 1 if the next to last version is OK, but the last version has issues, etc.

Returns
Integer.

```
var changeHistory = pdfDocument.validateChangeHistory();
```

hasUnsavedChanges()

Returns *true* if the document has been saved since it was last opened or saved.

Returns
Boolean.

```
var hasUnsavedChanges = pdfDocument.hasUnsavedChanges();
```

wasPureXFA()

Returns *true* if the document was an *XFA* form without *AcroForm* fields.

Returns
Boolean.

```
var wasPureXFA = pdfDocument.wasPureXFA();
```

wasRepaired()

Returns *true* if the document was repaired when opened.

Returns
Boolean.

```
var wasRepaired = pdfDocument.wasRepaired();
```

setPageLabels(*index*, *style*, *prefix*, *start*)

Sets the page label numbering for the page and all pages following it, until the next page with an attached label.

Arguments

- **index** – Integer.

- **style** – String Can be one of the following strings: "" (none), "D" (decimal), "R" (roman numerals upper-case), "r" (roman numerals lower-case), "A" (alpha upper-case), or "a" (alpha lower-case).
- **prefix** – String.
- **start** – Integer The ordinal with which to start numbering.

```
pdfDocument.setPageLabels(0, "D", "Prefix", 1);
```

deletePageLabels(*index*)

Removes any associated page label from the page.

Arguments

- **index** – Integer.

```
pdfDocument.deletePageLabels(0);
```

getTrailer()

The trailer dictionary. This contains indirect references to the "Root" and "Info" dictionaries. See: PDF object access.

Returns

PDFObject The trailer dictionary.

```
var dict = pdfDocument.getTrailer();
```

countObjects()

Return the number of objects in the *PDF*. Object number 0 is reserved, and may not be used for anything. See: PDF object access.

Returns

Integer Object count.

```
var num = pdfDocument.countObjects();
```

createObject()

Allocate a new numbered object in the *PDF*, and return an indirect reference to it. The object itself is uninitialized.

Returns

The new object.

```
var obj = pdfDocument.createObject();
```

deleteObject(*obj*)

Delete the object referred to by an indirect reference or its object number.

Arguments

- **obj** – The object to delete.

```
pdfDocument.deleteObject(obj);
```

formatURIWithPathAndDest(*path*, *destination*)

Format a link *URI* given a system independent path (see table 3.40 in the 1.7 specification) to a remote document and a destination object or a destination string suitable for createLink().

Arguments

- **path** – String An absolute or relative path to a remote document file.
- **destination** – Link destiation or String referring to a destination using either a destination object or a destination name in the remote document.

appendDestToURI(*uri*, *destination*)

Append a fragment representing a document destination to a an existing *URI* that points to a remote document. The resulting string is suitable for createLink().

Arguments

- **uri** – String An URI to a remote document file.
- **destination** – Link destiation or String referring to a destination using either a destination object or a destination name in the remote document.

6.22.1 *PDF JavaScript* actions

enableJS()

Enable interpretation of document *JavaScript* actions.

```
pdfDocument.enableJS();
```

disableJS()

Disable interpretation of document *JavaScript* actions.

```
pdfDocument.disableJS();
```

isJSSupported()

Returns *true* if interpretation of document *JavaScript* actions is supported.

Returns
Boolean.

```
var jsIsSupported = pdfDocument.isJSSupported();
```

setJSEventListener(*listener*)

Calls the listener whenever a document *JavaScript* action triggers an event.

Arguments

- **listener** – {} The *JavaScript* listener function.

Note: At present this listener will only trigger when a document *JavaScript* action triggers an alert.

```
pdfDocument.setJSEventListener({
        onAlert: function(message) {
                print(message);
        }
});
```

bake(*bakeAnnots*, *bakeWidgets*)

Baking a document changes all the annotations and/or form fields (otherwise known as widgets) in the document into static content. It "bakes" the appearance of the annotations and fields onto the page, before removing the interactive objects so they can no longer be changed.

Effectively this removes the "annotation or "widget" type of these objects, but keeps the appearance of the objects.

Arguments

- **bakeAnnots** – Boolean Whether to bake annotations or not. Defaults to `true`.
- **bakeWidgets** – Boolean Whether to bake widgets or not. Defaults to `true`.

6.22.2 *PDF* Journalling

enableJournal()

Activate journalling for the document.

```
pdfDocument.enableJournal();
```

getJournal()

Returns a PDF Journal Object.

Returns

Object PDF Journal Object.

```
var journal = pdfDocument.getJournal();
```

beginOperation(*op*)

Begin a journal operation.

Arguments

- **length** – String The name of the operation.

```
pdfDocument.beginOperation("my_operation");
```

beginImplicitOperation()

Begin an implicit journal operation. Implicit operations are operations that happen due to other operations, e.g. updating an annotation.

```
pdfDocument.beginImplicitOperation();
```

endOperation()

End a previously started normal or implicit operation. After this it can be undone/redone using the methods below.

```
pdfDocument.beginImplicitOperation();
```

abandonOperation()

Abandon an operation. Reverts to the state before that operation began.

```
pdfDocument.abandonOperation();
```

canUndo()

Returns *true* if undo is possible in this state.

Returns
Boolean.

```
var canUndo = pdfDocument.canUndo();
```

canRedo()

Returns *true* if redo is possible in this state.

Returns
Boolean.

```
var canRedo = pdfDocument.canRedo();
```

undo()

Move backwards in the undo history. Changes to the document after this throws away all subsequent history.

```
pdfDocument.undo();
```

redo()

Move forwards in the undo history.

```
pdfDocument.redo();
```

6.22.3 *PDF* Object Access

A *PDF* document contains objects, similar to those in *JavaScript*: arrays, dictionaries, strings, booleans, and numbers. At the root of the *PDF* document is the trailer object; which contains pointers to the meta data dictionary and the catalog object which contains the pages and other information.

Pointers in *PDF* are also called indirect references, and are of the form "32 0 R" (where 32 is the object number, 0 is the generation, and R is magic syntax). All functions in *MuPDF* dereference indirect references automatically.

PDF has two types of strings: `/Names` and `(Strings)`. All dictionary keys are names.

Some dictionaries in *PDF* also have attached binary data. These are called streams, and may be compressed.

Note: `PDFObjects` are always bound to the document that created them. Do **NOT** mix and match objects from one document with another document!

---

addObject(*obj*)

Add `obj` to the *PDF* as a numbered object, and return an indirect reference to it.

Arguments

- **obj** – Object to add.

Returns

`Object`.

```
var ref = pdfDocument.addObject(obj);
```

addStream(*buffer*, *object*)

Create a stream object with the contents of `buffer`, add it to the *PDF*, and return an indirect reference to it. If `object` is defined, it will be used as the stream object dictionary.

Arguments

- **buffer** – `Buffer` object.
- **object** – The object to add the stream to.

Returns

`Object`.

```
var stream = pdfDocument.addStream(buffer, object);
```

addRawStream(*buffer*, *object*)

Create a stream object with the contents of `buffer`, add it to the *PDF*, and return an indirect reference to it. If `object` is defined, it will be used as the stream object dictionary. The `buffer` must contain already compressed data that matches "Filter" and "DecodeParms" set in the stream object dictionary.

Arguments

- **buffer** – `Buffer` object.
- **object** – The object to add the stream to.

Returns
Object.

```
var stream = pdfDocument.addRawStream(buffer, object);
```

newNull()

Create a new null object.

Returns
PDFObject.

```
var obj = pdfDocument.newNull();
```

newBoolean(*boolean*)

Create a new boolean object.

Arguments

- **boolean** – The boolean value.

Returns
PDFObject.

```
var obj = pdfDocument.newBoolean(true);
```

newInteger(*number*)

Create a new integer object.

Arguments

- **number** – The number value.

Returns
PDFObject.

```
var obj = pdfDocument.newInteger(1);
```

newReal(*number*)

Create a new real number object.

Arguments

- **number** – The number value.

Returns
PDFObject.

```
var obj = pdfDocument.newReal(7.3);
```

newString(*string*)

Create a new string object.

Arguments

- **string** – String.

Returns

PDFObject.

```
var obj = pdfDocument.newString("hello");
```

newByteString(*byteString*)

Create a new byte string object.

Arguments

- **byteString** – String.

Returns

PDFObject.

```
var obj = pdfDocument.newByteString("hello");
```

newName(*string*)

Create a new name object.

Arguments

- **string** – The string value.

Returns

PDFObject.

```
var obj = pdfDocument.newName("hello");
```

newIndirect(*objectNumber*, *generation*)

Create a new indirect object.

Arguments

- **objectNumber** – Integer.
- **generation** – Integer.

Returns

PDFObject.

```
var obj = pdfDocument.newIndirect(100, 0);
```

newArray(*capacity*)

Create a new array object.

Arguments

- **capacity** – Integer Defaults to 8.

Returns
PDFObject.

```
var obj = pdfDocument.newArray();
```

newDictionary(*capacity*)

Create a new dictionary object.

Arguments

- **capacity** – Integer Defaults to 8.

Returns
PDFObject.

```
var obj = pdfDocument.newDictionary();
```

6.22.4 *PDF* Page Access

All page objects are structured into a page tree, which defines the order the pages appear in.

countPages()

Number of pages in the document.

Returns
Integer Page number.

```
var pageCount = pdfDocument.countPages();
```

loadPage(*number*)

Return the PDFPage for a page number.

Arguments

- **number** – Integer The page number, the first page is number zero.

Returns
PDFPage.

```
var page = pdfDocument.loadPage(0);
```

findPage(*number*)

Return the PDFObject for a page number.

Arguments

- **number** – Integer The page number, the first page is number zero.

Returns
PDFObject.

```
var obj = pdfDocument.findPage(0);
```

findPageNumber(*page*)

Given a PDFPage instance, find the page number in the document.

Arguments

- **page** – PDFPage instance.

Returns
Integer.

```
var pageNumber = pdfDocument.findPageNumber(page);
```

deletePage(*number*)

Delete the numbered PDFPage.

Arguments

- **number** – The page number, the first page is number zero.

```
pdfDocument.deletePage(0);
```

insertPage(*at*, *page*)

Insert the PDFPage object in the page tree at the location. If at is -1, at the end of the document.

Pages consist of a content stream, and a resource dictionary containing all of the fonts and images used.

Arguments

- **at** – The index to insert at.
- **page** – The PDFPage to insert.

```
pdfDocument.insertPage(-1, page);
```

addPage(*mediabox*, *rotate*, *resources*, *contents*)

Create a new PDFPage object. Note: this function does NOT add it to the page tree, use insertPage to do that.

Arguments

- **mediabox** – [ulx,uly,lrx,lry] Rectangle.
- **rotate** – Rotation value.
- **resources** – Resources object.
- **contents** – Contents string. This represents the page content stream - see section 3.7.1 in the PDF 1.7 specification.

Returns
PDFObject.

```
var helvetica = pdfDocument.newDictionary();
helvetica.put("Type", pdfDocument.newName("Font"));
helvetica.put("Subtype", pdfDocument.newName("Type1"));
helvetica.put("Name", pdfDocument.newName("Helv"));
helvetica.put("BaseFont", pdfDocument.newName("Helvetica"));
helvetica.put("Encoding", pdfDocument.newName("WinAnsiEncoding"));
var fonts = pdfDocument.newDictionary();
fonts.put("Helv", helvetica);
var resources = pdfDocument.addObject(pdfDocument.newDictionary());
resources.put("Font", fonts);
var pageObject = pdfDocument.addPage([0,0,300,350], 0, resources, "BT /Helv 12 Tf␣
↪100 100 Td (MuPDF!)Tj ET");
pdfDocument.insertPage(-1, pageObject);
```

Listing 1: docs/examples/pdf-create.js

```
// Create a PDF from scratch using helper functions.

// This example creates a new PDF file from scratch, using helper
// functions to create resources and page objects.
// This assumes a basic working knowledge of the PDF file format.

// Create a new empty document with no pages.
var pdf = new PDFDocument()

// Load built-in font and create WinAnsi encoded simple font resource.
var font = pdf.addSimpleFont(new Font("Times-Roman"))

// Load PNG file and create image resource.
var image = pdf.addImage(new Image("example.png"))

// Create resource dictionary.
var resources = pdf.addObject({
        Font: { Tm: font },
        XObject: { Im0: image },
})

// Create content stream data.
var contents =
        "10 10 280 330 re s\n" +
        "q 200 0 0 200 50 100 cm /Im0 Do Q\n" +
        "BT /Tm 16 Tf 50 50 TD (Hello, world!) Tj ET\n"

// Create a new page object.
var page = pdf.addPage([0,0,300,350], 0, resources, contents)

// Insert page object at the end of the document.
pdf.insertPage(-1, page)

// Save the document to file.
```

(continues on next page)

(continued from previous page)

```
pdf.save("out.pdf", "pretty,ascii,compress-images,compress-fonts")
```

addSimpleFont(*font*, *encoding*)

Create a PDFObject from the Font object as a simple font.

Arguments

- **font** – Font.
- **encoding** – The encoding to use. Encoding is either "Latin" (CP-1252), "Greek" (ISO-8859-7), or "Cyrillic" (KOI-8U). The default is "Latin".

Returns

PDFObject.

```
var obj = pdfDocument.addSimpleFont(new mupdf.Font("Times-Roman"), "Latin");
```

addCJKFont(*font*, *language*, *wmode*, *style*)

Create a PDFObject from the Font object as a UTF-16 encoded CID font for the given language ("zh-Hant", "zh-Hans", "ko", or "ja"), writing mode ("H" or "V"), and style ("serif" or "sans-serif").

Arguments

- **font** – Font.
- **language** – String.
- **wmode** – 0 for horizontal writing, and 1 for vertical writing.
- **style** – String.

Returns

PDFObject.

```
var obj = pdfDocument.addCJKFont(new mupdf.Font("ja"), "ja", 0, "serif");
```

addFont(*font*)

Create a PDFObject from the Font object as an Identity-H encoded CID font.

Arguments

- **font** – Font.

Returns

PDFObject.

```
var obj = pdfDocument.addFont(new mupdf.Font("Times-Roman"));
```

addImage(*image*)

Create a PDFObject from the Image object.

Arguments

- **image** – Image.

Returns
PDFObject.

```
var obj = pdfDocument.addImage(new mupdf.Image(pixmap));
```

loadImage(*obj*)

Load an Image from a PDFObject (typically an indirect reference to an image resource).

Arguments

- **obj** – PDFObject.

Returns
Image.

```
var image = pdfDocument.loadImage(obj);
```

6.22.5 Copying objects across *PDFs*

The following functions can be used to copy objects from one *PDF* document to another:

newGraftMap()

Create a graft map on the destination document, so that objects that have already been copied can be found again. Each graft map should only be used with one source document. Make sure to create a new graft map for each source document used.

Returns
PDFGraftMap.

```
var graftMap = pdfDocument.newGraftMap();
```

graftObject(*object*)

Deep copy an object into the destination document. This function will not remember previously copied objects. If you are copying several objects from the same source document using multiple calls, you should use a graft map instead.

Arguments

- **object** – Object to graft.

```
pdfDocument.graftObject(obj);
```

graftPage(*to*, *srcDoc*, *srcPageNumber*)

Graft a page and its resources at the given page number from the source document to the requested page number in the document.

Arguments

- **to** – The page number to insert the page before. Page numbers start at 0 and -1 means at the end of the document.

- **srcDoc** – Source document.
- **srcPageNumber** – Source page number.

This would copy the first page of the source document (0) to the last page (-1) of the current PDF document.

```
pdfDocument.graftPage(-1, srcDoc, 0);
```

6.22.6 Embedded files in *PDFs*

addEmbeddedFile(*filename*, *mimetype*, *contents*, *creationDate*, *modificationDate*, *addChecksum*)

Embedded a file into the document. If a checksum is added then the file contents can be verified later. An indirect reference to a File Specification Object is returned.

Arguments

- **filename** – String.
- **mimetype** – String See: Mimetype.
- **contents** – Buffer.
- **creationDate** – Date.
- **modificationDate** – Date.
- **addChecksum** – Boolean.

Returns

Object File Specification Object.

Note: After embedding a file into a *PDF*, it can be connected to an annotation using PDFAnnotation.setFilespec().

```
var fileSpecObject = pdfDocument.addEmbeddedFile("my_file.jpg",
                                                 "image/jpeg",
                                                 buffer,
                                                 new Date(),
                                                 new Date(),
                                                 false);
```

getEmbeddedFiles()

Returns the embedded files or null for the document.

Returns

Object File Specification Object.

getEmbeddedFileParams(*fileSpecObject*)

Return an object describing the file referenced by the fileSpecObject.

Arguments

- **fileSpecObject** – Object File Specification Object.

Returns
`Object` Embedded File Object.

```
var obj = pdfDocument.getEmbeddedFileParams(fileSpecObject);
```

getEmbeddedFileContents(*fileSpecObject*)

Returns a `Buffer` with the contents of the embedded file referenced by the `fileSpecObject`.

Arguments

- **fileSpecObject** – `Object` File Specification Object.

Returns
Buffer.

```
var buffer = pdfDocument.getEmbeddedFileContents(fileSpecObject);
```

verifyEmbeddedFileChecksum(*fileSpecObject*)

Verify the *MD5* checksum of the embedded file contents.

Arguments

- **fileSpecObject** – `Object` File Specification Object.

Returns
`Boolean`.

```
var fileChecksumValid = pdfDocument.verifyEmbeddedFileChecksum(fileSpecObject);
```

6.23 PDFGraftMap

graftObject(*object*)

Use the graft map to copy objects, with the ability to remember previously copied objects.

Arguments

- **object** – Object to graft.

```
var map = document.newGraftMap();
map.graftObject(obj);
```

graftPage(*map*, *dstPageNumber*, *srcDoc*, *srcPageNumber*)

Graft a page and its resources at the given page number from the source document to the requested page number in the destination document connected to the map.

