darktable 3.4 user manual

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darktable

darktable is an open source photography workflow application and raw developer — a virtual lighttable and darkroom for photographers. It manages your digital negatives in a database, lets you view them through a zoomable lighttable and enables you to develop and enhance your raw images.

The source repository for this documentation may be found at https://github.com/darktable-org/dtdocs.git. Any feedback relating to this documentation can be provided by creating a ticket or a pull request against this repository.

You can obtain this manual in PDF format here.

1. Overview

1.1. user interface

1.1.1. views

There are five different views available in darktable:

lighttable
Manage images and collections.

darkroom
Develop a single image.

map
Show images with a geo-tag data on a map and manually geo-tag new images.

print
Send images to your printer.

slideshow
Display images as a slideshow, processing them on-the-fly.

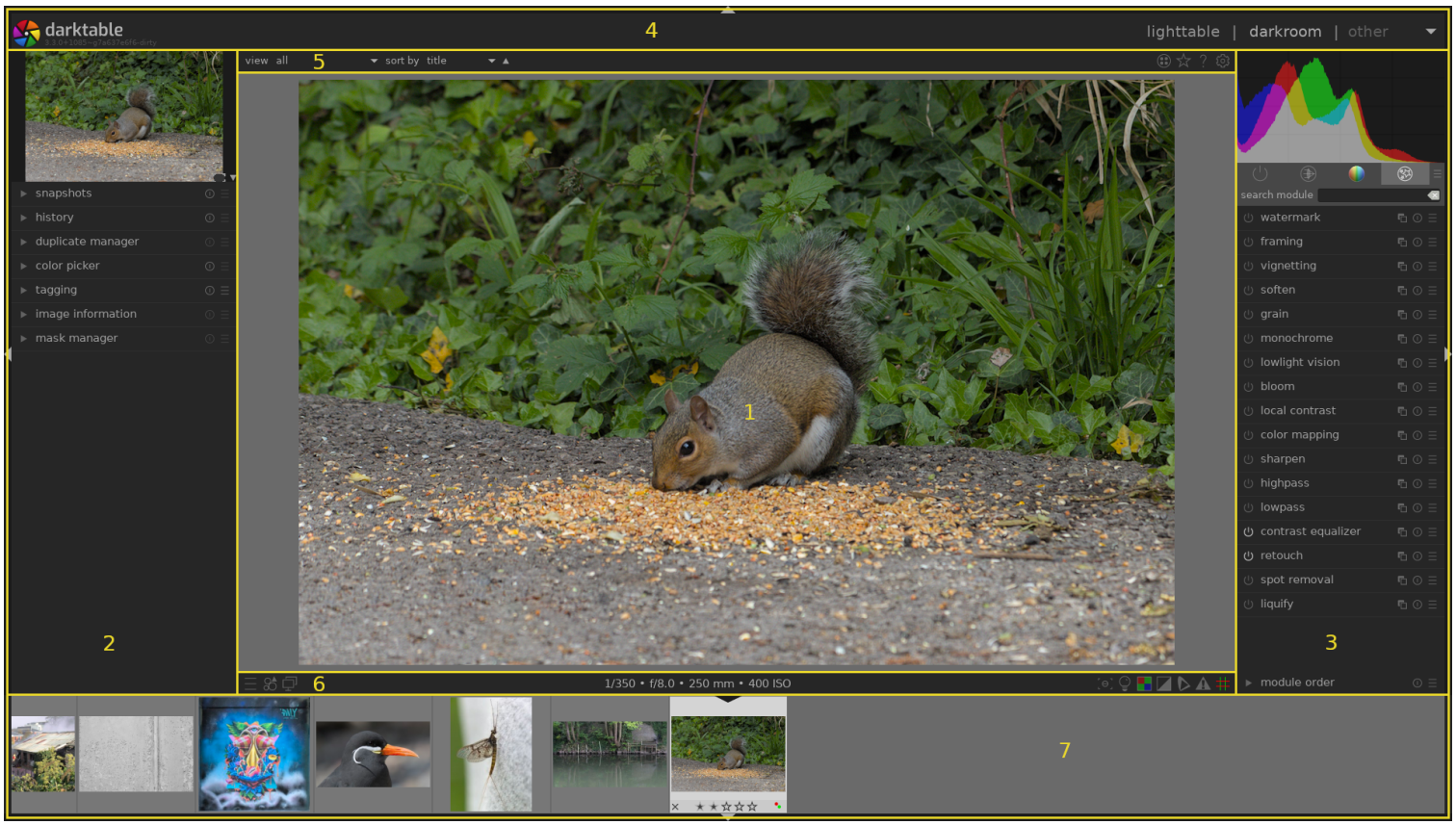
tethering
Remotely capture and save images taken with a connected camera.

You can switch between views by clicking the view name at the top of the right panel (the currently active view is highlighted) or by using one of the following keyboard shortcuts:

```
L       switch to lighttable
D       switch to darkroom
M       switch to map
P       switch to print
S       switch to slideshow
T       switch to tethering
```

1.1.2. screen layout

The layout of all views is similar and consists of a center area with panels at the edges:



1. center area : Contains information and functionality specific to the current view.
2. left panel : Contains modules primarily used to provide information.
3. right panel : Contains modules primarily used for image processing.
4. top banner : Contains information about the current darktable version and allows you to switch between views. Also used by some modules to show hints and messages.
5. top panel : Provides access to global settings and shortcuts
6. bottom panel : Provides access to view-specific settings and shortcuts.
7. filmstrip/timeline panel : An optional panel that can be enabled at the bottom of the screen to display a timeline (in the lighttable view) or a filmstrip (in other views) of images in the current collection.

panel size and visibility

The left, right and filmstrip/timeline panels can be resized by dragging their inner borders.

Each of the panels can be expanded or collapsed by pressing a triangle located at the outside edge of the panel. Panel visibility can also be adjusted using keyboard shortcuts, as follows:

```
TAB             Temporarily expand the centre view to fill the whole window.
                Press again to return to the previous view.
F11             Toggle fullscreen mode
Shift+Ctrl+t    Toggle the top panel (between the image and the top banner)
Shift+Ctrl+b    Toggle the bottom panel (beween the image and the filmstrip/timeline if shown)
```

```
Shift+Ctrl+l    Toggle the left panel
Shift+Ctrl+r    Toggle the right panel
Ctrl+f          Toggle the filmstrip/timeline
Ctrl+h          Toggle the top banner
b               Toggle all borders and panel-collapse controls
```

Note: Size and visibility of panels are stored independently for each view.

1.1.3. filmstrip

The filmstrip, when enabled, is shown at the bottom of the screen (except in the lighttable view, where it is replaced with the timeline module) and displays the images from the collection that is currently selected in the lighttable view. You can navigate along the filmstrip by scrolling with the mouse wheel.

The filmstrip allows you to interact with images while you are not in the lighttable view. For example, while developing an image in darkroom mode, you can switch to another image to by clicking its thumbnail in the filmstrip. You can also rate and color-classify the images as you do in lighttable, as well as copy & paste the history stack using keyboard shortcuts.

See the filmstrip module documentation for more information.

1.1.4. top panel

The top panel is common to all darktable views and provides a number of common utility functions.

On the left-hand-side

view
Choose which images to view in the lighttable/filmstrip, based on star rating and reject status.

sort by
Choose the property to sort by from the dropdown.

sort order
Switch the sort order (ascending / descending) with the arrow-toggle.

On the right-hand-side


grouping
Expand or collapse grouped images


thumbnail overlays
Define what information is displayed over thumbnails in the lighttable/filmstrip.
You can define different settings depending on the thumbnail size in preferences > lighttable


context-sensitive help
Click on this icon and then click on a control element to be directed to the appropriate online help page.


preferences
Open the preferences & settings dialog

1.1.5. keyboard shortcuts

Much of the functionality in darktable can be controlled via keyboard shortcuts which can be customised in preferences > shortcuts.

Press the H key (for help) in any darktable view to show a list of all shortcuts that are applicable to the current view.

1.2. supported file formats

darktable supports a huge number of file formats from various camera manufacturers. In addition darktable can read specific low dynamic range and high dynamic range images – mainly for data exchange between darktable and other software.

In order for darktable to consider a file for import, it must have one of the following extensions (case independent): `3FR, ARI, ARW, BAY, BMQ, CAP, CINE, CR2, CRW, CS1, DC2, DCR, DNG, GPR, ERF, FFF, EXR, IA, IIQ, JPEG, JPG, K25, KC2, KDC, MDC, MEF, MOS, MRW, NEF, NRW, ORF, PEF, PFM, PNG, PXN, QTK, RAF, RAW, RDC, RW1, RW2, SR2, SRF, SRW, STI, TIF, TIFF, X3F`

If darktable was compiled with JPEG2000 support, these extensions are also recognized: `J2C, J2K, JP2, JPC`.

If darktable was compiled with GraphicsMagick support, the following extensions are recognized in addition to the standard ones: `BMP, DCM, GIF, JNG, JPC, JP2, MIFF, MNG, PBM, PGM, PNM, PPM`.

camera raw files

darktable reads raw files using the open source library RawSpeed, originally developed by Klaus Post and now maintained as part of the darktable project. The number of supported cameras and file formats is constantly increasing. Most modern camera models are supported, and new ones tend to get added very quickly. It is beyond the scope of this manual to give an exhaustive list.

With the exception of Fujifilm X-Trans cameras, darktable does not decode images from cameras with non-Bayer sensors (e.g. Sigma cameras with the Foveon X3 sensor).

other image files

darktable natively reads “ordinary” images in JPEG, 8-bit/16-bit PNG and 8-bit/16-bit TIFF format, as well as 16-bit/32-bit floating point TIFF formats. JPEG2000 is also supported if the required libraries are present at compile time. Similarly, if darktable was compiled with GraphicsMagick support, there are further supported formats, such as GIF, Dicom DCM, additional “exotic” TIFF formats, and some of Sun’s “portable xyz-map” family.

darktable also reads high dynamic range images in OpenEXR, RGBE and PFM formats.

1.3. sidecar files & non-destructive editing

1.3.1. sidecar files

darktable is a non-destructive image editor and opens all images in read-only mode. Any data created within darktable (metadata, tags, and image processing steps) are stored in separate `.XMP` *sidecar* files. These files allow darktable to store information about the images as well as the full editing history without touching the original raw files. When you import an image into darktable for the first time, an XMP file is automatically generated (XMP generation can be disabled in preferences > storage but this is not recommended in normal use).

For a given source image, multiple editing versions, called *duplicates*, can co-exist, sharing the same input (raw) data but each having their own metadata, tags and processing steps. Each duplicate is represented by a separate XMP sidecar file (with a filename constructed in the form `<basename>_nn.<extension>.xmp`, where nn represents the version number of that edit). Information for the initial edit – the "duplicate" with version number zero – is stored in the sidecar file `<basename>.<extension>.xmp`. The version number of each duplicate is displayed in the image information module in each of darktable's views.

Sidecar files are automatically synchronized with your work without the need to press a "save" button. When backing up your data, make sure you also retain the XMP files, as these are needed to fully reconstruct your work in case of a disaster.

In addition to the sidecar files, darktable keeps all image-related data in its library database for fast access. An image can only be viewed and edited from within darktable if its data is loaded in the library database. This happens automatically when you first import an image. If an image is subsequently re-imported, the database will be updated from the data in the XMP file.

Once an image has been imported into darktable, the database entries take precedence over the XMP file. Subsequent changes to the XMP file by any other software are not visible to darktable – such changes will be overwritten the next time darktable synchronizes the file. On request darktable can be configured to search for updated XMP files at startup, offering a choice to update the database or overwrite the XMP file where changes are identified. This configuration can also be changed in preferences > storage.

1.3.2. importing sidecar files generated by other applications

When importing an image, darktable automatically checks if it is accompanied by a sidecar file. As well as looking for files named `<basename>.<extension>.xmp` and `<basename>_nn.<extension>.xmp` (darktable's XMP file naming formats) darktable also checks for the presence of a file in the form `<basename>.xmp` (the naming format for Lighroom's XMP sidecar files). Files with the latter naming format will be read by darktable but will not be written to. Once the image has been imported, darktable will generate an additional XMP file using its own naming convention.

At present, darktable is able to deal with the following metadata from Lightroom-generated sidecar files during the import phase:

- tags (including hierarchical tags)
- color labels
- ratings
- GPS information

In addition, darktable has been designed to help migrate some image operations from specific other applications. The aim here is not to make darktable a drop-in replacement for any other software, but rather to help you recover part of the work you have invested into your image on migration to darktable. It is important to understand that this import process will never give identical results. The underlying development engines are very different from application to application, and additionally depend a lot on the specific image. In some cases, the results may be similar but often, further adjustment will be required in darktable.

This migration happens automatically when entering the darkroom view, provided that a corresponding XMP sidecar is found.

At present, darktable is able to handle the following development steps from Lightroom-generated XMP files (with the corresponding darktable module in parentheses):

- crop and rotate (*crop and rotate*)
- black level (*exposure*)
- exposure (*exposure*)
- vignette (*vignetting*)
- clarity (*local contrast*)
- tone curve (*tone curve*)
- HSL (*color zones*)
- split-toning (*split-toning*)
- grain (*grain*)
- spot removal (*spot removal*)

1.3.3. local copies

Many users have huge image collections stored on extra hard drives in their desktop computer, or on an external storage medium like a RAID NAS, etc.

It is a common requirement to be able to develop a number of images while travelling using a laptop and then later synchronize them back to the original storage medium. However, copying images manually from the main storage to the laptop and back is cumbersome and prone to errors. The "local copies" feature of darktable has been designed to directly support these use cases.

You can create local copies of selected images from within the lighttable. Local copies are always used when present, giving continued access to images even if the external storage is no longer connected. At a later point, when your primary storage medium has been reconnected, you can synchronize the XMP sidecar files back to this storage, deleting any local copies. These operations can be found in the selected images module in the lighttable.

For safety reasons, if local copies exist and the external storage is available, the local XMP sidecars are automatically synchronized at start up.

Local copies are stored within the `$HOME/.cache/darktable` directory and named `img-<SIGNATURE>.<EXT>` (where `SIGNATURE` is a hash signature (MD5) of the full pathname, and `EXT` is the original filename extension).

Local copies can be identified in the lighttable view by a white marker on the top right of the thumbnail. In addition, all local copies carry the `darktable|local-copy` tag to allow them to be easily selected.

1.4. basic workflow

1.4.1. import, rate & tag images

When you want to edit some new images in darktable, the first step is to import them. This will create entries for the imported images in darktable's library database so it can keep track of the changes you make to them. There are two main methods for importing images:

import images from the filesystem

You can import a single image or a directory full of images (optionally recursing through subdirectories) from the filesystem. When importing images, darktable will read the image's internal metadata and any accompanying XMP sidecar file. If an image has already been imported, it will be ignored (though any updates to the sidecar file will be loaded). The location of each image is recorded in the library database, but darktable will not copy or move the files anywhere. If you want a program that will copy files into a specific directory, you can use a separate program like rapid photo downloader for this.

import images from a camera

To import images from a camera, first connect the camera to your system with a USB cable. If your system tries to automount the camera's files, you should choose to abort the mount operation, otherwise the camera cannot be accessed from within darktable. If you don't see your camera listed in the import module, press the "scan for devices" button. Once your camera is detected the import module should offer the ability to *import* images or *tether* your camera while shooting. Unlike when importing of images from the filesystem, darktable will physically copy files imported from the camera into a specified directory following the file naming pattern defined in preferences > import.

Once images are imported, they will appear in the lighttable view. By default, the images will all be given a one-star rating.

There are many different ways to manage a set of newly imported photos, such as giving them tags and adjusting their ratings. Please refer to the lighttable section of this guide for a full list of *digital asset management* features.

One example workflow might be:

1. Set the lighttable view to show photos with exactly a 1 star rating.
2. Perform a quick first-level screening of your photos. If any photos are badly out-of-focus or otherwise useless, *reject* them with the R key, or give them a 0-star rating. If a photo looks reasonable and should pass to the next phase, press 2 to give it a 2 star rating. Any photos that no longer have a 1 star rating will automatically disappear from view. Continue in this manner until you have completed the first level of assessment.
3. Now set the lighttable view to show only photos with exactly a 2 star rating. Go through these photos more carefully, and decide whether to promote them to a 3 star rating, or put them back down to a 1 star or rejected rating.
4. You can now spend some time performing a quick edit on your 3 star photos, to see if they are worth keeping. If you are happy with the results, you can create a tag for the photo, and promote it to a 4 or even 5 star rating.
5. Go through your 4 and 5 star photos, perform any final edits on them, print them out, publish on your portfolio site, etc. and bask in the copious amounts of critical acclaim you will receive!
6. If space is at a premium you might want to consider permanently deleting your rejected or 0-star images. Select these images in the lighttable and use the 'trash' option in the selected images module. You should probably only do this on photos you are certain you will never need again (badly focussed, significantly overexposed etc.).

1.4.2. editing an image: workflow overview

This section will guide you through the basics of developing an image in the darkroom view, where an arsenal of modules is at hand to help you reach your creative goals.

To begin, open an image in the darkroom by double clicking an image thumbnail in the lighttable view.

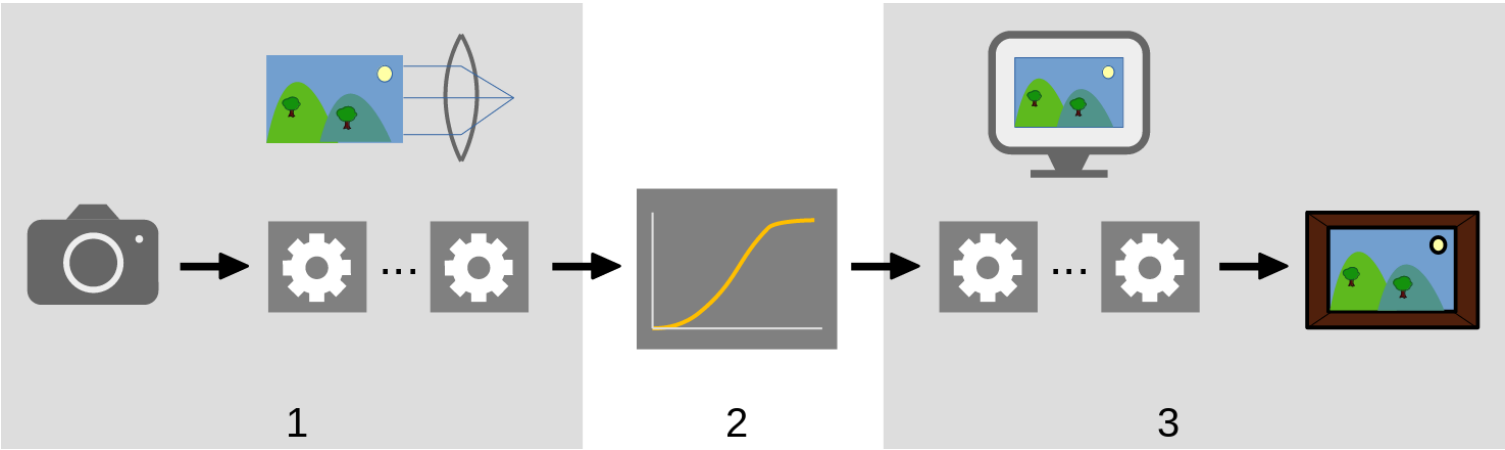
Each change you make to the image in the darkroom is turned into a history stack item. The history is stored in a database and in an XMP sidecar file for that image. All changes are stored automatically when you switch images or go from one darktable view to another. You can safely leave darkroom mode or quit darktable at any time and come back later to continue your work. For this reason darktable does not need a “save” button and it does not have one.

On the left panel in darkroom mode is the history stack module, listing the changes you have made, starting from the bottom – each edit adds a new item to the top of the stack. You can select an earlier point in this history to show how the image looked at that point, for comparison between changes. The stack can be compressed to remove redundant intermediate points in your edits – when you are happy with what you have done, just compress the history stack. Note that all edits above the selected history entry are permanently deleted when compressing the history stack.

A large number of processing modules are shipped with darktable, arranged into module groups. These groups are accessed via toggle buttons at the top of the right panel, just below the histogram.

choosing a workflow

When processing an image, we apply a sequence of modules, known as the pixelpipe.



1. The *scene-referred* modules are intended to process pixel values that are proportional to the amount of light collected by the camera at the scene. The dynamic range of an image in the scene-referred section of the pixelpipe is often larger than that of the display medium.
2. At some point in the pixelpipe, these pixel values are compressed by a tone mapping module into a smaller dynamic range more suitable for display on a monitor or hardcopy print.
3. The remaining modules operate in this non-linear *display-referred* section of the pixelpipe to produce the final output image.

There are two standard workflows offered in darktable (these can be changed in preferences > processing > auto-apply pixel workflow defaults):

- *scene-referred workflow*: Here the emphasis is on doing as much processing as possible in the scene-referred part of the pipeline, and performing dynamic range compression to display-referred space as late as possible. This is the preferred workflow for darktable. It uses the *filmic rgb* module to perform the tone mapping compression.
- *display-referred workflow*: This is the legacy workflow and is still the default setting when darktable is first installed. It performs the tone mapping compression much earlier in the pixelpipe, and many of the modules therefore operate in display-referred space. It uses the *base curve* module to perform the tone mapping compression.

A third option is to set the workflow presets option to *none*. In this case, the scene-referred workflow module order will be used by default but none of the above modules will be automatically applied. It is up to the user to arrange for appropriate tone mapping and reorder the modules where required.

Note: when changing the preferences between scene-referred and display-referred workflow, the new setting will only apply for newly imported images. If you have already imported an image using a different workflow setting, go to the *history stack* module in the darkroom view, select “original image”, and click “compress history stack”. This will discard any previous edits and reset the workflow for that image.

1.4.3. editing an image: scene-referred workflow

The *scene-referred* workflow places an emphasis on performing image processing in the linear scene-referred part of the pixelpipe. This helps to reduce artifacts and color shifts that can result from processing non-linear pixel values and, by decoupling the image processing from the characteristics of a specific display, it makes it easier to adapt your work in the future to new display media, such as high dynamic range displays.

This being the recommended way to process images in versions 3.0 and above, this section will provide a much more comprehensive overview than the next section on the *display-referred* workflow.

basic steps

Basic image processing in scene-referred workflow requires you, as a minimum, to consider the following steps in order to render a reasonable image on your display:

capture an image

Use your camera to take a properly exposed image. Normally you can rely on the camera’s metering and automatic exposure features. However, for some scenes you may need to use the camera’s exposure compensation dial or manual settings to get an optimal exposure. In general, you want to make the exposure in camera as bright as possible without clipping the highlights. This is known as “exposing to the right” (ETTR), and it ensures you take best advantage of the sensor’s dynamic range. Many cameras have features like “zebras” or “blinkies” to warn you when you are in danger of clipping.

exposure

This module is enabled by default, and it will include an initial exposure boost of +0.5EV to mimic the standard processing of most in-camera JPEGs. The metering systems in cameras vary, and some camera models might need a slightly larger exposure boost (eg. +0.8EV ~ 1.5EV), in which case you can create an auto-apply preset as required. The exposure module will detect if the camera’s exposure compensation dial was used (see above remarks about ETTR), and will re-adjust the exposure accordingly.

Use the exposure slider to adjust the midtones in the image to an appropriate brightness level. At this stage, don’t worry about highlights and shadows – these will be handled later.

You can also click+drag on the histogram to change the exposure, but this gives less control than using the *exposure* module slider. While you can use the *exposure* module to tweak the black level to supply more contrast, you need to be very careful doing this as you can end up with negative RGB values.

white balance

It is important that the white balance is set correctly to form a solid basis for subsequent processing. The camera will normally store the selected white balance setting inside the raw file’s metadata, and darktable will use this as a starting point. To get a more accurate white balance, you can either use the color picker to select a neutral grey tone in the image, or you can switch to a different white balance preset from your camera, where available. Fine adjustments to the global white balance are made using the *temperature* slider and, less often, the *tint* slider. Moving the *temperature* slider to the left makes the image cooler (more blue), and moving it to the right makes it warmer (more orange).

The *white balance* module is only able to make *global* adjustments to the white balance of the image. The *color balance* module, among other things, gives you even more control in cases where a scene was illuminated by multiple light sources at different color temperatures.

filmic rgb

This module performs tone mapping compression from the high-dynamic-range of the captured image, to the lower dynamic range of the display medium. The mid-grey tone level has already been set (above) with the *exposure* module. Filmic will propose, on its *scene* tab, an appropriate white point and black point for the image – you may need to adjust these for a particular scene. On the *look* tab you can adjust the midtone contrast and saturation settings if required.

other recommended modules

In addition to the basic modules described above, you may want to consider using the following modules to make your image look even prettier. These modules are known to work well with the scene-referred workflow:

crop and rotate* / *perspective correction

Quite frequently you want to only show part of the captured scene in your image, e.g. to take away some disturbing feature close to the frame. In other cases, the horizon in the image may need levelling, or there may be perspective distortions. All of this can be corrected with full manual control in the *crop and rotate* module. For a fully automatic correction of perspective distortions you may alternatively visit the *perspective correction* module.

retouch* / *spot removal* / *hot pixels

Sometimes you will need to remove spots caused by sensor dirt. The new *retouch* and the older *spot removal* modules are at hand for this and can also correct other disturbing elements like skin blemishes. If your camera has stuck pixels or tends to produce hot pixels at high ISO values or longer exposure times, take a look at the *hot pixels* module for automatic correction.

color balance

This is a versatile module that can be used to further adjust the contrast and saturation of an image, and can also be used to perform color grading (e.g. emulate “orange and teal” grading used in hollywood films, remove redness in skin tones, adjust for uneven color balance in shadows/midtones/highlights, etc.). The *color zones* module can also be helpful in some cases where you are unable to achieve the desired effect using the *color balance* module.

tone equalizer

Use this module to perform “dodging and burning” operations and recover detail in the shadows and highlights. This module generates a mask to average out the luminance in different parts of the image, and the equalizer allows you to selectively increase and decrease luminance levels using that mask. It is recommended that you first check the mask is set up appropriately, then you can use the sliders or the spline curve to adjust the various brightness levels. You can also place the mouse cursor over different parts of the image to see the EV level of the mask at that point, and then use the mouse wheel to adjust the brightness of that EV level accordingly.

local contrast

This module can emphasise detail and improve clarity, and is a good way to improve the general sharpness of an image. It is recommended that you use this module in *local laplacian* mode.

A more versatile but also more complex technique is to use the *contrast equalizer* module, which is very useful for making adjustments where spatial dimension plays a role. It has a number of pre-defined presets that may be helpful as a starting point in understanding this module.

denoise (profiled)

The *denoise (profiled)* module is usually your best option for reducing noise in an image. This module offers an almost “single-click” solution to remove noise. From a user perspective the effect only depends on camera type and ISO value, both derived from Exif data. All other settings are taken from a database of noise profiles that the darktable team has collected – now covering well above 300 popular camera models. The simplest way to use this module is *non-local means (auto)* mode. The wavelet feature of this module is also quite effective against color noise. It is recommended that you use this module at 100% zoom so that you can accurately see the effects of your changes.

Other modules that allow for image denoising include *raw denoise*, *surface blur*, *astrophoto denoise*, and the *contrast equalizer* module, which is based on wavelets. If your camera is not yet supported by *denoise (profiled)*, *astrophoto denoise* is probably the most convenient alternative, as it allows you to treat color and luminance noise separately.

haze removal

Does what is says on the tin – removes atmospheric haze.

color calibration

This module offers a range of presets for making black and white images emulating classic film. It can also be used to tweak your color profile matrices, for example, to deal with color gamut issues.

lens correction

If your camera/lens combination is supported, use this module to correct for standard lens distortions, where corrections have not already been performed in-camera. The *crop and rotate* or *perspective correction* modules can also be used to simulate the effects of a tilt-shift lens.

modules to be used with care

There are some modules for which there is not yet an alternative that is well-suited to the scene-referred workflow. If required, these modules should be used sparingly and with care.

vibrance

Tends to darken colors. Consider using *color zones* with a saturation parametric mask to give more control.

color zones

Transitions may not be graceful. An alternative can be to use *color balance* with a parameteric mask.

vignetting

This module can produce unnatural-looking results with too strong a fall-off. You may be better off using the *exposure* module with an elliptical mask with large transition area, and perhaps adding *color balance* with the same mask to reduce saturation at the edges.

Note: When using blend modes on any module, you should be aware that many of the blend modes are optimized for display-referred space and assume a mid-gray value of 50%. For the linear scene-referred space, stick with blend modes based on arithmetic operations (addition, multiplication, division, subtraction, average), on maximum/minimum comparisons (screen) or on channel separations (hue, color, chroma, etc.).

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other artistic effects

There are also a number of artistic effect modules available in darktable. To name just a few:

- Use the *watermark* module to add an individual watermark to your image.
- Use the *grain* module to simulate the typical noise of classical analogue photos.
- Use the *color mapping* module to transfer the look and feel of one color image onto another.
- Use the *lowlight vision* module to simulate human vision making low light pictures look closer to reality.
- Use the *graduated density* filter to add a neutral or colored gradient to your image for exposure and color correction.

Please see the processing module reference for a list of the available modules.

modules to avoid

There are a number of modules which are no longer recommended for use within a scene-referred workflow. This doesn't mean they can't be used, but they can produce undesirable effects when their sliders are pushed too far, and there are better alternatives. In each case, the preferred alternative module is listed along with a brief explanation.

local tone mapping (deprecated)

prefer tone equalizer

This module applies a bilateral blur over a non-linear (log) mapping that can provoke halos and fringing. This is common issue for modules performing blurs and occlusions that operate over a non-linear encoding.

global tonemap (deprecated)

prefer filmic rgb

This module tries to deal with HDR images using the Lab color space, which is not well suited for high dyanamic ranges. The *filmic rgb* module operates in a linear space and can easily scale over a wide range of input values from the scene and fit them into the narrower dynamic range demanded by display and printing devices.

shadows and highlights

prefer tone equalizer

This module works with blurs in Lab color space, resulting in problems including halos, high local contrast in highlights and hue shifts towards blue in the shadows.

lowpass

prefer contrast equalizer or tone equalizer

Another module doing blurs in Lab space. Prefer the *contrast equalizer* for blurring, or the *tone equalizer* if local dynamic range compression is needed.

highpass

prefer contrast equalizer or local contrast

Uses a blur performed in Lab space, so has the same problems as with the *lowpass* module. Use *contrast equalizer* for fine sharpness, or *local contrast* for general sharpness.

sharpen

prefer contrast equalizer or local contrast

The USM algorithm used in the *sharpen* module suffers from same issues as the *highpass* module, and can easily cause artifacts. Use the presets offered by the *contrast equalizer* for de-blurring, or *local contrast* for general sharpness.

monochrome

prefer color calibration (or color balance)

The *monochrome* module can be quite fiddly to use. The *color calibration* presets better emulate what physically happens with film, or you can set the *output saturation* slider in the *color balance* module to 0% for a more perceptual approach.

fill light (deprecated)

prefer tone equalizer (or exposure)

Used to add light to a scene, this module again uses blurs in Lab space. The *tone equalizer* works in linear space, or you can also achieve a similar effect by using the *exposure* module with a drawn mask.

bloom

prefer tone equalizer (or exposure)

Again, this module uses blurs in Lab space. Either use the *tone equalizer* module or the *exposure* module with a parametric mask, both of which operate with linear encodings.

zone system (deprecated)

prefer tone equalizer (or exposure)

This module again operates in Lab space, and becomes problematic if you push it too far. It is better to use the *tone equalizer* or multiple instances of the *exposure* module with parametric masks to narrow down on a zone.

color correction

prefer color balance

Prefer the *color balance* module, which works in RGB color space and allows easy adjustment of the white balance in shadows (*offset*), midtones (*power*) and highlights (*slope*). Note the *offset*, *power* and *slope* that we normally use in linear spaces roughly correspond to the *lift*, *gamma* and *gain* parameters used in non-linear gamma-encoded spaces.

velvia

prefer color balance

The *output saturation* slider of the *color balance* module uses similar logic as the *velvia* module, but without the hue and brightness shifts, which can be difficult to manage.

***levels*/rgb levels**

prefer color balance

These modules basically implement a subset of the functions of the *color balance* module, which pretty much makes them redundant.

***tone curve*/rgb curve**

prefer color balance

These modules are normally used to adjust contrast. Their user interface assumes the mid-grey level is around 50%, but in linear scene-referred space mid-grey is much lower at around 18%. It is better to adjust the contrast in *color balance* module, where the mid-grey reference point can be set with the *contrast fulcrum* slider.

contrast brightness saturation

prefer color balance

This module works in Lab color space (with the limitations that implies) and basically duplicates functions already provided by *color balance*.

1.4.4. editing an image: display-referred workflow

This is a legacy mode which is retained to provide backward-compatibility with edits in older darktable versions, and to allows users to continue with their former way of working without forcing them to use the newer *scene-referred* workflow.

The *display-referred* workflow places more emphasis on performing image processing in the non-linear *display-referred* part of the pixelpipe. By default it uses the *base curve* module to tone map images from the linear *scene-referred* space into *display-referred* space, although other tone-mapping tools (such as the *tone curve* module) can also be used. Many modules are moved later in the pipeline (after this tone mapping transition) so that they work with gamma-encoded (*display-referred*) pixel values rather than linearly-encoded (*scene-referred*) pixel values.

Most of the basic steps required to develop images under the *display-referred* workflow are quite similar to the *scene-referred* workflow. The main differences lie in the choice of modules, and the order in which they appear in the pixelpipe. To see the difference in the ordering of the modules between the *display-referred* and *scene-referred* workflows, please refer to the default module order section.

Note: This section discusses a number of legacy modules that are no longer recommended for use in the scene-referred workflow, and new users are recommended to instead refer to the scene-referred section for a guide to how best to process images in darktable.

---

white balance

The *white balance* module works the same as in *scene-referred* workflow and, by default, uses the white balance coefficients provided by the camera. If this does not give acceptable results, use the camera presets or take the white balance from a neutral spot in your image. The temperature slider can be used to make the image “warmer” or “cooler”. More advanced color grading is better left to other modules, as discussed later.

exposure correction

The *exposure* module works the same as in *scene-referred* mode, but the way you use it is a little different. In *display-referred* mode, you need to make sure you don’t blow out your highlights too much, and use the *base curve* module to adjust the middle tones if needed.

While you can use the *exposure* module to tweak the black level to supply more contrast, you need to be very careful doing this as you can end up with negative RGB values. It is better to increase the contrast by adjusting the toe of the *base curve*, however this can be a little fiddly and it is one of the reasons why the *filmic rgb* module was introduced to darktable.

noise reduction

As with the *scene-referred* workflow, the best starting point for noise reduction is the *denoise (profiled)* module. Similarly, you may also choose to use *raw denoise*, *surface blur*, *astrophoto denoise*, or the *contrast equalizer* module.

fixing spots

As with the *scene-referred* workflow, you can use the *retouch*, *spot removal* and *hot pixels* modules to correct artifacts in your image.

geometrical corrections

As with the *scene-referred* workflow you can use the *crop and rotate*, *perspective correction* and *lens correction* modules to correct distortions and crop your image.

bringing back detail

Raw images often contain more information than you can see at first sight, especially in the shadows. The *shadows and highlights* module helps bring these details back into visible tonal values. Structural details in fully blown-out highlights, by nature of the digital sensor, can not be recovered. However, you can correct unfavorable color casts in these areas with the *highlight reconstruction* module. The *color reconstruction* module is able to fill overexposed areas with suitable colors based on their surroundings. The *filmic rgb* module also offers highlight reconstruction, but be sure to disable *base curve* first.

adjusting tonal values

Almost every workflow is likely to include adjusting the image’s tonal range and darktable offers several modules to assist with this. The most basic is the *contrast brightness saturation* module. In the *tone curve* module, tonal values are adjusted by constructing a curve. The *levels* and *rgb levels* modules offer a concise interface, with three markers in a histogram. And of course, there is nothing to stopping you from using the *filmic rgb* module in a *display-referred* workflow if you so wish (after disabling *base curve*).

enhancing local contrast

Local contrast enhancement can emphasize detail and clarity in your image. Carefully used, it can give your photograph the right pop. Several modules are available for this task. The *local contrast* module is easy to handle, with just a few parameters. A much more versatile, but also more complex, technique is offered by the *contrast equalizer* module. Take a look at its presets to get a feeling for how it works. The *contrast equalizer* is darktable's "Swiss Army Knife" for many adjustments where spatial dimension plays a role. Note that the location of this module in the pixel pipeline differs significantly between the *scene-referred* and *display-referred* workflows.

color adjustments

darktable offers many modules for adjusting colors in an image. A very straightforward technique is implemented in the *color correction* module. Use this module to give an image an overall tint or to adjust overall color saturation. The *color zones* module offers a much finer control to adjust saturation, lightness and hue, in user defined zones. The *tone curve* module – in addition to the classical adjustment of tonal values – gives you fine control over the colors in an image. Finally, if you intend to convert an image into black & white, a good starting point, with an easy to use and intuitive user interface, is offered by the *monochrome* module. Alternatively, you might consider using the *color calibration* module.

sharpening

If you start your workflow from a raw image, your final output will need to be sharpened. The *sharpen* module can do this with the classical USM (unsharp mask) approach, available in most image processing software. Another very versatile way to enhance edges in an image is offered by the *highpass* module, in combination with darktable's rich set of *blending* operators.

artistic effects

darktable comes with a rich set of artistic effect modules. For example you can use the *watermark* module to add a watermark to your image. The *grain* module simulates the typical noise of classical analogue footage. Use the *color mapping* module to transfer the look and feel of one color image onto another. The *low light* module allows you to simulate human vision to make lowlight pictures look closer to reality. The *graduated density filter* adds a neutral or colored gradient to your image for exposure and color correction.

1.4.5. exporting and uploading images with metadata

Changes to an image are not saved directly to the image file contrary to a regular image editor. Rather, darktable is a non-destructive editor, which means that all changes are recorded in darktable's library database, and the original image is left untouched. Therefore, you need to export images in order to bake your processing options and metadata changes into an output file that can be distributed outside of darktable.

Images are exported from the lighttable view, using the export selected module in the right panel. This module offers a lot of options, but by far the most common use is to "save my developed raw image as a JPEG".

When exporting images in darktable, there are two basic questions you need to answer:

- *Where shall I send the exported images?* Most often you will choose to write the files to a folder on your local disk, but other options include writing them to a LaTeX photo book template or sending them to another program such as Hugin (for panarama stitching) or GIMP (for further editing).
- *In what format shall I save the exported images?* This covers not only the image file format (JPEG, PNG, TIFF, OpenEXR etc.) but also the quality, compression, resolution, picture profile settings and which metadata to embed in the exported image.

The most common steps would therefore be:

1. Select one or more images in the lighttable view
2. Choose the target storage and file format
3. Set the maximum width and height image restraints. Leave the width and height restraints at zero to export at full resolution.

By default, an image will be saved to local disk as a high-quality JPEG at full resolution. For further information on all the available export options, please refer to the export selected module reference section.

2. Lighttable

2.1. overview

The lighttable view allows you to view and manage your image collection.

The centre view contains thumbnails of your images – how they are displayed depends on which mode you are working in.

While the mouse is over an image thumbnail or images are selected, there are a number of actions you can perform:

```
0 – 5       set the rating of the image
            if an image has 1 star and you hit the 1 key, the image will become unrated
R           rate the image as "rejected"
F1 – F5     set a color label
Ctrl+C      copy the history stack
Ctrl+V      paste the copied history stack
D           open in darkroom view for developing
W           fully zoom into the current image while the key is pressed
Ctrl+W      fully zoom into the current image and show areas in focus
```

2.2. lighttable view layout

left panel

From top to bottom:

import
Import images from the filesystem or a connected camera.

collect images
Filter the images displayed in the lighttable center panel – also used to control the images displayed in the filmstrip and timeline modules.

recently used collections
View recently used collections of images

image information
Display image information

lua scripts installer **(optional)**
Install lua scripts

right panel

From top to bottom:

select
Select images in the lighttable using simple criteria.

selected images(s)
Perform actions on selected images.

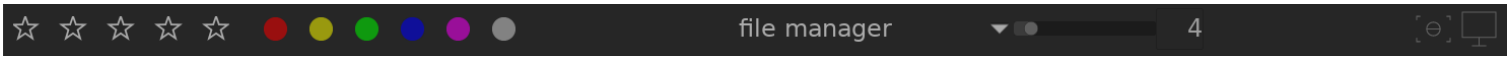
history stack
Manipulate the history stack of selected images.

styles
Store an image’s history stack as a named style and apply it to other images.

metadata editor
Edit metadata for selected images.

tagging
Tag selected images.
geotagging
Import and apply GPX track data to selected images.
export selected
Export selected images to local files or external services.

bottom panel



From left to right:

star ratings
Apply star ratings to images
color labels
Apply color categories to images
mode selector
Choose lighttable mode using the dropdown
zoom
Use the slider to change the size of thumbnails
enable focus-peaking mode
Click to enable focus-peaking mode
set display profile
Click to choose display profiles

2.3. undo/redo

Most changes made within the lighttable are recorded and can be reverted to a previous state. This includes modifications to color labels, ratings, geo-localization, tags, metadata, orientation, copy/paste of history, or application of a style. Note that the facility to undo/redo actions is unlimited in the number of steps while in the lighttable view, but it is reset each time you switch to a different view.

Press Ctrl+Z to undo the last modification and Ctrl+Y to redo the last undone modification (if any).

2.4. lighttable modes

2.4.1. filemanager

In the default mode images are displayed in a grid with an adjustable number of images per row.

controls

zoom
The number of images in each row can be altered using the slider in the bottom panel, or by holding Ctrl while scrolling over the center view with your mouse.
navigate
You can navigate through the images using the arrow keys (←/→/↑/↓) or by scrolling with your mouse. Press the Home key to scroll to the top of the collection, the End key to scroll to the bottom, and PageUp/PageDown to scroll up/down by a page.

select

You can select the image under the pointer by clicking on its thumbnail or by pressing Enter. A range of images can be selected by clicking on the first image and then Shift+clicking on the last one. Images can be added or removed from a selection by Ctrl+clicking on their thumbnails or by pressing Spacebar.

2.4.2. zoomable lighttable

The *zoomable lighttable* mode provides a different way to navigate large collections of images.

controls

zoom

Scroll with the mouse wheel to zoom in and out of the lighttable (compared to Ctrl+scroll in filemanager mode).

Zooming the thumbnails does not change the number of thumbnails per row, so the lighttable can exceed the visible area on all sides.

navigate

Hold down the left mouse button to drag the images around on the lighttable to navigate through your collection.

select

As with the filemanager mode, you can select the image under the pointer by clicking on its thumbnail or by pressing Enter. A range of images can be selected by clicking on the first image and then Shift+clicking on the last one. Images can be added or removed from a selection by Ctrl+clicking on their thumbnails or by pressing Spacebar.

Hint: you may find that the images are slow to load when zooming quickly through a large collection. One way to speed up the navigation is to generate a cache containing all the thumbnails using the `darktable-generate-cache` command.

2.4.3. culling

Culling mode allows you to display images side by side to easily compare them.

controls

zoom

In culling mode, you can zoom into images (up to 100%) by holding Ctrl while scrolling with the mouse wheel.

Pan within zoomed images with click+drag.

By default, zooming and panning are synchronized between all visible images. If you want to zoom or pan only a specific image, add the Shift modifier to the above actions.

navigate

Use the mouse wheel or arrow keys (←/→) to scroll through your collection.

modes

There are two different ways to define how many images are shown at the same time: “fixed” and “dynamic”. Switch between these methods while in culling mode by pressing the “<” key.

fixed mode

The number of images displayed is always the same, independent of the selection length. This number can be set with a slider on the bottom panel.

In this mode, you will navigate through all selected images. If no selection is set (or if only one image is selected), you will navigate through all images.

The default keyboard shortcut to enter culling in fixed mode is X.

dynamic mode

All of the selected images are shown. If no selection is set (or if only one image is selected) the last value from fixed mode is used.

The default keyboard shortcut to enter culling in dynamic mode is Ctrl+X.

Hint: To enhance performance when loading zoomed images, you can enable (preferences > cpu/gpu/memory > enable disk backend for full preview cache). Bear in mind that this can occupy a lot of disk space.

2.4.4. full preview

From any of the lighttable modes, you can display a fully zoomed preview of the image that is currently under the mouse pointer by pressing and holding down W. This is useful to more closely inspect an image while rating and selecting images.

Pressing and holding Ctrl+W fully zooms into the image and also identifies any regions of sharpness in the image that may indicate the image is in focus. For this tool to work the input image needs to hold an embedded JPEG thumbnail, which is the case for most raw files.

Regions in the image with a high level of sharpness are indicated with red borders. If there are no such regions found, any regions of moderate sharpness are identified with a blue border. Note that this is not the same as the focus peaking indicator, which is another way to identifying areas of sharpness within an image.

Sometimes pressing W or Ctrl+W may not appear to have any effect – in such cases, click on the image thumbnail and press the corresponding key again.

If you want the full preview to stay in place without having to hold the W key, you can use sticky preview mode by pressing Alt+W (no focus peaking) or Ctrl+Alt+W (with focus peaking). In sticky preview mode, you can zoom and pan within the image in a similar way to the culling mode. Press W again to return to the original view.

2.5. digital asset management

2.5.1. film rolls

The basic element for organizing images in darktable is called a film roll – a kind of virtual folder. Whenever you import images from the filesystem, the images are organized in a film roll whose name is derived from the name of their parent folder. Re-importing a folder will add any new images to the existing film roll; images already present in the film roll are not reimported (though the contents of their XMP sidecar files are reloaded into the library database).

Note: Importing images in darktable does not physically copy them to another location: *importing images will not back up your files*.

2.5.2. collections

A collection is a set of images defined by a specific combination of selection criteria. The most basic kind of collection is a film roll, which contains all of the images that have been imported from a specific folder on disk.

You can easily construct other kinds of collections based on various image attributes (Exif data, filename, tags etc.). Multiple criteria can be logically combined to narrow or extend your collection (see collect images).

darktable keeps a list of the most recently used collections for quick access (see recent collections).

2.5.3. thumbnails

Each image in the current collection is represented by a thumbnail in the lighttable view and filmstrip module. A cache of the last recently used thumbnails is stored in a file on disk and loaded into memory at startup. The size of this cache can be adjusted in preferences > cpu/gpu/memory.

thumbnail creation

Thumbnails are created whenever an image is imported into darktable for the first time, after an image has been modified in the darkroom, or when revisiting an image whose thumbnail is no longer available.

When an image is imported into darktable for the first time darktable can either try to extract an embedded thumbnail from the input image (most raw files contain these, usually in JPEG format) or process the raw image itself using default settings. You can define how darktable obtains its thumbnails in preferences > lighttable.

Extracting an embedded thumbnail from the input image has the advantage of being very fast. However, these thumbnails have been generated by the raw converter of the camera and do not represent darktable's "view" of that image. You will notice the difference as soon as you open the image in the darkroom mode, at which point darktable replaces the lighttable's thumbnail with its own internally processed version.

After importing a new film roll darktable automatically generates thumbnails for new images as they are needed. When importing a large set of new images, thumbnail generation can slow down navigation in the lighttable view. Alternatively you may terminate darktable and generate the thumbnail cache separately by running the darktable-generate-cache binary. This program will generate all missing thumbnails in one go.

As the thumbnail cache has a pre-defined maximum size it will eventually get filled up. If new thumbnails are subsequently added, old thumbnails are dropped from the cache. However, darktable will keep all thumbnails on disk if the corresponding disk backend option is activated in preferences > cpu/gpu/memory. Access to the thumbnails in this secondary cache is slower than the primary cache, but still much faster than reprocessing thumbnails from scratch. The size of the secondary cache is limited only by available disk space.

Thumbnails are never removed from the secondary cache. You can manually clean the secondary cache by recursively deleting all images in the `$HOME/.cache/darktable/mipmaps-xyz.d` folder (where `xyz` denotes an alphanumeric identifier of the cache). After clearing the secondary cache you can simply allow darktable to re-generate thumbnails as needed, or you can generate all thumbnails in one go with `darktable-generate-cache`.

If you choose not to activate the disk backend and select too small a cache size you may observe adverse effects: Continuous regeneration of thumbnails when you navigate your collection, flickering of thumbnail images, or darktable may even become unresponsive. A good choice of cache size is 512MB or higher (see memory for more information).

All thumbnails are fully color managed if the corresponding option is activated in preferences > lighttable. Colors are rendered accurately on screen as long as your system is properly set up to hand over the right monitor profile to darktable. For more information on color management see the color management section.

skulls

If for some reason darktable is unable to generate a thumbnail, it displays an image of a skull (). Don't panic!

There are three main reasons that this could happen:

- *Missing Image File*: darktable remembers all images ever imported, as long as they have not been removed from your database. If darktable wants to create a thumbnail but is not able to open the input file, a skull is displayed instead. Users are advised to remove images from the database using the selected images module before physically removing them from disk. Alternatively you may occasionally run the script `purge_non_existing_images.sh` from darktable's toolset to clean-up your database.
- *Invalid Image Format*: While the extension of an image may seem to be supported by darktable, its contents could be either an unsupported image format or a corrupt file.
- *Memory shortage*: If darktable runs out of memory while generating a thumbnail, it will warn you and display a skull. This can happen if darktable is run with suboptimal settings, especially on a 32-bit system. See memory for more information.

2.5.4. star ratings & color labels

Star ratings and color labels help you to sort and rank images according to your own criteria. An image's star rating and its color labels can be displayed over thumbnails in the lighttable view and filmstrip module.

star ratings

You can give an image a rating from zero to five stars. The quality criteria which lead to a rating are up to you. Whenever you import images, each image receives a default rating which you can define in preferences > import. You can also mark an image as “rejected”.

There are several ways to change a rating. While hovering the cursor over an image thumbnail, you can press a number key 0 – 5 to define the number of stars, or press R to “reject” an image. This is probably the fastest way to rate your images on first inspection of a film roll.

You can also directly click on the star icons that are overlayed on the thumbnails. Click the x to reject.

As Rejecting an image removes the currently-applied star rating, you can undo the rejection by clicking x or pressing R again.

Similarly you can click the first star for a second time to reset the image rating to unranked, or zero stars. This behavior can be changed in preferences > lighttable.

To rate multiple images at once, select those images in the lighttable or filmstrip and then press the appropriate shortcut key, or click the desired star rating in the bottom panel of the lighttable view.

color labels

Color labels are another way to classify images, and can be used as an alternative to star ratings or work alongside star ratings. Each image can carry any combination of one or more color labels in red, yellow, green, blue, and purple.

You can set the color labels for a single image by hovering your cursor over the thumbnail and pressing the function keys F1 – F5, which correspond with the labels in the order given above.

To toggle the color labels of one or more images, select the desired images in the lighttable or filmstrip and then press the appropriate shortcut key or click the corresponding color button in the bottom panel. To remove all labels from the selected images, press the grey button.

2.5.5. image grouping

Grouping images helps to improve the structure and clarity of your image collection when displayed in lighttable view.

You can combine images into a group by selecting them and clicking the “group” button in the selected image(s) module, or by pressing Ctrl+G. Likewise, you can remove selected images from a group by clicking the “ungroup” button, or pressing Ctrl+Shift+G. Images generated by duplicating an existing image are automatically grouped. Similarly, if you import multiple images with the same base name, but different extensions (eg. `IMG_1234.CR2` and `IMG_1234.JPG`), these images will automatically form a group.

Images which are members of a group are labeled with a () symbol in their thumbnails.

The “group” button () in the top panel of the lighttable view toggles grouping mode on and off. If grouping is off, each image is displayed as an individual thumbnail. If grouping is on, images of a group are collapsed, and are represented by a single thumbnail image. This displayed thumbnail is called the group head. If you press the () symbol in the group’s thumbnail, only this group is expanded. If you then expand another group, the first group collapses. To collapse an expanded group again, just click again on the () symbol of its group head.

An expanded group in the filemanager mode of lighttable view is indicated by an orange frame which appears as soon as your mouse pointer hovers over one of the images. This frame surrounds all images in the group.

You can define which image constitutes the group head, while in an expanded view of a group, by clicking on the () symbol of the desired image. That symbol is shown only if grouping mode is enabled, so to change the group head, you need to first enable group mode, then expand the group you want to change and finally click the () symbol on the desired image. To determine which image is the group leader, hover over the () and a popup will identify the group leader.

If you collapse an image group and then enter darkroom mode (e.g. by double-clicking on the thumbnail), the group head image will be opened for developing.

Image groups are also a convenient way to protect an existing history stack against unintentional changes. Suppose you have just finalized an image and want to protect its current version: Simply select the image, click “duplicate” in the selected images panel, and make sure that grouping is switched on and that the group is collapsed. Now, whenever you open the image group again in darkroom, only the group head will be altered. The underlying duplicate remains unchanged.

Note: “duplicating images” only generates a copy of an image’s history stack, stored in another small XMP file. There is still only one raw file.

2.5.6. metadata and tagging

darktable allows you to store additional information about your images to allow them to be more easily searched and grouped. This information is stored in darktable’s database and XMP sidecar files and can also be included within exported images.

metadata

Metadata (e.g. title, description) is free-format text that usually differs for each image.

See the metadata editor module for details of how to add metadata to images.

tagging

Tags are usually shared between multiple images and are used to categorise and group them.

See the tagging module for details of how to add tags to images.

3. Darkroom

3.1. overview

The darkroom view is where you develop your images. The center panel contains the image currently being edited.

zoom

Middle-click on the center panel to zoom to 1:1 and double-middle-click to zoom to 2:1.

Alternatively you can zoom in and out between 1:1 and “fit to screen” by scrolling with your mouse. Scroll with your mouse while holding the Ctrl key pressed to extend the zoom range to between 2:1 and 1:10.

export

Images are normally exported using the export selected module in the lighttable view. However, you can also export the current image directly from the darkroom by using the shortcut Ctrl+E. The image will be exported using the parameters currently set in the *export selected* module.

3.2. darkroom view layout

left panel

From top to bottom:

navigation
Navigate and zoom the center view
snapshots
Take and view snapshots for comparison with the current edit
duplicate manager
View and manage duplicates
global color picker
Select and display color information taken from parts of the image
tagging
Manage tags
image information
Display information about the current image
mask manager
View and edit drawn shapes

right panel

From top to bottom:

histogram
A graphical depiction of the image’s light levels
module groups
Select module groups (if enabled)
search module
Search for a module (if enabled)

processing modules
The modules used to process an image
module order
Choose the order in which processing modules are executed in the pixelpipe

bottom panel

From left to right:

presets
Quick access menu for module presets. You can manage the contents of this menu by selecting “manage quick presets list…”
styles
Quick access menu for styles
second darkroom window
For multi-monitor setup, allows the user to display a second image on another screen
focus peaking
Toggle focus peaking mode
color assessment
Toggle the ISO12646 color assessment view
raw overexposed warning
Toggle raw overexposed indicators (right-click for options)
clipping warning
Toggle clipping warnings (right-click for options)
soft proof
Toggle softproofing overlays (right-click for options)
gamut check
Toggle gamut checking (right-click for options)
overlay line colors
Set colors for modes that overlay lines on the image (masks, crop guides etc.)

You can also enable the filmstrip module at the bottom of the screen to allow you select and interact with the images that are currently visible in the lighttable view.

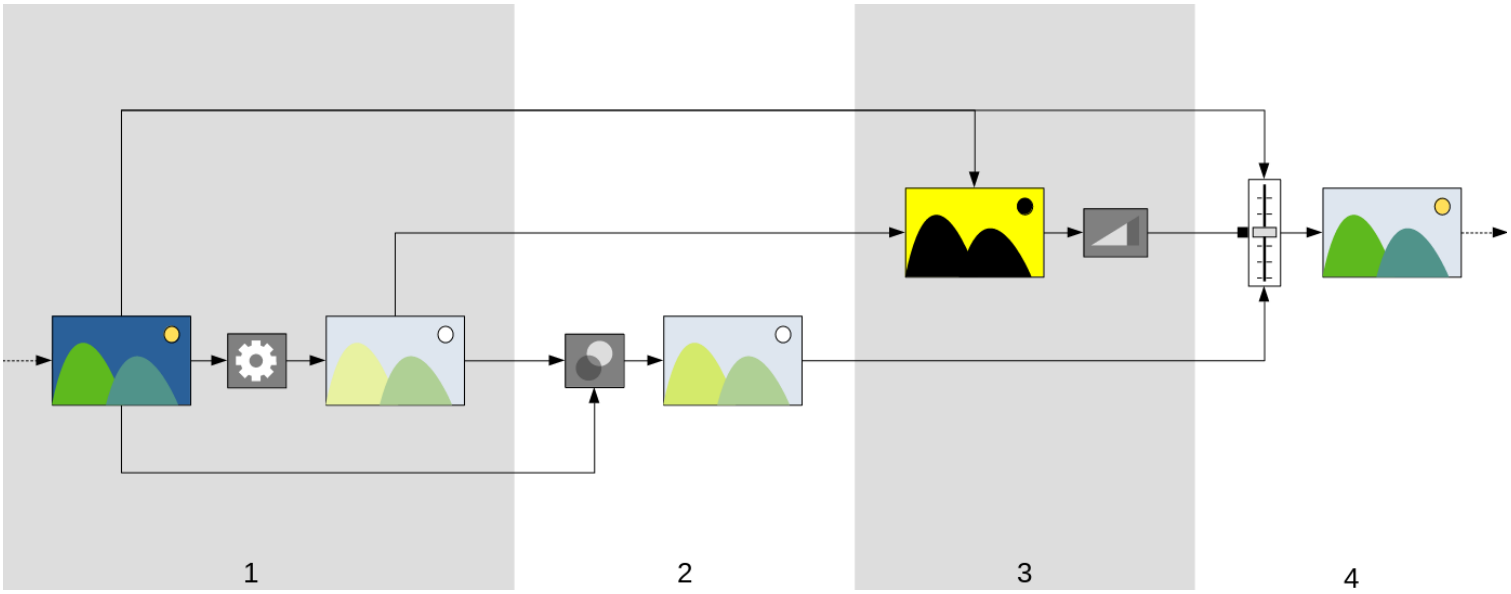
3.3. image processing modules & the pixelpipe

3.3.1. the anatomy of a module

The basic element of image processing in darktable is the processing module. In order to process a raw image a number of such modules act on the input image in sequence, each performing a different *operation* on the image data. For those familiar with Adobe Photoshop, the concept of a *processing module* in darktable is analagous to that of an *adjustment layer* in that both make an incremental adjustment to the image, building on top of the adjustments that came before.

darktable also provides utility modules, however these are not directly involved in image processing, and instead provide a GUI that allows you to manage your images, tag them, export them and so on.

Every processing module executes independently in a similar manner:



1. Receive the *module input* from the last executed module and perform an *operation* on it to produce the *processed output*. This *operation* is different for every processing module.

2. Combine the *module input* and *processed output* using a blending operator to produce the *blended output*. If no blending is performed, the output of this step is the same as the *processed output*.

3. Generate a *mask*, which defines an *opacity* for each pixel in the image. The *opacity* is later used to control how strongly the module's operation is applied to each part of the image.

   You may define your own mask by drawing shapes over the image or by using pixel properties from the *module input* or *processed output* (see masks for details). This mask may be further modified with a global opacity setting, which affects every pixel equally.

   If no drawn/parametric mask is used, the output of this step is a mask where every pixel has the same opacity (governed by the global opacity setting). If no opacity is defined (no blending is performed) a global opacity of 1.0 (or 100%) is assumed.

4. Combine the *module input* and *blended output* pixel-by-pixel using the *mask* as a mixing operator, to produce the *final output*. Where the mask opacity is 100%, the *final output* is the *blended output* for that pixel. Where the mask opacity is 0 the final output is the *module input* for that pixel. An intermediate opacity combines the *blended output* and *module input* proportionally. The *final output* is passed to the next module for further processing.

Steps 2 and 3 are optional and not supported by all modules. For example, the demosaic module must be applied to the entire raw file in order to produce a legible image so it does not make sense to mask or blend its output.

Each of the above steps is defined in more detail in subsequent sections.

3.3.2. the pixelpipe and module order

The ordered sequence of processing modules operating on an input file to generate an output image is known as the "pixelpipe".

The order of the pixelpipe is represented graphically by the order in which modules are presented in the user interface – the pixelpipe starts with a RAW image at the bottom of the list, and applies the processing modules one by one, piling up layer upon layer of processing from the bottom up, until it reaches the top of the list, where it outputs the fully processed image.

Note: The order in which processing modules are executed exactly matches the order in which the modules appear in darktable's user interface. **Changing the order of the modules in the user interface will change how your image is processed.**

---

module order and workflows

The order in which modules are executed within the pixelpipe has been carefully chosen to give the best output quality. In previous versions of darktable it was not possible to change the module order. However, there are a number of very specific use cases where the movement of some modules within the pixelpipe is advised.

One of the main reasons to change the module order came about with darktable version 3.0, which introduced the new *scene-referred* way of working. Version 3.2 formalised this by introducing the *display-referred* and *scene-referred* workflows, which are controlled by the preferences > processing > auto-apply pixel workflow defaults setting.

The main difference between these two workflows is that *display-referred* operates primarily in the low-dynamic-range of the user's screen, whereas *scene-referred* operates in the high-dynamic range of the original RAW file. The transition between *scene-referred* and *display-referred* is usually performed by a *tone mapping* module which takes the high-dynamic-range input from the camera and compresses it to fit the dynamic range of the output medium.

display-referred workflow

Prior to version 3.0 darktable's workflow was *display-referred* (auto-apply pixel workflow defaults = "display-referred") and this is still provided as the default workflow in the current version. In this workflow, the *base curve* or *filmic rgb* module performs tone mapping early in the pixelpipe and most other darktable modules operate on image data in the compressed *display-referred* space.

This worfklow enables the legacy (pre-darktable-3.0) module order and automatically switches on the *base curve* module for new images.

Pixel data within the *display-referred* space is non-linear and is not a physically realistic representation of the original scene. This can lead to various artifacts with some modules, hence the creation of the (now recommended) *scene-referred* workflow.

scene-referred workflow

The new *scene-referred* workflow (auto-apply pixel workflow defaults = "scene-referred") was introduced as part of darktable 3.0. The module order was entirely rearranged to place the *filmic rgb* and *base curve* tone mapping much later in the pixelpipe. This means that most pixel operations now operate in *linear rgb* space with only a few modules remaining within the non-linear *display-referred* space. Within this workflow it is now recommended that the majority of image processing takes place using the modules modules up to and including *filmic rgb*. Operations in this section of the pixelpipe, being truly linear, are much more physically realistic and produce fewer artifacts.

This workflow enables the new (darktable 3.0+) module order and automatically enables the *exposure* and *filmic rgb* modules with some presets designed to act as a reasonable starting point for scene-referred image editing.

changing module order

It remains highly recommended that users not change the order within the pixelpipe for a number of reasons:

- The sequence of modules has been selected with great care in order to give highest output quality. Changes to the sequence often worsen the result rather than improving it.
- Some processing modules simply don't make sense if they are shifted in the pixelpipe. For example, *highlight reconstruction* needs to be performed on raw data before *demosaic*, which itself needs to be performed before any *input color profile* can be applied. For this reason it is still not possible to move some of the modules that are placed early in the pixelpipe.
- Most of darktable's modules are designed to work within a specific color space (see the color management section for more details). Full flexibility would require modules to support different parallel algorithms depending on the color space they are working in, which would drastically increase complexity.

Despite the general recommendation to leave the pixelpipe order alone, it is possible to move modules within the pixelpipe by holding Ctrl+Shift and dragging and dropping the desired module to a new location. This should only be done by experienced users who understand the impact this will have on the image.

The module order can be manually changed back to either the *3.0* or *legacy* versions using the module order module, which can also be used to define your own custom module order presets.

3.3.3. the history stack

The *history stack* stores the entire editing history for a given image, in the order in which those edits were applied. It is saved to darktable's library database and the image's XMP sidecar file and persists between editing sessions.

Each time a processing module is enabled, disabled, moved or amended a new entry is added to the top of the *history stack*.

The history stack can be queried and modified within the history stack module in the darkroom.

Note: The history stack is not a representation of the order in which the modules are **executed** but the order in which they were **amended**. The execution order is represented by the order of the modules in the right-hand panel.

3.3.4. undo and redo

While you are editing your image, darktable records all of the modifications you make to that image. Thanks to this recording process it is possible to undo and redo changes to recover a previous editing state. Note that the undo/redo facility is unlimited in the number of steps while editing an image, but is reset each time the darkroom is switched to a new image.

Press Ctrl+Z to undo the last modification and Ctrl+Y to redo the last undone modification (if any).

3.4. interacting with modules

3.4.1. module header

At the top of each processing module is the *module header*.

Click on the module name to expand the module and display the parameters that control its operation.

By default darktable will only allow one processing module to be expanded at a time – if you click the header of another module, the previously-opened module's controls are collapsed. If you want to expand more than one module, you may expand further modules by Shift+clicking on the header and all previously expanded modules will remain open. This behaviour can be reversed via a setting in preferences > darkroom.

Note: Expanding a module does not cause it to be activated. See below for how to activate modules.

The module header contains the following controls in order from left to right:

on/off button
Click to toggle the module on or off. Some modules are essential for image processing and cannot be disabled (though their parameters may be amended). Similarly, some modules are not applicable for certain types of image and cannot be enabled.

Ctrl+click on the on/off button to toggle whether the module has focus. The focus state is usually used to activate any overlays that a module places over the image to control its functionality. For example, the *crop & rotate* module only shows the composition and crop guide lines on the image if it has focus.

module name
The module name consists of a description of the module's operation (which cannot be changed) followed by the module's instance name (which can). By default the first instance of a module has an empty instance name. If you create additional instances, the name of each new instance is initiated with a unique integer. For example, the second created instance of an exposure module will be automatically named exposure 1.

Ctrl+click on a module's name to manually amend its instance name.

multiple instance menu
This drop-down menu allows you to create, delete, move and rename module instances. Middle-click on this icon to directly create a new instance of the module. See the multiple instances section for more information.

reset parameters
Click to reset all parameters within the module to their default values. Ctrl+click to reapply any automatic presets for the module – if no automatic presets are applicable for this module, Ctrl+click will simply reset to default values (same as click).

presets menu
This menu allows you to apply, create and edit module presets. See the presets section for more information.

The visibility of the three icons to the right of the module name can be controlled through preferences > darkroom > show right-side buttons in darkroom module headers.

3.4.2. multiple instances

Many of darktable's modules can be applied more than once in the pixelpipe. Each instance of a module behaves independently, taking its input from the module below in the pixelpipe delivering its output to the module above.

As with the base instance of a module, all instances can be moved independently within the pixelpipe either by holding Ctrl+Shift while dragging & dropping or by choosing "move up" or "move down" in the *multiple instances* drop-down menu.

Instances can be renamed by Ctrl+clicking on the module header.

typical use cases

There are many occasions where it makes sense to have a module apply more than once in the pixelpipe. Here are some typical use cases.

- The *exposure* module can be used in combination with masks to lighten or darken parts of an image. A separate instance may be created to modify each part of the image.
- You may wish to handle luma and chroma noise independently. This can be accomplished by generating two instances of your chosen denoising module and using the first one only on luma (by selecting blend mode "lightness") and the second one only on chroma (by selecting blend mode "color").

Note: Each instance also adds to the workload of your pixelpipe. Generating too many instances – especially of the more demanding modules – will cause noticeable slow-down.

---

managing multiple instances

Click on the *multiple instance menu* in the module header to display a drop-down menu, with the following options.

new instance
Create a new instance of the current module with all of its parameters reset to default. The ‘instance name’ is automatically set to a unique integer so that it can be distinguished from its parent.

duplicate instance
Create a new instance of the current module with all of its parameters inherited from its parent. As with ‘new instance’ the ‘instance name’ is automatically set to a unique integer.

move up/down
Move the instance up or down in the pixelpipe

delete
Remove the current instance. This option is not available if only one instance is present.

rename
Rename the current instance. See the history stack section for more details on how the instance name impacts copying and pasting history stacks.

3.4.3. presets

Presets allow you to store commonly used module settings for future use. Some modules already come with pre-defined presets and you may also define your own. Both internal and user-defined presets can be shown by clicking the *presets menu* in the module header.

the presets menu

The presets menu will contain one or more of the following entries depending on what presets are defined or selected for the current module:

preset list
A list of the presets available for the current module. The currently selected preset (if any) is shown in **bold**.

edit this preset
If a preset has been selected, click to edit that preset (see below)

delete this preset
If a preset has been selected, delete that preset.

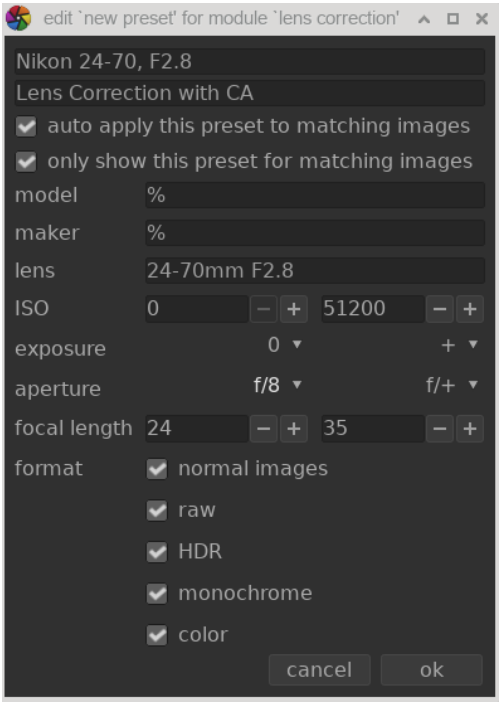
update preset [name]
Update the named preset to match the module’s current parameters.

store new preset
Create a new preset using the module’s current parameters.

Left-click on a preset name to apply the preset to the current instance of the module. Middle-click on a preset name to create a new instance of the module and apply the selected preset to it. You can also apply a preset at any time while you are in the darkroom by pressing the shortcut key that has been assigned to it (see preferences > shortcuts).

creating and editing presets

When creating or editing presets, the following dialog is shown:



The following options can be set:

name
The name of the preset

description
A searchable description for the preset (optional)

auto apply this preset to matching images
Check this box to automatically apply this preset to matching images when they are opened in the darkroom for the first time (you can reapply such automatic presets by Ctrl+clicking on the *reset* button in the module header). Additional controls will appear to allow you to define which images the preset will be applied to based on image Exif data.

For example, if you want a preset to be applied to all images from a specific camera leave all fields at default values except for the model field. Leave all fields unchanged to auto-apply a preset to all images.

The example dialog above sets up following rules: if the lens name matches, the aperture is greater than or equal to f/8 and the focal length is between 24 and 35mm the preset will be automatically applied.

The image information module displays the camera model and lens name for each image. Use this to ensure you have the correct spelling.

only show this preset for matching images
Check this box to automatically show the preset in the preset menu, using the same set of filters as above.

If you create a preset with the same name as a built-in preset, your newly created preset will override the built-in preset, which will no longer be accessible.

managing presets

Both user-created and pre-defined presets can be viewed and managed from within preferences > presets.

If you delete a preset that has the same name as one of the built-in presets, then your user preset will be deleted, and that preset name will no longer appear in the preset menu at all. The next time you start darktable, the corresponding built-in preset will once again become visible.