Arguments

- **dstPageNumber** – The page number where the source page will be inserted. Page numbers start at `0`, and `-1` means at the end of the document.
- **srcDoc** – Source document.
- **srcPageNumber** – Source page number.

```
var map = dstdoc.newGraftMap();
map.graftObject(-1, srcdoc, 0);
```

6.24 PDFObject

All functions that take `PDFObjects`, do automatic translation between *JavaScript* objects and `PDFObjects` using a few basic rules:

- Null, booleans, and numbers are translated directly.
- *JavaScript* strings are translated to *PDF* names, unless

they are surrounded by parentheses: "Foo" becomes the *PDF* name /Foo and "(Foo)" becomes the *PDF* string (Foo). - Arrays and dictionaries are recursively translated to *PDF* arrays and dictionaries. Be aware of cycles though! The translation does NOT cope with cyclic references! - The translation goes both ways: *PDF* dictionaries and arrays can be accessed similarly to *JavaScript* objects and arrays by getting and setting their properties.

`length`

Length of the array.

get(*ref*)

Access dictionaries and arrays in the `PDFObject`.

Arguments

- **ref** – Key or index.

Returns

The value for the key or index.

```
var dict = pdfDocument.newDictionary();
var value = dict.get("my_key");
var arr = pdfDocument.newArray();
var value = arr.get(1);
```

put(*ref*, *value*)

Put information into dictionaries and arrays in the `PDFObject`. Dictionaries and arrays can also be accessed using normal property syntax: `obj.Foo = 42; delete obj.Foo; x = obj[5]`.

Arguments

- **ref** – Key or index.

- **value** – The value for the key or index.

```
var dict = pdfDocument.newDictionary();
dict.put("my_key", "my_value");
var arr = pdfDocument.newArray();
arr.put(0, 42);
```

delete(*ref*)

Delete a reference from a PDFObject.

Arguments

- **ref** – Key or index.

```
pdfObj.delete("my_key");
var dict = pdfDocument.newDictionary();
dict.put("my_key", "my_value");
dict.delete("my_key");
var arr = pdfDocument.newArray();
arr.put(1, 42);
arr.delete(1);
```

resolve()

If the object is an indirect reference, return the object it points to; otherwise return the object itself.

Returns

Object.

```
var resolvedObj = pdfObj.resolve();
```

compare(*other_obj*)

Compare the object to another one. Returns 0 on match, non-zero on mismatch. Streams always mismatch.

Arguments

- **other** – PDFObject.

Returns

Boolean.

```
var match = pdfObj.compare(other_obj);
```

isArray()

Returns

Boolean.

```
var result = pdfObj.isArray();
```

isDictionary()

Returns
Boolean.

```
var result = pdfObj.isDictionary();
```

forEach(*fun*)

Iterate over all the entries in a dictionary or array and call a function for each value-key pair.

Arguments

- **fun** – Function in the format `function(value,key){...}`.

```
pdfObj.forEach(function(value,key){console.log("value="+value+",key="+key)});
```

push(*item*)

Append `item` to the end of an array.

Arguments

- **item** – Item to add.

```
pdfObj.push("item");
```

toString()

Returns the object as a pretty-printed string.

Returns
String.

```
var str = pdfObj.toString();
```

valueOf()

Convert primitive *PDF* objects to a corresponding primitive `Null`, `Boolean`, `Number` or `String` *JavaScript* objects. Indirect *PDF* objects get converted to the string "R" while *PDF* names are converted to plain strings. *PDF* arrays or dictionaries are returned unchanged.

Returns
Null | Boolean | Number | String.

```
var val = pdfObj.valueOf();
```

isIndirect()

Is the object an indirect reference.

Returns
Boolean.

```
var val = pdfObj.isIndirect();
```

asIndirect()

Return the object number the indirect reference points to.

Returns
Integer.

```
var val = pdfObj.asIndirect();
```

6.24.1 *PDF* streams

The only way to access a stream is via an indirect object, since all streams are numbered objects.

isStream()

True if the object is an indirect reference pointing to a stream.

Returns
Boolean.

```
var val = pdfObj.isStream();
```

readStream()

Read the contents of the stream object into a Buffer.

Returns
Buffer.

```
var buffer = pdfObj.readStream();
```

readRawStream()

Read the raw, uncompressed, contents of the stream object into a Buffer.

Returns
Buffer.

```
var buffer = pdfObj.readRawStream();
```

writeObject(*obj*)

Update the object the indirect reference points to.

Arguments

- **obj** – Object to update.

```
pdfObj.writeObject(obj);
```

writeStream(*buffer*)

Update the contents of the stream the indirect reference points to. This will update the "Length", "Filter" and "DecodeParms" automatically.

Arguments

- **buffer** – Buffer.

```
pdfObj.writeStream(buffer);
```

writeRawStream(*buffer*)

Update the contents of the stream the indirect reference points to. The buffer must contain already compressed data that matches the "Filter" and "DecodeParms". This will update the "Length" automatically, but leave the "Filter" and "DecodeParms" untouched.

Arguments

- **buffer** – Buffer.

```
pdfObj.writeRawStream(buffer);
```

6.24.2 Primitive Objects

Primitive *PDF* objects such as booleans, names, and numbers can usually be treated like *JavaScript* values. When that is not sufficient use these functions:

isNull()

Returns *true* if the object is a null object.

Returns
Boolean.

```
var val = pdfObj.isNull();
```

isBoolean()

Returns *true* if the object is a Boolean object.

Returns
Boolean.

```
var val = pdfObj.isBoolean();
```

asBoolean()

Get the boolean primitive value.

Returns
Boolean.

```
var val = pdfObj.asBoolean();
```

isNumber()

Returns *true* if the object is a `Number` object.

Returns
`Boolean`.

```
var val = pdfObj.isNumber();
```

asNumber()

Get the number primitive value.

Returns
`Integer`.

```
var val = pdfObj.asNumber();
```

isName()

Returns *true* if the object is a `Name` object.

Returns
`Boolean`.

```
var val = pdfObj.isName();
```

asName()

Get the name as a string.

Returns
`String`.

```
var val = pdfObj.asName();
```

isString()

Returns *true* if the object is a `String` object.

Returns
`Boolean`.

```
var val = pdfObj.isString();
```

asString()

Convert a "text string" to a *JavaScript* unicode string.

Returns
`String`.

```
var val = pdfObj.asString();
```

asByteString()

Convert a string to an array of byte values.

Returns

`[...]`.

```
var val = pdfObj.asByteString();
```

6.25 PDFPage

Extends Page.

getAnnotations()

Return array of all annotations on the page.

Returns

`[...]`.

```
var annots = pdfPage.getAnnotations();
```

createAnnotation(*type*)

Create a new blank annotation of a given type.

Arguments

- **type** – `String` representing annotation type.

Returns

`PDFAnnotation`.

```
var annot = pdfPage.createAnnotation("Text");
```

Annotation types

Note: Annotation types are also referred to as "subtypes".

Name	Supported	Notes
Text	Yes	
Link	Yes	Please use Page.createLink().
FreeText	Yes	
Square	Yes	
Circle	Yes	
Line	Yes	
Polygon	Yes	
PolyLine	Yes	
Highlight	Yes	
Underline	Yes	
Squiggly	Yes	
StrikeOut	Yes	
Redact	Yes	
Stamp	Yes	
Caret	Yes	
Ink	Yes	
Popup	No	
FileAttachment	Yes	
Sound	No	
Movie	No	
RichMedia	No	
Widget	No	
Screen	No	
PrinterMark	No	
TrapNet	No	
Watermark	No	
3D	No	
Projection	No	

deleteAnnotation(*annot*)

Delete the annotation from the page.

Arguments

- **annot** – PDFAnnotation.

```
pdfPage.deleteAnnotation(annot);
```

getWidgets()

Return array of all widgets on the page.

Returns

[...].

```
var widgets = pdfPage.getWidgets();
```

update()

Loop through all annotations of the page and update them. Returns true if re-rendering is needed because at least one annotation was changed (due to either events or *JavaScript* actions or annotation editing).

```
pdfPage.update();
```

applyRedactions(*blackBoxes*, *imageMethod*)

Applies redactions to the page.

Arguments

- **blackBoxes** – Boolean Whether to use black boxes at each redaction or not.
- **imageMethod** – Integer. 0 for no redactions, 1 to redact entire images, 2 for redacting just the covered pixels.

Note: Redactions are secure as they remove the affected content completely.

```
pdfPage.applyRedactions(true, 1);
```

process(*processor*)

Run through the page contents stream and call methods on the supplied PDF processor.

Arguments

- **processor** – User defined function.

```
pdfPage.process(processor);
```

toPixmap(*transform*, *colorspace*, *alpha*, *renderExtra*, *usage*, *box*)

Render the page into a Pixmap using the given colorspace and alpha while applying the transform. Rendering of annotations/widgets can be disabled. A page can be rendered for e.g. "View" or "Print" usage.

Arguments

- **transform** – [a,b,c,d,e,f] The transform matrix.
- **colorspace** – ColorSpace.
- **alpha** – Boolean.
- **renderExtra** – Boolean Whether annotations and widgets should be rendered.
- **usage** – String "View" or "Print".
- **box** – String Default is "CropBox".

Returns

Pixmap.

```
var pixmap = pdfPage.toPixmap(mupdf.Matrix.identity,
                              mupdf.ColorSpace.DeviceRGB,
                              false,
                              true,
                              "View",
                              "CropBox");
```

6.26 PDFAnnotation

PDF Annotations belong to a specific PDFPage and may be created/changed/removed. Because annotation appearances may change (for several reasons) it is possible to scan through the annotations on a page and query them to see whether a re-render is necessary. Finally redaction annotations can be applied to a PDFPage, destructively removing content from the page.

To get the annotations on a page see: PDFPage getAnnotations(), to create an annotation see: PDFPage createAnnotation().

getBounds()

Returns a rectangle containing the location and dimension of the annotation.

Returns

[ulx,uly,lrx,lry] Rectangle.

```
var bounds = annotation.getBounds();
```

run(*device*, *transform*)

Calls the device functions to draw the annotation.

Arguments

- **device** – Device.
- **transform** – [a,b,c,d,e,f]. The transform matrix.

```
annotation.run(device, mupdf.Matrix.identity);
```

toPixmap(*transform*, *colorspace*, *alpha*)

Render the annotation into a Pixmap, using the transform and colorspace.

Arguments

- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **colorspace** – ColorSpace.
- **alpha** – Boolean.

Returns

Pixmap.

```
var pixmap = annotation.toPixmap(mupdf.Matrix.identity, mupdf.ColorSpace.DeviceRGB,␣
↪true);
```

toDisplayList()

Record the contents of the annotation into a DisplayList.

Returns
DisplayList.

```
var displayList = annotation.toDisplayList();
```

getObject()

Get the underlying PDFObject for an annotation.

Returns
PDFObject.

```
var obj = annotation.getObject();
```

process(*processor*)

Run through the annotation appearance stream and call methods on the supplied PDF processor.

Arguments

- **processor** – User defined function.

```
annotation.process(processor);
```

setAppearance(*appearance*, *state*, *transform*, *displayList*)

Set the annotation appearance stream for the given appearance. The desired appearance is given as a transform along with a display list.

Arguments

- **appearance** – String Appearance stream ("N", "R" or "D").
- **state** – String The annotation state to set the appearance for or null for the current state. Only widget annotations of pushbutton, check box, or radio button type have states, which are "Off" or "Yes". For other types of annotations pass null.
- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **displayList** – DisplayList.

```
annotation.setAppearance("N", null, mupdf.Matrix.identity, displayList);
```

setAppearance(*appearance*, *state*, *transform*, *bbox*, *resources*, *contents*)

Set the annotation appearance stream for the given appearance. The desired appearance is given as a transform along with a bounding box, a *PDF* dictionary of resources and a content stream.

Arguments

- **appearance** – String Appearance stream ("N", "R" or "D").

- **state** – String The annotation state to set the appearance for or null for the current state. Only widget annotations of pushbutton, check box, or radio button type have states, which are "Off" or "Yes". For other types of annotations pass null.
- **transform** – [a,b,c,d,e,f]. The transform matrix.
- **bbox** – [ulx,uly,lrx,lry] Rectangle.
- **resources** – Resources object.
- **contents** – Contents string.

```
annotation.setAppearance("N", null, mupdf.Matrix.identity, [0,0,100,100], resources,
↪ contents);
```

Appearance stream values

Value	Description
N	normal appearance
R	roll-over appearance
D	down (pressed) appearance

update()

Update the appearance stream to account for changes in the annotation.

```
annotation.update();
```

getHot()

Get the annotation as being hot, *i.e.* that the pointer is hovering over the annotation.

Returns

Boolean.

```
annotation.getHot();
```

setHot(*hot*)

Set the annotation as being hot, *i.e.* that the pointer is hovering over the annotation.

Arguments

- **hot** – Boolean.

```
annotation.setHot(true);
```

getHiddenForEditing()

Get a special annotation hidden flag for editing. This flag prevents the annotation from being rendered.

Returns

Boolean.

```
var hidden = annotation.getHiddenForEditing();
```

setHiddenForEditing(*hidden*)

Set a special annotation hidden flag for editing. This flag prevents the annotation from being rendered.

Arguments

- **hidden** – Boolean.

```
annotation.setHiddenForEditing(true);
```

getType()

Return the annotation type.

Returns

String Annotation type.

```
var type = annotation.getType();
```

getFlags()

Get the annotation flags.

Returns

Integer representaton of a bit-field of flags specified below.

```
var flags = annotation.getFlags();
```

setFlags(*flags*)

Set the annotation flags.

Arguments

- **flags** – Integer representaton of a bit-field of flags specified below.

```
annotation.setFlags(8); // Clears all other flags and sets NoZoom.
```

Annotation flags

Bit position	Name
1	Invisible
2	Hidden
3	Print
4	NoZoom
5	NoRotate
6	NoView
7	ReadOnly
8	Locked
9	ToggleNoView
10	LockedContents

getContents()

Get the annotation contents.

Returns
String.

```
var contents = annotation.getContents();
```

setContents(*text*)

Set the annotation contents.

Arguments

- **text** – String.

```
annotation.setContents("Hello World");
```

getBorder()

Get the annotation border line width in points.

Returns
Float.

```
var border = annotation.getBorder();
```

setBorder(*width*)

Set the annotation border line width in points. Use `setBorderWidth()` to avoid removing the border effect.

Arguments

- **width** – Float Border width.

```
annotation.setBorder(1.0);
```

getColor()

Get the annotation color, represented as an array of 1, 3, or 4 component values.

Returns
The color value.

```
var color = annotation.getColor();
```

setColor(*color*)

Set the annotation color, represented as an array of 1, 3, or 4 component values.

Arguments

- **color** – The color value.

```
annotation.setColor([0,1,0]);
```

getOpacity()

Get the annotation opacity.

Returns
The opacity value.

```
var opacity = annotation.getOpacity();
```

setOpacity(*opacity*)

Set the annotation opacity.

Arguments

- **opacity** – The opacity value.

```
annotation.setOpacity(0.5);
```

getCreationDate()

Get the annotation creation date as a *JavaScript* `Date` object.

Returns
`Date`.

```
var date = annotation.getCreationDate();
```

setCreationDate(*date*)

Set the creation date.

Arguments

- **date** – `Date`.

```
annotation.setCreationDate(new Date());
```

getModificationDate()

Get the annotation modification date as a *JavaScript* `Date` object.

Returns
`Date`.

```
var date = annotation.getModificationDate();
```

setModificationDate(*date*)

Set the modification date.

Arguments

- **date** – `Date`.

```
annotation.setModificationDate(new Date());
```

getQuadding()

Get the annotation quadding (justification).

Returns

Quadding value, `0` for left-justified, `1` for centered, `2` for right-justified.

```
var quadding = annotation.getQuadding();
```

setQuadding(*value*)

Set the annotation quadding (justification).

Arguments

- **value** – Quadding value, `0` for left-justified, `1` for centered, `2` for right-justified.

```
annotation.setQuadding(1);
```

getLanguage()

Get the annotation language (or get the inherited document language).

Returns

`String`.

```
var language = annotation.getLanguage();
```

setLanguage(*language*)

Set the annotation language.

Arguments

- **language** – `String`.

```
annotation.setLanguage("en");
```

These properties are only present for some annotation types, so support for them must be checked before use.

hasRect()

Checks the support for annotation bounding box.

Returns

`Boolean`.

```
var hasRect = annotation.hasRect();
```

getRect()

Get the annotation bounding box.

Returns

`[ulx,uly,lrx,lry]` Rectangle.

```
var rect = annotation.getRect();
```

setRect(*rect*)

Set the annotation bounding box.

Arguments

- **rect** – `[ulx,uly,lrx,lry]` Rectangle.

```
annotation.setRect([0,0,100,100]);
```

getDefaultAppearance()

Get the default text appearance used for free text annotations.

Returns

`{font:String, size:Integer, color:[r,g,b]}` Returns a default text appearance with the key/value pairs.

```
var appearance = annotation.getDefaultAppearance();
```

setDefaultAppearance(*font*, *size*, *color*)

Set the default text appearance used for free text annotations.

Arguments

- **font** – `String` ("Helv" = Helvetica, "TiRo" = Times New Roman, "Cour" = Courier).
- **size** – `Integer`.
- **color** – The color value.

```
annotation.setDefaultAppearance("Helv", 16, [0,0,0]);
```

hasInteriorColor()

Checks whether the annotation has support for an interior color.

Returns

`Boolean`.

```
var hasInteriorColor = annotation.hasInteriorColor();
```

getInteriorColor()

Gets the annotation interior color.

Returns
The color value.

```
var interiorColor = annotation.getInteriorColor();
```

setInteriorColor(*color*)

Sets the annotation interior color.

Arguments

- **color** – The color value.

```
annotation.setInteriorColor([0,1,1]);
```

hasAuthor()

Checks whether the annotation has an author.

Returns
Boolean.

```
var hasAuthor = annotation.hasAuthor();
```

getAuthor()

Gets the annotation author.

Returns
String.

```
var author = annotation.getAuthor();
```

setAuthor(*author*)

Sets the annotation author.

Arguments

- **author** – String.

```
annotation.setAuthor("Jane Doe");
```

hasLineEndingStyles()

Checks the support for line ending styles.

Returns
Boolean.

```
var hasLineEndingStyles = annotation.hasLineEndingStyles();
```

`getLineEndingStyles()`

Gets the line ending styles object.