3.4.4. module controls

sliders

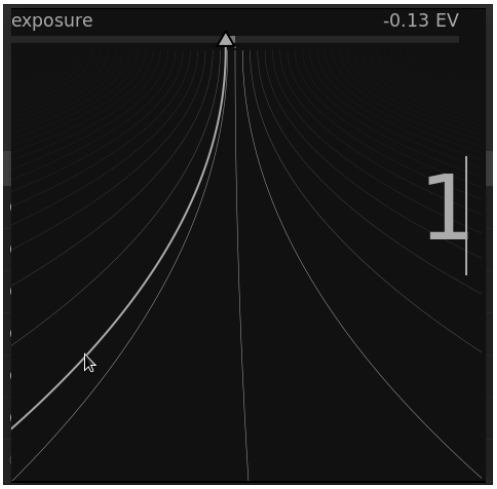
Sliders offer five different methods of interaction, depending on the level of control you require.

left-click
Click anywhere in the slider area to set the value. You can also click and drag to change it. You don't have to aim for the triangle or even the line - you can click anywhere in the entire height of the slider including the label.

mouse wheel
Hover over the slider with your mouse, then use your mouse wheel to adjust the value.

keyboard arrow keys
When the slider has focus you can hover over the slider with your mouse, then use your keyboard's arrow keys (←/↓ and →/↑) to adjust the value. In order to give focus to the widget without changing the current value you can right-click, then right-click again.

right-click
When your mouse is over a slider right-clicking enables a multi-functional pop-up below the slider for fine control with your mouse or numerical entry using the keyboard.



A bent line extending from the triangular marker moves with your mouse. The closer your mouse pointer is to the triangular marker the coarser the control you have over the value; the further away from the triangular marker the finer your control. Left-click with your mouse to accept the new value and and hide the pop-up.

Alternatively you can type in a new value using your keyboard and commit by hitting the enter key. You may even supply the new value in the form of an arithmetic expression which darktable will calculate for you – the previous value is referenced as "x".

double-click
You can double-click on a slider or its label to reset to the default value.

In addition, the precision of mouse-wheel and arrow key-adjustments can be altered:

- hold down the Shift key while adjusting to *increase* the step size by a factor of 10.
- hold down the Ctrl key while adjusting to *decrease* the step size by a factor of 10.

Both of these multipliers can be amended in the `$HOME/.config/darktablerc` file:

```
darkroom/ui/scale_rough_step_multiplier=10.0
darkroom/ui/scale_precise_step_multiplier=0.1
```

comboboxes

Click on a combobox to open a list of available options which you can click to select. Occasionally the selection list will open close to the bottom or top of the screen meaning that only some of the items are visible – simply scroll with your mouse wheel to bring up the full list. Alternatively, you can also use the mouse wheel and keyboard arrow keys to select an option.

color pickers

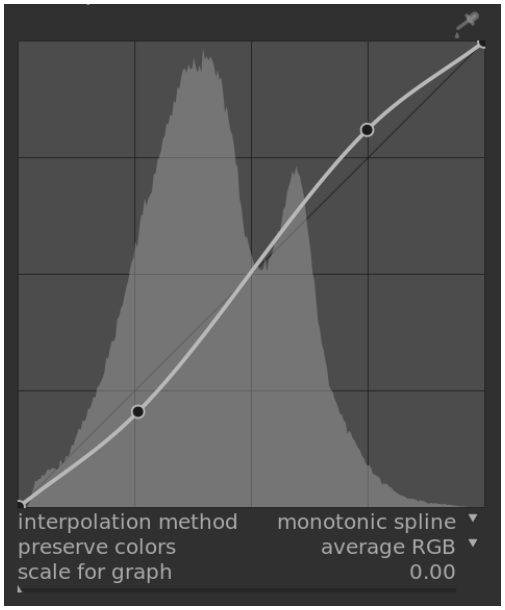
A number of modules allow parameters to be set using color pickers (identified by the  icon). These use a standard interface and most can operate in either point or area mode. Point mode can be activated by clicking on the color picker icon. Ctrl+click on the icon to activate area mode.

keyboard shortcuts

Module parameters can also be amended with keyboard shortcuts. See preferences > shortcuts for more information.

3.4.5. curves

Three image processing modules (base curve, tone curve and rgb curve) use curves to control the tones in the image. These modules have some common features that deserve separate discussion.



nodes

In their default state, curves are straight lines, defined by two anchor nodes at the top-right and bottom-left of the curve graph. You can move the nodes to modify the curve or generate new nodes by clicking on the curve. Ctrl+click to generate a new node at the x-location of the mouse pointer and the corresponding y-location of the current curve – this adds a node without the risk of accidentally modifying the curve. Up to 20 nodes can be defined per curve. To remove a node, click on it and drag it out of the widget area.

curve controls

The following controls are common to two or more of the above image processing modules and are therefore discussed separately here. Please see the individual module documentation for discussion of any additional module-specific controls.

interpolation method

tone curve and rgb curve modules only

Interpolation is the process by which a continuous curve is derived from a few nodes. As this process is never perfect, several methods are offered that can alleviate some of the issues you may encounter.

- Arguably, the most visually pleasing method is the “cubic spline” – since it gives smooth curves, the contrast in the image is better enhanced. However, this method is very sensitive to the nodes' position, and can produce cusps and oscillations when the nodes are too close to each other, or when there are too many of them. This method works best when there are only 4 to 5 nodes, evenly spaced.
- The “centripetal spline” method is designed specifically to avoid cusps and oscillations, but as a drawback it will follow the nodes more loosely. It is very robust, no matter the number of nodes and their spacing, but will produce a more faded and dull contrast.
- The “monotonic spline” method is designed specifically to give a monotonic interpolation, meaning that there will be none of the oscillations the cubic spline may produce. This method is most suitable when you are trying to build an analytical function from a node interpolation (for example: exponential, logarithm, power, etc.). Such functions are provided as presets. It is a good trade-off between the two aforementioned methods.

preserve colors

If a non-linear tone curve is applied to each of the RGB channels individually, then the amount of tone adjustment applied to each color channel may be different, and this can cause hue shifts. Therefore, the *preserve colors* combobox provides different methods of calculating the “luminance level” of a pixel. The amount of tone adjustment is calculated based on this luminance value, and then this same adjustment is applied to all three of the RGB channels. Different luminance estimators can affect the contrast in different parts of the image, depending on the specific characteristics of that image. The user can therefore choose a particular estimator that provides the best results for the given image. Some of these methods are discussed in detail in the **preserve chrominance** control in the *filmic rgb* module. The following options are available:

- *none*
- *luminance*
- *max RGB*
- *average RGB*
- *sum RGB*
- *norm RGB*
- *basic power*

scale for graph

tone curve and base curve modules only

The scale allows you to distort the graph display so that certain graphical properties emerge to help you draw more useful curves. Note that the scaling option only affects the curve display, not the actual parameters stored by the module.

By default, a “linear” scale is used (defined by a scale factor of 0). This scale uses evenly spaced abscissa and ordinates axes.

A logarithmic scale will compress the high values and dilate the low values, on both the abcissa and the axis of ordinates, so that the nodes in lowlights get more space on the graph and can be controlled more clearly.

Increase the ‘scale for graph’ slider to set the base of the logarithm used to scale the axes. This allows you to control the amount of compression/dilation operated by the scale. If you draw purely exponential or logarithmic functions from identity lines, setting this value defines the base of such functions.

3.4.6. wavelets

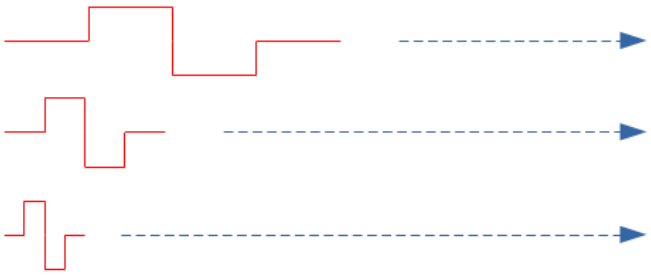
Wavelets are a technique used in image processing to separate (or *decompose*) an image into a number of distinct *layers*, each containing a different level of detail. After decomposing an image in this way, a module can limit its processing to one or more of these detail layers, and then piece the layers back together again at the end to form its output image. This allows us to be surgical about which features in the image we wish to impact when working with a module.

Some of the operations darktable can perform in this way are:

- noise removal (in the *denoise (profiled)*, *raw denoise* and *contrast equalizer* modules)
- contrast adjustment (in the *contrast equalizer* module)
- blurring or removal of unwanted detail (in the *retouch* module)

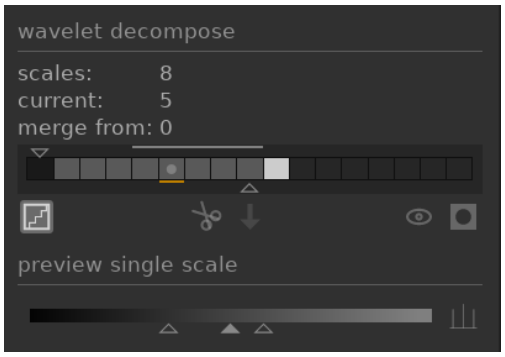
theory

A wavelet is a mathematical function that starts off at zero, oscillates up and down and then settles back to zero. The following diagram shows some simple wavelets of differing sizes.



These wavelet functions are used to scan across and down the image using a mathematical operation called *convolution*. This picks out details from the image that are on a similar scale to the size of a given wavelet, and builds a number of detail layers each corresponding to a different wavelet scale.

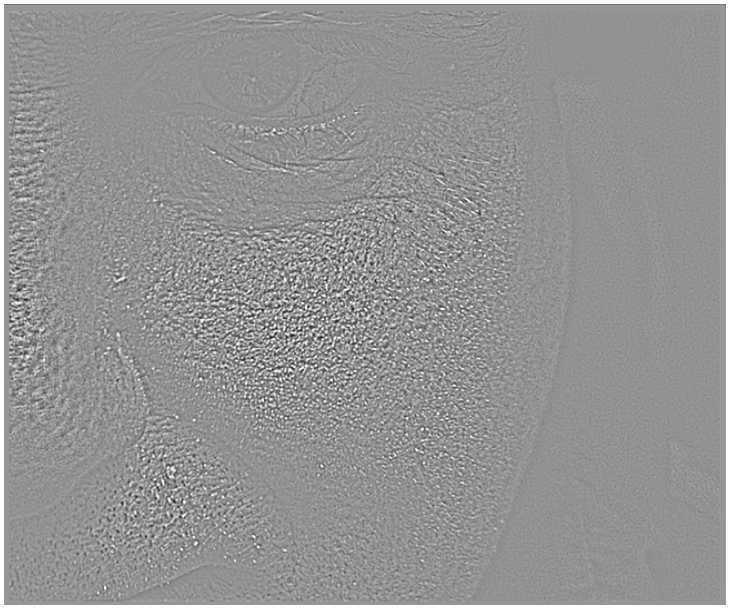
Below is an example where detail layers have been extracted from the image shown above. In this case, the images were produced using the *retouch* module, splitting the image into 8 different layers, and using the module's controls to visualise the details present at each of these wavelet scales:



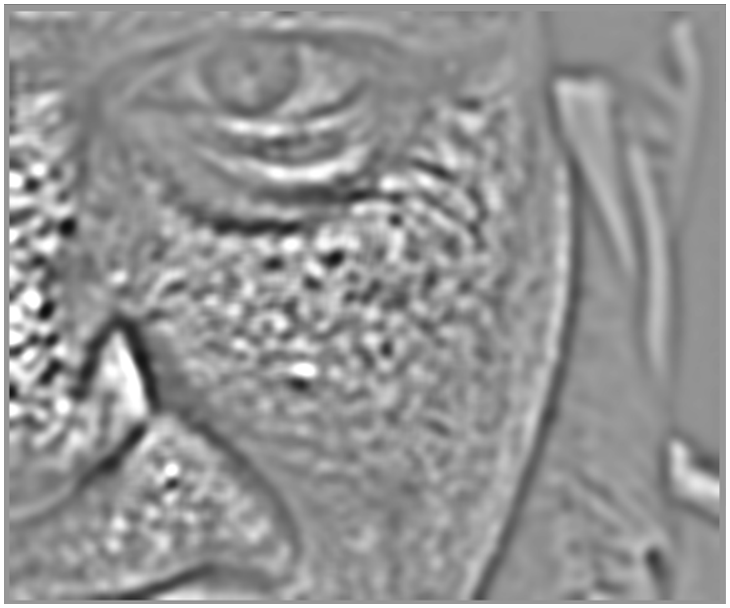
The bars in the *wavelet decompose* section indicate the layers that have been extracted at different wavelet scales. The darkest rectangle at the left represents the entire image (before decomposition) and the grey boxes represent each of the decomposed layers. Clicking on the staircase icon below the bar graph enables the layer visualisation overlay so that you can see what the currently selected layer looks like.

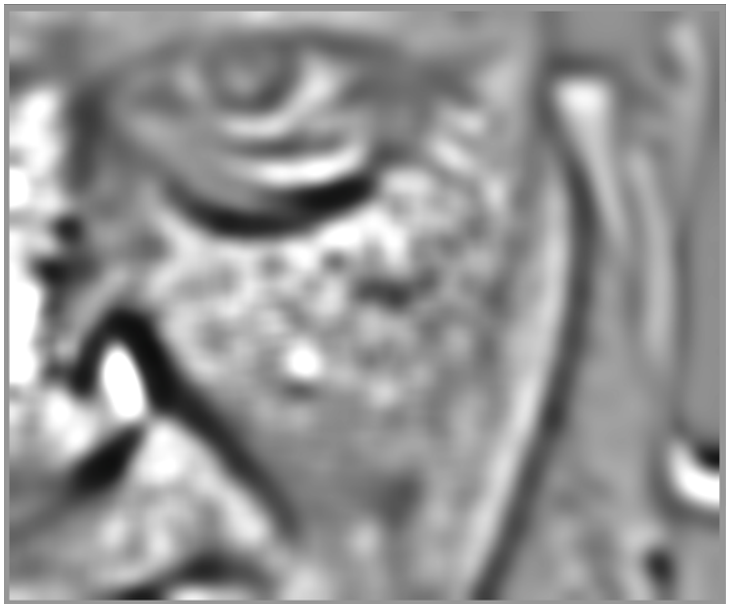
Let's take a look at some of the layers generated for the above image.

At scale #2, the image contains only very fine details, including the model’s eyebrows, eye lashes and the pores of his skin. It doesn’t include the coarser details of the image, because those details have been extracted to other layers:



At scales #5 and #6 we begin to see larger and larger features:



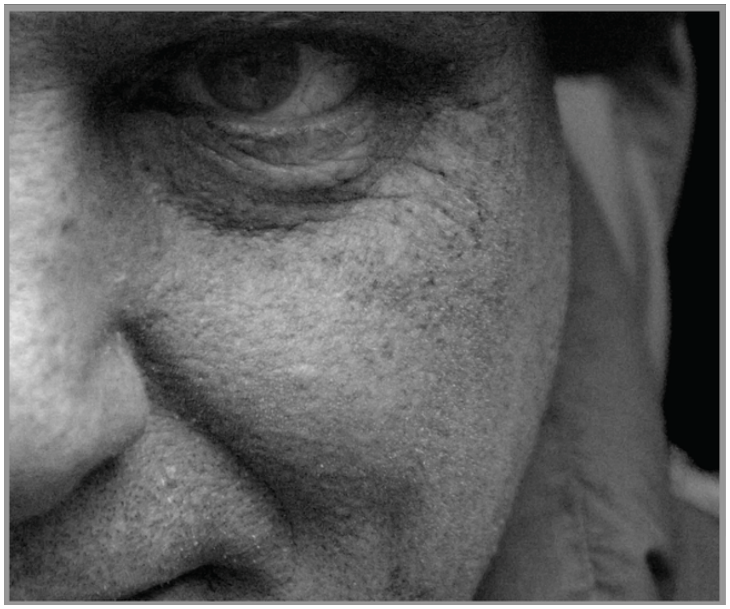


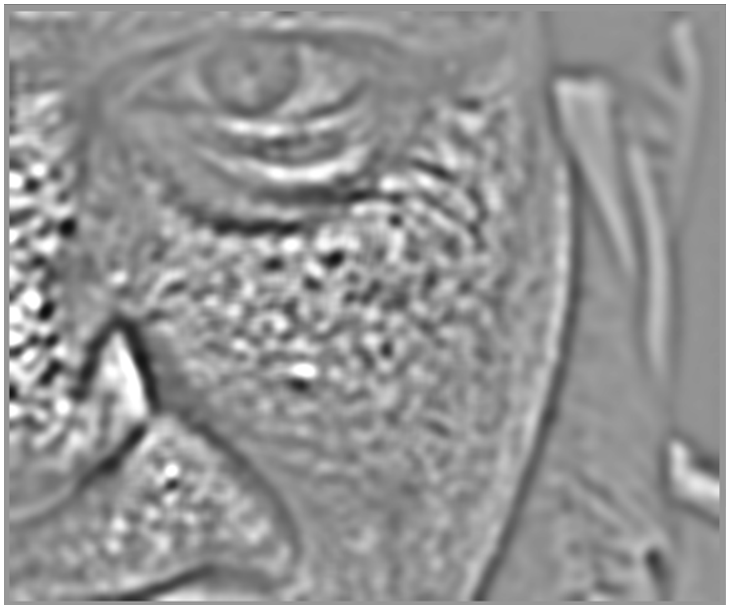
By scale #8 we only see very high-level features such as the overall shape of the model’s nose, eye and the cheek:

why use wavelets?

Suppose, in the above example, that we wanted to smooth out some of the blotchiness in the model’s skin, without losing any of the underlying skin texture. Wavelet decomposition makes this a trivial operation - we can simply use the retouch module to apply a Gaussian blur to only the ‘blotchy’ detail layer(s), leaving all other detail layers untouched. Once the adjustment is complete, the retouch module simply recombines that adjusted layer with the remaining untouched layers to produce the final image.

The sequence of images below shows (1) The original image; (2) The layer (scale 5) that we wish to blur; and (3) The final image after the scale 5 layer has been blurred and the layers recombined:





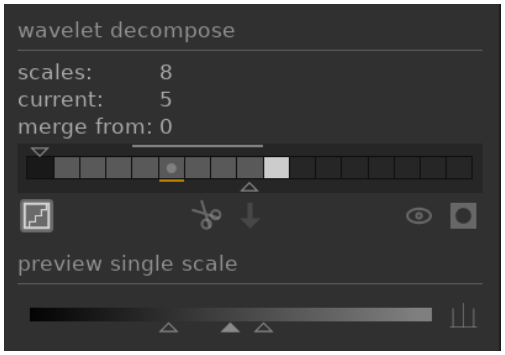
As you can see, the large-scale skin blotches have been removed, but the smaller-scale details remain untouched.

interacting with wavelet scales

There are two methods by which processing modules allow you to modify their operation using wavelet scales.

wavelet decomposition

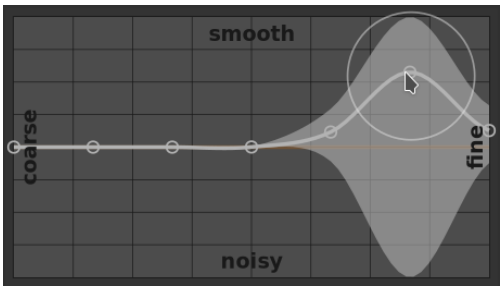
As discussed above, the *retouch* module allows you to choose how many detail levels to split your image into. It decomposes the image into separate layers and allows you to perform operations selectively on each individual layer or on the image as a whole:



See the *retouch* module documentation for more details.

spline controls

The *denoise (profiled)*, *raw denoise* and *contrast equalizer* modules allow their effects to be applied more or less to different wavelet scales using *splines*.

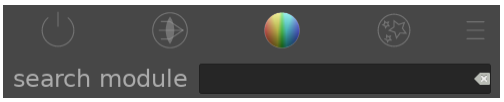


Here, each node in the graph represents a different level of detail in the image, from coarse detail on the left to fine detail on the right. You can raise or lower each of these nodes with your mouse to increase or decrease the module's effect, respectively, on that wavelet scale.

To modify the curve, click slightly above or below the line near to a node and drag up or down. You can change the width of your modification by scrolling with your mouse wheel, which increases or reduces the size of the circle displayed under your mouse pointer. A small circle indicates that the effect of dragging the curve up or down will be isolated mostly to the node being adjusted. A larger circle indicates that the effect will be more broad and will increasingly impact adjacent nodes. When you hover your mouse over the graph, shaded areas indicate the parts of the spline that will be impacted when you attempt to modify the curve.

3.4.7. searching and grouping modules

At the top of the right-hand panel in the darkroom view is a module that allows you to search for and select from pre-defined groups of processing modules:



darktable ships with some standard pre-defined module group presets, which can be selected from the presets menu on the right-hand-side of the module groups list. You can also customize and create your own groups by selecting "manage presets..." from the same drop-down menu. Please refer to the *manage module layouts* section for more details about this functionality.

groups

Click on one of the *module group* icons above the *search module* textbox to see all of the modules which belong to that group. Click on the *active modules* group () to list the modules that are active in the pixelpipe of the current edit.

If you click on any module group (including the *active modules* group) a second time, a complete list of all available modules is shown.

To quickly add a module to a group, right-click on the group icon and select a module from the resulting drop-down list.

search

When you enter some text in the *search module* entry, any modules whose name or tag/alias contains that text will be listed under the search box. All matching modules will be shown, regardless whether they are currently available in any of the module groups. You can then activate any of the listed modules by clicking on its activation icon, expand the module by clicking on its name, and adjust any settings as required.

If you choose to hide the module groups and show only the search entry, the module list will contain a list of either the currently-active modules or the results of any search term entered.

3.5. masking and blending

3.5.1. overview

By default each module takes its input from the preceding module in the pixelpipe, performs its operation on the image data, and hands the output over to the next module in the pixelpipe.

A module's output data can optionally be reprocessed (combined) with its input data before being handed to the next module. This additional processing step is called *blending*. Input and output data is reprocessed using algorithms called blending operators or blend modes.

Each blend mode is further controlled by the *opacity* parameter, having a value between 0% and 100%, which defines how much the input and output images contribute to the final result. Typically an opacity of 0% outputs an image which is identical to the input image (the module has no effect) whereas an opacity of 100% delivers the maximum effect of the module.

The opacity can be the same for every pixel in the image (by simply combining a blend mode with the single opacity slider) – in this case blending acts uniformly on the entire image. Alternatively the opacity values can vary based on the properties or location of each pixel. This local modification of opacity is called a *mask*. Masks provide the user with fine control over which parts of an image are affected by a module and to what extent. At your choice you may activate a drawn mask, a parametric mask or a combination of the two.

Blending and masking functionality is controlled via a group of icons located at the bottom of each applicable module.

These icons enable the following masking and blending options, from left to right:

off
: Module output is passed to the next module in the pixelpipe without additional reprocessing. No further controls are displayed.

uniformly
: Input and output images are reprocessed to the same extent for all pixels with the extent of the blending controlled by a single opacity slider. Additional controls to choose the blend mode and opacity are displayed. The default blend mode is "normal" with an opacity of 100%.

drawn mask
: Reprocessing takes place with the chosen blend mode and opacity based on pixel location as defined with a drawn mask. Additional controls are displayed which allow you to draw a mask using one or more shapes. If no mask elements are drawn then all pixels have the same opacity, as defined by the opacity slider.

parametric mask
: Reprocessing takes place with the chosen blend mode and opacity based on the properties of individual pixels. Additional controls are displayed that allow you to adjust the opacity on a per-pixel basis determined by pixel values.

drawn & parametric mask
: Reprocessing takes place with the chosen blend mode and opacity based on a combination of a drawn mask parametric mask.

raster mask
: Reprocessing takes place with the chosen blend mode and opacity based on a mask that was generated within a different module

blending options
: Choose which color space to use when calculating the blending mask, and specify whether or not to allow a mask to be generated based on the module's output channels (normally a parametric mask is generated based on the input channels coming into the module). The following options are available:
    - *reset to default blend colorspace*: Use the default color space for the module to specify the parametric mask.
    - *Lab*: Use the Lab color space (where available) when specifying the parametric mask.
    - *RGB (display)*: Use the display-referred RGB/HSL color space to specify the parametric mask.
    - *RGB (scene)*: Use the scene-referred RGB/JzCzhz color space to specify the parametric mask.
    - *show output channels*: Show the parametric mask output channel controls, so that the parametric mask can be defined in terms of the module's output channels.

Note: Not all of these blend options are available for every module.

3.5.2. blend modes

Blend modes define how the input and output of a module are combined (blended) together before a module's final output is passed to the next module in the pixelpipe. Most of the blend modes should be familiar from other imaging software and are thoroughly discussed in the GIMP user manual.

This section therefore only discusses some of the darktable-specific blend modes in detail.

Some blend modes depend on a fulcrum for their operation. This fulcrum usually defines the point at which the blend mode results in a "no-operation" which may be white or grey depending on the blend mode. The additional *blend fulcrum* parameter allows the position of this fulcrum to be adjusted where blending is performed within the RGB scene-referred color space. The effect depends on the operator used. For example, values above the fulcrum might be brightened and values below darkened, or vice versa.

normal
The most commonly used blend mode, "normal" simply mixes input and output to an extent determined by the opacity parameter. This mode is commonly used to reduce the strength of a module's effect by reducing the opacity. This is also usually the blend mode of choice when applying a module's effect selectively with masks.

normal bounded
This blend mode is the same as "normal", except that the input and output data are clamped to a particular min/max value range. Out-of-range values are effectively blocked and are not passed to subsequent modules. Sometimes this helps to prevent artifacts. However, in most cases (e.g. highly color-saturated extreme highlights) it is better to let unbound values travel through the pixelpipe to be properly handled later. The "normal" blend mode is therefore usually preferred.

lightness
This blend mode mixes lightness from the input and output images. Color (chroma and hue) is taken unaltered from the input image.

chroma
This blend mode mixes chroma (saturation) from the input and output images. Lightness and hue are taken unaltered from the input image.

hue
This blend mode mixes hue (color tint) from the input and output images. Lightness and chroma are taken unaltered from the input image.

color
This blend mode mixes color (chroma and hue) from the input and output images. Lightness is taken unaltered from the input image.

Caution: When modules drastically modify hue (e.g. when generating complementary colors) this blend mode can result in strong color noise.

Lab lightness
Only available with modules that work in the Lab color space, this blend mode mixes lightness from the input and output images, while color is taken unaltered from the input image. In contrast to "lightness" this blend mode does not involve any color space conversion and does not clamp any data. In some cases this blend mode is less prone to artifacts than "lightness".

Lab color
Only available with modules that work in the Lab color space, this blend mode mixes Lab color channels a and b from the input and output images, while lightness is taken unaltered from the input image. In contrast to "color" this blend mode does not involve any color space conversion and does not clamp any data. In some cases this blend mode is less prone to artifacts than "color".

HSV lightness
Only available with modules that work in the RGB color space, this blend mode mixes lightness from the input and output images, while color is taken only from the input image. In contrast to "lightness" this blend mode does not involve clamping.

HSV color
Only available with modules that work in the RGB color space, this blend mode mixes color from the input and output images, while lightness is taken only from the input image. In contrast to "color" this blend mode does not involve clamping.

color adjustment

Some modules act predominantly on the tonal values of an image but also perform some color saturation adjustments (e.g. the *levels* and *tone curve* modules). This blend mode takes the lightness from the module's output and mixes colors from input and output, enabling control of the module's color adjustments.

3.5.3. masks

3.5.3.1. overview

Masks allow you to limit the effect of a module so that it only applies to certain parts of the image.

A mask can be regarded as a grayscale image where each pixel has a value between 0 and 1.0 (or between 0% and 100%). This value is used to determine how much a module affects each pixel.

The following sections explain how to construct masks in darktable.

3.5.3.2. drawn masks

With the drawn mask feature you can construct a mask by drawing shapes directly onto the image canvas. Shapes can be used alone or in combination. Once a shape has been drawn on an image it can be adjusted, removed, or reused in other modules.

Shapes are stored internally as vector graphics and are rendered with the required resolution during pixelpipe processing. Shapes are expressed in the coordinate system of the original image and are transformed along with the rest of the image by any active distorting modules in the pipe (*lens correction*, *crop & rotate* for example). This means that a shape will always work on the same image area regardless of any modifications that may be subsequently applied. Please note that this distorting effect can cause straight lines in your mask to appear curved when the *lens correction* module is active.

The controls required to create and alter drawn masks may be enabled by selecting either the "drawn mask" or "drawn & parametric mask" icon at the bottom of a module.

creating shapes

Choose a shape by clicking on the appropriate shape icon (from left to right: brush, circle, ellipse, path, gradient).

This will take you into the creation mode for that shape. Once you have finished drawing your shape you will automatically be taken into edit mode.

Ctrl+click on the shape icon to continuously draw multiple shapes of the same type - each time a shape is completed, you will re-enter creation mode for a new instance of that shape. While in continuous creation mode, right-click to stop drawing shapes and enter edit mode.

For all drawn shapes, hold Shift while scrolling with the mouse wheel to change the extent of the shape's feathering (the blur at the edge of the shape) and use Ctrl+scroll to change the shape's opacity (how transparent it is). These operations are available in both creation and edit modes (as long as your mouse is over the shape in question).

Note: When used in shape creation mode, the preceding scroll operations will also cause the **default** feathering or opacity to be changed. The new default values will be used the next time you create a new shape.

---

editing shapes

Click on the 'show and edit mask elements' icon  to enter shape edit mode. This will show all drawn masks in use by the current module and allow you to edit those shapes. Ctrl+click on the same icon to enter restricted edit mode, where certain actions (e.g. dragging a complete shape or changing its size) are blocked. This is particularly useful to avoid costly mistakes when editing path and brush shapes.

Click and drag a shape to move it around the image canvas.

removing shapes

While in edit mode right-click on a shape to remove it.

reusing shapes

You can reuse shapes that you have drawn in other modules. Click on the shapes drop-down (next to the 'show and edit mask elements' button) to choose previously-drawn shapes individually or to use the same group of shapes as used by another module. The following options are available for selection:

add existing shape
Choose either an individual shape or a group of shapes that you've drawn previously (either within the mask manager or from within the drawn mask of another module). If that shape or group is used elsewhere, any changes you make will be reflected everywhere the shape or group is used.

use same shapes as
Add a list of shapes used in another module to the current module's mask. This differs from the previous option in that it creates a new group, allowing shapes to be added to or removed from the group independently of the module from which they are copied. All shapes that are common to both groups remain linked.

combining and managing shapes

The mask manager module can be used to manage your drawn shapes. This module also allows you to group and combine drawn masks using set operators (union, intersection, difference, exclusion).

available shapes

brush
Start drawing a brush stroke by left-clicking on the image canvas and moving the mouse while keeping the button pressed. The brush stroke is finalized once you release the mouse button. Scroll the mouse to change the shape size, either before you start drawing or at any time during the operation. Likewise you can use the "[" and "]" keys to decrease/increase brush size, the "{" and "}" keys to decrease/increase feathering, and the "<" and ">" keys to decrease/increase opacity.

If you have a graphics tablet with pen pressure sensitivity, darktable can apply the recorded pen pressure to certain attributes of the brush stroke. This operation can be controlled in preferences > darkroom > pen pressure control for brush masks.

On lifting the tablet pen or releasing the left mouse button the brush stroke is converted into a number of connected nodes, which define the final shape. A configuration option (preferences > darkroom > smoothing of brush strokes) controls how much smoothing is applied. A higher level of smoothing leads to fewer nodes being created – this eases subsequent editing at the expense of lower accuracy.

Nodes and segments of a brush stroke can be modified individually. See the documentation on path shapes below for more details.

Note: Rendering a complex brush shape can consume a significant number of CPU cycles. Consider using the circle, ellipse or path shapes instead where possible.

---

circle
Click on the image canvas to place the circle. Scroll while hovering over the circle to change its diameter. Scroll while hovering over the circle's border to change the width of the feathering (the same effect as holding Shift while scrolling with the mouse wheel within the main shape).

ellipse
The general principle is the same as for the circle shape. In addition, four nodes are shown on the ellipse line. Click on the nodes to adjust the ellipse's eccentricity. Ctrl+click on the nodes or use Shift+Ctrl+scroll (with the mouse wheel) to rotate the ellipse. Shift+click within the shape to toggle the gradual decay between equidistant and proportional mode.

path

Click on the image canvas to place a number of nodes and generate a free-format enclosed shape, terminating the path by right-clicking after having set the last point. By default, nodes are connected with smooth lines. If you want a node to instead define a sharp corner, you can do so by creating it with Ctrl+click.

In edit mode Ctrl+click on existing nodes to convert them from smooth to sharp corners and vice versa. Ctrl+click on one of the line segments to insert an additional node. Right-click on a node to delete it. Take care to ensure that the mouse pointer is over the desired node and the node is highlighted, to avoid accidentally removing the whole path.

The size of the completed shape can be modified by scrolling. The same holds true for the width of the border (the area with a gradual opacity decay), which can also be changed with Shift+scroll (with the mouse wheel) from anywhere within the shape. Single nodes as well as path segments can be moved by dragging them with the mouse. If a node is selected by clicking on it, a further control point appears which allows you to modify the curvature of the line (reset to default by right-clicking). Dragging one of the control points on the border adjusts the border width just in that part of the shape.

Consider fine-tuning paths in restricted edit mode (enabled by Ctrl+clicking on the ‘show and edit mask elements’ icon). This allows you to adjust single nodes and segments without the risk of accidentally shifting or resizing the whole shape.

gradient

The gradient shape is a linear gradient which extends from a given point to the edge of the image.

Click on the image canvas to define the position of the line that defines 50% opacity. Dotted lines indicate the distance beyond which the opacity is 100% and 0%. Between these dotted lines the opacity changes linearly.

The line has two anchor nodes which you can drag to change the rotation of the gradient.

Gradient lines can also be curved by scrolling close to the center line. This can be useful to counteract the distortion caused by the *lens correction* module.

Depending on the module and the underlying image, using a gradient shape might provoke banding artifacts. You should consider activating the *dithering* module to alleviate this.

reversing the polarity of a drawn mask

Click on the “+/-” button to reverse the polarity of the entire drawn mask. For example, a circular mask will, by default, cause the module to be applied only to the area inside the drawn circle. Reversing its polarity will cause the module to apply to the whole image, *except for* that circle.

3.5.3.3. parametric masks

The parametric mask feature offers fine-grained selective control over how individual pixels are masked. It does this by automatically generating an intermediate blend mask from user-defined parameters. These parameters are color coordinates rather than the geometrical coordinates used in drawn masks.

For each data channel of a module (Lab, RGB) and several virtual data channels (e.g. hue, saturation) you can construct a per-channel opacity function. Depending on each pixel’s value for a given data channel this function calculates a blending factor between 0 and 1 (100%) for that pixel.

Each pixel of an image thus has different blending factors for each of its data channels. All blending factors are finally multiplied together (pixel-by-pixel), along with the value of the global opacity slider, to form a complete parametric blend mask for the image.

If the blend mask has a value of 0 for a given pixel, the input of the module is left unchanged. If the blend mask has a value of 1 (100%) for a pixel, the module has its full effect.

channel tabs

Click on one of the channel tabs to select a data channel to use to build your mask.

Modules acting in (*display-referred*) *Lab* color space have data channels for L, a, b, C (chroma of LCh) and h (hue of LCh).

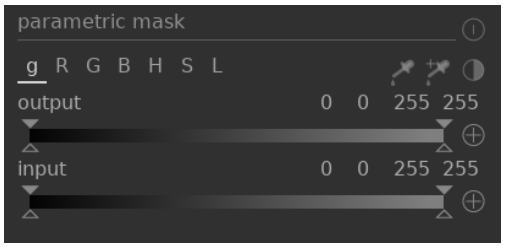
Modules acting in *display-referred RGB* color space have data channels for g (gray), R, G, B, H (hue of HSL), S (saturation of HSL), and L (lightness of HSL).

Modules acting in *scene-referred RGB* color space have data channels for g (gray), R, G, B, Jz (luminance component of JzCzhz), Cz (chroma, or saturation, of JzCzhz), and hz (hue of JzCzhz). The JzCzhz color space is a polar representation of the Jzazbz color space, in the same way that LCh is a polar represrntation of the Lab space. However, Jzazbz is much better for high dynamic range images and is less susceptible to hue shifts than Lab space.

See Wikipedia for more details about these color spaces.

Two sliders can be shown for each associated data channel: one that works on the *input data* that the module receives and one that works on the *output data* that the module produces prior to blending. The sliders for the output data channels are hidden by default and can be shown using the *show output channels* option in the blending menu.

The *boost factor* slider allows the range of values targetted by the parametric mask sliders to be extended. It may be used in scene referred editing, where luminance values may extend beyond 100%, to target highlights. This slider is only available for channels where it is meaningful.



inspecting data channels & masks

Press the letter C while hovering over a channel's input/output slider to view the input/output image data for that color channel. The center image changes to display that color channel either in graycale values or in false colors depending on the setting in preferences > darkroom > display of individual color channels.

Press the letter M to see the resulting mask for that slider overlaid on the image.

When the mouse pointer leaves the slider the image returns to normal after a short delay.

linear / log mode

Press the "A" key while hovering over the a slider to change its display to 'log' mode. This provides more fine control in the shadows. Press A again to toggle back to 'linear' mode.

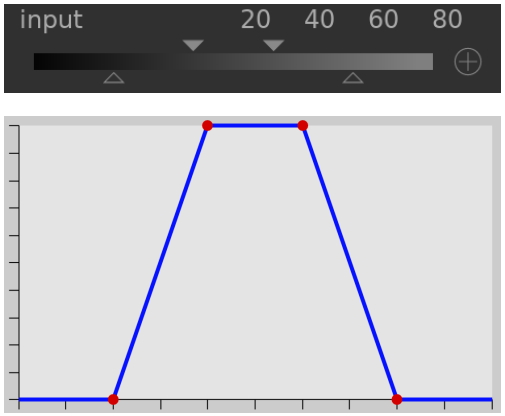
channel input/output sliders

With each color channel slider you can construct a trapezoidal opacity function. For this purpose there are four markers per slider. Two filled triangles above the slider mark the range of values where opacity is 1. Two open triangles below the slider mark the range values where opacity is zero. Intermediate points between full and zero are given a proportional opacity.

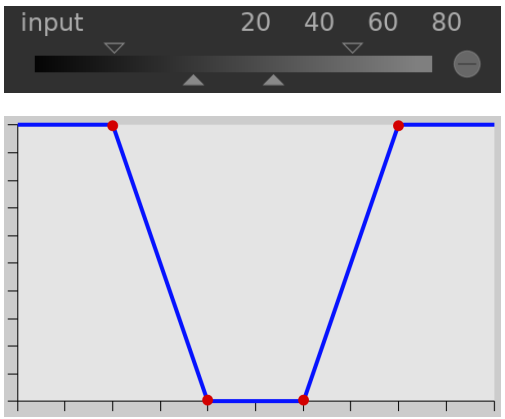
The filled triangles, or inside markers, indicate the closed (mostly narrower) edge of the trapezoidal function. The open triangles, or outside markers, indicate the open (mostly wider) edge of the trapezoidal function. The sequence of the markers always remains unchanged: they can touch one another but they cannot switch position.

A polarity (+/-) button to the right of each the slider switches between “range select” and “range de-select” function modes with visual confirmation provided by exchanging the upper and lower triangle markers. These two types of trapezoidal functions are represented graphically in the following images.

range select



range deselect



In their default state all markers are at their extreme positions. In this state a range select function selects the whole range of values giving an “all at 100%” mask. Starting from there one can move the sliders inwards to gradually exclude more and more parts of the image except for the remaining narrow range.

Conversely a range de-select function (enabled by toggling the polarity) by default deselects the whole range of values, giving an “all-zero” mask as a starting point. Moving the sliders inwards gradually includes more and more parts of the image except for the remaining narrow range.

color pickers

With the left-hand color picker button you can select a point or area probe from your image. The corresponding values for the real and virtual data channels are then displayed within each color channel slider.

With the right-hand color picker button you can automatically set the slider’s values based on the selected range. Click and drag to set the parameters for the input slider from the drawn rectangle; Ctrl+click and drag to set the parameters for the output slider.

invert

Click the invert button above the sliders to invert the polarity of the entire parametric mask. This differs from the polarity buttons beside the individual sliders which just invert the parameters for the current slider/channel.

reset

Click the reset button above the sliders to revert all parametric mask parameters to their default state.

3.5.3.4. combining drawn & parametric masks

Drawn and parametric masks can be used in combination to form a single mask that can be applied to a module.

There are two main elements which control how individual masks are combined: the *polarity* setting of each individual mask (defined by the plus or minus buttons) and the setting in the “combine masks” combobox.

The “combine masks” combobox contains the following options, defining how the drawn and parametric masks will be combined:

exclusive

A straightforward method of combining masks is by multiplying together the individual pixel values from each of the component masks.

For a given pixel, the final mask will have value of 0 if *any* of the individual masks are 0 at that location and it will only have a value of 1.0 if *all* masks have a value of 1.0 at that location. This method of combination is known as *exclusive*.

Any individual mask can *exclude* a pixel by setting its value to 0, regardless of what the other masks do. Once a pixel is excluded by a mask there is no way for another mask to include it again.

inclusive

An alternative method of combining masks is to first invert each individual mask (subtract its value from 1.0), multiply the inverted masks together, and finally invert the combined mask once again.

For a given pixel, the final mask will have a value of 1.0 if *any* of the individual masks are 1.0 at that location and it will only have a value of 0 if *all* masks have a value of 0 at that location. This method of combination is known as *inclusive*.

Any individual mask can *include* a pixel by setting its value to 1.0, regardless of what the other masks do. Once a pixel is fully included by a mask (its value is 1.0) there is no way for another mask to exclude it again.

exclusive and inclusive inverted modes

Using the above combination methods alone would still be rather limiting. We gain maximum flexibility by allowing an additional inversion step for each individual mask. This is governed by the polarity buttons that you find close to the individual channels.

Toggling the polarity button of a mask inverts its values (subtracts the original value from 1.0).

Finally within the “combine masks” combobox you may select the *exclusive & inverted* or *inclusive & inverted* options. Each of these options is equivalent to the *exclusive* and *inclusive* modes described above but with a final step that inverts the resulting mask.

typical use cases

inclusive mode

For this mode you set the “combine masks” combobox to inclusive mode and make sure that all polarity buttons of all the individual channels and of the drawn mask are set to negative (-). Your starting point is a mask where all pixels have a value of zero, i.e. no pixel is selected. You now adjust the parametric mask sliders to bring more and more pixels into the selection or you draw shapes on the canvas to select specific areas of your image.

exclusive mode

In the opposite case you set the “combine masks” combobox to exclusive mode and make sure that all polarity buttons are set to positive (+). Your starting point is a mask with all values at 1.0, i.e. all pixels selected. You now adjust the parametric mask sliders to exclude parts of your image as needed or directly draw shapes on the canvas to exclude those areas.

For your convenience the parametric masks GUI provides a toggle button that inverts all channel polarities and toggles between inclusive and exclusive mode in the “combine masks” combobox.

For novice users it is recommended that you stick to the above two use cases. This means that you should decide beforehand how you want to construct your mask.

3.5.3.5. mask refinement & additional controls

When a parametric or drawn mask is active, several additional sliders are shown which allow the mask to be further refined.

feathering guide

Mask feathering smooths a drawn or parametric mask such that the mask’s edges automatically align with the edges of features in the image. The smoothing is guided either by the module’s input or output (before blending), depending on whether you select “input image” or “output image” in the “feathering guide” combobox. Feathering is particularly sensitive to this choice when used with edge-modifying modules (modules for sharpening or blurring an image).

feathering radius

Adjust the strength of the feathering effect. Feathering works best if the mask’s edges already approximately match some edges in the guiding image. The larger the “feathering radius” the better the feathering algorithm can align the mask to more distant edges. If this radius is too large, however, the feathered mask may overshoot (cover regions that the user wants to exclude). Feathering is disabled when the feathering radius is set to 0.

mask blur

Blurring the mask creates a softer transition between blended and unblended parts of an image and can be used to avoid artifacts. The mask blur slider controls the radius of a gaussian blur applied to the final blend mask. The higher the radius, the stronger the blur (set to 0 for an unblurred mask). Gaussian blur is always applied after feathering if both kinds of mask adjustment are activated. This allows any resulting sharp edges or artifacts to be smoothed.

mask opacity

The strength of the module’s effect is determined by the mask’s local opacity. Feathering and blurring the mask may reduce the opacity of the original mask. The “mask opacity” slider allows you to readjust the mask opacity to compensate. If the mask opacity is decreased (negative slider values) less opaque parts are affected more strongly. Conversely, if the mask opacity is increased (positive slider values) more opaque parts are affected more strongly. As a consequence, completely opaque portions of the mask always remain opaque and completely transparent portions always remain transparent. This is to ensure that regions which have been excluded from or fully included in a module’s effect (by setting the mask’s opacity to 0% or 100%) remain fully excluded or included.

mask contrast

This slider increases or decreases the mask contrast. This allows you to adjust the transition between opaque and transparent parts of the mask.

 **temporarily switch off mask**

Sometimes it is useful to visualize a module’s effect without the mask being active. Click on this icon to temporarily deactivate the mask (the selected blend mode and global opacity remain in effect).

 **display mask**

Click on this icon to display the current mask as a yellow overlay over a black-and-white version of the image. Solid yellow indicates an opacity of 100%; a fully visible gray background image (without yellow overlay) indicates an opacity of 0%.

example: feathering a drawn mask

It can be rather tedious to create a drawn mask which precisely covers a particular feature in an image. In this example, we want to enhance the color contrast of the lion sculpture shown in the left image above without affecting the background.

1. The first image above shows the original, unaltered image.
2. The second image shows a rough selection of the sculpture created with a drawn mask. Note that the mask is rather fuzzy and does not precisely follow the outline of the lion sculpture.
3. The third image shows the effect of adjusting the feathering radius, mask opacity and mask contrast, leading to a well matched mask with little effort. In this example the feathering radius has been adjusted to 50 and a blur radius of 5 was chosen to smooth the mask to some degree. The mask opacity and mask contrast have been increased to 0.3 and 0.5, respectively.
4. The final image above shows the end result, where the color enhancement (via the *color contrast* module) is restricted to only the lion sculpture.

Mask feathering works particularly well in this example because the sculpture is well separated from the out-of-focus background. The distinct edge at the border of the sculpture guides the feathering mask adjustment to match the shape of the sculpture.

3.5.3.6. raster masks

As described in the previous sections, the final output of a module's mask (the combined effect of any drawn and parameteric masks) is a greyscale raster image representing the extent to which the module's effect should be applied to each pixel. This raster image is stored internally for active modules and can be subsequently reused within other modules in the pixelpipe.

As with any mask, if the value for a pixel in a raster mask is zero the input to the module is passed in the module's output unchanged. If the value is 1.0 the module has full effect. For each value between 0 and 1.0 the module's effect is applied proportionally at that location.

You can choose a raster mask from the combobox. Raster masks can be identified by the name of the module against which they were originally generated. Raster masks can only be selected from modules that are currently active in the pixelpipe. If a module is subsequently deactivated its raster mask can no longer be used.

4. Tethering

4.1. overview

The tethering view allows you to capture images directly into darktable from a connected camera.

To use the tethering feature you need to connect your camera to your PC using a USB cable. Your computer might ask to mount or view the connected camera. *Do not mount or view the camera*. If your camera is mounted or viewed automatically, you will need to “unmount/eject” the camera before darktable can access it. This unlocks the camera so that darktable can take control of it – darktable will then re-lock the camera so that it cannot be used by other applications.

After the USB cable is connected, look at the import module in the lighttable view. If your camera is not visible in this module, click the “scan devices” button and it should appear with two functions available: “import from camera” and “tethered shoot”. Click “tethered shoot” to enter the tethering view.

darktable uses gphoto2 to interface with your camera. If you have problems finding the connected camera as described above, check the troubleshooting section in this chapter to verify that your camera has tethering support.

In the center view, images are shown while you capture them. You can capture an image by either using darktable’s user interface or by manually triggering a capture with your camera. If you are using Live View the image will be shown in darktable’s center view.

When entering tethering view, a film roll will be created using the same structure as defined for camera import (see preferences > import > session options). The job code will be predefined as “capture”.

If you want to group your captures into different film rolls, you should use the session module in the right-hand panel to set a different job code. When entering a new name and pressing Enter, a new film roll will be created and newly-captured images will be added into this new film roll.

darktable provides some useful tools to set up an image capture in the user interface. You can set up timelapse captures, brackets for HDR and even sequential captures of bracketed images. For more information read the documentation on the camera settings module and the examples later in this chapter.

4.2. tethering view layout

left panel

image information
Display image information

right panel

From top to bottom:

histogram
The histogram for the current image
session
Session settings
live view
Live view settings
camera settings
Camera settings
metadata editor
Edit metadata for selected images.
tagging
Tag selected images.

bottom panel

From left to right:

star ratings
Apply star ratings to images
color labels
Apply color categories to images

4.3. examples

This section contains examples of typical usages of tethering.

studio setup with screening

This is a pretty common use case. You have your studio and subject set up, the camera is connected to your computer and tethering view is active in darktable. You work at the camera and take images. Whenever you like, you can screen the image directly on your computer monitor instead of using the camera LCD for validation.

This workflow is efficient and effective, since you can immediately review your captures instead of waiting until after the shoot when everyone is gone. If you're shooting a model this is a pretty nice way to preview the captures with the client instead of fumbling around with your camera.

Working in the tethering view can save you time and aggravation. Set a session name, shoot your images and they will save in the correct film roll for the session for easy on-site review.

capturing a timelapse

A timelapse is a video clip composed of images taken in a timed sequence. A typical example is to take a timelapse of cityscapes where you capture clouds and traffic etc.

To setup a timelapse capture, create a new session. Now decide if you want to shoot in manual or auto mode. Only use auto in situations were the ambient light will change significantly during the time of the shoot. For example, shooting a timelapse over 24 hours might give you easier control of light in that kind of captured sequence.

The camera settings module is where you define delay and sequence. Sequence will give you the opportunity to choose how many images you want to capture and delay will set the time in seconds between captures.

To start the capture click the capture button in the same panel and watch the filmstrip fill up with images. The latest captured image is always displayed in the center view.

4.4. troubleshooting

This troubleshooting guide will provide you with some steps to verify whether your camera can be used with tethering. This is done using the gphoto2 command-line tools. This is what darktable uses to interface with your camera.

Find your camera port name to use it in the following tests. Usually the port "usb:" will be enough and therefore is used in these examples.

is your camera detected?

The following command will verify that your camera is connected to the computer and detected by gphoto2.

```
env LANG=C gphoto2 --auto-detect
```

check the camera’s driver abilities

Execute the following command and ensure that the capture choices ability supports “Image” and configuration support is “yes”. darktable will check these two abilities to decide if the “tethered shoot” button should be shown or not.

```
env LANG=C gphoto2 --port usb: --abilities
```

remote capture

This step will verify that your camera can be remotely controlled – i.e. that it can capture an image, download it to your computer and display it within darktable.

```
env LANG=C gphoto2 --port usb: --capture-image-and-download
```

tethered capture

This last step tests if your camera supports events, which darktable heavily relies on. Running this command will make the gphoto2 process wait for an image capture event which you must manually trigger on your camera. If successful, the image will be downloaded to your computer.

```
env LANG=C gphoto2 --port usb: --capture-tethered
```

now what?

If any of the above steps failed, there are problems with your specific camera and driver. Please report the issues to the gphoto2 mailing list for further help. You can find the mailing list at www.gphoto.org. Add the following flags to the failed command above for better support and attach the log output to your mail:

```
--debug --debug-file gphoto2_debug.log
```

If you successfully went through all the tests above, your camera will most likely be supported by darktable. Even if successful, if you stumble upon a problem in darktable, please file a bug on the bugtracker. Please attach the log outputs from the steps above and the log file output generated after starting darktable with the following command.

```
darktable -d camctl 2>1 >camctl.log
```

5. Map

5.1. overview

The map view is where you geo-tag your images.

Map view shows a world map with the currently open image or film roll of images, pinned to their geo-tagged location. This requires that the image was geo-tagged by a camera with that feature. Some newer cameras, including smartphones, are already equipped with GPS receivers. Other cameras may need additional GPS hardware to do this.

Even if your camera doesn't support this feature, there is an alternative method – darktable can match the Exif time and date data in your image(s) to a separate GPX data tracking file created by a GPS tracker recording your movements. These can be handheld devices or a GPS tracker app on your smartphone. This is all done in the geotagging module in the lighttable view.

center map view

In the center of the map view you will see a map.

Map data is taken from open map sources on the internet. New map data is only available if you are connected to the internet – darktable keeps a disk cache of previously loaded map data.

You can navigate within the map using your mouse. Left-click and drag to move the map. Use the scroll-wheel to zoom in and out.

There are on-screen controls and displays that assist you to find your way. A navigation area is located on top left of the map. Use it as an alternative to mouse-dragging and scrolling. The scale of your map is displayed on bottom left. On bottom right you see the geographical coordinates for the center of the map.

Images that already have geo-location attributes in their metadata are displayed as small icons on the map. Images close to each other are grouped and a count of grouped images is displayed on the bottom-left corner.

In order to assign geo coordinates to an image, activate the filmstrip on the lower panel (press Ctrl+F). You can assign a geo location to an image by dragging the image icon from the film-strip and positioning it on the map. darktable will record the new location (longitude and latitude) as part of the image metadata. This data will be included in exported images.

In order to remove location data from an image simply drag it from the map and drop it onto the filmstrip.

Images close to each other are grouped under a single image group. You can use the map settings module to control the grouping as needed. The number displayed on the bottom left of the thumbnail gives the number of images inside the group. A white number means that all images of the group are exactly at the same location. A yellow number means that the locations of images within the group are not all the same. Use the mouse scroll wheel while hovering over a group of images to scroll through the thumbnails of the images in that group.

Normally images in the center map view have black borders. If an image is selected in the filmstrip, then the corresponding image on the map will be highlighted with a white border.

Click+drag to adjust the position of an image. Shift+click to move a complete group of images.

On the left and right of the central map are panels that provide additional controls (see map view layout).

undo/redo

All image movements in the map view are recorded by darktable. It is possible to undo or redo such changes to recover a previous state. Note that this undo/redo facility is unlimited while moving images but it is reset each time you leave the map view.

Press Ctrl+Z to undo the last modification and Ctrl+Y to redo the last undone modification (if any).

5.2. map view layout

left panel

These modules are identical to the lighttable view. From top to bottom:

collect images
Filter the list of images displayed in the map view.
recently used collections
View recently used collections of images.
image information
Display image information.

right panel

Here you can find the modules specific to the map view. From top to bottom:

find location
Search for a place on map.
locations
Manage a hierarchical list of location tags and their corresponding regions on the map.
map settings
Set up your map overlay information and map providers.
tagging
Tag selected images.

bottom panel

filmstrip
Drag images from the filmstrip onto the map as described in the *find location* module documentation.

6. Slideshow

6.1. overview

The slideshow view allows you to watch a slideshow of your current collection with the associated filtering rules and sort order applied.

To learn more about how to define the collection and filtering rules, see the section on collections. Select the sort criteria and sort order of the images in the top panel.

The next section provides more details on the usage of the slideshow view.

6.2. usage

The slideshow view is still in an early stage of development with only a basic set of features.

If you don’t need the auto-advance mode, you could even use the sticky preview feature instead.

spacebar	start and stop auto-advance mode which automatically switches to the next images every five seconds by default.
ESC	leave slideshow mode and return to lighttable view.
+ or up arrow	increase delay between each image.
- or down arrow	decrease delay between each image.
left-click or right arrow or right shift-key	switch to the next image of the collection.
right-click or left arrow or left shift-key	switch to the previous image of the collection.

Hint: To take full advantage of your screen size, put darktable into fullscreen mode by pressing F11 and hide the border-controls by pressing the B key.

---

7. Print

7.1. overview

This view is about printing. Because printing is not easy, there are many technical aspects to be taken into account.

After selecting an image in the lighttable view one can enter the print settings module to adjust printer settings and initiate printing.

This module supports the printer's ICC profile which is somewhat mandatory if you want to get a high quality print close to the image displayed on the screen.

It is important to note that ICC profiles provided by the paper and/or printer manufacturers cannot be used on GNU/Linux as they depend on the printer drivers. The darktable print module uses CUPS and there are no ready-to-use ICC profiles for this driver.

7.2. print view layout

The central area displays the image layout on the paper (the white area). Some gray borders may be displayed around the image to represent the printable area (the page minus the borders) not filled by the image.

The filmstrip below the image allows you to select more images.

left panel

collect images
Filter the list of images displayed in the lighttable.

image information
Display image information

right panel

print settings
Adjust print settings and initiate printing.

8. Module Reference

8.1. overview

The modules in this reference section are broken down into two types:

processing modules
: These modules are used exclusively in the darkroom view, and each performs its processing operation on the image before passing the image up to the next module for further processing. Together this sequence of processing steps forms the pixelpipe.

utility modules
: These modules may be used in any darktable view. They are not directly involved in processing the pixels of your image; instead they perform other ancillary functions related to managing the image metadata and tags, editing history, modifying overall pixel pipeline order, snapshots and duplicates, image export and so on.

The two types of modules have a few aspects in common, as described below.

module header

Each module has a header at the top, normally consisting of the following elements:

module name
: Click on the name to expand or collapse the rest of the module and show/hide its controls.

reset parameters button
: This normally appears to the right of the module name and is used to reset the state of the module back to its original condition.

presets menu
: This normally appears at the far right of the module header. The presets menu is predominantly used in processing modules, but many of the utility modules allow presets to be defined as well.

Processing modules contain additional elements in their module header, as described in the darkroom module header section.

module resizing

Some modules contain lists of infomation which can grow as more entries are added. To help manage screen real-estate, it is possible to shrink or expand the number of entries that are displayed in the list of a module. Place the mouse over an entry in the list, and hold Ctrl while scrolling your mouse wheel to increase or reduce the number of entries that are shown. If the list contains more entries that can be shown at one time, a scrollbar will appear to the right of the list, so that you can access the hidden entries.

8.2. processing modules

8.2.1. astrophoto denoise

Remove image noise while preserving structure.

This is accomplished by averaging each pixel with some surrounding pixels in the image. The weight of such a pixel in the averaging process depends on the similarity of its neighborhood with the neighborhood of the pixel being denoised. A patch with a defined size is used to measure that similarity.

As denoising is a resource-intensive process, it slows down pixelpipe processing significantly. Consider activating this module late in your workflow.

module controls

patch size
The radius of the patch used for similarity evaluation.
strength
The strength of the denoising.
luma
The amount of denoising to apply to luma. Select carefully in order not to lose too much structure.
chroma
The amount of denoising to apply to chroma. You can be much more aggressive with this parameter.

8.2.2. base curve

Simulate the in-camera JPEG by applying a characteristic base curve to the image.

darktable comes with a number of base curve presets that attempt to mimic the curves of various camera manufacturers. These presets are automatically applied according to the manufacturer ID found in the image's Exif data. Camera-specific base curve presets are also available for some camera models.

This module will be enabled by default if the *default pixel workflow* is set to "display-referred" in preferences > processing. A second option in the preferences dialog defines whether darktable should by default attempt to apply a camera-specific base curve (if found) or the generic manufacturer one.

module controls

*Please refer to the curves section for more details about how to modify curves including the **scale for graph** and **preserve colors** controls.*

fusion
Trigger the exposure fusion feature (see this Wikipedia article). This feature allows you to merge the image with one or two copies of itself after applying the current base curve and boosting its exposure by a selected number of EV units. The resulting image is thus a combination of two or three different exposures of the original image. Use this feature to compress the dynamic range of extremely underexposed images or for true HDR input. For best results, use the *exposure* module to apply a suitable adjustment for correctly exposed highlights.
exposure shift (fusion)
The exposure difference between the merged images in EV units (default 1). This slider is only visible if the *exposure fusion* feature is activated.
exposure bias (fusion)
Determines how the multiple exposures are computed. With a bias of 1 (the default), the image is fused with overexposed copies of itself. With a bias of -1, it is fused with underexposed copies. A bias of 0 attempts to preserve the overall lightness of the image by combining both over- and under-exposed copies of the image. This slider is only visible if the *exposure fusion* feature is activated.

8.2.3. basic adjustments

A convenience module that combines controls from *exposure*, *highlight reconstruction*, *color balance* and *vibrance* into a single module.

While this module can provide a quick and convenient way to make simple adjustments to an image, it must be used with care. Normally exposure adjustments should come before input color profile in the pixelpipe, and color adjustments should come after. Because the *basic adjustments* module combines all of these functions into a single operation in the pixelpipe, it may not play nicely with other modules. Therefore, if you plan to use *basic adjustments* with other modules, please instead consider using the *exposure* + *base curve* / *tone curve* / filmic rgb + *color balance* modules so that these operations occur in the correct places in the pixelpipe.

module controls

black level correction

Equivalent to black level correction in the *exposure* module, this slider defines the threshold at which dark gray values are cut off to pure black. Reducing this can bring some dark colors back into gamut. Increasing this slider may appear to increase the contrast and pop of an image, but it can push dark colors out of gamut, and clipped data cannot be recovered further down the pixel pipe. To control the contrast in the shadows, it is better to use other modules such as *tone curve* or *levels*, which mitigate these negative impacts further down the pixel pipeline.

exposure

Adjust exposure compensation. Adding 1 EV of exposure compensation is equivalent to doubling the exposure time in camera, opening the aperture by 1 stop, or doubling the ISO.

Positive exposure corrections will make the image brighter. As a side effect noise level is increased. Depending on the basic noise level of your camera and the ISO value of your image, positive exposure compensations with up to 1EV or 2EV should still give reasonable results.

Negative exposure corrections will make the image darker. Given the nature of digital images this can not correct for fully blown out highlights but allows you to reconstruct data if only some of the RGB channels are clipped (see the *highlight reconstruction* module for information on how to deal with clipped pixels).

highlight compression

Compress the highlights of the image in order to recover detail.

contrast

Equivalent to the *contrast* slider in the *color balance* module, this is used to increase the separation of luminance values around a fulcrum point, in effect making the tone curve steeper. The *middle grey* slider sets the fulcrum point for the contrast, and any pixels whose luminance matches this middle grey point will be unaffected. Pixels brighter than the middle grey point will become even brighter, and pixels darker darker than the middle grey point will become even darker.

preserve colors

If a non-linear tone curve is applied to each of the RGB channels individually, then the amount of tone adjustment applied to each color channel may be different, and this can cause hue shifts. Therefore, the *preserve colors* menu provides different methods of calculating the “luminance level” of a pixel. The amount of tone adjustment is calculated based on this luminance value, and then this same adjustment is applied to all three of the RGB channels. Different luminance estimators can affect the contrast in different parts of the image, depending on the specific characteristics of that image. The user can therefore choose a particular estimator that provides the best results for the given image.

middle grey

Set the fulcrum point for the *contrast* slider. This is equivalent to the *contrast fulcrum* slider on the *color balance* module. If the contrast slider is set to 0 this slider will not have any effect.

brightness

Equivalent to increasing the *gamma factor* slider in the *color balance* module. Moving the slider to the right will increase the brightness of the image, with an emphasis on the mid-tones.

saturation

Equivalent to the *output saturation* slider on the *color balance* module, this slider affects the saturation, or brilliance and intensity of the colors. Moving the slider to the right will increase the amount of color in the image; moving the slider to the left will reduce the amount of color in the image.

vibrance

Accentuate the colors of the image without adding unnatural colors, as it’s often the case with the *saturation* slider. It works by reducing the lightness of already saturated pixels to make the colors more vivid. You can also achieve some interesting effects by combining it with the saturation slider to target more or less saturated areas of the image.

auto

Automatically adjust the exposure, taking into account the entire image, or use the color picker to select a rectangular area of the image – the exposure will be automatically adjusted based on the selected region. This allows you to prioritise which parts of the image should be well-exposed.

clip

This affects the number of pixels that will be clipped to black or white during the auto-exposure calculation. Moving this slider to the right will allow more pixels to be clipped and increase the contrast; moving this slider to the left will compress the image more and lower the contrast.

8.2.4. bloom

Create a soft bloom over the image. This module works by blurring the highlights and then blending them with the original image.

module controls

size
The spacial extent of the bloom effect

threshold
The threshold for the increase in brightness

strength
The strength of the overlighting for the effect

8.2.5. channel mixer (deprecated)

Please note that this module is deprecated in darktable 3.4 and should no longer be used for new edits. Please use the *color calibration* module instead.

A simple yet powerful tool to manage color channels.

This module accepts red, green and blue channels as an input and provides red, green, blue, gray, hue, saturation and lightness channels as output. It allows you to independently control how much each input channel contributes to each output channel.

RGB matrix multiplication

You can think of the *channel mixer* as a type of matrix multiplication between a 3x3 matrix and the input [R G B] values.

$$\begin{bmatrix} R_{out} \\ G_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} Rr & Rg & Rb \\ Gr & Gg & Gb \\ Br & Bg & Bb \end{bmatrix} \times \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix}$$

If, for example, you've been provided with a matrix to transform from one color space to another, you can enter the matrix coefficients into the *channel mixer* as follows:

- set the destination to *red* then set the Rr, Rg & Rb values using the red, green and blue sliders
- set the destination to *green* then set the Gr, Gg & Gb values using the red, green and blue sliders
- set the destination to *blue* then set the Br, Bg & Bb values using the red, green and blue sliders

By default, *channel mixer* just copies the input [R G B] channels straight over to the matching output channels. This is equivalent to multiplying by the identify matrix:

$$\begin{bmatrix} R_{out} \\ G_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix}$$

As an example use case, the following matrix is useful for taming ugly out-of-gamut blue LED lights by making them more magenta:

$$\begin{bmatrix} 1.00 & -0.18 & 0.18 \\ -0.20 & 1.00 & 0.20 \\ 0.05 & -0.05 & 1.00 \end{bmatrix}$$

In this case it is useful to use a parameteric mask to limit the effect of the *channel mixer* to just the problematic colors.

A more intuitive take for what the *channel mixer* sliders do:

- for the *red* destination, adjusting sliders to the right will make the R, G or B areas of the image more red. Moving the slider to the left will make those areas more cyan.
- for the *green* destination, adjusting sliders to the right will make the R, G or B areas of the image more green. Moving the slider to the left will make those areas more magenta.
- for the *blue* destination, adjusting sliders to the right will make the R, G or B areas of the image more blue. Moving the slider to the left will make those areas more yellow.

monochrome

Another very useful application of the *channel mixer* is the ability to mix the channels together to produce a grayscale output – a monochrome image. Use the *gray* destination, and set the red, green and blue sliders to control how much each channel contributes to the brightness of the output. This is equivalent to the following matrix multiplication:

$$GRAY_{out} = \begin{bmatrix} r & g & b \end{bmatrix} \times \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix}$$

When dealing with skin tones, the relative weights of the three channels will affect the level of detail in the image. Placing more weight on red (e.g. [0.9, 0.3, -0.3]) will make for smooth skin tones, whereas emphasising green (e.g. [0.4, 0.75, -0.15]) will bring out more detail. In both cases the blue channel is reduced to avoid emphasising unwanted skin texture.

Different types of traditional black and white film have differing sensitivities to red, green and blue colors, and this can be simulated by setting the gray destination coefficients appropriately. The *channel mixer* module has a number of built-in presets that can be used to achieve this.

module controls

destination
Select the destination channel that will be affected by the slider settings immediately below. The red, green and blue destination channels are used for color mixing as described in the *matrix multiplication* section above. The gray channel is used for making grayscale images as described in the *monochome* section above. It is also possible to define the R, G & B input channels to produce HSL (hue, saturation and lightness) values on the output, although this is a very specialised application.

red
Defines how much the red input channel should contribute to the selected destination channel.

green
Defines how much the green input channel should contribute to the selected destination channel.

blue
Defines how much the blue input channel should contribute to the selected destination channel.

8.2.6. chromatic aberrations

Correct chromatic aberrations.

The underlying model assumes as input an uncropped photographic image. The module is therefore likely to fail when you zoom in, as it is only able to operate on the visible portion of the image. This limitation only applies to interactive work and not to the final export.

This module currently only works for images recorded with a Bayer sensor (the sensor used in the majority of cameras). It will not apply any corrections to photos that have been identified as monochrome (see developing monochrome images for more information). This module has no parameters.

8.2.7. color balance

A versatile tool for adjusting the image's color balance.

This module can be used to revert parasitic color casts or to enhance the visual atmosphere of an image using color grading, a popular technique in the cinema industry.

overview

The *color balance* module allows you to shift colors selectively by luminance range: shadows, mid-tones, and highlights. It does so using two different methods:

lift, gamma, gain
: the classic method, which allows a more separated control of shadows versus highlights.

slope, offset, power
: the new standard defined by the American Society of Cinematographers Color Decision List (ASC CDL) and more suited to scene-referred editing.

The *master* settings affect the whole image. They are not available in *lift, gamma, gain (sRGB)* mode. The slider ranges are limited to usual values ([50%; 150%] for saturation, [-50%; 50%] for contrast), but higher and lower values can be defined via keyboard input after right-clicking on the corresponding slider.

For better efficiency, in *slope, offset, power* mode it is recommended that you set the slope first, then the offset, and finally the power, in that order. The name of the mode can be use as a mnemonic to remember the order.

The shadows parameter has a far heavier effect in *slope, offset, power* mode than in *lift, gamma, gain* mode. When switching from the former to the latter, you should adapt the saturation in shadows, dividing by around 10.

Note: Although this module acts on RGB colors its location in the pixelpipe puts it into the Lab color space. Accordingly the module converts from Lab to RGB, performs its color adjustments, and then converts back to Lab.

---

presets

Several presets are provided in this module to help you to better understand how it can best be used. The "teal/orange color-grading" preset is a very popular look in cinema and is a good showcase model. It is meant to be used with two instances combined with masks. The first instance will exclude skin tones and will shift neutral colors toward teal blue. The second will partially revert the first one and add more vibrance to skin tones only. Together they will create separation between subject and background. The masking and blending parameters will need to be tweaked to suit every image.

Other presets provide Kodak film emulations. In this way you can recreate any film look you like using *color balance*.

module controls

mode
: *lift, gamma, gain (sRGB)* is the legacy mode from darktable 2.4 and earlier. In this mode, the color transformations are applied in sRGB color space encoded with the sRGB gamma (average gamma of 2.2).

  lift, gamma, gain (ProPhotoRGB) is the same as the previous mode but works in ProPhoto RGB space, encoded linearly. In this mode, the RGB parameters are corrected in XYZ luminance (Y channel) internally so they affect only the color, and only the "factors" adjust the luminance.

  slope, offset, power (ProPhotoRGB) applies the ASC CDL in ProPhoto RGB space, encoded linearly. As with the previous mode, the RGB parameters are corrected in XYZ luminance internally. In this mode, the slope parameter acts as an exposure compensation, the offset acts as a black level correction, and the power acts as a gamma correction. All parameters will have some impact on the whole luminance range but the slope will mostly affect the highlights, the offset will mostly affect the shadows, and the power will mostly affect the mid-tones.

color control sliders

This combobox selection affects the user interface used for the shadows, mid-tones and highlights controls.