Returns

`{start:String, end:String}` Returns an object with the key/value pairs.

```
var lineEndingStyles = annotation.getLineEndingStyles();
```

`setLineEndingStyles(start, end)`

Sets the line ending styles object.

Arguments

- **start** – `String`.
- **end** – `String`.

```
annotation.setLineEndingStyles({start:"Square", end:"OpenArrow"});
```

Line ending names
"None"
"Square"
"Circle"
"Diamond"
"OpenArrow"
"ClosedArrow"
"Butt"
"ROpenArrow"
"RClosedArrow"
"Slash"

`hasIcon()`

Checks the support for annotation icon.

Returns

`Boolean`.

```
var hasIcon = annotation.hasIcon();
```

`getIcon()`

Gets the annotation icon name, either one of the standard icon names, or something custom.

Returns

`String`.

```
var icon = annotation.getIcon();
```

setIcon(*name*)

Sets the annotation icon name, either one of the standard icon names, or something custom. Note that standard icon names can be used to resynthesize the annotation apperance, but custom names cannot.

Arguments

- **name** – String.

```
annotation.setIcon("Note");
```

Icon type	Icon name
File attachment	"Graph"
	"PaperClip"
	"PushPin"
	"Tag"
Sound	"Mic"
	"Speaker"
Stamp	"Approved"
	"AsIs"
	"Confidential"
	"Departmental"
	"Draft"
	"Experimental"
	"Expired"
	"Final"
	"ForComment"
	"ForPublicRelease"
	"NotApproved"
	"NotForPublicRelease"
	"Sold"
	"TopSecret"
Text	"Comment"
	"Help"
	"Insert"
	"Key"
	"NewParagraph"
	"Note"
	"Paragraph"

hasLine()

Checks the support for annotation line.

Returns

Boolean.

```
var hasLine = annotation.hasLine();
```

getLine()

Get line end points, represented by an array of two points, each represented as an [x, y] array.

Returns
[[x,y],...].

```
var line = annotation.getLine();
```

setLine(*endpoints*)

Set the two line end points, represented by an array of two points, each represented as an [x, y] array.

Arguments

- **endpoint1** – [x,y].
- **endpoint2** – [x,y].

```
annotation.setLine([100,100], [150, 175]);
```

hasOpen()

Checks the support for annotation open state.

Returns
Boolean.

```
var hasOpen = annotation.hasOpen();
```

getIsOpen()

Get annotation open state.

Returns
Boolean.

```
var isOpen = annotation.getIsOpen();
```

setIsOpen(*state*)

Set annotation open state.

Arguments

- **state** – Boolean.

```
annotation.setIsOpen(true);
```

Note: "Open" refers to whether the annotation is display in an open state when the page is loaded. A Text Note annotation is considered "Open" if the user has clicked on it to view its contents.

---

hasFilespec()

Checks support for the annotation file specification.

Returns
Boolean.

```
var hasFileSpec = annotation.hasFilespec();
```

getFilespec()

Gets the file specification object.

Returns

`Object` File Specification Object.

```
var fileSpec = annotation.getFilespec(true);
```

setFilespec(*fileSpecObject*)

Sets the file specification object.

Arguments

- **fileSpecObject** – `Object` File Specification object.

```
annotation.setFilespec({filename:"my_file.pdf",
                        mimetype:"application/pdf",
                        size:1000,
                        creationDate:date,
                        modificationDate:date});
```

The border drawn around some annotations can be controlled by:

hasBorder()

Check support for the annotation border style.

Returns

`Boolean`.

```
var hasBorder = annotation.hasBorder();
```

getBorderStyle()

Get the annotation border style, either of "Solid" or "Dashed".

Returns

`String`.

```
var borderStyle = annotation.getBorderStyle();
```

setBorderStyle(*style*)

Set the annotation border style, either of "Solid" or "Dashed".

Arg

`String`.

```
annotation.setBorderStyle("Dashed");
```

getBorderWidth()

Get the border width in points.

Returns
Float.

```
var w = annotation.getBorderWidth();
```

setBorderWidth(*width*)

Set the border width in points. Retain any existing border effects.

Arguments

- **width** – Float.

```
annotation.setBorderWidth(1.5);
```

getBorderDashCount()

Returns the number of items in the border dash pattern.

Returns
Integer.

```
var dashCount = annotation.getBorderDashCount();
```

getBorderDashItem(*i*)

Returns the length of dash pattern item `i`.

Arguments

- **i** – Integer Item index.

Returns
Float.

```
var length = annotation.getBorderDashItem(0);
```

setBorderDashPattern(*dashPattern*)

Set the annotation border dash pattern to the given array of dash item lengths. The supplied array represents the respective line stroke and gap lengths, e.g. `[1,1]` sets a small dash and small gap, `[2,1,4,1]` would set a medium dash, a small gap, a longer dash and then another small gap.

Arguments

- **dashpattern** – [Float, Float, ...].

```
annotation.setBorderDashPattern([2.0, 1.0, 4.0, 1.0]);
```

clearBorderDash()

Clear the entire border dash pattern for an annotation.

```
annotation.clearBorderDash();
```

addBorderDashItem(*length*)

Append an item (of the given length) to the end of the border dash pattern.

Arguments

- **length** – Float.

```
annotation.addBorderDashItem(10.0);
```

Annotations that have a border effect allows the effect to be controlled by:

hasBorderEffect()

Check support for annotation border effect.

Returns
Boolean.

```
var hasEffect = annotation.hasBorderEffect();
```

getBorderEffect()

Get the annotation border effect, either of "None" or "Cloudy".

Returns
String.

```
var effect = annotation.getBorderEffect();
```

setBorderEffect(*effect*)

Set the annotation border effect, either of "None" or "Cloudy".

Arg
String.

```
annotation.setBorderEffect("None");
```

getBorderEffectIntensity()

Get the annotation border effect intensity.

Returns
Float.

```
var intensity = annotation.getBorderEffectIntensity();
```

setBorderEffectIntensity(*intensity*)

Set the annotation border effect intensity. Recommended values are between `0` and `2` inclusive.

Arg
`Float`.

```
annotation.setBorderEffectIntensity(1.5);
```

Ink annotations consist of a number of strokes, each consisting of a sequence of vertices between which a smooth line will be drawn. These can be controlled by:

hasInkList()

Check support for the annotation ink list.

Returns
`Boolean`.

```
var hasInkList = annotation.hasInkList();
```

getInkList()

Get the annotation ink list, represented as an array of strokes, each an array of points each an array of its X/Y coordinates.

Returns
`[...]`.

```
var inkList = annotation.getInkList();
```

setInkList(*inkList*)

Set the annotation ink list, represented as an array of strokes, each an array of points each an array of its X/Y coordinates.

Arg
`[...]`.

```
annotation.setInkList([
                            [
                                [0,0]
                            ],
                            [
                                [10,10], [20,20], [30,30]
                            ]
                        ]);
```

clearInkList()

Clear the list of ink strokes for the annotation.

```
annotation.clearInkList();
```

addInkList(*stroke*)

To the list of strokes, append a stroke, represented as an array of vertices each an array of its X/Y coordinates.

Arguments

- **stroke** – [].

```
annotation.addInkList(
                        [
                            [0,0]
                        ],
                        [
                            [10,10], [20,20], [30,30]
                        ]
                    );
```

addInkListStroke()

Add a new empty stroke to the ink annotation.

```
annotation.addInkListStroke();
```

addInkListStrokeVertex(*vertex*)

Append a vertex to end of the last stroke in the ink annotation. The vertex is an array of its X/Y coordinates.

Arguments

- **vertex** – [...].

```
annotation.addInkListStrokeVertex([0,0]);
```

Text markup and redaction annotations consist of a set of quadadrilaterals controlled by:

hasQuadPoints()

Check support for the annotation quadpoints.

Returns
Boolean.

```
var hasQuadPoints = annotation.hasQuadPoints();
```

getQuadPoints()

Get the annotation quadpoints, describing the areas affected by text markup annotations and link annotations.

Returns
[...].

```
var quadPoints = annotation.getQuadPoints();
```

setQuadPoints(*quadPoints*)

Set the annotation quadpoints, describing the areas affected by text markup annotations and link annotations.

Arguments

- **quadPoints** – [...].

```
annotation.setQuadPoints([
                            [1,2,3,4,5,6,7,8],
                            [1,2,3,4,5,6,7,8],
                            [1,2,3,4,5,6,7,8]
                        ]);
```

clearQuadPoints()

Clear the list of quad points for the annotation.

```
annotation.clearQuadPoints();
```

addQuadPoint(*quadpoint*)

Append a single quad point as an array of 8 elements, where each pair are the X/Y coordinates of a corner of the quad.

Arguments

- **quadpoint** – [].

```
annotation.addQuadPoint([1,2,3,4,5,6,7,8]);
```

Polygon and polyline annotations consist of a sequence of vertices with a straight line between them. Those can be controlled by:

hasVertices()

Check support for the annotation vertices.

Returns

Boolean.

```
var hasVertices = annotation.hasVertices();
```

getVertices()

Get the annotation vertices, represented as an array of vertices each an array of its X/Y coordinates.

Returns

[...].

```
var vertices = annotation.getVertices();
```

setVertices(*vertices*)

Set the annotation vertices, represented as an array of vertices each an array of its X/Y coordinates.

Arguments

- **vertices** – `[...]`.

```
annotation.setVertices([
                         [0,0],
                         [10,10],
                         [20,20]
                       ]);
```

clearVertices()

Clear the list of vertices for the annotation.

```
annotation.clearVertices();
```

addVertex(*vertex*)

Append a single vertex as an array of its X/Y coordinates.

Arguments

- **vertex** – `[...]`.

```
annotation.addVertex([0,0]);
```

applyRedaction(*blackBoxes*, *imageMethod*)

Applies redaction to the annotation.

Arguments

- **blackBoxes** – `Boolean` Whether to use black boxes at each redaction or not.
- **imageMethod** – `Integer`. `0` for no redactions, `1` to redact entire images, `2` for redacting just the covered pixels.

Note: Redactions are secure as they remove the affected content completely.

```
annotation.applyRedaction(true, 1);
```

6.27 PDFWidget

Widgets refer to components which make up form items such as buttons, text inputs and signature fields.

To get the widgets on a page see: PDFPage getWidgets().

getFieldType()

Return `String` indicating type of widget: "button", "checkbox", "combobox", "listbox", "radiobutton", "signature" or "text".

Returns
`String`.

```
var type = widget.getFieldType();
```

getFieldFlags()

Return the field flags. Refer to the *PDF* specification for their meanings.

Returns
`Integer` which determines the bit-field value.

```
var flags = widget.getFieldFlags();
```

getRect()

Get the widget bounding box.

Returns
`[ulx,uly,lrx,lry]` Rectangle.

```
var rect = widget.getRect();
```

setRect(*rect*)

Set the widget bounding box.

Arguments

- **rect** – `[ulx,uly,lrx,lry]` Rectangle.

```
widget.setRect([0,0,100,100]);
```

getMaxLen()

Get maximum allowed length of the string value.

Returns
`Integer`.

```
var length = widget.getMaxLen();
```

getValue()

Get the widget value.

Returns
String.

```
var value = widget.getValue();
```

setTextValue(*value*)

Set the widget string value.

Arguments

- **value** – String.

```
widget.setTextValue("Hello World!");
```

setChoiceValue(*value*)

Sets the value against the widget.

Arguments

- **value** – String.

```
widget.setChoiceValue("Yes");
```

toggle()

Toggle the state of the widget, returns 1 if the state changed.

Returns
Integer.

```
var state = widget.toggle();
```

getOptions()

Returns an array of strings which represents the value for each corresponding radio button or checkbox field.

Returns
[...].

```
var options = widget.getOptions();
```

layoutTextWidget()

Layout the value of a text widget. Returns a Text Layout Object.

Returns
Object.

```
var layout = widget.layoutTextWidget();
```

isReadOnly()

If the value is read only and the widget cannot be interacted with.

Returns
Boolean.

```
var isReadOnly = widget.isReadOnly();
```

getLabel()

Get the field name as a string.

Returns
String.

```
var label = widget.getLabel();
```

getEditingState()

Gets whether the widget is in editing state.

Returns
Boolean.

```
var state = widget.getEditingState();
```

setEditingState(*state*)

Set whether the widget is in editing state.

Arguments

- **state** – Boolean.

```
widget.getEditingState(false);
```

Note: When in editing state any changes to the widget value will not cause any side-effects such as changing other widgets or running *JavaScript*. This is intended for, e.g. when a text widget is interactively having characters typed into it. Once editing is finished the state should reverted back, before updating the widget value again.

---

update()

Update the appearance stream to account for changes to the widget.

```
widget.update();
```

6.27.1 Signature Methods

isSigned()

Returns *true* if the signature is signed.

Returns
Boolean.

```
var isSigned = widget.isSigned();
```

validateSignature()

Returns number of updates ago when signature became invalid. Returns 0 is signature is still valid, 1 if it became invalid during the last save, etc.

Returns
Integer.

```
var validNum = widget.validateSignature();
```

checkCertificate()

Returns "OK" if signature checked out OK, otherwise a text string containing an error message, e.g. "Self-signed certificate." or "Signature invalidated by change to document.", etc.

Returns
String.

```
var result = widget.checkCertificate();
```

getSignatory()

Returns a text string with the distinguished name from a signed signature, or a text string with an error message.

Returns
String.

```
var signatory = widget.getSignatory();
```

previewSignature(*signer*, *signatureConfig*, *image*, *reason*, *location*)

Return a Pixmap preview of what the signature would look like if signed with the given configuration. Reason and location may be undefined, in which case they are not shown.

Arguments

- **signer** – PDFPKCS7Signer.
- **signatureConfig** – Signature Configuration Object.
- **image** – Image.
- **reason** – String.

- **location** – String.

Returns

Pixmap.

```
var pixmap = widget.previewSignature(signer, {showLabels:true, showDate:true},␣
↪image, "", "");
```

sign(*signer*, *signatureConfig*, *image*, *reason*, *location*)

Sign the signature with the given configuration. Reason and location may be undefined, in which case they are not shown.

Arguments

- **signer** – PDFPKCS7Signer.
- **signatureConfig** – Signature Configuration Object.
- **image** – Image.
- **reason** – String.
- **location** – String.

```
widget.sign(signer, {showLabels:true, showDate:true}, image, "", "");
```

clearSignature()

Clear a signed signature, making it unsigned again.

```
widget.clearSignature();
```

6.27.2 Widget Events

eventEnter()

Trigger the event when the pointing device enters a widget's active area.

```
widget.eventEnter();
```

eventExit()

Trigger the event when the pointing device exits a widget's active area.

```
widget.eventExit();
```

eventDown()

Trigger the event when the pointing device's button is depressed within a widget's active area.

```
widget.eventDown();
```

eventUp()

Trigger the event when the pointing device's button is released within a widget's active area.

```
widget.eventUp();
```

eventFocus()

Trigger the event when the a widget gains input focus.

```
widget.eventFocus();
```

eventBlur()

Trigger the event when the a widget loses input focus.

```
widget.eventBlur();
```

6.28 PDFPKCS7Signer

Creating a Signer

To create a signer object an instance of `PDFPKCS7Signer` is required.

new(*filename*, *password*)

Read a certificate and private key from a *pfx* file and create a *signer* to hold this information. Used with PDFWidget.sign().

Arguments

- **filename** – `String`.
- **password** – `String`.

Returns

`PDFPKCS7Signer`.

```
var signer = new PDFPKCS7Signer(<file_name>, <password>);
```

6.29 OutlineIterator

An outline iterator can be used to walk over all the items in an *Outline* and query their properties. To be able to insert items at the end of a list of sibling items, it can also walk one item past the end of the list. To get an instance of `OutlineIterator` use Document outlineIterator.

Note: In the context of a *PDF* file, the document's *Outline* is also known as *Table of Contents* or *Bookmarks*.

item()

Return an Outline Iterator Object or `undefined` if out of range.

Returns

`Object`.

```
var obj = outlineIterator.item();
```

next()

Move the iterator position to "next".

Returns

`Int` which is negative if this movement is not possible, `0` if the new position has a valid item, or `1` if the new position has no item but one can be inserted here.

```
var result = outlineIterator.next();
```

prev()

Move the iterator position to "previous".

Returns

`Int` which is negative if this movement is not possible, `0` if the new position has a valid item, or `1` if the new position has no item but one can be inserted here.

```
var result = outlineIterator.prev();
```

up()

Move the iterator position "up".

Returns

`Int` which is negative if this movement is not possible, `0` if the new position has a valid item, or `1` if the new position has no item but one can be inserted here.

```
var result = outlineIterator.up();
```

down()

Move the iterator position "down".

Returns

`Int` which is negative if this movement is not possible, `0` if the new position has a valid item, or `1` if the new position has no item but one can be inserted here.

```
var result = outlineIterator.down();
```

insert(*item*)

Insert item before the current item. The position does not change.

Arguments

- **item** – `Object` which conforms to the Outline Iterator Object.

Returns

`Int` which is `0` if the current position has a valid item, or `1` if the position has no valid item.

```
var valid = outlineIterator.insert(item);
```

delete()

Delete the current item. This implicitly moves to the next item.

Returns

`Int` which is `0` if the new position has a valid item, or `1` if the position contains no valid item, but one may be inserted at this position.

```
outlineIterator.delete();
```

update(*item*)

Updates the current item properties with values from the supplied item's properties.

Arguments

- **item** – `Object` which conforms to the Outline Iterator Object.

```
outlineIterator.update(item);
```

6.30 Archive

new Archive(*path*)

Constructor method.

Create a new archive based either on a *tar* or *zip* file or the contents of a directory.

Arguments

- **path** – `String`.

Returns
Archive.

```
var archive = new mupdf.Archive("example1.zip");
var archive2 = new mupdf.Archive("example2.tar");
```

getFormat()

Returns a string describing the archive format.

Returns
String.

```
var archive = new mupdf.Archive("example1.zip");
print(archive.getFormat());
```

countEntries()

Returns the number of entries in the archive.

Returns
Integer.

```
var archive = new mupdf.Archive("example1.zip");
var numEntries = archive.countEntries();
```

listEntry(*idx*)

Returns the name of entry number idx in the archive.