RGBL controls allow direct access to the RGB parameters that will be sent to the algorithm and internally adjusted in XYZ luminance, depending on the mode used. They are the only ones stored in darktable's development history.

HSL controls allow a more intuitive control, but are only an interface: the hues and saturations are computed dynamically from and to the RGB parameters and never stored. During the HSL to RGB conversion, the HSL lightness is always assumed to be 50%, so the RGB parameters are always balanced to avoid lightness changes. However, during the RGB to HSL conversion, the HSL lightness is not corrected.

As a consequence, editing in RGB, then in HSL, then again in RGB will not retain the original RGB parameters, but will normalize them so their HSL lightness is 50%. The difference is barely noticeable in most cases, especially using the modes that already correct the RGB parameters internally in XYZ luminance.

In both modes, additional "factor" sliders act on all RGB channels at once. Their effect is similar to the controls of the *levels* module and affect only the luminance.

input saturation

A saturation correction applied before the color balance. This can be used to dampen colors before adjusting the balance, to make difficult images easier to process. When you entirely desaturate the image, this creates a luminance-based monochrome image that can be used as a luminance mask, to create color filters with the *color balance* settings, like a split-toning or sepia effect (when used with blending modes).

output saturation

A saturation correction applied after the color balance. This is useful once you have found a proper hue balance but find the effect too heavy, so you can adjust the global saturation at once instead of editing each channel saturation separately at the expense of possibly messing up the colors.

contrast / contrast fulcrum

The contrast slider allows the luminance separation to be increased. The fulcrum value defines the luminance value that will not be affected by the contrast correction, so the contrast will roll over the fulcrum. Luminance values above the fulcrum will be amplified almost linearly. Luminance values below the fulcrum value will be compressed with a power function (creating a toe). This correction comes after the output saturation and is applied on all RGB channels separately, so hues and saturations might not be preserved in case of dramatic settings (shadows might be resaturated, highlights might be desaturated, and some color shift is to be expected).

shadows, mid-tones, highlights

Depending on the mode used, the shadows settings will control either the lift or the offset, the mid-tones settings will control either the gamma or the power, and the highlights settings will control either the gain or the slope. Parameters are transferred unaltered when you change the mode.

In *RGBL* mode, the RGB sliders' range is limited to [-0.5; 0.5]. In *HSL* mode, the saturation sliders range is limited to [0%; 25%]. Values outside of these bounds can be defined with keyboard input by right-clicking on the slider.

Note: The shadows, mid-tones and highlights sliders can take up a great deal of space in the *color balance* module. The overall layout of these sliders can therefore be cycled through three different layouts by clicking on the title *shadows, mid-tones, highlights*. You can also set the default layout via a setting in preferences > darkroom > colorbalance slider block layout.

---

optimize luma

The color-picker beside the optimize luma label will select the whole image and optimize the factors for shadows, mid-tones and highlights so that the average luminance of the image is 50% Lab, the maximum is 100% and the minimum is 0%, at the output of this module. This is essentially histogram normalization, similar to that performed by the *levels* module. The optimizer is only really accurate when used in *slope, offset, power* mode.

If you want more control, you can define three control patches by using the color pickers beside each factor slider to sample luminance in selected areas. The shadows color picker samples the minimum luminance, the mid-tones color picker samples the average, and the highlights color picker samples the maximum luminance. The most sensitive parameter is the mid-tones factor, since selecting a slightly different area can lead to dramatic parameter changes. Using the factors color pickers alone, without triggering the luma optimization, will allow you to perform adjustments without general optimization, but each parameter is always computed taking the other two into account. Once patches are selected, the label changes to read “optimize luma from patches”. To reset one patch, you can just redo the selection. Patches are not saved in the parameters and are retained only during the current session.

It is important to note that the luminance adjustment targets only the output of the *color balance* module and does not account for other luminance adjustments performed in modules coming later in the pixelpipe (e.g. *filmic rgb*, *tone curve*, *color zones*, *levels*). Using the *color balance* to remap the luminance globally on the image is not recommended because it does not preserve the original colors, and modules such as *tone curve* or *filmic rgb* are better suited for this purpose. Luminance adjustments in *color balance* are better suited for local correction, in combination with color adjustments, for color-grading with masks.

neutralize colors

In an image where some areas are exposed to direct sunlight and some areas are exposed to reflected light (shadows), or where several artificial light sources are present simultaneously, shadows and highlights often have different color temperatures. These images are particularly difficult to correct since no general white balance will match all the colors at once. The color neutralization optimizer aims at helping you find the complementary color for shadows, midtones, and highlights so that all the color casts are reverted, and the average color of the image is a neutral grey.

As with the luma optimization, the color picker beside the neutralize colors label will trigger a general optimization over the whole image. This works fairly well in landscape photography, or for any photograph with a full spectrum of colors and luminances.

For night and events photography, this will most likely fail and you will need to manually input the sampling areas with the color-pickers beside each hue slider. For the highlights sample, use a color exposed to spotlights that should be neutral white or light grey. For the shadows sample, use a color exposed to ambient light that should be neutral black or dark grey. For the mid-tones sample, use a color exposed by both ambient and spotlights.

The success of the optimization depends on the quality of the samples. Not every set of samples will converge to a good solution and you need to ensure that the color patches you choose are really a neutral color in real life. In many cases the optimizer will output the correct hue but an excessive saturation that will need some extra tweaking. In some cases, no valid optimization will be delivered and you will need to reset the saturation parameters and start over, or simply stop after the patches selection. Notice that in the auto-optimization the maximum saturation is 25%, which might not be enough in very few cases but will avoid inconsistent results in most.

If you select color patches from the hue color pickers without triggering the optimization, the software will only perform one round of optimization and then stop. This allows you to control each luminance range separately and avoid divergence of the solution in corner cases. The hue and saturation corrections are computed taking into account the two other luminance ranges and three factors, and will always output the complementary color of the selected area. If you want to reinforce the color of the area instead, you can then add 180° to the computed hue. Once patches are selected, the label changes to read “neutralize colors from patches”. To reset one patch you can just redo the selection. Patches are not saved in the parameters and are retained only during the current session. The parameters found by the automatic neutralization are accurate only in *slope, offset, power* mode, but can work to some extent in *lift, gamma, gain* mode too.

8.2.8. color calibration

A fully-featured color-space correction, white balance adjustment and channel mixer. This simple yet powerful module can be used in the following ways:

- To adjust the white balance (chromatic adaptation), working in tandem with the *white balance* module. In this case, the *white balance* module performs an initial white balance step (which is still required in order for the *demosaic* module to work effectively). The *color calibration* module then calculates a more perceptually-accurate white balance after the input color profile has been applied.
- As a simple RGB channel mixer, adjusting the output R, G and B channels based on the R, G and B input channels, to perform cross-talk color-grading.
- To adjust the color saturation and brightness of the pixels, based on the relative strength of the R, G and B channels of each pixel.
- To produce a greyscale output based on the relative strengths of the R, G and B channels, in a way similar to the response of black and white film to a light spectrum.

White Balance in the Chromatic Adaptation Transformation (CAT) tab

Chromatic adaptation aims to predict how all surfaces in the scene would look if they had been lit by another illuminant. What we actually want to predict, though, is how those surfaces would have looked if they had been lit by the same illuminant as your monitor, in order to make all colors in the scene match the change of illuminant. White balance, on the other hand, aims only at ensuring that whites and greys are really neutral (R = G = B) and doesn't really care about the rest of the color range. White balance is therefore only a partial chromatic adaptation.

Chromatic adaptation is controlled within the Chromatic Adaptation Transformation (CAT) tab of the *color calibration* module. When used in this way the *white balance* module is still required as it needs to perform a basic white balance operation (connected to the input color profile values). This technical white balancing ("camera reference" mode) is a flat setting that makes greys lit by a standard D65 illuminant look achromatic, and makes the demosaicing process more accurate, but does not perform any perceptual adaptation according to the scene. The actual chromatic adaptation is then performed by the *color calibration* module, on top of those corrections performed by the *white balance* and *input color profile* modules. The use of custom matrices in the *input color profile* module is therefore discouraged. Additionally, the RGB coefficients in the *white balance* module need to be accurate in order for this module to work in a predictable way.

The *color calibration* and *white balance* modules can be automatically applied to perform chromatic adaptation for new edits by setting the chromatic adaptation workflow option (preferences > processing > auto-apply chromatic adaptation defaults) to "modern". If you prefer to perform all white balancing within the *white balance* module, a "legacy" option is also available. Neither option precludes the use of other modules such as *color balance* further down the pixel pipeline for creative color grading.

By default, *color calibration* performs chromatic adaptation by:

- reading the RAW file's Exif data to fetch the scene white balance set by the camera,
- adjusting this setting using the camera reference white balance from the *white balance* module,
- further adjusting this setting with the input color profile in use (standard matrix only).

For consistency, the *color calibration* module's default settings always assume that the standard matrix is used in the *input color profile* module – any non-standard settings in this module are ignored. However, *color calibration*'s defaults can read any auto-applied preset in the *white balance* module.

It is also worth noting that, unlike the *white balance* module, *color calibration* can be used with masks. This means that you can selectively correct different parts of the image to account for differing light sources.

To achieve this, create an instance of the *color calibration* module to perform global adjustments using a mask to exclude those parts of the image that you wish to handle differently. Then create a second instance of the module reusing the mask from the first instance (inverted) using a raster mask.

CAT tab workflow

The default illuminant and color space used by the chromatic adaptation are initialised from the Exif metadata of the RAW file. There are 4 options available in the CAT tab to set these parameters manually:

- Use the color-picker (to the right of the color patch) to select a neutral color from the image or, if one is unavailable, select the entire image. In this case, the algorithm finds the average color within the chosen area and sets that color as the illuminant. This method relies on the “grey-world” assumption, which predicts that the average color of a natural scene will be neutral. This method does not work for artificial scenes, for example those with painted surfaces.
- Select *(AI) detect from edges*, which uses a machine-learning technique to detect the illuminant using the entire image. This algorithm finds the average gradient color over the edges found in the image and sets that color as the illuminant. This method relies on the “grey-edge” assumption, which may fail if large chromatic aberrations are present. As with any edge-detection method, it is sensitive to noise and poorly suited to high-ISO images, but it is very well suited for artificial scenes where no neutral colors are available.
- Select *(AI) detect from surfaces*, which combines the two previous methods also using the entire image. This algorithm finds the average color within the image, giving greater weight to areas where sharp details are found and colors are strongly correlated. This makes it more immune to noise than the *edge* variant and more immune to legitimate non-neutral surfaces than the naïve average, but sharp colored textures (like green grass) are likely to make it fail.
- Select *as shot in camera* to restore the camera defaults and re-read the RAW Exif.

The color patch shows the color of the currently calculated illuminant projected into sRGB space. The aim of the chromatic adaptation algorithm is to turn this color into pure white, which does not necessarily means shifting the image toward its *perceptual* opponent color. If the illuminant is properly set, the image will be given the same tint as shown in the color patch when the module is disabled.

To the left of the color patch is the *CCT* (correlated color temperature) approximation. This is the closest temperature, in kelvin, to the illuminant currently in use. In most image processing software it is customary to set the white balance using a combination of temperature and tint. However, when the illuminant is far from daylight, the CCT becomes inaccurate and irrelevant, and the CIE (International Commission on Illumination) discourages its use in such conditions. The CCT reading informs you of the closest CCT match found:

- When the CCT is followed by *(daylight)*, this means that the current illuminant is close to an ideal daylight spectrum ± 0.5 %, and the CCT figure is therefore meaningful. In this case, you are advised to use the *D (daylight)* illuminant.
- When the CCT is followed by *(black body)*, this means that the current illuminant is close to an ideal black body (Planckian) spectrum ± 0.5 %, and the CCT figure is therfore meaningful. In this case, you are advised to use the *Planckian (black body)* illuminant.
- When the CCT is followed by *(invalid)*, this means that the CCT figure is meaningless and wrong, because we are too far from either a daylight or a black body light spectrum. In this case, you are advised to use the *custom* illuminant. The chromatic adaptation will still perform as expected (see the note below), so the *(invalid)* tag only means that the current illuminant color is not accurately tied to the displayed CCT. This tag is nothing to be concerned about – it is merely there to tell you to stay away from the daylight and planckian illuminants because they will not behave as you might expect.

When one of the above illuminant detection methods is used, the program checks where the calculated illuminant sits using the 2 idealized spectra (daylight and black body) and chooses the most accurate spectrum model to use in the *illuminant* parameter. The user-interface will change accordingly:

- A temperature slider will be provided if the detected illuminant is close to a *D (daylight)* or *Planckian (black body)*, for which the CCT is meaningful.
- Hue and chroma sliders in CIE 1976 Luv space are offered for the *custom* illuminant, which allows direct selection of the illuminant color in a perceptual framework without any intermediate assumption.

Note: Internally, the illuminant is represented by its absolute chromaticity coordinates in CIE xyY color space. The illuminant selection options in the module are merely interfaces to set up this chromaticity from real-world relationships and are intended to make this process faster. It does not matter to the actual algorithm if the CCT is tagged “invalid” – this just means that the relationship between the CCT and the corresponding xyY coordinates is not physically accurate. Regardless, the color set for the illuminant, as displayed in the patch, will always be honored by the algorithm.

When switching from one illuminant to another, the module attempts to translate the previous settings to the new illumninant as accurately as possible. Switching from any illuminant to *custom* preserves your settings entirely, since the *custom* illuminant is a general case. Switching between other modes, or from *custom* to any other mode, will not precisely preserve your settings from the previous mode due to rounding errors.

Other hard-coded *illuminants* are available (see below). Their values come from standard CIE illuminants and are absolute. You can use them directly if you know exactly what kind of light bulb was used to illuminate the scene and if you trust your camera's input profile and reference (D65) coefficients to be accurate (otherwise, see *caveats* below).

CAT tab controls

adaptation

The working color space in which the module will perform its chromatic adaptation transform and channel mixing. The following options are provided:

- *Linear Bradford (1985)*: This is accurate for illuminants close to daylight and is compatible with the ICC v4 standard, but produces out-of-gamut colors for more difficult illuminants.
- *CAT16 (2016)*: This is more robust in avoiding imaginary colors while working with large gamut or saturated cyan and purple, and is more accurate than the Bradform CAT in general.
- *Non-linear Bradford (1985)*: This can produce better results than the linear version but is unreliable.
- *XYZ*: This is the least accurate method and is generally not recommended except for testing and debugging purposes.
- *none (disable)*: Disable any adaptation and use the pipeline working RGB space.

illuminant

The type of illuminant assumed to have lit the scene. Choose from the following:

- *same as pipeline (D50)*: Do not perform chromatic adaptation in this module instance but perform channel mixing using the selected *adaptation* color space.
- *CIE standard illuminant*: Choose from one of the CIE standard illuminants (daylight, incandescent, fluorescent, equi-energy, or black body), or a non-standard "LED light" illuminant. These values are all pre-computed – as long as your camera sensor is properly profiled, you can just use them as-is. For illuminants that lie near the Planckian locus, an additional "temperature" control is also provided (see below).
- *custom*: If a neutral grey patch is available in the image, the color of the illuminant can be selected using the color picker, or can be manually specified using hue and saturation sliders (in LCh perceptual color space). The color swatch next to the color picker shows the color of the calculated illuminant used in the CAT compensation. The color picker can also be used to restrict the area used for AI detection (below).
- *(AI) detect from image surfaces*: This algorithm obtains the average color of image patches that have a high covariance between chroma channels in YUV space and a high intra-channel variance. In other words, it looks for parts of the image that appear as though they should be grey, and discards flat colored surfaces that may be legitimately non-grey. It also discards chroma noise as well as chromatic aberrations.
- *(AI) detect from image edges*: Unlike the *white balance* module's auto-white-balancing which relies on the "grey world" assumption, this method auto-detects a suitable illuminant using the "grey edge" assumption, by calculating the Minkowski p-norm (p = 8) of the laplacian and trying to minimize it. That is to say, it assumes that edges should have the same gradient over all channels (grey edges). It is more sensitive to noise than the previous surface-based detection method.
- *as shot in camera*: Calculate the illuminant based on the white balance settings provided by the camera.

temperature

Adjust the color temperature of the illuminant. Move the slider to the right to assume a more blue illuminant, which will make the white-balanced image appear warmer/more red. Move the slider to the left to assume a more red illuminant, which makes the image appear cooler/more blue after compensation.

This control is only provided for illuminants that lie near the Planckian locus and provides fine-adjustment along that locus. For other illuminants the concept of "color temperature" doesn't make sense, so no temperature slider is provided.

hue

For custom white balance, set the *hue* of the illuminant color in LCh color space, derived from CIE Luv space.

chroma

For custom white balance, set the *chroma* (or saturation) of the illuminant color in LCh color space, derived from CIE Luv space.

gamut compression

Most camera sensors are slightly sensitive to invisible UV wavelengths, which are recorded on the blue channel and produce “imaginary” colors. Once corrected by the input color profile, these colors will end up out of gamut (that is, it may no longer be possible to represent certain colors as a valid [R,G,B] triplet with positive values in the working color space) and produce visual artifacts in gradients. The chromatic adaptation may also push other valid colors out of gamut, at the same time pushing any already out-of-gamut colors even further out of gamut. *Gamut compression* uses a perceptual, non-destructive, method to attempt to compress the saturation while preserving the luminance as-is and the hue as close as possible, in order to fit the whole image into the gamut of the pipeline working color space. One example where this feature is very useful is for scenes containing blue LED lights, which are often quite problematic and can result in ugly gamut clipping in the final image.

clip negative RGB from gamut

Remove any negative RGB values (set them to zero). This helps to deal with bad black level as well as the blue channel clipping issues that may occur with blue LED lights.

CAT warnings

The chromatic adaptation in this module relies on a number of assumptions about the earlier processing steps in the pipeline in order to work correctly, and it can be easy to inadvertently break these assumptions in subtle ways. To help you to avoid these kind of mistakes, the *color calibration* module will show warnings in the following circumstances.

- If the *color calibration* module is set up to perform chromatic adaptation but the *white balance* module is not set to “camera reference”, warnings will be shown in both modules. These errors can be resolved either by setting the *white balance* module to “camera reference” or by disabling chromatic adaptation in the *color calibration* module. Note that some sensors may require minor corrections within the *white balance* module in which case these warnings can be ignored.
- If two or more instances of *color calibration* have been created, each attempting to perform chromatic adaptation, an error will be shown on the second instance. This could be a valid use case (for instance where masks have been set up to apply different white balances to different non-overlapping areas of the image) in which case the warnings can be ignored. For most other cases, chromatic adaptation should be disabled in one of the instances to avoid double-corrections.

  By default, if an instance of the *color calibration* module is already performing chromatic adaptation, each new instance you create will automatically have its adaptation set to “none (bypass)” to avoid this “double-correction” error.

The chromatic adaptation modes in *color calibration* can be disabled by either setting the *adaptation* to “none (bypass)” or setting the *illuminant* to “same as pipeline (D50)” in the CAT tab.

These warnings are intended to prevent common and easy mistakes while using the automatic default presets in the module in a typical RAW editing workflow. When using custom presets and some specific workflows, such as editing film scans or JPEGs, these warnings can and should be ignored.

channel mixing

The remainder of this module is a standard channel mixer, allowing you to adjust the output R, G, B, colorfulness, brightness and grey of the module based on the relative strengths of the R, G and B input channels.

Channel mixing is performed in the color space defined by the *adaptation* control on the CAT tab. For all practical purposes, these CAT spaces are particular RGB spaces tied to human physiology and proportional to the light emissions in the scene, but they still behave in the same way as any other RGB space. The use of any of the CAT spaces can make the channel mixer tuning process easier, due to their connection with human physiology, but it is also possible to mix channels in the RGB working space of the pipeline by setting the *adaptation* to “none (bypass)”. To perform channel mixing in one of the *adaptation* color spaces without chromatic adaptation, set the *illuminant* to “same as pipeline (D50)”.

Note: The actual colors of the CAT or RGB primaries used for the channel mixing, projected to sRGB display space, are painted in the background of the RGB sliders, so you can get a sense of the color shift that will result from your altered settings.

Channel mixing is a process that defines a boosting/muting factor for each channel as a ratio of all the original channels. Instead of entering a single flat correction that ties the output value of a channel to its input value (for example, `R_output = R_input × correction`), the correction to each channel is dependent on the input of *all* of the channels for each pixel (for example, `R_output = R_input × R_correction + G_input × G_correction + B_input × B_correction`). Thus a pixel's channels contribute to each other (a process known as "cross-talk") which is equivalent to rotating the primary colors of the color space in 3D. This is, in effect, digital simulation of physical color filters.

Although rotating primary colors in 3D is ultimately equivalent to applying a general hue rotation, the connection between the RGB corrections and the resulting perceptual hue rotation is not directly predictable, which makes the process non-intuitive. "R", "G" and "B" should be taken as a mixture of 3 lights that we dial up and down, not as a set of colors or hues. Also, since RGB tristimulus does not decouple luminance and chrominance, but is an additive lighting setup, the "G" channel is more strongly tied to human luminance perception than the "R" and "B" ones; All pixels have a non-zero G channel, which implies that any correction to the G channel will likely affect all pixels.

The channel mixing process is therefore tied to a physical interpretation of the RGB tristimulus (as additive lights) that makes it well-suited for primary color grading and illuminant corrections, and blends the color changes smoothly. However, trying to understand and predict it from a perceptual point of view (luminance, hue and saturation) is going to fail and is discouraged.

Note: The "R", "G" and "B" labels on the channels of the color spaces in this module are merely conventions formed out of habit. These channels do not necessarily look "red", "green" and "blue", and users are advised against trying to make sense out of them based on their names. This is a general principle that applies to *any* RGB space used in any application.

R, G and B tabs

At its most basic level, you can think of the R, G and B tabs of the *color calibration* module as a type of matrix multiplication between a 3x3 matrix and the input [R G B] values. This is in fact very similar to what a matrix-based ICC color profile does, except that the user can input the matrix coefficients via the darktable GUI rather than reading the coefficients from an ICC profile file.

$$\begin{bmatrix} R\_out \\ G\_out \\ B\_out \end{bmatrix} = \begin{bmatrix} Rr & Rg & Rb \\ Gr & Gg & Gb \\ Br & Bg & Bb \end{bmatrix} \times \begin{bmatrix} R\_in \\ G\_in \\ B\_in \end{bmatrix}$$

If, for example, you've been provided with a matrix to transform from one color space to another, you can enter the matrix coefficients into the *channel mixer* as follows:

- select the *red* tab and then set the Rr, Rg & Rb values using the red, green and blue input sliders
- select the *green* tab and then set the Gr, Gg & Gb values using the red, green and blue input sliders
- select the *blue* tab and then set the Br, Bg & Bb values using the red, green and blue input sliders

By default, the mixing function in *color calibration* just copies the input [R G B] channels straight over to the matching output channels. This is equivalent to multiplying by the identify matrix:

$$\begin{bmatrix} R\_out \\ G\_out \\ B\_out \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} R\_in \\ G\_in \\ B\_in \end{bmatrix}$$

To get an intuitive understanding of how the mixing sliders on the red, greeen and blue tabs behave:

- for the *red* destination, adjusting sliders to the right will make the R, G or B areas of the image more red. Moving the slider to the left will make those areas more cyan.
- for the *green* destination, adjusting sliders to the right will make the R, G or B areas of the image more green. Moving the slider to the left will make those areas more magenta.
- for the *blue* destination, adjusting sliders to the right will make the R, G or B areas of the image more blue. Moving the slider to the left will make those areas more yellow.

R, G, B tab controls

The following controls are shown for each of the R, G and B tabs:

input red/green/blue
Choose how much the input R, G and B channels influence the output channel relating to the tab concerned.

normalize channels
Select this checkbox to normalize the coefficients to try to preserve the overall brightness of this channel in the final image as compared to the input image.

brightness and colorfulness tabs

The brightness and colorfulness (color saturation) of pixels in an image can also be adjusted based on the R, G and B input channels. This uses the same basic algorithm that the *filmic rgb* module uses for tone mapping (which preserves RGB ratios) and for midtones saturation (which massages them).

colorfulness tab controls

input red/green/blue
Adjust the color saturation of pixels, based on the R, G and B channels of those pixels. For example, adjusting the *input red* slider will affect the color saturation of pixels containing a lot of red more than colors containing only a small amount of red.

normalize channels
Select this checkbox to try to keep the overall saturation constant between the input and output images.

brightness tab controls

input red/green/blue
Adjust the brightness of certain colors in the image, based on the R, G and B channels of those colors. For example, adjusting the *input red* slider will affect the brightness of colors containing a lot of R channel much more than colors containing only a small amount of R channel. When darkening/brightening a pixel, the ratio of the R, G and B channels for that pixel is maintained, in order to preserve the hue.

normalize channels
Select this checkbox to try to keep the overall brightness constant between the input and output images.

grey tab

Another very useful application of *color calibration* is the ability to mix the channels together to produce a greyscale output – a monochrome image. Select the *grey* tab, and set the red, green and blue sliders to control how much each channel contributes to the brightness of the output. This is equivalent to the following matrix multiplication:

$$GRAY_{out} = \begin{bmatrix} r & g & b \end{bmatrix} \times \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix}$$

When dealing with skin tones, the relative weights of the three channels will affect the level of detail in the image. Placing more weight on red (e.g. [0.9, 0.3, -0.3]) will make for smooth skin tones, whereas emphasising green (e.g. [0.4, 0.75, -0.15]) will bring out more detail. In both cases the blue channel is reduced to avoid emphasising unwanted skin texture.

grey tab controls

input red/green/blue
Choose how much each of the R, G and B channels contribute to the grey level of the output. The image will only be converted to monochrome if the three sliders add up to some non-zero value. Adding more blue will tend to bring out more details, adding more red will tend to smooth skin tones.

normalize channels
Select this checkbox to try to keep the overall brightness constant as the sliders are adjusted.

Caveats

The ability to use standard CIE illuminants and CCT-based interfaces to define the illuminant color depends on sound default values for the standard matrix in the *input color profile* module as well as reasonable RGB coefficients in the *white balance* module.

Some cameras, most notably those from Olympus and Sony, have unexpected white balance coefficients that will always make the detected CCT invalid even for legitimate daylight scene illuminants. This error most likely comes from issues with the standard input matrix, which is taken from the Adobe DNG Converter.

It is possible to alleviate this issue, if you have a computer screen calibrated for D65 illuminant, using the following process:

1. Display a white surface on your screen, for example by opening a blank canvas in any photo editing software you like
2. Take a blurry (out of focus) picture of that surface with your camera, ensuring that you don’t have any “parasite” light in the frame, you have no clipping, and using an aperture between f/5.6 and f/8,
3. Open the picture in darktable and extract the white balance by using the spot tool in the *white balance* module on the center area of the image (non-central regions might be subject to chromatic aberrations). This will generate a set of 3 RGB coefficients.
4. Save a preset for the *white balance* module with these coefficients and auto-apply it to any color RAW image created by the same camera.

8.2.9. color contrast

A simplified control for changing the contrast or separation of colors between the green/magenta and blue/yellow axes in Lab color space. Higher values increase color contrast, lower values decrease it.

module controls

green-magenta contrast
Change the green-magenta color contrast. This is equivalent to raising or lowering the steepness of the a* curve in Lab. Lower values desaturate greens and magenta, while higher values increase their saturation.

blue-yellow contrast
Change the blue-yellow color contrast. This is equivalent to raising or lowering the steepness of the b* curve in Lab. Lower values desaturate blues and yellows, while higher values increase their saturation.

8.2.10. color correction

Modify the global image saturation to give the image a tint or as an alternative method to split-tone the image.

module controls

color board
For split toning move the white dot to the desired highlight tint and then select a tint for shadows with the dark spot. For a simple global tint set both spots to the same color.

saturation
Correct the global saturation.

8.2.11. color look up table

A generic color look up table implemented in Lab space. The input is a list of source and target points and the complete mapping is interpolated using splines. The resulting look up tables (LUTs) are editable by hand and can be created using the darktable-chart utility to match given input (such as hald-cluts and RAW/JPEG with in-camera processing pairs). See using darktable-chart for details.

module controls

color board

The color board grid shows a list of colored patches. The colors of the patches are the source points. The target color of the selected patch is shown as offsets which are controlled by sliders beneath the color board. An outline is drawn around patches that have been altered (where the source and target colors differ).

Click a patch to select it, or use the combo box or color picker. The currently-selected patch is marked with a white square, and its number is displayed in the combo box below.

By default, the module will load the 24 patches of a classic color checker and initialise the mapping to identity (no change to the image). Configurations with more than 24 patches are shown in a 7x7 grid.

interaction

To modify the color mapping, you can change the source and target colors, though the main use is to change the target colors.

Start with an appropriate palette of source colors (either from the presets menu or from a style you have downloaded). You can then change the lightness (L), green-red (a), blue-yellow (b), or saturation (c) of the patches' target values via sliders.

To change the source color of a patch you can select a new color from your image by using the color picker and Shift+click on the patch you want to replace.

Double-click a patch to reset it; Right-click a patch to delete it; Shift+click on empty space to add a new patch (with the currently picked color as source color).

8.2.12. color mapping

Transfer the look and feel of one image to another. This module statistically analyses the color characteristics of a source and target image. The colors of the source image are then mapped to corresponding colors on the target image.

Two steps are required to use this module:

1. Open the source image in darkroom mode and acquire its color characteristics by pressing the “acquire as source” button. A set of color clusters is generated and displayed in the “source clusters” area. Each cluster is represented by a set of color swatches with the mean value in the center surrounded by swatches indicating the variance within that cluster. The clusters are sorted in ascending order by their weight, i.e. the number of pixels that contribute to the clusters.
2. Open the target image in darkroom mode. The previously collected source clusters should be stored; if they are not yet displayed, press the button. Now press the “acquire as target” button to generate a corresponding set of color clusters for your target image, which gets displayed in the “target clusters” area.

When both source and target clusters are collected an automatic color mapping is applied to the target image. In its default settings the overall effect is quite exaggerated. A set of sliders gives you control of the effect’s strength. You can also use the *normal* blend mode along with the *opacity* slider to tame the effect. As the color mapping module comes early in the pixelpipe, you can finetune the colors with later modules.

module controls

acquire as source/target

Press these buttons to generate color clusters for the source and target image, respectively. The processing takes a few seconds during which the GUI remains unresponsive.

number of clusters

The number of color clusters to use. If you change this parameter all collected color clusters are reset and need to be acquired anew.

color dominance

This parameter controls the mapping between source and target clusters. At the minimum value mapping is based on color proximity. This typically leads to very subtle effects on the target image. At the maximum value mapping is based on the relative weight of the color clusters – dominant colors of the source image are mapped to dominant colors of the target image. This typically leads to a very strong effect. Intermediate values incrementally shift between these extremes.

histogram equalization
Modify the target image's contrast by matching its histogram with the histogram of the source image. This slider controls the extent of this effect.

8.2.13. color reconstruction

Recover color information in blown-out highlights.

Due to the nature of digital sensors, overexposed highlights lack valid color information. Most frequently they appear neutral white or exhibit some color cast – depending on what other image processing steps are involved. This module can "heal" overexposed highlights by replacing their colors with better fitting ones. The module acts on pixels whose luminance exceeds a user-defined threshold. Replacement colors are taken from neighboring pixels. Both the spatial distance and the luminance distance (range) are taken into account for color selection.

Due to a limitation of the underlying algorithm, reconstructed colors may sometimes be displayed incorrectly if you zoom into the image in the darkroom view. If this happens you might observe a magenta shift in highlight areas close to high contrast edges, or you might see colorless highlight areas when used alongside the "reconstruct color" method of the *highlight reconstruction* module. These artifacts only influence on-screen image display – the final output remains unaffected. It is recommended that you finetune the parameters of this module only when viewing the fully zoomed-out image.

module controls

threshold
The color reconstruction module replaces the color of all target pixels having luminance values above this threshold. Only pixels with luminance values below the threshold are taken as valid source pixels for replacement colors. Setting this parameter too high will cause the module to have no effect on any pixels. Setting it too low will minimize the "pool" of replacement colors – if no suitable colors are available the original colors are maintained. This parameter therefore exhibits a "sweet spot" characteristic with an optimum setting depending on the individual image.

spatial extent
The spatial distance that source pixels may have from target pixels in order for them to contribute to color replacement. Higher values cause ever more distant pixels to contribute. This increases the chance of finding a replacement color but makes the replacement color less well defined.

range extent
The range difference (in luminance) that source pixels may have from target pixels in order for them to contribute to color replacement. Higher values cause more pixels to contribute even if their luminance differs more strongly from the target pixels. This again increases the chance of finding a replacement color but at the same time increases the risk of unfitting colors creeping in.

precedence
This combobox defines whether certain replacement colors shall take precedence over others as follows:

- *off* (default): All pixels contribute equally
- *saturated colors*: Pixels contribute according to their chromaticity – the more highly-saturated a color, the more it contributes
- *hue*: give precedence to a specific hue (see below)

hue
This slider is only visible if you set the *precedence* to "hue". It allows you to select a preferred hue for replacement colors. This only has an effect if the preferred hue is actually present within the selected spatial and range distance of the target pixels (see above). A typical use case is repairing highlights on human skin in situations where diverging colors are in close proximity (e.g. textiles or hair with a luminance close that of to skin). Setting a hue preference on skin tones prevents these other colors from creeping in.

8.2.14. color zones

Selectively adjust the lightness, saturation and hue of pixels based on their current lightness, saturation and hue.

This module works in CIE LCh color space, which separates pixels into *lightness*, chroma (or *saturation*) and *hue* components. It allows you to manipulate the lightness, saturation and hue of targeted groups of pixels through the use of curves.

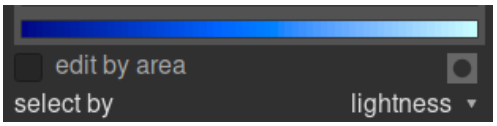
In the *color zones* module, you first need to choose whether you wish to adjust (select) pixels based on their lightness, saturation or hue. Once you have chosen the pixel selection method you can then use three curves, on their respective tabs, to adjust the lightness, saturation and hue of ranges of pixels selected via this method.

pixel selection method

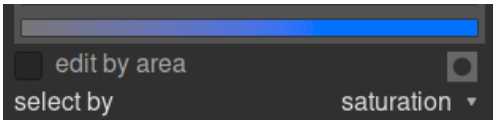
The *color zones* module offers three different methods for selecting which pixels you want to adjust. They are:

select by hue (default)
Choose which pixels to manipulate based on their hue. For example, you may want to darken a blue sky, or to change a red porche into a yellow one. The following image shows the full range of hues that you can choose to operate on:

select by lightness
Choose which pixels to manipulate based on their lightness. For example, you may want to make your shadows brighter (which is like doing a sort of tone mapping), or to make your highlights a little more yellow in hue. The following image shows the range of lightness levels that you can choose to operate on, from dark to light:



select by saturation
Choose which pixels to manipulate based on their saturation. For example, you may want to tone down the saturation of some already highly saturated pixels, or to change their hue. The following image shows the range of saturation levels that you can choose to operate on, from a completely unsaturated monochrome grey through to the most highly saturated color:



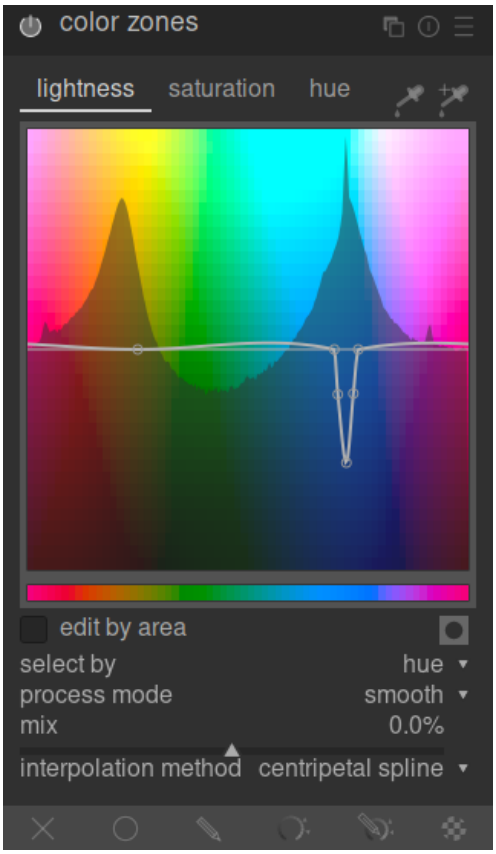
pixel manipulation curves

Once you have chosen a pixel selection method, the selected range of lightness, saturation or hue levels will appear along the horizonal axis of the pixel manipulation curves. There are three tabs, each with their own curve for manipulating either the hue, lightness or saturation.

If, for example, you were to choose to *select by hue* (the default), the horizontal axis (below the manipulation curves) would show the range of hues you can work with, and the three pixel manipulation curves would appears as follows:

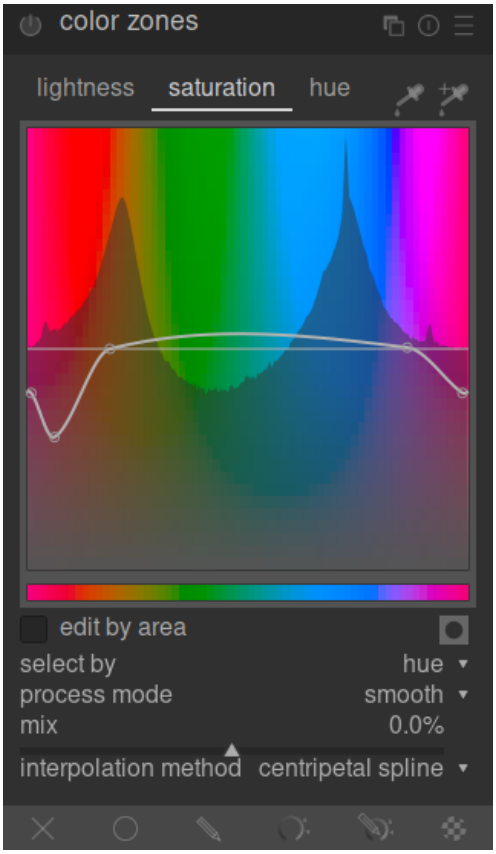
lightness

By adjusting the lightness curve up or down in a given (hue) location, you can brighten or darken pixels matching hues where the curve has been raised or lowered, respectively. In the example below the blue sky in an image has been darkened for dramatic effect:



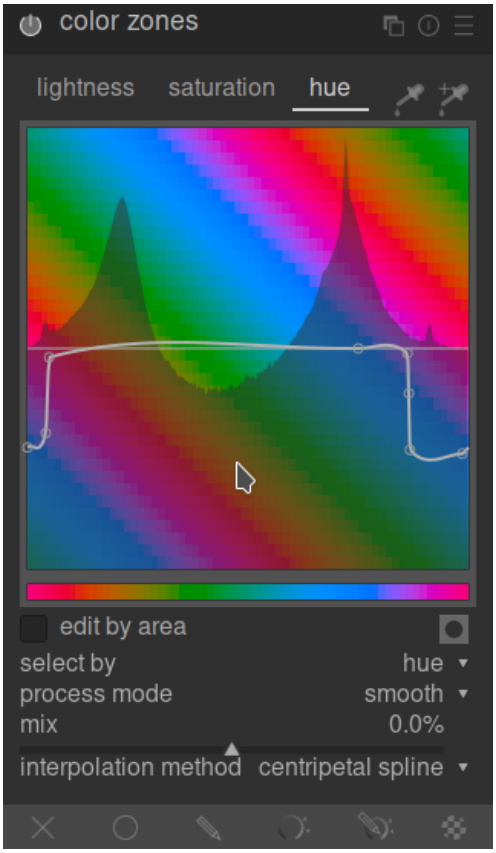
saturation

By adjusting the saturation curve up or down in a given (hue) location, you can desaturate (make less colorful) or resaturate (make more colorful) pixels matching hues where the curve has been raised or lowered, respectively. In the example below, a red object in the background has been desaturated so it is less of a distraction to the main subject of the photo:



hue

By adjusting the hue curve up or down in a given (hue) location, you can shift the hue of pixels matching hues where the curve has been raised or lowered, respectively, allowing you to replace one color with another. In the example below, a pink toy in an image has been changed to blue:



The curves work similarly in the lightness-based and saturation-based selection modes as well. See the section on curves to see how spline curves work in general.

In practical use, these examples would probably need to be combined with drawn and/or parametric masks to further isolate their effect.

range selection

When adjusting the pixel manipulation curves, it can sometimes be difficult to judge exactly where on the horizontal axis pixels will fall. Just above the curve are a pair of color pickers that can be used to help identify where to make your adjustments, and they can even assist further by automatically setting up some initial control points for you.

If you click the color picker on the left and then choose a pixel in the image, you will see a dark vertical line showing where that pixel falls on the horizontal axis. If you Ctrl+click on the same color picker you can choose a rectangular area from the image – the range of values represented within that rectangular will be shaded vertically, with a similar dark line showing the median value.

If you click on the color picker on the right, you can similarly choose a rectangular area on the image and the display will be shown as described above (a shaded area with a dark vertical line). However, in this case the color picker will also automatically add some control points to the curve for you, at the start, median and end of the highlighted range (see below). Simply drag on the center notde to push up or pull down the curve within that selected range.

If you hold Ctrl while selecting a region using the right-hand color picker, the auto-generated curve nodes will be automatically pushed up in the selected range. You can then fine-tune by dragging on the individual nodes. If you hold Shift while selecting a region, the curve will instead be pushed down in the selected range.

module controls

Here is a summary of all the settings available in the *color zones* module:

tabbed controls

The module provides tabs with a curve for each of the three channels “lightness”, “saturation”, and “hue”, so that you can adjust these attributes individually based on the pixel selection method (see the *pixel manipulation curves* section above).

edit by area

Control the interaction mode with the curve. This setting is disabled by default, which allows the control points for the curve to be freely placed and dragged. By enabling this setting, the adjustment of the curve falls back to a legacy mode, which functions in a similar to the spline curve controls used in the wavelets modules.

 **mask display**

Enable the *mask display* to highlight any pixels that have been affected by *color zones* adjustments in yellow.

select by

Define the horizontal axis, i.e. the range of values to work on. You can choose between “lightness”, “saturation”, and “hue” (default). Changing this parameter resets any defined curve to a straight horizontal line. If you want to work on multiple ranges, you’ll need to use multiple instances of the *color zones* module.

process mode

Choose between a “smooth” (default) or “strong” processing mode, which alters the final effect.

mix

Use this parameter to tune the strength of the overall effect.

interpolation method

The interpolation is the strategy used to draw a continuous curve through a set of control points. The different interpolation methods are described more fully in the curves section.

8.2.15. colorize

Add a solid layer of color to the image.

module controls

hue

The hue of the color layer.

saturation

The saturation of shadow tones.

lightness

The lightness of the color layer.

source mix

Controls how the lightness of the input image is mixed with the color layer. Setting this to zero will result in a uniformly colored plane.

8.2.16. contrast brightness saturation

A very basic tool for adjusting the *contrast*, *brightness* and *saturation* of an image. Please note that a number of other modules provide much more versatile methods of adjusting these parameters.

All module controls default to a neutral position (zero) and provide the ability to increase or decrease the relevant parameter

module controls

contrast

The contrast

brightness

The brightness

saturation

The saturation

8.2.17. contrast equalizer

This versatile module can be used to achieve a variety of effects, for example, bloom, denoising, clarity, and local contrast enhancement. It works in the wavelet domain and parameters can be tuned independently for each wavelet detail scale. It operates in CIE LCh color space, which means that it is able to treat luminosity and chromaticity separately.

A number of presets are provided, which should give you a better understanding the full power of this module.

module controls

Each scale of detail can be tweaked independently. In particular, you can adjust the contrast boost and denoise threshold splines for both lightness (“luma') and chromaticity (“chroma”, or color saturation), as well as tune the edge-awareness parameters (“edges”) of the wavelet transform on each detail scale. The luma, chroma and edge-awareness splines are available on separate tabs, and some examples of their use are given in the following sections.

Below the spline graphs on each tab is a *mix* slider. This can be used to adjust how strong or weak you want the effect of the module to be. This is a not a separate setting stored within the module within it’s own right – it merely provides a convenient way to shift the control points in a coordinated way. If you leave and re-enter the module, the effect of the *mix* setting will have been integrated into the control point positions, and the *mix* slider will once again be at the 1.00 position.

In the background of the curve you will see a number of alternating light and dark stripes. These represent the levels of detail that are visible at your current zoom scale – any details without these stripes are too small to be seen your current view. Adjustments to control points within the striped section *may* produce a visible effect (depending on the strength of the adjustment). Adjustments outside of the striped region *will not*. Zoom in to see higher levels of detail and make adjustments to the detailed areas of the image visible.

Tip: if you are having trouble visualising which parts of the curve will affect which details in the image, you can set the blending mode for the module to “difference”. This will make the image go black except for those areas where the output of the module differs from the input. By pushing up the curve at one of the control points, you will be able to see which details in the image are represented by that point.

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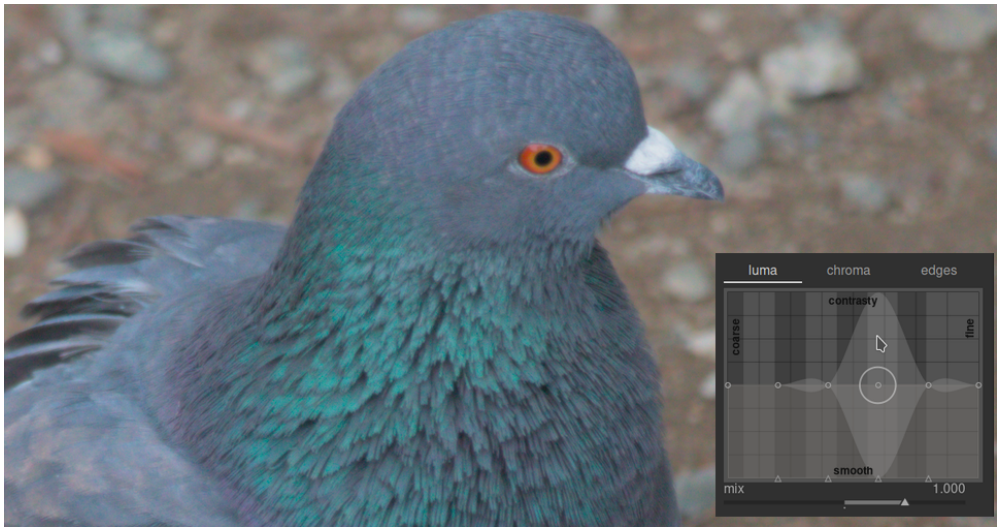
luma tab

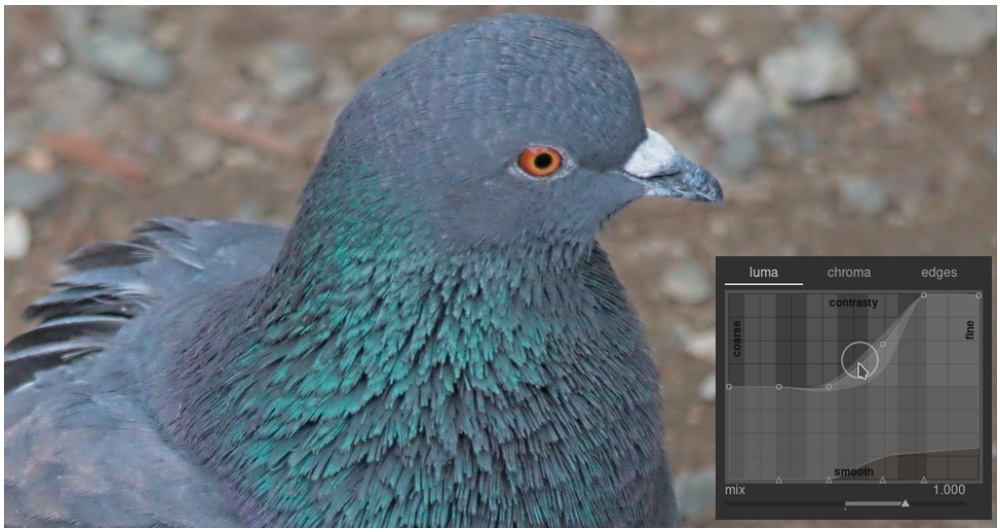
The luma tab allows you to adjust the local contrast in the luminance or brightness in the image. It is represented by a white spline that starts off running across the centre of the graph (indicating that no change will be made). Raise or lower the white spline at the left end of the graph to increase or decrease the local contrast of coarse detail in the image. Perform similar adjustments towards the right side of the graph to adjust the local contrast of the fine details in the image.

When you hover the mouse pointer over the graph, a white circle indicates the radius of influence of the mouse pointer, and this circle can be made larger or smaller with the mouse wheel. When you adjust a control point, the larger the circle, the more the control points either side will be affected by the adjustment. You will see in the background a highlighted region which shows what the spline would look like if you pushed the currently-hovered control point all the way to the top or bottom on the graph. See the screenshot below for examples of these features. For more information see the wavelets section.

Let’s look at an example. The following image shows the default state of the contrast equalizer module before any adjustments have been made:



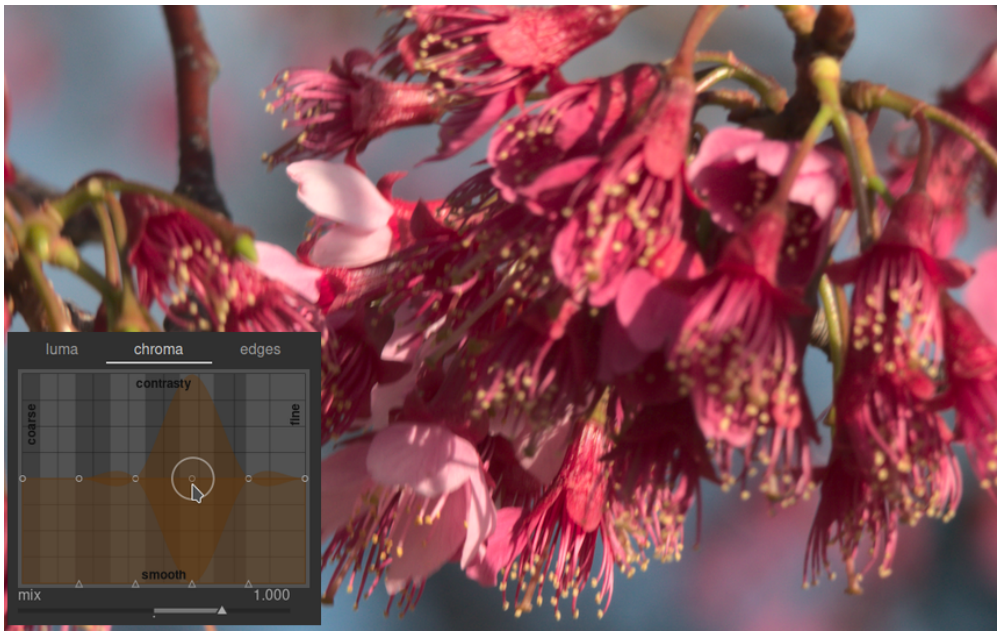
By pushing up the two control points at the right hand end of the graph, you will make the fine details in the eye and feathers of the bird much sharper, but the contrast in the rocks in the background remains largely unaffected. The example below has been purposely exaggerated to better illustrate the effect.



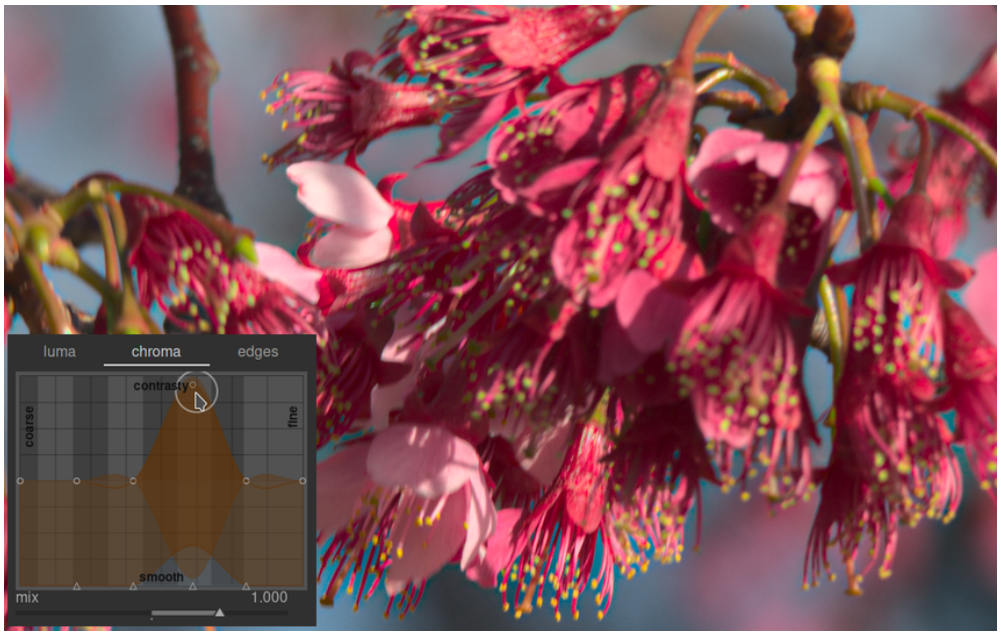
Increasing the local contrast can also amplify the luma noise in the image. A second spline located at the bottom of the graph can be used used for denoising at selected detail scales. Raise this spline (by clicking just above one of the triangles at the bottom of the graph and dragging the line upwards) to reduce noise at the given wavelet scale. On the example above the dark denoising spline has been pushed up at the fine detail end of the graph.

chroma tab

The chroma tab allows the color contrast or saturation to be adjusted at the selected wavelet scales. In the example below are some pink flowers:



Say you wanted to bring out the green color of the anthers at the end of the stamen in the flowers. The pink petals of the flowers are already quite saturated, but using contrast equalizer you can selectively boost the saturation on the small scale of the anthers without impacting the saturation of the petals. By pushing up the third control point from the right, you can target the saturation of the anthers only:



Just like on the luma tab, the chroma tab also has a denoising spline at the bottom of the graph. This can be used to deal with chroma noise at different scales within the image. Chroma denoising can generally be more agressive on larger wavelet scales and has less effect on a smaller scale.

edge tab

The basic wavelet *à trous* transform has been enhanced in contrast equalizer to be “edge-aware”, which can help reduce the gradient reversals and halo artifacts that the basic algorithm can produce. The *edge* tab does not directly act on edges in an image; rather it adjusts the level of the edge awareness feature of the wavelet transform. If you have not adjusted the luma or chroma splines, adjusting the edge awareness spline will have no effect.

To see the sorts of artifacts that the edge awareness tries to combat, here is an example taken from the paper “Edge-Optimized À-Trous Wavelets for Local Contrast Enhancement with Robust Denoising” (Hanika, Damertz and Lensch 2011). In the image on the left, the edge curve was reduced to a minimum, effectively disabling the edge awareness. You can see that this results in halos. In the middle image, the edge spline was increased too much, and you can see that we get gradient reversals. The image on the right shows an image where the edge spline was placed somewhere in between the two extremes, which results in nice clean edges in the image.

Usually the default central position of the spline is a good starting point, but if there are objectionable artifacts around the edges, this control can be helpful in mitigating them.

8.2.18. crop & rotate

Crop, rotate, and correct perspective distortions using on-screen guides.

Whenever the user interface of this module is in focus, the full uncropped image will be shown, overlaid with crop handles and optional guiding lines.

Resize the crop by dragging the border and corner handles. Move the crop rectangle by clicking and dragging. Constrain movement to the horizontal/vertical axis by holding Ctrl/Shift, respectively while dragging. Commit changes by either giving focus to another module or by double-clicking on the image.

Note: Some of the tools in this module (angle adjustment and perspective distortion correction) require the original image data to be interpolated. For best sharpness results set “lanczos3” as the pixel interpolator in preferences > processing.

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module controls

The *crop and rotate* module controls are split between two tabs as follows:

main tab

flip

Flip the image on the horizontal, vertical or both axes.

angle

Correct the rotation angle to level an image by setting a numerical value in degrees or using the mouse. To use the mouse, right-click and drag to draw a line along a suitable horizontal or vertical feature. As soon as you release the mouse button the image is rotated so that the line you drew matches the horizontal or vertical axis.

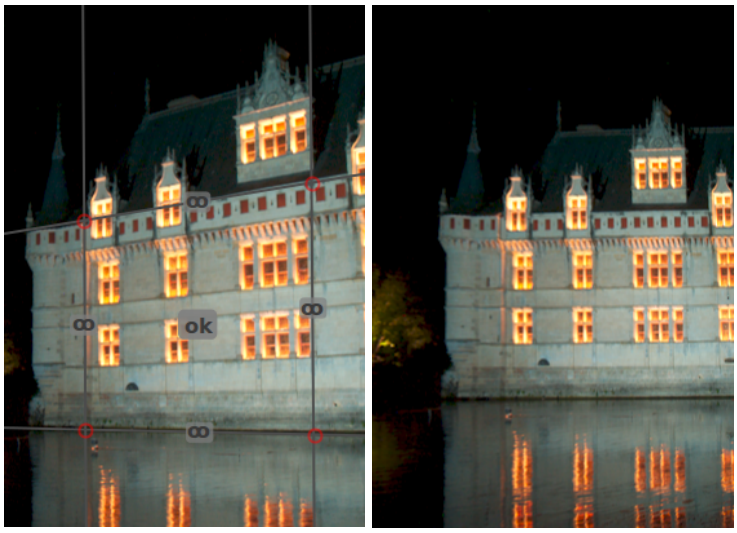
keystone

Correct perspective distortions. This tool is useful, for example, when you shoot a high building from the ground with a short focal length, aiming upwards with your camera. The combobox allows you to select the type of correction you want to use:

- *vertical*: Limit the correction to vertical lines
- *horizontal*: Limit the correction to horizontal lines
- *full*: Correct horizontal and vertical lines at the same time

Depending on the selected correction type you will see two or four straight adjustment lines overlaid on your image. Two red circles on every line allow you to modify the line positions with your mouse. Each line additionally carries a "symmetry" button. If activated (and highlighted in red) all movements of the affected line will be mirrored by the opposite line.

In order to correct perspective distortions, you need to find suitable horizontal and/or vertical features in your image and align the adjustment lines with them. When finished, press the "OK" button, located close to the center of your image. The image will be corrected immediately. You can at any time come back and refine your corrections by selecting "correction applied" in the keystone combobox.



automatic cropping

Automatically crop the image to avoid black edges on the image borders. This is useful when rotating the image.

aspect

Set the aspect ratio of the crop, constraining the width:height ratio of the crop rectangle to the chosen aspect. Many common numerical ratios are pre-defined. A few special aspect ratios deserve explanation:

- *freehand*: Crop without any ratio restrictions.
- *original image*: Retain the aspect ratio of the original image
- *square*: Constrains the aspect ratio to be 1:1
- *golden cut*: The golden ratio (1.62:1)

You can also select any other ratio after opening the combobox and typing it in the form of "x:y" or as a decimal (e.g. "0.5" to apply a ratio of 2:1). If you want to add an aspect ratio to the pre-defined drop-down list you can do this by including a line of the form "`plugins/darkroom/clipping/extra_aspect_ratios/foo=x:y`" in darktable's configuration file `$HOME/.config/darktable/darktablerc`. Here "`foo`" defines the name of the new aspect ratio and "x" and "y" the corresponding numerical values.

Finally, the button beside the aspect combobox allows you to switch between portrait and landscape orientation if you have selected a rectangular aspect ratio.

Note: When resizing an image in freehand mode you may retain the currently-set aspect ratio by holding Shift while dragging on any of the resize controls.

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guides

Overlay standard compositional guide lines on the image while cropping.

guides flip
If the chosen guidelines are not symmetrical relative to the image frame, you can flip them on the horizontal, vertical or both axes.

margins tab

These sliders allow you to directly set how much of the image to crop from each side. They are automatically updated if you move or resize the crop area on the image using the mouse.

left
The percentance of the image that should be cropped from the left side.
right
The percentance of the image that should be cropped from the right side.
top
The percentance of the image that should be cropped from the the top.
bottom
The percentance of the image that should be cropped from the bottom.

8.2.19. defringe

Remove color fringing, which often results from Longitudinal Chromatic Aberrations (LCA), also known as Axial Chromatic Aberrations.

This module uses edge-detection. Where pixels are detected as a fringe, the color is rebuilt from less saturated neighboring pixels.

module controls

operation mode
global average: This mode is is usually the fastest but might show slightly incorrect previews at high magnification. It might also protect the wrong regions of color too much or too little by comparison with local average.

local average: This mode is slower because it computes local color references for every pixel. However it might protect color better than global average and allows for rebuilding color where actually required.

static threshold: This mode does not use a color reference but directly uses the threshold as given by the user.

edge detection radius
The algorithm uses the difference between the input image and a gaussian-blurred version of the same image to detect edges. This parameter controls the spatial extent of the gaussian blur used in the edge detection. Try increasing this value if you want a stronger detection of the fringes or the thickness of the fringe edges is too high.
threshold
The threshold over which the edge of a pixel is counted as a “fringe”. Try lowering this value if there is not enough fringe detected and increasing it if too many pixels are desaturated.

8.2.20. demosaic

Control how raw files are demosaiced.

bayer filters

The sensor cells of a digital camera are not color-sensitive – they are only able to record different levels of lightness. In order to obtain a color image, each cell is covered by a color filter (red, green or blue) that primarily passes light of that color. This means that each pixel of the raw image only contains information about a single color channel.

These color filters are commonly arranged in a mosaic pattern known as a Bayer filter array. The demosaic algorithm reconstructs the missing color channels by interpolation with data of the neighboring pixels. For further reading see the Wikipedia articles on the Bayer filter and Demosaicing.

Demosaic interpolation algorithms are often prone to produce artifacts, which are typically visible as Moiré-like patterns when zooming into the image. Various demosaic algorithms have been developed in an attempt to overcome these artifacts. Currently darktable supports *PPG*, *AMaZE*, and *VNG4* demosaic algorithms for Bayer filters. *AMaZE* is reported to sometimes give slightly better results. However, since *AMaZE* is significantly slower, darktable uses *PPG* by default. *VNG4* produces the softest results of the three algorithms, but if you see “maze” artifacts with the other algorithms, try using *VNG4* to eliminate them.

sensors without bayer filters

There are a few cameras whose sensors do not use a Bayer filter. Cameras with an “X-Trans” sensor have their own set of demosaic algorithms. The default algorithm for X-Trans sensors is *Markesteijn 1-pass*, which produces fairly good results. For slightly better quality (at the cost of much slower processing), choose *Markesteijn 3-pass*. Though *VNG* is faster than *Markesteijn 1-pass* on certain computers, it is more prone to artifacts.

Additionally, darktable supports a special *passthrough (monochrome)* demosaic algorithm. This algorithm is only useful for cameras which have had the color filter array physically removed from the sensor (e.g. scratched off). Normally, demosaic algorithms reconstruct the missing color channels by interpolation with data of the neighboring pixels. However, if the color filter array is not present, there is nothing to interpolate, so this algorithm simply sets all the color channels to the same value, resulting in a monochrome image. This method therefore avoids the interpolation artifacts that the standard demosaic algorithms might produce.

module controls

method
The demosaic algorithm to use (see above).

edge threshold (*PPG* only)
The threshold for an additional median pass. Defaults to “0” which disables median filtering.

color smoothing
Activate a number of additional color smoothing passes. Defaults to “off”.

match greens
In some cameras the green filters have slightly varying properties. This parameter adds an additional equalization step to suppress artifacts. Available options are “disabled”, “local average”, “full average” and “full and local average”. This option is not shown for X-Trans sensors.

8.2.21. denoise (profiled)

An easy to use and highly efficient denoise module, adapted to the noise profiles of specific camera sensors.

One issue with a lot of denoising algorithms is that they assume that the variance of the noise is independent of the luminosity of the signal. By profiling the noise characteristics of a camera’s sensor at different ISO settings, the variance at different luminosities can be assessed, and the denoising algorithm can be adjusted to more evenly smooth out the noise.

Currently, darktable has sensor noise profiles for over 300 popular camera models from all the major manufacturers. If you generate your own noise profile for a camera that is not yet supported by darktable, be sure to share it with the darktable development team so they can include it in the next release! Please see darktable’s camera support page for more information.

modes

The *denoise (profiled)* module implements two main algorithms, each of which is available in either an easy-to-use “auto” mode or a more advanced mode, with additional controls:

non-local means

This algorithm works in the spatial domain in much the same way as the *astrophoto denoise* module. This algorithm averages each pixel with some surrounding pixels in the image. The weight of such a pixel in the averaging process depends on the similarity of its neighborhood with the neighborhood of the pixel being denoised. A patch with a defined size is used to measure that similarity.

Note that this algorithm is quite resource-intensive.

wavelets

This algorithm works in the wavelet domain, and provides a simplified user interface. Wavelet decomposition allows you to adjust the strength of the denoising depending on the coarseness of the noise in the image. This mode can be used in either *Y0U0V0 color mode* (which allows you to independently control luminance and chroma noise) or *RGB color mode* (which allows you to independently control noise for each RGB channel).

The wavelet algorithm is less resource-intensive than *non-local means*.

luma versus chroma noise

Both “non-local means” and “wavelet” algorithms can efficiently tackle luma (lightness) noise and chroma (color) noise.

In the past, it was suggested that you should use two separate instances of the *denoise (profiled)* module. The first instance would be used together with a color blending mode to tackle *chroma* noise, and the second instance with a lightness blending mode to tackle *luma* noise.

This isn’t really recommended any more, since the *denoise (profiled)* module occurs early in the pixel pipe, before the input color profile (in order that the profile parameters are accurate) but color blending modes should really only be used after the input color profile has been applied.

The new algorithms in this module now provide their own methods of dealing separately with luma and chroma noise, and in both cases this can be handled within a single module instance.

module controls

The *denoise (profiled)* module provides a few controls that are independent of the algorithm used. These are described first, before moving on to the algorithm-specific controls.

When describing the controls specific to an algorithm, we will first cover the simplified interface, and then move on to the more advanced controls for that algorithm.

Note that sliders are provided with minimum and maximum values by default. However these are only soft limits and, where needed, higher values can be entered by right-clicking on the slider and using the keyboard.

common controls

profile

darktable will automatically determine the camera model and ISO based on Exif data of your raw file. If found in its database, the corresponding noise profile will be used. If your image has an intermediate ISO value, the statistical properties will be interpolated between the two closest datasets in the database, and this interpolated setting will show up as the first line in the combo box. You can also manually override this selection if necessary. Re-selecting the top-most entry in the combo box will return you to the default profile.

mode

Choose which denoising algorithm to use (see above), and whether to present the simplified (“auto”) or full manual interface for that algorithm.

whitebalance-adaptive transform

As white balance amplifies the RGB channels differently, each channel exhibits different noise levels. This checkbox makes the selected algorithm adapt to the white balance. This option should be disabled on the second instance if you have used a first instance with a color blend mode.

adjust autoset parameters (auto mode only)

Automatically adjust all the other parameters on the current denoising algorithm using a single slider interface. This is particularly useful when you have had to increase the exposure on an under-exposed image, which normally introduces additional noise as if you had taken the shot with a higher ISO. This control compensates for that by using settings similar to what it would use for a higher ISO image. In general, the value of this slider indicates the number of stops by which you had to increase the exposure. For example, if you had to push the exposure 2 stops above what you normally use, then set this slider to 2.

strength

Fine-tune the strength of the denoising. The default value has been chosen to maximize the peak signal to noise ratio. It's mostly a matter of taste if you prefer a rather low noise level at the costs of a higher loss of detail, or if you accept more remaining noise in order to have finer structures better preserved within your image.

In the case of *wavelets* mode, the default value of this slider may not be sufficient. If you do not set a high enough strength, then adjusting the wavelet curves above it will not have a large enough effect. It is therefore recommended that you set a reasonably high strength on this slider, and than make finer adjustments on the wavelet curves. Don't hesitate to right-click and enter a higher value if the default soft limit for this slider doesn't allow for enough denoising.

preserve shadows (advanced mode only)

Choose whether to denoise the shadows more agressively. Lower the value to denoise the shadows more. Usually, as noise increases, you will need to lower this value.

bias correction (advanced mode only)

Correct any color cast that may appear in the shadows. Increase this value if dark shadows appear too greenish, decrease it if they appear purple-ish.

non-local means auto sliders

central pixel weight (details)

Control the amount of detail that should be preserved by the denoising algorithm. By default, this will have a low value, meaning that the algorithm will treat both luma and chroma noise equally. Moving this slider to the right will reduce the amount of luma denoising, so that the denoising will primarily affect chroma noise. By adjusting this slider together with the *strength* slider, you can find a good balance in the amount of luma versus chroma denoising.

non-local means advanced sliders

When you take non-local means out of auto mode, the *adjust autoset parameters* slider will be replaced by the following controls. You can use the auto-adjust slider to arrive at some initial settings then, when you switch to manual mode, the sliders will show the set of manual settings that are equivalent to that auto-adjust setting. You can then continue to fine-tune the manual settings using the initial auto setting as a starting point.

patch size

Control the size of the patches being matched when deciding which pixels to average – see *astrophoto denoise*. Set this to higher values as the noise gets higher. Be aware that high values may smooth out small edges. The effect of this slider on processing time is minimal.

search radius

Control how far away from a pixel the algorithm will try to find similar patches. Increasing the value can give better results for very noisy images when coarse grain noise is visible, but the processing time is hugely impacted by this parameter (the processing time is in the order of the square of this parameter). A lower value will make execution faster, a higher value will make it slower. It most cases it is better to use the scattering parameter, which has a similar effect but without the heavy processing cost.

scattering (coarse-grain noise)

Like the *search radius*, this slider controls how far from a pixel the algorithm will try to find similar patches. However, it does this without increasing the number of patches considered. As such, processing time will stay about the same. Increasing the value will reduce coarse grain noise, but may smooth local contrast. This slider is particularly effective at reducing chroma noise.

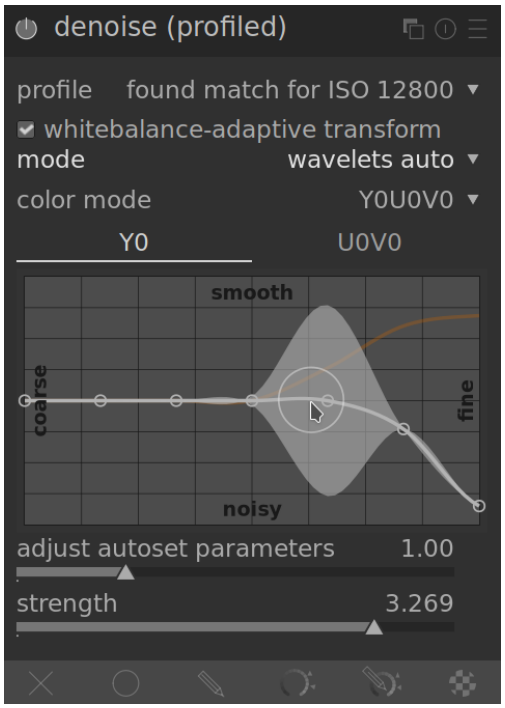
wavelet curves

These curves are only available if the “wavelet” mode is selected. The noise in an image usually consists of both fine grain and coarse grain noise, to varying degrees. These curves allow the strength of the denoising to be adjusted depending on the coarseness of the visible noise. The left end of the curve will act on very coarse grain noise, while the right of the curve will act on very fine grain noise. Pushing up the curve will increase the amount of smoothing, whereas pulling it down will decrease the amount of smoothing.