Arguments

- **idx** – Integer.

Returns
String.

```
var archive = new mupdf.Archive("example1.zip");
var entry = archive.listEntry(0);
```

hasEntry(*name*)

Returns *true* if an entry of the given name exists in the archive.

Arguments

- **name** – String.

Returns
Boolean.

```
var archive = new mupdf.Archive("example1.zip");
var hasEntry = archive.hasEntry("file1.txt");
```

readEntry(*name*)

Returns the contents of the entry of the given name.

Arguments

- **name** – String.

Returns

String.

```
var archive = new mupdf.Archive("example1.zip");
var contents = archive.readEntry("file1.txt");
```

6.31 MultiArchive

new MultiArchive()

Constructor method.

Create a new empty multi archive.

Returns

MultiArchive.

```
var multiArchive = new mupdf.MultiArchive();
```

mountArchive(*subArchive*, *path*)

Add an archive to the set of archives handled by a multi archive. If path is null, the subArchive contents appear at the top-level, otherwise they will appear prefixed by the string path.

Arguments

- **subArchive** – Archive.
- **path** – String.

```
var archive = new mupdf.MultiArchive();
archive.mountArchive(new mupdf.Archive("example1.zip"), null);
archive.mountArchive(new mupdf.Archive("example2.tar"), "subpath");
print(archive.hasEntry("file1.txt"));
print(archive.hasEntry("subpath/file2.txt"));
```

Assuming that example1.zip contains a file1.txt and example2.tar contains file2.txt, the multi-archive now allows access to "file1.txt" and "subpath/file2.txt".

6.32 TreeArchive

new TreeArchive()

Constructor method.

Create a new empty tree archive.

Returns

TreeArchive.

```
var treeArchive = new mupdf.TreeArchive();
```

add(*name*, *buffer*)

Add a named buffer to a tree archive.

Arguments

- **name** – String.
- **buffer** – Buffer.

```
var buf = new mupdf.Buffer();
buf.writeLine("hello world!");
var archive = new mupdf.TreeArchive();
archive.add("file2.txt", buf);
print(archive.hasEntry("file2.txt"));
```

6.33 Story

new Story(*contents*, *userCSS*, *em*, *archive*)

Constructor method.

Create a new story with the given contents, formatted according to the provided userCSS and em size, and an archive to lookup images, etc.

Arguments

- **contents** – String *HTML* source code. If omitted, a basic minimum is generated.
- **userCSS** – String *CSS* source code. If provided, must contain valid *CSS* specifications.
- **em** – Float The default text font size.
- **archive** – An Archive from which to load resources for rendering. Currently supported resource types are images and text fonts. If omitted, the Story will not try to look up any such data and may thus produce incomplete output.

```
var story = new mupdf.Story(<contents>, <css>, <em>, <archive>);
```

document()

Return an `XML` for an unplaced story. This allows adding content before placing the `Story`.

Returns
XML.

```
var xml = story.document();
```

place(*rect*)

Place (or continue placing) a `Story` into the supplied rectangle, returning a Placement Result Object. Call `draw()` to draw the placed content before calling `place()` again to continue placing remaining content.

Arguments

- **rect** – `[ulx,uly,lrx,lry]` Rectangle.

Returns
Placement Result Object.

```
var result = story.place([0,0,100,100]);
```

draw(*device*, *transform*)

Draw the placed `Story` to the given `device` with the given `transform`.

Arguments

- **device** – Device.
- **transform** – `[a,b,c,d,e,f]`. The transform matrix.

```
story.draw(device, mupdf.Matrix.identity);
```

6.34 XML

This represents an *HTML* or an *XML* node. It is a helper class intended to access the *DOM* (*Document Object Model*) content of a Story object.

body()

Return an `XML` for the body element.

Returns
`XML`.

```
var result = xml.body();
```

documentElement()

Return an XML for the top level element.

Returns
XML.

```
var result = xml.documentElement();
```

createElement(*tag*)

Create an element with the given tag type, but do not link it into the XML yet.

Arguments

- **tag** – String.

Returns
XML.

```
var result = xml.createElement("div");
```

createTextNode(*text*)

Create a text node with the given text contents, but do not link it into the XML yet.

Arguments

- **text** – String.

Returns
XML.

```
var result = xml.createElement("Hello world!");
```

find(*tag*, *attribute*, *value*)

Find the element matching the tag, attribute and value. Set either of those to null to match anything.

Arguments

- **tag** – String.
- **attribute** – String.
- **value** – String.

Returns
XML.

```
var result = xml.find("tag", "attribute", "value");
```

findNext(*tag*, *attribute*, *value*)

Find the next element matching the tag, attribute and value. Set either of those to null to match anything.

Arguments

- **tag** – String.
- **attribute** – String.
- **value** – String.

Returns
XML.

```
var result = xml.findNext("tag", "attribute", "value");
```

appendChild(*dom*, *childDom*)

Insert an element as the last child of a parent, unlinking the child from its current position if required.

Arguments

- **dom** – XML.
- **childDom** – XML.

```
xml.appendChild(dom, childDom);
```

insertBefore(*dom*, *elementDom*)

Insert an element before this element, unlinking the new element from its current position if required.

Arguments

- **dom** – XML.
- **elementDom** – XML.

```
xml.insertBefore(dom, elementDom);
```

insertAfter(*dom*, *elementDom*)

Insert an element after this element, unlinking the new element from its current position if required.

Arguments

- **dom** – XML.
- **elementDom** – XML.

```
xml.insertAfter(dom, elementDom);
```

remove()

Remove this element from the XML. The element can be added back elsewhere if required.

Returns
XML.

```
var result = xml.remove();
```

clone()

Clone this element (and its children). The clone is not yet linked into the XML.

Returns
XML.

```
var result = xml.clone();
```

firstChild()

Return the first child of the element as a XML, or null if no child exist.

Returns
XML | null.

```
var result = xml.firstChild();
```

parent()

Return the parent of the element as a XML, or null if no parent exists.

Returns
XML | null.

```
var result = xml.parent();
```

next()

Return the next element as a XML, or null if no such element exists.

Returns
XML | null.

```
var result = xml.next();
```

previous()

Return the previous element as a XML, or null if no such element exists.

Returns
XML | null.

```
var result = xml.previous();
```

addAttribute(*attribute*, *value*)

Add attribute with the given value, returns the updated element as an XML.

Arguments

- **attribute** – String.
- **value** – String.

Returns
XML.

```
var result = xml.addAttribute("attribute", "value");
```

removeAttribute(*attribute*)

Remove the specified attribute from the element.

Arguments

- **attribute** – String.

```
xml.removeAttribute("attribute");
```

attribute(*attribute*)

Return the element's attribute value as a String, or null if no such attribute exists.

Arguments

- **attribute** – String.

Returns

String | null.

```
var result = xml.attribute("attribute");
```

getAttributes()

Returns a dictionary object with properties and their values corresponding to the element's attributes and their values.

Returns

{}.

```
var dict = xml.getAttributes();
```

6.35 Global *MuPDF* methods

print(...)

Print arguments to stdout, separated by spaces and followed by a newline.

Arguments

- **...** – Arguments to print.

```
var document = new Document.openDocument("my_pdf.pdf");
print(document); // [object pdf_document]
```

write(...)

Print arguments to stdout, separated by spaces.

Arguments

- `...` – Arguments to print.

repr(*object*)

Format the `object` into a string with *JavaScript* syntax.

Arguments

- **object** – Object to format.

```
var document = new Document.openDocument("my_pdf.pdf");
print(document.getJournal()); // "[object Object]"
print(repr(document.getJournal())); // "{position: 0, steps: []}"
```

gc(*report*)

Run the garbage collector to free up memory. Optionally report statistics on the garbage collection.

Arguments

- **report** – `Boolean` If *true* then the results will be printed to `stdout`.

load(*fileName*)

Load and execute script in `fileName`.

Arguments

- **fileName** – `String` *JavaScript* file to load.

read(*fileName*)

Read the contents of a file and return them as a *UTF-8* encoded string.

Arguments

- **fileName** – `String`.

readline()

Read one line of input from `stdin` and return it as a string.

Returns
`String`.

require(*module*)

Load a *JavaScript* module.

Arguments

- **module** – Module to load.

setUserCSS(*userStyleSheet*, *usePublisherStyles*)

Set user styles and whether to use publisher styles when laying out reflowable documents.

Arguments

- **userStyleSheet** – Link to *CSS* stylesheet file.
- **usePublisherStyles** – `Boolean`.

`quit`(*exitStatus*)

Terminate script execution and exit with the provided exit status.

Arguments

- **`exitStatus`** – `Integer` exit status to return.

6.36 PDF Processor

A *PDF processor* provides callbacks that get called for each *PDF* operator handled by `PDFPage process()` & `PDFAnnotation process()` methods. The callbacks whose names start with `op_` correspond to each *PDF* operator. Refer to the *PDF* specification for what these do and what the callback arguments are.

6.36.1 Methods

Main methods

- `push_resources(resources)`
- `pop_resources()`

General graphics state callbacks

- `op_w(lineWidth)`
- `op_j(lineJoin)`
- `op_J(lineCap)`
- `op_M(miterLimit)`
- `op_d(dashPattern, phase)`
- `op_ri(intent)`
- `op_i(flatness)`
- `op_gs(name, extGState)`

Special graphics state

- `op_q()`
- `op_Q()`
- `op_cm(a, b, c, d, e, f)`

Path construction

- op_m(x, y)
- op_l(x, y)
- op_c(x1, y1, x2, y2, x3, y3)
- op_v(x2, y2, x3, y3)
- op_y(x1, y1, x3, y3)
- op_h()
- op_re(x, y, w, h)

Path painting

- op_S()
- op_s()
- op_F()
- op_f()
- op_fstar()
- op_B()
- op_Bstar()
- op_b()
- op_bstar()
- op_n()

Clipping paths

- op_W()
- op_Wstar()

Text objects

- op_BT()
- op_ET()

Text state

- op_Tc(charSpace)
- op_Tw(wordSpace)
- op_Tz(scale)
- op_TL(leading)
- op_Tf(name, size)
- op_Tr(render)
- op_Ts(rise)

Text positioning

- op_Td(tx, ty)
- op_TD(tx, ty)
- op_Tm(a, b, c, d, e, f)
- op_Tstar()

Text showing

- op_TJ(textArray)
- op_Tj(stringOrByteArray)
- op_squote(stringOrByteArray)
- op_dquote(wordSpace, charSpace, stringOrByteArray)

Type 3 fonts

- op_d0(wx, wy)
- op_d1(wx, wy, llx, lly, urx, ury)

Color

- op_CS(name, colorspace)
- op_cs(name, colorspace)
- op_SC_color(color)
- op_sc_color(color)
- **op_SC_pattern(name, patternID, color)**
  API not settled, arguments may change in the future.
- **op_sc_pattern(name, patternID, color)**
  API not settled, arguments may change in the future.
- **op_SC_shade(name, shade)**
  API not settled, arguments may change in the future.

- **op_sc_shade(name, shade)**
  API not settled, arguments may change in the future.
- op_G(gray)
- op_g(gray)
- op_RG(r, g, b)
- op_rg(r, g, b)
- op_K(c, m, y, k)
- op_k(c, m, y, k)

Shadings, images and XObjects

- op_BI(image, colorspace)
- **op_sh(name, shade)**
  API not settled, arguments may change in the future.
- op_Do_image(name, image)
- op_Do_form(xobject, resources)

Marked content

- op_MP(tag)
- op_DP(tag, raw)
- op_BMC(tag)
- op_BDC(tag, raw)
- op_EMC()

Compatibility

- op_BX()
- op_EX()

CHAPTER

SEVEN

LANGUAGE BINDINGS

Auto-generated *C++*, *Python* and *C#* versions of the *MuPDF C API* are available.

These *APIs* are currently a beta release and liable to change.

7.1 The C++ MuPDF API

7.1.1 Basics

- Auto-generated from the MuPDF C API's header files.
- Everything is in C++ namespace `mupdf`.
- All functions and methods do not take `fz_context*` arguments. (Automatically-generated per-thread contexts are used internally.)
- All MuPDF `setjmp()/longjmp()`-based exceptions are converted into C++ exceptions.

7.1.2 Low-level C++ API

The MuPDF C API is provided as low-level C++ functions with `ll_` prefixes.

- No `fz_context*` arguments.
- MuPDF exceptions are converted into C++ exceptions.

7.1.3 Class-aware C++ API

C++ wrapper classes wrap most `fz_*` and `pdf_*` C structs.

- Class names are camel-case versions of the wrapped struct's name, for example `fz_document`'s wrapper class is `mupdf::FzDocument`.
- Classes automatically handle reference counting of the underlying C structs, so there is no need for manual calls to `fz_keep_*()` and `fz_drop_*()`, and class instances can be treated as values and copied arbitrarily.

Class-aware functions and methods take and return wrapper class instances instead of MuPDF C structs.

- No `fz_context*` arguments.
- MuPDF exceptions are converted into C++ exceptions.
- Class-aware functions have the same names as the underlying C API function.
- Args that are pointers to a MuPDF struct will be changed to take a reference to the corresponding wrapper class.

- Where a MuPDF function returns a pointer to a struct, the class-aware C++ wrapper will return a wrapper class instance by value.
- Class-aware functions that have a C++ wrapper class as their first parameter are also provided as a member function of the wrapper class, with the same name as the class-aware function.
- Wrapper classes are defined in `mupdf/platform/c++/include/mupdf/classes.h`.
- Class-aware functions are declared in `mupdf/platform/c++/include/mupdf/classes2.h`.

Usually it is more convenient to use the class-aware C++ API rather than the low-level C++ API.

7.1.4 C++ Exceptions

C++ exceptions use classes for each `FZ_ERROR_*` enum, all derived from a class `mupdf::FzErrorBase` which in turn derives from `std::exception`.

For example if MuPDF C code does `fz_throw(ctx, FZ_ERROR_GENERIC, "something failed")`, this will appear as a C++ exception with type `mupdf::FzErrorGeneric`. Its `what()` method will return `code=2: something failed`, and it will have a public member `m_code` set to `FZ_ERROR_GENERIC`.

7.1.5 Example wrappers

The MuPDF C API function `fz_new_buffer_from_page()` is available as these C++ functions/methods:

```
// MuPDF C function.
fz_buffer *fz_new_buffer_from_page(fz_context *ctx, fz_page *page, const fz_stext_
↪options *options);

// MuPDF C++ wrappers.
namespace mupdf
{
    // Low-level wrapper:
    ::fz_buffer *ll_fz_new_buffer_from_page(::fz_page *page, const ::fz_stext_options␣
↪*options);

    // Class-aware wrapper:
    FzBuffer fz_new_buffer_from_page(const FzPage& page, FzStextOptions& options);

    // Method in wrapper class FzPage:
    struct FzPage
    {
        ...
        FzBuffer fz_new_buffer_from_page(FzStextOptions& options);
        ...
    };
}
```

7.1.6 Extensions beyond the basic C API

- Some generated classes have extra `begin()` and `end()` methods to allow standard C++ iteration:

```
#include "mupdf/classes.h"
#include "mupdf/functions.h"

#include <iostream>

void show_stext(mupdf::FzStextPage& page)
{
    for (mupdf::FzStextPage::iterator it_page: page)
    {
        mupdf::FzStextBlock block = *it_page;
        for (mupdf::FzStextBlock::iterator it_block: block)
        {
            mupdf::FzStextLine line = *it_block;
            for (mupdf::FzStextLine::iterator it_line: line)
            {
                mupdf::FzStextChar stextchar = *it_line;
                fz_stext_char* c = stextchar.m_internal;
                using namespace mupdf;
                std::cout << "FzStextChar("
                        << "c=" << c->c
                        << " color=" << c->color
                        << " origin=" << c->origin
                        << " quad=" << c->quad
                        << " size=" << c->size
                        << " font_name=" << c->font->name
                        << "\n";
            }
        }
    }
}
```

- There are various custom class methods and constructors.
- There are extra functions for generating a text representation of 'POD' (plain old data) structs and their C++ wrapper classes.

  For example for `fz_rect` we provide these functions:

```
std::ostream& operator<< (std::ostream& out, const fz_rect& rhs);
std::ostream& operator<< (std::ostream& out, const FzRect& rhs);
std::string to_string_fz_rect(const fz_rect& s);
std::string to_string(const fz_rect& s);
std::string Rect::to_string() const;
```

  These each generate text such as: `(x0=90.51 y0=160.65 x1=501.39 y1=1215.6)`

7.1.7 Runtime environmental variables

All builds

- **MUPDF_mt_ctx**

  Controls support for multi-threading on startup.

  - If set with value `0`, a single `fz_context*` is used for all threads; this might give a small performance increase in single-threaded programmes, but will be unsafe in multi-threaded programmes.
  - Otherwise each thread has its own `fz_context*`.

  One can instead call `mupdf::reinit_singlethreaded()` on startup to force single-threaded mode. This should be done before any other use of MuPDF.

Debug builds only

Debug builds contain diagnostics/checking code that is activated via these environmental variables:

- **MUPDF_check_refs**

  If `1`, generated code checks MuPDF struct reference counts at runtime.

- **MUPDF_check_error_stack**

  If `1`, generated code outputs a diagnostic if a MuPDF function changes the current `fz_context`'s error stack depth.

- **MUPDF_trace**

  If `1` or `2`, class-aware code outputs a diagnostic each time it calls a MuPDF function (apart from keep/drop functions).

  If `2`, low-level wrappers output a diagnostic each time they are called. We also show arg POD and pointer values.

- **MUPDF_trace_director**

  If `1`, generated code outputs a diagnostic when doing special handling of MuPDF structs containing function pointers.

- **MUPDF_trace_exceptions**

  If `1`, generated code outputs diagnostics when it converts MuPDF `setjmp()`/`longjmp()` exceptions into C++ exceptions.

- **MUPDF_trace_keepdrop**

  If `1`, generated code outputs diagnostics for calls to `*_keep_*()` and `*_drop_*()`.

7.1.8 Limitations

- Global instances of C++ wrapper classes are not supported.

  This is because:

  - C++ wrapper class destructors generally call MuPDF functions (for example `fz_drop_*()`).
  - The C++ bindings use internal thread-local objects to allow per-thread `fz_context`'s to be efficiently obtained for use with underlying MuPDF functions.
  - C++ globals are destructed *after* thread-local objects are destructed.

So if a global instance of a C++ wrapper class is created, its destructor will attempt to get a `fz_context*` using internal thread-local objects which will have already been destroyed.

We attempt to display a diagnostic when this happens, but this cannot be relied on as behaviour is formally undefined.

7.2 The Python and C# MuPDF APIs

- A Python module called `mupdf`.
- A C# namespace called `mupdf`.
  - C# bindings are experimental as of 2021-10-14.
- Auto-generated from the C++ MuPDF API using SWIG, so inherits the abstractions of the C++ API:
  - No `fz_context*` arguments.
  - Automatic reference counting, so no need to call `fz_keep_*()` or `fz_drop_*()`, and we have value-semantics for class instances.
  - Native Python and C# exceptions.
- Output parameters are returned as tuples.

  For example MuPDF C function `fz_read_best()` has prototype:

```
fz_buffer *fz_read_best(fz_context *ctx, fz_stream *stm, size_t initial, int␣
↪*truncated);
```

  The class-aware Python wrapper is:

  mupdf.fz_read_best(stm, initial)

  and returns `(buffer, truncated)`, where `buffer` is a SWIG proxy for a `mupdf::FzBuffer` instance and `truncated` is an integer.
- Allows implementation of mutool in Python - see mupdf:scripts/mutool.py and mupdf:scripts/mutool_draw.py.
- Provides text representation of simple 'POD' structs:

```
rect = mupdf.FzRect(...)
print(rect) # Will output text such as: (x0=90.51 y0=160.65 x1=501.39 y1=215.6)
```

  - This works for classes where the C++ API defines a `to_string()` method as described above.
    - Python classes will have a `__str__()` method, and an identical `__repr__()` method.
    - C# classes will have a `ToString()` method.
- Uses SWIG Director classes to allow C function pointers in MuPDF structs to call Python code.
  - This has not been tested on C#.

7.3 Installing the Python mupdf module using `pip`

The Python `mupdf` module is available on the Python Package Index (PyPI) website.

- Install with `pip install mupdf`.
- Pre-built Wheels (binary Python packages) are provided for Windows and Linux.
- For more information on the latest release, see changelog below and: https://pypi.org/project/mupdf/

7.4 Doxygen/Pydoc API documentation

Auto-generated documentation for the C, C++ and Python APIs is available at: https://ghostscript.com/~julian/mupdf-bindings/

- All content is generated from the comments in MuPDF header files.
- This documentation is generated from an internal development tree, so may contain features that are not yet publicly available.
- It is updated only intermittently.

7.5 Example client code

7.5.1 Using the Python API

Minimal Python code that uses the `mupdf` module:

```
import mupdf
document = mupdf.FzDocument('foo.pdf')
```

A simple example Python test script (run by `scripts/mupdfwrap.py -t`) is:

- scripts/mupdfwrap_test.py

More detailed usage of the Python API can be found in:

- scripts/mutool.py
- scripts/mutool_draw.py

Example Python code that shows all available information about a document's Stext blocks, lines and characters.

```
#!/usr/bin/env python3

import mupdf

def show_stext(document):
    '''
    Shows all available information about Stext blocks, lines and characters.
    '''
    for p in range(document.fz_count_pages()):
        page = document.fz_load_page(p)
```

(continues on next page)

(continued from previous page)

```
        stextpage = mupdf.FzStextPage(page, mupdf.FzStextOptions())
        for block in stextpage:
            block_ = block.m_internal
            log(f'block: type={block_.type} bbox={block_.bbox}')
            for line in block:
                line_ = line.m_internal
                log(f'    line: wmode={line_.wmode}'
                        + f' dir={line_.dir}'
                        + f' bbox={line_.bbox}'
                        )
                for char in line:
                    char_ = char.m_internal
                    log(f'        char: {chr(char_.c)!r} c={char_.c:4} color=
↪{char_.color}'
                            + f' origin={char_.origin}'
                            + f' quad={char_.quad}'
                            + f' size={char_.size:6.2f}'
                            + f' font=('
                                +  f'is_mono={char_.font.flags.is_mono}'
                                + f' is_bold={char_.font.flags.is_bold}'
                                + f' is_italic={char_.font.flags.is_italic}'
                                + f' ft_substitute={char_.font.flags.ft_
↪substitute}'
                                + f' ft_stretch={char_.font.flags.ft_stretch}'
                                + f' fake_bold={char_.font.flags.fake_bold}'
                                + f' fake_italic={char_.font.flags.fake_italic}
↪'
                                + f' has_opentype={char_.font.flags.has_
↪opentype}'
                                + f' invalid_bbox={char_.font.flags.invalid_
↪bbox}'
                                + f' name={char_.font.name}'
                                + f')'
                            )

document = mupdf.FzDocument('foo.pdf')
show_stext(document)
```

7.5.2 Basic PDF viewers written in Python and C#

- scripts/mupdfwrap_gui.py
- scripts/mupdfwrap_gui.cs
- Build and run with:
  - `./scripts/mupdfwrap.py -b all --test-python-gui`
  - `./scripts/mupdfwrap.py -b --csharp all --test-csharp-gui`

7.6 Changelog

[Note that this is only for changes to the generation of the C++/Python/C# APIs; changes to the main MuPDF API are not detailed here.]

- **2023-11-16**:
  - Fixed debug builds on Windows.
  - Fixed 32-bit builds on Windows.
  - Fixed cross-build to arm64 on MacOS.
  - Fixed unsafe custom fz_search_page2().
  - Added custom fz_highlight_selection2().
  - Added debug diagnostics to Director `use_virtual_*()` methods.
  - Various fixes for Pyodide builds.
  - Use version numbers in names of shared libraries.
  - Added custom wrapping of struct pdf_clean_options.
  - Use $CXX if defined when building bindings (not Windows).
- **2023-07-13**:
  - Improved generation of extra/customised functions and methods.

    Instead of adding custom C++/Python/C# code, we instead inject new C++ functions as though they were part of the MuPDF C API when parsing MuPDF C headers. Thus customised functions are automatically wrapped and available as low-level functions, class-aware functions and class methods.
- **2023-05-02**:
  - Improved implementation of Python-specific wrappers:
    - Consistently use low-level wrappers to implement high-level wrappers.
    - Added missing low-level wrappers.
      - `ll_fz_buffer_storage_memoryview()`
      - `ll_fz_fill_text2()`
      - `ll_fz_pixmap_copy()`
      - `ll_fz_parse_page_range_orig()`
      - `ll_fz_format_output_path()`
      - `ll_fz_buffer_extract()`
      - `ll_fz_buffer_extract_copy()`
      - `ll_fz_new_buffer_from_copied_data()`
      - `ll_pdf_dict_getl()`
      - `ll_pdf_dict_putl()`
      - `ll_fz_fill_text()`
      - `ll_fz_pixmap_samples_memoryview()`
    - Renamed `mupdf.python_bytes_data()` to `mupdf.python_buffer_data()` because it works on any instance that supports the Python Buffer interface.

    - Renamed `python_buffer_to_memoryview()` to `fz_buffer_storage_memoryview()`, because it uses a MuPDF `fz_buffer`, not a Python buffer.
    - Added `ll_fz_pixmap_copy_raw()` for copying raw sample data directly into a `fz_pixmap`.
    - In wrappers for `pdf_dict_getl()` and `pdf_dict_putl()`, generate diagnostics if variadic args are the wrong type.
    - Renamed `fz_pixmap_samples2()` to `ll_fz_pixmap_samples_memoryview()`.
    - Added `fz_warn()`, same as `ll_fz_wrap()`.
  - Fixes for MacOS and improved finding of struct members.
  - Give Python and C# access to arrays of floats; e.g. for `fz_stroke_state`'s `float dash_list[32];`.
  - Updated bindings to cope with recent rename `pdf_field_name()` => `pdf_load_field_name()`.
  - `MUPDF_trace` also enables `fz_clone_context()`/`fz_new_context()`/`fz_drop_context()` diagnostics.
  - Disabled questionable diagnostics about memory leaks.
  - In `fz_compressed_buffer` class wrapper, give access to `m_internal->buffer`.
  - If Python callback raises an exception, add a Python backtrace to the exception text.
  - Allow building with Visual Studio 2022 without VS-2019 v142 tools installed. See new `--vs-upgrade 0|1` option.
  - Also use pdf_new_*() as constructors of `fz_*` structs where applicable. For example this adds `pdf_new_stext_page_from_annot()` as a constructor of `fz_stext_page`.
  - Use new `scripts/wrap/wdev.py` to find C# compiler `csc.exe` on Windows.
  - Fixed handling of functions that return `const fz_foo*`.
  - Use our own handling of out-params instead of SWIG.
  - Fixes for use with libclang-16.0.0
- **2023-02-14**:
  - Simplified builds by requiring a standalone libclang (typically pypi.org's libclang in a Python venv) and fixed various issues with using latest libclang.
  - Added test for exceptions from Python SWIG Director callbacks.
- **2023-02-03**:
  - Provide a default constructor for all wrapper classes.
  - Added Python `__repr__()` methods for POD classes, identical to the existing `__str__()` methods.
  - Fixed handling of exceptions in Python SWIG Director callbacks.
  - Fixed wrapping of PDF filters.
- **2023-01-20**:
  - Don't disable SWIG Directors on Windows.
  - Show warnings if env settings (e.g. `MUPDF_trace`) will be ignored because we are a release build.
  - Added Python support for MuPDF Stories.
- **2023-01-12**: New release of Python package **mupdf-1.21.1.20230112.1504** (from **mupdf-1.21.x** git 04c75ec9db31), with pre-built Wheels for Windows and Linux. See: https://pypi.org/project/mupdf

  - Reduced size of Python sdist by excluding some test directories.
  - Python installation with `pip` will now automatically install `libclang` and `swig`.
  - Added Windows-specific documentation.
  - Fixes for Windows builds.

- **2022-11-23**:
  - Avoid need to specify `LD_LIBRARY_PATH` on Unix by using `rpath`.
  - Allow misc prefixes in build directory.
  - Added accessors to fz_text_span wrapper class. This simplifies use from Python, e.g. returning class wrappers for .font and .trm members, and giving access to the .items[] array.
  - Improved control over single-threaded behaviour.
  - Fixed python wrappers for `fz_set_warning_callback()` and `fz_set_error_callback()`.
  - Fixed implementation of `ll_pdf_set_annot_color()`.

- **2022-10-21**:
  - Document that global instances of wrapper classes are not supported.
  - Python: provide class-aware out-param wrappers.
  - Generate `operator==` and `operator!=` for POD structs and wrapper classes.
  - Moved `operator<<` into top-level namespace.
  - Document that we require the `clang` package on Linux when building.
  - Disable unhelpful SWIG warnings when building.
  - Support for calling `fz_document_handler` fnptrs in C++ API.
  - Work around Memento build problem on Linux.
  - Fixed some leaks by improving detection of functions returning kept/borrowed references.
  - Fixed handling of kept/borrowed references in Python/C# functions with out-params.

- **2022-08-29**: Simplified naming of C++/Python/C# classes and functions.
  - Don't remove leading `fz_` from function/method names.
  - For low-level wrappers, add `ll_` prefix to the original name; don't remove initial `fz_`; don't add `p` prefix for `pdf_*()` wrappers.
  - For class-aware wrapper functions, use original C name; don't use `m` prefix.
  - Include initial `Fz` prefix for wrapper classes of `fz_*` structs.

  So new naming scheme is:

  - Low-level wrappers: prepend `ll_` to the full MuPDF C function name.
  - Wrapper class names: convert the full struct name to camel-case.
  - Wrapper class methods: use the full wrapped MuPDF C function name.
  - Class-aware wrappers: use the full wrapped MuPDF C function name.

- **2022-5-11**: Documented the experimental C# API.

- **2022-3-26**: New release of Python package **mupdf-1.19.0.20220326.1214** (from **mupdf-1.19.0** git 466e06fc7e01), with pre-built Wheels for Windows and Linux. See: https://pypi.org/project/mupdf/

  - Fixed SWIG Directors wrapping classes on Windows.

- **2022-3-23**: New release of Python package **mupdf-1.19.0.20220323.1255** (from **mupdf-1.19.0** git 58e2b82bf7d1e7), with pre-built Wheels for Windows and Linux. See: https://pypi.org/project/mupdf

  Details

  - Use SWIG Director classes to support MuPDF structs that contain fn pointers. This allows MuPDF to call Python callback code. [.line-through]#Only available on Unix at the moment.#
    * This allows us to provide Python wrappers for `fz_set_warning_callback()` and `fz_set_error_callback()`.
  - Added alternative wrappers for MuPDF functions in the form of free-standing functions that operate on our wrapper classes. Useful when porting existing code to Python, and generally as a non-class-based API that still gives automatic handling of reference counting. New functions have same name as underlying MuPDF function with a `m` prefix; they do not take a `fz_context` arg and take/return references to wrapper classes instead of pointers to MuPDF structs.
    * Class methods now call these new free-standing wrappers.
  - Various improvements to enums and non-copyable class wrappers.
  - Use `/** ... */` comments in generated code so visible to Doxygen.
  - Improvements to and fixes to reference counting.
    * Use MuPDF naming conventions for detection of MuPDF functions that return borrowed references.
    * Improved detection of whether a MuPDF struct uses reference counting.
    * Fixed some reference counting issues when handling out-params.
  - Added optional runtime ref count checking.
  - For fns that return raw unsigned char array, provide C++ wrappers that return a `std::vector`. This works much better with SWIG.
  - Allow construction of `Document` from `PdfDocument`.
  - Allow writes to `PdfWriteOptions::opwd_utf8` and `PdfWriteOptions::upwd_utf8`.
  - Added `Page::doc()` to return wrapper for `.doc` member.
  - Added `PdfPage::super()` to return `Page` wrapper for `.super`.
  - Added `PdfDocument::doc()` to return wrapper for `.doc` member.
  - Added `PdfObj::obj()` to return wrapper for `.obj` member.
  - Made Python wrappers for `fz_fill_text()` take Python tuple/list for `float* color` arg.
  - Improved wrapping of `pdf_lexbuf`.
  - Added `Page` downcast constructor from `PdfPage`.
  - Expose `pdf_widget_type` enum.
  - Improved python bindings for `*dict_getl()` and `*dict_putl()`. We now also provide `mpdf_dict_getl()` etc handling variable number of args.
  - Improvements to wrapping of `pdf_filter_options`, `pdf_redact_options`, `fz_pixmap`, `pdf_set_annot_color`, `pdf_obj`.
  - Allow direct use of `PDF_ENUM_NAME_*` enums as `PdfObj`'s in Python.
  - Added wrappers for `pdf_annot_type()` and `pdf_string_from_annot_type()`.

  - Buffer.buffer_storage() raises an exception with useful error info (it is not possible to use it from SWIG bindings).
  - Added various fns to give Python access to some raw pointer values, e.g. for passing to mupdf.new_buffer_from_copied_data().
  - Avoid excluding class method wrappers for pdf_*() fns in python.

- **2022-02-05**: Uploaded Doxygen/Pydoc documentation for the C, C++ and Python APIs, from latest development tree.
- **2021-09-29**: Released Python bindings for **mupdf-1.19.0** (git 61b63d734a7) to pypi.org (**mupdf 1.19.0.20210929.1226**) with pre-built Wheels for Windows and Linux.
- **2021-08-05**: Released Python package **mupdf-1.18.0.20210805.1716** on pypi.org with pre-built Wheels for Windows and Linux.
  - Improved constructors of fz_document_writer wrapper class DocumentWriter.
  - Fixed operator<< for POD C structs - moved from mupdf namespace to top-level.
  - Added scripts/mupdfwrap_gui.py - a simple demo Python PDF viewer.
  - Cope with fz_paint_shade()'s new fz_shade_color_cache **cache arg.
- **2021-05-21**: First release of Python package, **mupdf-1.18.0.20210521.1738**, on pypi.org with pre-built Wheels for Windows and Linux.

  Details

  * Changes that apply to both C++ and Python bindings:
  - Improved access to metadata - added Document::lookup_metadata() overload that returns a std::string. Also provided extern const std::vector<std::string> metadata_keys; containing a list of the supported keys.
  - Iterating over Outline's now returns OutlineIterator objects so that depth information is also available.
  - Fixed a reference-counting bug in iterators.
  - Page::search_page() now returns a std::vector.
  - PdfDocument now has a default constructor which uses pdf_create_document().
  - Include wrappers for functions that return fz_outline*, e.g. Outline Document::load_outline();.
  - Removed potentially slow call of getenv("MUPDF_trace") in every C++ wrapper function.
  - Removed special-case naming of wrappers for fz_run_page() - they are now called mupdf::run_page() and mupdf::Page::run_page(), not mupdf::run() etc.
  - Added text representation of POD structs.
  - Added support for 32 and 64-bit Windows.
  - Many improvements to C++ and Python code generation.
  - Changes that apply only to Python:
    * Improved handling of out-parameters:
      · If a function or method has out-parameters we now systematically return a Python tuple containing any return value followed by the out-parameters.
      · Don't treat FILE* or pointer-to-const as an out-parameter.

    * Added methods for getting the content of a `mupdf.Buffer` as a Python `bytes` instance.
    * Added Python access to nested unions in `fz_stext_block` wrapper class `mupdf.StextBlock`.
    * Allow the MuPDF Python bindings to be installed with `pip`.
        - This uses a source distribution of mupdf that has been uploaded to `pypi.org` in the normal way.
        - Installation involves compiling the C, C++ and Python bindings so will take a few minutes. It requires SWIG to be installed.
        - Pre-built wheels are not currently provided.
    * Write generated C++ information into Python pickle files to allow building on systems without clang-python.
    * Various changes to allow building in Python "Manylinux" containers.
    * Allow Python access to nested unions in `fz_stext_block` wrapper. SWIG doesn't handle nested unions so instead we provide accessor methods in our generated C++ class.
    * Added accessors to `fz_image`'s wrapper class.
    * Improved generated accessor methods - e.g. ignore functions and function pointers and return `int` instead of `int8_t` to avoid SWIG getting confused.