For example, you can preserve very-fine-grain noise by pulling the right-most part of the curve down towards the bottom. If you were tackling chroma noise (eg. on a U0V0 curve, or on a second module instance with a color blend mode) you could push the right side of the curve up towards the top, since colors are not supposed to change a lot on fine grain scales. This can be useful if you see some noisy isolated pixels with the wrong color.

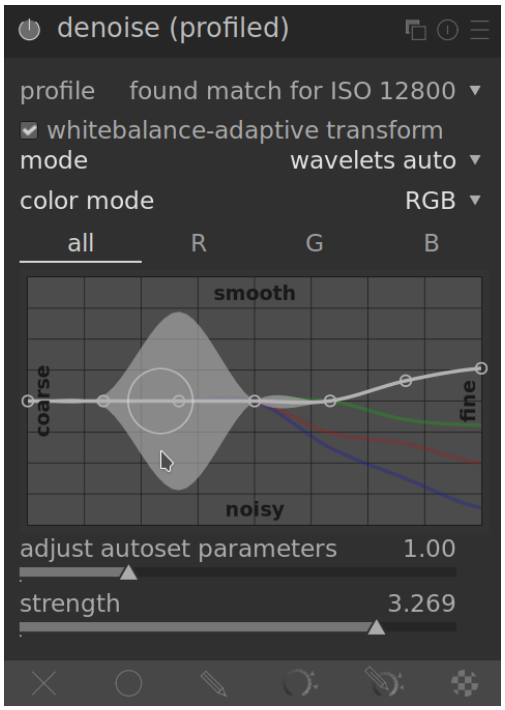
wavelets *Y0U0V0* color mode

The preferred way to use wavelets is with the new *Y0U0V0 color mode*. This separates the denoising curves into luminance (*Y0*) and color (*U0V0*) components. You can then use the *Y0* curve to control the level of luma denoising at different scales, and the *U0V0* curve to control the level of chroma denoising at different scales.



wavelets *RGB* color mode

Before the *Y0U0V0 color mode*, wavelet-based denoising could only be performed directly on the *R*, *G* and *B* channels, either all together in one go, or on an individual channel basis.



If you want to denoise the channels separately, the best way to do this is to use an instance of the *color calibration* module immediately before the *denoise (profiled)* module so that it outputs a grey channel based on the *red* channel only, then denoise that monochrome image using the *red* wavelet curve. Repeat this procedure for the blue and green channels. This procedure is time-consuming, but gives the best result because looking at the color of a noisy pixel is not a reliable way to determine which channel to adjust (e.g. a noisy red pixel could be due to a noise peak on the red channel, but could also be due to a noise lull on the blue and green channels).

The issue with denoising the *RGB* channels individually like this is that there can still be some residual chroma noise at the end that requires excessive smoothing to eliminate. This was in fact one of the key motivations behind implementing the *Y0U0V0 color mode*.

wavelets advanced sliders

When you take *wavelets* out of *auto* mode, the *adjust autoset parameters* slider will be replaced by the *preserve shadows* and *bias correction* controls listed above in the *common controls* section.

8.2.22. dithering

This module eliminates some of the banding artifacts that can result when darktable's internal 32-bit floating point data is transferred into discrete 8-bit or 16-bit integer output format for display or export.

Although not an inherent problem in any of darktable's modules, some operations may provoke banding if they produce a lightness gradient in the image. To mitigate possible artifacts you should consider activating dithering when using the *vignetting* or *graduated density* modules. This is especially relevant for images with extended homogeneous areas such as cloudless sky. Also watch out for banding artifacts when using a gradient drawn mask.

Viewing an image dithered into a very low bit depth from some distance (e.g. "floyd-steinberg 1-bit b&w") will give the impression of a homogeneous grayscale image. darktable attempts to mimic this impression when rendering zoomed-out images in the center view, the navigation window and thumbnails. This is accomplished by dithering those images into a higher number of grayscale levels. Note that, as a consequence, the histogram – which is derived from the navigation window – will show this increased number of levels and is therefore not a full match to the output image.

module controls

method
Choose the dithering method to use.

floyd-steinberg: Systematically distribute quantization errors over neighboring pixels. This method can be selected with some typical output bit depths. Alternatively, you can select *floyd-steinberg auto*, which automatically adapts to the desired output format.

random dithering: This method just adds some level of randomness to break sharp tonal value bands.

damping (“random” method only)
Controls the level of added random noise expressed as a damping factor in a 10*log 2 basis. A value of -80 is a good fit for 8-bit output formats; -160 for 16-bit output.

8.2.23. exposure

Increase or decrease the overall brightness of an image.

This module has two modes of operation:

manual
Set the *exposure*, *black level* and *clipping threshold* manually
automatic (RAW images only)
Use an analysis of the image’s histogram to automatically set the exposure. Darktable automatically selects the exposure compensation that is required to shift the selected *percentile* to the selected *target level* (see definitions below). This mode is particularly useful for automatically altering a large number of images to have the same exposure. A typical use case of automatic mode is deflickering of time-lapse photographs.

module controls

mode
Choose the mode of operation (automatic/manual)
compensate camera exposure (manual mode)
Automatically remove the camera exposure bias (taken from the image’s Exif data)
exposure (manual mode)
Increase (move to the right) or decrease (move to the left) the exposure value (EV)
clipping threshold (manual mode)
Define what percentage of bright values are to be clipped in the calculation of the *exposure* and *black level correction*. Use the color picker to sample a portion of the image to be used for this calcuation.
percentile (automatic mode)
Define a location in the histogram to use for automatic exposure correction. A percentile of 50% denotes a position in the histogram where 50% of pixel values are above and 50% of pixel values are below that exposure.
target level (automatic mode)
Define the target level for automatic exposure correction (EV) relative to the white point of the camera.
black level correction (manual and automatic modes)
Adjust the black level point to unclip negative RGB values.

Note: Do not use the black level correction to add more density in blacks as this can clip near-black colors out of gamut by generating negative RGB values. This can cause problems with some modules later in the pixelpipe. Instead, use a tone mapping curve to add density to the blacks (e.g. use the *relative black exposure* slider on the *scene* tab of filmic rgb, or establish a deeper toe in base curve).

8.2.24. fill light (deprecated)

Please note that this module is deprecated in darktable 3.4 and should no longer be used for new edits. Please use the *tone equalizer* module or the *exposure* module with a drawn mask.

Locally modify exposure based on pixel lightness.

This module pushes exposure by increasing lightness with a Gaussian curve of a specified width, centered on a given lightness.

module controls

exposure
The fill-light exposure (EV)

center
The median lightness impacted by the fill-light. The lightness must be set manually but a color picker can be used to provide a guide based on a sample from the image. The lightness of the selected point/area is displayed in the gradient bar.

width
The width of the Gaussian curve. This number is expressed in zones, with the full range being 10 zones.

8.2.25. filmic rgb

Remap the tonal range of an image by reproducing the tone and color response of classic film. This module can be used either to expand or to contract the dynamic range of the scene into the dynamic range of the display.

This module protects colors and contrast in the mid-tones, recovers the shadows, and compresses bright highlights and dark shadows. Highlights will need extra care when details need to be preserved (e.g. clouds).

The module is derived from a module of the same name in Blender 3D modeller by T. J. Sobotka. While it is primarily intended to recover high-dynamic-range images from raw sensor data it can be used with any image in place of the *base curve* module. The developer has provided a detailed explanation of the module in a video: filmic rgb: remap any dynamic range in darktable 3.

filmic rgb is the successor to the *filmic* module from darktable 2.6.x. While the underlying principles have not changed much, the default settings and their assumptions have, so users of the previous version should not expect a 1:1 translation of their workflow to the new version.

Note: Despite the technical look of this module, the best way to set it up is to assess the quality of the visual result. Do not overthink the numbers that are put in the GUI to quantify the strength of the effects.

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prerequisites

In order to get the best from this module, your images need some preparation:

capturing (ETTR)
In-camera, it is recommended that you use a technique known as “Expose To The Right” (ETTR). This means exposing the shot so that the exposure is as bright as possible without clipping the highlights. It is called “exposing to the right” because the in-camera histogram should be touching all the way up to the right hand side without peaking at the right hand side (which could indicate clipping). This technique ensures you make maximum use of the dynamic range of your camera’s sensor.

The default auto-exposure metering mode in your camera will normally expose the image so that the average brightness in the image tends towards middle grey. Sometimes, for scenes dominated by light tones (e.g. snowy scenes), the camera will underexpose the image to bring those light tones more towards middle grey. For scenes dominated by dark tones, it may over-expose the image and end up clipping the highlights. In such cases you can use the exposure compensation dial in your camera to raise or lower the exposure – the darktable exposure module can take this into account when processing your image.

In some cases, such as for specular highlights reflecting off shiny objects, it may be acceptable to have some clipping, but be aware that any clipped data in your image is irrevocably lost. Where data has been clipped, *filmic rgb* offers a “highlight reconstruction” feature to help mitigate the effects of the clipping and blend it smoothly with the rest of the image. The settings for this feature are on the *reconstruct* tab. It is also helpful to know that some cameras offer a “highlight priority” exposure metering mode that can help to maximise exposure while protecting the highlights, and many offer features such as “zebras” or “blinkies” to help alert the photographer when parts of the image are being clipped.

adjust for the mid-tones

In the *exposure* module, adjust the exposure until the midtones are clear enough. Do not worry about losing the highlights when setting exposure - they will be recovered as part of the filmic processing. However, it is important to avoid negative pixels in black areas else the computations performed by *filmic rgb* will result in unpredictable results. For some camera models (Canon, mainly), rawspeed (the raw decoding library of darktable) may set an exaggerated black level, resulting in crushed blacks and negative pixel values. If so, brighten the blacks by setting a negative black level correction value in the *exposure* module.

white balance, denoise, demosaic

If you plan on using *filmic rgb*'s auto-tuners, use the *white balance* module to first correct any color casts and obtain neutral colors. In RGB color spaces, luminance and chrominance are linked, and *filmic rgb*'s luminance detection relies on accurate measurements of both. If your image is very noisy, add an initial step of denoising to improve the black exposure readings, and use a high quality *demosaicing* method. You do not need to worry about noise if you are planning to set up filmic manually, without using the auto-tuners.

disable tone mapping modules

If you plan to use one of *filmic rgb*'s chrominance preservation modes, avoid using *base curve* and the various tone mapping modules. These may produce unpredictable color shifts that would make the chrominance preservation useless. None of these modules should be required when using *filmic rgb*.

usage

The *filmic rgb* module aims at mapping the dynamic range of the photographed scene (RAW image) to the dynamic range of the display.

This mapping is defined in three steps, each handled in a separate tab in the interface:

- The *scene* tab contains the "input" settings of the scene, defining what constitutes middle grey, white and black in the photographed scene.
- The *reconstruct* tab offers some tools to handle blown highlights in the image.
- The *look* tab contains the artistic intent of the mapping that is applied to the input parameters (defined in the scene tab). Notably, this part of the module applies an S-shaped parametric curve to enhance the contrast of the mid-tones and remap the grey value to the middle grey of the display. This is similar to what the *base curve* and *tone curve* modules do. As a general guideline, you want to increase the latitude as much as possible without clipping the extremes of the curve.
- The *display* tab defines the output settings required to map the transformed image to the display. In typical use cases, the parameters in this tab will rarely require adjustment.
- The *options* tab includes some optional advanced settings and parameters.
- *filmic rgb* tends tends to compress local contrast, so after you have set up *filmic rgb* you may want to compensate for this using the *local contrast* module. You may also want to increase the saturation in the *color balance* module, and maybe further adjusts the tones using *tone equalizer*.

The ranges of *filmic rgb*'s sliders are limited to usual and safe values, but you can enter values outside of these limits by right-clicking and entering values with the keyboard.

Note: *filmic rgb* cannot be set with entirely neutral parameters (resulting in a "no-operation") – as soon as the module is enabled, the image is always at least slightly affected. You can, however, come close to neutral with the following settings:

- in the *look* tab, set contrast to 1.0, latitude to 99 % and middle tones saturation to 0 %,
- in the *options* tab, set contrast in shadows and in highlights to *soft*.

In this configuration, filmic will only perform a logarithmic tone mapping between the bounds set in the *scene* tab.

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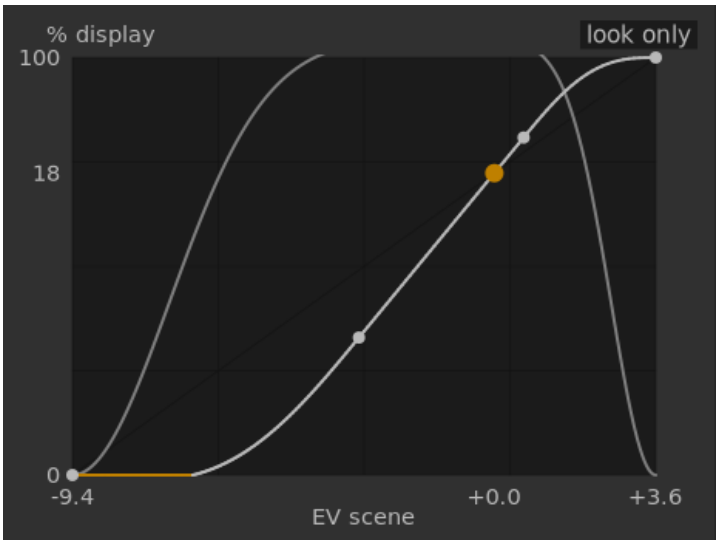
graphic display

The graphic display of the *filmic rgb* module now offers multiple views. You can cycle through the different views using the  icon to the right of the graph display. You can also toggle the labels on the axes on and off using the  icon. The available displays are:

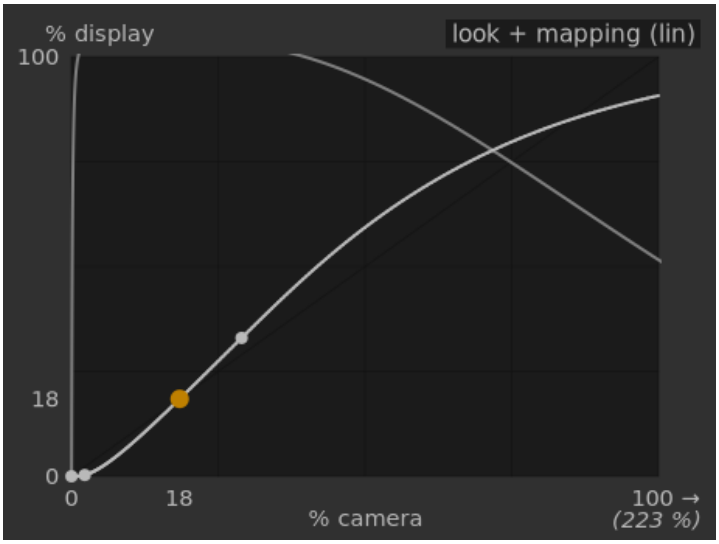
look only

This is the traditional graph provided by *filmic rgb*. The main bright curve shows how the dynamic range of scene (in EV) is compressed into the display-referred output range. The orange dot shows the middle grey point, the white dots either side mark out the latitude range, and the organge part of the curve at the bottom indicates an overshoot problem with the spline (the *look* tab in the *module controls* section has some controls to deal with this). The darker curve shows how the color saturation is rolled off in the highlights and shadows extremes.



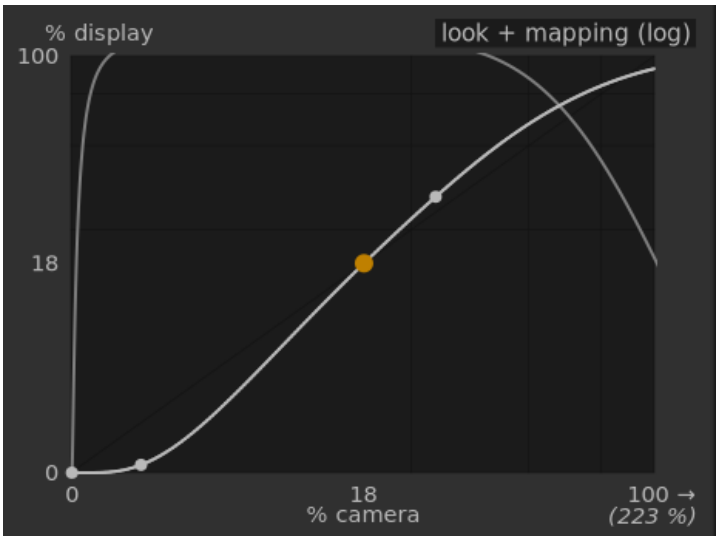
look + mapping (linear)

This view shows the mapping of input values [0,1] to output values in linear space, including the dynamic range mapping and the output transfer function. Note that in a scene-referred workflow, input values are allowed to exceed 1, however the graph only shows in/out values in the interval [0,1] in order to make the shape of the graph comparable to other tone curve mapping tools such as *base curve* or *tone curve*. The actual value of the scene white point is shown in brackets on the *X axis* (expressed as a percentage of an input value of 1).



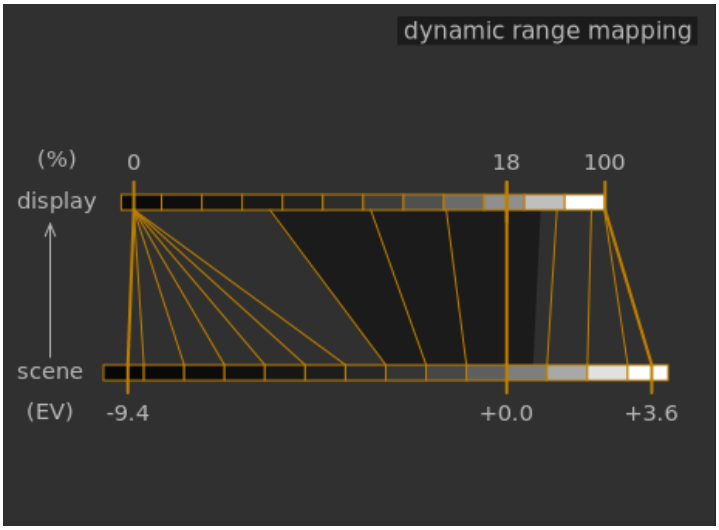
look + mapping (log)

The same as the previous view, but plotted in log space.



dynamic range mapping

This view is inspired by the Ansel Adams Zone System, showing how the EV zones in the input scene are mapped to the output. Middle grey from the scene is always mapped to 18% in the output (linear) space, and it shows how the tonal ranges towards the extremes of the scene exposure range are compressed into a smaller number of zones in the display space, leaving more room for the mid-tones to be spread out over the remaining zones. The latitude range is represented by the darker grey portion in the middle.



module controls

scene

The controls of the *scene* tab are similar in principle to those of the *levels* module (black, grey, white). The difference is that *levels* assume display-referred pixels values (between 0 and 100%), while *filmic* allows you to work on scene-referred pixels (between -infinity EV and + infinity EV), which forces the use of a different interface.

middle-grey luminance (hidden by default)

It is not recommended that you use this control, hence it is now hidden by default. You should instead use the *exposure* module to set the mid-grey level (see *usage*, above). However, if you want to make this slider visible, enable the *use custom mid-grey values* checkbox in the *options* tab.

This setting lets you decide what luminance in the scene should be considered the reference middle grey, which will be remapped to 18% in display. Use the color picker tool to read the average luminance over the drawn area. If you have a photograph of a grey card or a color chart (IT8 chart or colorchecker) shot in the scene lighting conditions, then the grey color picker tool can be used to quickly sample the luminance of the grey patch on that image. In other situations, the color picker can be used to sample the average luminance of the subject.

It has an effect on the picture that is analogous to a brightness correction. Values close to 100% do not compress the highlights but fail to recover shadows. Values close to 0% greatly recover the shadows but compress the highlights more harshly and result in local-contrast losses.

When modifying the middle-grey luminance, the white and black exposures are automatically adjusted accordingly, to prevent the dynamic range from clipping and to help you set the right parameter faster. If you are not happy with the auto adjustment performed by the grey slider, you can correct the white and black exposure parameters afterwards.

white relative exposure

The number of stops (EV) between the scene middle grey luminance and the scene luminance that is to be remapped to display pure white (peak-white). This is the right bound of the scene dynamic range that will be represented on the display – everything brighter than this value on the scene will be clipped on the display. The color picker tool reads the maximum luminance in RGB space over the drawn area, assumes it is pure white, and sets the white exposure parameter to remap the reading to 100% luminance.

black relative exposure

The number of stops (EV) between middle grey luminance and the scene luminance that is to be remapped to display pure black (maximum density). This is the left bound of the scene dynamic range that wll be represented on the display – everything darker than this value on the scene will be clipped on display. The color picker tool reads the minimum luminance in RGB space over the drawn area, assumes it is pure black, and sets the black exposure parameter to remap the minimum reading to 0% luminance. The black color picker measurement is very sensitive to noise, and cannot identify whether the minimum luminance is pure black (actual data) or just noise. It works better on low ISO pictures and with high quality demosaicing. When the color picker puts the black exposure at -16EV, it is a sign that the measurement has failed and you will need to adjust it manually.

The black relative exposure allows you to choose how far you want to recover lowlights.

dynamic range scaling and auto-tune

The auto-tune color picker combines all three color pickers above, and allows you to set the grey, white and black exposures all at once, using the average of the drawn region as the grey estimation, the maximum as the white, and the minimum as the black. This gives good results in landscape photography but usually fails for portraits and indoor scenes.

When no true white and no true black are available on the scene, the maximum and minimum RGB values read on the image are not valid assumptions any more, so the dynamic range scaling symmetrically shrinks or enlarges the detected dynamic range and the current parameters. This works with all color pickers, and adjusts the current values of white and black relative exposures.

Note: There is no direct relationship between your camera sensor’s dynamic range (to be found in DxoMark.com or PhotonsToPhotos.org measurements) and the dynamic range in filmic (scene white EV - scene black EV). Many things happen before *filmic* in the pipeline, amongst them a black raw offset that could map black to 0, such that *filmic* sees a theoretically infinite dynamic range at its input (which has to do only with pixel encoding manipulation in software, not actual sensor capabilities).

The *scene-referred* workflow forces a black level correction of -0.0002, in the *exposure* module, which ensures that the dynamic range seen by *filmic’s* input is around 12.3 EV most of the time. Decrease this value even more if setting the black relative exposure in *filmic* to -16 EV fails to unclip blacks.

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reconstruct

This tab provides controls that will help to blend transisitons between unclipped and clipped areas within an image and can also help to reconstruct colors from adjacent pixels. It is designed to deal with spotlights that could not possibly be unclipped when taking the shot (such as naked light bulbs or the sun disc when they are in the frame) and aims at diffusing their edges as film would do. It is not designed to recover large areas of clipped pixels or in-paint missing parts of the image.

Firstly, a mask needs to be set up to identify the areas of the image that will be affected by the highlights reconstruction. Then there are some controls to fine-tune some of the tradeoffs made by the reconstruction algorithm.

highlights clipping

These controls allow you to choose which areas of the image are impacted by the highlight reconstruction algorithms.

threshold
Any pixels brighter than this threshold will be affected by the reconstruction algorithm. The units are in EV, and are relative to the white point set in the *scene* tab. By default, this control is set to +3 EV, meaning that pixels need to be at least +3 EV brighter than the white point set in the scene tab in order for the highlight reconstruction to have any effect. In practise, this means that highlight reconstruction is effectively disabled by default (for performance reasons it should only be enabled when required). Therefore, to use the *filmic rgb highlights reconstruction* feature, first click the *display highlight reconstruction mask* icon to show the mask, and lower this threshold until the highlight areas you want to reconstruct are selected in white by the mask. It may be useful to first review the image using the raw overexposed warning to show you which pixels in the raw file have been clipped, and whether those pixels are clipped on just one RGB channel or all of them.

transition
Use this control to soften the transition between clipped and valid pixels. Moving this control to the right will increase the amount of blur in the mask, so that the transition between clipped and non-clipped areas is softer. This will allow for a smoother blending between the clipped and non-clipped regions. Moving this control to the left will reduce the blur in the mask, making the transition in the mask much sharper and therefore reducing the amount of feathering between clipped and non-clipped areas.

display highlight reconstruction mask
Click on the icon to the right of this label to toggle the display of the highlight reconstruction mask. It is recommended that you turn this on while adjusting the above controls.

balance

These controls allow you to balance the trade-offs between the various reconstruction algorithms.

structure/texture
Use this to control whether the reconstruction algorithm should favor painting in a smooth color gradient (structure), or trying to reconstruct the texture using sharp details extracted from unclipped pixel data. By default, the control is in the middle at 0%, which favors both strategies equally. If you have lots of areas where all three channels are clipped, there is no texture detail available to reconstruct in those clipped areas, so it is better to move the slider to the left to favor color reconstruction. If you have lots of areas where only one or two channels are clipped, then there may be some texture detail in the unclipped channel(s), and moving the slider to the right will place more emphasis on trying to reconstruct texture using this unclipped data.

bloom/reconstruct
Use this to control whether the algorithm tries to reconstruct sharp detail in the clipped areas, or whether it should apply a blur that approximates the blooming effect you get with traditional film. By default, this is set to 100% which tries to maximise the sharpness of the detail in the clipped areas. Move this slider to the left if you want to introduce more blur in these areas. Introducing more blur will usually tend to darken the highlights as a by-product, which may lead to a more colorful reconstruction.

grey/colorful details
Use this to control whether the algorithm favors the recovery of monochromatic highlights or colorful highlights. Move the slider to the right if you want more color in the highlights. Move the slider to the left if you want to reduce the saturation of the highlights. It can be helpful to reduce the saturation in the highlights if you see start seeing magenta or out-of-gamut colors.

look

When working on the *look* tab, it is recommended that you monitor the S-curve spline on the *look only* graph. This curve starts from the scene/display black levels at the bottom left of the graph, and should smoothly increase up to the scene/display white levels at the top right. Sometimes, if the constraints on the S-curve are too tight, the splines in the shadows and/or highlights regions can “overshoot” the limits of the display, and an orange warning is shown on those parts of the spline.

If you see the orange warning indicator at either end of the S-curve, corrective actions should be performed to bring the S-curve back to a smooth monotonically increasing curve. This may involve:

- reducing the latitude and/or contrast,
- adjusting the shadows/highlights slider to shift the latitude and allow more room for the spline,
- ensuring that the scene-referred black and white relative exposure sliders on the *scene* tab have been properly set for the characteristics of the scene,
- setting one or both of the contrast settings on the *filmic rgb options* tab to *hard*.

If the *target black luminence* setting on the *display* tab is non-zero, this can also make it difficult for *filmic rgb* to find a smooth monotonic spline, and reducing this can also help to relax the constraints. See the *display* section to understand the implications of this.

contrast

The *filmic rgb* S-curve is created, from the user parameters, by computing the position of virtual nodes and interpolating them. This is similar to how the tone curve module operates, but here, the nodes cannot be moved manually. The curve is split into three parts – a middle linear part, and two extremities that transition smoothly from the slope of the middle part to the ends of the exposure range.

The contrast slider controls the slope of the middle part of the curve, as illustrated in the graph display. The larger the dynamic range is, the greater the contrast should be set to, in order preserve a natural-looking image. This parameter mostly affects mid-tones. Note here that global contrast has an impact on the acutance, which is the perceived sharpness. A low-contrast image will look unsharp even though it is optically sharp in the sense of the MTF.

Setting the contrast to 1 almost completely disables the S-curve, though there will be a very small residual effect from the splines in the highlights and shadows.

hardness (previously *target power factor function*)

Previously the *target power factor function* slider in older versions of *filmic rgb*, this slider is hidden by default, and is set automatically based on other values provided in the *scene* tab. To make this slider visibile, you need to uncheck *auto adjust hardness* in the *options* tab.

This parameter is the power function applied to the output transfer function, and it is often improperly called the *gamma* (which can mean too many things in imaging applications, so we should stop using that term). It is used to raise or compress the mid-tones to account for display non-linearities or to avoid quantization artifacts when encoding in 8 bit file formats. This is a common operation when applying ICC color profiles (except for linear RGB spaces, like REC 709 or REC 2020, which have a linear “gamma” of 1.0). However, at the output of *filmic rgb*, the signal is logarithmically encoded, which is not something ICC color profiles know to handle. As a consequence, if we let them apply a gamma of 1/2.2 on top, it will result in a double-up, which would cause the middle-grey to be remapped to 76% instead of 45% as it should in display-referred space.

latitude

The latitude is the range between the two nodes enclosing the central linear portion of the curve, expressed as a percentage of the dynamic range defined in the scene tab (white-relative-exposure minus black-relative-exposure). It is the luminance range that is remapped in priority, and it is remapped to the luminance interval defined by the contrast parameter. It is usually advisable to keep the latitude as large as possible, while avoiding clipping. If clipping is observed, you can compensate for this effect by either decreasing the latitude, shifting the latitude interval with the *shadow/highlights balance* parameter, or decreasing the contrast.

The latitude also defines the range of luminances that are not desaturated at the extremities of the luminance range (See *extreme luminance saturation*).

shadows/highlight balance

By default, the latitude is centered in the middle of the dynamic range. If this produces clipping in one part of the other of the curve, the balance parameter allows you to slide the latitude along the slope, towards the shadows or towards the highlights. This allows more room to be given to one extremity of the dynamic range than to the other, if the properties of the image demand it.

middle tones saturation (previously *extreme luminance saturation*)

At extreme luminances, the pixels will tend towards either white or black. Because neither white nor black have color associated with them, the saturation of these pixels must be 0%. In order to gracefullly transition towards this 0% point, pixels outside the midtone latitude range are progressively desaturated as they approach those extremes. The darker curve in the *filmic rgb* graph indicates the amount of desaturation being applied to pixels falling outside the latitude range. Moving the slider to the right pushes the point where desaturation will start to be applied towards the extremes, resulting in a steeper desaturation curve (if pushed too far, this can result in fringing around the highlights). Moving the slider to the left brings the point at which color desaturation will start to be applied closer to the center, resulting in a gentler desaturation curve. If you would like to see more color saturation in the highlights, and you have checked that the white relative exposure in the *scene* tab is not yet clipping those highlights, move the middle tones saturation slider to the right to increase the saturation.

Please note that this desaturation strategy has changed compared to previous versions of *filmic rgb* which provided a different slider control labelled *extreme luminance saturation*. You can revert to the previous desaturation behaviour by selecting “v3 (2019)” in the *color science* setting on the *options* tab.

display

The parameters in this tab will only rarely require adjustment.

target black luminance

The destination parameters set the target luminance values used to remap the tones through *filmic rgb*. The default parameters will work 99% of the time, the remaining 1% being when you output in linear RGB space (REC709, REC2020) for media handling log-encoded data. These settings should therefore be used with caution because darktable does not allow separate pipelines for display preview and file output.

The target black luminance parameter sets the ground-level black of the target medium. By default it is set to the minimum non-zero value that can be encoded by the available number of bits in the ouput color space. Reducing it to zero means that some non-zero luminences will be mapped to 0 in the output, potentially losing some detail in the very darkest parts of the shadows. Increasing this slider will produce raised, faded blacks that can provide something of a “retro” look.

target middle-grey

This is the middle-grey of the output medium that is used as a target for the *filmic rgb* S curve central node. On gamma corrected media, the actual grey is computed with the gamma correction (middle-grey^(1/gamma)), so a middle-grey parameter of 18% with a gamma of 2.2 gives an actual middle-grey target of 45.87%.

target white luminance

This parameter allows you to set the ceiling level white of the target medium. Set it lower than 100% if you want dampened, muted whites to achieve a retro look.

To avoid double-ups and washed pictures, *filmic rgb* applies a “gamma” compression reverting the output ICC gamma correction, so the middle-grey is correctly remapped at the end. To remove this compression, set the destination power factor to 1.0 and the middle-grey destination to 45%.

options

color science

This setting defaults to *v4 (2020)* for new images, and defines the algorithms used by the *filmic rgb* module (such as the extreme luminance desaturation strategy). To revert to the behaviour of previous versions of *filmic rgb*, set this parmaeter to *v3 (2019)*. If you have previously made edits to an image using older versions of *filmic rgb*, this will already be set to *v3 (2019)* in order to provide backward compatibility for those edits.

preserve chrominance

Define how the chrominance should be handled by *filmic rgb* – either not at all, or using one of the three provided norms.

When applying the S-curve transformation independently on each color, the proportions of the colors are modified, which modifies the properties of the underlying spectrum, and ultimately the chrominance of the image. This is what happens if you choose “no” in the preserve chrominance parameter. This value may yield seemingly “better” results than the other values, but it may negatively impact later parts of the pipeline, when it comes to global saturation, for example.

The other values of this parameter all work in a similar way. Instead of applying the S-curve to the channels R, G and B independently, *filmic rgb* uses a norm (N), divides all the three components by that norm, and applies the S-curve to N. This way, the relationship between the channels is preserved.

The different values of the preserve chrominance parameter indicate which norm is used (the value used for N):

- *no* means that the ratios between the RGB channels are not preserved. It will tend to saturate the shadows and desaturate the highlights. It can be helpful when there are out-of-gamut blues or reds.
- *max RGB* is the maximum value of the three channels R, G and B. This is the same behaviour as the previous version of the *filmic rgb* module. It tends to darken the blues, especially skies, and to yield halos/fringes, especially if some channels are clipped. It can also flatten the local contrast somewhat.
- *luminance Y* is a linear combination of the three channels R, G and B. It tends to darken and increase local contrast in the reds, and tends not to behave so well with saturated and out-of-gamut blues.
- *RGB power norm* is the sum of the cubes of the three channels R, G, and B, divided by the sum of their squares - that is to say, $(R^3 + G^3 + B^3)/(R^2 + G^2 + B^2)$. It is usally a good compromise between the max RGB and the luminance Y values.
- *RGB euclidean norm* has the property of being RGB-space-agnostic, so it will yeild the same results regardless which working color profile is used. It weighs more heavily on highlights than the power norm and gives more highlights desaturation, and is probably the closest to color film look.

There is no “right” choice for the norm, and the appropriate choice depends strongly on the image to which it is applied - you should experiment and decide for yourself which setting gives the most pleasing result with the fewest artifacts.

contrast in highlights

This control selects the desired curvature at the highlights end of the *filmic rgb* spline curve. Selecting *hard* (default) places a tighter constraint on the slope of the spline, which makes the curve sharper and hence introduces more tonal compression in the highlights. Selecting *soft* loosens this constraint, resulting in a gentler curve with less tonal compression in the highlights.

contrast in shadows

This control selects the desired curvature at the shadows end of the *filmic rgb* spline curve. Selecting *hard* (default) places a tighter constraint on the slope of the spline, which makes the curve sharper and hence introduces more tonal compression in the shadows. Selecting *soft* loosens this constraint, resulting in a gentler curve with less tonal compression in the shadows.

use custom middle-grey values

Enabling this setting makes the *middle-grey luminance* slider visible on the *scene* tab. With this new edition of *filmic rgb*, it is now recommended to use the *exposure* module to set the middle-grey level, so this setting is disabled by default (and the *middle-grey luminance slider* is hidden).

auto-adjust hardness

By default, this setting is enabled, and *filmic rgb* will automatically calculate the power function (aka “gamma”) to be applied on the output transfer curve. If this setting is disabled, a *hardness* slider will appear on the *look* tab so that value can be manually set.

iterations of high-quality reconstruction

Use this setting to increase the number of passes of the *filmic rgb* highlight reconstruction algorithm. More iterations means more color propagation into clipped areas from pixels in the surrounding neighbourhood. This can produce more neutral highlights, but it also costs more in terms of processing power. It can be useful in difficult cases where there are magenta highlights due to channel clipping.

The default reconstruction works on separate RGB channels and has only one iteration applied, whereas the *high quality* reconstruction uses a different algorithm that works on RGB ratios (which is a way of breaking down chromaticity from luminance) and can use several iterations to graduately propagate colors from neighbouring pixels in clipped areas. However, if too many iterations are used, the reconstruction can denegenerate, which will result in far colors being improperly inpainted into clipped objects (color bleeding), such as white clouds being inpainted with blue sky, or the sun disc shot through trees being inpainted with leaf green.

add noise in highlights
This artificially introduces noise into the reconstructed highlights to prevent them from looking too smooth compared to surrounding areas that may already contain noise. This can help to blend the reconstructed areas more naturally with the surrounding non-clipped areas.

type of noise
This specifies the statistical distribution of the noise. It can be helpful to match the look of the artificially generated noise with the naturally occurring noise in the surrounding areas from the camera's sensor. The *poissonian* noise is the closest to natural sensor noise but is less visually pleasing than *gaussian*, which is probably closer to film grain. Also note that most denoising modules will turn the sensor noise from poissonian to slightly gaussian, so you should pick the variant that blends better into the actual noise in your image.

8.2.26. framing

Generate a frame around the image.

The frame consists of a border (of a user-defined color) and a frame line within that border (of a second user-defined color). Various options are available to control the geometry of the frame.

module controls

border size
The size of the frame as a percentage of the underlying full image.

aspect
The aspect ratio of the final module output (i.e. of the underlying image plus the frame)

orientation
The orientation of the frame (portrait/landscape). Select 'auto' for darktable to choose the most reasonable orientation based on the underlying image.

horizontal/vertical position
Select from a set of pre-defined ratios defining where you want your underlying image be positioned on the horizontal/vertical axis. You can also right click and enter your own ratio as "x/y".

frame line size
The percentage of the frame line size relative to the border size at its smallest part.

frame line offset
Where the frame line should be positioned, relative to the underlying image. Choose 0% for a frame line touching the image. Choose 100% for a frame line touching the outer border.

border color / frame line color
A pair of color selectors which allow the border and frame line colors to be defined. Clicking on the colored field will open a color selector dialog which offers a choice of commonly used colors, or allows you to define a color in RGB color space.

You can also activate a color picker to take a color probe from the image.

8.2.27. global tonemap (deprecated)

Please note that this module is deprecated in darktable 3.4 and should no longer be used for new edits. Please use the *filmic rgb* module instead.

Compress the tonal range of an HDR image into the limited tonal range of a typical LDR output file.

Global tonemap processes each pixel of an HDR image, without taking the local surrounding into account. This is generally faster than local *tone mapping (deprecated)*, but might lead to less convincing results with very high-dynamic-range scenes.

module controls

operator
The operator to use. *Reinhard*, *Filmic* and *Drago* global tonemap operators are available. Depending on the selected operator, different parameters can be adjusted.

Some operators are fully self-adjusting, and do not require specific controls.

bias (*Drago* operator only)
This parameter influences the contrast of the output image. It is an essential parameter for adjusting the compression of high values and the visibility of details in dark areas. A value of 0.85 is recommended as a starting point.

target (*Drago* operator only)
A scale factor to adjust the global image brightness to the brightness of the intended display. It is measured in cd/m, and should match the brightness of your output device. Higher values lead to a brighter image, while lower values lead to a darker image.

detail (all operators)
This parameter controls how much detail is preserved from the original input image and transferred back into the output image after tonemapping.

8.2.28. graduated density

Simulate a graduated density filter in order to correct exposure and color in a progressive manner.

A line is shown on screen allowing the position and rotation of the gradient to be modified with the mouse.

This module is known to provoke banding artifacts under certain conditions. You should consider activating the *dithering* module to alleviate these issues.

module controls

density
Set the density of the filter (EV). A low value underexposes slightly whereas a high value creates a strong filter.

hardness
The progressiveness of the gradient. A low value creates a smooth transition, whereas a high value makes the transition more abrupt.

rotation
The rotation of the filter. Negative values rotate clockwise. The rotation can also be set by dragging the end of the gradient line with the mouse.

hue
Choose a hue to add a color cast to the gradient.

saturation
The saturation of the color cast to add to the gradient (defaults to a neutral color cast of 0)

8.2.29. grain

Simulate the grain of analog film. The grain is processed on the L channel of Lab color space.

module controls

coarseness
The grain size, scaled to simulate an ISO number.

strength
The strength of the effect.

8.2.30. haze removal

Automatically reduce the effect of dust and haze in the atmosphere, which often reduce the color contrast in landscape photographs. This module may also be employed more generally to give pictures a color boost specifically in low-contrast regions of the image.

Haze absorbs light from objects in the scene but it is also a source of diffuse background light. The haze removal module first estimates, for each image region, the amount of haze in the scene. It then removes the diffuse background light according to its local strength and recovers the original object light.

Setting both of the module’s controls to unity maximizes the amount of haze removal but is also likely to produce some artifacts. Removing the atmospheric light entirely may render the image flat and result in an unnatural looking style. Optimal values are typically below unity and are rather image dependent but also a matter of personal aesthetic preferences.

module controls

strength
The amount of haze removal. At unity, the module removes 100 percent of the detected haze up to the specified distance. Negative values increase the amount of haze in the image.

distance
Limit the distance up to which haze is removed. For small values, haze removal is restricted to the foreground of the image. Haze is removed from the entire image if the distance parameter is set to unity. If the *strength* is negative the distance control has no effect.

8.2.31. highlight reconstruction

Attempt to reconstruct color information for pixels that are clipped in one or more RGB channel.

If these pixels are left partially clipped it can result in unrealistic colors appearing in the image. For example pixels with both green and blue channels clipped will appear to be red without any highlight reconstruction.

Three methods of reconstruction are available:

clip highlights
Clamp all pixels to the white level (i.e. clip the remaining color channels). This method is most useful in cases where clipped highlights occur in naturally desaturated objects (e.g. clouds).

reconstruct in LCh
Analyse each pixel with at least one clipped channel and attempt to correct the clipped pixel (in LCh color space) using the values of the other (3 for Bayer or 8 for X-Trans) pixels in the affected sensor block. The reconstructed highlights will still be monochrome, but brighter and with more detail than with “clip highlights”. This method works fairly well with a high-contrast base curve, which renders highlights desaturated. As with *clip highlights* this method is a good option for naturally desaturated objects.

reconstruct color
Use an algorithm that transfers color information from unclipped surroundings into the clipped highlights. This method works very well on areas with homogeneous colors and is especially useful on skin tones with smoothly fading highlights. Please note that this method can produce maze-like artifacts on highlights behind high-contrast edges, for example well-exposed fine structures in front of an overexposed background.

For highlight reconstruction to be effective you need to also apply a negative EV correction in the exposure module

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When using the highlight reconstruction included with the filmic rgb module it may be useful to disable this module so that filmic has more information to work with.

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module controls

method
Choose the method for highlight reconstruction (see above)

clipping threshold
Manually adjust the clipping threshold against magenta highlights. You shouldn’t need to adjust this.

8.2.32. highpass

A high pass filter.

This module is primarily intended to be used in combination with a *blend mode*. For example, try using the module with a blend mode of “soft light” for high pass sharpening.

Module Controls

sharpness
The sharpness of the filter

contrast boost
The contrast boost

8.2.33. hot pixels

Automatically detect and eliminate hot pixels.

Hot pixels are pixels which have failed to record a light level correctly. Detected hot pixels are replaced by an average of their neighbors.

module controls

threshold
How strong a pixel's value needs to deviate from that of its neighbors to be regarded as a hot pixel.

strength
The blending strength of the hot pixels with their surrounding.

detect by 3 neighbours
Extend the detection of hot pixels – regard a pixel as hot if a minimum of only three (instead of four) neighbor pixels deviate by more than the threshold level.

mark fixed pixels
Visually mark the corrected pixels on the image and display a count of hot pixels that have been fixed

8.2.34. input color profile

The input color profile module defines how darktable will interpret the colors of the image. It takes the color space used by the source of the image (e.g. camera, scanner) and converts the pixel encodings to a standardised working color space. This means that subsequent modules in the pipeline don't need to be concerned with the specifics of the input device, and can work with and convert to/from the working color space.

Where an image has been captured in a camera raw file, the input color profile module will normally apply either a standard or enhanced color matrix specific for that camera model, which will be used to map the colors into the working profile color space. If color space information is embedded in the image, the *input color profile* module will use this information when mapping the colors to the working profile color space. The user can also explicitly specify a color space for the incoming image, and can even supply a custom ICC color profile specifically made for the input device.

As part of the mapping from the input color space to the working profile space, the colors can be confined to a certain gamut using the *gamut clipping* options, which can help to mitigate some (infrequent) color artifacts. This is also influenced by the chosen rendering intent.

Note that the final color profile that will be used when exporting the image is controlled by the *output color profile* module.

module controls

input profile
The profile or color matrix to apply. A number of matrices are provided along with an enhanced color matrix for some camera models. The enhanced matrices are designed to provide a look that is closer to that of the the camera manufacturer.

You can also supply your own input ICC profiles and put them into `$DARKTABLE/share/darktable/color/in` or `$HOME/.config/darktable/color/in` (where `$DARKTABLE` is the darktable installation directory and `$HOME` is your home directory). One common source of ICC profiles is the software that is shipped with your camera, which often contains profiles specific to your camera model. You may need to activate the *unbreak input profile* module to use your own profiles.

If your input image is a low dynamic range file like JPEG, or a raw in DNG format, it might already contain an embedded ICC profile which darktable will use by default. You can restore this default by selecting "embedded icc profile".

working profile
The working profile used by darktable modules. Each module can specify an alternative space that it will work in, and this will trigger a conversion. By default darktable will use "linear Rec2020 RGB", which is a good choice in most cases.

gamut clipping

Activate a color clipping mechanism. In most cases you can leave this control in its default “off” state. However, if your image shows some specific features such as highly saturated blue light sources, gamut clipping might be useful to avoid black pixel artifacts. See possible color artifacts for more information.

Choose from a list of RGB profiles. Input colors with a saturation that exceeds the permissible range of the selected profile are automatically clipped to a maximum value. “linear Rec2020RGB” and “Adobe RGB (compatible)” allow for a broader range of unclipped colors, while “sRGB” and “linear Rec709 RGB” produce a tighter clipping. Select the profile that prevents artifacts while still maintaining the highest color dynamics.

8.2.35. invert (deprecated)

Please note that this module is deprecated in darktable 3.4 and should no longer be used for new edits. Please use the *negadoctor* module instead.

Invert scanned negatives.

module controls

color of film material

Clicking on the colored field will open a color selector dialog which offers you a choice of commonly used colors, or allows you to define an RGB color. You can also activate the color picker to take a color probe from your image – preferably from the unexposed border of your negative.

8.2.36. lens correction

Automatically correct for lens distortion, transversal chromatic aberrations (TCA) and vignetting.

This module identifies the camera/lens combination from the image’s Exif data and uses the external lensfun library to provide correction parameters for the image.

If your system’s lensfun library has no correction profile for the automatically identified camera/lens combination the controls for the three photometric parameters (below) are replaced with a warning message. You may try to find the right profile yourself by searching for it in the menu.

If your lens is present in the list but has not been correctly identified, this may require some adjustment within the exiv2 program (see this post for details). Note that you may need to re-import the images once such adjustments have been made.

If you can’t find your lens, check if it is in the list of currently supported lenses, and try running the lensfun-update-data tool. If there is still no matching profile for your lens, please visit this lens calibration service offered by Torsten Bronger, one of darktable’s users. Alternatively you may go to lensfun’s home page and learn how to generate your own set of correction parameters. Don’t forget to share your profile with the lensfun team!

module controls

camera

The camera make and model as determined by the image’s Exif data. You can override this manually and select your camera from a hierarchical menu. Only lenses with correction profiles matching the selected camera will be shown.

lens

The lens make and model as determined by the image’s Exif data. You can override this manually and select your lens from a hierarchical menu. This is mainly required for pure mechanical lenses, but may also be needed for off-brand / third party lenses.

photometric parameters: focal length, aperture, focal distance

Lens corrections depend on certain photometric parameters that are read from the image’s Exif data: focal length (for distortion, TCA, vignetting), aperture (for TCA, vignetting) and focal distance (for vignetting). Many cameras do not record focal distance in their Exif data, in which case you will need to set this manually.

You can manually override all automatically selected parameters. Either take one of the predefined values from the drop-down menu or, with the drop-down menu still open, just type in your own value.

corrections
Choose which corrections (distortion, TCA, vignetting) darktable should apply. Change this from its default “all”, if your camera has already performed some internal corrections (e.g. vignetting), or if you plan to undertake some corrections with a separate program.

geometry
In addition to the correction of lens flaws, this module can change the projection type of your image. Set this combobox to the aimed projection type, such as “rectilinear”, “fish- eye”, “panoramic”, “equirectangular”, “orthographic”, “stereographic”, “equisolid angle”, “thoby fish-eye”.

scale
Adjust the scaling factor of your image to avoid black corners. Press the auto scale button (to the right of the slider) for darktable to automatically find the best fit.

mode
The default behavior of this module is to *correct* lens flaws. Switch this combobox to “distort” in order to instead *simulate* the flaws/distortions of a specific lens (inverted effect).

TCA red; TCA blue
Override the correction parameters for TCA. You can also use this slider to manually set the parameter if the lens profile does not contain TCA correction. Look out for colored seams at features with high contrast edges and adjust these parameters to minimize those seams.

corrections done
Occasionally, for a given camera/lens combination, only some of the possible corrections are supported by lensfun’s profiles. This message box will tell you which corrections have actually been applied to the image.

Note: TCA corrections will not be applied to photos that have been identified as monochrome (see developing monochrome images for more information).

8.2.37. levels

Adjust black, white and mid-gray points.

The levels tool offers two modes of operation:

manual
The levels tool shows a histogram of the image, and displays three bars with handles. Drag the handles to modify the black, middle-gray and white points in absolute values of image lightness (the L value from Lab).

Moving the black and white bars to match the left and right borders of the histogram will make the output image span the full available tonal range. This will increase the image’s contrast.

Moving the middle bar will modify the middle-gray tones. Shifting it left will make the image look brighter, shifting it right will make it darker. This is often referred to as changing the image’s gamma.

Three color pickers are available for sampling the black, white and gray points from the image. The “auto” button auto-adjusts the black and white point and puts the gray point exactly in the mean between them.

automatic
The module automatically analyses the histogram of the image, detects the left and right histogram borders, and lets you define the black point, the gray point and the white point in terms of percentiles relative to these borders.

Note: Under certain conditions, especially with highly saturated blue light sources, the *levels* module may produce black pixel artifacts. See the “gamut clipping” option of the *input color profile* module for information about how to mitigate this issue.

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module controls

mode
The mode of operation (automatic or manual).

black (automatic mode only)
The black point in percentiles relative to the left border of the histogram.

gray
The gray point in percentiles relative to the left and right borders of the histogram after having applied the black point and white point corrections.

white
The white point in percentiles relative to the right border of the histogram.

8.2.38. liquify

Move pixels around by applying freestyle distortions to parts of the image using points, lines and curves.

nodes

Each of liquify's tools is based on nodes. A point is given by a single node and a line or curve consists of a set of nodes defining a path.

There is a limit of 100 nodes in a single liquify instance. For more nodes than this, use additional module instances. However, note that the liquify module consumes a lot of system resources.

Drag the central point of a node to move the node around. The radius describes the area of the applied effect (the distortion occurs only inside this radius). To change the radius drag the handle at the circumference. A strength vector starting from the center describes the direction of the distortion, and its strength is depicted by the length of the vector. Change the vector by dragging its arrowhead.

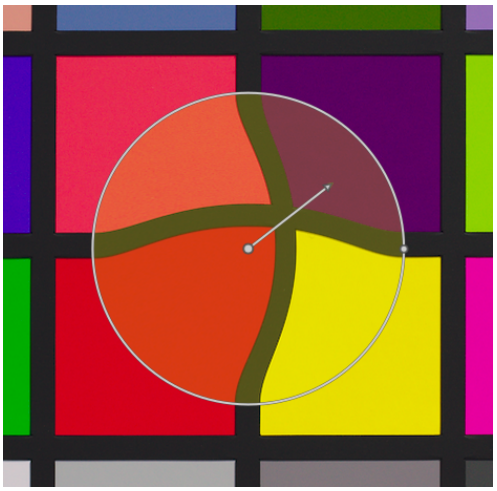
points

Click the point icon to activate the point tool and click on the image to place it. Holding Ctrl while clicking on the point icon allows you to add multiple points without having to click the icon again. Right-click to exit creation mode.

A point is formed by a single node. In a point the strength vector has three different modes which are toggled using Ctrl+click over the arrowhead of the strength vector.

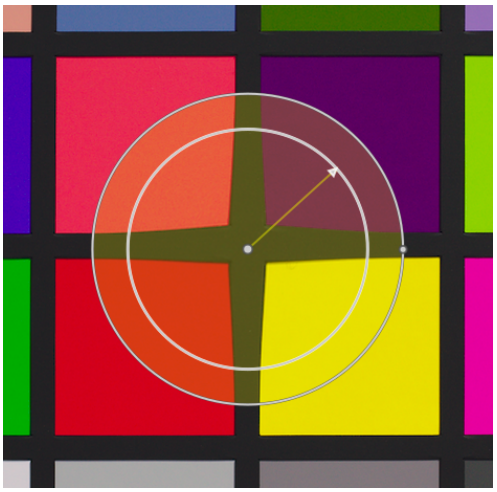
point modes

linear
A linear distortion inside the circle, starting from the opposite side of the strength vector and following the vector's direction. This is the default mode.



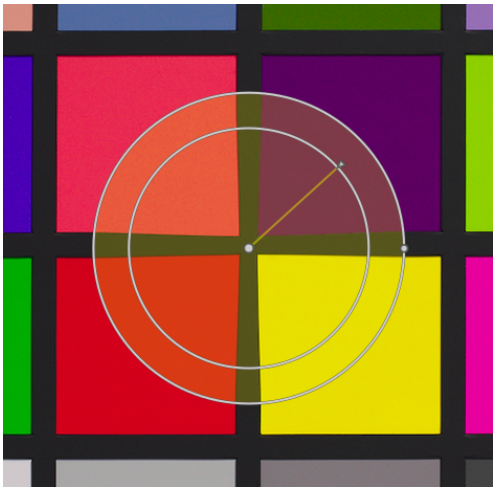
radial growing

The strength vector’s effect is radial, starting with a strength of 0% in the center and increasing away from the center. This mode is depicted by an additional circle with the arrow pointing outwards.



radial shrinking

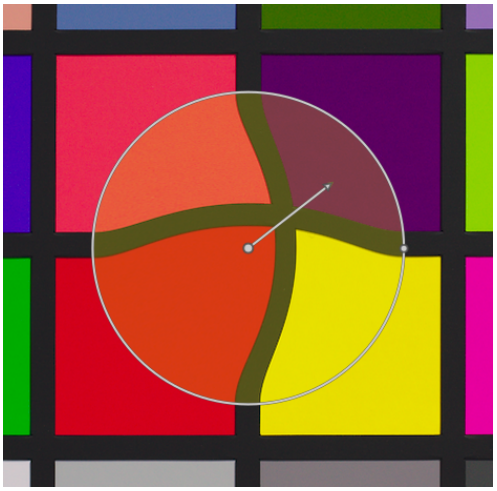
The strength vector’s effect is radial, starting with a strength of 100% in the center and decreasing away from the center. This mode is depicted by an additional circle with the arrow pointing inwards.



feathering

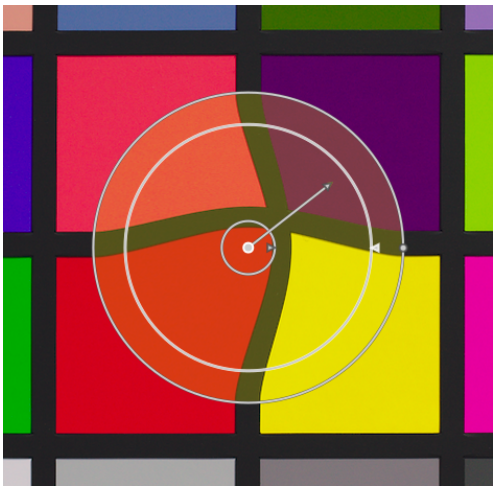
default mode

By default the strength varies linearly from 0% to 100% between the center and the radius of the control point. It is possible to modify the feathering effect by clicking on the center of the circle.



feathered mode

In “feathered” mode, two control circles are displayed and can be modified independently to feather the strength of the effect. Note that clicking the center of the circle again hides the feathering controls but does *not* return to the default mode.



removing points

A point can be removed by right-clicking on the center of the node.

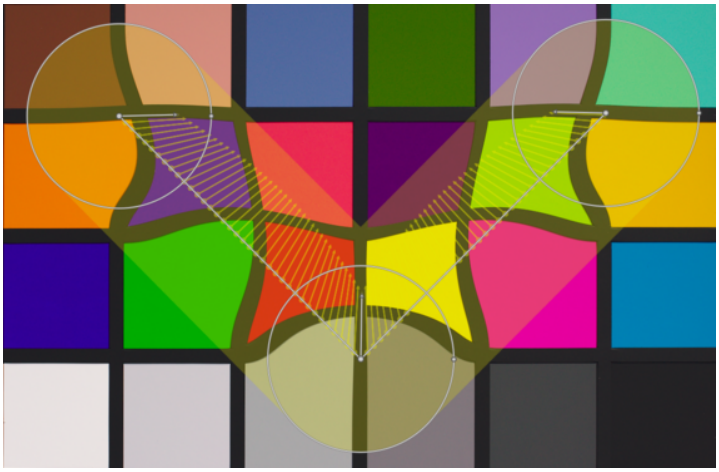
lines and curves

Lines and curves are sets of points linked together by straight or curved lines. The effect is interpolated by a set of strength vectors.

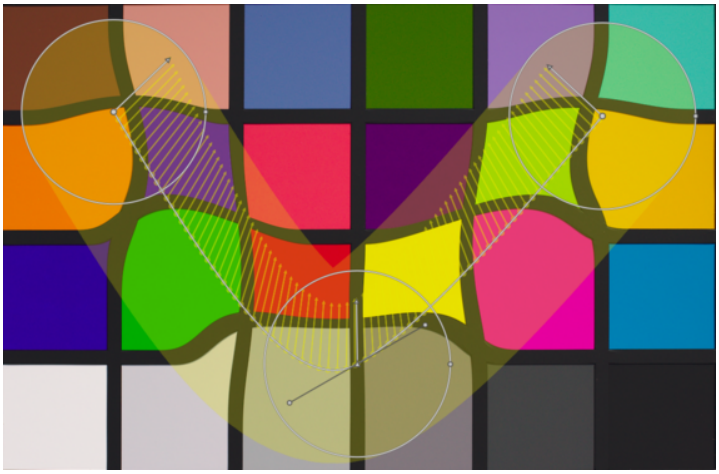
Click the appropriate icon to activate the line or curve tool and click on the image to place points to form the path. Right-click anywhere when the last point has been placed in order to finish drawing a line/curve.

Holding Ctrl while clicking on the point icon allows you to add multiple points without having to click the icon again. Right-click a second time to exit creation mode after a line or curve has been completed.

lines



curves



Ctrl+click on a line or curve segment to add a new control point. Ctrl+right-click on the center of a node to remove a control point.

Right-click on a segment to remove the shape completely. Ctrl+Alt+click on a segment to change that segment from a line to a curve and vice versa.

link modes

Ctrl+click on the center of a node to change the way the points of a curve are linked together. There are four modes which correspond to different ways of handling the steepness of the bezier curve using control handles:

autosmooth
This is the default mode, in which control handles are not displayed as they are automatically computed to give a smooth curve.

cusp
Control handles can be moved independently. This mode is depicted by a triangle symbol in the node center.

smooth
Control handles always give a smooth curve. This mode is depicted by a diamond symbol in the node center.

symmetrical
Control handles are always moved together. This mode is depicted by a square symbol in the node center.

view and edit nodes

Click the node tool icon to activate or deactivate the node edit tool displaying all defined distortion objects and their controls. Alternatively you can at any time right-click on the image for the same effect.

warps and nodes count

This information field displays the number of warps (individual distortion objects) and nodes currently used.

8.2.39. local contrast

Enhance local contrast.

This is achieved using either a *local laplacian* filter (the default mode) or an *unnormalized bilateral* filter. Both modes work exclusively on the L channel from Lab. The *local laplacian* filter has been designed to be very robust against unwanted halo effects and gradient reversals along edges.

module controls

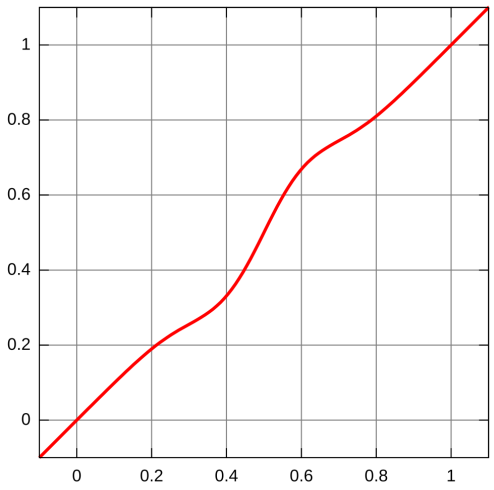
mode
Choice of *local laplacian* filter or *bilateral grid*. The following sections define the controls available for each of these modes.

bilateral grid

coarseness
Adjust the coarseness of the details to be adjusted.
contrast
How strongly the algorithm distinguishes between brightness levels. Increasing this parameter results in a more contrasty look.
detail
Add or remove detail. Higher values will increase local contrast.

local laplacian

To understand the parameters of the local laplacian filter, one can think of it as applying a curve to the image, similar to the following graph:



This curve will be applied to the image in a way that works locally and avoids halo artifacts.

The local laplacian mode also supports shadow lifting and highlight compression, similar to the *shadows and highlights* module.

detail
Add or remove detail. Higher values will increase local contrast. This will insert an S shaped element in the center of the curve, to increase or decrease local contrast.
highlights
This affects one end of the S shaped contrast curve, effectively increasing or compressing contrast in the highlights. A low value will pull the highlights down.

shadows
Similar to the highlights parameter, this affects the other end of the S shaped contrast curve, and will increase or decrease contrast in the shadows. A higher value gives more contrast in the shadows. A lower value lifts the shadows and can effectively simulate a fill light. Note that this is done via local manipulation of the image. However, this means that a completely dark image cannot be brightened in this way – only dark objects in front of bright objects are affected.

midtone range
This controls the extent of the S shaped part of the contrast curve. A larger value will make the S wider, and thus classify more values to be midtone range and fewer values to belong to the highlights and shadows part. In more high dynamic range settings it can be useful to reduce this value to achieve stronger range compression by lowering the contrast in the highlights and the shadows. Note however that for really strong HDR scenarios this may work best in combination with a *base curve* which pre-compresses the range, perhaps with an approximately logarithmic base curve. The exposure fusion feature in the *base curve* module may lead to more pleasing results at times, but is also more prone to producing halo effects.

This setting can cause banding artifacts in the image if pushed to extreme values. This is due to the way darktable computes the fast approximation of the local laplacian filter.

8.2.40. lowlight vision

Simulate human lowlight vision making pictures look closer to human lowlight perception. This module can also be used to perform a day-to-night conversion.

The idea is to calculate a scotopic vision image, which is perceived by the rods rather than than the cones in the eyes under low light. Scotopic lightness is then mixed with photopic value (regular color image pixel) using some blending function. This module is also able to simulate the Purkinje effect by adding some blueness to the dark parts of the image.

This module comes with several presets which can be used to get a better idea of how the module works.

module controls

curve
The horizontal axis represents pixel lightness from dark (left) to bright (right). The vertical axis represents the kind of vision from night vision (bottom) to day vision (top).

blue
Set the blue hint in shadows (Purkinje effect).

8.2.41. lowpass

Apply a low pass filter (for example, a Gaussian blur) to the image, while controlling the output contrast and saturation.

This module is primarily intended to be used in combination with a blend mode. For example, try using the *local contrast mask* preset with the *overlay* blend mode.

module controls

radius
The radius of the blur

soften with
The blur algorithm to use

- *gaussian blur*: Blur all image channels (L, a, b)
- *bilateral filter*: Blur the L channel only, while preserving edges

contrast
Higher absolute values increase contrast. Lower absolute values reduce contrast. Negative values result in an inverted negative image. A value of zero leads to a neutral plane.

brightness
Negative values darken the image. Positive values lighten the image.

saturation
The color saturation. Negative values result in complementary colors by inverting the a/b channels. Higher absolute values increase color saturation. Lower absolute values reduce color saturation. A value of zero fully desaturates the image.

8.2.42. lut 3D

A 3D LUT is a tridimensional table which is used to transform a given RGB value into another RGB value, and is normally used for film simulation and color grading.

This module accepts `.cube` and `.png` (haldclut) files. The 3D LUT data is not saved in the database or the XMP file, but is instead saved to the 3D LUT file path inside the 3D LUT root folder. This means that it is important to back up your 3D LUT folder properly. Sharing an image with its XMP is useless if the recipient doesn't also have the same 3D LUT file in their own 3D LUT folder.

module controls

file selection
Choose the 3D LUT file to use. File selection is inactive until the 3D LUT root folder has been defined in preferences > processing.

application color space
A 3D LUT is defined relative to a specific color space. Choose the color space for which the selected 3D LUT file has been built. Cube files are usually related to REC.709 while most others are related to sRGB.

interpolation
This defines how to calculate output colors when input colors are not exactly on a node of the RGB cube described by the 3D LUT. There are three interpolation methods available: tetrahedral (default), trilinear and pyramid. Usually you won't see any difference between interpolation methods except with smaller sized LUTs.

8.2.43. monochrome

Quickly convert an image to black & white using a variable color filter.

To use this module, first reduce the filter size (to concentrate its effect) and move it across the hue pallet to find the best filter value for your desired image rendition. Then gradually expand the filter to include more hues and achieve more natural tonality.

Note: Under certain conditions, especially highly saturated blue light sources in the frame, this module may produce black pixel artifacts. Use the gamut clipping option of the *input color profile* module to mitigate this issue.

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module controls

filter size/position
The default central location of the filter has a neutral effect but dragging it to an alternate position applies a filter analogous to taking a b&w photograph through a conventional color filter.

A color picker can be activated to automatically set the position and size of the filter based on the selected portion of the image. Scroll the mouse wheel to change the filter size, making the filter's range of hues more or less selective.

highlights
Control how much to retain highlights.

8.2.44. negadoctor

Negadoctor allows you to process a scanned film negative.

You can obtain an image of a negative using a film scanner, or by photographing it against a white light (e.g. a light table or computer monitor) or off-camera flash.

preparation

If the image of the negative was obtained using a digital camera, then in order to obtain accurate colors in the final image, you will need to take the following points into consideration:

- When taking the photograph, adjust the exposure to fully utilise the entire dynamic range of your camera sensor – i.e. “expose-to-the-right”, so that the histogram in your camera touches the right hand side without clipping the image.
- Ensure the white balance is correctly set up to compensate for the light source used to illuminate the negative. You can take a profiling picture of the light source with no film negative in front of it, and then use the “spot” feature in the *white balance* module to obtain a reference white-balance setting. This reference white balance setting can then be made into a style or simply pasted onto the images taken from your film negatives.
- Apply the standard or enhanced camera matrix in the *input color profile* module.

When scanning or photographing your film negative, make sure you include some unexposed part of the film within the captured image. This is required to set the *Dmin* parameter (see below). If this is not possible (e.g. your film holder completely obscures the unexposed parts of the film), you can take a separate image of an unexposed part of the film, measure the *Dmin* parameter from that image, and then paste that setting to the rest of the images from that film.

When developing the scanned/photographed film negatives, it is recommended that you disable any tone mapping modules such as *filmic rgb*, *base curve* and the like.

The *working profile* parameter in darktable’s *input color profile* module should be set to either *linear Rec2020 RGB*, or to an ICC profile representing the actual color space of your film emulsion. Some examples of such ICC profiles may be found in the following forum posts:

- https://discuss.pixls.us/t/any-interest-in-a-film-negative-feature-in-rt/12569/177
- https://discuss.pixls.us/t/input-color-profile-to-use-for-negatives/20271/13

Note: if you want to use *tone equalizer* with *negadoctor*, you’ll need to move the *tone equalizer* **after** *negadoctor* in the pixelpipe, since the *tone equalizer* is not designed to work with negatives.

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module controls

It is strongly recommended that you set the parameters following the order in which they are presented in the GUI. Start by setting the *film stock*, then work through each of the tabs (*film properties*, *corrections*, *print properties*) in order, working from top to bottom.

When using color pickers, be careful to avoid including dust and scratches, which can skew the results of the sampled region.

film stock

The first step is to choose “color” or “black and white” in the *film stock* drop-down. If you select “black and white”, any sliders that are only used for color will be hidden from view.

film properties

This tab contains a number of basic settings. If, after adjusting these settings, your image is still not quite as you would like it, you can make further adjustments on the the *corrections* tab. These are technical settings, and serve a somewhat similar purpose to the *scene* tab in the *filmic rgb* module, in that they adjust the black and white points and hence define the dynamic range of the negative.

color of the film base

Sample an area of the base film stock from your scan. This is the area just outside of the image (i.e. an unexposed part of the film). When working with black and white negatives, you can leave this at its default (white). If working on color film, click the color picker to the right of the color bar. This will create a bounding box which covers about 98% of your image. Then, click and drag across an area of your negative which contains only unexposed film stock. This will automatically calculate values for the *D min* slider(s). It is likely at this point that your image will still look too dark, but you can correct this later.

D min

If the *film stock* is set to “black and white”, this slider indicates the minimum value corresponding to the unexposed film stock. If you set *film stock* to “color”, this control will consist of 3 separate sliders, one for each of the red, green and blue channels.

D max

This slider represents the dynamic range of your film, and it effectively sets its white point. Dragging this to the left will make the negative brighter. Dragging to the right will make the negative darker. When adjusting this slider manually, it’s a good idea to closely watch your histogram to ensure that you don’t clip the highlights (i.e. where the histogram has been pushed over too far off the right hand side of the graph). If you click the color picker icon (on the right) negadoctor will automatically calculate this value to ensure maximal use of the histogram without clipping. To use the color picker, click and drag to draw a rectangle across only the exposed parts of the negative. Don’t include the unexposed film stock, as this will skew the result.

scan exposure bias

This slider allows you to set the black point. It is a technical adjustment that ensures a proper zeroing of the RGB values and a spreading of the histogram between [0, 1] values for robustness in the operations that follow. Dragging this to the left will make the negative brighter. Dragging to the right will make the negative darker. When adjusting this slider manually, it’s a good idea to closely watch your histogram and ensure that you don’t clip the shadows (where the histogram is pushed too far off the left hand side of the graph). You can use the color picker to allow negadoctor to automatically calculate any required offset. To use the color picker, select a region in the darkest lowlights, or select the entire image without including any unexposed film stock. Double-check the histogram to ensure the left part of it doesn’t clip.

corrections

This tab contains sliders which allow you to make color cast corrections within both the shadow and highlight regions.

The settings on this tab should not be needed for most well-preserved negatives and will mostly be useful for old and poorly-preserved negatives having a decayed film base that introduces undesirable color casts. Note that the shadows color cast setting will have no effect if the *scan exposure bias* setting in the *film properties* tab is set to a non-zero value.

The other case where these color cast corrections may be needed is if the white balance properties of the light used to scan the film negative are significantly different to the light source under which the original film camera took the shot. For example, if you illuminate the film with an LED light, but the original shot was taken under daylight, this may require some additional color cast corrections.

shadows color cast

These three sliders allow you to correct for color casts in the shadows by adjusting the *red*, *green* and *blue* channels individually. Use the color picker to set the sliders automatically by selecting a neutral grey shadow region requiring correction. Because the shadows sliders can also affect highlights color casts, it is import to finish setting the shadows sliders before moving on to the highlights sliders.

highlights white balance

These three sliders allow you to correct the white balance in the highlights by adjusting the *red*, *green* and *blue* channels individually. Use the color picker to set the sliders automatically by selecting a neutral grey region in the highlights that is not properly balanced.

print properties

This tab contains settings that mimic the tonal effect of the photochemical papers that would have been used to create the hard copy image if you were not developing the photo digitally. These are creative settings, and serve a similar overall purpose to the creative tone curve settings on the *look* tab of the *filmic rgb* module.

The *print exposure*, *paper black*, *paper grade* and *print exposure* are analogous to the *slope*, *offset* and *power* controls in the *color balance* module (which in turn is based on the ASC CDL standard). These settings define a creative tone curve to enforce your contrast intent after the inversion, at the end of the module. The equation governing this slope/offset/power behaviour is:

$$RGB\_out = (RGB\_in \times exposure + black)^{grade}$$

paper black (density correction)
For this slider, select the color picker and click and drag to select a region that encompasses only the exposed part of the film negative. If you can see unexposed film stock around the edges of your image, ensure that these areas are excluded from the drawn rectangle when calculating the *paper black* slider setting. Paper black represents the density of the blackest silver-halide crystal available on the virtual paper. In the analog development process, this black density always results in non-zero luminance, but the digital pipeline usually expects that black should be encoded with a zero RGB value. This slider setting lets you remap paper black to pipeline black via an offset. You can use the color picker to select a region of the image that should be mapped to black in the final image.

paper grade (gamma)
This slider is your gamma (contrast) control, and it defaults to a value of 4. If all has gone well, this value (4) minus the value of D max (from the “film properties” tab) should normally leave you with a value between 2 and 3.

paper gloss (specular highlights)
This slider is essentially a highlights compression tool. As you drag this slider to the left, you will see in the histogram that the highlight values are being compressed (pushed to the left). Adjust this accordingly, so that your highlights are not clipped in the histogram. You can also use this to simulate a matte photo print with low-contrast highlights.

print exposure adjustment
This slider offers one final opportunity to correct any clipping of the highlights. If you have followed all the previous instructions carefully, you shouldn’t need to adjust this setting. Note that you can increase the print exposure while at the same time decreasing the paper gloss, which allows you to brighten the midtones without losing any highlights. You can use the color picker to select the brightest highlights, or select the entire image without including any unexposed film stock. This will set the exposure so that the brightest part of the selected region is not clipped. Double-check the histogram to make sure the right part of the histogram doesn’t clip.

8.2.45. orientation

Rotate the image 90 degrees at a time.

The module is enabled by default and the orientation is automatically set based on the image’s Exif data.

The orientation can also be set using the selected images module in the lighttable view.

module controls

rotate
Double click the label to reset the image’s rotation

counter-clockwise
Rotate the image 90 degrees counter-clockwise

clockwise
Rotate the image 90 degrees clockwise

8.2.46. output color profile

Manage the output profile for export and the rendering intent to be used when mapping between color spaces.

darktable comes with pre-defined profiles *sRGB*, *AdobeRGB*, *XYZ* and *linear RGB*. You can provide additional profiles by placing them in `$DARKTABLE/share/darktable/color/out` and `$HOME/.config/darktable/color/out` (where `$DARKTABLE` is the darktable installation directory and `$HOME` is your home directory).

The output color profile may also be defined within the export module in the lighttable view.

module controls

output intent
The rendering intent for output/export. Rendering intent can only be selected when using LittleCMS2 to apply the output color profile (this can be changed in preferences > processing). If darktable’s internal rendering routines are used, this option is hidden. For more details see rendering intent.

output profile
The profile used to render colors for output/export. The profile data will be embedded into the output file (if supported by the file format) allowing other applications to correctly interpret its colors. As not all applications are aware of color profiles, the general recommendation is to stick to sRGB unless you know what you are doing and have a good reason to do otherwise.

8.2.47. perspective correction

Automatically correct for converging lines, a form of perspective distortion. The underlying mechanism is inspired by Markus Hebel's *ShiftN* program.

Perspective distortions are a natural effect when projecting a three dimensional scene onto a two dimensional plane and cause objects close to the viewer to appear larger than objects further away. Converging lines are a special case of perspective distortions frequently seen in architectural photographs. Parallel lines, when photographed at an angle, are transformed into converging lines that meet at some vantage point within or outside of the image frame.

This module is able to correct converging lines by warping the image in such a way that the lines in question become parallel to the image frame. Corrections can be applied in a vertical and horizontal direction, either separately or in combination. In order to perform automatic correction the module first analyzes the image for suitable structural features consisting of line segments. Based on these line segments a fitting procedure is initiated which determines the best values for the module's parameters.

analysing the structure of an image

Click the  icon to analyze the image for structural elements – darktable will automatically detect and evaluate line elements. Only lines that form a set of vertical or horizontal converging lines are used for the subsequent processing steps. The line segments are displayed as overlays on the image canvas, with the type of line identified by color:

green
Vertical converging lines
red
Vertical lines that do not converge
blue
Horizontal converging lines
yellow
Horizontal lines that do not converge
grey
Other lines identified which are not of interest to this module

Lines marked in red or yellow are regarded as outliers and are not taken into account for the automatic fitting step. This outlier elimination involves a statistical process using random sampling which means that each time you press the "get structure" button the color pattern of the lines will look slightly different.

You can manually change the status of line segments: Left-Click on a line to select it (turn the color to green or blue) and Right-click to deselect it (turn the color to red or yellow). If you keep the mouse button pressed, you can use a sweeping action to select/deselect multiple lines in a row. The size of the select/deselect brush can be changed with the mouse wheel. Hold down the Shift key and keep the left or right mouse button pressed while dragging to select or deselect all lines in the chosen rectangular area.

Click on one of the "automatic fit" icons (see below) to initiate an optimization process which finds the best suited module parameters based on the detected structure. The image and the overlaid lines are then displayed with perspective corrections applied.

module controls

Once the initial image analysis is done, the following controls can be used to perform the perspective corrections.

rotation
Control the rotation of the image around its center to correct for a skewed horizon.
lens shift (horizontal)
Correct converging horizontal lines (i.e. to make the *blue* lines parallel).

lens shift (vertical)

Correct converging vertical lines (i.e. to make the *green* lines parallel). In some cases you can obtain a more natural looking image if you correct vertical distortions to an 80 ~ 90% level rather than to the maximum extent. To do this, reduce the correction slider after having performed the automatic correction.

shear

Shear the image along one of its diagonals. This is needed when correcting vertical and horizontal perspective distortions simultaneously.

guides

When activated, a grid is overlaid on the image to help you judge the quality of the correction.

automatic cropping

When activated, this feature crops the image to remove any black areas at the edges of the image caused by a distortion correction. You can either crop to the “largest area”, or to the largest rectangle that maintains the original aspect ratio (“original format”). In the latter case you can manually adjust the automatic cropping result: click in the clip region and move it around. The size of the region is modified automatically to exclude any black corners.

lens model

This parameter controls the lens focal length, camera crop factor and aspect ratio that will be used by the correction algorithm. If set to “generic” a lens focal length of 28mm on a 35mm full-frame camera is assumed. If set to “specific”, the focal length and crop factor can be set manually using the sliders provided.

focal length

If the *lens model* is set to “specific”, set the lens focal length. The default value is taken from the Exif data of the image, and can be overridden by adjusting the slider manually.

crop factor

If the *lens model* is set to “specific”, set the camera crop factor. You will normally need to set this value manually.

aspect ratio

If the *lens model* is set to “specific”, this parameter allows for a free manual adjustment of the image’s aspect ratio. This is useful for “unsqueezing” images taken with an anamorphic lens (which changes the ratio of image height to width).

automatic fit

Click on one of the *automatic fit* icons to set the distortion correction sliders automatically based on the edge detection analysis. You can choose to automatically apply just the vertical corrections  , just the horizontal corrections  , or both together  . Ctrl+click on any of the icons to apply a rotation without the lens shift. Shift+click on any of the icons to apply the lens shift without any rotation.

get structure

Click on the  icon to (re-)analyze the image for suitable line segments. Shift+click to apply a contrast enhancement step before performing further analysis. Ctrl+click to apply an edge enhancement step before performing further analysis. Both variations can be used alone or in combination if the default analysis is not able to detect a sufficient number of lines.

Click on the  icon to discard any structural information collected during previous analysis steps.

Click on the  icon to toggle the display of line segments identified by any previous structural analysis.

examples

Here is an image with a skewed horizon and converging lines caused by directing the camera upwards:

Here is the image after having corrected for vertical and horizontal perspective distortions. Note the framing by the automatic cropping feature and the still-visible overlay of structural lines:

8.2.48. raw black/white point

Define camera-specific black and white points.

This module is activated automatically for all raw images. Default settings are applied for all supported cameras. Changes to the defaults are normally not required.

module controls

black level 0-3
The camera-specific black level of the four pixels in the RGGB Bayer pattern. Pixels with values lower than the defined level are considered not to contain valid data.

white point
The camera-specific white level. All pixels with values above this are likely to be clipped and will be handled accordingly in the *highlight reconstruction* module.

8.2.49. raw denoise

Perform denoising on raw image data before it is demosaiced.

This module has been ported from dcraw.

module controls

noise threshold
The threshold for noise detection. Higher values lead to stronger noise removal and greater loss of image detail.

coarse/fine curves
The noise of an image is usually a combination of fine-grained and coarse-grained noise. These curves allow the image to be denoised more or less depending on the coarseness of the visible noise. The left of the curve will act on very coarse grain noise, while the right of the curve will act on very fine grain noise.

Pushing the curve up will result in more smoothing, pulling it down will result in less smoothing. As an example, you can preserve very fine-grained noise by pulling down the rightmost point of the curve to the minimum value.

As another example, if you are tackling chroma noise with a blend mode, you can push the rightmost part of the curve up, as colors do not change a lot on fine grain scales. This will help especially if you see some isolated pixel left un-denoised.

The best way to use the R, G, and B curves is to examine each of the channels in turn using the *color calibration* module in gray mode, denoise that channel, and then repeat for the other channels. This way, you can take into account the fact that some channels may be noisier than others. Beware that guessing which channel is noisy without actually seeing the channels individually is not straightforward and can be counterintuitive. A pixel which is completely red may not be caused by noise on the R channel, but actually by noise on G and B channels.

See the wavelet section for more details.

8.2.50. retouch

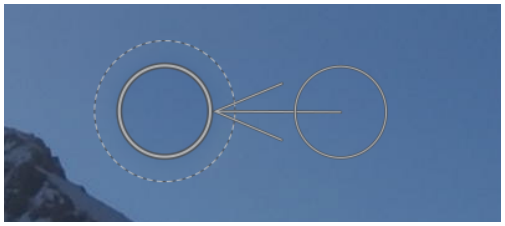
Remove unwanted image elements by cloning, healing, blurring and filling using drawn shapes.

This module extends the capabilities of the *spot removal* module by including a “heal” tool (based on the heal tool from GIMP) which provides a type of seamless cloning. It can also take advantage of wavelet decomposition, allowing the image to be separated into layers of varying detail (from coarse to fine). These layers can then be selectively retouched before being recombined to produce the output image. Examples of these capabilities are shown in the following sections.

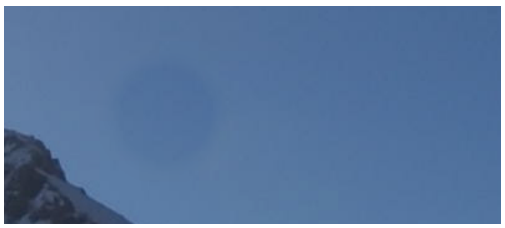
clone and heal

Cloning allows us to hide part of an image by replacing it with an area copied from another part of the image. For example, we may wish to get rid of a small cloud in a blue sky:

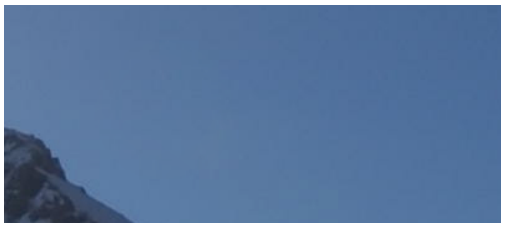
The simplest way to do this is with the *basic cloning* tool () – simply take a circle of blue sky next to the cloud, and use it to paint over the cloud we want to hide:



However, if the sample we take doesn't precisely match the surroundings of the item we want to clone out, the result can look a bit jarring. In our example, the sample of sky we chose to use (the clone "source" patch) was slightly darker than the piece of sky we wanted to replace (the "target" patch):



If we instead use the *heal* tool (), the color and luma of the sample is blended to fit better with the surroundings. In our example, using *heal* instead of *clone* gives a much more uniform-looking result:



fill and blur

The *clone* and *heal* tools both require us to specify another part of the image, which is used to "fill in" the region we want to hide. Sometimes there is no suitable sample in the image that we can use to fill over the spot. In such cases, the *retouch* module offers two further options:

 **fill tool**

This tool will fill in the selected region using a chosen color.

blur tool

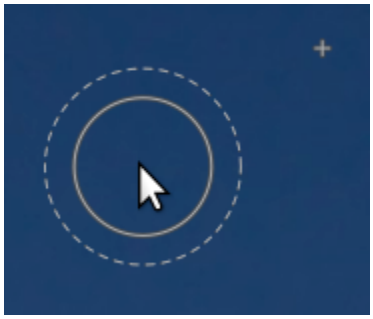
This tool applies a blur to the selected region, smoothing out any detail.

These two options are most useful when used together with wavelet decomposition, where they can be used to smooth over features within a selected detail layer.

source and target shapes

When you activate the *clone* or *heal* tool, you will place one or more matching pairs of shapes on the image, each consisting of a target region to be repaired, and a source region to use to undertake that repair. You must first choose the shape you wish to use (you can choose from *circle*, *ellipse*, *path* or *brush* – see the drawn masks section for details) and (except when using the path shape), an outline of the shape will appear under the cursor.

While you hover over the image with your mouse, a small plus sign (+) will be shown somewhere on the image, marking where the source shape will be placed by default. This plus sign will either be in a fixed position on the image or will move about with your cursor depending on whether the last pair of shapes was placed using absolute or relative mode (see below).



The source and target shapes can be placed onto the image in the following ways:

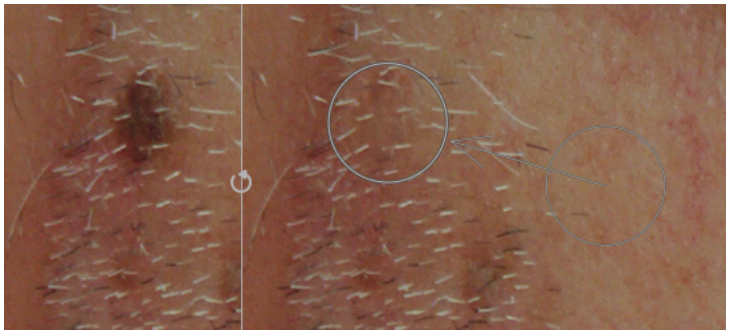
- Click on the image to begin placing the target shape (see the drawn masks section for details on how to draw shapes). The source shape will be placed at the position of the “plus” (+) sign on the image and can be adjusted later.
- Shift+click to change the position of the source shape in “relative mode”. The position of the “plus” (+) symbol will move to the clicked location. Then move the mouse and Click to begin placing the target shape. If you place subsequent shapes without changing the target location, the source shape will be placed at the same offset from the target shape as was used for the first stroke.
- Ctrl+Shift+click to change the position of the source shape in “absolute” mode. As above, the position of the “plus” (+) symbol will move to the clicked location and you can then place your target shape. If you place subsequent shapes without changing the target location, exactly the same source position will be used, fixed in the absolute coordinate system of the image.
- For *circle* and *ellipse* shapes only, you can simply click on the desired target location and then drag, releasing your mouse button when you reach the desired source location. This operation does not affect the placement of subsequent shapes.

The positions of the source and target shapes may then be altered manually.

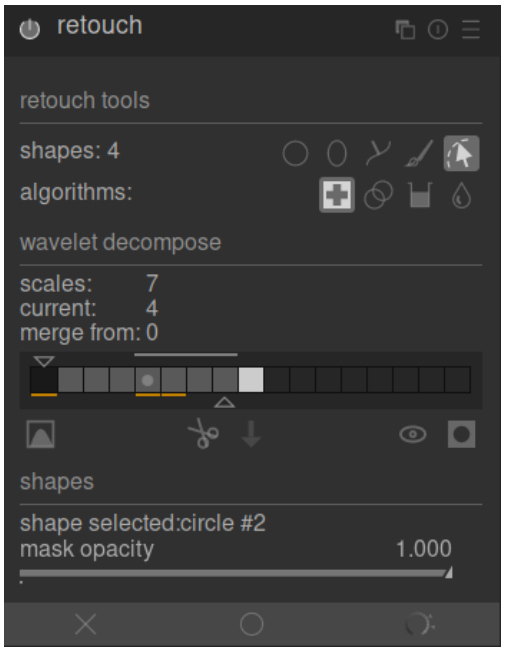
retouch with wavelet decomposition

Wavelets allow us to decompose an image into different layers with varying levels of detail, so that we can work on the layers independently and then recombine them at the end. This is particularly useful in portrait photography, where we are able to deal with skin blotches and blemishes on a coarse layer of detail, while leaving the skin texture in a finer layer of detail untouched. The *wavelets* section provides an example of how wavelets decompose the image into detail layers.

Through this method, we could for example use the healing tool to paint over a spot that appears in one of the coarse detail layers, while leaving the whiskers in the fine detail layers intact:



module controls



retouch tools

The *retouch tools* section consists of two items:

shapes

The number after the *shapes* label indicates how many shapes have been placed on the image, either directly or within a wavelet layer.

Click on one of the shape icons to draw a new shape on the image (see drawn masks for details).

Ctrl+click on a shape icon to draw multiple shapes continuously (right-click to cancel).

Click the *show and edit shapes* button () to show all existing shapes for the currently-selected wavelet scale (see below) and edit them.

algorithms
Choose a retouching algorithm: clone, heal, fill or blur (see above for details).

wavelet decompose

The *wavelet decompose* section centres around a bar graph showing how the image has been decomposed into different detail (scale) layers. The key features of the bar graph are:

- The black square on the left represents the entire non-decomposed image.
- The grey squares show the various wavelet layers, with fine details to the left, and coarse details to the right.
- The white square on the right represents the residual image (the remainder of the image after the detail layers have been extracted).
- A light grey dot in a square indicates the currently-selected layer. Click on another square to select a different layer.
- The light grey bar running along the top indicates which levels of detail are visible at the current zoom level. Zoom in closer to see the finer levels of detail.
- The triangle at the bottom shows how many layers the image has been decomposed into. Drag the triangle to the right to create more layers. Drag it to the left to decrease the number of layers. By default no wavelet decomposition is performed.
- The triangle at the top shows the current value of the “merge from” parameter (see below)
- The orange lines under the squares indicate which layers have retouching edits applied.

The remaining items in this ection are:

scales
Indicates how many detail layers the image has been decomposed into. Zero indicates that no wavelet decomposition has been performed.

current
Indicates which layer is currently selected (also marked with the light grey dot on the bar graph).

merge from
This setting allows a common edit to be applied to multiple consecutive scales within a group starting from the coarsest scale (not including the residual image) down to the scale selected. For example, if “merge from” is set to 3 and the maximum scale is 5 then all edits that are added to scale 5 will be applied to scales 3 to 5. Edits added to scale 4 will be applied to scales 3 and 4, and edits added to scale 3 will be applied only to scale 3. If you set *merge from* to 0, then merging is disabled, and all edits apply only to the scale that are defined in. Setting *merge from* to the highest scale (in this example, 5) would also effectively disable any merging.

```
         merge_from
             v
  0   1   2   3   4   5    scale
             <-------o     scale 5 edits
             <---o         scale 4 edits
             o             scale 3 edits
         o                 scale 2 edits
     o                     scale 1 edits
```

 **display wavelet scale**
Toggles whether to display the currently-selected wavelet layer on the center image. Selecting this option brings up an additional control – *preview single scale*.

preview single scale
An additional control that allows the black, white and grey points of the wavelet scale preview to be adjusted to make it easier to see. Click the  to set them automatically. This does not affect the module’s operation – only the wavelet scale preview.

 **cut**
Place all shapes on the currently-selected layer onto the clipboard so they can be moved to another layer

 **paste**
Move the shapes on the clipboard to the currently-selected layer.

 **temporarily switch off shapes**
Toggle all shapes (whether on the current layer or not) on or off, so temporarily removing the module’s effect.

display masks

Show the target shapes associated with the currently-selected layer with a yellow overlay.

shapes

This section allows you to modify settings related to the currently-selected shape:

shape selected

Indicates which shape is currently selected, and what type of shape it is.

fill mode

If the *fill* algorithm has been selected for the currently-selected shape, choose whether to “erase” or fill the selected shape with a chosen “color”.

fill color

If a *fill mode* of “color” has been selected, choose which color to fill the shape with. You can click to select or enter a custom rgb value or use the color picker to take a sample from the image.

brightness

If a *fill* algorithm has been selected, fine-tune the color’s brightness. This slider also works in “erase” mode.

blur type

If the *blur* algorithm has been selected for the currently-selected shape, choose whether to use a “gaussian” or “bilateral” blur.

blur radius

If the *blur* algorithm has been selected for the currently-selected shape, choose the radius of the blur.

mask opacity

Alter the opacity of the mask associated with the currently-selected shape. An opacity of 1.000 indicates the shape is completely opaque and the module’s effect is fully applied, whereas a value less than 1.000 indicates that the effect applied by the shape is blended with the underlying image to the degree indicated by the slider.

8.2.51. rgb curve

A classic digital photography tool to alter an image’s tones using curves.

This module is very similar to the *tone curve* module but works in RGB color space.

Activate the color picker on the left to show the picked values in the graph (Ctrl+click to use the picker in area mode). Numerical (Lab) values of the input and output (see below) at the selected spot or area are shown at the top left of the widget.

A second color picker to the right can be used to automtaically create new nodes based on the sampled area. Ctrl+click+drag to alter the created nodes to have a positive curve for the selected area; Shift+click+drag to create a negative curve.

module controls

*Please refer to the curves section for more details about how to modify curves including the **interpolation method** and **preserve colors** controls.*

mode

RGB is a linear color space designed to capture and display images in additive synthesis. It is related to the capture and display media and does not isolate color and lightness information in the same way that Lab and XYZ color spaces do. This module works in ProPhoto RGB. Adding contrast in RGB space is known to desaturate highlights and boost saturation in the shadows, but this has been proven to be the most reliable way to edit contrast, and is the standard method in most software

Depending on the desired intent you can apply the RGB curve in two different modes

- *RGB, linked channels*: Apply the L-channel curve to all three channels in the RGB color space.
- *RGB, independent channels*: R, G and B curves can be adjusted independently.

compensate middle grey

Select this to change the histogram display in the module. This option does not alter the processing but may assist when editing the curve.

8.2.52. rgb levels

Adjust black, white and mid-gray points in RGB color space. This module is silmilar to the *levels* module, which works in Lab color space.

The rgb levels tool shows a histogram of the image, and displays three bars with handles. Drag the handles to modify the black, middle-gray and white points in lightness (in “RGB, linked channels” mode) or independently for each of the R, G and B channels (in “RGB, independent channels” mode).

Moving the black and white bars to match the left and right borders of the histogram will make the output image span the full available tonal range. This will increase the image’s contrast.

Moving the middle bar will modify the middle-gray tones. Shifting it left will make the image look brighter, shifting it right will make it darker. This is often referred to as changing the image’s “gamma”.

Three color pickers are available for sampling the black, white and gray points from the image.

Note: Under certain conditions, especially with highly saturated blue light sources, the *levels* module may produce black pixel artifacts. See the “gamut clipping” option of the *input color profile* module for information about how to mitigate this issue.

---

module controls

mode
The mode of operation. “RGB, linked channels” (default) provides a single levels tool which updates all channels, taking into account the selected color preservation method (see “preserve colors” below). “RGB, independent channels” provides separate levels controls for each of the R, G and B channels.

auto
Auto-adjust the black and white point and put the gray point exactly in the mean between them. Use the color picker to auto-adjust based on a selected region of the image.

preserve colors
Choose a color preservation method when using “RGB, linked channels” mode (default “luminance”).

8.2.53. rotate pixels

The sensors of some cameras (such as the Fujifilm FinePix S2Pro, F700, and E550) have a diagonally oriented Bayer pattern instead of the usual orthogonal layout.

Without correction this would lead to a tilted image with black corners. This module applies the required rotation.

darktable detects images that need correction using their Exif data and automatically activates this module where required. For other images the module always remains disabled.

The module has no controls.

8.2.54. scale pixels

Some cameras (such as the Nikon D1X) have rectangular instead of the usual square sensor cells. Without correction this would lead to distorted images. This module applies the required scaling.

darktable detects images that need correction using their Exif data and automatically activates this module where required. For other images the module always remains disabled.

The module has no controls.

8.2.55. shadows and highlights

Modify the tonal range of the shadows and highlights of an image by enhancing local contrast.

module controls

shadows
Control the effect on shadows. Positive values will lighten shadows while negative values will darken them.

highlights
Control the effect on highlights. Positive values will lighten highlights while negative values will darken them.

white point adjustment
By default the algorithm of this module leaves the black and white points untouched. In some cases an image might contain tonal variations beyond the white point, i.e. above a luminance value of 100. A negative shift in the white point adjustment can bring these values back into the proper range so that further details in the highlights become visible.

soften with
The underlying blurring filter: gaussian or bilateral. Try the bilateral filter if the gaussian blur generates halos.

radius
The radius of the blurring filter used by the algorithm. Higher values give softer transitions between shadows and highlights but might introduce halos. Lower values will reduce the size of halos but may lead to an artificial look. The bilateral filter is much less prone to halo artifacts.

compress
Control how strongly the effect extends to the midtones. High values limit the effect to only the extreme shadows and highlights. Lower values also cause adjustments to the midtones. At 100% this module has no visible effect as only absolute black and absolute white are affected.

shadows color adjustment
Control the color saturation adjustment made to shadows. High values cause saturation enhancements on lightened shadows. Low values cause desaturation on lightened shadows. It is normally safe to leave this at its default of 100%. This gives a natural saturation boost on shadows – similar to what you would expect in nature if shadows were to receive more light.

highlights color adjustment
Control the color saturation adjustment made to highlights. High values cause saturation enhancements on darkened highlights. Low values cause desaturation on darkened highlights. Often highlights do not contain enough color information to give convincing colors when darkened. You might need to adjust this parameter in order to find the best fitting value depending on your specific image, but be aware that sometimes the results might not be fully satisfying.

8.2.56. sharpen

Sharpen the details in the image using a standard UnSharp Mask (USM).

This module works by increasing the contrast around edges and thereby enhancing the *impression* of sharpness of an image. This module is applied to the L channel in Lab color space.

module controls

radius
The unsharp mask applies a gaussian blur to the image as part of its algorithm. This parameter controls the radius of that blur which, in turn, defines the spatial extent of the edge enhancement. Very high values will lead to ugly over-sharpening.

amount
The strength of the sharpening.

threshold
Contrast differences below this threshold are excluded from sharpening. Use this to avoid amplification of noise.

8.2.57. soften

Create a softened image using the Orton effect.

Michael Orton achieved his results on slide film by using two exposures of the same scene, one well exposed and one overexposed. He then used a darkroom technique to blend these two images into a final image where the overexposed image was blurred.

This module is a near-copy of Orton’s analog process into the digital domain.

module controls

size
The size of blur of the overexposed image. The bigger the size, the softer the result.
saturation
The saturation of the overexposed image.
brightness
The brightness (EV) of the overexposed image.
mix
How the two images are mixed. 50% represents an equal mix of the well exposed and overexposed images.

8.2.58. split-toning

Create a two color linear toning effect where the shadows and highlights are represented by two different colors.

The split-toning module does not convert images to black and white and has limited benefits on color images. In order to perform traditional split-toning, the input to this module should therefore be monochrome.

module controls

shadows and highlights color
Set the desired hue and saturation for both shadows and highlights. Clicking on the colored squares will open a color selector dialog which offers you a choice of commonly used colors, or allows you to define a color in RGB color space.
balance
The ratio of toning between shadows and highlights. When set to 50%, half of the lightness range in image is used for shadows toning and the other half for highlights toning.
compression
The percentage of total (mid-tone) lightness range that is not affected by color toning. This compresses the effect on the shadows and highlights while preserving the mid-tones.

8.2.59. spot removal

Correct areas of an image (the target) using details from another area of the image (the source).

This module uses some of the shapes that are available for drawn masks (circles, ellipses and paths), and the user interface is similar.

To use this module, first select the desired shape by clicking the corresponding shape icon (Ctrl+click to enable continuous shape creation mode). Next, you may optionally choose the source for the correction by using Shift+Ctrl+click or Shift+click on the image canvas to choose absolute or relative mode, respectively (see below). Finally click on the canvas to choose the area to be healed (the target area). A cross is displayed where the source area will be positioned.

The source positioning has two modes

absolute mode
Before placing a shape on the image canvas, Shift+Ctrl+click on the desired position for the source. From this point on, all new shapes will have their source created at the same absolute position (in image co-ordinates).

relative mode
Before placing a shape on the image canvas, Shift+click on the desired position for the source. The current shape will have the source created at that position and subsequent shapes will have their source created at the same position, *relative to the target shape*.

After creation the source and target areas of each shape can be shifted independently until the result matches your expectations. An arrow points from the source area of each shape to its target.

Use the shape-specific controls to adjust each shape's size, border width, and other attributes.

Right-click on a shape to delete it.

This module is equivalent to the "cloning" tool in the *retouch* module; see the description of the cloning tool for additional details and examples. If *spot removal* produces unsatisfactory results, you may want to try the "heal" tool in *retouch* instead.

8.2.60. surface blur

Denoise high ISO images.

This module reduces noise in the image while preserving sharp edges. This is accomplished by averaging pixels with their neighbors, taking into account not only their geometric distance but also their distance on the range scale (i.e. differences in the RGB values). This module is particularly effective if one RGB channel is more noisy than the others. In such a case, use the *color calibration* module to examine the channels one by one, in order to set the blur intensities accordingly.

As denoising is a resource-intensive process, it slows down pixelpipe processing significantly. Consider activating this module late in your workflow.

module controls

radius
The spacial extent of the gaussian blur.
red, green, blue
The blur intensity for each of the RGB channels.

8.2.61. tone curve

A classic digital photography tool to alter an image's tones using curves.

This module is very similar to the *rgb curve* module but works in Lab color space.

Activate the color picker to show the picked values in the histogram (Ctrl+click to use the picker in area mode). Numerical (Lab) values of the input and output (see below) at the selected spot or area are shown at the top left of the widget.

module controls

*Please refer to the curves section for more details about how to modify curves including the **interpolation method**, **scale for graph** and **preserve colors** controls.*

color spaces

Depending on the desired intent, you can apply the tone curve in three different color spaces:

- Lab (linked channels or separated channels),
- XYZ (linked channels)
- RGB (linked channels)

Lab is a perceptual color space that is designed to approximate the way humans perceive colors and lightness, and represents color information independently of lightness information. In “Lab, separated channels”, you are given fully independent control over the luminance (L-channel) and the chrominance (a/b-channels). In “Lab, linked channels” mode, only the luminance (L-channel) control is available. The color saturation correction will be automatically computed, for each pixel, from the contrast correction applied to the luminance channel. This works better in cases where a subtle contrast correction is applied, but gives increasingly inaccurate saturation correction as the contrast gets more dramatically enhanced.

XYZ is a linear technical color space designed to link the physiological light response of human eyes to RGB spaces. As with Lab, it separates lightness from color information, but it does so in a way that does not account for the role of the brain’s correction in human perception. The “XYZ, linked channels” mode offers an alternative to “Lab, linked channels”. It works by applying the L-channel curve to all three channels in the XYZ color space. Look at blend mode “coloradjustment” if you want to tune the strength of automatic chroma scaling. This mode is known to produce a slight hue shift towards yellow.

RGB is a linear color space designed to capture and display images in additive synthesis. It is related to capture and display media and does not isolate color and lightness information. The “RGB, linked channels” mode works in ProPhoto RGB and applies the L-channel curve to all three channels in the RGB color space. Adding contrast in RGB space is known to desaturate highlights and boost saturation in lowlights, but this has proven to be the most reliable way to edit contrast, and is the standard method used in most software. This mode makes the tone curve module behave in much the same way as the base-curve module, except that the latter works in camera RGB space.

Note that the interface works in Lab color space in all cases. This means that the middle-gray coordinate is always 50% in the graph, no matter what color space is used. The same applies to the inset histogram displayed in the background of the curve. The controls are converted to the relevant color space before the corrections are applied – in RGB and XYZ, the middle-gray is therefore remapped from 50% to 18%.

L-channel curve

The tone curve in L-channel works on Lightness. To provide a better overview, a lightness histogram is displayed in the module. When working in one of the “linked channels” modes, the L-channel curve is the only one available.

The horizontal line represents the lightness of the input image pixels. The vertical line represents the lightness of the output image pixels. The default straight diagonal line does not change anything. A curve above the default diagonal increases the lightness, whereas a curve below decreases it. An S-like curve will enhance the contrast of the image. You can move the end-points of the default diagonal to change the black point and white point and hence alter the overall contrast – this has the same effect as changing the black and white points in the *levels* module.

a/b-channel curves

The curves in the a and b channels work on color values and are available only in the “Lab, separated channels” mode. The horizontal line represents the color channel value of the input image pixels. The vertical line represents the color channel value of the output image pixels. Positive a-values correspond to more magenta colors; negative a-values correspond to more greenish colors. Positive b-values correspond to more yellowish colors; negative b-values correspond to more blueish colors.

The default diagonal straight line does not change anything. Shifting the center of the curve will give the image a color tint: shifting the a-channel upwards gives a magenta tint; shifting the b-channel upwards gives a yellow tint; shifting the a-channel downwards gives a green tint; shifting the b-channel downwards gives a blue tint.

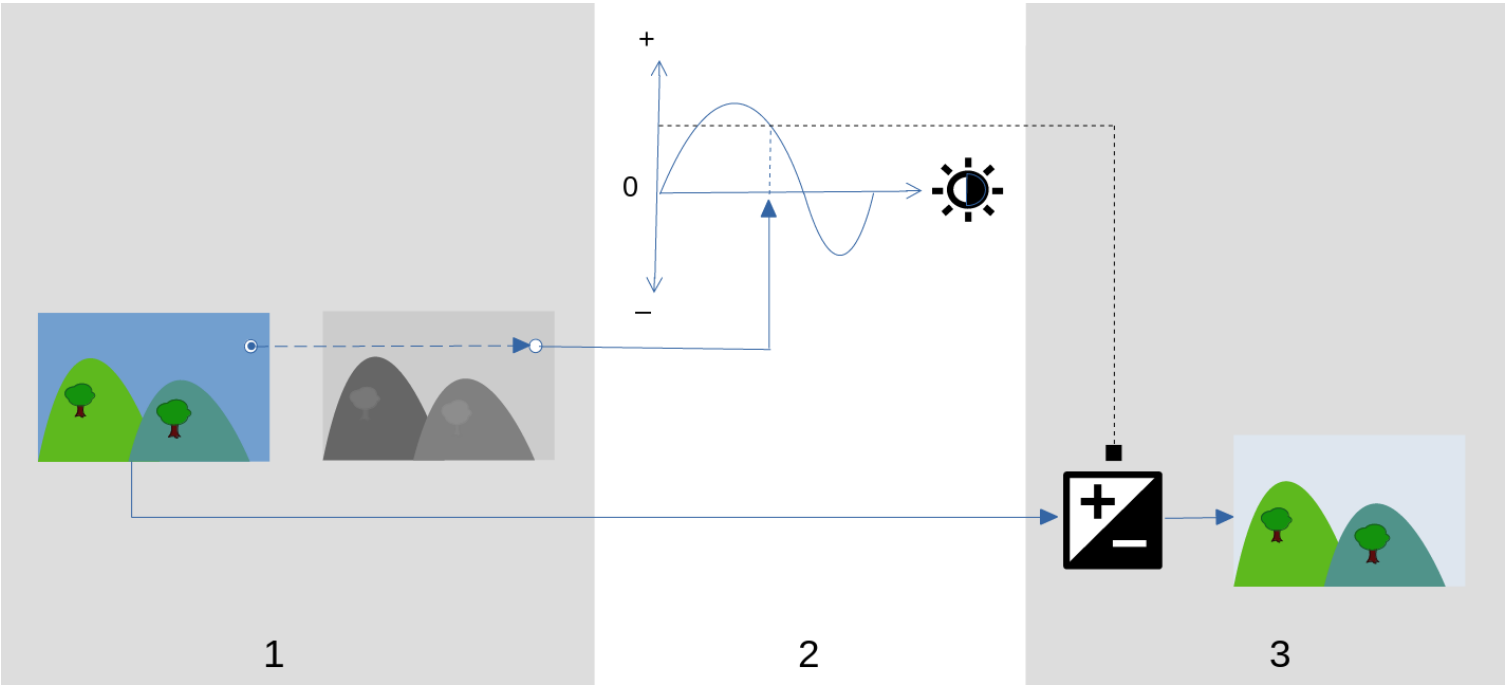
Increasing/decreasing the steepness of a curve, without shifting its center, will increase/decrease the color saturation of the respective channel. With properly defined curves you can exert fine control on color saturation, depending on the input pixel’s colors.

8.2.62. tone equalizer

Perform dodging and burning on an image while preserving local contrast.

This module can selectively brighten or darken up to 9 different ranges of luminosity. When used together with *filmic rgb*, it replaces the need for other tone-mapping modules such as the *base curve*, *shadows and highlights*, *tone curve* and *zone system (deprecated)* modules. It works in linear RGB space and uses a mask to guide the dodging and burning adjustments, helping to preserve local contrast within the image.

In order to understand how the tone equalizer works, please refer to the following diagram and subsequent explanation:



1. Produce a monochrome mask which divides the input image into regions of similar luminosity. The resulting mask should blur the fine details within the image so that pixels within that region are all treated similarly. This will help to preserve local contrast.

2. Once the mask is defined, the sliders (in the simple tab) or the equalizer graph (in the advanced tab) can be adjusted to increase or decrease the brightness of the image, based on the brightness of the mask. That is, the horizonal axis of the equalizer graph corresponds to the brightness level of the mask, and the vertical axis specifies the exposure adjustment that will be be made to pixels where the mask matches that brightness level.

3. The exposure of each pixel of the input image is adjusted using the mask and the equalizer graph. For each pixel, the module looks up the brightness of the mask, finds the matching brightness on the horizontal axis of the equalizer graph and increases or decreases the exposure accordingly (using the vertical axis of the graph).

It is important when using the tone equalizer that the mask divides your image up into different regions of similar brightness, and that a suitable amount of blur is applied within those regions. This means that all of the pixels in each region will have a similar adjustment to their exposure, without adversely affecting local contrast. Examine your image beforehand to identify which regions you wish to dodge and burn, and use the controls on the *masking tab* to ensure that those areas are reasonably separated in tone in the final mask. This will allow those regions to be adjusted independently of one another.

module controls

The controls of the *tone equalizer* module are spread across 3 tabs. It is also possible to adjust the exposure levels when hovering the mouse cursor over different parts of the preview image.

The following control is provided in all three tabs:

display exposure mask
Click on the icon to the right of this label to show/hide the module's guided mask over the top of the image.

simple

This tab provides a set of sliders that control how the module affects the pixels falling under 9 different mask intensity levels. This is a simplified interface and is used to generate the tone adjustment curve, which is more fully illustrated in the *advanced* tab.

-8 EV through to 0 EV

Each of these sliders will adjust the brightness of all pixels having that intensity level *in the guided mask*. Sliders towards the top will generally affect the shadows of the image, whereas sliders towards the bottom will generally affect the highlights of the image, assuming the mask's histogram is nicely spread over the entire tonal range (you can check this by referring to the histogram image shown on the *advanced* tab).

advanced

This tab allows you to control the same intensity levels as in the basic tab, though here they are represented as control points on a curve. Behind the curve is a histogram representing the intensity levels of the ***mask*** (not of the input or output image). If the histogram is too bunched up, it means your mask doesn't have a good spread of intensity levels, which makes it harder to independently control the brightness of different parts of your image. It is therefore recommended that the histogram is adjusted so that it extends the entire range, and covers as many control points as possible, thereby providing you with maximum flexibility. You can adjust the mask using the controls in the *masking* tab.

control points on the curve

Click+drag the control points on the tone equalizer curve up or down to adjust the brightness of all pixels that are classified under that mask intensity level. Control points to the left will normally affect the shadows, and control points to the right will normally affect the highlights, assuming you have a nice spread of the mask histogram. Moving one control point will generally affect control points on either side to ensure the curve remains smooth.

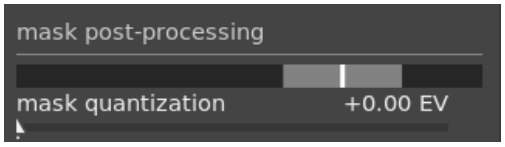
curve smoothing

Moving this control to the right will cause the transitions between the control points to become more gradual. However, going past about 0.6 can introduce some instability in the curve, causing oscillations due to the mathematical constraints on the curve. Moving this slider to the left will result in a better behaved curve, but it may result in harsher tone transitions that may damage local contrast.

masking

This tab contains all of the controls required to set up the guided mask. The purpose of the mask is to mark out areas in your image with different tonal ranges so that these areas can be independently brightened or darkened by the tone equalizer. The masking filters are designed to allow sharp edges between these areas to be preserved, while blurring details within a particular tonal range so that the brightness can be adjusted without adversely impacting local contrast. Ideally you want the mask histogram shown in the *advanced* tab to be nicely spread out across all the control points.

To avoid having to switch back and forth between the *advanced* tab and the *masking* tab, under the "mask post processing" label there is a grey bar which shows a representation of the middle 80% of the histogram. By using the controls mentioned below to centre and spread out this grey bar, you can then expect to have a nicely shaped histogram when you return to the "advanced" tab. If you see orange at either end of the grey bar, it means too much of the histogram has moved off the edge of the screen, and you need to bring it back to centre and/or compress it a bit more.



When setting up the mask, there are a number of trade-offs to be made to balance the blurring within tonal regions against the preservation of boundaries between these regions.

Often the key controls requiring adjustment are the *exposure/contrast compensation* sliders at the bottom of the module.

The controls on the masking tab allow you to ensure that the mask properly covers the required range of tones. They also allow you to strike a balance between obtaining a smooth blur that preserves local contrast and creating more or less well defined edges between the different regions as required. Having this mask displayed while making these adjustments will assist in understanding the parameters that follow.

luminence estimator

Choose the method by which the luminence of a pixel will be estimated when mapping it to a mask intensity value (default *RGB euclidean norm*).

preserve details

Choose the smoothing algorithm to use when blurring the mask. An exposure independent guided filter will be used by default, which is effective at preserving strong edges while avoiding gradient reversals that result in artifacts like halos.

- *no:* Do not smooth the mask (effect is the same as using normal tone curves). When the module is used to compress dynamic range, the use of this option can cause compression of local contrast. It can be useful when increasing (local and global) contrast.
- *guided filter:* Use the original guided filter algorithm to blur the mask while attempting to preserve edges. One of the limitations of this algorithm is that the guided filter is exposure-sensitive, meaning that shadows will experience a lot more blurring than the highlights. Note that this limitation can be an asset sometimes: if one wants to lighten shadows a lot, the guided filter can provide very good local contrast preservation.
- *average guided filter:* Use this option in cases where the effect of the guided filter is too strong. In this mode, a geometric mean is taken between the output of the original *guided filter* algorithm and the output that is given by the *no* option.
- *eigf (default):* The *exposure independent guided filter* solves the problem of the original *guided filter*, in that it makes the degree of blurring independent of the exposure. This means the degree of blurring applied to the highlights and the shadows regions should be about the same. This improved algorithm is now the default option.
- *averaged eigf:* This option takes the geometric mean between the *eigf* mask and the mask generated by the *no* option, and is useful in cases where the degree of blurring in the mask needs to be mitigated.

filter diffusion

By default this is set to a value of 1, meaning that the filtering algorithm is run once on the input image in order to produce the blurred monochrome mask.

If you increase this to 2, the filtering algorithm will be run once on the input image to produce an intermediate mask, and will then be applied a second time on the intermediate mask to produce the final mask. As a result, the final mask will be more blurred than when using a single iteration. Progressively higher values will diffuse the mask even further, however because the mask filtering algorithm is run multiple times, it will cost more in terms of processing time.

smoothing diameter

This controls how much of the surrounding image to take into account when calculating the mask's blur at a particular point, defined as a percentage of the length of the longer side of the image (default 5%). With lower values, the transition between darker and lighter areas of the mask will be more pronounced. As this value is increased, those transitions become smoother/softer. For the default exposure-independent guided filter (EIGF), you should typically use blurring radii around 1-10%. With the original guided filter, blurring radii around 1-25% will typically yield better results.

edges refinement/feathering

Higher values will force the mask to follow high contrast edges more closely. Lower values will give smoother gradients, but may introduce some halos. If needed, feathering can be set to values as high as 10000.

mask post-processing

As discussed above, this provides a representation of the span of the histogram. It covers the middle 80% of the histogram, dropping the first and last decile to prevent outliers from skewing the indicator too much.

mask quantisation

This slider applies some degree of posterisation to the mask, so that the mask will tend to centre round a few discrete levels. In some cases, this may be useful to help separate out areas of your image into different masking levels.

mask exposure compensation

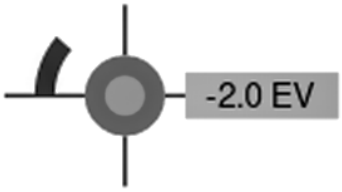
Adjust the histogram to the left or right. Often if you have used the *exposure* module earlier in your pixel pipeline to adjust the image brightness, you'll need to offset that adjustment by using this exposure compensation slider to re-centre the mask's histogram. Click on the eyedropper icon to the right of the slider to set the exposure compensation such that the average of the mask's histogram will coincide with the central -4EV control point. The slider can then be fine tuned as required.

mask contrast compensation

Spread out (dilate) or compress the histogram as needed. The auto-adjust eyedropper icon to the right of the slider will propose a reasonable starting point, which can then be fine-tuned to optimize the spread of the histogram under the tone equalizer control points.

cursor indicator/control

When the *tone equalizer* module is selected, moving the mouse pointer over the preview image reveals a cursor that displays information about the pixel under the mouse pointer. When this cursor is shown, the mouse wheel can be used to brighten or darken areas of your image that match the mask intensity level at that point. This provides a convenient way to quickly brighten or darken specific parts of the image.



- cross hairs indicate the pixel for which information is being displayed
- the text label shows the intensity of the mask at that point, in EV.
- the shade of the larger grey circle provides a visual indication of the intensity of the mask at that point
- if the tone equalizer is going to brighten or darken pixels matching this mask intensity, the magnitude of this adjustment is indicated by an arc around the outside of the large circle. The longer the arc, the greater the brightness adjustment,
- if there has been an exposure adjustment, the shade of the smaller inner circle indicates the amount of brightening or darkening, relative to the mask intensity indicated by the outer grey circle. That is to say, if the pixel under the crosshairs will be brightened, the inner circle will be a lighter shade of grey than the larger circle; if the pixel is to be darkened, the inner circle will be a darker shade of grey than the outer circle.

presets

The *tone equalizer* comes with several presets that can use used to compress shadows and highlights. Each comes in two variants, using either the guided filter (gf) or the exposure independent guided filter (eigf). The variants using the guided filter tend to preserve local contrast in the shadows better those that use the exposure independent guided filter, but at the price of reducing the local contrast in the highlights. Depending on your photo, either of these variants may lead to better results. In both cases, the presets preserve middle-grey so that you don’t have to adjust the global exposure before and after activating the tone equalizer.

8.2.63. tone mapping (deprecated)

Please note that this module is deprecated in darktable 3.4 and should no longer be used for new edits. Please use the *tone equalizer* module instead.

Compress the tonal range of HDR images so that they fit into the limits of an LDR image, using Durand’s 2002 algorithm.

The underlying algorithm uses a bilateral filter to decompose an image into a coarse base layer and a detail layer. The contrast of the base layer is compressed, while the detail layer is preserved, then both layers are re-combined.

module controls

contrast compression
The contrast compression level of the base layer. A higher compression will make the image fit a lower dynamic range.

spatial extent
The spatial extent of the bilateral filter. Lower values cause the contrast compression to have stronger effects on image details.

8.2.64. unbreak input profile

Add a correction curve to image data. This is required if you have selected certain input profiles in the *input color profile* module.

If you decide to use an ICC profile from the camera manufacturer in the *input color profile* module, a correction curve frequently needs to be pre-applied to image data to prevent the final output from looking too dark. This extra processing is not required if you use darktable's standard or enhanced color matrices.

The correction curve is defined with a linear part extending from the shadows to some upper limit and a gamma curve covering mid-tones and highlights. For further information please see darktable's neighboring project UFRaw.

linear
The upper limit for the region counted as shadows and where no gamma correction is performed. Typically values between 0.0 and 0.1 are required by the profile.

gamma
The gamma value required to compensate the input profile. Often the required value is 0.45 (the reciprocal of the 2.2 gamma used by some manufacturer's profiles).

8.2.65. velvia

Resaturate pixels in a weighted manner that gives more weight to blacks, whites and low-saturation pixels.

module controls

strength
The strength of the effect

mid-tones bias
Reduce the effect on mid-tones in order to avoid unnatural skin tones. Reducing the mid-tone bias reduces mid-tone protection and makes the overall velvia effect stronger.

8.2.66. vibrance

Saturate and reduce the lightness of the most saturated pixels to make the colors more vivid.

module controls

vibrance
The amount of vibrance to apply to the image.

8.2.67. vignetting

Apply a vignetting effect to the image.

Vignetting is a modification of the brightness and saturation at the borders of the image in a specified shape. Many of the parameters listed below can also be modified with a graphical control that overlays the image when the module has focus, showing the shape and extent of the effect.

Note: This module is known to provoke banding artifacts under certain conditions. You should consider activating the *dithering* module to alleviate this.

---

module controls

scale
The radius of the vignetting area

fall-off strength
The progressiveness of the fall-off. Higher values will cause a steeper transition.

brightness
The intensity of brightening (positive values) or darkening (negative values).

saturation
Control how strong colors become when desaturated/saturated in the darkened/brightened vignetting area.

horizontal/vertical center
Shift the center of the vignetting area horizontally/vertically.

shape
The shape of the vignetting effect. The default value of 1 creates a circular or elliptical area. Smaller values will shift the shape to being more square; higher values turn it into a cross-like shape.

automatic ratio
Automatically adjust the width/height ratio of the vignetting area to match the aspect ratio of the underlying image. The vignetting area will typically become elliptical.

width/height ratio
Manually adjust the width/height ratio of the vignetting area.

dithering
Activate random noise dithering to alleviate banding artifacts caused by vignette gradients. Select “8-bit output” to prevent banding on monitor display and for JPEGs. When set to “16-bit output”, only a little dithering will be applied, just strong enough to compensate for banding on the fine grained 16-bit level. It is now recommended that you instead use the *dithering* module to alleviate banding artifacts.

8.2.68. watermark

Render a vector-based overlay onto your image. Watermarks are standard SVG documents and can be designed using Inkscape.

The SVG processor of darktable can also substitute strings within the SVG document, which allows you to include image dependent information in the watermark.

User-designed watermarks should be placed into the directory `$HOME/.config/darktable/watermarks`. Once in place, use the reload button update the list of available watermarks.

The following is a list of variable strings that are supported for substitution within the SVG document.

In addition to this list you can also use the variable strings defined in the variables section.

```
$(DARKTABLE.NAME)             The application name
$(DARKTABLE.VERSION)          The version of darktable
$(WATERMARK_TEXT)             A short free text (max. 63 characters)
$(WATERMARK_COLOR)            The color to use for $WATERMARK_TEXT
$(WATERMARK_FONT_FAMILY)      The font family to use for $WATERMARK_TEXT
$(WATERMARK_FONT_STYLE)       The font style (normal, oblique, italic)
$(WATERMARK_FONT_WEIGHT)      The font weight (boldness)
$(IMAGE.ID)                   The unique image id within current library
$(IMAGE.FILENAME)             The image filename
$(IMAGE.BASENAME)             The image file basename
$(IMAGE.EXIF)                 The image Exif string
$(EXIF.DATE)                  The image date
$(EXIF.DATE.SECOND)           Seconds from the image Exif data
$(EXIF.DATE.MINUTE)           Minutes from the image Exif data
$(EXIF.DATE.HOUR)             Hours from the image Exif data (24h)
$(EXIF.DATE.HOUR_AMPM)        Hours from the image Exif data (12h, AM/PM)
$(EXIF.DATE.DAY)              Day of month from the image Exif data (01 .. 31)
$(EXIF.DATE.MONTH)            Month from the image Exif data (01 .. 12)
$(EXIF.DATE.SHORT_MONTH)      Month from the image Exif data localized (Jan, Feb, .. Dec)
$(EXIF.DATE.LONG_MONTH)       Month from the image Exif data localized (January, February, .. December)
$(EXIF.DATE.SHORT_YEAR)       Abbreviated year from the image Exif data (2013 is "13")
$(EXIF.DATE.LONG_YEAR)        Full year from the image Exif data
$(DATE)                       Current system date
$(DATE.SECOND)                Current system time seconds
$(DATE.MINUTE)                Current system time minutes
$(DATE.HOUR)                  Current system time hours (24h)
$(DATE.HOUR_AMPM)             Current system time hours (12, AP/PM)
$(DATE.DAY)                   Current system time day of month (01 .. 31)
```

```
$(DATE.MONTH)                Current system time month (01 .. 12)
$(DATE.SHORT_MONTH)          Current system time month localized (Jan, Feb, .. Dec)
$(DATE.LONG_MONTH)           Current system time month localized (January, February, .. December)
$(DATE.SHORT_YEAR)           Current system time year (abbreviated)
$(DATE.LONG_YEAR)            Current system time year
$(EXIF.MAKER)                The maker of camera model
$(EXIF.MODEL)                The camera model
$(EXIF.LENS)                 The specific lens used
$(Xmp.dc.creator)            The creator string
$(Xmp.dc.publisher)          The publisher string
$(Xmp.dc.title)              The title of the image
$(Xmp.dc.description)        The description of the image.
                             Some cameras use this to store shoot-time user-specified text (also called “Exif.P
$(Xmp.dc.rights)             The rights assigned to the image
$(GPS.LATITUDE)              The image latitude coordinate (N/S 0 .. 90)
$(GPS.LONGITUDE)             The image longitude coordinate (E/W 0 .. 180)
$(GPS.ELEVATION)             The image elevation level (meters)
$(GPS.LOCATION)              All three coordinates (latitude, longitude, elevation)
```

module controls

marker
Choose the watermark to apply. You can use the reload button to update the list to include any newly-added watermarks.

text
A free text field in which you can enter up to 63 characters to be printed where referenced by the corresponding watermark. An example is supplied as `simple-text.svg`.

text color
The color of the text. Click on the colored field to open a color selector dialog which offers you a choice of commonly used colors, or allows you to define a color in RGB color space.

text font
The font to use (default “DejaVu Sans Book”). Clicking on the field opens a dialog box which shows the fonts available on your system. Fonts can be searched by name and a preview of each available font is shown next to the font name. You may specify your own sample text.

opacity
The opacity of the watermark’s rendering.

scale
Scale the watermark pixel-independently.

rotate
The rotation angle of the watermark.

scale on
The reference for the scale parameter. The default setting “image” scales the watermark relative to the horizontal image size. Alternatively you can scale the watermark relative to the “larger border” or “smaller border”.

alignment
Use these controls to align the watermark to any edge or the center of the image.

x offset
Pixel-independent offset relative to the choice of alignment on the x-axis.

y offset
Pixel-independent offset relative to the choice of alignment on the y-axis.

8.2.69. white balance

Adjust the white balance of the image by altering the temperature and tint, defining a coefficient for each (RGB) channel, or choosing from list of predefined white balance settings.

The default settings for this module are derived from the camera white balance stored in the image’s Exif data.

White balance is not intended as a “creative” module – its primary goal is is to technically correct the white balance of the image ensuring that neutral colored objects in the scene are rendered as neutral colors in the image. For creative color operations, it is usually better to use other modules such as the *color calibration* or the *color balance* module.

module controls

scene illuminant temp

This section provides scene-illuminanant *temperature* and *tint* controls to adjust the white balace of the image. Click on the 'scene illuminant temp' label to cycle between 3 different slider color modes. See the *colored sliders* section below for more information.

temperature
Set the color temperature in Kelvin.

tint
Alter the color tint of the image, from magenta (value < 1) to green (value > 1)

white balance presets

setting
Choose from a predetermined list of white balances. The available selections are dervied from the presets available in the camera that was used to take the photograph. The following options are provided in addition to any camera-defined white balance presets.

- *as shot* (default): The white balance as reported by the camera
- *from image area*: Draw a rectangle over a neutral color in the image from which the white balance will be automatically calculated
- *user modifed*: The most recently modified setting. Manual adjustment of temperature, tint or r/g/b channel coefficients will automatically select this option. Choosing this setting after selecting any other preset will return parameters to the most recent user-modified state
- *camera reference*: Set the temperate to the camera reference white point, which is assumed to be D65 (or ~6502K). The white balance channel multipliers are calculated such that pure white in the camera colorspace is converted into pure white in sRGB D65 (where pure white means that each color channel has an equal value).

For convenience the final four modes can also be set by clicking on one of the buttons above the *setting* drop-down.

finetune
Finetune a camera-specific white balance preset. This is only shown if it is available for the camera in question. The direction of adjustment is dependent on the provided presets. If your camera doesn't have white balance presets available, check this guide to see how you can submit your own.

channel coefficients

By default the RGB channel coefficients are hidden. You can expand/collapse the channel coefficients section by clicking on either the 'channel coefficients' label or the adjacent triangular button.

red/green/blue
Set the value of each RGB channel from 0 to 8

additional functionality

colored sliders

By default the module's sliders are monochrome. However two flavors of colored sliders can be enabled in preferences > darkroom > white balance slider colors or by clicking on the 'scene illuminant temp' label in the module.

no color
This is the default mode, meaning that background of the sliders is not colored at all.

illuminant color
The slider colors represent the color of the light source (the color you are adjusting to in order to achieve neutral white).

effect emulation
The slider colors represent the effect the adjustment would have had on the scene. This is how most other raw processors show temperature/tint sliders colors.

button bar

The button bar is simple addition to allow one-click access to the internal white balance settings. If desired, you can disable this by editing your `darktablerc` file. Find line that says

```
plugins/darkroom/temperature/button_bar=TRUE
```

and change it to:

```
plugins/darkroom/temperature/button_bar=FALSE
```

usage warning

The only parameters that are used internally by this module's operation are the *rgb channel coefficients*, with the *temperature* and *tint* sliders provided merely as more user-friendly ways to adjust those parameters. The relationship between the channel coefficients and temperature/tint sliders depends on camera-specific characteristics. This means that applying the white balance settings from an image made with one camera model to an image made with another model will, in general, not give consistent results.

The mathematical relationship between the two sets of values is not straightforward. It is possible to set the channel coefficients such that there is no valid equivalent setting in terms of temperature and tint (mainly where very high temperature values are calculated from the slider values). Editing white balance using temperature and tint on an image previously edited using channel coefficients may therefore give odd results, at least where high temperature values are involved.

8.2.70. zone system (deprecated)

Please note that this module is deprecated in darktable 3.4 and should no longer be used for new edits. Please use the *tone equalizer* or multiple instances of the *exposure* module with parametric masks to narrow down on a zone.

Adjust the lightness of an image using Ansel Adams' zone system.

The lightness of the image (the L channel in Lab color space) is divided into a number of zones ranging from pure black to pure white. These zones are displayed in a zonebar beneath a preview image. The number of zones can be changed by mouse-scrolling on that bar (default 10 zones).

The zonebar is split horizontally with the lower part showing the zones of the module's input and the upper part the zones of the module's output. In its default state both parts are fully aligned. While the output zones are static you can left click and drag a control point in the input zones to modify the mapping between input and output.

Shifting a control point proportionally expands the zones on one side and compresses the zones on the other side of that point. All pre-existing control points stay in place, effectively preventing changes to the zones beyond the next control point. Use right click to remove a control point.

The preview image above the zonebar shows how the image's zones are broken down. When hovering above a zone, that zone – either from input or output – is highlighted in yellow on the preview image.

8.3. utility modules

8.3.1. darkroom

8.3.1.1. clipping warning

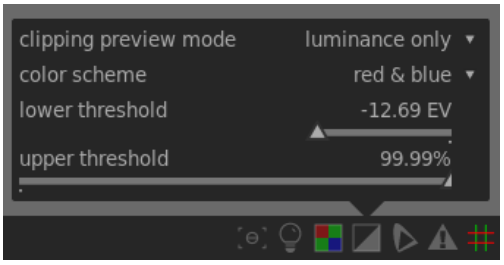
When an image is sent to a display device, each pixel is normally represented as a set of 3 numbers, representing the intensity of the red, green and blue primary colors in the output color space. Because the output color space is usually closely related to hardware with physical limations, there is a maximum permitted value for the [R,G,B] channels, representing the maximum available intensity for that color space. Similarly, there is also a minimum value below which pixel values will be mapped to zero. When we try to convert from a larger color space to the final output color space, any values exceeding this maximum will be clamped to the maximum value, and any values below the minimum will be clamped to zero. This process is called “clipping” and it will lead to lost detail, or “incorrect” colors for any pixels with clipped channels.

There are two ways in which a pixel might become clipped when represented in the output color space.

- *luminance* clipping can occur when a pixel is too bright to be represented in the output color space. The pixel luminance is calculated as a weighted average of the [R,G,B] channels. If this average exceeds the maximum allowed value, it is an indication of over-exposure. The overall luminance of a pixel can also be too dark to be represented by an [R,G,B] value in the output color space, in which case it will simply be shown as black. We normally deal with luminance clipping by carefully adjusting tone mappings and exposure levels.
- *gamut* clipping. The output color space defines a set of primary colors that, mixed together in certain ratios, produce the final output color. However, there are only so many colors that can be produced by mixing together a combination of those three primary colors. Highly saturated colors in particular can be difficult to represent, especially for pixels that are very bright or very dark. If there is no set of positive [R,G,B] values that can represent a given color at a given level of brightness, we say the color is “out of gamut”, and we’ll need to settle for another color instead that *can* be represented by permitted [R,G,B] values within the color space. We can handle gamut clipping by
being careful not to over-saturate colors in the highlights and shadows, and possibly by using some color grading/ color mapping techniques.

The “clipping warning” module is used to highlight those pixels that cannot be accurately represented in the output color space, either due to luminance or gamut clipping. Prior to darktable 3.4, the clipping highlighted any pixels that exceeded the maximum allowed value on any of the [R,G,B] channels, or that had been completely crushed to black. From darktable 3.4 onwards, the clipping warning indicator has some additional modes to help you to differentiate between luminance and gamut clipping, so that you can make better decisions about how to address any issues.

As the clipping warning runs at the end of the preview pixelpipe, it receives data in display color space then converts it to histogram color space. If you are using a display color space which is not “well behaved” (this is common for a device profile), then colors which are outside of the gamut of the display profile will clip or distort.



The clipping warning module, described here, deals with clipping caused by image processing and the limitations of the output color space. It should not be confused with the following similar tools:

- The raw overexposed warning indicates where pixels in the original raw file are clipped due to physical limitations in the dynamic range of the camera sensor. This module highlights information that was permanently lost at the point of image capture, and you need to deal with it as best you can using highlight recovery techniques.
- The gamut check module also provides information about clipping arising from image processing. It is based on the external littleCMS library, and is more or less equivalent to the *full gamut* mode in the clipping warning module. The downsides of the gamut check module are that it doesn’t allow you to distinguish between clipping caused by luminance and gamut mapping, and it is much slower than the clipping warning indicator.

module controls

clipping preview mode

This allows you to choose which type of clipping you want the indicator to highlight, and can be one of the following:

- *any RGB channel*: Provides an over-clipping indication if any one of the three [R,G,G] channels exceeds the maximum permitted value for the histogram color space, or an under-clipping indication if the three [R,G,B] channels are too dark and are all forced to black. This was the default mode prior to darktable version 3.4.
- *luminance only*: Indicates any pixels that are clipped because their luminance falls outside of the range set in the “upper threshold” and “lower threshold” sliders. If this happens, it generally means that tone mapping or exposure settings have been poorly set
- *saturation only*: Indicates where over-saturated colors have pushed one or more of the [R,G,B] channels towards a value outside the permitted range of the histogram color space, even though the overall luminance of the pixel may lie within acceptable limits. This means this pixel color is imposible to represent in the histogram color space, and can arise from poorly set gamut mapping or saturation settings,
- *full gamut*: Shows the combination of the 3 previous options. This is the default mode from darktable 3.4 onwards, and it gives the most complete indication of potentially problematic pixels.

color scheme

By default, the indicator marks pixels with *red* where the upper threshold is exceeded (over-clipping) and with *blue* where the lower threshold is breached (under-clipping). This color scheme can be changed to *black & white* or *purple & green* for “over & under” indicators, which may be useful to improve visibility for some images.

lower threshold

Expressed in EV relative to the white point (which is nominally EV = 0). If the [R,G,B] channels all fall below this value, an under-clipping indicator is shown warning that the pixel may be end up being crushed to black. Use the following reference to set this threshold, depending on your intended output medium:

- *8-bit sRGB* clips blacks at -12.69 EV
- *8-bit Adobe RGB* clips blacks at -19.79 EV
- *16-bit sRGB* clips blacks at -20.69 EV
- *fine-art matte prints* typically produce black at -5.30 EV
- *color glossy prints* typically produce black at -8.00 EV
- *black-and-white glossy prints* typically produce black at -9.00 EV

upper threshold

How close a pixel should be to the upper limit before being flagged by the clipping warning, expressed as a percentage. Defaults to 98%. In the case of gamut checks, this controls how close the saturation of the pixel is allowed to get to the limits of the color space’s gamut before a clipping indication is flagged.

8.3.1.2. color assessment

When developing an image, the way we perceive brightness, contrast and saturation is influenced by the surrounding ambient conditions. If an image is displayed against a dark background, as with the default theme in darktable, it can have the a number of adverse effects on our perception of that image:

- Exaggeration of the perceived exposure makes the image seems brighter than it really is. This is nicely illustrated by the Adelson checkerboard shadow effect.
- A decrease in the perceived saturation in the image makes the colors seem less rich than they really are (the Hunt effect).
- A decrease in the perceived contrast in the image makes the tones seem flatter than they really are (Bartleson-Breneman effect 3)

The end result is that the image can end up being too dark, and overly-processed in terms of contrast and color saturation. To avoid this, the “ISO 12646:2008” standard makes some recommendations about the conditions under which the colors of an image should be assessed. The *color assessment* module in the darkroom places a frame around the image to help the user better assess the colors in the image, along the lines of those recommendations.

When the lightbulb icon () is selected in the bottom panel, the image is zoomed out so that a thick mid-grey border appears around the image to act as a reference against which to compare the image’s tones. A thinner white border is placed immediately around the image to give the eyes a basis for comparison when looking at parts of the image that are meant to be a bright white.

Although the color assessment mode provides a mid-grey surrounding to the image, it is recommended that you also set your user interface (in preferences > general) to one of the “grey” themes. These themes are designed to provide a user interface that is close to middle grey (it is actually slightly darker to allow better contrast with the text in the user interface). When one of these themes is used together with the color assessment mode, this will help to avoid the above perception issues.

Color assessment mode can also be toggled by pressing Ctrl+B.

8.3.1.3. duplicate manager

The duplicate manager lists all versions of the current darkroom image with their preview thumbnails. Hold down the left mouse button on a thumbnail to temporarily show that version in the center view. Double click to switch to this version and edit it.

The buttons on the top-right allow you to create new duplicates of the current image. You can either create a ‘virgin’ version (with an empty history stack) or an exact duplicate of the current image. For your convenience, you can also assign a name to each version.

The displayed name is stored in the *version name* metadata tag, which can also be edited within the metadata editor module.

8.3.1.4. gamut check

Click the icon on the right of the bottom panel to activate the gamut check display mode for your image. This function highlights, in cyan, all pixels that are out of gamut with respect to the selected softproof profile. You can also activate gamut check with the keyboard shortcut Ctrl+G. A message “gamut check” on the bottom left of your image tells you that you are in gamut check display mode. Gamut check and soft proof are mutually exclusive modes.

Right-click on the icon to open a dialog with configuration parameters – these are the same as for the soft proof option.

8.3.1.5. global color picker

Take color samples from the current darkroom image, display their values in multiple ways and compare colors from different locations.

The color picker is activated by pressing the color picker icon. The module’s parameters will remain in effect until you leave the darkroom mode.

Besides the global color picker described here, many darktable modules (e.g. *tone curve*) also contain local color pickers which are used to set individual module parameters. You should be aware that these two forms of color picker do not always work in the same color space. The global color picker works in the histogram color space and takes its samples after the complete pixelpipe has been processed. Local color pickers run in the color space of the module in which they are activated and reflect the input or output data of that module within the pixelpipe.

As the global color picker runs at the end of the preview pixelpipe, it receives data in display color space then converts it to histogram color space. If you are using a display color space which is not “well behaved” (this is common for a device profile), then colors which are outside of the gamut of the display profile will clip or distort.

module controls

point/area mode

The global color picker can be run in point or area mode by clicking or Ctrl+clicking on the color picker icon, respectively. When in point mode only a small spot under your cursor is taken as a sample. In area mode you can draw a rectangle and darktable samples the area within that rectangle.

mean/min/max

If samples are taken in area mode, darktable will calculate mean, minimum and maximum color channel values. This combobox allows you to select which of those are displayed. For obvious statistical reasons mean, min and max are identical for the single sample of point mode.

color swatch / color values

A color swatch representing the sampled point or area is displayed alongside numerical values. Clicking on the swatch will toggle on/off a much larger swatch for easier viewing.

The global color picker works in monitor RGB color space. Select “Lab” to translate these numerical values into Lab color space. Beware that Lab values are approximated here. Depending on the monitor color profile there may be some deviations from the actual values.

live samples

The sampled colors (in either area or point mode) can be stored as live samples by pressing the “add” button. A color swatch and numerical values will be shown for each stored sample. You can select which numerical value (mean, min, max) is to be displayed and whether the display should be in RGB or Lab color space.

Newly created live samples are not locked. If you change your image those changes will be reflected in your live samples. This can be used to show you how changing a parameter affects different parts of an image. Clicking on a live sample’s color swatch locks it and a lock symbol is displayed. Further image changes will then no longer affect the sample. You can use this to compare two live samples by locking just one of them, providing a before and after comparison.