- **2020-10-07**: Experimental release of C++ and Python bindings in MuPDF-1.18.0.

7.7 Building the C++, Python and C# MuPDF APIs from source

7.7.1 General requirements

- Windows, Linux, MacOS or OpenBSD.
- Build should take place inside a Python venv.
- libclang Python interface onto the libclang C/C++ parser.
- swig, for Python and C# bindings.
- Mono, for C# bindings on platforms other than Windows.

7.7.2 Setting up

Windows only

- Install Python.
    - Use the Python Windows installer from the python.org website: http://www.python.org/downloads
    - Don't use other installers such as the Microsoft Store Python package.
        * If Microsoft Store Python is already installed, leave it in place and install from python.org on top of it - uninstalling before running the python.org installer has been known to cause problems.
    - A default installation is sufficient.
    - Debug binaries are required for debug builds of the MuPDF Python API.

  - If "Customize Installation" is chosen, make sure to include "py launcher" so that the `py` command will be available.
  - Also see: https://docs.python.org/3/using/windows.html
- Install Visual Studio 2019. Later versions may not work with MuPDF's solution and build files.

All platforms

- Get the latest version of MuPDF in git.

```
git clone --recursive git://git.ghostscript.com/mupdf.git
```

- Create and enter a Python venv and upgrade pip.
  - Windows.

```
py -m venv pylocal
.\pylocal\Scripts\activate
python -m pip install --upgrade pip
```

  - Linux, MacOS, OpenBSD

```
python3 -m venv pylocal
. pylocal/bin/activate
python -m pip install --upgrade pip
```

7.7.3 General build flags

In all of the commands below, one can set environmental variables to control the build of the underlying MuPDF C API, for example `USE_SYSTEM_LIBJPEG=yes`.

In addition, `XCXXFLAGS` can be used to set additional C++ compiler flags when building the C++ and Python bindings (the name is analogous to the `XCFLAGS` used by MuPDF's makefile when compiling the core library).

7.7.4 Building and installing the Python bindings using `pip`

- Windows, Linux, MacOS.

```
cd mupdf && pip install -vv .
```

- OpenBSD.

  Building using `pip` is not supported because `libclang` is not available from pypi.org so pip will fail to install prerequisites from `pypackage.toml`.

  Instead one can run `setup.py` directly:

```
cd mupdf && setup.py install
```

7.7.5 Building the Python bindings

- Windows, Linux, MacOS.

```
pip install libclang swig setuptools
cd mupdf && python scripts/mupdfwrap.py -b all
```

- OpenBSD.

  `libclang` is not available from pypi.org, but we can instead use the system `py3-llvm` package.

```
sudo pkg_add py3-llvm
pip install swig setuptools
cd mupdf && python scripts/mupdfwrap.py -b all
```

7.7.6 Building the C++ bindings

- Windows, Linux, MacOS.

```
pip install libclang setuptools
cd mupdf && python scripts/mupdfwrap.py -b m01
```

- OpenBSD.

  `libclang` is not available from pypi.org, but we can instead use the system `py3-llvm` package.

```
sudo pkg_add py3-llvm
pip install setuptools
cd mupdf && python scripts/mupdfwrap.py -b m01
```

7.7.7 Building the C# bindings

- Windows.

```
pip install libclang swig setuptools
cd mupdf && python scripts/mupdfwrap.py -b --csharp all
```

- Linux.

```
sudo apt install mono-devel
pip install libclang swig
cd mupdf && python scripts/mupdfwrap.py -b --csharp all
```

- MacOS.

  Building the C# bindings on MacOS is not currently supported.

- OpenBSD.

```
sudo pkg_add py3-llvm mono
pip install swig setuptools
cd mupdf && python scripts/mupdfwrap.py -b --csharp all
```

7.7.8 Using the bindings

To use the bindings, one has to tell the OS where to find the MuPDF runtime files.

- C++ and C# bindings:
  - Windows.

```
set PATH=.../mupdf/build/shared-release-x64-py3.11;%PATH%
```

    * Replace `x64` with `x32` if using 32-bit.
    * Replace `3.11` with the appropriate python version number.
  - Linux, OpenBSD.

```
LD_LIBRARY_PATH=.../mupdf/build/shared-release
```

    (`LD_LIBRARY_PATH` must be an absolute path.)
  - MacOS.

```
DYLD_LIBRARY_PATH=.../mupdf/build/shared-release
```

- Python bindings:

  If the bindings have been built and installed using `pip install`, they will already be available within the venv.

  Otherwise:
  - Windows.

```
PYTHONPATH=.../mupdf/build/shared-release-x64-py3.11
```

    * Replace `x64` with `x32` if using 32-bit.
    * Replace `3.11` with the appropriate python version number.
  - Linux, MacOS, OpenBSD.

```
PYTHONPATH=.../mupdf/build/shared-release
```

7.7.9 Notes

- Running tests.

  Basic tests can be run by appending args to the `scripts/mupdfwrap.py` command.

  This will also demonstrate how to set environment variables such as `PYTHONPATH` or `LD_LIBRARY_PATH` to the MuPDF build directory.
  - Python tests.
    * `--test-python`
    * `--test-python-gui`
  - C# tests.
    * `--test-csharp`
    * `--test-csharp-gui`

  - C++ tests.
    * `--test-cpp`

- Specifying the location of Visual Studio's `devenv.com` on Windows.

  `scripts/mupdfwrap.py` looks for Visual Studio's `devenv.com` in standard locations; this can be overridden with:

```
python scripts/mupdfwrap.py -b --devenv <devenv.com-location> ...
```

- Specifying compilers.

  On non-Windows, we use `cc` and `c++` as default C and C++ compilers; override by setting environment variables `$CC` and `$CXX`.

- OpenBSD `libclang`.
  - `libclang` cannot be installed with pip on OpenBSD - wheels are not available and building from source fails.

    However unlike on other platforms, the system python-clang package (`py3-llvm`) is integrated with the system's libclang and can be used directly.

    So the above examples use `pkg_add py3-llvm`.

- Alternatives to Python package `libclang` generally do not work.

  For example pypi.org's clang, or Debian's python-clang.

  These are inconvenient to use because they require explicit setting of `LD_LIBRARY_PATH` to point to the correct libclang dynamic library.

- Debug builds.

  One can specify a debug build using the `-d` arg before `-b`.

```
python ./scripts/mupdfwrap.py -d build/shared-debug -b ...
```

  - Debug builds of the Python and C# bindings on Windows have not been tested. There may be issues with requiring a debug version of the Python interpreter, for example `python311_d.lib`.

- C# build failure: `cstring.i not implemented for this target` and/or `Unknown directive '%cstring_output_allocate'`.

  This is probably because SWIG does not include support for C#. This has been seen in the past but as of 2023-07-19 pypi.org's default swig seems ok.

  A possible solution is to install SWIG using the system package manager, for example `sudo apt install swig` on Linux, or use `./scripts/mupdfwrap.py --swig-windows-auto ...` on Windows.

- More information about running `scripts/mupdfwrap.py`.
  - Run `python ./scripts/mupdfwrap.py -h`.
  - Read the doc-string at beginning of `scripts/wrap/__main__.py`+.

7.7.10 How `scripts/mupdfwrap.py` builds the APIs

Building the MuPDF C API

- On Unix, runs `make` on MuPDF's `Makefile` with `shared=yes`.
- On Windows, runs `devenv.com` on `.sln` and `.vcxproj` files within MuPDF's platform/win32/ directory.

Generation of the MuPDF C++ API

- Uses clang-python to parse MuPDF's C API.
- Generates C++ code that wraps the basic C interface, converting MuPDF `setjmp()`/`longjmp()` exceptions into C++ exceptions and automatically handling `fz_context`'s internally.
- Generates C++ wrapper classes for each `fz_*` and `pdf_*` struct, and uses various heuristics to define constructors, methods and static methods that call `fz_*()` and `pdf_*()` functions. These classes' constructors and destructors automatically handle reference counting so class instances can be copied arbitrarily.
- C header file comments are copied into the generated C++ header files.
- Compile and link the generated C++ code to create shared libraries.

Generation of the MuPDF Python and C# APIs

- Uses SWIG to parse the previously-generated C++ headers and generate C++, Python and C# code.
- Defines some custom-written Python and C# functions and methods, for example so that out-params are returned as tuples.
- If SWIG is version 4+, C++ comments are converted into Python doc-comments.
- Compile and link the SWIG-generated C++ code to create shared libraries.

7.7.11 Building auto-generated MuPDF API documentation

Build HTML documentation for the C, C++ and Python APIs (using Doxygen and pydoc):

```
python ./scripts/mupdfwrap.py --doc all
```

This will generate the following tree:

```
mupdf/docs/generated/
    index.html
    c/
    c++/
    python/
```

All content is ultimately generated from the MuPDF C header file comments.

As of 2022-2-5, it looks like `swig -doxygen` (swig-4.02) ignores single-line `/** ... */` comments, so the generated Python code (and hence also Pydoc documentation) is missing information.

7.7.12 Generated files

All generated files are within the MuPDF checkout.

- C++ headers for the MuPDF C++ API are in `platform/c++/include/`.
- Files required at runtime are in `build/shared-release/`.

Details

```
mupdf/
    build/
        shared-release/    [Unix runtime files.]
            libmupdf.so    [MuPDF C API, not MacOS.]
            libmupdf.dylib [MuPDF C API, MacOS.]
            libmupdfcpp.so [MuPDF C++ API.]
            mupdf.py       [MuPDF Python API.]
            _mupdf.so      [MuPDF Python API internals.]
            mupdf.cs       [MuPDF C# API.]
            mupdfcsharp.so [MuPDF C# API internals.]

        shared-debug/
            [as shared-release but debug build.]

        shared-release-x*-py*/      [Windows runtime files.]
            mupdfcpp.dll            [MuPDF C and C++ API, x32.]
            mupdfcpp64.dll          [MuPDF C and C++ API, x64.]
            mupdf.py                [MuPDF Python API.]
            _mupdf.pyd              [MuPDF Python API internals.]
            mupdf.cs                [MuPDF C# API.]
            mupdfcsharp.dll         [MuPDF C# API internals.]

    platform/
        c++/
            include/    [MuPDF C++ API header files.]
                mupdf/
                    classes.h
                    classes2.h
                    exceptions.h
                    functions.h
                    internal.h

            implementation/  [MuPDF C++ implementation source files.]
                classes.cpp
                classes2.cpp
                exceptions.cpp
                functions.cpp
                internal.cpp

            generated.pickle    [Information from clang parse step, used by later stages.
↪]
            windows_mupdf.def   [List of MuPDF public global data, used when linking␣
↪mupdfcpp.dll.]

        python/ [SWIG Python input/output files.]
```

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```
            mupdfcpp_swig.cpp
            mupdfcpp_swig.i

        csharp/  [SWIG C# input/output files.]
            mupdf.cs
            mupdfcpp_swig.cpp
            mupdfcpp_swig.i

        win32/
            Release/    [Windows 32-bit .dll, .lib, .exp, .pdb etc.]
            x64/
                Release/    [Windows 64-bit .dll, .lib, .exp, .pdb etc.]
                    mupdfcpp64.dll  [Copied to build/shared-release*/mupdfcpp64.dll]
                    mupdfpyswig.dll [Copied to build/shared-release*/_mupdf.pyd]
                    mupdfcpp64.lib
                    mupdfpyswig.lib

        win32-vs-upgrade/   [used instead of win32/ if PYMUPDF_SETUP_MUPDF_VS_UPGRADE is
↪'1'.]
```

7.8 Windows-specifics

7.8.1 Required predefined macros

Code that will use the MuPDF DLL must be built with `FZ_DLL_CLIENT` predefined.

The MuPDF DLL itself is built with `FZ_DLL` predefined.

7.8.2 DLLs

There is no separate C library, instead the C and C++ APIs are both in `mupdfcpp.dll`, which is built by running devenv on `platform/win32/mupdf.sln`.

The Python SWIG library is called `_mupdf.pyd` which, despite the name, is a standard Windows DLL, built from `platform/python/mupdfcpp_swig.cpp`.

7.8.3 DLL export of functions and data

On Windows, `include/mupdf/fitz/export.h` defines `FZ_FUNCTION` and `FZ_DATA` to `__declspec(dllexport)` and/or `__declspec(dllimport)` depending on whether `FZ_DLL` or `FZ_DLL_CLIENT` are defined.

All MuPDF C headers prefix declarations of public global data with `FZ_DATA`.

In generated C++ code:

- Data declarations and definitions are prefixed with `FZ_DATA`.
- Function declarations and definitions are prefixed with `FZ_FUNCTION`.
- Class method declarations and definitions are prefixed with `FZ_FUNCTION`.

When building `mupdfcpp.dll` on Windows we link with the auto-generated `platform/c++/windows_mupdf.def` file; this lists all C public global data.

For reasons that are not fully understood, we don't seem to need to tag C functions with `FZ_FUNCTION`, but this is required for C++ functions otherwise we get unresolved symbols when building MuPDF client code.

7.8.4 Building the DLLs

We build Windows binaries by running `devenv.com` directly.

Building `_mupdf.pyd` is tricky because it needs to be built with a specific `Python.h` and linked with a specific `python.lib`. This is done by setting environmental variables `MUPDF_PYTHON_INCLUDE_PATH` and `MUPDF_PYTHON_LIBRARY_PATH` when running `devenv.com`, which are referenced by `platform/win32/mupdfpyswig.vcxproj`. Thus one cannot easily build `_mupdf.pyd` directly from the Visual Studio GUI.

[In the git history there is code that builds `_mupdf.pyd` by running the Windows compiler and linker `cl.exe` and `link.exe` directly, which avoids the complications of going via devenv, at the expense of needing to know where `cl.exe` and `link.exe` are.]

7.9 C++ bindings details

7.9.1 Wrapper functions

Wrappers for a MuPDF function `fz_foo()` are available in multiple forms:

- Functions in the `mupdf` namespace.
  - `mupdf::ll_fz_foo()`
    - Low-level wrapper:
      - Does not take `fz_context*` arg.
      - Translates MuPDF exceptions into C++ exceptions.
      - Takes/returns pointers to MuPDF structs.
      - Code that uses these functions will need to make explicit calls to `fz_keep_*()` and `fz_drop_*()`.
  - `mupdf::fz_foo()`
    - High-level class-aware wrapper:
      - Does not take `fz_context*` arg.
      - Translates MuPDF exceptions into C++ exceptions.
      - Takes references to C++ wrapper class instances instead of pointers to MuPDF structs.
      - Where applicable, returns C++ wrapper class instances instead of pointers to MuPDF structs.
      - Code that uses these functions does not need to call `fz_keep_*()` and `fz_drop_*()` - C++ wrapper class instances take care of reference counting internally.
- Class methods
  - Where `fz_foo()` has a first arg (ignoring any `fz_context*` arg) that takes a pointer to a MuPDF struct `foo_bar`, it is generally available as a member function of the wrapper class `mupdf::FooBar`:
    - `mupdf::FooBar::fz_foo()`

  - Apart from being a member function, this is identical to class-aware wrapper `mupdf::fz_foo()`, for example taking references to wrapper classes instead of pointers to MuPDF structs.

7.9.2 Constructors using MuPDF functions

Wrapper class constructors are created for each MuPDF function that returns an instance of a MuPDF struct.

Sometimes two such functions do not have different arg types so C++ overloading cannot distinguish between them as constructors (because C++ constructors do not have names).

We cope with this in two ways:

- Create a static method that returns a new instance of the wrapper class by value.
  - This is not possible if the underlying MuPDF struct is not copyable - i.e. not reference counted and not POD.
- Define an enum within the wrapper class, and provide a constructor that takes an instance of this enum to specify which MuPDF function to use.

7.9.3 Default constructors

All wrapper classes have a default constructor.

- For POD classes each member is set to a default value with `this->foo = {};`. Arrays are initialised by setting all bytes to zero using `memset()`.
- For non-POD classes, class member `m_internal` is set to `nullptr`.
- Some classes' default constructors are customized, for example:
  - The default constructor for `fz_color_params` wrapper `mupdf::FzColorParams` sets state to a copy of `fz_default_color_params`.
  - The default constructor for `fz_md5` wrapper `mupdf::FzMd5` sets state using `fz_md5_init()`.
  - These are described in class definition comments in `platform/c++/include/mupdf/classes.h`.

7.9.4 Raw constructors

Many wrapper classes have constructors that take a pointer to the underlying MuPDF C struct. These are usually for internal use only. They do not call `fz_keep_*()` - it is expected that any supplied MuPDF struct is already owned.

7.9.5 POD wrapper classes

Class wrappers for MuPDF structs default to having a `m_internal` member which points to an instance of the wrapped struct. This works well for MuPDF structs which support reference counting, because we can automatically create copy constructors, `operator=` functions and destructors that call the associated `fz_keep_*()` and `fz_drop_*()` functions.

However where a MuPDF struct does not support reference counting and contains simple data, it is not safe to copy a pointer to the struct, so the class wrapper will be a POD class. This is done in one of two ways:

- `m_internal` is an instance of the MuPDF struct, not a pointer.
  - Sometimes we provide members that give direct access to fields in `m_internal`.
- An 'inline' POD - there is no `m_internal` member; instead the wrapper class contains the same members as the MuPDF struct. This can be a little more convenient to use.

7.9.6 Extra static methods

Where relevant, wrapper class can have static methods that wrap selected MuPDF functions. For example `FzMatrix` does this for `fz_concat()`, `fz_scale()` etc, because these return the result by value rather than modifying a `fz_matrix` instance.

7.9.7 Miscellaneous custom wrapper classes

The wrapper for `fz_outline_item` does not contain a `fz_outline_item` by value or pointer. Instead it defines C++-style member equivalents to `fz_outline_item`'s fields, to simplify usage from C++ and Python/C#.

The fields are initialised from a `fz_outline_item` when the wrapper class is constructed. In this particular case there is no need to hold on to a `fz_outline_item`, and the use of `std::string` ensures that value semantics can work.

7.10 Extra functions in C++, Python and C#

[These functions are available as low-level functions, class-aware functions and class methods.]

```
/**
C++ alternative to `fz_lookup_metadata()` that returns a `std::string`
or calls `fz_throw()` if not found.
*/
FZ_FUNCTION std::string fz_lookup_metadata2(fz_context* ctx, fz_document* doc, const␣
↪char* key);

/**
C++ alternative to `pdf_lookup_metadata()` that returns a `std::string`
or calls `fz_throw()` if not found.
*/
FZ_FUNCTION std::string pdf_lookup_metadata2(fz_context* ctx, pdf_document* doc, const␣
↪char* key);

/**
C++ alternative to `fz_md5_pixmap()` that returns the digest by value.
*/
FZ_FUNCTION std::vector<unsigned char> fz_md5_pixmap2(fz_context* ctx, fz_pixmap*␣
↪pixmap);

/**
C++ alternative to fz_md5_final() that returns the digest by value.
*/
FZ_FUNCTION std::vector<unsigned char> fz_md5_final2(fz_md5* md5);

/** */
FZ_FUNCTION long long fz_pixmap_samples_int(fz_context* ctx, fz_pixmap* pixmap);

/**
Provides simple (but slow) access to pixmap data from Python and C#.
*/
FZ_FUNCTION int fz_samples_get(fz_pixmap* pixmap, int offset);
```

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```
/**
Provides simple (but slow) write access to pixmap data from Python and
C#.
*/
FZ_FUNCTION void fz_samples_set(fz_pixmap* pixmap, int offset, int value);

/**
C++ alternative to fz_highlight_selection() that returns quads in a
std::vector.
*/
FZ_FUNCTION std::vector<fz_quad> fz_highlight_selection2(fz_context* ctx, fz_stext_page*␣
↪page, fz_point a, fz_point b, int max_quads);

struct fz_search_page2_hit
{{
    fz_quad quad;
    int mark;
}};

/**
C++ alternative to fz_search_page() that returns information in a std::vector.
*/
FZ_FUNCTION std::vector<fz_search_page2_hit> fz_search_page2(fz_context* ctx, fz_
↪document* doc, int number, const char* needle, int hit_max);

/**
C++ alternative to fz_string_from_text_language() that returns information in a␣
↪std::string.
*/
FZ_FUNCTION std::string fz_string_from_text_language2(fz_text_language lang);

/**
C++ alternative to fz_get_glyph_name() that returns information in a std::string.
*/
FZ_FUNCTION std::string fz_get_glyph_name2(fz_context* ctx, fz_font* font, int glyph);

/**
Extra struct containing fz_install_load_system_font_funcs()'s args,
which we wrap with virtual_fnptrs set to allow use from Python/C# via
Swig Directors.
*/
typedef struct fz_install_load_system_font_funcs_args
{{
    fz_load_system_font_fn* f;
    fz_load_system_cjk_font_fn* f_cjk;
    fz_load_system_fallback_font_fn* f_fallback;
}} fz_install_load_system_font_funcs_args;

/**
Alternative to fz_install_load_system_font_funcs() that takes args in a
struct, to allow use from Python/C# via Swig Directors.
*/
```

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```
FZ_FUNCTION void fz_install_load_system_font_funcs2(fz_context* ctx, fz_install_load_
↪system_font_funcs_args* args);

/** Internal singleton state to allow Swig Director class to find
fz_install_load_system_font_funcs_args class wrapper instance. */
FZ_DATA extern void* fz_install_load_system_font_funcs2_state;

/** Helper for calling a `fz_document_open_fn` function pointer via Swig
from Python/C#. */
FZ_FUNCTION fz_document* fz_document_open_fn_call(fz_context* ctx, fz_document_open_fn␣
↪fn, fz_stream* stream, fz_stream* accel, fz_archive* dir);

/** Helper for calling a `fz_document_recognize_content_fn` function
pointer via Swig from Python/C#. */
FZ_FUNCTION int fz_document_recognize_content_fn_call(fz_context* ctx, fz_document_
↪recognize_content_fn fn, fz_stream* stream, fz_archive* dir);

/** Swig-friendly wrapper for pdf_choice_widget_options(), returns the
options directly in a vector. */
FZ_FUNCTION std::vector<std::string> pdf_choice_widget_options2(fz_context* ctx, pdf_
↪annot* tw, int exportval);

/** Swig-friendly wrapper for fz_new_image_from_compressed_buffer(),
uses specified `decode` and `colorkey` if they are not null (in which
case we assert that they have size `2*fz_colorspace_n(colorspace)`). */
FZ_FUNCTION fz_image* fz_new_image_from_compressed_buffer2(
        fz_context* ctx,
        int w,
        int h,
        int bpc,
        fz_colorspace* colorspace,
        int xres,
        int yres,
        int interpolate,
        int imagemask,
        const std::vector<float>& decode,
        const std::vector<int>& colorkey,
        fz_compressed_buffer* buffer,
        fz_image* mask
        );

/** Swig-friendly wrapper for pdf_rearrange_pages(). */
void pdf_rearrange_pages2(fz_context* ctx, pdf_document* doc, const std::vector<int>&␣
↪pages);

/** Swig-friendly wrapper for pdf_subset_fonts(). */
void pdf_subset_fonts2(fz_context *ctx, pdf_document *doc, const std::vector<int>&␣
↪pages);
```

7.11 Python/C# bindings details

7.11.1 Extra Python functions

Access to raw C arrays

The following functions can be used from Python to get access to raw data:

- `mupdf.bytes_getitem(array, index)`: Gives access to individual items in an array of `unsigned char`'s, for example in the data returned by `mupdf::FzPixmap`'s `samples()` method.
- `mupdf.floats_getitem(array, index)`: Gives access to individual items in an array of `float`'s, for example in `fz_stroke_state`'s `float dash_list[32]` array. Generated with SWIG code `carrays.i` and `array_functions(float, floats);`.
- `mupdf.python_buffer_data(b)`: returns a SWIG wrapper for a `const unsigned char*` pointing to a Python buffer instance's raw data. For example `b` can be a Python `bytes` or `bytearray` instance.
- `mupdfpython_mutable_buffer_data(b)`: returns a SWIG wrapper for an `unsigned char*` pointing to a Python buffer instance's raw data. For example `b` can be a Python `bytearray` instance.

[These functions are implemented internally using SWIG's `carrays.i` and `pybuffer.i`.

7.11.2 Python differences from C API

[The functions described below are also available as class methods.]

Custom methods

Python and C# code does not easily handle functions that return raw data, for example as an `unsigned char*` that is not a zero-terminated string. Sometimes we provide a C++ method that returns a `std::vector` by value, so that Python and C# code can wrap it in a systematic way.

For example `Md5::fz_md5_final2()`.

For all functions described below, there is also a `ll_*` variant that takes/returns raw MuPDF structs instead of wrapper classes.

New functions

- `fz_buffer_extract_copy()`: Returns copy of buffer data as a Python `bytes`.
- `fz_buffer_storage_memoryview(buffer, writable)`: Returns a readonly/writable Python memoryview onto `buffer`. Relies on `buffer` existing and not changing size while the memory view is used.
- `fz_pixmap_samples_memoryview()`: Returns Python `memoryview` onto `fz_pixmap` data.
- `fz_lookup_metadata2(fzdocument, key)`: Return key value or raise an exception if not found:
- `pdf_lookup_metadata2(pdfdocument, key)`: Return key value or raise an exception if not found:

Implemented in Python

- `fz_format_output_path()`
- `fz_story_positions()`
- `pdf_dict_getl()`
- `pdf_dict_putl()`

Non-standard API or implementation

- `fz_buffer_extract()`: Returns a *copy* of the original buffer data as a Python `bytes`. Still clears the buffer.
- `fz_buffer_storage()`: Returns `(size, data)` where `data` is a low-level SWIG representation of the buffer's storage.
- `fz_convert_color()`: No `float* fv` param, instead returns `(rgb0, rgb1, rgb2, rgb3)`.
- `fz_fill_text()`: `color` arg is tuple/list of 1-4 floats.
- `fz_lookup_metadata(fzdocument, key)`: Return key value or None if not found:
- `fz_new_buffer_from_copied_data()`: Takes a Python `bytes` (or other Python buffer) instance.
- `fz_set_error_callback()`: Takes a Python callable; no `void* user` arg.
- `fz_set_warning_callback()`: Takes a Python callable; no `void* user` arg.
- `fz_warn()`: Takes single Python `str` arg.
- `pdf_dict_putl_drop()`: Always raises exception because not useful with automatic ref-counts.
- `pdf_load_field_name()`: Uses extra C++ function `pdf_load_field_name2()` which returns `std::string` by value.
- `pdf_lookup_metadata(pdfdocument, key)`: Return key value or None if not found:
- `pdf_set_annot_color()`: Takes single `color` arg which must be float or tuple of 1-4 floats.
- `pdf_set_annot_interior_color()`: Takes single `color` arg which must be float or tuple of 1-4 floats.
- `fz_install_load_system_font_funcs()`: Takes Python callbacks with no `ctx` arg, which can return `None`, `fz_font*` or a `mupdf.FzFont`.

  Example usage (from `scripts/mupdfwrap_test.py:test_install_load_system_font()`):

```
def font_f(name, bold, italic, needs_exact_metrics):
    print(f'font_f(): Looking for font: {name=} {bold=} {italic=} {needs_exact_
↪metrics=}.')
    return mupdf.fz_new_font_from_file(...)
def f_cjk(name, ordering, serif):
    print(f'f_cjk(): Looking for font: {name=} {ordering=} {serif=}.')
    return None
def f_fallback(script, language, serif, bold, italic):
    print(f'f_fallback(): looking for font: {script=} {language=} {serif=} {bold=}
↪{italic=}.')
    return None
mupdf.fz_install_load_system_font_funcs(font_f, f_cjk, f_fallback)
```

7.11.3 Making MuPDF function pointers call Python code

Overview

For MuPDF structs with function pointers, we provide a second C++ wrapper class for use by the Python bindings.

- The second wrapper class has a `2` suffix, for example `PdfFilterOptions2`.
- This second wrapper class has a virtual method for each function pointer, so it can be used as a SWIG Director class.
- Overriding a virtual method in Python results in the Python method being called when MuPDF C code calls the corresponding function pointer.
- One needs to activate the use of a Python method as a callback by calling the special method `use_virtual_<method-name>()`. [It might be possible in future to remove the need to do this.]
- It may be possible to use similar techniques in C# but this has not been tried.

Callback args

Python callbacks have args that are more low-level than in the rest of the Python API:

- Callbacks generally have a first arg that is a SWIG representation of a MuPDF `fz_context*`.
- Where the underlying MuPDF function pointer has an arg that is a pointer to an MuPDF struct, unlike elsewhere in the MuPDF bindings we do not translate this into an instance of the corresponding wrapper class. Instead Python callbacks will see a SWIG representation of the low-level C pointer.
  - It is not safe to construct a Python wrapper class instance directly from such a SWIG representation of a C pointer, because it will break MuPDF's reference counting - Python/C++ constructors that take a raw pointer to a MuPDF struct do not call `fz_keep_*()` but the corresponding Python/C++ destructor will call `fz_drop_*()`.
  - It might be safe to create an wrapper class instance using an explicit call to `mupdf.fz_keep_*()`, but this has not been tried.
- As of 2023-02-03, exceptions from Python callbacks are propagated back through the Python, C++, C, C++ and Python layers. The resulting Python exception will have the original exception text, but the original Python backtrace is lost.

Exceptions in callbacks

Python exceptions in Director callbacks are propagated back through the language layers (from Python to C++ to C, then back to C++ and finally to Python).

For convenience we add a text representation of the original Python backtrace to the exception text, but the C layer's fz_try/catch exception handling only holds 256 characters of exception text, so this backtrace information may be truncated by the time the exception reaches the original Python code's `except ...` block.

Example

Here is an example PDF filter written in Python that removes alternating items:

Details

```
import mupdf

def test_filter(path):
    class MyFilter( mupdf.PdfFilterOptions2):
        def __init__( self):
            super().__init__()
            self.use_virtual_text_filter()
            self.recurse = 1
            self.sanitize = 1
            self.state = 1
            self.ascii = True
        def text_filter( self, ctx, ucsbuf, ucslen, trm, ctm, bbox):
            print( f'text_filter(): ctx={ctx} ucsbuf={ucsbuf} ucslen={ucslen} trm={trm}␣
↪ctm={ctm} bbox={bbox}')
            # Remove every other item.
            self.state = 1 - self.state
            return self.state

    filter_ = MyFilter()

    document = mupdf.PdfDocument(path)
    for p in range(document.pdf_count_pages()):
        page = document.pdf_load_page(p)
        print( f'Running document.pdf_filter_page_contents on page {p}')
        document.pdf_begin_operation('test filter')
        document.pdf_filter_page_contents(page, filter_)
        document.pdf_end_operation()