If you hover the mouse over the “delete” button of one of the live sample entries, the selected region for that sample will be highlighted in the image preview.

display sample areas on image

When this checkbox is ticked, live sample locations are visually indicated on your image.

restrict histogram to selection

When this checkbox is ticked, only the values of the selected area or point are taken into account by the main histogram at the top of the right hand panel. This allows you to see what tonal values are present in a specific area.

8.3.1.6. history stack

Query and modify the history stack of the current darkroom image.

This module lists every change of state (activate/de-activate/move/change parameters) for all image processing modules that have been modified for the current image. You can select a point in the stack to return to that point in the development history of the image.

Caution: adjusting any module will cause all modules above the currently selected one to be discarded. It is easy to lose development work on an image in this way!

It is safe to quit the program, leave the darkroom mode, or switch to another image while having selected some earlier state in the history stack module. When returning to that image you will find the history stack panel in the state where you left it.

Hovering the mouse over an item in the history stack will show a tooltip with details of all changes that were made in that module compared to its previous or default state. This can help track down adjustments that were made unintentionally and have unintended effects.

Clicking “compress history stack” generates the shortest history stack that reproduces the current image. It causes all edits above the currently-selected step to be discarded. If any module appears multiple times in the remainder of the stack, these multiple appearances will be *compressed* into a single step in the history.

Clicking “compress history stack” while holding the Ctrl key truncates the history stack, but without compressing it i.e. it discards all modules above the currently selected one but leaves the remainder of the history stack unchanged.

Clicking the “reset parameters” button in the module header discards the entire history stack and reactivates any default modules. This can also be achieved by selecting the “original image” history item and clicking “compress history stack”.

The button to the right of the “compress history stack” button allows you to create a new style from the history stack of the current image, which can then be applied to other images. Use the first line of the popup dialog window to name your style and the second to add a searchable description. You will be prompted to choose which of the current history stack modules to include in the style.

Once created, styles can be managed and applied to other images with the lighttable’s styles module. You can also assign shortcut keys to your styles (see preferences > shortcuts) and apply the associated style to all selected images by pressing the shortcut key whenever you are in the lighttable or darkroom view.

8.3.1.7. image information line

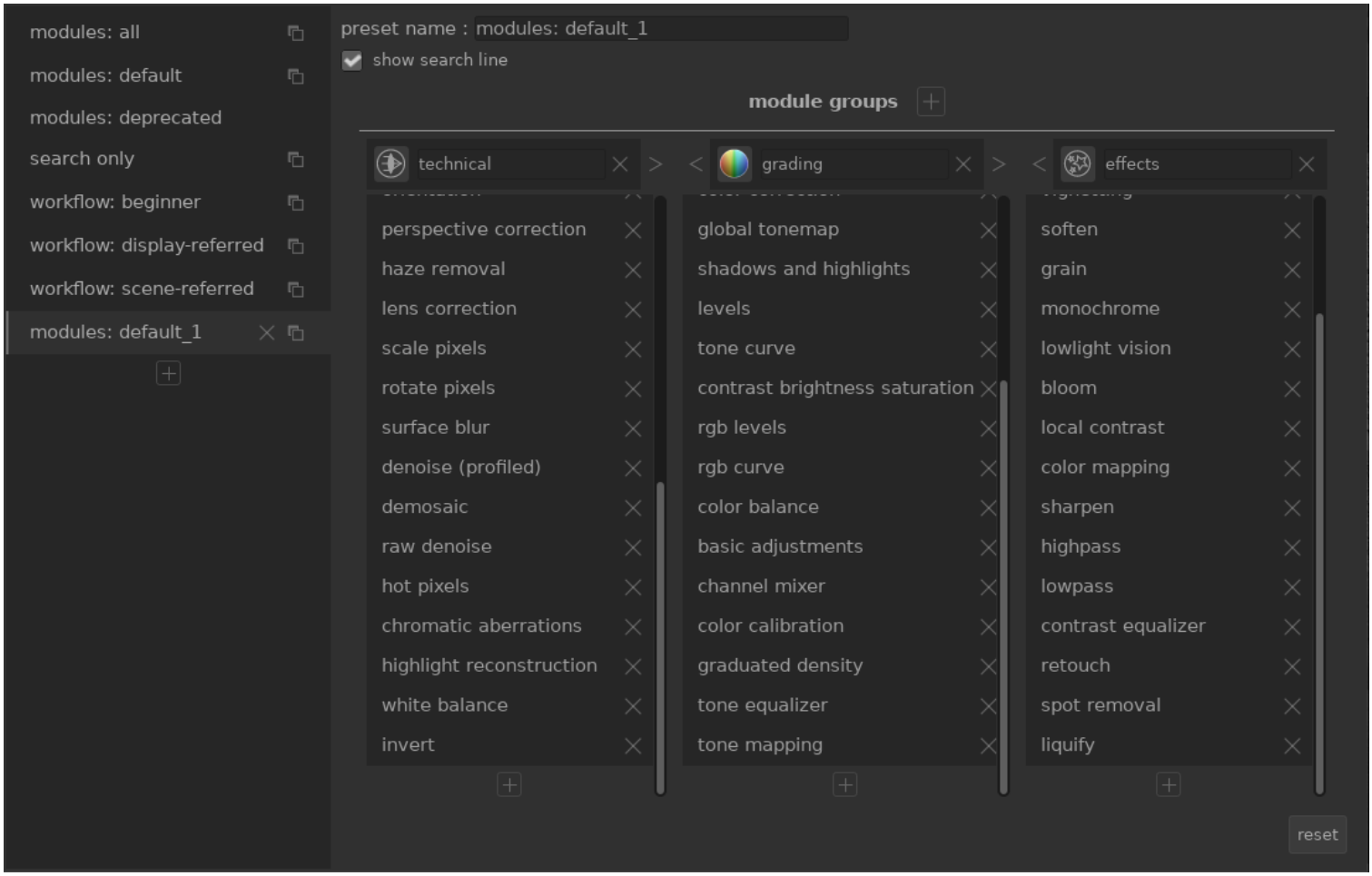
Display information about the current image in a darkroom panel. The contents of this line can be set in preferences > darkroom.

See the variables section for information about the variables that can be used here. You can also insert a newline with `$(NL)`.

The image information line can be displayed in the top, bottom, left or right panel depending on an additional configuration item in preferences > darkroom.

8.3.1.8. manage module layouts

Manage the layout and grouping of processing modules.



This maintenance screen can be accessed from the *presets* menu beside the module search box or group icons (below the histogram in the darkroom view).

module controls

preset list

The left-hand panel lists the currently-defined module layout presets. Those at the top of the list are fixed and cannot be altered. User-defined presets are placed at the bottom of the list.

To create a new (empty) preset, click on the + button at the bottom of the left-hand panel. Alternatively click on the *duplicate* button to the right of one of the existing module presets to copy that preset to a new one. The above screenshot shows a new preset which has been created by duplicating the “modules: default” preset.

Delete a user-defined preset with the X button.

Rename a preset using the text entry box at the top of the right-hand panel. Right-click to bring up a menu which can be used to copy, paste, select all, delete or insert an emoji)

module groups

The right-hand panel allows you to create and amend module groups for the selected preset.

Add a new group by clicking on the + sign beside the “module groups” header. Remove a group by clicking on the X button beside the header of that module group.

Add a module to a group by clicking the + sign at the bottom of the group, and select the required module from the list that appears. Remove a module by clicking the X beside the module name.

Change the icon assigned to a group by clicking on the existing group icon and selecting a new one from the drop-down list.

Change order the groups are displayed in by clicking on the < and > buttons beside the group headers.

Rename a module group using the text entry box at the top of the module list. Right-click to bring up a menu which can be used to copy, paste, select all, delete or insert an emoji)

Settings will be automatically saved when you exit the screen. Click *reset* to reset the settings to the start of your editing session.

system-defined presets

There are seven standard presets that ship with darktable, which cannot be amended:

- **modules: all**: This contains the complete set of modules, sorted by the traditional module groupings used before darktable 3.4.
- **modules: default**: This is the default module group layout from darktable 3.4 onwards, and consists of a new simplified set of module groups.
- **modules: deprecated**: This contains a list of deprecated modules. This is the only way to access deprecated modules for new edits but be warned: these modules will be removed for new edits in the next release of darktable. This group cannot be duplicated and the modules within it cannot be added to user-created groups.
- **search only**: Display the module search box but do not show module groups.
- **workflow: beginner**: This contains a limited set of modules that are most important when first starting out with darktable. It is suggested that beginners start by copying this minimal preset, and add to it as they gain experience with additional modules.
- **workflow: display referred**: This contains the modules commonly used for the display-referred workflow.
- **workflow: scene referred**: This contains the modules commonly used for the scene-referred workflow.

For each preset you can also choose whether or not to show the search line using the tick box at the top of the screen.

In addition, if you have upgraded an older version of darktable to 3.4, two additional presets may be automatically created as part of the upgrade. These allow you to retain some or all of your previous module group layouts and can be edited or deleted as required:

- **previous config**: Where you have previously set up favourites or altered the *hidden* flag on modules, this preset contains those customisations, retaining the legacy module groups.
- **previous config with new layout**: Where you have previously set up favourites or altered the *hidden* flag on modules, this preset contains those customisations but with modules grouped according to the new (darktable 3.4+) default group layout.

modules: default

The *modules: default* layout preset consists of the following module groups

technical modules

Modules that deal with technical issues relating to the physics of sensors and denoising, lenses and associated corrections, color profiles, dynamic range and tone mapping, and recovering from damage to the image by physical limitations (hot pixels, clipped highlights, etc.)

grading modules

Modules concerned with primary (corrective) and secondary (creative) subjective corrections of colors and tones

(special) effects modules

“Special effect” modules such as retouch, liquify, bloom, sharpen, etc..

modules: all

The *modules: all* preset contains all modules, sorted according to the following groups:

base modules

A minimal set of modules normally required to render a presentable image.

tone modules

Other modules relating to tone levels and contrast

color modules

Modules relating to color grading and color profiles

corrective modules

Modules relating to correcting problems relating to lens distortions, sensor noise, sharpening, etc..

(special) effects modules

Includes special effects such as retouch, liquify, bloom, sharpen, etc..

workflow: scene-referred, *workflow: display-referred*

The *workflow: scene-referred* and *workflow: display-referred* presets define groups of modules relevant to those workflows, sorted into groups as shown below:

base modules

A basic set of modules to adjust the cropping/orientation, adjust the exposure, and apply tone mappings and contrast as appropriate to the workflow.

color modules

Modules relating to color grading and color saturation.

corrective modules

Modules relating to correcting problems relating to lens distortions, sensor noise, sharpening, retouching, etc..

(special) effects modules

Includes special effects such as watermarks, framing, vignetting, etc..

workflow: beginner

The *workflow: beginner* preset provides a minimal set of modules targeted as a starting point for beginners, and consists of the following module groups:

base modules

A basic set of modules to adjust the cropping/orientation, adjust the exposure, and apply a basic tone mapping via base curve or basic adjustments.

grading modules

Modules dealing with creative tone and color grading.

(special) effects modules

Includes special effects such as retouch, sharpen, watermarks, etc..

previous config module groups

These follow the layouts of the previous two groups, but include an additional *favourites* group where users made use of this feature in prior versions of darktable. Now that users may create their own custom groups, there is no longer a need for an explicit “favourites” group.

favourite modules

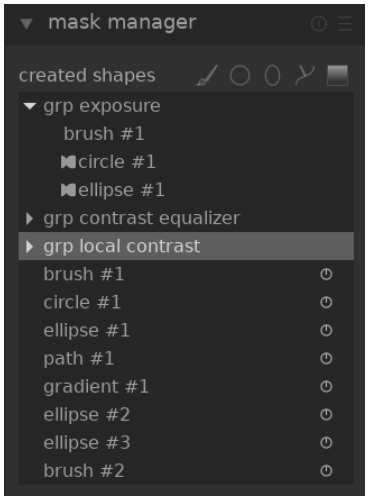
This group was previously used by users to make it easier to find frequently-used modules, and is available under the “previous config” presets. New users can, of course, still create their own custom group and name it “favourites” if they so desire.

active module group

In addition, all module layouts include the *active group*, which lists all modules that are currently active in the pixelpipe.

8.3.1.9. mask manager

Manage all masks and shapes for the current image.



This module can be used to create, rename, edit and delete shapes. You can add shapes to and remove shapes from a mask, group shapes together, and combine them using set operators.

In the top line of the mask manager panel are buttons that can be used to create new shapes. These are the same as in the drawn mask interface of the individual modules.

The panel below these buttons displays a list of all masks and individual shapes defined for the current image.

Groups of shapes forming a mask are displayed with a headline in the form “grp <module_name>” indicating the module in which they are used, with the component shapes listed below. The list of mask groups is followed by a list of all individual shapes that have been generated in the context of the current image. If a shape is in use by any masks this is indicated by a symbol to the right of the shape name.

shapes

By default each shape receives an automatically generated name, consisting of the shape type (“brush”, “circle”, “ellipse”, “path”, “gradient”) and an automatically-incremented integer. You can rename a shape by double-clicking on its current name. It is a good habit to give shapes and groups meaninful names, especially if you are going to use the same selection in different masks.

Click on a shape name to show the selected shape on the image canvas with all of its controls, allowing you to edit the properties of just that shape. This is especially useful where there are many overlapping shapes within a mask, making it difficult to select the right one with the mouse.

Right-click on a shape name to show a menu with options to remove the current shape or to remove all shapes not currently in use.

Note: darktable retains all shapes that have ever been defined for the current image unless you explicitly remove them. If you choose to include develop history when exporting an image, all defined shapes will be exported with the image. Beware that if the list of shapes is very long the space required to store those shapes might exceed the size limit of certain file formats. This can cause XMP tag creation to fail during export.

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masks

Masks are constructed by adding shapes in the order that they are listed from top to bottom. Each shape adjusts the existing mask using one of four logical set operators (see below). Because order is important it is also possible to move shapes up and down the list.

Click on the name of a mask to expand the list of the individual shapes which constitute that mask.

Right-click on the mask name to show a menu which with options to add new or existing shapes to the mask, or to clean up unused shapes.

Right-click on any of the constituent shapes to control how that shape contributes to the mask:

remove from group
Remove the shape from the current mask

use inverted shape
Invert the polarity of the selected shape

mode
Choose how this shape will interact with the preceding mask by selecting one of the four set operators defined below

move up/down
Move the shape up or down the list

set operators

As an example we will use a mask that combines a gradient followed by a path, to demonstrate the effect of each set operator when applied to the path shape. As a convention we say that a pixel is “selected” in a mask or shape if it has a value higher than zero.

union

This is the default set operator. It is depicted by the symbol  to the left of the shape name. The shape adds to the existing mask in such a way that the resulting mask contains the pixels that are *either* selected in the existing mask *or* in the added shape. In overlapping areas the maximum value is taken:

intersection

This set operator is depicted by the symbol  to the left of the shape name. The shape adds to the existing mask in such a way that the resulting mask contains only pixels that are selected in *both* the existing mask *and* the added shape. In overlapping areas the minimum value is used. In the given example we use this operator to “imprint” the path with a gradient:

difference

This set operator is depicted by the symbol  to the left of the shape name. In the non-overlapping area the existing mask is unchanged. In the resulting mask, pixels are selected only if they are selected in the existing mask but *not* in the added shape. This set operator can be chosen if you want to “cut out” a region from within an existing selection:

exclusion

This set operator is depicted by the symbol  to the left of the shape name. The resulting mask has all pixels selected that are either selected in the existing mask and not in the added shape or vice versa. This is equivalent to an “exclusive or”:

8.3.1.10. module order

Change the order of the processing modules in the darkroom using presets.

When processing an image, the active modules are applied in a specific order, which is shown in the right-hand panel of the darkroom view. This module provides information about the current ordering of the processing modules in the pixelpipe. The single parameter “current order” can take on the following values:

v3.0

This is the default module order for scene-referred workflow.

legacy
This module order is used for the legacy display-referred workflow. You will also see this order displayed for any images you previously edited in versions prior to darktable 3.0.

custom
Since darktable 3.0, it is possible to change the order in which modules are applied in the pixelpipe by clicking on the module header while holding Ctrl+Shift and dragging it into a new position. If you have changed the order of any modules, this parameter will show the value “custom”.

Note: changing the order of modules in the pixelpipe is not a cosmetic change to the presentation of the GUI – it has real consequences on how the image will be processed. Please do not change the order of the modules unless you have a specific technical reason and understand why this is required from an image processing perspective.

It is possible to reset the module order back to the v3.0 default order by clicking on the *reset parameters* icon on the *module order* header. You can also use the *presets menu* to change the ordering to either v3.0 default or to legacy ordering.

For a list of the default module orders, please refer to the default module order section.

8.3.1.11. navigation

On the top left hand side of the darkroom, the navigation panel displays a full preview of the current image with a rectangle showing the currently visible zoom area in the central panel. Drag the rectangle around to pan the zoomed-in view. The current zoom scale is displayed to the right of the preview image. Click on that figure for a quick access to some common zoom levels.

The navigation panel can be toggled on/off with a keyboard shortcut (Ctrl+Shift+N by default).

8.3.1.12. raw overexposed warning

This option warns you about areas of your raw input image with clipped color channels. Clipped color channels imply an overexposed image with loss of information in the affected areas. You may use the *highlight reconstruction* or *color reconstruction* modules to attempt to reconstruct these areas.

Right-click on the icon to open a dialog containing the following configuration parameters.

mode
Choose how to mark clipped areas:
- *mark with CFA color*: Display a pattern of the respective primary colors (red, green, and blue) to indicate which color channels are clipped.
- *mark with solid color*: Mark clipped areas with a user defined solid color (see below) independent of the affected color channels.
- *false color*: Set clipped color channels to zero in the affected areas.

color scheme
Choose the solid color for the *mark with solid color* mode.

clipping threshold
Set the threshold defining what values are considered to be overexposed. You can safely leave this slider at its default value of 1.0 (white level) in most cases.

8.3.1.13. snapshots

A snapshot is a stored bitmap of the center image in the darktable view. Snapshots can be taken at any point in the development process and later selected to be overlaid onto the current center view. This allows you to undertake a side by side comparison (by default left=snapshot, right=active edit) while you are tuning parameters of a module. This can also be combined with history stack module to compare a snapshot against different stages of development.

You can control the split view by moving the splitline back and forth over the image with your mouse. If you hover with the mouse over the splitline, a small rotation icon will appear on the center of the line. Click this icon to change between vertical and horizontal split view.

At all times, an arrow containing the letter “S” is displayed to indicate which side of the image is the snapshot and which is the current edit.

Click the module’s reset button to remove all existing snapshots.

Note: Snapshots are retained for the duration of your darktable session. This means that you can also use snapshots to compare with a duplicate edit of the same image. Just navigate to that image and enable the snapshot view as normal.

8.3.1.14. soft proof

Click the icon on the right of the bottom panel to activate the soft proof display mode on your image. Soft proof allows you to preview your image rendered using a printer profile to see how colors will end up on the final print. You can also activate soft proof with the keyboard shortcut Ctrl+S. A message “soft proof" on the bottom left of your image tells you that you are in soft proof display mode.

Right-click on the icon to open a dialog with the following configuration parameters.

display intent
Set the rendering intent for your display – only available if rendering with LittleCMS2 is activated. See rendering intent for a list of available options.

softproof profile
Set the color profile for soft proofing from the list of available profiles in `$DARKTABLE/share/darktable/color/out` and `$HOME/.config/darktable/color/out` (where `$DARKTABLE` represents darktable’s installation directory and `$HOME` your home directory). Typically these profiles are supplied by your printer or generated during printer profiling.

display profile
Set the color profile for the display. The option “system display profile” is the preferred setting when working with a calibrated display. The profile is taken either from your system’s color manager or from your X display server. The method darktable uses to detect your system display profile can be changed in preferences > miscellaneous. For more information see display profile.

8.3.2. lighttable

8.3.2.1. export selected

Export images that have been selected in the lighttable.

Files can be exported to a file on disk, email, various on-line storage locations, a webalbum, or a book template.

You can also press Ctrl+E within the darkroom mode to export the currently-edited image using the last settings from this module.

module controls

storage options

target storage
The type of location to store your selected images. A number of different back-ends are implemented, including file on disk, a LaTeX book template and various web albums. Depending on the selected target, you will be asked to provide additional information, like filenames, or account name and password.

filename template
You can define filenames that darktable generates for export using image data. Several pre-defined variables can be used. See the variables section for details.

output directory
The button beside the filename entry opens a dialog to select the parent directory for export.

on conflict
Choose what to do if the generated filename conflicts with an existing file on export:

- *create unique filename*: Automatically choose a unique new file name by appending an integer to the conflicting filename.
- *overwrite*: Automatically overwrite existing files. This option will present you with a confirmation dialog in order to protect you from accidental data loss. *(**Note:** This dialog is not presented per-file but as a one-off confirmation before the export job starts.)*
- *skip*: Do not export images where the destination filename already exists.

format options

Options within this section will appear or not depending on the selected *file format*.

file format
Choose the file format for the exported image.

quality
The quality of the exported file. Higher values will lead to larger file sizes. The default quality (95) is a good setting for very high quality exports, e.g. for archiving or printing purposes. If you need a good compromise between size and quality, e.g. for online image display or uploads, you should consider a value of “90” instead.

bit depth
The number of bits used for each color channel. More bits means less posterization/color banding.

compression
Choose what sort of compression to use.

compression level
For export formats where *compression* can be specified, the *compression level* specifies how much compression to apply. The higher the level, the more the data will be compressed, at the cost of more CPU cycles.

b&w image
For TIFF export format, it is possible to save a monochrome image. This setting controls whether the resulting file encodes the shades of grey as separate RGB channels, or as a single greyscale channel. The latter option will reuslt in smaller files.

global options

set size
Choose how to measure the maximum size of your exported image

- *in pixels (for file)*: Enter the maximum width and height in pixels. Entering a value of 0 places no constraint on that dimension.
- *in cm (for print)*: Enter the maximum width and height in cm and define the image’s dpi. The equivalent size in pixels will be automatically calculated.
- *in inch (for print)*: Enter the maximum width and height in inches and define the image’s dpi. The equivalent size in pixels will be automatically calculated.
- *by scale (for file)*: Enter a multiplier to specify by how much the output image should be scaled compared to the input image. For example, entering a value of 0.5 will result in an output image with half the width and height (in pixels) of the original image.

dpi
If units of cm or inches are chosen, set the dpi of the output image.

max size
Set the maximum width and height of the exported image(s) in pixels, cm or inches (depending on the selected unit) – zero means no maximum. Exported images will be constrained so as not to exceed either of these values, while retaining the correct aspect ratio. Set both to zero to export with the original dimensions (after cropping). If the entered values exceed the original dimensions darktable will either export with the original dimensions or upscale the image, depending on the “allow upscaling” parameter.

allow upscaling

Set to “yes” to perform an upscaling step if the user-defined maximum width and height exceed the original dimensions of the image. If set to “no” the exported image’s dimensions will not exceed the dimensions of the original image (after cropping).

high quality resampling

Set this to ‘yes’ to perform high quality resampling on the image. The image will be processed in full resolution and only downscaled at the very end. This can sometimes result in better quality, but will always be slower.

profile

The output color profile. Select “image settings” if you want the settings in the *output color profile* module of the individual images to take precedence.

intent

This option lets you define the intent, i.e. the way in which darktable will deal with out-of-gamut colors. See rendering intent for a more detailed description of the available options.

style

This option lets you choose a style which darktable will combine with the existing history stack to generate the output image. These history items are only added temporarily – the original history stack is not overwritten. You can use this feature to add processing steps and parameters that you want to be applied specifically to images before export. For example you may define a style that adds a stronger level of sharpening when you produce scaled-down JPEG files for the internet or add a certain level of exposure compensation to all of your output images.

mode

When applying a style during export this option defines whether the history stack items of that style replace the original history stack of the image or are appended to it. Technically speaking, in append mode history stack items of the style will constitute separate instances of the respective modules on top of any existing ones (see also multiple instances). As a consequence the original history stack will remain in effect with the new items being applied in addition. This way you can apply an overall adjustment (e.g. exposure) to a number of exported images while respecting the settings of each individual image.

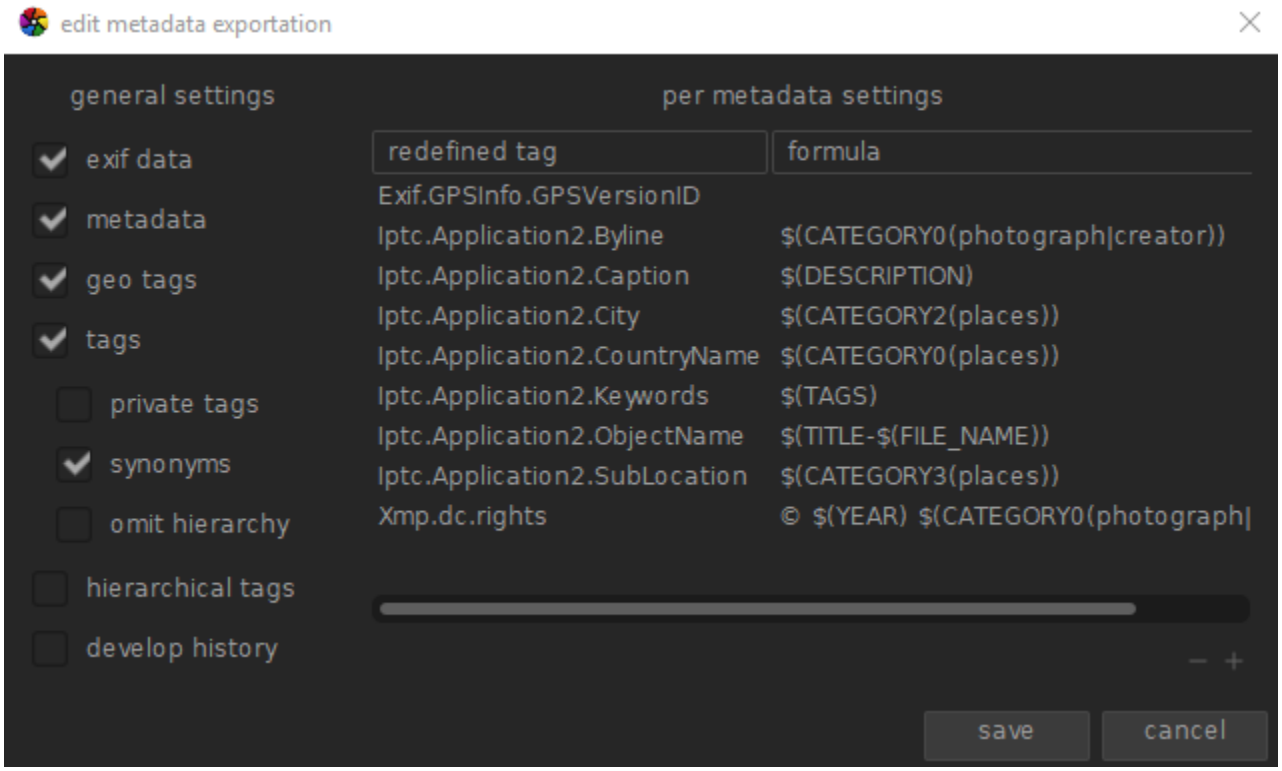
export

Press this button to start a background job to export all selected images. A bar at the bottom of the left hand panel displays the progress of the export job. Furthermore a notification message pops up reporting the completion of each individual export. You may click on the pop-up to make it disappear. You may abort the export job by clicking on the “x” icon located close to the progress bar.

metadata

Press the icon on the right of the export button to bring up the *edit metadata exportation* dialog. This dialog allows you to to configure which metadata items are to be embedded into the exported image. See the following section for more details.

including metadata in the exported image



The *edit metadata exportation* dialog can be used to control what metadata is included within exported files. The parameters entered into this dialog are saved along with other export parameters to user presets and the last entered values are retained when darktable is closed. The following options can be set:

general settings

The left-hand-side of this dialog allows you to choose which groups of metadata are to be exported with the image. The following options are available:

exif data
Export the source image's exif data

metadata
Export metadata defined in the metadata editor module. Metadata fields tagged as *private* or *hidden* will not be exported.

geo tags
Export geo tags

tags
Export tags created in the tagging module (to `Xmp.dc.Subject`). Three additional options can also be selected:

- *private tags*: Export private tags
- *synonyms*: Export tag synonyms
- *omit hierarchy*: Only export the last part of hierarchical tags

hierarchical tags
Export hierarchical tags (to `Xmp.lr.Hierarchical Subject`)

develop history
Export the development history (history stack and shapes) where supported (e.g. JPEG, JPEG2000, TIFF). The development history will be stored as XMP tags within the output file. This information can later be used to reconstruct the parameters and settings that were used to produce the exported image.

Caution: For various reasons embedding XMP tags into output files may fail without notice, e.g. if certain size limits are exceeded. Users are therefore advised to not rely on this feature for their backup strategy. To back up your data always make sure to save your input (raw) file as well as all of darktable's XMP sidecar files.

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per metadata settings

The right-hand-side of this dialog allows you to define formulas to populate image metadata. The formulas defined here have priority over the settings in the left-hand-side of the dialog. The first column identifies the entry to be edited. The second column allows you to define how to calculate the value for that metadata entry using a formula.

Leave the formula empty to prevent a given metadata entry from being exported (`Exif.GPSInfo.GPSVersionID` in the above example). To define a formula to calculate the metadata value, you can use the same variables and rules as for filenames (as documented in the variables section). Press Enter to validate the formula.

Use the “–” icon to remove a metadata entry from the list and the “+” icon to add a new one from a predefined list of available metadata tags.

Click on the “add” button to add a metadata entry to the configuration list.

The formulas allow you virtually define all the metadata you need to qualify your images in tagging and export the values in the XMP or IPTC tags of your choice. The exported tags can be different from one export to the next depending on the destination of the images. Tags and Categories are displayed separately in image information.

Remember that a tag set up as a category is never exported.

examples

example 1

A first level tag called places is set as a category, and is followed by four levels of information (or keywords): country, region, city and location (e.g. `places|France|Nord|Lille|rue Nationale`). Each level can be retrieved (when it is defined) by one of the variables `$(CATEGORY0(places))`, `$(CATEGORY1(places))`, `$(CATEGORY2(places))` and `$(CATEGORY3(places))`. In this example, the returned values are “France”, “Nord”, “Lille” and “rue Nationale”, respectively. These keywords can also be retrieved as simple tags by the variable `$(TAGS)`. The last keyword level defined (the leaf) is displayed in image information, here “rue Nationale”.

example 2

A first level tag called creator is followed by the name of the photographer, both set as categories: `creator|firstname lastname`. The formula copyrights (`$(YEAR) $(CATEGORY0(creator))`) builds the text associated with image rights. Here, image information displays “creator: firstname lastname” as categories. Neither creator nor firstname lastname appear in the tags list and they are not exported as simple tags.

Note: tagging is not appropriate to define free text metadata, like a title or a description, which may be specific to each image. Use the metadata editor for this type of information.

8.3.2.2. geotagging

Import and apply GPX track data to a selection of images.

A GPS receiver calculates its current position based on the information it receives from satellites and records it in a GPX file, together with the current date and time. The Exif data of the images also contains a time stamp defined by the camera settings. The *geotagging* module takes the time stamp of the image, looks up the position in the GPX file at that time, and stores the appropriate coordinates (latitude/longitude/elevation) in its database and the image’s XMP sidecar file.

Two problems may occur during this process:

- In contrast to GPS devices, most cameras don’t record the time accurately.
- The time stored in the Exif data does not include the time zone. Most people set their camera to local time, while the GPS devices store the time in the UTC (Universal Time, Coordinated, i.e. Greenwich (London)) time zone. If the time zones of camera and GPX file differs, than the related location will be wrong.

If your image already carries the UTC time stamp you can directly apply the GPX track without further adjustments.

Otherwise follow the following process to correlate the time of camera and GPS tracker

offset

To fix the offset of the camera time setting you can either enter it manually into the offset input field or let darktable calculate it. All you need is to take a photograph of a reliable time source. This can be any precise clock or, even better, the time displayed on your GPS device (bear in mind that GPS devices also normally *show* the local time, even though they *store* universal time).

When you have this image selected simply click on the magnifying glass button and darktable will present you with an entry box. Enter the time that is shown on the image and you will obtain the difference (offset) between the time entered and the time stored in the image's Exif data.

Now you can select all the images you want to geotag and click the apply button (currently represented by a check mark). This will alter the time in darktable's internal database for these pictures – you will see this change in the image information module on the left.

time zone

Finally you can apply a GPX track. Click the corresponding button and navigate to the GPX file. Before confirming the dialog that appears you should first select the corresponding time zone for your camera in the drop-down-menu.

Should you choose an incorrect time zone you can reapply the GPX file with a different time zone.

8.3.2.3. history stack

Manipulate the history stack of one or more selected images.

module controls

copy parts…
Copy the history stack of the selected image. A dialog appears within which you may choose which items from the history stack to include. If more than one image is selected, the history stack is taken from the image that was selected first. Double-click on an item to copy that item only and immediately close the dialog.

copy
Copy the complete history stack from the selected image. If more than one image is selected, the history stack is taken from the image that was selected first.

Information relating to internal display encoding and mask management is considered unsafe to automatically copy to other images and will therefore not be copied when using this button. These modules may still be pasted onto images using the *paste parts...* button.

The following modules will be excluded from the *copy* operation:

- *orientation*
- *lens correction*
- *raw black/white point*
- *rotate pixels*
- *scale pixels*
- *white balance*

compress history
Generate the shortest history stack that reproduces the current image. If any module appears multiple times in the stack, these occurrences will be *compressed* into a single step in the history. *Beware, this action can not be undone!*

discard history
Physically delete the history stack of the selected images. *Beware, this action can not be undone!*

paste parts…
Paste a previously copied history stack onto all selected images. A dialog appears within which you may choose which items from the source history stack to include.

paste
Paste all items of a copied history stack onto all selected images.

mode

This setting defines how the paste actions behave when applied to an image that already has a history stack. In simple terms the “overwrite” mode deletes the previous history stack before pasting, whereas “append” will concatenate the two history stacks together.

A copied history stack can have multiple entries of the same module (with the same name or different names) and pasting behaves differently for these entries in append and overwrite modes.

In *append* mode, for each copied module of the source image, if there is a module in the destination image with the same name it will be replaced. If there is no such module, a new instance will be created. In both cases the pasted instance is placed on top of the history stack. If a particular module appears multiple times in either history stack only the last occurrence of that module will be processed.

In *overwrite* mode the behavior is the same except that the history of the destination image is deleted before the paste operation commences. The “copy all”/“paste all” actions in this mode will precisely duplicate the entire history stack of the source image onto the destination (including any duplicate occurrences).

Notes

- Automatic module presets are only added to an image when it is first opened in the darkroom. If you use *overwrite* mode to paste history stack entries to images that haven’t previously been opened in the darkroom then the next time that image is opened in the darkroom, automatic presets will be applied to the image. It may therefore seem as if the “overwrite” mode did not accurately duplicate the existing history stack, but in this case, those automatic modules were added subsequently.
- The *append* mode allows you to later reconstruct your pre-existing history stack (because previous history items are retained in the stack of the destination image). However, in “overwrite” mode all previous edits are irrevocably lost.
- The *mode* setting is retained when you quit darktable – if you change it for a one-off copy and paste, make sure to change it back again.

---

load sidecar file

Open a dialog box which allows you to import the history stack from a selected XMP file. This copied history stack can then be pasted onto one or images.

Images that were exported by darktable typically contain the full history stack if the file format supports embedded metadata (see the export selected module for details of this feature and its limitations). You can load an exported image as a sidecar file in the same way as you can with an XMP file. This feature allows you to recover all parameter settings if you have accidentally lost or overwritten the XMP file. All you need is the source image, typically a raw, and the exported file.

write sidecar files

Write XMP sidecar files for all selected images. The filename is generated by appending “.xmp” to the name of the underlying input file.

By default darktable generates and updates sidecar files automatically whenever you work on an image and change the history stack. You can disable automatic sidecar file generation in preferences > storage. This can be useful when you are running multiple versions of darktable (so that edits in each version do not conflict with one another) however, in general, disabling this feature is not recommended.

8.3.2.4. import

Import images into one or more film rolls.

Images can be imported from the local filesystem or from a connected camera. See supported file formats for more information.

import from filesystem

You can import either a single image or a folder of images from the filesystem by clicking the relevant button. The imported image(s) will be automatically added to a film roll with the same name as the filesystem folder they are imported from.

Clicking on “image” or “folder” opens a file selector dialog. Navigate through the filesystem, and select the item(s) to import.

On the lower part of the dialog, are some additional *import options* as follows. Default values for all of these options can be set in preferences > import.

import folders recursively (folder import only)
Check this option to import images in the currently selected folder and all subfolders. It is not recommended to use this option to import a large number of images at the same time. The import process causes darktable to generate thumbnails for all of the imported images, but in the end it will only be able to keep the most recent in its cache. It is better to import images in smaller chunks.

ignore JPEG files
Check this option if there are JPEG images in the same folder that you do not want to import. This option is usually used where the camera stores RAW+JPEG and you only want to work on the raw files, leaving the JPEG images untouched.

apply metadata on import
This option allows you to automatically set some metadata fields on your images at import time.

Note: When importing images, darktable does not create duplicates of your image files in a separate folder structure but processes them in-situ. The import process simply adds details of those images to darktable’s database (and creates an XMP sidecar file if applicable) allowing the images to be viewed and developed.

This means that if you delete images from disk after having imported them, darktable cannot access them any more: Importing an image or folder in darktable is not a backup of your filesystem! Moreover, darktable does not watch for changes in the filesystem. Any new images will not be shown until they are explicitly imported.

---

import from a connected camera

When a camera is detected, it will show up in the device panel after pressing “scan for devices”. If you hover your mouse over the camera tab label, a tooltip will pop up with information about the camera (model, firmware version etc.). Depending on the capabilities of the camera, the following options may be displayed:

import from camera
This will bring up an import dialog, showing any images on camera that can be selected for import into a film roll.

The base folder for storing imported images and the naming pattern of subfolders and individual images can be set in preferences > import.

tethered shoot
Tethering is used to integrate darktable with your camera. When you take images with your camera, they are automatically imported into darktable, so you can review the result of the shoot. You can also setup remote capture jobs, controlling the number of images and time between captures, along with camera settings such as exposure time, aperture etc.

If supported by your camera, selecting *tethered shoot* will take you into the tethering view.

8.3.2.5. lua scripts installer

This panel provides an interface for installing darktable lua scripts. The first time it is run, instructions are displayed in the module.

It can be disabled with an option in preferences > lua options.

8.3.2.6. select

Select images in the lighttable according to simple criteria.

module controls

select all
Select all images shown in the current lighttable view

select none
De-select all images.

invert selection
Select all images that are not currently selected.

select film roll
Select all images that are in the same film roll as the currently-selected images.

select untouched
Select all images that have not yet been developed.

8.3.2.7. selected images

Perform actions on images that have been selected in the lighttable view.

module controls

The module controls are spread over two tabs, one for manipulating the image files, and the other for manipulating the metadata related to the images.

images tab

remove
Remove the selected images from the darktable database. Removed images can no longer be viewed or edited within darktable but the image files remain on the filesystem along with any XMP sidecar files. As darktable keeps the XMP files up-to-date with your latest development history, you can later fully restore your work by re-importing the images.

delete/trash
Eliminate the selected images from the darktable database and remove any associated XMP sidecar files. If no duplicates of the selected image remain in the darktable database, the image file itself is also deleted. You can control whether this action irrevocably deletes the images or puts them into your system's trash bin with a configuration item in preferences > security. A second configuration item in the same tab allows you to control whether or not to be prompted before deleting images.

move
Physically move selected images (the image file plus all associated XMP sidecar files) to another filesystem folder. If an image with the given filename already exists in the target folder the source image will not be moved.

copy
Physically copy selected images (the image file plus all associated XMP sidecar file) to another filesystem folder. If an image with the given filename already exists in the target folder it will not be overwritten – instead a new duplicate will be generated with the same history stack as the source image.

create hdr
Create a high dynamic range image from the selected images, and store it as a new source file in DNG format. Images need to be properly aligned, which implies that they have been taken on a sturdy tripod. You can also generate HDRs with programs like Luminance HDR, and later import them into darktable for further processing. Note that darktable will only create HDR images from raw files.

duplicate
Create a virtual copy of the selected images within darktable. This allows you to test different edits on the same image, for example. Duplicate images share the same parent input file, but each have their own XMP sidecar file and separate entry in darktable's database.

rotation
Perform a clockwise or counter-clockwise rotation on the selected images. The third button resets the image rotation to the value stored in the image's Exif data. This feature is directly linked to the *orientation* processing module – adjustments made here are automatically converted into a history stack item for that module.

copy locally
This action will create local copies of the selected images on the local drive. These copies will then be used when the original images are not accessible (see local copies).

resync local copy
This action will synchronize the XMP sidecar of the local copy of each selected image with the copy in external storage, if needed, and will remove the local copies. Note that if a local copy has been modified and the external storage is not accessible the local copy won't be deleted (see local copies).

group
Create a new group from selected images (see image grouping).

ungroup
Remove selected images from a group (see image grouping).

metadata tab

metadata type checkboxes
Choose which types of metadata (ratings, tags, metadata, colors, geo tags) you want to operate on.

copy
Copy the chosen types of metadata from the selected image onto the clipboard. If you have more than one image selected, or no images selected, then this button is unavailable.

paste
Paste any metadata in the clipboard onto the selected images.

clear
Clear the chosen types of metadata from the selected images.

mode
When pasting metadata onto images, this option controls whether the metadata on the clipboard should be merged with the existing metadata (*merge*), or should replace it entirely (*overwrite*).

refresh exif
Refresh the Exif data from the source file. Warning: this may overwrite some tags that you have subsequently changed in darktable (such as star ratings).

monochrome
Flag the image as monochrome, meaning that it will receive any monochrome-specific workflow treatment that is offered by the processing modules. Refer to the developing monochrome images section for more details.

color
Remove the monochrome flag from the image so that it will receive the default workflow treatment that is normally used when developing color photos.

8.3.2.8. styles

Create named styles from selected images' history stacks and apply styles to selected images.

Styles can either be created within this panel or in the history stack module in the darkroom.

A list of all available styles is displayed at the top of the module. A search field above the list allows you to locate a style by name or description. This module also allows styles to be edited and deleted.

Double-click on a style name to apply that style to all selected images. A style may also be applied to all selected images by pressing a shortcut key assigned to it (see preferences > shortcuts) while in either lighttable or darkroom view.

module controls

create duplicate
When applying a style to images, tick this box to create a duplicate of each image before applying the chosen style to that duplicate. Disable this option to apply the chosen style directly to the selected images. Beware that in this case any existing history stack is overwritten (depending on the mode – see below) and cannot be recovered.

mode
As with the history stack module, this combobox allows you to either "append" the style to the current history stack or to "overwrite" the history stack of the target image.

create
Create new style(s) using the history stack of the selected image(s). For each selected image a style creation window is shown. You must supply a unique name for each new style and you can also add an optional description. You will be given the option to de-select any history stack items that you don't want to be part of the created style.

The panel supports a hierarchical view, meaning that you can create categories using the pipe symbol "|" as a separator. For example "print|tone curve +0.5 EV" will create a "print" category with a style of "tone curve +0.5 EV" below it.

edit
Select “edit” to bring up a dialog which allows you to include or exclude specific items from the stack of an existing style. Check the “duplicate” option if you want to create a new style, instead of overwriting the existing one. In this case you will need to provide a unique name for the new style.

remove
Delete the selected style, without any further prompt.

import
Import a previously saved style. Styles are stored as XML files with the extension `.dtstyle`.

export
Save the selected style to disk as a `.dtstyle` file. This allows styles to be published and shared with other users.

8.3.2.9. timeline

View your images by the date/time they were taken.

In the lighttable filemanager view, you can show/hide the timeline module in the bottom panel with the shortcut Ctrl+F.

Within the timeline, you can show the next and previous dates by scrolling your mouse; Ctrl+scroll to zoom in/out.

You can also use timeline to select images by date range with mouse click+drag.

8.3.3. map

8.3.3.1. find location

Search for a location on the map. You must be connected to the internet to use this feature.

To use this module, type in a place name or address, press Enter and a list of results will be shown. Click on one of the resulting items and the map will zoom to that location. An outline covering that location or a pin pointing at the location will be displayed. Drag images from the filmstrip at the bottom of the screen to their location on the map. The GPS location will be embedded in the image.

8.3.3.2. locations

Create areas or locations and organize them as hierarchical tags. The pipe “|” character can be used to insert a new level (a group of locations).

A location is shown as a shape on the map when selected. Initially each location will be represented as a square or circle and can be changed to a rectangle or ellipse by adjusting the shape’s width and/or height. Each location is stored as tag entry under the geotagging collection.

module controls

shape
Select the circle or rectangle symbol to choose the default shape for new locations.

new location / new sub-location
When no location is selected the *new location* button lets you create a location at root level. When a location is selected the *new sub-location* button lets you create a sub-location within the selected location.

show all
Show or hide all locations that are visible on the current map.

actions on the locations list

click
Select (or de-select) a location. If the location is not visible on the map, the map is automatically centred on that location.

Ctrl+click
Edit the name of the location. Press Enter to save changes or Esc to close the editing window without saving.

right-click
Call up a sub-menu which allows you to:
- Edit the name of the location.
- Delete the location.
- Update the filmstrip – the filmstrip will be populated all images within the selected location.
- Switch to the lighttable view and show a collection that contains all the images within the selected location.

actions on locations in the map

click and drag
Move the location shape to a new position on the map.
Ctrl+click or Ctrl+Shift+click
Move an image or a group of images to place them inside a location shape.
mouse scroll
When inside a location shape (but not over an image), increase or decrease the size of that shape.
When hovering over an image, display the different thumbnails of images located at that position on the map.
When outside a location shape (and not over an image) zoom the map in or out.
Shift+scroll
Increase or decrease the width of the location shape.
Ctrl+scroll
Increase or decrease the height of the location shape.
click on a location shape
Select a different location when the *show all* checkbox is selected.

8.3.3.3. map settings

Select preferred map data from various providers. Some will provide additional layers (satellite view etc.) which you can toggle.

module controls

show OSD
Choose whether to display the OSD controls on top-left of the center view.
filtered images
When selected, only the images from the filmstrip are displayed in the center view. If not selected, all images in the current library are displayed as long as the corresponding images have GPS data associated with them.
map source
Choose the mapping provider to source map information from.
group size factor
Increase or decrease the size of the area that causes images to be grouped.
min images per group
The minimum number of images that need to be placed in the same position in order to automatically create an image group for them.

8.3.4. print

8.3.4.1. print settings

Manage settings for the print view and initiate printing.

module controls

printer

printer
Select one of the installed printers.
media
The type of media loaded on the printer (Plain Paper, Luster Photo Paper, etc.).

profile
The printer's ICC profile for the loaded paper. This is the profile specific to the printer and paper. This profile is the last color space transformation applied to the picture whose goal is to create a high quality print.

intent
The print rendering intent ("perceptual", "relative colorimetric", "saturation" or "absolute colorimetric"). See rendering intent for more details.

black point compensation
Whether to adjust the black point of the output profile, which is often lighter than the input profile. This should be "on" when the *intent* is set to "relative colorimetric".

page

paper size
The size of the paper on which to print.

orientation
Portrait or landscape (note that darktable chooses the best fit by default).

units
The unit to use for setting the margins: "mm", "cm", or "inch".

margins
Set each margin separately, or all together by clicking on the middle "lock" button.

image width/height
This information field displays the actual image width and height (given with the selected units) on the paper.

scale factor
This information field displays the scaling of the image to fit on the paper. If this value is less than 1 the image is down-scaled, otherwise it is up-scaled. This is an important factor to watch – a value that is too large (up-scale) may result in a low quality print. The corresponding dpi (dots per inch) is also displayed.

alignment
Select the alignment of the image on the paper.

print settings

profile
The export profile to use. This profile is the entry point used for the next transformation using the printer's ICC profile. Usually it is better to prefer a large gamut (e.g. AdobeRGB) rather than a smaller one (e.g. sRGB).

intent
The rendering intent to use when exporting the image. For more information see rendering intent.

style
Choose a style to apply when exporting the image – defaults to "none". See the export selected module for a more detailed discussion of applying a style during export.

mode
Whether the chosen style should be appended to the existing history stack or replace it completely. See the export selected module for more details.

print button

When clicked, the image is exported using the selected options and sent to the printer.

8.3.5. shared

8.3.5.1. collect images

Filter the images shown in the lighttable view and filmstrip panel using image attributes. This set of filtered images is known as a *collection*.

All images imported imported into darktable are stored in darktable's library database, along with attributes describing each image. A collection may be defined by applying filtering rules to these attributes, thus creating a subset of images to display in the lighttable view and the filmstrip module.

The default collection is based on the *film roll* attribute and displays all images of the last imported or selected film roll.

available filtering attributes

The images in a collection can be filtered using the following image attributes:

files

film roll
The name of the film roll to which the image belongs (which is the same as the name of the folder in which the image resides)
folders
The folder (file path) where the image file is located
filename
The filename of the image

metadata

tag
Any tag that is attached to the image. When activated a hierarchical list of known tags is displayed
creator
The image's metadata "creator" field
publisher
The image's metadata "publisher" field
title
The image's metadata "title" field
description
The image's metadata "description" field
rights
The image's metadata "rights" field
notes
The image's metadata "notes" field
color label
Any color label attached to the image ("red", "yellow", "green", "blue", "purple")
geotagging
The geo location of the image (see locations)

times

date taken
The date the photo was taken, in the format `YYYY:MM:DD`
date-time taken
The date & time the photo was taken, in the format `YYYY:MM:DD hh:mm:ss`
import timestamp
The date/time the file was imported, in the format `YYYY:MM:DD hh:mm:ss`
change timestamp
The date/time the file was last changed, in the format `YYYY:MM:DD hh:mm:ss`
export timestamp
The date/time the file was last expoted, in the format `YYYY:MM:DD hh:mm:ss`
print timestamp
The date/time the file was last printed, in the format `YYYY:MM:DD hh:mm:ss`

capture details

camera
The Exif data entry describing the camera make and model
lens
The description of the lens, as derived from Exif data

aperture
The aperture, as derived from Exif data
exposure
The shutter speed, as derived from Exif data
focal length
The focal length, as derived from Exif data
ISO
The ISO, as derived from Exif data
aspect ratio
The aspect ratio of the image, including any cropping within darktable

darktable

grouping
Choose between “group followers” and “group leaders”
local copy
Show files that are, or are not copied locally
history
Choose images whose history stacks have been altered or not
module
Filter based on which processing modules have been applied to the image
module order
Choose images with “v3.0”, “legacy” or “custom” module orders

module controls

defining filter criteria

The top line of the module can be used to define filter criteria for your collection as follows:

image attribute
The left combobox allows you to choose which attribute to use to filter your collection (from the list described in the previous section)
search pattern
In the text field to the right of the attribute combobox, you can write a matching pattern. The pattern is compared against all database entries with the selected attribute. The filtering mechanism detects a match if any image’s attribute contains the pattern in its full text. You may use % as wildcard character. The collection will be limited to only the matching images. Leave the text field empty to match all images having that attribute.

Attributes with numerical or date/time attributes can be used in combination with comparative and range operators. Use <, <=, >, >=, <>, and = to select images with attributes less than, less than or equal, greater than, greater than or equal, not equal, or equal to the given value, respectively. An expression in the form `[from;to]` can be used to select using a range of values.

select by value
As well as defining filter criteria using a search pattern, you can also manually choose from a list of entries taken from the currently-matching set of images.

The box below the *search pattern* will list values for the selected attribute that are present in the currently-selected images. This list is continuously updated as you type. You may also choose a sorting criteria by scrolling through the list and double-clicking.

If you enable single-click mode (see preferences > lighttable) you can select with a single-click rather than double-click. This mode also allows you to select a range of values with the mouse. This only works for numerical and date-time attributes.

combining multiple filters

You can combine multiple filters together to create more complex collections of images using a series of rules. A rule is a combination of a filter critera along with a logical operation that defines how that criteria is combined with any previous rules.

Click on the button (to the right of the search field) to open a menu with the following options:

clear this rule
Remove the current rule – or reset to default if this is the only rule defined.

narrow down search
Add a new rule, which is combined with the previous rule(s) in a logical AND operation. An image is only retained as part of the collection if it also fulfills the new criteria.

add more images
Add a new rule, which is combined with the previous rule(s) in a logical OR operation. Images that fulfill the new criteria are added to the collection.

exclude images
Add a new rule, which is combined with the previous rule(s) in a logical EXCEPT operation. Images that are selected by the new criteria are excluded from the collection.

The logical operators defining how rules are combined are indicated with icons to the right of each added rule: AND by the symbol, OR by the symbol, and EXCEPT by the symbol. Clicking on any of these icons allows you to change the logical operation for that rule.

updating the folder path of moved images

While it is best to not touch imported files behind darktable's back, this module can help you recover from situations when you have moved or renamed image folders after importing them. The collect images module has a feature that allows you to update darktable's library database with the new folder location. The process is as follows:

1. Set the *image attribute* combobox to "folders"
2. Locate the original folder name in the tree. The folder name will be displayed struck-through to emphasize that it is no longer present.
3. Right-click on the folder name, select "search filmroll...", and then select the new location of the folder.

8.3.5.2. filmstrip

The filmstrip can be used to quickly switch between images in any darktable view. The images shown are the same as displayed in the lighttable view and are defined by the currently-selected collection.

The filmstrip can be switched on and off using the shortcut Ctrl+F. The height of the filmstrip panel can be changed by clicking and dragging its top border.

Quickly navigate through the images in the filmstrip by scrolling with the mouse. In the darkroom you can change the photo currently being processed by clicking on another image in the filmstrip.

In the darkroom, the image currently being processed is selected and highlighted. Use Mouse over to select any other image from the filmstrip (in order to act on it with a keyboard shortcut) without changing the image being processed.

If you wish to select multiple images in the filmstrip, use Alt+click to select the first image and then Ctrl+click to add to or remove images from the selection or Shift+click select a range of images.

The following shortcuts are available to select images in the filmstrip or to perform actions on the selected images:

```
Ctrl+A          select all images in the filmstrip
Ctrl+Shift+A    deselect all images
Ctrl+I          invert the current selection

F1 – F5         toggle color label (red, yellow, green, blue, purple)
0 – 5           set/change image rating
R               reject image
Ctrl+D          duplicate image
Ctrl+C          copy the full history stack
Ctrl+V          paste all of the copied history stack
Alt+Ctrl+C      selectively copy the history stack
Alt+Ctrl+V      selectively paste from the copied history stack
```

See the lighttable's history stack documentation for more details of the copy and paste functionality.

8.3.5.3. focus peaking

The *focus peaking* module allows you to identify which parts of the image are sharp and in-focus. It works both in the lighttable view, where you can easily see at a glance which images are sharp and which are blurry, and in the darkroom view, when you are processing a single image.

The module is activated by clicking on the focus-peaking icon (). It highlights the sharp parts of the image with a yellow, green and blue overlay:

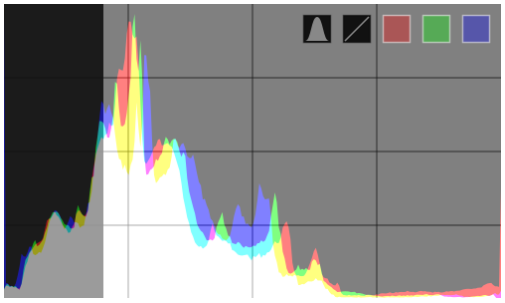
The module works by filtering out image noise, measuring the gradients of intensity in the image and calculating average and standard deviation statistics. When the gradient of an edge differs significantly from the mean, the associated pixels are marked up with a "heat map" indicating how sharp the edge is.

- *yellow* represents a large (6σ) jump in gradient, indicating a very sharp edge.
- *green* represents a medium (4σ) jump in gradient, indicating a reasonably sharp edge.
- *blue* represents a small (2σ) jump in gradient, indicating a slightly sharp edge.

The image above was taken with a wide aperture to give a shallow depth of field, and you can see how the camera has focused on the chinese character written on the second red lantern along from the front. There are also stems of the pink flowers which fall within the area of acceptable sharpness around the focal plane, and these have also been marked up with yellow and green.

8.3.5.4. histogram

A graphical depiction of the developed image’s light levels.

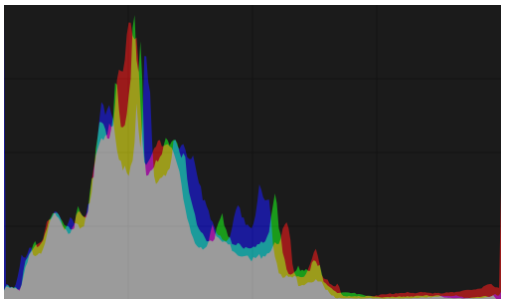


Move the mouse over the panel to show buttons to adjust the display. The leftmost button cycles the mode between a “regular” and a waveform-style histogram. The next button controls how the data for the current mode is displayed. The three rightmost colored squares are toggles which enable or disable the display of the red, green and blue color channels.

When the mouse is over the histogram panel, scrolling with the mouse while holding down the Ctrl key will change the height of the panel. You can show/hide the histogram entirely with a keyboard shortcut (default Ctrl+Shift+H).

For the purposes of speed, the histogram display is calculated from the image preview (the image which is displayed in the navigation module) rather than the higher quality image displayed in the center view. The preview is calculated at a lower resolution and may use shortcuts to bypass time-consuming image processing steps. Hence the display may not accurately represent fine detail in the image, and may deviate in other ways from the final developed image.

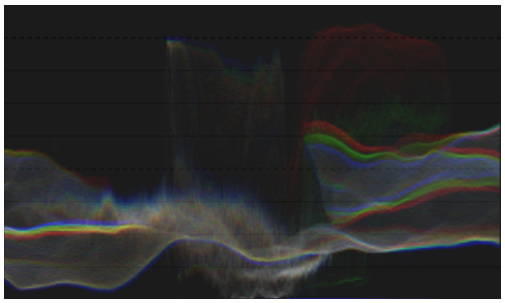
the “regular” histogram



This shows the distribution of pixels by lightness for each color channel channel. In its default state, data for all three RGB color channels is displayed. The x-axis runs from 0% to 100% lightness for each channel. The y-axis gives the count of pixels with the given lightness.

Click the second-to-leftmost button on the panel to toggle between a logarithmic and a linear rendering of the y-axis data.

waveform



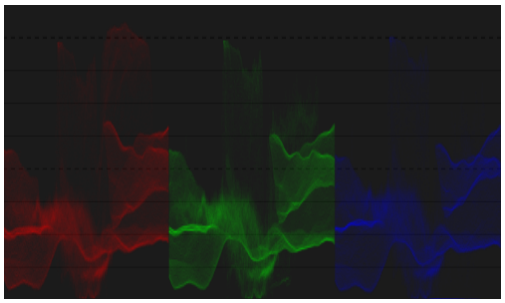
The waveform scope includes spatial data about the image. The y-axis represents the distribution of pixels by lightness for each channel. The x-axis represents the distribution of this data across the x-axis of the image. The lightness of each point of the waveform represents the number of pixels at that position.

The thick dotted horizontal line at the top of the waveform histogram represents 100% lightness. Any channel displayed above that line may be clipped in the resulting image. The thinner dotted horizontal line represents 50% lightness. The bottom of the scope represents 0% lightness.

As with the “regular” histogram, it is possible to selectively display red, green, and blue channels, or (the default) all three of them.

See Of Histograms and Waveforms for more on darktable’s waveform scope.

rgb parade



This shows the same data as the waveform, but with the red, green, and blue channels presented side-by-side. When in waveform mode, clicking the second-to-leftmost button on the panel toggles between waveform (overlaid) and RGB parade rendering of the data.

The RGB parade can be useful for matching the intensities of the red, green, and blue channels. It can also help with understanding the differences between and individual qualities of each channel.

exposure adjustment

The histogram can be used to directly alter the *exposure* and *black level* of the *exposure* module.

For the regular histogram, click towards the right hand side of the histogram and then drag right to increase or drag left to decrease the exposure. In a similar manner you can control the black level by clicking and dragging in the left hand side.

For waveform-style scopes, dragging the upper portion of the histogram up/down will increase/decrease exposure. Dragging the lower portion up/down will increase/decrease the black level.

Scrolling in the appropriate area – rather than dragging – will also adjust exposure and black point. Double-click in the histogram to reset the exposure module’s parameters to their defaults.

histogram profile

The image data is converted to the *histogram profile* before the histogram is calculated. You can choose this profile by right-clicking on the soft-proof or gamut check icons in the bottom panel and then selecting the profile of interest.

As the histogram runs at the end of the preview pixelpipe, it receives data in display color space. If you are using a display color space which is not “well behaved” (this is common for a device profile), then colors which are outside of the gamut of the display profile may be clipped or distorted.

8.3.5.5. image information

This module displays the information embedded within an image’s Exif data as well as a number of additional data fields defined within darktable.

When hovering with the mouse over thumbnails, darktable will update this view, displaying information about the image currently under the mouse cursor.

8.3.5.6. metadata editor

Edit the metadata (title, description, creator, publisher, rights etc.) of selected images.

module controls

metadata entry fields
A separate field is displayed for each metadata item. Hold Ctrl while scrolling with your mouse to increase the height of a field. Press Ctrl+Enter to insert a new line. Press Enter to apply any text entered in the current metadata field to the selected images.

clear
Delete existing metadata from the selected images.

apply
Apply new settings, from the metadata entry fields, to the selected images.

configure metadata
Click this button to bring up a dialog where you can configure how metadata is handled within darktable. For each metadata item, two check boxes are available which allow you to restrict how metadata is handled:

- *hidden*: Hide this metadata field. It will not be displayed anywhere in darktable and will not be included in exported images.
- *private*: Keep this metadata field private. It will be displayed within darktable but will not be included in exported images.

If both options are unchecked, the field will be displayed within darktable and included in exported images.

8.3.5.7. recently used collections

Display a list of recently used collections from the collect images module.

Click on an entry to reopen the selected collection. This also updates the collect images module with the appropriate filter criteria and rules.

8.3.5.8. tagging

Manage tags attached to images.

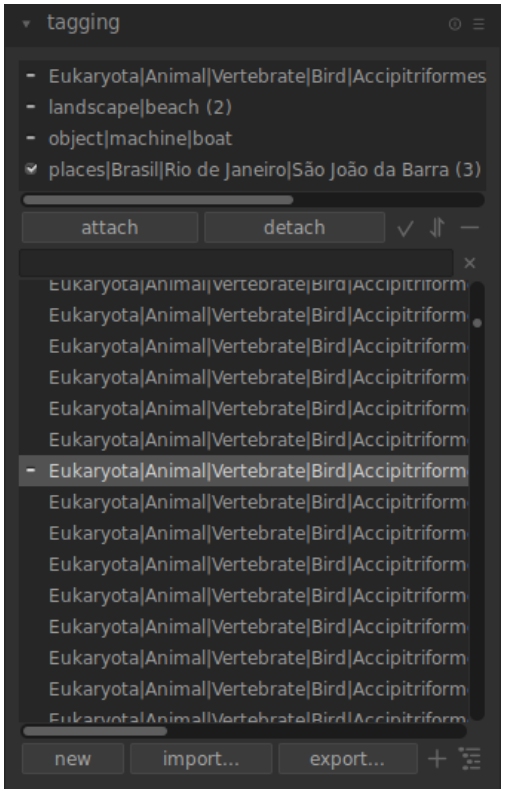
Tags provide a means of adding information to images using a keyword dictionary. You can also manage tags as a hierarchical tree, which can be useful when their number becomes large. Only tags at the leaves of the tree add information to an image – parent tags simply serve as categories and are are used to organise the leaf tags. For example, in the “color|white” tag, “color” is a category for the “white” tag.

Tags are physically stored in XMP sidecar files as well as in darktable’s library database and can be included in exported images.

module sections

The tagging module consists of two sections

1. The upper *attached tags* section (with the *attach/detatch* buttons under it)
2. The lower *tag dictonary* section (with the *new/import.../export...* buttons under it)



attached tags section

The *attached tags* section displays tag(s) attached to image(s) that are

- currently selected (if the mouse cursor is not hovering over an image on the lighttable); or
- under the cursor (if hovering over an image in the lighttable view)

At the bottom of the *attached tags* section are the following buttons, from left to right:

attach
If a tag is selected in the *tag dictionary* section, attach this tag to the selected images.

detach
If a tag is selected in the *attached tags* list, detach that tag from the selected images. A tag can also be detached if you right click on the tag name and select *detach* from the pop-up menu.

check mark [✓]
Choose whether to view any hidden tags that darktable has automatically attached to the selected images.

sort [⇵]
Choose whether to sort the *attached tags* list alphabetically or by the count shown in brackets next to the tag (this count indicates how many of the selected images have that tag attached to them).

minus [–]
Choose whether or not to show the parent categories of the tag.

You can adjust the height of the *attached tags* window by holding Ctrl and scrolling with your mouse wheel.

tag dictionary section

The *tag dictionary* section displays all of the tags that are available in darktable's database. At the top of the *tag dictionary* section is a text box where tag names can be entered. Below this is a list of available tags, which may also include indicator symbols to the left of the tag names. The meanings of these symbols are:

- a check mark [✓] indicates that the tag is attached to all of the selected images
- a minus sign [–] indicates that the tag is attached to at least one of the selected images. If the symbol is next to a category name in the hierarchical *tree* view, it means that one of the child tags under that category is attached to at least one of the selected images.
- if no indicator symbol is present, this means that the tag is not attached to any of the selected images, or that the category has no child tags attached to any of the selected images.

In the hierarchical *tree* view, a name in italics represents a category, and not a child tag. Note that categories are just used to organise the tags, and that a category cannot be directly attached to an image or exported.

Below the *tag dictionary* list are the following buttons, from left to right:

new
Create a new tag, using the name that has been entered into the text entry box at the top of the *tag dictionary* section.

import...
Import tags from a Lightroom keyword file.

export...
Export all tags to a Lightroom keyword file.

plus sign [+] toggle
Show a list of tags that have been attached to some of the selected images but not to all of them. This can be useful to help you decide whether you want to apply any of those tags to the rest of the selected images.

list/tree [☷]
Toggle the display of tags between a straight *list* view and a hierarchical *tree* view.

You can adjust the height of the *tag dictionary* window by holding Ctrl while scrolling with your mouse wheel.

usage

The following sections describe the operations that can be performed with tags.

text entry

The text entry box (shown under the *attach*/*detach* buttons) has multiple purposes.

- If the *tag dictionary* list is in *list* view mode (rather than *tree* view mode), then typing the first few characters of a tag will bring up a list of suggestions. You can then scroll down with the arrow keys and press Enter to select one of the suggestions. Pressing Enter a second time will attach it to the selected images. You can also edit the name of the tag before pressing Enter – in this case the tag will be created if it doesn't already exist in the database.
- Aside from the auto-completion suggestions, typing some partial text into the text entry box allows you filters the set of tags shown in the *tag dictionary* window to those whose name or synonym matches the entered text. Press Enter to attach a tag with the entered name to the selected images. If that tag name does not yet exist in the database, it will be created before being attached.
- The pop-up menu entry "copy to entry" can be used to copy a selected tag to the text entry box. You can then edit this name and press Enter to create a new tag with that name, making it easy to create multiple tags with similar names.

Note: If you find the auto-completion behaviour annoying, it can be disabled in preferences > miscellaneous > disable the entry completion.

---

create tag

There are several ways to create a new tag:

- *Import a text file*. You can import one or more text files in the Lightroom tagging file format. You can also export your tags, add information to the exported file, then re-import it. The import function updates existing tags and creates new tags as required. If you change the name of a tag in the import file, it will be treated as a new tag.
- *Import already-tagged images*. This method does not offer any flexibility to change tag names or categories during the import process.
- *Use the "create tag" sub-menu*. A tag can be created manually, under an existing one (hierarchical) or at the root level.
- *Type into the text box and press the "new" button*. Hierarchical tags are created using the pipe symbol "|". Note that the entered tag is also attached to any selected images.

A number of tags are also generated automatically by dartable (e.g. "darktable|exported" or "darktable|styles|your style"). These help keep track of what actions may have been undertaken on those images. For example, these automatic tags allow you to identify which images have previously been exported, or which images have had styles applied.

edit/rename tag

The *tag dictionary* can be mainained via the "edit tag..." and "rename path..." items in the right-click pop-up menu.

The "edit tag..." operation allows you to change the name of a tag, though you cannot change which category it belongs to (you cannot use the pipe "|" symbol in the tag name field). The command is aborted if you try to enter a tag name that already exists. You can set the *private* and *category* flags and define *synonyms* for the tag (see below). These attributes are recorded in the `XMP-dc Subject` and `XMP-lr Hierarchical Subject` metadata entries, respectively. You can control which tags are included in exports by changing settings in the export selected module.

- A tag set as "private" is, by default, not exported.
- A tag set as "category" is not exported in `XMP-dc Subject`. However it is exported in `XMP-lr Hierarchical Subject` as this XMP metadata holds the organization of your tags.
- "synonyms" enrich the tag information and are mainly used to assist search engines. For example "juvenile", "kid" or "youth" can be set as synonyms of "child". Synonyms can also be used to translate tag names to other languages.

The "rename path..." operation is only available in the *tree* view mode, and it shows the number of tagged images which would be impacted by a change to the name of this tag or category. The rename path window lets the user change the full path of the tag, including the categories to which it belongs (categories can be specified using the pipe | symbol). This operation is powerful, but please take care as it can have a significant impact on the metadata of your images. The operation is aborted if the requested change causes a conflict with an existing tag.

A quick way to organize the tag structure is to drag and drop the tags. In the *tree* view mode, you can drag any node or leaf tag and drop it on top of any other node or leaf tag. The first tag and its descendants, if any, become descendants of the second tag. Dragging over a node automatically opens that node. To place a tag at the root level, drag it onto the top of the tagging window. If the requested change causes a conflict with an existing tag, the operation is aborted.

attach tag

There are a number of ways to attach an existing tag to a group of selected images:

- click on a tag in the *tag dictionary* window to select it, then click on the *attach* button.
- right-click on a tag in the *tag dictionary* window which will bring up a pop-up menu, then select the “attach tag” menu item.
- double-click on a tag in the *tag dictionary* window.
- right-click on a tag shown in the *attached tags* view to show a pop-up menu. If some of the selected images do not currently have that tag, the “attach tag to all” menu item will attach that tag to all the selected images.
- Type into the text box and press the “new” button or the Enter key. This will create the tag if it doesn’t already exist, and attach it to the selected images.
- Press Ctrl+T to open a small text box at the bottom of the central view of the lighttable. Type in the name of a tag and press Enter. The tag will be created if it doesn’t exist, and the tag will be attached to all the selected images.
- Drag an image or group of images and drop it onto the desired tag.