    document.pdf_save_document('foo.pdf', mupdf.PdfWriteOptions())
```

CHAPTER

EIGHT

PROGRESSIVE LOADING

8.1 What is progressive loading?

The idea of progressive loading is that as you download a *PDF* file into a browser, you can display the pages as they appear.

MuPDF can make use of 2 different mechanisms to achieve this. The first relies on the file being "linearized", the second relies on the caller of *MuPDF* having fine control over the http fetch and on the server supporting byte-range fetches.

For optimum performance a file should be both linearized and be available over a byte-range supporting link, but benefits can still be had with either one of these alone.

8.2 Progressive download using "linearized" files

Adobe defines "linearized" PDFs as being ones that have both a specific layout of objects and a small amount of extra information to help avoid seeking within a file. The stated aim is to deliver the first page of a document in advance of the whole document downloading, whereupon subsequent pages will become available. *Adobe* also refers to these as "Optimized for fast web view" or "Web Optimized".

In fact, the standard outlines (poorly) a mechanism by which 'hints' can be included that enable the subsequent pages to be found within the file too. Unfortunately this is very poorly supported with many tools, and so the hints have to be treated with suspicion.

MuPDF will attempt to use hints if they are available, but will also use a linear search of the file to discover pages if not. This means that the first page will be displayed quickly, and then subsequent ones will appear with 'incomplete' renderings that improve over time as more and more resources are gradually delivered.

Essentially the file starts with a slightly modified header, and the first object in the file is a special one (the linearization object) that:

- indicates that the file is linearized.
- gives some useful information (like the number of pages in the file).

This object is then followed by all the objects required for the first page, then the "hint stream", then sets of object for each subsequent page in turn, then shared objects required for those pages, then various other random things.

Note: While page 1 is sent with all the objects that it uses, shared or otherwise, subsequent pages do not get shared resources until after all the unshared page objects have been sent.

8.3 The Hint Stream

Adobe intended "Hint Stream" to be useful to facilitate the display of subsequent pages, but it has never used it. Consequently you can't trust people to write it properly - indeed *Adobe* outputs something that doesn't quite conform to the specification.

Consequently very few people actually use it. *MuPDF* will use it after sanity checking the values, and should cope with illegal/incorrect values.

8.4 So how does *MuPDF* handle progressive loading?

MuPDF has made various extensions to its mechanisms for handling progressive loading.

8.4.1 Progressive streams

At its lowest level *MuPDF* reads file data from a `fz_stream`, using the `fz_open_document_with_stream` call. (`fz_open_document` is implemented by calling this). We have extended the `fz_stream` slightly, giving the system a way to ask for meta information (or perform meta operations) on a stream.

Using this mechanism *MuPDF* can query:

- whether a stream is progressive or not (i.e. whether the entire stream is accessible immediately).
- what the length of a stream should ultimately be (which an http fetcher should know from the Content-Length header).

With this information *MuPDF* can decide whether to use its normal object reading code, or whether to make use of a linearized object. Knowing the length enables us to check with the length value given in the linearized object - if these differ, the assumption is that an incremental save has taken place, thus the file is no longer linearized.

When data is pulled from a progressive stream, if we attempt to read data that is not currently available, the stream should throw a `FZ_ERROR_TRYLATER` error. This particular error code will be interpreted by the caller as an indication that it should retry the parsing of the current objects at a later time.

When a *MuPDF* call is made on a progressive stream, such as `fz_open_document_with_stream`, or `fz_load_page`, the caller should be prepared to handle a `FZ_ERROR_TRYLATER` error as meaning that more data is required before it can continue. No indication is directly given as to exactly how much more data is required, but as the caller will be implementing the progressive `fz_stream` that it has passed into *MuPDF* to start with, it can reasonably be expected to figure out an estimate for itself.

8.4.2 Cookie

Once a page has been loaded, if its contents are to be 'run' as normal (using e.g. `fz_run_page`) any error (such as failing to read a font, or an image, or even a content stream belonging to the page) will result in a rendering that aborts with an `FZ_ERROR_TRYLATER` error. The caller can catch this and display a placeholder instead.

If each pages data was entirely self-contained and sent in sequence this would perhaps be acceptable, with each page appearing one after the other. Unfortunately, the linearization procedure as laid down by *Adobe* does **not** do this: objects shared between multiple pages (other than the first) are not sent with the pages themselves, but rather **after** all the pages have been sent.

This means that a document that has a title page, then contents that share a font used on pages 2 onwards, will not be able to correctly display page 2 until after the font has arrived in the file, which will not be until all the page data has been sent.

To mitigate against this, *MuPDF* provides a way whereby callers can indicate that they are prepared to accept an 'incomplete' rendering of the file (perhaps with missing images, or with substitute fonts).

Callers prepared to tolerate such renderings should set the `incomplete_ok` flag in the cookie, then call `fz_run_page` etc. as normal. If a `FZ_ERROR_TRYLATER` error is thrown at any point during the page rendering, the error will be swallowed, the 'incomplete' field in the cookie will become non-zero and rendering will continue. When control returns to the caller the caller can check the value of the 'incomplete' field and know that the rendering it received is not authoritative.

8.5 Progressive loading using byte range requests

If the caller has control over the *http* fetch, then it is possible to use byte range requests to fetch the document 'out of order'. This enables non-linearized files to be progressively displayed as they download, and fetches complete renderings of pages earlier than would otherwise be the case. This process requires no changes within *MuPDF* itself, but rather in the way the progressive stream learns from the attempts *MuPDF* makes to fetch data.

Consider, for example, an attempt to fetch a hypothetical file from a server.

- The initial http request for the document is sent with a "Range:" header to pull down the first (say) 4k of the file.
- As soon as we get the header in from this initial request, we can respond to meta stream operations to give the length, and whether byte requests are accepted.
  - If the header indicates that byte ranges are acceptable the stream proceeds to go into a loop fetching chunks of the file at a time (not necessarily in-order). Otherwise the server will ignore the Range: header, and just serve the whole file.
  - If the header indicates a content-length, the stream returns that.
- *MuPDF* can then decide how to proceed based upon these flags and whether the file is linearized or not. (If the file contains a linearized object, and the content length matches, then the file is considered to be linear, otherwise it is not).

If the file is linear:

- We proceed to read objects out of the file as it downloads. This will provide us the first page and all its resources. It will also enable us to read the hint streams (if present).
- Once we have read the hint streams, we unpack (and sanity check) them to give us a map of where in the file each object is predicted to live, and which objects are required for each page. If any of these values are out of range, we treat the file as if there were no hint streams.
- If we have hints, any attempt to load a subsequent page will cause *MuPDF* to attempt to read exactly the objects required. This will cause a sequence of seeks in the `fz_stream` followed by reads. If the stream does not have the data to satisfy that request yet, the stream code should remember the location that was fetched (and fetch that block in the background so that future retries will succeed) and should raise an `FZ_ERROR_TRYLATER` error.

Note: Typically therefore when we jump to a page in a linear file on a byte request capable link, we will quickly see a rough rendering, which will improve fairly fast as images and fonts arrive.

- Regardless of whether we have hints or byte requests, on every `fz_load_page` call *MuPDF* will attempt to process more of the stream (that is assumed to be being downloaded in the background).

As linearized files are guaranteed to have pages in order, pages will gradually become available. In the absence of byte requests and hints however, we have no way of getting resources early, so the renderings for these pages will remain incomplete until much more of the file has arrived.

Note: Typically therefore when we jump to a page in a linear file on a non byte request capable link, we will see a rough rendering for that page as soon as data arrives for it (which will typically take much longer than would be the case with byte range capable downloads), and that will improve much more slowly as images and fonts may not appear until almost the whole file has arrived.

- When the whole file has arrived, then we will attempt to read the outlines for the file.

For a non-linearized PDF on a byte request capable stream:

- *MuPDF* will immediately seek to the end of the file to attempt to read the trailer. This will fail with a `FZ_ERROR_TRYLATER` due to the data not being here yet, but the stream code should remember that this data is required and it should be prioritized in the background fetch process.
- Repeated attempts to open the stream should eventually succeed therefore. As *MuPDF* jumps through the file trying to read first the xrefs, then the page tree objects, then the page contents themselves etc., the background fetching process will be driven by the attempts to read the file in the foreground.

Note: Typically therefore the opening of a non-linearized file will be slower than a linearized one, as the xrefs/page trees for a non-linear file can be 20%+ of the file data. Once past this initial point however, pages and data can be pulled from the file almost as fast as with a linearized file.

For a non-linearized PDF on a non-byte request capable stream:

- *MuPDF* will immediately seek to the end of the file to attempt to read the trailer. This will fail with a `FZ_ERROR_TRYLATER` due to the data not being here yet. Subsequent retries will continue to fail until the whole file has arrived, whereupon the whole file will be instantly available.

Note: This is the worst case situation - nothing at all can be displayed until the entire file has downloaded.

A typical structure for a fetcher process (see `curl-stream.c`, `mupdf-curl` in `platform/win32/mupdf-curl.vcxproj`) as an example) might therefore look like this:

- We consider the file as an (initially empty) buffer which we are filling by making requests. In order to ensure that we make maximum use of our download link, we ensure that whenever one request finishes, we immediately launch another. Further, to avoid the overheads for the request/response headers being too large, we may want to divide the file into 'chunks', perhaps 4 or 32k in size.
- We can then have a receiver process that sits there in a loop requesting chunks to fill this buffer. In the absence of any other impetus the receiver should request the next 'chunk' of data from the file that it does not yet have, following the last fill point. Initially we start the fill point at the beginning of the file, but this will move around based on the requests made of the progressive stream.
- Whenever *MuPDF* attempts to read from the stream, we check to see if we have data for this area of the file already. If we do, we can return it. If not, we remember this as the next "fill point" for our receiver process and throw a `FZ_ERROR_TRYLATER` error.

CHAPTER

NINE

ANDROID LIBRARY

9.1 Introduction

This document outlines the steps necessary to use the *MuPDF Android Library* in various ways.

First, we show you how to embed *MuPDF* in your app. Then, we explain how to customize the viewer if you need to change how it looks or behaves. Finally, we tell you where to go if you need to do work on the library itself.

Embedding the viewer in your app provides an activity that you can start to view *PDF* documents from within your app. This should be enough for most use cases.

9.2 Acquire a valid license

9.2.1 Open Source license

If your software is open source, you may use *MuPDF* under the terms of the GNU Affero General Public License.

This means that *all of the source code* for your *complete* app must be released under a compatible open source license!

It also means that you may *not* use any proprietary closed source libraries or components in your app. This includes (but is not limited to):

- Google Play Services
- Google Mobile Services
- AdMob by Google
- Crashlytics
- Answers

etc.

Just because a library ships with *Android* or is made by *Google* does *not* make it *AGPL* compatible!

If you cannot or do not want to comply with these restrictions, you **must** acquire a commercial license instead.

9.2.2 Commercial license

If your software is not open source, *Artifex Software* can sell you a license to use *MuPDF* in closed source software.

Fill out the MuPDF product inquiry form for commercial licensing terms and pricing.

9.3 Add the *MuPDF* Library to your project

The *MuPDF* library uses the *Gradle* build system. In order to include *MuPDF* in your app, you also need to use *Gradle*. The *Eclipse* and *Ant* build systems are not supported.

The *MuPDF* library needs *Android* version 4.1 or newer. Make sure that the `minSdkVersion` in your app's `build.gradle` is at least 16.

```
android {
   defaultConfig {
      minSdkVersion 16
      ...
   }
   ...
}
```

The *MuPDF* library can be retrieved as a pre-built artifact from our *Maven* repository. In your project's top `build.gradle`, add the line to the repositories section:

```
allprojects {
   repositories {
      jcenter()
      maven { url 'http://maven.ghostscript.com' }
      ...
   }
}
```

Then add the *MuPDF* viewer library to your app's dependencies. In your app's `build.gradle`, add the line to the dependencies section:

```
dependencies {
   api 'com.artifex.mupdf:viewer:1.15.+'
   ...
}
```

9.4 Invoke the document viewer activity

Once this has been done, you have access to the *MuPDF* viewer activity. You can now open a document viewing activity by launching an `Intent`, passing the `URI` of the document you wish to view.

```
import com.artifex.mupdf.viewer.DocumentActivity;

public void startMuPDFActivity(Uri documentUri) {
   Intent intent = new Intent(this, DocumentActivity.class);
   intent.setAction(Intent.ACTION_VIEW);
```

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```
    intent.setData(documentUri);
    startActivity(intent);
}
```

9.5 How to customize the viewer

If you've already tried embedding the viewer in your app, but are unhappy with some aspect of the look or behavior and want to modify it in some way, this section should point you in the right direction.

9.5.1 Decide which viewer to base your customizations on

In order to customize the viewer UI, you will need to modify the existing *Android* viewer activity. There are two separate code bases you can start with:

- **mupdf-android-viewer**
  The main viewer app. This code is difficult to work with, but has the most features and pre-renders neighboring pages into a page cache for faster page turning performance.
- **mupdf-android-viewer-mini**
  This is a minimalist viewer which has fewer features but is designed to be easy to understand and modify. It does not (currently) have high-resolution zooming, and it does not use the swipe gesture to flip pages (it requires the user to tap on the side of the screen to flip pages).

If all you want to do is brand the UI with your own colors and icons, you are welcome to use whichever code base you prefer. However, if you want to do extensive modifications, we suggest you base your code on the mini viewer.

9.5.2 Check out the chosen project

When you have decided which project to base your modifications on, you should check out the corresponding *git* repository:

```
$ git clone git://git.ghostscript.com/mupdf-android-viewer.git
$ git clone git://git.ghostscript.com/mupdf-android-viewer-mini.git
```

Inside the checked out project you will find two modules: `app` and `lib`. The `app` module is a file chooser activity that lets the user open files from the external storage. The `lib` module is the viewer activity, which provides the `com.artifex.mupdf:viewer` package that you're already using.

The `lib` module is the one you want; ignore everything else in this project.

9.5.3 Copy the viewer library module into your project

Copy the 'lib' directory to your project, renaming it to something appropriate. The following instructions assume you called the directory 'mupdf-lib'.

Don't forget to include the module in the `settings.gradle` file:

```
include ':app'
include ':mupdf-lib'
...
```

You'll also want to change your app's dependencies to now depend on your local copy rather than the official *MuPDF* viewer package. In your app `build.gradle`:

```
dependencies {
   api project(':mupdf-lib')
   ...
}
```

The `lib` module depends on the *JNI* library `com.artifex.mupdf:fitz`, so do *not* remove the *Maven* repository from your top `build.gradle`.

9.5.4 Edit the viewer activity

If all has gone well, you can now build your project with the local viewer library, and access the *MuPDF* viewer activity just as you used to.

You're now free to customize the resources in `mupdf-lib/src/main/res` and behavior in `mupdf-lib/src/main/java` as you desire.

9.6 Working on the MuPDF Library

If you want to work on the library itself, rather than just use it, you will need to check out the following *git* repositories.

- **`mupdf.git`**
  This repository contains the low-level "fitz" *C* library and the *JNI* bindings.
- **`mupdf-android-fitz.git`**
  This repository contains an *Android* project to build the *C* library and *JNI* bindings. It uses `mupdf.git` as a *Git* submodule.
- **`mupdf-android-viewer.git`**
  This repository contains the *Android* viewer library and app. It uses `mupdf-android-fitz.git` as either a *Maven* artifact or *Git* submodule.
- **`mupdf-android-viewer-mini.git`**
  This repository contains the minimalist *Android* viewer library and app. It uses `mupdf-android-fitz.git` as either a *Maven* artifact or *Git* submodule.
- **`mupdf-android-viewer-old.git`**
  This repository contains the old *Android* viewer. It has its own *JNI* bindings and uses `mupdf.git` as a submodule directly. It is only listed here for history.

Since these repositories are set up as *Git* submodules, if you're a *Git* expert, you can clone one of the viewer repositories recursively and get all of them at once. However, working with *Git* submodules can be fraught with danger, so it may be easier to check them out individually.

If you only want to work with one of the viewer repositories, you can use the *Maven* artifact for the *JNI* bindings library and not worry about the `mupdf.git` and `mupdf-android-fitz.git` repositories.

CHAPTER

TEN

CHANGES

- For the full list of changes between versions of *MuPDF* see CHANGES.
- For changes to *existing APIs* see below.

10.1 Changes to the existing *API*

Why does the API change?

From time to time, during development, it becomes clear that the public *API* needs to change; either because the existing *API* has flaws in it, or to accommodate new functionality. Such changes are not undertaken lightly, and they are kept as minimal as possible.

The alternative would be to freeze the *API* and to introduce more and more compatibility veneers, ultimately leading to a bloated *API* and additional complexity. We have done this in the past, and will do it again in future if circumstances demand it, but we consider small changes in the *API* to be a price worth paying for clarity and simplicity.

To minimise the impact of such changes, we undertake to list the *API* changes between different versions of the library here, to make it as simple as possible for integrators to make the small changes that may be require to update between versions.

Important: The changes listed below only affects *existing APIs*.

10.1.1 Changes from 1.20 to 1.21

None.

10.1.2 Changes from 1.19 to 1.20

Text search *API* extended to be able to distinguish between separate search hits.

10.1.3 Changes from 1.18 to 1.19

We were inconsistent with the behaviour of `fz_create_` and `pdf_create_` functions, in that sometimes they returned a borrowed reference, rather than a reference that the caller had to drop. We now always return a reference that the caller owns and must drop.

10.1.4 Changes from 1.17 to 1.18

None.

10.1.5 Changes from 1.16 to 1.17

The accessors for reading and creating `QuadPoints`, `InkList` and `Vertices` data for *Highlight*, *Underline*, *StrikeOut*, *Squiggle*, *Ink*, *Polygon*, and *PolyLine* annotation types have been simplified. They now take and return `fz_quad` and `fz_point` structs instead of float arrays. We have also added functions to construct the datastructures one piece at a time, removing the need to allocate a temporary array to pass.

- `typedef struct fz_quad { fz_point ul, ur, ll, lr; };`

To facilitate loading *EPUB* documents without laying out the entire document at once, we have introduced chapters into the document structure. Each document instead of having just a plain list of pages, now has a list of chapters, and each chapter has a list of pages. Most of the old functions have the same functionality, but we have added several new functions, which if used, will provide significant speedups when jumping to a random page in large *EPUB* documents.

- `int fz_count_chapters(ctx, doc)`
- `int fz_count_chapter_pages(ctx, doc, chapter)`
- `fz_page *fz_load_chapter_page(ctx, doc, chapter, page)`
- `int fz_search_chapter_page_number(ctx, doc, chapter, page, needle, hit_quads, hit_size)`

However, in order to support bookmarks and links using chapters we have had to introduce a new struct `fz_location`, and the functions to resolve links have changed to use this new struct.

- `typedef struct { int chapter, page; } fz_location;`
- `fz_location fz_resolve_link(ctx, doc, uri, x, y);`

Functions to map between a fixed page number and a `fz_location` have been added to help facilitate migration to the new *API*.

- `int fz_page_number_from_location(ctx, doc, location);`
- `fz_location fz_location_from_page_number(ctx, doc, number);`
- `fz_location fz_next_page(ctx, doc, location);`
- `fz_location fz_previous_page(ctx, doc, location);`
- `fz_location fz_last_page(ctx, doc);`

The layout information for each chapter can at your option be cached in an "accelerator" file for even faster loading. This will help performance when using the old page number based rather than location based functions.

- `fz_document fz_open_accelerated_document(ctx, filename, accelerator_filename);`
- `void fz_save_accelerator(ctx, document, accelerator_filename);`

10.1.6 Changes from 1.15 to 1.16

There has been a major overhaul of the color management architecture. Unless you're implementing custom devices or interpreters, this should only have a minor impact.

- Argument order when passing color and colorspace to functions regularized: sourceColorspace, sourceColorArray, destinationColorspace, destinationColorArray, proofColorspace, colorParams.
- Pass `fz_color_params` argument by value.
- Changed `fz_default_parameters` from a function to a global constant.
- Replaced `fz_set_icc_engine` with `fz_enable_icc` and `fz_disable_icc` to toggle color management at runtime.
- Replaced pixmap color converter struct with a single `fz_convert_pixmap` function call.
- Replaced `fz_cal_colorspace` struct with constructor to create an ICC-backed calibrated colorspace directly.
- Passing `NULL` is not a shortcut for *DeviceGray* any more!
- Added public definitions for *Indexed* and *Separation* colorspaces.
- Changed colorspace constructors.

The `fz_set_stdout` and `fz_set_stderr` functions have been removed. If you were using these to capture warning and error messages, use the new user callbacks for warning and error logging instead: `fz_set_warning_callback` and `fz_set_error_callback`.

The structured text *html* and *xhtml* output formats take an additional argument: the page number. This number is used to create an *id* attribute for each page to use as a hyperlink target.

10.1.7 Changes from 1.14 to 1.15

- **PDF Portfolios**
  This functionality has been removed. We do not believe anyone was using this. If you were, please contact us for assistance. This functionality can be achieved using "mutool run" and `docs/examples/pdf-portfolio.js`.
- **`FZ_ERROR_TRYLATER`**
  This functionality has been removed. We do not believe anyone was using this. If you were, please contact us for assistance.
- **Annotations/Forms**
  We are undertaking a significant rework of this functionality at the moment. We do not believe anyone is using this at the moment, and would therefore encourage anyone who is to contact us for help in upgrading.
- **Various functions involving `fz_colorspace` have lost consts.**
  `fz_colorspaces` are immutable once created, other than changes due to reference counting. Passing a const `fz_colorspace` to a function that might keep a reference to it either has to take a non const `fz_colorspace` pointer, or take a const one, and 'break' the const. Having some functions take const `fz_colorspace` and some not is confusing, so therefore, for simplicity, all `fz_colorspaces` are now passed as non const. This should not affect any user code.
- **`fz_process_shade()`**
  This now takes an extra 'scissor' argument. To upgrade old code, if you don't have an appropriate scissor rect available, it is safe (but unwise) to pass `fz_infinite_rect`.
- **`fz_tint_pixmap()`**
  Rather than taking `r`, `g` and `b`, values to tint with, the function now takes 8 bit hex rgb values for black and white, enabling greater control, allowing "low contrast" and "night view" effects.

- `pdf_add_image()`
  This no longer requires a mask flag. The image already knows if it is a mask.
- `pdf_processor.op_BI()`
  The `op_BI` callback is now passed an additional colorspace resource name.

CHAPTER

ELEVEN

THIRD PARTY LIBRARIES USED BY *MUPDF*

These are the third party libraries used by *MuPDF*.

Library	Version	Function	License
Required			
freetype	2.13.0	Font scaling and rendering	BSD-style
harfbuzz	6.0.0	Text shaping	MIT-style
libjpeg	9.0e with patches	JPEG decoding	BSD-style
Incompatible fork of lcms2	2.14 with patches	Color management	MIT-style
openjpeg	2.5.0	JPEG 2000 decoding	BSD-style
zlib	1.2.13	Deflate compression	zlib License
gumbo-parser	0.10.1	HTML5 parser	Apache 2.0
Optional			
FreeGLUT	3.0.0 with patches	OpenGL API for UI	MIT-style
curl	7.66.0 with patches	HTTP data transfer	MIT-style
JPEG-XR reference	1.32 with patches	JPEG-XR decoding	special
Tesseract	5.0.0-alpha-20201231 with patches	OCR	Apache 2.0
Leptonica	1.80.0 with patches	Tesseract dependency	BSD-style

Note: jbig2dec and MuJS are included in "thirdparty" but are copyright *Artifex Software Inc*.