When hovering over the images in the ligthtable you can check which tags are attached to the image, either by looking at the *attached tags* window in the *tagging* module, or in the *tags* attribute in the image information module.

detach tag

There are several ways to remove a tag from a group of selected images:

- click on a tag in the *attached tag* window of the *tagging* module to select the tag, then click on the *detach* button.
- double-click on a tag in the *attached tag* window.
- right-click on a tag in the *attached tag* window, to show a pop-up menu, and select “detach”.

delete tag

It is possible to completely remove a tag from all images (whether selected or not) and delete the tag from the database. Because this could impact a large number of images, a warning will be displayed indicating how many images currently have this tag attached. Take this warning seriously as there is no way to undo this action (except by restoring your database and/or XMP sidecar files from a backup). A tag in *tag dictionary* window can be deleted in the following ways:

- right-click on a tag in the *tag dictionary* window, to show a pop-up menu, and choose “delete tag”.
- right-click on a tag or category in the *tag dictionary* window, to show a pop-up menu, and choose “delete path” to delete the tag or category, together with any child tags or categories.

import / export

The “import” button allows you to choose a text file (which must comply with the Lightroom tag text file format) and import its content. If a tag in the imported file already exists, its properties will be updated, otherwise a new tag will be created.

The “export” button exports your entire tag dictionary into a text file of your choice (Lightroom tag text file format).

navigation

To see the images bearing a particular tag in the *tag dictionary* window, right-click on the tag name and choose “go to tag collection” in the resulting pop-up menu. This opens a collection in the *collect images* module showing all images containing this tag. You can also select other tags in the *collect images* module by double-clicking on the collection for the other tag.

To return to the collection that was selected before opening a tag collection select the “go back to work” item from the pop-up menu. This will allow you to return to the original collection, as long ans you haven’t selected any other collections in the meantime.

8.3.6. tethering

8.3.6.1. camera settings

The camera settings module allows you to set up an image capture job.

This can include sequence, bracket and delayed captures. You are also able to control other camera settings such as focus mode, aperture, shutter speed, ISO and white balance.

8.3.6.2. live view

This module gives you control of your camera’s live view mode. Functionality such as focus setting, rotation, adding guides and overlays are supported.

8.3.6.3. session

A session is a sequence of exposures taken in tethering mode and placed into a single film roll. A new session means the creation of a new film roll.

The session module allows you to set a jobcode, which can be used to create your new film roll. See preferences > import > session options for details about how to create new film rolls using the `$(JOBCODE)` variable in the session module.

9. Preferences & Settings

9.1. overview

darktable comes with a number of user-configurable preferences. These can be adjusted in the preferences dialog, which can be reached by clicking the gear icon on the right of the top panel. Preferences are separated into tabs, each of which is described in more detail in the following sections.

When opened from within the lighttable or darkroom views, the appropriate tab will be loaded by default to allow you to modify that view's settings.

Any altered settings (i.e. those that differ from their default state) are highlighted with a bullet beside them. If you change a setting that needs a restart to take effect, a message will appear as a reminder after you exit the preferences dialog.

Double click on a setting's label to reset to its default value.

The preferences dialog can be closed by clicking on the close button in your window manager or pressing the Escape key.

9.2. general

The preferences in this tab control the overall look and feel of darktable.

interface language
Set the language of the user interface. The system default is marked with an * (needs a restart)

theme
Set the theme for the user interface. Apart from any aesthetic considerations, the recommended interface color for color evaluation is middle grey. Indeed, visual perception is affected by ambient brightness, and a low brightness of the interface causes all kinds of illusions. Using a dark interface to retouch photos can therefore lead to excessive retouching (abuse of contrast and saturation) and to a photo that is too dark once printed. It is therefore highly recommended that you use one of the "grey" themes for retouching work as these are designed so that the user interface approximates middle grey (default "darktable").

performance mode
Enable this option to render thumbnails and previews at a lower quality. This increases the rendering speed by a factor of 4, and is useful when working on slower computers (default off). This also improves the performance of the slideshow image rendering.

use system font size
Select this option to use the font size defined by your system. If unchecked, you may enter a custom font size in the box below (default on).

font size in points
If the "use system font size" option is switched off, enter a font size (in points) for darktable to use. The font size will be changed immediately.

GUI controls and text DPI
Adjust the global GUI resolution to rescale controls, buttons, labels, etc. Increase for a magnified GUI, decrease to fit more content in the window. Set to -1 to use the system-defined global resolution. Default is 96 DPI on most systems. (needs a restart)

CSS Theme Modifications

In addition to selecting a pre-built theme you can also apply additional CSS customisations of your own to tweak the look-and-feel of darktable. A text entry box is provided for this purpose.

When you have finished entering your CSS tweaks, click on the ‘save and apply’ button. This will save your CSS to a file (`$HOME/.config/darktable/user.css`) and immediately apply it to the current darktable session.

If your changes cause any issues, you can uncheck the “modify selected theme with CSS tweaks below” check box. This will immediately restore the base theme but will leave your tweaks in the editor so that you can re-edit and try again. Simply press “save and apply” again when you are ready to retry. This will automatically re-check the “modify selected theme with CSS tweaks below” checkbox and apply the new CSS.

If you have any issues with darktable please retry with this option unchecked to be certain that they were not caused by any of your changes.

9.3. import

This tab contains a number of default settings for the lighttable import module.

import

ignore JPEG images when importing film rolls
When you have RAW+JPEG images together in one directory it usually doesn’t make sense to import both. Set this flag to ignore all JPEGs when importing images (default off).

recursive directory traversal when importing film rolls
When importing images from a folder, also recursively import images from its sub-folders. (default off).

creator to be applied when importing
If provided, automatically add this string as a metadata creator tag when importing images (default none).

publisher to be applied when importing
If provided, automatically add this string as a metadata publisher tag when importing images (default none).

rights to be applied when importing
If provided, automatically add this string as a metadata rights tag when importing images (default none).

comma separated tags to be applied when importing
If you want to add further tags by default when importing images, you can provide them here as a comma separated list (default none).

initial import rating
Initial star rating (from 0 to 5) for all images when importing a film roll (default 1).

session options

These options define a naming pattern to organize images on disk when importing from a connected camera and when taking photos in the tethering view.

The naming pattern consists of three parts: a base part defining the parent folder, a session part defining a sub directory (which is specific to the individual import session), and a file name part defining the filename structure for each imported image.

Several pre-defined variables can be used in the pattern as placeholders:

```
$(HOME)              the home folder as defined by the system
$(PICTURES_FOLDER)   the pictures folder as defined by the system (usually “$HOME/Pictures”)
$(DESKTOP)           the desktop folder as defined by the system (usually “$HOME/Desktop”)
$(USERNAME)          your user account name on the system
$(FILE_NAME)         basename of the imported image
$(FILE_EXTENSION)    extension of the imported image
$(JOBCODE)           unique identifier of the import job
```

```
$(SEQUENCE)          a sequence number within the import job
$(MAX_WIDTH)         maximum image width to limit within export session
$(MAX_HEIGHT)        maximum image height to limit within export session
$(ID)                unique identification number of the image in darktable's database
$(YEAR)              year at the date of import
$(MONTH)             month at the date of import
$(DAY)               day at the date of import
$(HOUR)              hour at the time of import
$(MINUTE)            minute at the time of import
$(SECOND)            second at the time of import
$(EXIF_YEAR)         year the photo was taken (from Exif data)
$(EXIF_MONTH)        month the photo was taken (from Exif data)
$(EXIF_DAY)          day the photo was taken (from Exif data)
$(EXIF_HOUR)         hour the photo was taken (from Exif data)
$(EXIF_MINUTE)       minute the photo was taken (from Exif data)
$(EXIF_SECOND)       seconds the photo was taken (from Exif data)
$(EXIF_ISO)          ISO value of the photo (from Exif data)
```

base directory naming pattern
The base directory part of the naming pattern (default `$(PICTURES_FOLDER)/Darktable`).

sub directory naming pattern
The sub directory part of the naming pattern (default `$(YEAR)$(MONTH)$(DAY)_$(JOBCODE)`).

keep original filename
Check this box to keep original the filename instead of using the pattern below when importing from a camera or card (default off).

file naming pattern
The file name part of the naming pattern (default `$(YEAR)$(MONTH)$(DAY)_$(SEQUENCE).$(FILE_EXTENSION)`).

9.4. lighttable

The following options control functionality in the lighttable view and modules.

general

number of folder levels to show in lists
The number of folder levels to show in film roll names, starting from the right (default 1).

sort film rolls by
Sort film rolls by either the “folder” (path) or the “id” (roughly equivalent to the date the film rolls were first imported) in the collect images module (default “id”).

sort collection recent to older
When selecting folders and dates/times within the collect images module, sort items from recent to older (default on).

hide built-in presets for utility modules
If enabled, only user-defined presets will be shown in presets menu for utility modules – built-in presets will be hidden (default off).

use single-click in the collect module
Enable “single click” mode in the collect images module, which allows ranges to be selected (default off).

expand a single utility module at a time
Controls how utility modules are expanded. If this option is enabled, expanding a module by clicking collapses any other currently expanded panel. If you want to expand a panel without collapsing the others you can do so with Shift+click. Disabling this option inverts the meaning of click and Shift+click (default off).

scroll to utility modules when expanded/collapsed
With this option enabled the side panels will scroll a utility module to the top of the panel when it is expanded or collapsed (default off).

rating an image one star twice will not zero out the rating
Normally clicking a one star rating twice will set a zero star rating to that image. Check this option to disable this functionality (default off).

show scrollbars for center view
Should scrollbars be shown in the center view of the lighttable (default on).

thumbnails

color manage cached thumbnails
If activated, darktable generates thumbnails in a general color space (AdobeRGB) in order to render them independently of the individual monitor. Conversion to the monitor color space is undertaken at display time. If this option is not activated thumbnails are stored directly in a monitor-specific color space at generation time and are subsequently displayed without further corrections (default on).

don’t use embedded preview JPEG but half-size raw
If activated, darktable will process the raw image data in order to generate all images in the lighttable. If deactivated, darktable will use the JPEG preview embedded in the raw file until the image has been processed in the darkroom (default off).

high quality thumbnail processing from size
If the thumbnails size is greater than this value, it will be processed using the full quality rendering path, which is better but slower (default 720p).

delimiters for size categories
Size categories are used to allow different thumbnail overlays to be shown depending on the thumbnail size. A pipe delimited set of values defines at what image sizes the categories change. The default value of “120|400” means that there will be 3 categories of thumbnails: 0-120px, 120-400px and >400px.

pattern for the thumbnail extended overlay text
If the user has chosen to show extended overlay text over thumbnail images, this setting allows the user to define what information is displayed. This pattern can use any of the variables defined in the variables section.

pattern for the thumbnail tooltip (empty to disable)
Defines what information is displayed in the tooltip when the mouse hovers over image thumbnails. This pattern can use any of the variables defined in the variables section.

9.5. darkroom

The following options control functionality in the darkroom view and associated modules.

general

pen pressure control for brush masks
Controls how the pressure reading of a graphics tablet impacts newly generated drawn mask brush strokes. You can control the brush width, hardness and opacity. “Absolute” control means that the pressure reading directly defines the attribute with a value between 0% and 100%. “Relative” means that the pressure reading adjusts the attribute between zero and the pre-defined default value (default off).

smoothing of brush strokes
Sets the level for smoothing of drawn mask brush strokes. Stronger smoothing leads to fewer nodes and easier editing at the expense of lower accuracy.

pattern for the image information line
Set the information to be displayed in the image information line. You can use any variables in the variables section as well as `$(NL)` for a new line.

position of the image information line
Choose the darkroom panel in which the image information line is displayed. Choose between “top left” “top right” “top center” “bottom” and “hidden” (default “bottom”).

border around image in darkroom mode
Process the center image in darkroom mode with a border of the given number of pixels (default 20).

show scrollbars for center view
Should scrollbars be shown in the center view of the darkroom (default off).

demosaicing for zoomed out darkroom mode

Choose how to demosaic images in the darkroom view when not viewing the image at 1:1 zoom scale

- *always bilinear (fast)* is fastest, but not as sharp
- *at most PPG (reasonable)* uses PPG + interpolation modes
- *full (possibly slow)* will use exactly the settings for full-size export

(default "*at most ppg (reasonable)*").

reduce resolution of preview image

Reduce the resolution of the navigation preview image (choose from "original", "1/2", "1/3" or "1/4" size). This may improve the speed of the rendering but take care as it can also hinder accurate color-picking and masking (default "original").

show right-side buttons in processing module headers

Choose whether to show the three buttons (multi-instance, reset, presets) on the right-hand-side of the module header for processing modules. These buttons will always appear when the mouse is over the module. At other times they will be shown or hidden according to this preference selection:

- *always*: always show all buttons
- *active*: only show the buttons when the mouse is over the module
- *dim*: buttons are dimmed when mouse is away
- *auto*: hide the buttons when the panel is narrow
- *fade*: fade out all buttons when the panel narrows
- *fit*: hide all the buttons if the module name doesn't fit
- *smooth*: fade out all buttons in one header simultaneously
- *glide*: gradually hide individual buttons as needed

(default *always*)

modules

display of individual color channels

Controls how individual color channels are displayed when activated in the parametric masks feature. You can choose between "false color" and "grey scale" (default "false color").

hide built-in presets for processing modules

If enabled, only user-defined presets will be shown in presets menu for processing modules – built-in presets will be hidden (default off).

expand a single processing module at a time

Controls how processing modules are expanded in the darkroom. If this option is enabled, expanding a module by clicking collapses any currently expanded module. If you want to expand a module without collapsing the others you can do so with Shift+click. Disabling this option inverts the meaning of click and Shift+click (default on).

only collapse modules in current group

When choosing to expand a single processing module at a time (using the logic defined in the previous setting), only collapse other modules that appear in the current visible group. Disable this option to ensure that modules in non-visible groups are also collapsed (default on).

expand the module when it is activated, and collapse it when disabled

Select this option for the darkroom to automatically expand or collapse processing modules when they are enabled or disabled. (default off)

scroll to processing modules when expanded/collapsed

With this option enabled the darkroom side panel will scroll a processing module to the top when it is expanded or collapsed (default on).

white balance slider colors

Controls the appearance of the sliders in the white balance module.

- *no color*: background of the sliders is not colored at all.
- *illuminant color*: slider colors represent the color of the light source, i.e. the color you are adjusting to in order to achieve neutral white
- *effect emulation*: slider colors represent the effect the adjustment would have had on the scene. This is how most other raw processors show temperature/tint sliders colors.

(default *no color*)

colorbalance slider block layout

Controls the appearance of the shadows/mid-tones/highlights sections in the color balance module.

- *list*: all sliders are shown in one long list (with headers)
- *tabs*: use tabs to switch between the blocks of sliders
- *columns*: the blocks of sliders are shown next to each other (in narrow columns)

(default *list*)

9.6. other views

The following options control functionality in the map and slideshow views.

map / geolocalisation

maximum number of images drawn on map

The maximum number of geotagged images drawn on the map. Increasing this number can slow down the drawing of the map. Needs a restart if changed (default 100).

pretty print the image location

Show a more readable representation of the geo-location in the image information module (default on).

slideshow

waiting time before each picture in slideshow

The number of seconds before displaying the next image (default 5).

9.7. processing

The following options control how images are processed.

always use LittleCMS 2 to apply output color profile

If this option is activated, darktable will use the LittleCMS 2 system library to apply the output color profile instead of its own internal routines. This is significantly slower than the default but might give more accurate results in some cases.

If the given ICC is LUT-based or contains both a LUT and a matrix, darktable will use LittleCMS 2 to render the colors regardless of this configuration parameter's value (default off).

pixel interpolator

The pixel interpolator used in rotation, lens correction, up-scaling and down-scaling. Options are "bilinear", "bicubic", "lanczos2", "lanczos3" (default).

3D lut root folder

Define the root folder (and sub-folders) containing Lut files used by the *lut 3D* module

auto-apply chromatic adaptation defaults

Choose which module is responsible for performing white balance adjustments (chromatic adaptation) by default. Select "legacy" (default) to perform basic chromatic adaptation within the *white balance* module only. Select "modern" to use a combination of the *white balance* and *color calibration* modules to perform modern chromatic adaptation with improved color science. These settings are applied by default to new edits and will not impact old edits.

auto-apply pixel workflow defaults

Choose which modules and module order to apply to new images by default:

- *scene-referred* workflow is based on linear RGB modules. Selecting this option will automatically enable *filmic rgb* and *exposure* modules will set the pixelpipe order to the (scene-referred) order defined for darktable 3.0 and later.

  The *exposure* module will include an automatic adjustment of +0.5 EV to adjust the mid-grey to match that of the majority of SLR cameras. This adjustment can be overridden with an automatically-applied preset if the default produces consistently dark images for your camera.

  Finally, this setting automatically enables the “compensate camera exposure” option in the *exposure* module to adjust the global brightness appropriately in cases where the camera’s exposure compensation dial was used to protect highlights in the image or Expose To The Right (ETTR) to optimally make use of the sensor’s dynamic range.

- *display-referred* (default) workflow is based on Lab modules and is the legacy mode from darktable 2.6 and earlier. Selecting this option will automatically enable the *base curve* module and set the pixelpipe order to the legacy (display-referred) order used by default up to version 2.6.

- *none* will not enable any modules by default and will set the pixelpipe to the (scene-referred) order defined for darktable 3.0 and later.

auto-apply per camera basecurve presets

Use the per-camera basecurve by default instead of the generic manufacturer one if there is one available. This should only be used in conjunction with the *display referred* workflow defined above (default off).

auto-apply sharpen

Auto-apply the sharpen module to new images by default. This option is not recommended on cameras without a low-pass filter. (default on, requires a restart).

detect monochrome previews

Enable this to analyse images during import and tag them with the `darkroom|mode|monochrome` tag if they are found to be monochrome. The analysis is based on the preview image embedded within the imported file. This makes for a more convenient workflow when working with monochrome images, but it slows down the import, so this setting is disabled by default.

9.8. security

The following options allow the user to switch on warnings when certain activities are undertaken.

ask before removing images from database

Always ask the user before any image is removed from the database (default on).

ask before erasing images from disk

Always ask the user before any image file is deleted (default on).

ask before discarding history stack

Always ask the user before the history stack of an image is discarded (default on).

send files to trash when erasing images

Instead of physically deleting images from disk put them into the system’s trash bin (default on).

ask before moving images from film roll folder

Always ask the user before any image file is moved (default on).

ask before copying images to new film roll folder

Always ask the user before any image file is copied (default on).

ask before removing empty folders

Always ask the user before removing any empty folder. This can happen after moving or deleting images (default off).

ask before deleting a tag

Always ask user before deleting a tag from an image (default on).

ask before deleting a style

Always ask user before deleting a style (default on).

ask before deleting a preset

Always ask user before deleting a preset (default on).

9.9. cpu/gpu/memory

This preference tab contains mostly performance-related settings:

memory in megabytes to use for thumbnail cache
In order to speed-up the display of film rolls, darktable stores image thumbnails in a cache file on disk (primary cache) and loads it into memory at startup. This setting controls the size of the cache in megabytes. It needs a restart if changed (default 256MB).

enable disk backend for thumbnail cache
If activated, darktable stores all thumbnails on disk as a secondary cache, and thereby keeps thumbnails accessible if they get dropped from the primary cache. This needs more disk space but speeds up the lighttable view as it avoids reprocessing of thumbnails (default on).

enable disk backend for full preview cache
If enabled, darktable writes full preview images to disk (`.cache/darktable/`) when evicted from the memory cache. Note that this can take a lot of storage (several gigabytes for 20k images) and darktable will never delete cached images. It's safe to delete these manually if you want. Enabling this option will greatly improve lighttable performance when zooming an image in full preview mode (default off).

number of background threads
This controls how many parallel threads are used to create thumbnails during import. Needs a restart if changed (default 2).

host memory limit (in MB) for tiling
In order to manage large images on systems with limited memory darktable does tile-wise processing. This variable controls the maximum amount of memory (in MB) a module may use during image processing. Lower values will force memory-hungry modules to process an image with increasing number of tiles. Setting this to 0 will omit any limits. Values below 500 will be treated as 500. Needs a restart if changed (default 1500).

minimum amount of memory (in MB) for a single buffer in tiling
If set to a positive, non-zero value, this variable defines the minimum amount of memory (in MB) that darktable should take for a single tile. Needs a restart if changed (default 16).

activate OpenCL support
darktable can use your GPU to significantly speed up processing. The OpenCL interface requires suitable hardware and matching OpenCL drivers on your system. If one of those is not found the option is greyed out. Can be switched on and off at any time and takes immediate effect (default on).

OpenCL scheduling profile
Defines how preview and full pixelpipe tasks are scheduled on OpenCL enabled systems:

- *default*: the GPU processes the center view pixelpipe; the CPU processes the preview pipe;
- *multiple GPUs*: both pixelpipes are processed in parallel on two different GPUs;
- *very fast GPU*: both pixelpipes are processed sequentially on the GPU.

9.10. storage

The following options are related to darktable's library database and XMP sidecar files.

database

check for database maintenance
Indicates when darktable should check for database fragmentation and perform maintenance. Options are "never", "on startup", "on close" and "on both". Each of these is also available with an additional "(don't ask)" option to perform the checks automatically without prompting (default "on close").

database fragmentation ratio threshold
Fragmentation ratio (in per cent) above which database maintenance should be performed (subject to the selection made in the option above) (default 25).

create database snapshot
Specifies how often darktable should create database snapshots. Options are "never", "once a month", "once a week", "once a day" and "on close" (default "once a week")

how many snapshots to keep
Number of snapshots to keep after creating a new snapshot, not counting database backups taken when moving between darktable versions. Enter “-1” to store an unlimited number of snapshots. (default 10)

xmp

write sidecar file for each image
XMP files provide a redundant method of saving the changes you have made to an image, independently of darktable’s database. XMP files can later be re-imported into a different database, preserving your changes to the image. It’s strongly recommended that you leave this option activated so that you don’t lose data if your database becomes corrupted. Backing up your raw file plus the accompanying XMP file will allow you to fully restore your work (default on).

store xmp tags in compressed format
Entries in XMP tags can get rather large and may exceed the available space to store the history stack in some output files on export. This option allows binary XMP tags to be compressed in order to save space. Available options are “never”, “always”, and “only large entries” (default).

look for updated xmp files on startup
Scan all XMP files on startup and check if any have been updated in the meantime by some other software. If updated XMP files are found, a menu is opened for the user to choose which of the XMP files to reload (replacing darktable’s database entries by the XMP file contents) and which of the XMP to overwrite from darktable’s database. Activating this option also causes darktable to check for text sidecar files that have been added after import time – see preferences > lighttable > overlay txt sidecar over zoomed images (default off).

9.11. miscellaneous

interface

sort built-in presets first
Choose how the presets menu is sorted. If this option is enabled, built-in presets are shown first. If the option is disabled, user presets are shown first (default on).

mouse wheel scrolls modules side panel by default
When enabled, the mouse wheel scrolls side panels by default and Ctrl+Alt+wheel scrolls data entry fields. When disabled, this behavior is reversed (default off).

always show panels' scrollbars
Defines whether the panel scrollbars should be always visible or activated only depending on the panel content (default on). (needs a restart)

method to use for getting the display profile
This option allows the user to force darktable to use a specific method to obtain the current display profile for color management. In the default setting “all”, darktable will choose to query the X display server’s xatom or the colord system service. You can set this option to “xatom” or “colord” to enforce a specific method if the two methods give different results. You can run the darktable-cmstest binary to examine your color management subsystem.

tags

omit hierarchy in simple tag lists
When exporting images any hierarchical tags are also added as a simple list of non-hierarchical tags to make them visible to some other programs. When this option is checked darktable will only include the last part of the hierarchy and ignore the rest. So `foo|bar|baz` will only add `baz`.

disable the entry completion
The entry completion is useful for those who enter tags using the keyboard only. For others the entry completion can be embarrassing (default off). (needs a restart)

keyboard shortcuts with multiple instances

It is possible to create multiple instances of many processing modules. In this scenario it is not always obvious which instance should be controlled by keyboard shortcut operations. The following options control rules that are applied (in order) to decide which module instance keyboard shortcuts should be applied to.

These rules are also used when clicking and dragging on the histogram to change exposure.

prefer expanded instances
If instances of the module are expanded, ignore collapsed instances (default off).

prefer enabled instances
After applying the above rule, if remaining instances of the module are active, ignore inactive instances (default off).

prefer unmasked instances
After applying the above rules, if remaining instances of the module are unmasked, ignore masked instances (default off).

selection order
After applying the above rules, apply the shortcut to the first or last instance remaining (default “last instance”).

other

do not show april 1st game
Don’t show a game when opening darktable on April 1st (default on).

password storage backend to use
The backend to use for password storage. Options: “auto” (default), “none”, “libsecret”, “kwallet”.

executable for playing audio files
Define an external program which is used in the lighttable view to play audio files that some cameras record to keep notes for images (default “aplay”).

9.12. shortcuts

Much of the functionality of darktable can be accessed via shortcuts using the keyboard or keyboard/mouse combinations. These shortcuts are user-configurable via the *shortcuts* tab.

Many important shortcut actions are provided with default key combinations, but most must be manually configured by the user. Any key may be used for a keyboard shortcut, and may be combined with the Shift, Control or Alt modifier keys (or any combination thereof).

When you open the *shortcuts* tab you are initially presented with a hierarchical list of all actions that can be applied with a keyboard shortcut. At the top of this hierarchy is a short list of key *categories* which are defined below.

add or amend a shortcut

In order to add or amend a shortcut, first navigate to the action you want to change and double-click on it. You will be prompted to press the new key combination to be mapped to the selected action.

If a conflict is found you will be given the option to retain the existing shortcut or replace it. Depending on context, it is possible to use the same keyboard shortcut for multiple actions. For example the same key combination may be used for one action in the lighttable view and another in the darkroom view.

remove a shortcut

To remove a keyboard shortcut, single-click on the action you wish to remove it from and press the Backspace key.

search for a shortcut action

A search field is shown at the bottom of the *shortcuts* tab. Enter the text you wish to search for and press Enter or click the *search* button. Press Enter or *search* multiple times to cycle through all matching shortcut actions.

view currently assigned shortcuts

Press the H key in any darktable view to show a list of all shortcuts that are assigned for the current view.

import, export, reset

You can import your shortcut mappings from or export them to a file.

Press the *default* button to reset all shortcuts to their default state. *Take care when using this option as it is not possible to restore back to a previous state unless you have first exported existing shortcuts to a file or taken a backup of your configuration directory.*

shortcut categories

Keyboard shortcuts are categorized within a hierarchical list so that they can easily be found. The following sections summarize these categories and list some common options.

global

Shortcut actions in this section are applicable to all darktable views.

If you have created any user-defined styles, these will be available as actions within a “styles” sub-section.

views

A single section is provided for each darktable view. Shortcut actions are only applicable to the selected view.

processing modules

Shortcut actions for the processing modules in the darktable view. A section is provided for each processing module.

common shortcuts

Every processing module provides the following shortcut actions by default

enable module
Enable or disable the module, regardless of whether it is currently visible

show module
Expand or collapse the module. If the module is not currently displayed on the screen, darktable will switch to an appropriate module group (if applicable) before displaying it

focus module
Cause the module to receive or lose focus.

reset module parameters
Reset the module to its default state

show preset menu
Show the presets menu for the module

presets
An expandable category which lists all currently-defined presets for the module as possible actions. It will not be shown if there are no presets.

For comboboxes and sliders, some standard shortcut actions are provided, as described in the following sections.

In addition, other module-specific controls will be provided with their own shortcut actions.

sliders

All sliders in processing modules can be adjusted via keyboard shortcuts, regardless of whether the module is currently shown or enabled. The following shortcut actions are provided as standard for each slider:

increase/decrease
Separate shortcuts which allow you to increase or decrease the slider's value by a single step.
dynamic
A single shortcut that can be used in combination with the mouse scroll wheel to increase and decrease slider values.
edit
A shortcut to bring up the slider's edit dialog within which you may key a value directly or modify the slider with the mouse.
reset
Reset the slider to its default value.

In addition, you can modify the precision of the increase/decrease operations with a keyboard shortcut (*shortcuts > views > darkroom > change keyboard shortcut slider precision*), choosing between fine, normal and coarse. See module controls for more details.

When performing increase/decrease and dynamic operations on sliders a toast message will appear at the top of the image to indicate the current value of the slider.

comboboxes

As with sliders, all comboboxes in processing modules can be adjusted via keyboard shortcuts. The following shortcut actions are provided as standard for each combobox:

next/previous
Separate shortcuts which allow you to change to the next or previous entry in the combobox
dynamic
A single shortcut that can be used in combination with the mouse scroll wheel to change to the next/previous entry in the combobox

If the end of a combobox list is reached, these shortcuts will cycle back to the beginning of the list. Similarly, if the beginning of the list is reached the shortcuts will cycle to the end.

multiple module instances

It is possible to create multiple instances of many processing modules. In this scenario it is not always obvious which instance should be controlled by keyboard shortcut operations.

See preferences > miscellaneous for some additional settings that allow you to control how keyboard shortcuts are handled when multiple instances of a processing module are present.

utility modules

Shortcut actions for the utility modules. These are modules that are not used for image processing and may appear on any panel. Some utility modules can be used in multiple views.

As with processing modules, some shortcut actions are provided by default for each module:

show module
Expand or collapse the module.

reset module parameters
Reset the module to its default state.

show preset menu
Show the presets menu for the module.

Some of the above actions may not be available for all utility modules.

9.13. presets

This menu gives you an overview of the presets that are defined for darktable's modules. In this dialog you can select whether a user-defined preset should be auto-applied to matching images. By pressing the "import" button at the bottom of the window you can import a saved preset.

Pre-defined presets (those that are included by default within darktable) are shown with a lock symbol. Their auto-apply properties cannot be changed.

Selecting a user-defined preset and pressing Enter or double-clicking on it will open an edit dialog. This allows the chosen preset to be edited, saved to an external `.dtpreset` file or deleted. Selecting a user-defined preset and pressing the Delete key will delete the preset.

auto apply this preset to matching images
Activate this checkbutton to automatically apply the preset to newly imported images – a set of fields is displayed where you can define patterns to be matched against Exif data.

only show this preset for matching images
Activate this checkbutton to hide the preset in darkroom mode if it does not match the defined patterns.

model
A pattern to be matched against the Exif field that describes your camera model; use % as wildcard.

maker
A pattern to be matched against the Exif field that describes the maker of your camera; use % as wildcard.

lens
A pattern to be matched against the Exif field that describes your lens; use % as wildcard.

iso
Only apply the preset if the ISO value of your image lies within the given range.

exposure
Only apply the preset if the exposure time of your image lies within the given range; set + as the upper value to match arbitrarily long exposures.

aperture
Only apply the preset if the aperture of your image lies within the given range; set f/0 as the lower value to match arbitrarily open apertures; set f/+ as the upper value to match arbitrarily closed apertures.

focal length
Only apply the preset if the focal length of your image lies within the given range (from 0 to 1000).

See the presets section for more information.

9.14. lua options

lua scripts installer don’t show again
Check this box to hide the lua scripts installer in the lighttable if no lua scripts are installed.

10. Scripting with Lua

darktable comes with a versatile scripting interface language for functionality enhancement.

10.1. overview

Lua scripts can be used to define actions for darktable to perform when an event is triggered. One example might be calling an external application during file export in order to apply additional processing steps outside of darktable.

Lua is an independent project founded in 1993, providing a powerful, fast, lightweight, embeddable scripting language. Lua is widely used by many open source applications, in commercial programs, and for games programming.

darktable uses Lua version 5.3. Describing the principles and syntax of Lua is beyond the scope of this usermanual. For a detailed introduction see the Lua reference manual.

The following sections will provide you with a brief introduction to how Lua scripts can be used within darktable.

10.2. basic principles: luarc files

At startup, darktable will automatically run the Lua scripts `$DARKTABLE/share/darktable/luarc` and `$HOME/.config/darktable/luarc` (where `$DARKTABLE` represents the darktable installation directory and `$HOME` represents your home directory).

This is the only time darktable will run Lua scripts by itself. These scripts can register callbacks to perform actions on various darktable events. This callback mechanism is the primary method of triggering lua actions.

10.3. a simple lua example

Let's start with a simple example which will print some code on the console. Create a file called `luarc` in darktable's configuration directory (usually `$HOME/.config/darktable/`) and add the following line to it:

```
print("Hello World !")
```

Start darktable and you will see the sentence "`Hello World !`" printed on the console. Nothing fancy but it's a start.

At this point, there is nothing darktable-specific in the script. We simply use Lua's standard print function to print a string. That's nice and all, but we can do better than that. To access the darktable API you first need to `require` it and save the returned object in a variable. Once this is done you can access the darktable API as subfields of the returned object. All of this is documented in darktable's Lua API reference manual.

```
local darktable = require "darktable"
darktable.print_error("Hello World !")
```

Run the script and ... nothing happens. The function `darktable.print_error` is just like `print` but will only print the message if you have enabled lua traces by running darktable with "`darktable -d lua`" on the command line. This is the recommended way to do traces in a darktable lua script.

10.4. printing labeled images

This first example showed us the very basics of lua and allowed us to check that everything is working properly. Let's do something a little bit more complex. Let's try to print the list of images that have a "red" label attached to them. But first of all, what is an image?

```
local darktable = require "darktable"
local debug = require "darktable.debug"
print(darktable.debug.dump(darktable.database[1]))
```

Running the code above will produce a lot of output. We will look at it in a moment, but first let's look at the code itself.

We know about `require darktable`. Here, we need to separately `require darktable.debug` which is an optional section of the API that provides helper functions to help debug lua scripts.

`darktable.database` is a table provided by the API that contains all images in the database (currently visible or not, duplicate or not...). Each entry in the database is an image object. Image objects are complex objects that allow you to manipulate your image in various ways (it is all documented in the `types_dt_lua_image_t` section of the API manual). To display our images, we use `darktable.debug.dump` which is a function that will take anything as its parameter and recursively dump its content. Since images are complex objects that indirectly reference other complex objects, the resulting output is huge. Below is a cut down example of the output.

```
toplevel (userdata,dt_lua_image_t) : /images/100.JPG
   publisher (string) : ""
   path (string) : "/images"
   move (function)
   exif_aperture (number) : 2.7999999523163
   rights (string) : ""
   make_group_leader (function)
   exif_crop (number) : 0
   duplicate_index (number) : 0
   is_raw (boolean) : false
   exif_iso (number) : 200
   is_ldr (boolean) : true
   rating (number) : 1
   description (string) : ""
   red (boolean) : false
   get_tags (function)
   duplicate (function)
   creator (string) : ""
   latitude (nil)
   blue (boolean) : false
   exif_datetime_taken (string) : "2014:04:27 14:10:27"
   exif_maker (string) : "Panasonic"
   drop_cache (function)
   title (string) : ""
   reset (function)
   create_style (function)
   apply_style (function)
   film (userdata,dt_lua_film_t) : /images
      1 (userdata,dt_lua_image_t): .toplevel
      [......]
   exif_exposure (number) : 0.0062500000931323
   exif_lens (string) : ""
   detach_tag (function): toplevel.film.2.detach_tag
   exif_focal_length (number) : 4.5
   get_group_members (function): toplevel.film.2.get_group_members
   id (number) : 1
   group_with (function): toplevel.film.2.group_with
   delete (function): toplevel.film.2.delete
   purple (boolean) : false
   is_hdr (boolean) : false
   exif_model (string) : "DMC-FZ200"
   green (boolean) : false
   yellow (boolean) : false
   longitude (nil)
   filename (string) : "100.JPG"
   width (number) : 945
   attach_tag (function): toplevel.film.2.attach_tag
```

```
   exif_focus_distance (number) : 0
   height (number) : 648
   local_copy (boolean) : false
   copy (function): toplevel.film.2.copy
   group_leader (userdata,dt_lua_image_t): .toplevel
```

As we can see, an image has a large number of fields which provide all sort of information about it. Here, we are interested in the “red” label. This field is a boolean, and the documentation tells us that it can be written. We now just need to find all images with that field and print them out:

```
darktable = require "darktable"
for _,v in ipairs(darktable.database) do
  if v.red then
    print(tostring(v))
  end
end
```

This code should be quite simple to understand at this point, but it contains a few interesting aspects of lua that are worth highlighting:

- `ipairs` is a standard lua function that will iterate through all numeric indices of a table. We use it here because darktable’s database has non-numeric indices which are functions to manipulate the database itself (adding or deleting images, for example).
- Iterating through a table will return both the key and the value used. It is conventional in lua to use a variable named “_” to store values that we don’t care about.
- Note that we use the standard lua function `tostring` here and not the darktable specific `darktable.debug.dump`. The standard function will return a name for the object whereas the debug function will print the content. The debug function would be too verbose here. Once again, it is a great debug tool but it should not be used for anything else.

10.5. adding a simple shortcut

So far, all our scripts have done things during startup. This is of limited use and doesn’t allow us to react to real user actions. To do more advanced things we need to register a function that will be called on a given event. The most common event to react to is a keyboard shortcut.

```
darktable = require "darktable"

local function hello_shortcut(event, shortcut)
darktable.print("Hello, I just received '"..event..
       "' with parameter '"..shortcut.."'")
end

darktable.register_event("shortcut",hello_shortcut,
       "A shortcut that prints its parameters")
```

Now start darktable, go to “preferences > shortcuts > lua > A shortcut that prints its parameters”, assign a shortcut and try it. You should see a nice message printed on the screen.

Let’s look at the code in detail. We first define a function which takes two strings as input parameters. The first one is the type of event that is triggered (“shortcut”) and the second one is the name of the shortcut (“A shortcut that prints its parameters”). The function itself calls `darktable.print`, which will print the message as an overlay in the main window.

Once that function is defined, we register it as a shortcut callback. To do that we call `darktable.register_event` which is a generic function for all types of events. We tell it that we are registering a shortcut event, then we give the callback to call and last, we give the string to use to describe the shortcut in the preferences window.

Let’s try a shortcut that is a little more interactive. This one will look at the images the user is currently interested in (selected or moused-over) and increase their rating.

```
darktable = require "darktable"

darktable.register_event("shortcut",function(event,shortcut)
    local images = darktable.gui.action_images
    for _,v in pairs(images) do
      v.rating = v.rating + 1
    end
  end,"Increase the rating of an image")
```

At this point, most of this code should be self explanatory. Just a couple of notes:

- Instead of declaring a function and referencing it, we declare it directly in the call to `darktable.register_event` this is strictly equivalent but slightly more compact.
- `image.rating` is a field that gives the star rating of any image (between 0 and 5 stars, -1 means rejected).
- `darktable.gui.action_images` is a table containing all the images of interest. darktable will act on selected images if any image is selected, and on the image under the mouse if no image is selected. This function makes it easy to follow darktable's UI logic in lua.

If you select an image and press your shortcut a couple of times, it will work correctly at first but when you have reached five stars, darktable will start showing the following error on the console:

```
<![CDATA[
LUA ERROR : rating too high : 6
stack traceback:
   [C]: in ?
   [C]: in function '__newindex'
  ./configdir/luarc:10: in function <./configdir/luarc:7>
      LUA ERROR : rating too high : 6
  ]]>
```

This is lua's way of reporting errors. We have attempted to set a rating of 6 to an image, but a rating can only go as high as 5. It would be trivial to add a check, but let's go the complicated way and catch the error instead:

```
darktable.register_event("shortcut",function(event,shortcut)
    local images = darktable.gui.action_images
    for _,v in pairs(images) do
      result,message = pcall(function()
        v.rating = v.rating + 1
        end)
      if not result then
        darktable.print_error("could not increase rating of image "..
          tostring(v).." : "..message)
      end
    end
end,"Increase the rating of an image")
```

`pcall` will run its first argument and catch any exception thrown by it. If there is no exception it will return `true` plus any result returned by the function; if there is an exception it will return `false` and the error message of the exception. We simply test these results and print them to the console.

10.6. exporting images with lua

So far we have learned to use lua to adapt darktable to our particular workflow. Let's look now at how to use lua to easily export images to an online service. If you are able to upload an image to a service via the command line then you can use lua to integrate this into darktable's user interface.

In this next example we will use lua to export via scp. A new storage type will appear in darktable's UI which will export images to a remote target via the copy mechanism in ssh.

```
darktable = require "darktable"

darktable.preferences.register("scp_export","export_path",
  "string","target SCP path",
  "Complete path to copy to. Can include user and hostname","")

darktable.register_storage("scp_export","Export via scp",
  function( storage, image, format, filename,
     number, total, high_quality, extra_data)
    if not darktable.control.execute("scp "..filename.." "..
      darktable.preferences.read("scp_export",
         "export_path","string")) then
      darktable.print_error("scp failed for "..tostring(image))
    end
end)
```

`darktable.preferences.register` will add a new preference to darktable's preferences menu, `scp_export` and `export_path` allow us to uniquely identify our preference. These fields are reused when we read the value of the preference. The `string` field tells the lua engine that the preference is a string. It could also be an integer, a filename or any of the types detailed in the API manual relating to `types_lua_pref_type` . We then have the label for the preference in the preference menu, the tooltip when hovering over the value and a default value.

`darktable.register_storage` is the call that actually registers a new storage type. The first argument is a name for the storage type, the second is the label that will be displayed in the UI and last is a function to call on each image. This function has a lot of parameters, but `filename` is the only one we use in this example. It contains the name of a temporary file where the image was exported by darktable's engine.

This code will work but it has a couple of limitations. This is just a simple example after all:

- We use preferences to configure the target path. It would be nicer to add an element to the export UI in darktable. We will detail how to do that in the next section
- We do not check the returned value of `scp`. That command might fail, in particular if the user has not correctly set the preference.
- This script can't read input from the user. The remote `scp` must use password-less copy. `scp` can't be provided a password easily, so we will leave it that way
- There is no message displayed once the example is done, only the progress bar on the lower left side tells the user that the job is done.
- We use `coroutine.yield` to call an external program. The normal `os.execute` would block other lua codes from happening.

10.7. building user interface elements

Our previous example was a bit limited. In particular the use of a preference for the export path wasn't very nice. We can do better than that by adding elements to the user interface in the export dialog.

UI elements are created via the `darktable_new_widget` function. This function takes a type of widget as a parameter and returns a new object corresponding to that widget. You can then set various fields in that widget to set its parameters. You will then use that object as a parameter to various functions that will add it to the darktable UI. The following simple example adds a lib in the lighttable view with a simple label

```
local my_label = darktable.new_widget("label")
my_label.label = "Hello, world !"

dt.register_lib("test","test",false,{
    [dt.gui.views.lighttable] = {"DT_UI_CONTAINER_PANEL_LEFT_CENTER",20},
    },my_label)
```

There is a nice syntactic trick to make UI elements code easier to read and write. You can call these objects as functions with a table of key values as an argument. This allows the following example to work. It creates a container widget with two sub-widgets: a label and a text entry field.

```
   local my_widget = darktable.new_widget("box"){
      orientation = "horizontal",
      darktable.new_widget("label"){ label = "here => " },
      darktable.new_widget("entry"){ tooltip = "please enter text here" }
   }
```

Now that we know that, let's improve our script a bit.

```
darktable = require "darktable"

local scp_path = darktable.new_widget("entry"){
  tooltip ="Complete path to copy to. Can include user and hostname",
  text = "",
  reset_callback = function(self) self.text = "" end
}

darktable.register_storage("scp_export","Export via scp",
  function( storage, image, format, filename,
     number, total, high_quality, extra_data)
    if not darktable.control.execute(scp "..filename.." "..
      scp_path.text
    ) then
      darktable.print_error("scp failed for "..tostring(image))
    end
    end,
    nil, --finalize
    nil, --supported
    nil, --initialize
    darktable.new_widget("box") {
    orientation ="horizontal",
    darktable.new_widget("label"){label = "target SCP PATH "},
    scp_path,
})
```

10.8. sharing scripts

So far, all of our lua code has been in *luarc*. That's a good way to develop your script but not very practical for distribution. We need to make this into a proper lua module. To do that, we save the code in a separate file (`scp-storage.lua` in this case):

```
--[[
SCP STORAGE
a simple storage to export images via scp

AUTHOR
Jérémy Rosen (jeremy.rosen@enst-bretagne.fr)

INSTALLATION
* copy this file in $CONFIGDIR/lua/ where CONFIGDIR
is your darktable configuration directory
* add the following line in the file $CONFIGDIR/luarc
  require "scp-storage"

USAGE
* select "Export via SCP" in the storage selection menu
* set the target directory
* export your images

LICENSE
GPLv2

]]
darktable = require "darktable"
```

```
darktable.configuration.check_version(...,{2,0,0})

local scp_path = darktable.new_widget("entry"){
  tooltip ="Complete path to copy to. Can include user and hostname",
  text = "",
  reset_callback = function(self) self.text = "" end
}

darktable.register_storage("scp_export","Export via scp",
  function( storage, image, format, filename,
     number, total, high_quality, extra_data)
    if coroutine.yield("RUN_COMMAND","scp "..filename.." "..
      scp_path.text
    ) then
      darktable.print_error("scp failed for "..tostring(image))
    end
    end,
    nil, --finalize
    nil, --supported
    nil, --initialize
    darktable.new_widget("box") {
    orientation ="horizontal",
    darktable.new_widget("label"){label = "target SCP PATH "},
    scp_path,
})
```

darktable will look for scripts (following the normal lua rules) in the standard directories plus `$CONFIGDIR/lua/*.lua`. So our script can be called by simply adding `require "scp-storage"` in the *luarc* file. A couple of extra notes...

- The function `darktable.configuration.check_version` will check compatibility for you. The "`...`" will turn into your script's name and `{2,0,0}` is the API version you have tested your script with. You can add multiple API versions if you update your script for multiple versions of darktable.
- Make sure to declare all your functions as `local` so as not to pollute the general namespace.
- Make sure you do not leave debug prints in your code – `darktable.print_error` in particular allows you to leave debug prints in your final code without disturbing the console.
- You are free to choose any license for your script but scripts that are uploaded on darktable's website need to be GPLv2.

Once you have filled all the fields, checked your code, you can upload it to our script page here.

10.9. calling lua from dbus

It is possible to send a lua command to darktable via its DBus interface. The method `org.darktable.service.Remote.Lua` takes a single string parameter which is interpreted as a lua command. The command will be executed in the current lua context and should return either nil or a string. The result will be passed back as the result of the DBus method.

If the Lua call results in an error, the DBus method call will return an error `org.darktable.Error.LuaError` with the lua error message as the message attached to the DBus error.

10.10. using darktable from a lua script

Warning: This feature is very experimental. It is known that several elements don't yet work in library mode. Careful testing is highly recommended.

The lua interface allows you to use darktable from any lua script. This will load darktable as a library and provide you with most of the lua API (darktable is configured headless, so the functions relating to the user interface are not available).

As an example, the following program will print the list of all images in your library:

```
#!/usr/bin/env lua
package = require "package"
package.cpath=package.cpath..";./lib/darktable/lib?.so"

dt = require("darktable")(
"--library", "./library.db",
"--datadir", "./share/darktable",
"--moduledir", "./lib/darktable",
"--configdir", "./configdir",
"--cachedir","cachedir",
"--g-fatal-warnings")

require("darktable.debug")

for k,v in ipairs(dt.database) do
   print(tostring(v))
end
```

Note the third line that points to the location of the `libdarktable.so` file.

Also note that the call to require returns a function that can be called only once and allows you to set darktable's command line parameter. The `:memory:` parameter to `--library` is useful here if you don't want to work on your personal library.

10.11. lua API

darktable's Lua API is documented in its own manual with a detailed description of all data structures and functions. You can download the API manual from here.

11. Guides & Tutorials

11.1. developing monochrome images

Photography has a long history of producing monochrome images, and many still enjoy this aspect of photography. While there are some specialised/modified cameras with a truly monochrome sensor, most still use a regular camera to capture a color image, and turn it into a monochrome image during post-processing.

There are two main approaches this conversion:

- A *physical approach*, where we attempt to simulate how a silver-based photographic film emulsion would react to the light captured at the scene.
- A *perceptual approach*, where we develop a color image and reduce the color saturation in a perceptual color space such as *CIE Lab*.

These approaches and other monochrome-related features in darktable are discussed in the following sections.

importing and flagging images as monochrome

When importing an image, there are a number of properties that can be used to indicate that the image requires a monochrome treatment:

- If the image was taken using an achromatic camera, the image will be automatically flagged as monochrome.
- When you capture a scene from which you would like to produce a monochrome image, it can be helpful to put your camera into a “black & white” creative mode. This allows you to visualise what the scene would look like in monochrome through your camera’s liveview screen or electronic viewfinder. The camera will still capture the full color data in the raw file, but the embedded jpeg preview image will be monochrome. When you import such an image, darktable can automatically flag the image as monochrome based on the preview image.

  Checking whether the preview is monochrome slows down the import process, so this is disabled by default. You can enable this check in preferences > processing > detect monochrome previews
- When processing a raw file, one of the first steps is to *demosaic* the image. If you set the *demosaicing method* to “passthrough (monochrome)”, this discards color information during the demosaicing process, and darktable will flag the image as monochrome.

  Note: You should only use this for images taken on a camera where the Bayer filter has been removed.
- After you have imported the image, you can manually flag an image as monochrome (or not) using the *metadata* tab on the lighttable’s selected images module,

If any of the above methods result in an image being flagged as monochrome, darktable modules can use this information to present the user with some monochrome-specific module controls and/or apply special processing to the image.

The `darktable|mode|monochrome` tag will be automatically applied to any images flagged as monochrome, and if you have enabled any permanent overlay information on your lighttable thumbnails, such images will be marked with a visual indicator `B&W` next to the file type information. By automatically applying this tag and visual indicator, darktable makes it easy to set up filters to single out any images for monochrome treatment, and to see at a glance which images in the current collection bear the *monochrome* tag.

monochrome conversion

physical approach

This approach tends to work with linear scene-referred data from the sensor, and attempts to mimic the response of a photographic film with a silver emulsion. It consists of three steps:

1. Map the color channels from the sensor into a single monochrome channel. Different types of monochrome photographic film have different levels of sensitivity to various wavelengths of light, and this can be simulated by giving the three color channels different weightings when combining them together into a single monochrome channel. The *color calibration* module allows the three channels to be mixed into a grey channel by varying amounts, and it includes a number of presets that are designed to emulate the characteristics of some well-known types of photographic film.

2. Apply a luminosity saturation curve. As a piece of photographic film is exposed to more intense light, its response will fall off as the silver emulsion becomes saturated. This saturation curve is simulated by the *filmic rgb* module.

3. Developing a monochrome film in the darkroom traditionally involves “dodging and burning” to control the level of exposure across different parts of the image. This can be emulated in darktable by using either the *exposure* module with manually created masks, or by using the *tone equalizer* module, which will automatically generate a mask for you using a guided filter.

perceptual approach

The other option for producing a monochrome image is to reduce the color saturation in the image, which can be done in a linear colorspace, or in a color space oriented towards modelling human perception.

- The *color balance* module operates in linear RGB, and allows you to reduce the color saturation in the image using either the input or output color saturation slider – which you choose depends on whether you want to make any other adjustments to either the color or monochrome image in the color balance module. The color balance module tends to give a predictable and perceptually uniform result.

- The *monochrome* module works in Lab color space, and it allows the user to graphically define a weighted combination of colors to determine the density of the blacks in the monochrome image. The interface can be somewhat sensitive to the settings, with small changes producing large effects, and you may experience problems with the global contrast and/or black pixel artifacts.

- Other modules such as *color zones* can also be used to remove color saturation from the image, but these don’t offer any real advantage over the simplicity of the *color balance* module’s saturation sliders.

11.2. other resources

The official places to obtain information concerning darktable are the following:

- darktable.org
- GitHub wiki

The following articles provide some useful background information about darktable's scene-referred workflow:

- darktable 3.0 for dummies in 3 modules
- darktable 3.0 for dummies – hardcore edition
- darktable 3.0: RGB or Lab? Which modules? Help!
- darktable's filmic FAQ
- Introducing color calibration module

The following resources can provide a deeper understanding of the functionality of some specific processing modules:

- Image processing and the pixel pipeline in darktable 3.0
- Filmic RGB v3: remapping any dynamic range in darktable 3.0
- Filmic RGB v4: highlights reconstruction in darktable 3.2
- Dodging and burning with tone equalizer in darktable 3.0
- Noise reduction (profiled) with non-local means in darktable 3.0
- Noise reduction (profiled) with wavelets in darktable 3.0
- Contrast equalizer modules in darktable

Some other YouTube channels with recent content on using darktable are:

- Bruce Williams Photography
- Rico Richardson
- Boris Hajdukovic

For help and support, you can also ask questions on the main discussion forums at discuss.pixls.us.

12. Special Topics

12.1. color management

12.1.1. overview

darktable employs a fully color managed workflow:

- Input color specifications are taken from embedded or user-supplied ICC profiles or – in the case of raw files – from a library of camera-specific color matrices.
- darktable automatically reads the display profile of your monitor (if properly configured) for accurate on-screen color rendition. Multi-screen setups are fully supported as long as a system service like colord is in place and properly set up to inform darktable of the correct monitor profile.
- Output files can be encoded in one of darktable's built-in profiles, including sRGB and Adobe RGB, or into a color space supplied by the user as an ICC profile.

12.1.2. display profile

For darktable to faithfully render colors on screen it needs to find the correct display profile for your monitor. In general this requires your monitor to be properly calibrated and profiled, and it needs the profile to be correctly installed on your system. darktable queries your X display server's xatom as well as the system service colord (if available) for the right profile. If required you can enforce a specific method in preferences > miscellaneous.

To investigate your display profile configuration you can run the darktable-cmstest binary (Linux only) which prints out useful information (e.g. profile name per-monitor) and tells you if the system is correctly configured.

In rare cases you may need to manually select the display profile. This is possible from the soft proof and gamut check option dialogs in the darkroom view and the display profile dialog in the lighttable view.

Bear in mind that high-tier consumer-grade screens do not need a user-made display profile unless you need to perform soft-proofing with professional expectations, since they are properly calibrated to sRGB in the factory.

A poorly made display profile will be more harmful than sticking to the default sRGB profile, since the default might be slightly inaccurate but will at least be reliable. Advanced and professional users are advised to proceed with the production of custom display profiles only if they have the training to assess the quality of the resulting profile and understanding of the profiling options.

12.1.3. rendering method

darktable can render colors either with its internal algorithms or by using the external library LittleCMS2. darktable's internal method is, by an order of magnitude, faster than the external one. The external option gives you a choice of the rendering intent and might offer a slightly higher accuracy in some cases.

You can change the default method in preferences > processing > always use LittleCMS 2 to apply output color profile

---

Note: If the given ICC is LUT-based or contains both, a LUT and a matrix, darktable will use LittleCMS2 to render the colors regardless of the configuration parameter's value.

12.1.4. rendering intent

If rendering with LittleCMS2 is activated (see rendering method) you can define how out-of-gamut colors are handled when converting between color spaces. A selection box in the export selected module, the *output color profile* module, and soft proof gives you a choice of the following rendering intents:

perceptual
Suited to photographs as it maintains the relative position of colors. This is usually the best choice.

relative colorimetric
Out-of-gamut colors are converted to colors having the same lightness, but different saturation. Other colors remain unmodified.

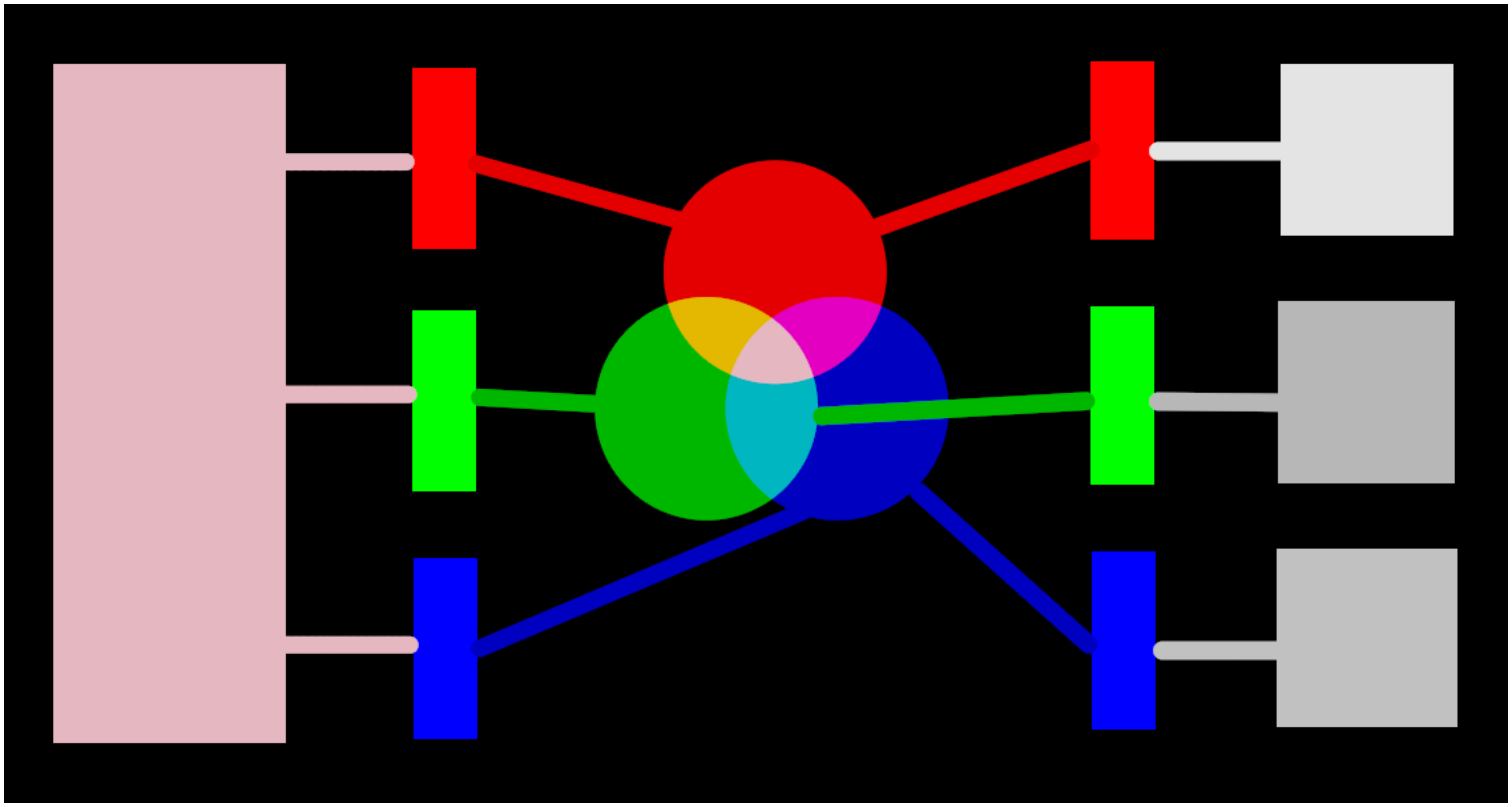
saturation
Saturation is retained but lightness is slightly changed.

absolute colorimetric
Keep the white point.

12.1.5. darktable's color spaces

darktable’s input images are either RGB files (like JPEGs or TIFFs) or camera RAWs. Both store visual information as a combination of primary colours (such as red, green and blue) which together describe a light emission to be later recreated by a display.

The following image illustrates this concept.



On the left-hand-side of the image is a colored light that we need to represent digitally. Using three ideal color filters, we can decompose this light into three colored primary lights at different intensities. In order to recreate the original colored light from our ideal decomposition, as illustrated in the center of the image, we simply need to recombine those 3 primary lights by addition.

It should be possible to reproduce this original light by taking a combination of white lights at the correct intensities and projecting that light through appropriately colored filters. This experiment can be performed at home using gels and dimmable white bulbs. This is roughly what old color CRT displays did and how video projectors still work.

In photography, the initial decomposition step is performed by the color filter array that sits on top of your camera’s sensor. This decomposition is not ideal, so it is not possible to recreate the original emission directly by a simple addition. Instead we need to provide some intermediate scaling to adjust the three intensities.

On screens, the LED bulbs are dimmed proportionally to each intensity, and the emissions of the three lights physically added to reconstruct the original emission. Digital images store the intensities of these primary lights as a set of 3 numbers for each pixel, depicted on the right of the above image as shades of grey.

While a set of display intensities can be easily combined to recreate an original light on a screen (for example, if we created a synthetic image in-computer) the set of captured intensities from a sensor needs some scaling in order for the on-screen light addition to reasonably reproduce the original light emission. This means that every set of intensities, expressed as an RGB set, must be linked to a set of filters (or primary LED colors) that define a *color space* – any RGB set only makes sense with reference to a color space.

Not only do we need to temper the captured intensities to make them summable again, but if we are to recompose the original light on a display that does not have the same colored filters or primaries as the space in which our RGB set belongs, these intensities need to be rescaled to take into account the differing filters on the display. The mechanism for this scaling is described in *color profiles*, usually stored within .icc files.

Note: Color is not a physical property of light – it exists only in the human brain, as a product of the decomposition of a light emission by the cone cells in the retina, again very similar in principle to the above filtering example. An “RGB” value should be understood as “light emissions encoded on 3 channels connected to 3 primaries”, but the primaries themselves may look different from what humans would call “red”, “green” or “blue”.

To summarize, the filters described here are overlapping band-pass filters. Since they overlap, summing them back together would not preserve the energy of the original spectrum so, long story short, we need to dial them down with regard to the retina cone response

Most of darktable’s actual image processing takes place in a large RGB “working profile” space, with some (mostly older) modules internally working in the CIELab 1976 color space (often just called “Lab”). The final output of the image processing pipeline is once again in an RGB space shaped for either the monitor display or the output file.

This process implies that the pixelpipe has two fixed color conversion steps: *input color profile* and *output color profile*. In addition there is the *demosaic* step for raw images, where the colors of each pixel are reconstructed by interpolation.

Each module has a position in the pixelpipe which tells you which color space the module lives in:

- up to *demosaic* : The raw image information does not yet constitute an “image” but merely “data” about the light captured by the camera. Each pixel carries a single intensity for one single primary color, and camera primaries are very different from primaries used in models of human vision. Bear in mind that some of the modules in this part of the pipe can also act on non-raw input images in RGB format with full information on all three color channels.
- between *demosaic* and *input color profile* : Image is in RGB format within the color space of the specific camera or input file.
- between *input color profile* and *output color profile* : Image is in the space defined by the selected working profile (linear Rec2020 RGB by default). As darktable processes images in 4x32-bit floating point buffers, we can handle large working color spaces without risking banding or tonal breaks.
- after *output color profile* : Image is in RGB format as defined by the selected display or output ICC profile.

12.1.6. unbounded colors

Screens and most image file formats can only encode RGB intensities confined within a certain range. For example, images encoded on 8 bits can only contain values from 0 to 255, images on 10 bits from 0 to 1023, and so on… Graphic standards postulate that the maximum of that range, no matter its actual value, will always represent the maximum brightness that the display medium is able to render, usually between 100 and 160 Cd/m² (or nits) depending on the actual standard. We generally call this maximum “100 % display-referred”. The minimum of the range, encoded 0 no matter the bit-depth used, becomes then “0 % display-referred”. 100 % encodes pure white, 0 % encodes pure black.

This is a limitation for image processing applications, because it means that any pixel lying outside of this range will be clipped to the nearest bound, resulting in non-recoverable loss of data (colors and/or textures).

For the longest time, image processing software too was bounded to this limitation for technical reasons, and some still is, but now by design choice. As a result, they would clip RGB intensities at 100 % display-referred between image operations.

darktable uses floating-point arithmetic inside its color pipeline, which means it can handle any RGB value internally, even those outside the display-referred range, as long as it is positive. Only at the very end of the pipeline, before the image is saved to a file or sent to display, are the RGB values clipped if needed.

Pixels that can take values outside of the display range are said to have “unbounded colors”. One could choose to clamp (i.e. confine) those values to the allowed range at every processing step or choose to carry on with them, and clamp them only at the last step in the pipeline. However, it has been found that processing is less prone to artifacts if the unbounded colors are not clamped but treated just like any other color data.

At the end of the pipeline, modules like *filmic* can help you to remap RGB values to the display-referred range while maximizing the data preservation and avoiding hard clipping, which is usually not visually pleasing.

However, at all times in the pipeline, you must ensure that you do not create negative RGB values. RGB intensities encode light emissions and negative light does not exist. Those modules which rely on a physical understanding of light to process pixels will fail if they encounter a non-physical light emission. For safety, negative RGB values are still clipped whenever they might make the algorithms fail, but the visual result might look degraded. Negative values can be produced when abusing the *black level* in *exposure* or the *offset* in *color balance* and care should be taken when using these modules.

12.1.7. possible color artifacts

There are some infrequent situations which still can lead to problematic results unless the user takes some action. Some modules in Lab color space, like *levels* and *monochrome*, need to rely on the fact that the L channels carries all lightness information, with the a and b channels purely representing chroma and hue. Unbounded colors with negative L values are especially problematic to these modules and can lead to black pixel artifacts.

It has been found that highly saturated blue light sources in the image frame are likely candidates for pixels with negative L values. If you are engaged in stage photography you should pay close attention to such lights appearing in images.

In order to mitigate this issue the *input color profile* module has a gamut clipping option. This option is switched off by default but can be activated if artifacts are observed. Depending on the settings, colors will be confined to one of the available RGB gamuts. In effect black pixel artifacts are prevented at the costs of losing some color dynamics.

12.2. memory

darktable's memory requirements are high. A simple calculation makes this clear. If you have a 20MPx image then, for precision reasons, darktable will store this internally as a 4 x 32-bit floating point cell for each pixel. Each full image of this size will therefore need about 300MB of memory. As we want to process the image, we will at least need two buffers for each module – one for input and one for output. If we have a more complex module, its algorithm might additionally require several intermediate buffers of the same size. Without further optimization, anything between 600MB and 3GB would be needed merely to store and process image data. On top of that we have darktable's code segment, the code and data of all dynamically linked system libraries, and not to forget, further buffers where darktable stores intermediate images for quick access during interactive work (mip map cache).

All in all, darktable needs a minimum of about 4GB of memory to run happily.

total system memory

From the above analysis, it is evident that your computer needs a sane memory setup to properly run darktable. We suggest that you have a least 4GB of physical RAM plus 4 to 8GB of additional swap space installed.

Theoretically, you could run darktable with lower amounts of physical RAM and balance this with enough swap space. However, you this could cause your system to "thrash", as it reads or writes data pages to and from the hard disk. We have positive reports that this functions well for several users, but it still might get extremely slow for others. A solid-state drive can ease the pain slightly.

available address space

Besides the total amount of system memory there is another limiting factor: the available address space of your hardware architecture. How much memory can be addressed by a process depends on the number of address bits your CPU offers. For a CPU with 32-bit address registers, this is 2^32 bytes, which makes a total of 4GB. This is the absolute upper limit of memory that can be used by a process and it constitutes a tight situation for darktable as we have seen above.

darktable's escape route is called tiling. Instead of processing an image in one big chunk, darktable splits the image into smaller parts for every processing module. This still requires one full input and output buffer, but intermediate buffers can be made small enough to fit everything into the hardware's limits.

memory fragmentation

Unfortunately this is not yet the full story. An effect called memory fragmentation can and will hit software that needs to perform extensive memory management. If such a program allocates 5 times 300MB at a time and frees it again, that memory should normally be available for one big 1.5GB allocation afterwards. However this is often not the case. The system's memory allocator may no longer see this area as one contiguous 1.5GB block but as a row of separate 300MB areas. If there is no other free area of 1.5GB available, a subsequent allocation would fail. During a program run this mechanism will take away more and more of the larger memory blocks in favor of smaller ones. darktable's mip map cache allocates several small memory blocks per thumbnail, so this problem is even bigger. For this reason, as of darktable 2.0, 32-bit support is soft-deprecated.

further limitations

As if this were not challenging enough, there are further things that might limit darktable's access to memory. On some older boards you need to activate the "memory mapping" BIOS option in order to have all physically installed memory enabled. In addition if you are on a 32-bit OS you will probably need a kernel version that has "Physical Address Extension" (PAE) enabled. This is often but not always the case for Linux. Many distributions deliver different kernels, some with and some without PAE activated; you need to choose the right one. To check if the system is setup correctly, use the command "free" in a terminal and examine the output. If the output reports less RAM than you have installed, you have an issue needing correction; for example you have 4GB on your board, but your kernel is only seeing 3GB or less. You should consult your BIOS manual and the information about your Linux variant for further help.

setting up darktable on 32-bit systems

As we've seen, 32-bit systems are difficult environments for darktable. Still some users are running darktable on them, if the basic requirements in terms of total system memory and the topics mentioned in the paragraphs above are addressed properly.

There are several parameters that require adjustment in order to get it running. If you install fresh, darktable will detect your system and set conservative values by default. However, if you upgrade darktable from an older version, chances are you have unfavorable settings in your preferences. The consequences might be darktable aborting due to allocation failures or – very typically – darktable not being able to properly import a new film roll. As a frequent symptom you get skulls displayed instead of thumbnails for many of your pictures.

If this is the case, take a minute to optimize your preference settings. You will find them in preferences > cpu/gpu/memory.

Here is a short explanation of the relevant parameters and their proposed settings:

number of background threads

This parameter defines the maximum number of threads that are allowed to run in parallel when importing film rolls or doing other background stuff. For obvious reasons on 32-bit systems you can only have one thread consuming resources at a time. So you need set this parameter to 1; anything higher will kill you.

host memory limit (in MB) for tiling

This parameter tells darktable how much memory (in MB) it should assume is available to store image buffers during module operations. If an image can not be processed within these limits in one chunk, tiling will take over and process the image in several parts, one after the other. Set this to the lowest possible value of 500 as a starting point. You might experiment later whether you can increase it a bit in order to reduce the overhead of tiling.

minimum amount of memory (in MB) for a single buffer in tiling

This is a second parameter that controls tiling. It sets a lower limit for the size of intermediate image buffers in megabytes. The parameter is needed to avoid excessive tiling in some cases (for some modules). Set this parameter to a low value of 8. You might tentatively increase it to 16 later.

memory in megabytes to use for thumbnail cache

This controls how many thumbnails (or mip maps) can be stored in memory at a time. As a starting point set this to something like 256MB. Since darktable 2.0, the cache does allocate a few small buffers per thumbnail in cache, thus causing significant memory fragmentation. As explained before, this poses a problem for 32-bit systems. For this reason, as of darktable 2.0, 32-bit support is soft-deprecated.

darktable on 64-bit systems

There’s not much to be said here. Of course 64-bit systems also require a sufficient amount of main memory, so the 4GB plus swap recommendation holds true. On the other hand, 64-bit architectures do not suffer from the specific 32-bit limitations like small address space and fragmentation madness.

Most modern Intel or AMD 64-bit CPUs will have available address space in the range of several Terabytes. The word “modern” is relative in this context: all AMD and Intel CPUs introduced since 2003 and 2004, respectively, offer a 64-bit mode. Linux 64-bit has been available for many years.

All relevant Linux distributions give you the choice to install a 32-bit or a 64-bit version with no added cost. You can even run old 32-bit binaries on a 64-bit Linux. The only thing you need to do is invest some time into the migration. In the end we strongly recommend moving to a 64-bit version of Linux. There really is no reason not to.

On a 64-bit system you can safely leave the tiling related configuration parameters at their defaults: “host memory limit (in MB) for tiling” should have a value of 1500 and “minimum amount of memory (in MB) for a single buffer in tiling” should be set to 16. If you are migrating from a 32-bit to a 64-bit system you will need to check these settings and manually change them if needed in darktable’s preference dialog.

Typically there is no need to restrict oneself in the number of background threads on a 64-bit system. On a multi-processor system a number of two to eight threads can speed up thumbnail generation considerably versus only one thread. The reason is not so much taking maximum advantage of all your CPU cores – darktable’s pixelpipe uses all of them in parallel anyway – but hiding I/O latency.

One exception is worth mentioning. If you use darktable to process stitched panoramas (e.g. TIFFs as generated by Hugin) these images can reach considerable sizes. Each background thread needs to allocate enough memory to keep one full image plus intermediates and output in its buffers. This may quickly cause even a well equipped 64-bit system to run out of memory. In that case lower the number of background threads to only one.

12.3. opencl

12.3.1. the background

Processing high resolution images is a demanding task needing a modern computer. Both in terms of memory requirements and CPU power, getting the best out of a typical 15, 20 or 25 Megapixel image can quickly take your computer to its limits.

darktable’s requirements are no exception. All calculations are performed on 4 x 32bit floating point numbers. This is slower than “ordinary” 8 or 16 bit integer algebra, but eliminates all problems of tonal breaks or loss of information.

A great deal of optimization has been undertaken to make darktable as fast as possible. If you run a current version of darktable on a modern computer, you might not notice any “slowness”. However, there are conditions and certain modules where you will feel (or hear from the howling of your CPU fan) how much your poor multi-core processor has to struggle.

That’s where OpenCL comes in. OpenCL allows darktable to take advantage of the enormous power of modern graphics cards. Gamers' demand for highly detailed 3D worlds in modern shooters has fostered GPU development. ATI, NVIDIA and Co had to put enormous processing power into their GPUs to meet these demands. The result is modern graphics cards with highly parallelized GPUs that can quickly calculate surfaces and textures at high frame rates.

You are not a gamer and you don’t take advantage of that power? Well, then you should at least use it in darktable! For the task of highly parallel floating point calculations modern GPUs are much faster than CPUs. This is especially true when you want to repeat the same few processing steps millions of items. Typical use case: processing of high megapixel images.

12.3.2. how opencl works

As you can imagine, the hardware architecture of GPUs can vary significantly. There are different manufacturers, and even different generations of GPUs from the same manufacturer may not be comparable. At the same time GPU manufacturers don't normally disclose all the hardware details of their products to the public. One of the consequences of this is the need to use proprietary drivers under Linux, if you want to take full advantage of your graphics card.

Fortunately an industry consortium lead by The Khronos Group has developed an open, standardized interface called OpenCL. It allows your GPU to be used as a numerical processing device. OpenCL offers a C99-like programming language with a strong focus on parallel computing. An application that wants to use OpenCL will need OpenCL source code that it hands over to a hardware specific compiler at run-time. This way the application can use OpenCL on different GPU architectures (even at the same time). All of the hardware "secrets" are hidden in this compiler and are normally not visible to the user (or the application). The compiled OpenCL code is loaded onto your GPU and – with certain API calls – it is ready to perform calculations for you.

12.3.3. activating opencl in darktable

Using OpenCL in darktable requires that your PC is equipped with a suitable graphics card and that it has the required libraries in place. Most modern graphics cards from NVIDIA and AMD come with full OpenCL support. The OpenCL compiler is normally shipped as part of the proprietary graphics driver and is used as a dynamic library called `libOpenCL.so`. This library must be in a folder where it can be found by your system's dynamic linker.

When darktable starts, it will first try to find and load `libOpenCL.so` and, on success, check if the available graphics card comes with OpenCL support. A sufficient amount of graphics memory (1GB+) needs to be available for darktable to take advantage of the GPU. If that check passes, darktable tries to setup its OpenCL environment: a processing context needs to be initialized, a calculation pipeline to be started, OpenCL source code files (extension is `.cl`) needs to be read and compiled and the included routines (called OpenCL kernels) need to be prepared for darktable's modules. If all that completes successfully, the preparation is finished.

By default OpenCL support is activated in darktable if all the above steps were successful. If you want to de-activate it you can do so in preferences > cpu/gpu/memory. This configuration parameter is greyed out if the OpenCL initialization failed.

You can switch OpenCL support off and on at any time without requiring a restart. Depending on the type of modules you are using, you will notice the effect as a general speed-up during interactive work and export. Most modules in darktable can take advantage of OpenCL but not all modules are demanding enough to make a noticeable difference. In order to feel a real difference, use modules like *shadows and highlights*, *sharpen*, *lowpass*, *highpass* or even more extreme *contrast equalizer* and *denoise (profiled)*.

If you are interested in profiling statistics, you can start darktable with command line parameters `-d opencl -d perf`. After each run of the pixelpipe you will be shown details of processing time for each module plus an even more fine-grained profile for all used OpenCL kernels.

Besides the speed-up you should not see any difference in the results between CPU and GPU processing. Except for some rounding errors, the results are designed to be identical. If, for some reason, darktable fails to properly finish a GPU calculation, it will normally detect the failure and automatically (and transparently) fall back to CPU processing.

12.3.4. setting up opencl

The huge diversity of systems and the marked differences between OpenCL vendors and driver versions makes it impossible to give an comprehensive overview of how to setup OpenCL. We only can give you an example, in this case for NVIDIA driver version 331.89 on Ubuntu 14.04. We hope that this will serve you as a first impression and will help to solve possible problems of your specific setup.

The principle OpenCL function flow is like this:

```
darktable > libOpenCL.so > libnvidia-opencl.so.1 > kernel driver module(s) > GPU
```

- darktable dynamically loads `libOpenCL.so`, a system library which must be accessible to the system's dynamic loader (`ld.so`).
- `libOpenCL.so` reads the vendor-specific information file (`/etc/OpenCL/vendors/nvidia.icd`) to find the library which contains the vendor-specific OpenCL implementation.
- The vendor-specific OpenCL implementation comes as a library `libnvidia-opencl.so.1` (which in our case is a symbolic link to `libnvidia-opencl.so.331.89`).
- `libnvidia-opencl.so.1` needs to talk to the vendor-specific kernel modules `nvidia` and `nvidia_uvm` via device special files `/dev/nvidia0`, `/dev/nvidiactl`, and `/dev/nvidia-uvm`.

At system startup the required device special files (`/dev/nvidia*`) need to be created. If this does not happen on your system by default, the easiest way to set them up and make sure all modules are loaded is by installing the `nvidia-modprobe` package.

A user account which needs to make use of OpenCL from within darktable must have read-write access to NVIDIA's device special files. On some systems these files allow world read-write access by default, which avoids permission issues but might be debatable in terms of system security. Other systems restrict the access to a user group, e.g. "video". In this case your user account has to be member of that group.

To summarise, the packages which needed to be installed in this specific case were:

```
nvidia-331 (331.89-0ubuntu1~xedgers14.04.2)
nvidia-331-dev (331.89-0ubuntu1~xedgers14.04.2)
nvidia-331-uvm (331.89-0ubuntu1~xedgers14.04.2)
nvidia-libopencl1-331 (331.89-0ubuntu1~xedgers14.04.2)
nvidia-modprobe (340.24-1)
nvidia-opencl-dev:amd64 (5.5.22-3ubuntu1)
nvidia-opencl-icd-331 (331.89-0ubuntu1~xedgers14.04.2)
nvidia-settings (340.24-0ubuntu1~xedgers14.04.1)
nvidia-settings-304 (340.24-0ubuntu1~xedgers14.04.1)
nvidia-libopencl1-331 (331.89-0ubuntu1~xedgers14.04.2)
nvidia-opencl-dev:amd64 (5.5.22-3ubuntu1)
nvidia-opencl-icd-331 (331.89-0ubuntu1~xedgers14.04.2)
opencl-headers (1.2-2013.10.23-1)
```

The list of NVIDIA related kernel modules as reported by lsmod is:

```
nvidia
nvidia_uvm
```

The list of NVIDIA related device special files (`ls -l /dev/nvidia*`) should read like:

```
crw-rw-rw- 1 root root 195,   0 Jul 28 21:13 /dev/nvidia0
crw-rw-rw- 1 root root 195, 255 Jul 28 21:13 /dev/nvidiactl
crw-rw-rw- 1 root root 250,   0 Jul 28 21:13 /dev/nvidia-uvm
```

Beware that the major/minor numbers (e.g. `250/0` for `/dev/nvidia-uvm` in this example) may vary depending on your system.

12.3.5. possible problems & solutions

darktable will detect OpenCL run-time errors automatically. On detecting an error, it will then reprocess everything on the CPU. While this will slow down processing it should not affect the end result.

There can be various reasons why OpenCL might fail during the initialization phase. OpenCL depends on hardware requirements and on the presence of certain drivers and libraries. In addition all these have to fit in terms of maker model and revision number. If anything does not fit (e.g. your graphics driver – loaded as a kernel module – does not match the version of your `libOpenCL.so`) OpenCL support will likely not be available.

In this case, the best thing to do is start darktable from a console with `darktable -d opencl`.

This will give additional debugging output about the initialization and use of OpenCL. First, if you find a line that starts with `[opencl_init] FINALLY ...` that should tell you whether OpenCL support is available for you or not. If initialization failed, look at the messages above for anything that reads like `could not be detected` or `could not be created`. Check if there is a hint about where it failed.

Here are a few cases that have been observed in the past:

- darktable states that no OpenCL aware graphics card is detected or that the available memory on your GPU is too low and the device is discarded. In that case you might need to buy a new card, if you really want OpenCL support.
- darktable finds your `libOpenCL.so` but then tell you that it couldn't get a platform. NVIDIA drivers will often give error code -1001 in this case. This happens because `libOpenCL.so` is only a wrapper library. For the real work further vendor-specific libraries need to be loaded. This has failed for some reason. There is a structure of files in `/etc/OpenCL` on your system that `libOpenCL.so` consults to find these libraries. Check if you find something fishy in there and try to fix it. Often the required libraries cannot be found by your system's dynamic loader. Giving full path names might help.
- darktable states that a context could not be created. This often indicates a version mismatch between the loaded graphics driver and libOpenCL. Check if you have left-over kernel modules or graphics libraries from an older installation and take appropriate action. When in doubt, perform a clean reinstall of your graphics driver. Sometimes, immediately after a driver update, the loaded kernel driver does not match the newly installed libraries. In this case reboot your system before trying again.
- darktable crashes during startup. This can happen if your OpenCL setup is completely broken or if your driver/library contains a severe bug. If you can't fix it, you can still use darktable with option `--disable-opencl`, which will skip the entire OpenCL initialization step.
- darktable fails to compile its OpenCL source files at run-time. In this case you will see a number of error messages looking like typical compiler errors. This could indicate an incompatibility between your OpenCL implementation and darktable's interpretation of the standard. In that case visit the developers in IRC in `#darktable` on FreeNode or on the developers mailing list at darktable-dev@lists.darktable.org and report the problem. Chances are good that we can help you. Please also report if you see significant differences between CPU and GPU processing of an image.

A few on-CPU implementations of OpenCL also exist, coming as drivers provided by INTEL or AMD. We have observed that they do not provide any speed gain versus our hand-optimized CPU code. Therefore darktable simply discards these devices by default. This behavior can be changed by setting the configuration variable `opencl_use_cpu_devices` (in `$HOME/.config/darktablerc`) to TRUE.

12.3.6. amd/ati devices

While NVIDIA devices and most modern AMD/ATI devices will often run out of the box, there is more to do for older AMD/ATI graphics cards, namely those prior to the HD7xxx series. This starts with the fact that those devices will only report part of their total GPU memory to darktable. For a 1GB device this typically amounts to only 512MB, a value which darktable in its standard configuration will refuse as insufficient. In consequence the device will not be used.

On the web you might find as a tip to set environment variable `GPU_MAX_HEAP_SIZE` to 100 if this happens. Indeed this will cause the AMD/ATI driver to report the full installed memory to darktable. However, there is a problem. On many (most?) cards this will cause buffers to be allocated on your computer (host) and not on the video card! In this case all memory accesses will need to go through the slow PCIe bus. This will cost you a factor of 10x or more in performance and will render OpenCL useless for you, especially when exporting files.

Another environment variable which changes driver behavior is `GPU_MAX_ALLOC_PERCENT`. You could set this to 100 in order to allow memory allocations as high as 1GB on your AMD/ATI card. The problem is that this tends to cause darktable to crash sooner or later.

Our recommendation is therefore to leave these settings untouched. Often your card will be recognized with 512MB memory and a maximum allocation size of 128MB. There are three configuration parameters which you can set in `$HOME/.config/darktable/darktablerc` to get things running. Here are the details:

opencl_memory_requirement
: Set this parameter to 500 so that darktable will accept your 512MB graphics memory as having sufficient memory.

opencl_memory_headroom
: This parameter controls how much graphics memory (from that reported by your card) darktable should leave untouched for driver and display use. Since for AMD/ATI devices we can only get half of the available RAM anyway, it’s safe to set this to zero so that all of the 512MB can be used by darktable.

opencl_avoid_atomics
: Atomic operations in OpenCL are a special method of data synchronization. They are only used in a few kernels. Unfortunately, some (most?) AMD/ATI devices are extremely slow in processing atomics. It’s better to process the affected modules on the CPU rather than accepting an ultra-slow GPU codepath. Therefore, set this parameter to TRUE if you experience slow processing of modules like *shadows and highlights*, *monochrome*, *local contrast*, or *global tonemap (deprecated)* or if you get intermittent system freezes.

These recommendations do not apply to the more recent Radeon HD7xxx series with GCN architecture. Besides being very fast in terms of GPU computing they normally run out of the box, though you might consider trying some of the performance optimization options described in the following section.

12.3.7. performance optimization

There are a number of configuration parameters in `$HOME/.config/darktable/darktablerc` that can help to finetune your system’s OpenCL performance. Performance in this context mostly means the latency of darktable during interactive work, i.e. how long it takes to reprocess the pixelpipe. For a comfortable workflow it is essential to keep latency low.

In order to obtain profiling info you need to start darktable from a terminal with `darktable -d opencl -d perf`.

After each reprocessing of the pixelpipe – caused by module parameter changes, zooming, panning, etc. – you will see the total time and the time spent in each of the OpenCL kernels. The most reliable value is the total time spent in pixelpipe. Please note that the timings given for each individual module are unreliable when running the OpenCL pixelpipe asynchronously (see opencl_async_pixelpipe below).

To allow for fast pixelpipe processing with OpenCL it is essential that we keep the GPU busy. Any interrupts or a stalled data flow will add to the total processing time. This is especially important for the small image buffers we need to handle during interactive work. These can be processed quickly by a fast GPU. However, even short-term stalls of the pixelpipe will easily become a bottleneck.

On the other hand darktable’s performance during file exports is more or less only governed by the speed of our algorithms and the horse-power of your GPU. Short-term stalls will not have a noticeable effect on the total time of an export.

darktable comes with default settings that should deliver a decent GPU performance on most systems. However, if you want to fiddle around a bit by yourself and try to optimize things further, here is a description of the relevant configuration parameters.

opencl_async_pixelpipe

This flag controls how often darktable blocks the OpenCL pixelpipe to get a status on success/failure of the kernels that have been run. For optimum latency set this to TRUE, so that darktable runs the pixelpipe asynchronously and tries to use as few interrupts as possible. If you experience OpenCL errors like failing kernels, set the parameter to FALSE. darktable will then interrupt after each module so that you can more easily isolate the problem. Problems have been reported with some older ATI/AMD cards, like the HD57xx, which can produce garbled output if this parameter is set to TRUE. If in doubt, leave it at its default of FALSE.

opencl_number_event_handles

Event handles are used so that darktable can monitor the success/failure of kernels and profiling info even if the pixelpipe is executed asynchronously. The number of event handles is a limited resource of your OpenCL driver. For sure they can be recycled but there is a limited number that can be used at the same time. Unfortunately, there is no way to find out what the resource limits are, so darktable needs to guess. The default value of 25 is quite conservative. You might want to see if higher values like 100 give better OpenCL performance. If your driver runs out of free handles you will experience failing OpenCL kernels with error code -5 (CL_OUT_OF_RESOURCES) or even crashes or system freezes. Reduce the number again if that happens. A value of 0 will block darktable from using any event handles. This will prevent darktable from properly monitoring the success of your OpenCL kernels but saves some driver overhead. The consequence is that any failures will likely lead to garbled output without darktable taking notice. This is only recommended if you know for sure that your system runs rock-solid. You can also set this parameter to -1, which means that darktable assumes no restriction in the number of event handles. This is not recommended.

opencl_synch_cache

This parameter, if set to “true”, will force darktable to fetch image buffers from your GPU after each module and store them in its pixelpipe cache. This is a resource consuming operation, but can make sense depending on your GPU (including if the GPU is rather slow). In this case darktable might in fact save some time when module parameters have changed, as it can go back to some cached intermediate state and reprocess only part of the pixelpipe. In many cases this parameter should be set to “active module” (the default), which will only cache the input of the currently focused module.

opencl_micro_nap

In an ideal case you will keep your GPU busy at 100% when reprocessing the pixelpipe. That’s good. On the other hand your GPU may also be needed to do regular GUI updates. It might happen that there is no sufficient time left for this task. The consequence would by a jerky reaction of your GUI on panning, zooming or when moving sliders. To resolve this issue darktable can add small naps into its pixelpipe processing to have the GPU catch some breath and perform GUI related activities. The opencl_micro_nap parameter controls the duration of these naps in microseconds. You will need to experiment in order to find an optimum value for your system. Values of 0, 100, 500 and 1000 are good starting points to try. The default is 1000.

opencl_use_pinned_memory

During tiling huge amounts of memory need to be transferred between host and device. On some devices (namely AMD) direct memory transfers to and from an arbitrary host memory region may give a huge performance penalty. This is especially noticeable when exporting large images. Setting this configuration parameter to TRUE tells darktable to use a special kind of intermediate buffer for host-device data transfers. On some devices this can speed up exporting of large files by a factor of 2 to 3. NVIDIA devices and drivers seem to have a more efficient memory transfer technique even for arbitrary memory regions. As they may not show any performance gain and even may produce garbled output, opencl_use_pinned_memory should be left at its default FALSE for those devices.

12.3.8. scheduling profile

darktable can use the CPU and one or several OpenCL capable GPUs. Depending on the relative performance of these devices, users can choose among certain scheduling profiles to optimize performance. This is achieved by setting the configuration parameter preferences > cpu/gpu/memory > OpenCL scheduling profile which offers the following choices:

default

If an OpenCL capable GPU is found darktable uses it for processing the center image view while the navigation preview window is processed on the CPU in parallel. This is the preferred setting for systems with a reasonably fast CPU and a moderately fast GPU. The exact allocation of devices to the various pixelpipe types can be finetuned with the “opencl_device_priority” configuration parameter (see multiple devices).

very fast GPU

With this scheduling profile darktable processes the center image view and the preview window on the GPU sequentially. This is the preferred setting for systems with a GPU that strongly outperforms the CPU.

multiple GPUs

This setting addresses systems with multiple GPUs whose relative performance does not differ significantly. Whenever a processing job is started darktable uses any currently idle GPU but not the CPU. Users of systems with a variety of GPUs will need better control on their relative priority. They would be better off selecting the “default” profile and fine-tuning their system with the “opencl_device_priority” configuration parameter (see multiple devices).

On first start-up or after any detected change in the GPU configuration of your system darktable tries to identify the best suited profile for you. You can change it at any time in preferences > cpu/gpu/memory.

12.3.9. multiple devices

The scheduling of OpenCL devices on most systems can be optimized using the “OpenCL scheduling profile” settings. However, if your system is equipped with more than one GPU you might want to set the relative device priority manually. To do this you need to select the “default” scheduling profile and change the settings in the “opencl_device_priority” configuration parameter.

It is important to understand how darktable uses OpenCL devices. Each processing sequence of an image – to convert an input to the final output using a history stack – is run in a pixelpipe. There are four different types of pixelpipe in darktable. One type is responsible for processing the center image view (or full view) in darkroom mode, another pixelpipe processes the preview image (navigation window). There can be one of each of these two pixelpipes running at any one time – with the full and preview pixelpipes running in parallel. In addition there can be multiple parallel pixelpipes performing file exports as well as multiple parallel pixelpipes generating thumbnails. If an OpenCL device is available darktable dynamically allocates it to one specific pixelpipe for one run and releases it afterwards.

The computational demand varies significantly depending on the type of pixelpipe being executed. The preview image and thumbnails are low resolution and can be processed quickly. Processing the center image view is more demanding. A full export pixelpipe is more demanding still.

The configuration parameter “opencl_device_priority” holds a string with the following structure: `a,b,c.../k,l,m.../o,p,q.../x,y,z...`. Each letter represents one specific OpenCL device. There are four fields in the parameter string separated by a slash, each representing one type of pixelpipe. `a,b,c...` defines the devices that are allowed to process the center image (full) pixelpipe. Likewise devices `k,l,m...` can process the preview pixelpipe, devices `o,p,q...` the export pixelpipes and finally devices `x,y,z...` the thumbnail pixelpipes. An empty field means that no OpenCL device may serve this type of pixelpipe.

darktable has an internal numbering system, whereby the first available OpenCL device receives the number `0`. All further devices are numbered consecutively. This number, together with the device name, is displayed when you start darktable with `darktable -d opencl`. You can specify a device either by number or by name (upper/lower case and whitespace do not matter). If you have more than one device with the same name you need to use the device numbers in order to differentiate them.

A device specifier can be prefixed with an exclamation mark `!`, in which case the device is excluded from processing a given pixelpipe. You can also use an asterisk * as a wildcard, representing all devices not previously explicitly mentioned in that group.

Sequence order within a group matters – darktable will read the list from left to right and whenever it tries to allocate an OpenCL device to a pixelpipe it will scan the devices in that order, taking the first free device it finds.

If a pixelpipe process is about to be started and all GPUs in the corresponding group are busy, darktable automatically processes the image on the CPU by default. You can enforce GPU processing by prefixing the list of allowed GPUs with a plus sign +. In this case darktable will not use the CPU but rather suspend processing until the next permitted OpenCL device is available.

darktable’s default setting for “opencl_device_priority” is `*/!0,*/*/*`.

Any detected OpenCL device is permitted to process the center view image. The first OpenCL device (0) is not permitted to process the preview pixelpipe. As a consequence, if there is only one GPU available on your system, the preview pixelpipe will always be processed on the CPU, keeping your single GPU exclusively for the more demanding center image view. This is a reasonable setting for most systems. No such restrictions apply to export and thumbnail pixelpipes.

The default is a good choice if you have only one device. If you have several devices it forms a reasonable starting point. However, as your devices might have quite different levels of processing power, it makes sense to invest some time to optimize your priority list.

Here is an example. Let’s assume we have a system with two devices, a fast Radeon HD7950 and an older and slower GeForce GTS450. darktable (started with `darktable -d opencl`) will report the following devices:

```
[opencl_init] successfully initialized.
[opencl_init] here are the internal numbers and names of
                        OpenCL devices available to darktable:
[opencl_init]           0       'GeForce GTS 450'
[opencl_init]           1       'Tahiti'
[opencl_init] FINALLY: opencl is AVAILABLE on this system.
```

Here, the GeForce GTS 450 is detected as the first device; the Radeon HD7950 ('Tahiti') as the second. This order will normally not change unless the hardware or driver configuration is modified, but it's better to use device names rather than numbers to be on the safe side.

As the GTS450 is slower than the HD7950, an optimized "opencl_device_priority" could look like: `!GeForce GTS450,*/!Tahiti,*/Tahiti,*/Tahiti,*`.

The GTS450 is explicitly excluded from processing the center image pixelpipe; this is reserved to "all" other devices (i.e. the HD7950/Tahiti). Conversely, for the preview pixelpipe, the Tahiti is excluded, so that only the GTS450 is permitted to do the work.

For file export and thumbnail generation we want all hands on deck. However, darktable should first check whether the Tahiti device is free, because it's faster. If it is not free, then all other devices – in fact only the GTS450 – are checked.

12.3.10. opencl still does not run for me

As has been mentioned, OpenCL systems come with a huge variety of setups: different GPU manufacturers and models, varying amounts of GPU memory, different drivers, different distributions etc..

Many of the potential problems will only appear with very specific combinations of these factors. As the darktable developers only have access to a small fraction of these variations, please understand that we might not be able to fix your specific problem. There is not much we can do if we are unable to reproduce your issue.

If nothing else helps, the best option is probably to start darktable with

```
darktable --disable-opencl
```

In the end there is nothing in darktable which only runs on GPU. Don't let the lack of OpenCL discourage you – darktable's CPU code is also highly optimized for performance!

12.4. using darktable-chart

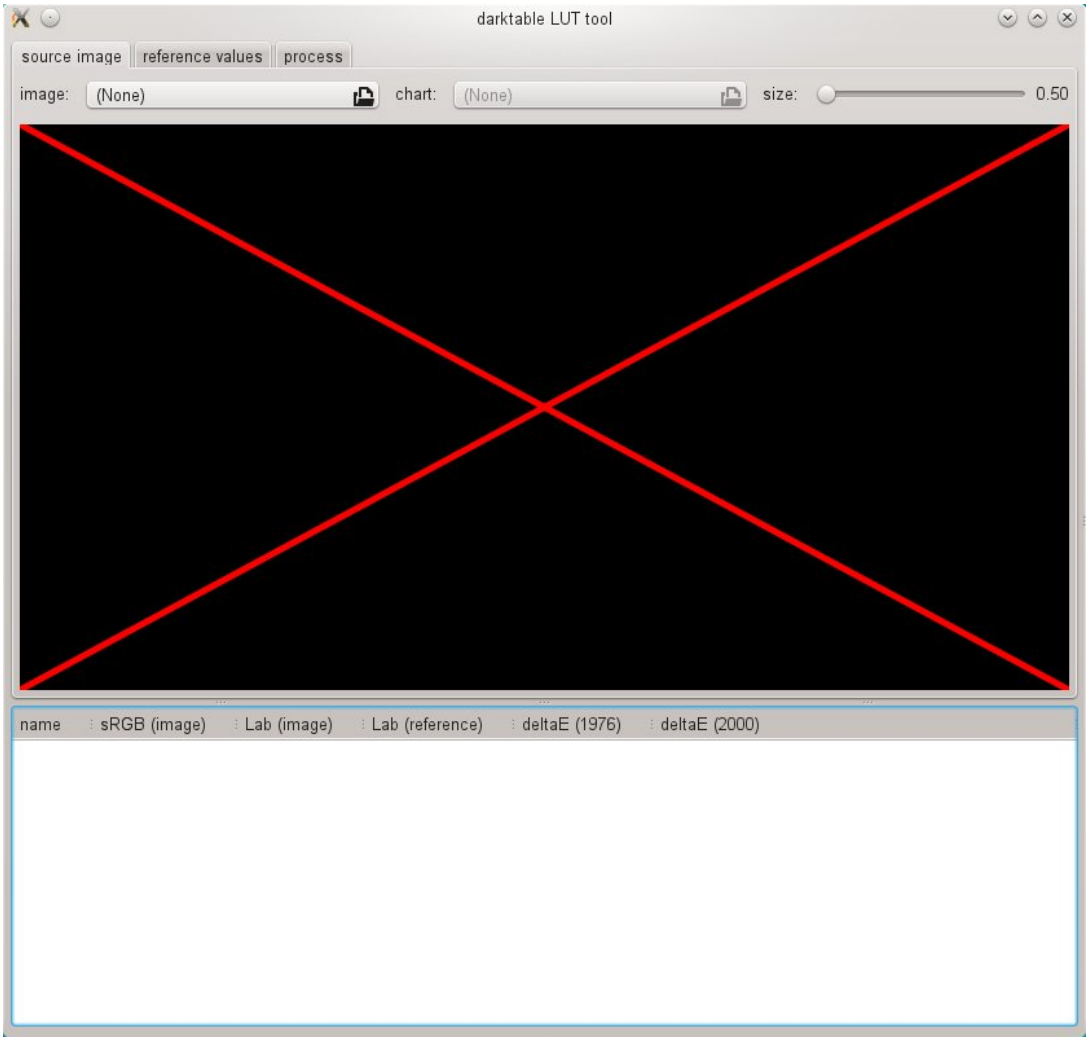
12.4.1. overview

`darktable-chart` is a tool for extracting luminance and color values out of images taken from color reference cards such as IT8.7/1 charts. Its main purpose is to compare a source image (typically a largely unprocessed raw image) to a target image (typically a JPEG image created in-camera) and produce a darktable style that is able to use the luminance and color values of the source image to produce the target image. This style employs the *tone curve* module, the *input color profile* module, and the *color look up table* module for that purpose.

Some cameras offer various film simulation modes of your choice. With the help of `darktable-chart` and the underlying modules you can create styles that replicate these film simulations from within darktable.

12.4.2. usage

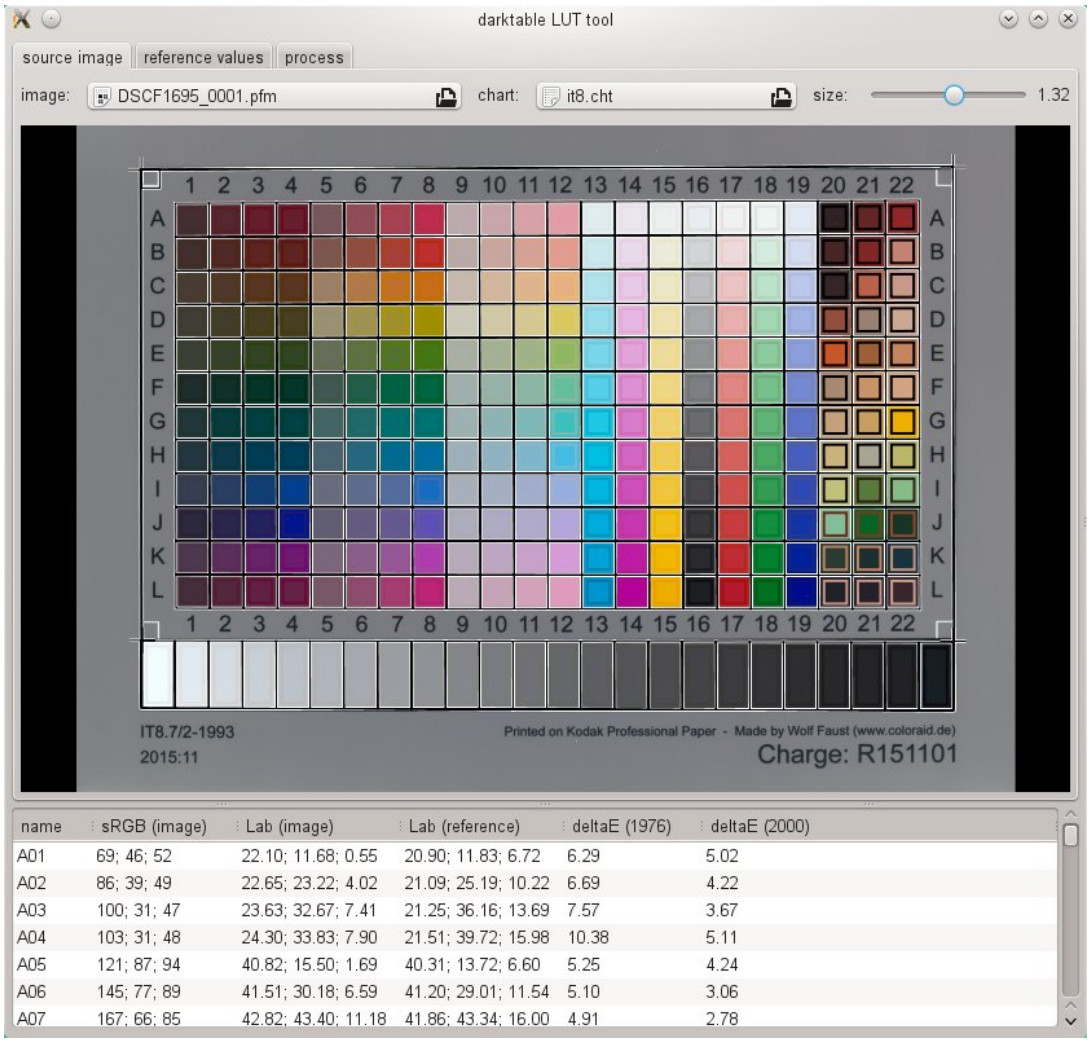
The tool is organized into three tabs in the upper part and a text output frame in the lower part.



The first tab is used to define the source image, the second tab defines the reference (target) and the third tab contains the controls to generate the resulting darktable style.

12.4.3. source image

In the “source image” tab you set your source image, which requires two elements. The first element is an input file in Lab Portable Float Map format (extension `.pfm`). The source file represents the largely unmodified data as the camera sees it. Information about how to take photos of a color reference card and produce a `.pfm` output file are described below. The second element is a chart file that contains a formal description of the underlying color reference card’s layout (extension `.cht`). Chart files are usually shipped with your color reference card or can be downloaded from the internet.



name	sRGB (image)	Lab (image)	Lab (reference)	deltaE (1976)	deltaE (2000)
A01	69; 46; 52	22.10; 11.68; 0.55	20.90; 11.83; 6.72	6.29	5.02
A02	86; 39; 49	22.65; 23.22; 4.02	21.09; 25.19; 10.22	6.69	4.22
A03	100; 31; 47	23.63; 32.67; 7.41	21.25; 36.16; 13.69	7.57	3.67
A04	103; 31; 48	24.30; 33.83; 7.90	21.51; 39.72; 15.98	10.38	5.11
A05	121; 87; 94	40.82; 15.50; 1.69	40.31; 13.72; 6.60	5.25	4.24
A06	145; 77; 89	41.51; 30.18; 6.59	41.20; 29.01; 11.54	5.10	3.06
A07	167; 66; 85	42.82; 43.40; 11.18	41.86; 43.34; 16.00	4.91	2.78

In real life the photo taken from the color reference card will show some perspective distortions relative to the layout defined in the chart file. For that reason the layout is displayed as a grid over the image and can be modified.

You can move the corners of the grid using the mouse to reach best alignment of grid and image.

A rectangular frame is displayed for each patch and defines the area from which `darktable-chart` will sample the required input data. You may need to modify the size of these rectangles so that the sampling area is big enough but does not overlap with neighboring patches. Use the “size” slider in the upper right part of the GUI. Higher values lead to smaller sizes.

12.4.4. reference values

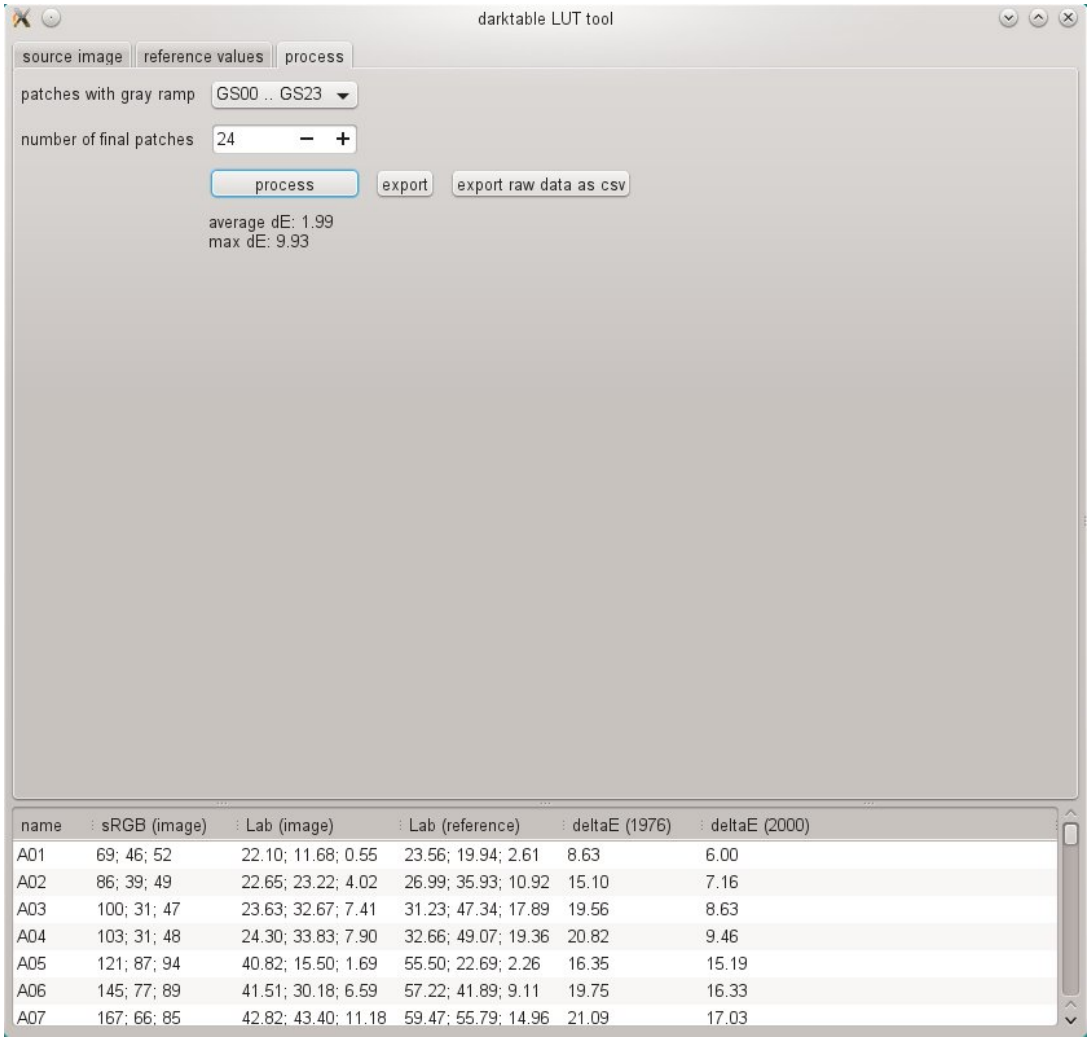
The “reference values” tab determines the target values to which the source image must to be modified by the resulting style. You can either supply reference values in the form of measured data of your color reference card (mode “cie/it8 file”), or you can supply a photographic image (mode “color chart image”) much in the same way as described above. This second image must also be supplied in Lab Portable Float Map format. There is no need to supply the chart file again as `darktable-chart` takes the same one as defined under “source image”. You only need to again align the layout grid and the image and potentially adjust the “size” slider.

In a typical use case the second image will be based on a JPEG file produced in-camera. This way you can create a style to simulate the in-camera processing within darktable.

In the lower text output frame you will see the color values extracted from the available data for each individual color patch. The first column gives the name of the patch, the second and third column show the corresponding color values of the source image in RGB and Lab format, respectively. The fourth column contains the Lab value coming from the reference (or from the chart file if no reference image has been given). Finally, the fifth and sixth columns display how strongly source and reference values deviate in terms of delta-E values.

12.4.5. process

If all of the required settings in the “source image” and “reference values” tabs are ready you can move on to the “process” tab.



First, you need to tell `darktable-chart` which of the patches represents the gray ramp. In the screenshot displayed above, the gray ramp is positioned in the lower part of the color reference chart, denoted as “GS00...GS23”.

The “number of final patches” input defines how many editable color patches the resulting style will use within the *color look up table* module.

Click the “process” button to start the calculation.

The quality of the result (in terms of average delta-E and maximum delta-E) is displayed below the button. This data shows how closely the resulting style (when applied to the source image) will be able to match the reference values – the lower the better.

Once you are happy with the result you can click on “export” to save the generated style.

Supply a style name and a style description under which the style will later appear in darktable. `darktable-chart` saves the style as a `.dtstyle` file which can be imported into darktable and shared with others. See styles.

The “export raw data as csv” button allows you to save the extracted raw data as a CSV file for debugging purposes or later use. `darktable-chart` offers a command line option to produce a style with the desired number of final patches from a supplied CSV file (see `darktable-chart`).

12.4.6. making input images for darktable-chart

To start with, you need a suitable photo of your color reference card in RAW+JPEG format. It goes beyond the scope of this manual to explain the details of how to take this photo, but in a nutshell you need to make the shot on a sunny day around midday with the light source (the sun) shining at an angle onto the card. You need to avoid any glare in the image. The neutral white color patch in the gray ramp (G00) should end up at the L value specified in the description of your card. Often this is L=92 and requires you to overexpose the shot by about 1/3 EV. Ideally you will make several shots with slightly different exposures and later select the right one in darktable. Make sure that the chart fills up most of the frame. Use a lens with a “normal” focal length (e.g. 50mm equivalent) and stop down a bit to avoid vignetting.

You then open the raw file in darktable and disable most modules, especially *base curve*. Select the standard input matrix in the *input color profile module* and disable gamut clipping. Select “camera white balance” in the *white balance* module.

There is a special situation if your camera automatically applies some lens corrections (namely vignetting correction) to the resulting JPEG file. In this case you need to activate the *lens correction* module in darktable so that raw processing matches the JPEG in this respect. However, since darktable’s vignetting correction may not exactly match the in-camera correction, it is better to disable this correction in-camera if possible.

To output your image go to the export selected module in the lighttable.

You will need to select “Lab” as the output color profile. This color space is not visible in the combobox by default. You first need to enable it by setting `allow_lab_output` to `TRUE` in `$HOME/.config/darktable/darktablerc`. Alternatively, you can start darktable with:

```
darktable --conf allow_lab_output=true
```

Then select “PFM (float)” as the output format and press “export” to generate the source image file.

You can prodce the corresponding reference (target) image from the JPEG in a similar way. This time you will need to disable all modules and export with the “Lab” output color profile in “PFM (float)” format.

12.5. program invocation

12.5.1. darktable

The `darktable` binary starts darktable with its GUI and full functionality. This is the standard way to use darktable.

`darktable` can called with the following command line parameters:

```
darktable [-d {all,cache,camctl,camsupport,control,dev,
               fswatch,input,lighttable,lua,masks,memory,nan,
               opencl,perf,pwstorage,print,sql,ioporder,
               imageio,undo,signal}]
          [<input file>|<image folder>]
          [--version]
          [--disable-opencl]
          [--library <library file>]
          [--datadir <data directory>]
          [--moduledir <module directory>]
          [--tmpdir <tmp directory>]
          [--configdir <user config directory>]
          [--cachedir <user cache directory>]
          [--localedir <locale directory>]
          [--luacmd <lua command>]
          [--noiseprofiles <noiseprofiles json file>]
          [--d-signal <signal>]
          [--d-signal-act <all,raise,connect,disconnect,print-trace>]
          [--conf <key>=<value>]
          [-t <num openmp threads>]
```

All parameters are optional. In most cases darktable should be started without any additional parameters, in which case darktable uses suitable defaults.

-d
{all,cache,camctl,camsupport,control,dev,fswatch,input,lighttable,lua,masks,memory,nan,opencl,perf,pwstorage,pri
Enable debug output to the terminal. There are several subsystems of darktable and debugging of each of them can be activated separately. You can use this option multiple times if you want debugging output of more than one subsystem.

<input file>|<image folder>
Optionally supply the name of an image file or folder. If a filename is given darktable starts in darkroom view with that file opened. If a folder is given darktable starts in lighttable view with the content of that folder as the current collection.

--version
Print the darktable version number, a copyright notice, some other useful information, and then terminate.

--disable-opencl
Prevent darktable from initializing the OpenCL subsystem. Use this option if darktable crashes at startup due to a defective OpenCL implementation.

--library <library file>
darktable keeps image information in an sqlite database for fast access. The default location of that database file is `$HOME/.config/darktable/library.db`. Use this option to provide an alternative location, e.g. if you want to do some experiments without compromising your original `library.db`. If the database file does not exist, darktable creates it for you. You may also provide `:memory:` as the library file, in which case the database is kept in system memory – all changes are discarded when darktable terminates.

Whenever darktable starts, it will lock the library to the current user. It does this by writing the current process identifier (PID) into a lock file `<library file>.lock` next to the library specified. If darktable finds an existing lock file for the library, it will terminate immediately.

--datadir <data directory>
Define the directory where darktable finds its runtime data. The default place depends on your installation. Typical locations are `/opt/darktable/share/darktable/` and `/usr/share/darktable/`.

--moduledir <module directory>
darktable has a modular structure and organizes its modules as shared libraries for loading at runtime. This option tells darktable where to look for its shared libraries. The default location depends on your installation. Typical locations are `/opt/darktable/lib64/darktable/` and `/usr/lib64/darktable/`.

--tmpdir <tmp directory>
Define where darktable should store its temporary files. If this option is not supplied darktable uses the system default.

--configdir <config directory>
Define the directory where darktable stores the user specific configuration. The default location is `$HOME/.config/darktable/`.

--cachedir <cache directory>
darktable keeps a cache of image thumbnails for fast image preview and of precompiled OpenCL binaries for fast startup. By default the cache is located in `$HOME/.cache/darktable/`. Multiple thumbnail caches may exist in parallel – one for each library file.

--localedir <locale directory>
Define where darktable can find its language specific text strings. The default location depends on your installation. Typical locations are `/opt/darktable/share/locale/` and `/usr/share/locale/`.

--luacmd <lua command>
A string containing lua commands to execute after lua initialization. These commands will be run after your “luarc” file.
If lua is not compiled in, this option will be accepted but won’t do anything.

--noiseprofiles <noiseprofiles json file>
Provide a json file that contains the camera specific noise profiles. The default location depends on your installation. Typical locations are `/opt/darktable/share/darktable/noiseprofile.json` and `/usr/share/darktable/noiseprofile.json`.

--d-signal <signal>
If `-d signal` or `-d all` is specified, specify signal to debug using this option. Specify `ALL` to debug all signals or specify signal using it’s full name. Can be used multiple times.

--d-signal-act <all,raise,connect,disconnect,print-trace>
If `-d signal` or `-d all` is specified, specify signal action to debug using this option.

--conf <key>=<value>
darktable supports a rich set of configuration parameters which the user defines in `$HOME/.config/darktable/darktablerc`. You may temporarily overwrite individual settings on the command line with this option – however, these settings will not be stored in “darktablerc” on exit.

-t <num openmp threads>
limit number of openmp threads to use in openmp parallel sections

12.5.2. darktable-cli

The `darktable-cli` binary starts the command line interface variant of darktable which allows images to be exported.

This variant does not open any display – it works in pure console mode without launching a GUI. This mode is particularly useful for servers running background jobs.

`darktable-cli` can be called with the following command line parameters:

```
darktable-cli [<input file or folder>]
              [<xmp file>]
              <output file or folder>
              [--width <max width>]
              [--height <max height>]
              [--bpp <bpp>]
              [--hq <0|1|true|false>]
              [--upscale <0|1|true|false>]
              [--style <style name>]
              [--style-overwrite]
              [--apply-custom-presets <0|1|false|true>]
              [--out-ext <extension>]
              [--import <file or dir>]
              [--icc-type <type>]
              [--icc-file <file>]
              [--icc-intent <intent>]
              [--verbose]
              [--help [option]]
              [--core <darktable options>]
```

The user must supply an input filename and an output filename. All other parameters are optional.

<input file or folder>
The name of the input file or folder (containing images) to be exported. If you wish to process multiple images or multiple folders use the `--import` option instead.

<xmp file>
The optional name of an XMP sidecar file containing the history stack data to be applied during export. If this option is not provided darktable will search for an XMP file that belongs to the given input file(s).

<output file or folder>
The name of the output file or destination folder. The export file format is derived from the file extension or from `--out-ext` option. You can also use a number of variables in the output filename. For obvious reasons this parameter is mandatory if you use the program on an image folder containing multiple images. If you specify output folder it is recommended that you also specify the file format with `--out-ext`.

--width <max width>
Limit the width of the exported image to the given number of pixels.

--height <max height>
Limit the height of the exported image to the given number of pixels.

--bpp <bpp>
Define the bit depth of the exported image. Permitted values depend on the output file format.

Note: This option is not currently functional. If you need to define the bit depth you need to use the following workaround:

```
--core
--conf plugins/imageio/format/<FORMAT>/bpp=<VALUE>
```

where <FORMAT> is the name of the selected output format.

--hq <0|1|true|false>
Define whether to use high quality resampling during export (see the export selected module for more details). Defaults to true.

--upscale <0|1|true|false>
Define whether allow upscaling during export. Defaults to false.

--style <style name>
Specify the name of a style to be applied during export. If a style is specified, the path to the darktable configuration directory must also be specified (i.e. `--core --configdir ~/.config/darktable`). By default no style is applied.

--style-overwrite
The specified style overwrites the history stack instead of being appended to it.

--apply-custom-presets <0|1|false|true>
Whether to load `data.db` which contains presets and styles. Disabling this option allows you to run multiple instances of `darktable-cli` at the cost of being unable to use the `--style` option. Defaults to true.

--out-ext <extension>
Set the output extension to use. If specified takes precedence over `<output file>`. By default this is extracted from `<output file>`. Defaults to `jpg` if `<output folder>` is specified.

--import <file or dir>
Specify input file or folder, can be used multiple times. This option cannot be combined with `<input file or folder>`.

--icc-type <type>
Specify the ICC profile type, which is the same as specifying `output profile` in `output color profile` module. Defaults to “image specified”. Use `--help icc-type` to obtain a list of the supported types. See output color profile for a more detailed description of the available options.

--icc-file <file>
Specify ICC profile filename. Defaults to an empty filename.

--icc-intent <intent>
Specify rendering intent. Defaults to “image specified”. Use `--help icc-intent` to obtain a list of the supported intents. See rendering intent for a more detailed description of the available options.

--verbose
Enables verbose output.

--help [option]
Prints usage and exits. If `option` is specified, additionally prints usage for the given option.

--core <darktable options>
All command line parameters following `--core` are passed to the darktable core and handled as standard parameters. See the darktable binary section for a detailed description.

12.5.3. darktable-generate-cache

The `darktable-generate-cache` binary updates darktable’s thumbnail cache. Invoke this program to generate all missing thumbnails in the background when your computer is idle.

`darktable-generate-cache` can be called with the following command line parameters:

```
darktable-generate-cache
              [-h, --help]
              [--version]
              [--min-mip <0-7>] [-m, --max-mip <0 - 7>]
              [--min-imgid <N>] [--max-imgid <N>]
              [--core <darktable options>]
```

All parameters are optional. If started without parameters `darktable-generate-cache` uses reasonable defaults.

-h, --help
Display usage information and terminate.

--version
Display copyright and version information and terminate.

--min-mip <0 - 7>, -m, --max-mip <0 - 7>
darktable can store thumbnails with up to eight different resolution steps for each image. These parameters define the maximum resolutionw which should be generated (defaults to a range of 0-2). There is normally no need to generate all possible resolutions here; missing ones will be automatically generated by darktable the moment they are needed. When asked to generate multiple resolutions at once, the lower-resolution images are quickly downsampled from the highest-resolution image.

--min-imgid <N>, --max-imgid <N>
Specifies the range of internal image IDs from the database to work on. If no range is given, `darktable-generate-cache` will process all images.

--core <darktable options>
All command line parameters following `--core` are passed to the darktable core and handled as standard parameters. See the darktable binary section for a detailed description.

12.5.4. darktable-chart

The `darktable-chart` binary is a dedicated utility to create styles out of pairs of images such as RAW+JPEG with in-camera processing. Details about its usage can be found in the using darktable-chart section.

`darktable-chart` can either start a GUI or be used as a command-line program.

```
darktable-chart
              [--help]
              [<input Lab pfm file>]
              [<cht file>]
              [<reference cgats/it8 or Lab pfm file>]
```

All parameters are optional, however, if you want to supply the second file name you also need to supply the first one etc. Starting darktable-chart this way opens a special GUI (details can be found in the using darktable-chart section).

--help
Provide usage information and terminate.

<input Lab pfm file>
Open the utility with the given file as source image. The input file needs to be in Lab Portable Float Map format.

<cht file>
Specify a chart file describing the layout of the used color reference chart.

<reference cgats/it8 or Lab pfm file>
Specify the reference values, either as measured values according to the CGATS standard, or as a reference image in Lab Portable Float Map format.

Alternatively `darktable-chart` can be used as a command line program to generate darktable style files out of previously saved CSV files.

```
darktable-chart
              --csv
              <csv file>
              <number patches>
              <output dtstyle file>
```

All parameters are mandatory.

<csv file>
A CSV file previously saved from within darktable-chart.

<number patches>
The number of color patches to be used in the color look up table settings of the created style.

<output dtstyle file>
The name of the style file to be created.

12.5.5. darktable-cltest

The `darktable-cltest` binary checks if there is a usable OpenCL environment on your system that darktable can use. It emits some debug output that is equivalent to calling `darktable -d opencl` and then terminates.

`darktable-cltest` is called without command line parameters.

12.5.6. darktable-cmstest

The `darktable-cmstest` binary (Linux only) investigates whether the color management subsystem of your computer is correctly configured and displays some useful information about the installed monitor profile(s).

`darktable-cmstest` is called without command line parameters.

12.6. variables

darktable supports variable substitution in a number of modules and preference settings. For example:

- Defining file names in the export selected lighttable module
- Displaying image information in the darkroom's image information line
- Displaying image information in the lighttable's overlays and tooltips (see preferences > lighttable)
- Placing text on an image in the *watermark* processing module

available variables

The following variables are available, though they may not all be available in all contexts:

```
$(ROLL_NAME)               roll of the input image
$(FILE_FOLDER)             folder containing the input image
$(FILE_NAME)               basename of the input image
$(FILE_EXTENSION)          extension of the input image
$(ID)                      the image id
$(VERSION)                 the duplicate version number
$(VERSION_IF_MULTI)        same as $(VERSION) but null string if only one version exists
$(VERSION_NAME)            version name from metadata
$(SEQUENCE)                a sequence number within export job
$(MAX_WIDTH)               maximum image width to limit within export session
$(MAX_HEIGHT)              maximum image height to limit within export session
$(YEAR)                    year at date of export
$(MONTH)                   month at date of export
$(DAY)                     day at date of export
$(HOUR)                    hour at time of export
$(MINUTE)                  minute at time of export
$(SECOND)                  second at time of export
$(EXIF_YEAR)               Exif year
$(EXIF_MONTH)              Exif month
$(EXIF_DAY)                Exif day
$(EXIF_HOUR)               Exif hour
$(EXIF_MINUTE)             Exif minute
$(EXIF_SECOND)             Exif second
$(EXIF_ISO)                ISO value
$(EXIF_EXPOSURE)           Exif exposure
$(EXIF_EXPOSURE_BIAS)      Exif exposure bias
$(EXIF_APERTURE)           Exif aperture
$(EXIF_FOCAL_LENGTH)       Exif focal length
$(EXIF_FOCUS_DISTANCE)     Exif focus distance
$(LONGITUDE)               longitude
$(LATITUDE)                latitude
$(ELEVATION)               elevation
$(STARS)                   star rating
$(RATING_ICONS)            star rating (using star characters)
```

```
$(LABELS)                  colorlabels (text only)
$(LABELS_ICONS)            colorlabels (using colored bullet characters)
$(LABELS_COLORICONS)       colorlabels (using colored icons)
$(MAKER)                   camera maker
$(MODEL)                   camera model
$(LENS)                    lens
$(TITLE)                   title from metadata
$(DESCRIPTION)             description from metadata
$(CREATOR)                 creator from metadata
$(PUBLISHER)               publisher from metadata
$(RIGHTS)                  rights from metadata
$(TAGS)                    tags list (Xmp.dc.Subject)
$(CATEGORYn(category))     tag name of level n [0,9] of selected category (or tag)
$(SIDECAR_TEXT)            content of the text sidecar file (if any)
$(PICTURES_FOLDER)         pictures folder
$(HOME)                    home folder
$(DESKTOP)                 desktop folder
$(OPENCL_ACTIVATED)        whether OpenCL is activated
$(USERNAME)                user name defined by OS
$(NL)                      newline character
$(JOBCODE)                 internal jobcode of current job
```

string substitution

All of the variables support basic string substitution inspired by bash though some of the details differ.

All patterns are treated as simple string comparisons. There is no regex support.

The following string replacement functions are provided, where var is one of the variables listed above:

```
$(var-default)                  If var is empty, return "default"
$(var+alt_value)                If var is set, return "alt_value" else return empty string
$(var:offset)                   Return var starting from offset
                                If offset is negative count from the end of the string
$(var:offset:length)            Starting from offset, return at most length characters of var
                                If offset is negative the length is counted from the end of var
                                If length is negative this indicates the end of the result,
                                 counted from the end of var, and not an actual length
$(var#pattern)                  Remove "pattern" from the start of var
$(var%pattern)                  Remove "pattern" from the end of var
$(var/pattern/replacement)      Replace the first occurrence of "pattern" in var with "replacement"
                                If "replacement" is empty then "pattern" will be removed
$(var//pattern/replacement)     Replace all occurrences of "pattern" in var with "replacement"
                                If "replacement" is empty then "pattern" will be removed
$(var/#pattern/replacement)     If var starts with "pattern then "pattern" is replaced with "replacement"
$(var/%pattern/replacement)     If var ends with "pattern" then "pattern" is replaced with "replacement"
$(var^)                         Make the first character of var uppercase
$(var^^)                        Make all characters of var uppercase
$(var,)                         Make the first character of var lowercase
$(var,,)                        Make all characters of var lowercase
```

12.7. default module order

The following sections describe the default module order in the new scene-referred workflow and the legacy display-referred workflow. Note that in the following sections the module order goes from top (input file) to bottom (output image).

scene-referred module order

The default ordering of modules when using the new scene-referred workflow is as follows:

1. **raw black/white point**
2. invert (deprecated)
3. **white balance**
4. **highlight reconstruction**
5. chromatic aberrations
6. hot pixels
7. *raw denoise*
8. demosaic
9. denoise (profiled)
10. *surface blur*
11. *rotate pixels*
12. *scale pixels*
13. lens correction
14. haze removal
15. perspective correction
16. **orientation**
17. crop and rotate
18. liquify
19. spot removal
20. retouch
21. **exposure**
22. local tone mapping (deprecated)
23. tone equalizer
24. graduated density
25. unbreak input profile
26. *legacy equalizer*
27. **input color profile**
28. negadoctor
29. *astrophoto denoise*
30. color look up table
31. defringe
32. contrast equalizer
33. lowpass
34. highpass
35. sharpen
36. lut 3D
37. color mapping
38. channel mixer (deprecated)
39. basic adjustments
40. color balance
41. *rgb curve*
42. *rgb levels*
43. *base curve*
44. *filmic (legacy)*
45. **FILMIC RGB** – transition from scene-referred to display-referred space
46. *contrast brightness saturation*
47. *tone curve*
48. *levels*
49. *shadows and highlights*
50. *zone system (deprecated)*
51. *global tonemap (deprecated)*
52. *fill light (deprecated)*
53. local contrast
54. *color correction*
55. *color contrast*
56. velvia
57. vibrance
58. color zones
59. *bloom*
60. colorize
61. lowlight vision
62. *monochrome*
63. grain
64. soften

65. split-toning
66. vignetting
67. color reconstruction
68. **output color profile**
69. dithering
70. framing
71. watermark

key:

- *italic*: not recommended for scene-referred workflow
- **bold**: module on by default

legacy/display-referred module order

The default ordering of modules when using the legacy display-referred workflow is as follows:

1. **raw black/white point**
2. invert (deprecated)
3. **white balance**
4. **highlight reconstruction**
5. chromatic aberrations
6. hot pixels
7. raw denoise
8. demosaic
9. denoise (profiled)
10. local tone mapping (deprecated)
11. exposure
12. spot removal
13. retouch
14. lens correction
15. perspective correction
16. liquify
17. rotate pixels
18. scale pixels
19. orientation
20. crop and rotate
21. tone equalizer
22. graduated density
23. **BASE CURVE** – default transition between scene-referred and diaplay-refered space
24. surface blur
25. unbreak input profile
26. haze removal
27. **input color profile**
28. negadoctor
29. basic adjustments
30. color reconstruction
31. color look up table
32. defringe
33. legacy equalizer
34. vibrance
35. color balance
36. colorize
37. color mapping
38. bloom
39. astrophoto denoise
40. global tonemap (deprecated)
41. shadows and highlights
42. contrast equalizer
43. local contrast
44. color zones
45. lowlight vision
46. monochrome
47. filmic (legacy)
48. filmic rgb
49. contrast brightness saturation
50. zone system (deprecated)
51. tone curve
52. levels
53. rgb levels
54. rgb curve
55. fill light (deprecated)
56. color correction
57. **sharpen**
58. lowpass
59. highpass
60. grain
61. lut 3D
62. color contrast
63. **output color profile**
64. channel mixer (deprecated)

65. soften
66. vignetting
67. split-toning
68. velvia
69. dithering
70. framing
71. watermark

12.8. darktable's color pipeline

Most image processing applications come from the 1990s and/or inherit a 1990s workflow. These applications processed images encoded with 8 bit unsigned integers because it was more memory and computationally efficient. However, due to the use of an integer format (which implies rounding errors) they had to apply a “gamma” (essentially a transfer function applying a power 1/2.2 or 1/2.4 to encode the RGB values) and increase the bit-depth in the low-lights in order to reduce rounding errors there (humans are very sensitive to low-light details). The 8 bit integer formats are also technically limited to the 0-255 range. Anything outside of this range overflows and is clipped to the nearest bound.

These workflows, using bounded RGB representations and possibly non-linear transforms to encode RGB signals, are called “display-referred”. They rely on the assumption that the image has been prepared for display at an early stage in the processing pipeline, and embed hard-coded assumptions about the RGB values of black, middle-grey and white. Most of the image-processing algorithms used in these workflows have been tuned around these assumptions. For example, the darken and lighten blending modes expect a middle-grey encoded at 50% (or 128 in integer encoding).

Unfortunately the non-linear scaling, which is mandatory to make the integer encoding work, breaks the natural relationships between pixel values. Hue and saturation change in unpredictable ways, and value relationships between neighbouring pixels are dilated or compressed such that gradients are also altered unpredictably.

Display-referred pipelines therefore break optical filters (lens blurring or deblurring), alpha compositing (which rely on optical and geometrical definitions of occlusion), colors and gradients (local relationships between chrominance and luminance of pixels). They also don’t scale well to HDR images, which led to the development of many questionable local and global tonemapping methods and the infamous 2010s “HDR look”.

Modern computers are not tied to the same computational limitations as those from the 1990s, and can work on pixels whose values are completely unbounded (from 0 up to +infinity) and encoded as real numbers (using floating point formats). These possibilities enable what we call a “scene-referred” workflow, in which pixels can retain their original radiometric relationships along almost the entire processing pipe. In scene-referred workflow, pixels are prepared for display only at the last stage of the pipeline, in the display transform. This means that the RGB values of the pixels are kept proportional to the intensity of the light emission recorded by the camera on the scene, enabling accurate alpha compositing and optical filter emulations, while also scaling to any dynamic range through the same algorithm (SDR as well as HDR).

However, scene-referred pipelines lose the convenient fixed values of white, middle-grey and black which characterised display-referred pipelines, and setting these values, according to the scene and to the conditions of shooting, now becomes the responsibility of the user. This requires a more complex user interface.

Also, because scene-referred values are supposed to be physically-meaningful, pixels cannot have zero intensity. This would mean they have no light at all, and the existence of zero light breaks many physically-accurate algorithms. In fact, white and black mean nothing with regard to the original scene, which is only a collection of luminances at varying intensities. The scene-referred workflow simply aims at remapping some arbitrary scene luminances to what will appear white or black on the output medium.

Versions of darktable prior to 2.6 had a non-linear display-referred pipeline, assuming that a non-linear transform took place early in the pipe and middle-grey was thereafter encoded as 50%. However, not all modules and filters clipped pixel values above 100%, leaving open the possibility of recovering those values later in the pipe.

The *filmic* module’s view transform, introduced in darktable 2.6, was the first step toward a scene-referred pipeline, and deferred the mandatory, non-linear, display preparation to the end of the pipe, along with the ability to set custom black, grey and white values. The *color balance* module then introduced a way to deal with a variable definition of middle-grey.

Starting in darktable 3.2, users could choose between two workflows that defined consistent default settings, modules and pipeline order for both *display-referred* and *scene-referred* processing.

In darktable 3.4, a full scene-referred masking and blending option has been introduced, allowing masks to be defined for pixel values above 100% and using only unbounded blending operators.

Switching to *scene-referred* is a cognitive leap for most experienced users, who are used thinking in display-referred ways. In a display-referred workflow, it is customary to anchor the white value and let tone adjustments revolve around that point, trying to maximize brightness while avoiding clipping. In a scene-referred workflow, white and black values are fluid and adapted to the output medium. It is advised that users anchor middle-grey (which will be preserved as-is for any output medium) and let the view transform (*filmic*) dilate or contract the dynamic range around that point. Because 10 bit HDR white is 4 times as bright as 8 bit SDR white, any rigid definition of “white” becomes irrelevant. But anchoring for middle-grey is actually more convenient, since it keeps the average brightness of the picture unchanged through the view transform.

Some modules (*levels*, *rgb levels*, *tone curve*, *rgb curve*) are inherently incompatible with a scene-referred workflow, because their graphical interface implicitly suggests RGB values that are bounded within the 0-100% range. While the pixel operations they perform can be used in either scene-referred or display-referred workflows because they are unbounded internally, their controlling interface does not allow pixels to be selected outside of the 0-100% range.

Similarly, blending modes such as overlay, linear light, soft light, hard light, darken, brighten, etc. all have hard-coded thresholds that internally expect display-referred non-linear encoding.

In darktable 3.4, hovering the cursor over a module header shows a tooltip detailing the color spaces, ranges and encodings that the module expects, uses and produces. Here are the definitions of the terms used:

linear
Pixel values are proportional to the scene radiometric emission, in a way that enables accurate emulation of physical filters.

non-linear
Pixel values are re-scaled such that low-lights are given a larger encoding range, usually to remap the 18.45% reference middle-grey to a value between 46 and 50%.

display-referred
Pixel values are expected to lie between 0 and 100% of the display range, where 100% is understood to be the luminance of a 20% reflective white surface (the white patch of a Color Checker) and 0% is understood to be the maximum density of the output medium (saturated black ink or minimum LED panel backlighting).

scene-referred
Pixel values are expected to be greater than zero up to +infinity. The meaning of specific pixel values needs to be defined at runtime by the user. Scene-referred values don’t automatically imply a linear, radiometrically scaled, encoding.

12.9. contributing to dtdocs

This page defines the style guide for dtdocs and information about how to contribute to the project.

It is included in the user manual so that you can see how the page is rendered as well as how it is written. Please go to GitHub to see the source for this page.

format

This website is authored in pure markdown, using some extensions. It is initially designed to work with the Hugo SSG but indended to be portable enough that it can be easily rendered with another application if required.

File should be rendered in UTF-8 and should not include any column wrapping.

structure

The following shows the structure of an example main chapter with subsections in the dtdocs website.

```
example-chapter/
   _index.md
   section1-with-subsections/
      subsection1/
         image.png
```

```
      _index.md
      subsection1.md
      subsection2.md
   section2.md
   section3.md
```

A couple of notes on the above structure:

- `_index.md` files do not contain any content (they contain metadata only) and are used to render section headers and ToC entries. In the above example `example-chapter/_index.md` defines the title of the example chapter and the order in which it appears in the main table of contents. Similarly `example-chapter/section1-with-subsections/_index.md` defines metadata for the first section of the chapter.
- Media files should be contained in a directory with the same name as the page to which they relate. In this example, `example-chapter/section1-with-subsections/subsection1` contains media related to the `subsection1.md` page.

metadata

Metadata for the markdown files is presented at the head of the page using yaml. Any metadata may be defined – the module reference sections contain quite a lot of specific metadata – however the following defines some minimal metadata for the example page `example-chapter/section1-with-subsections/subsection1.md`.

```
---
title: Sub Section 1 Title
id: subsection1
weight: 10
---
```

title

This should contain the rendered title of your page. To include a colon within a title, enclose the title in double-quotes.

id

This is the id used to identify the page by Hugo. It should usually be the same name as the file (for content files) or the parent directory (for `_index.md` files).

weight

This is an optional metadata field used to define the order in which sections are presented in the Table of Contents. If the *weight* field is not included, pages will be rendered in alphabetic order by default. For example, to define the sections and subsections of the above example in reverse order, the following metadata would need to be set:

```
example-chapter/
   section1-with-subsections/
      _index.md               # weight: 30 (place section1 page at the end of example-chapter)
      subsection1.md             # weight: 20 (place subsection1 page at the end of section1)
      subsection2.md             # weight: 10 (place subsection2 page at the start of section1)
   section2.md                # weight: 20 (place section2 in the middle of example-chapter)
   section3.md                # weight: 10 (place section3 at the start of example-chapter)
```

content

general style guidance

- All content should be authored in plain markdown without shortcodes and HTML should be kept to an absolute minimum , if used at all
- Minimalism is an absolute must. Fewer words are preferred
- Markdown files should be as short as possible
- Follow the naming and capitalization norms present in the GUI of the application - namely all headers and titles are in lower case, except for the very top-level chapter names
- Headers in a file should not exceed level three (###)
- The primary authoring language is English
- Assume the reader has the application open while reading the user manual and only include images where they contribute to the explanation of complex functionality
- Use image callouts if you need to annotate an image (i.e. mark parts of the image with a letter or number and then explain the meaning in some text following the image). Do not place words directly into the image for annotations, as this makes localization difficult. See this page for an example.
- Changes to the content should be proposed via pull request or a similar mechanism
- Your submissions will be copy edited, don't take it personally

definition lists

The standard method of presenting information about darktable module controls is with the use of definition lists.

gui control name
A declaration of what the control does. For example "Set the exposure in EV units".

You can include as many paragraphs as you like, but try to limit to 2 or 3 where possible.

 **a control accessed through a button with an icon**
When a control is activated using an icon, take a screenshot of the icon using the standard darktable theme and add it before the name of the control

gui combobox name
Comboboxes often have multiple options that all need to be displayed with separate definitions. Use bulleted lists with *italics* for the combobox values.

- *the first value*: What the first value means
- *the second value*: What the second value means

Definition lists are also used throughout the document, wherever a named piece of functionality needs to be defined. See, for example, darktable-cli.

notes

If you wish to present an important note to the user, use the following format:

Note: This is an important note.

---

fixed-width fonts and code blocks

Fixed width fonts (using the ` character) should normally only be used for code blocks and when referencing file names and command line parameters.

links

Internal links must be relative to the current file and must point to a valid markdown (.md) file. Start links with either `./` to represent the current directory or `../` to represent the parent directory.

- Links to a processing module should be in italics, e.g. *exposure*
- Links to a utility module should be in plaintext, e.g. history stack
- Link to a top level section by referencing the `_index.md` file, e.g. module reference
- Link to a tab in the preferences dialog: preferences > general
- Link to a specific preference setting: preferences > general > interface language
- Each header within a page can be linked to directly with an anchor link: contributing/notes

images

When taking screenshots from the darktable application itself, use the default darktable theme.

Several filename suffixes can be used to control how an image is rendered.

icon

To insert an image as an icon, include #icon after the image name in the link. The markdown `![squirrel icon](./contributing/contributing.png#icon)` outputs the following: 

image width

You can set the image width to 25, 33, 50, 66, 75 or 100 per cent of the rendered page width by including #wxx after the image name in the link, where xx is the desired width. For example:

`![squirrel](./contributing/squirrel.png#w25)` outputs

`![squirrel](./contributing/squirrel.png#w75)` outputs

inline

With the exception of icons, images are included as block elements by default. You can override this by including `#inline` after the image name. This can be combined with the width setting as follows.

`![squirrel](./contributing/squirrel.png#w25#inline)` outputs 

default

By default images are presented as block elements with 100% width. So `![squirrel](./contributing/squirrel.png#w100)` and `![squirrel](./contributing/squirrel.png)` are equivalent and both output the following:

darktable 3.4 user manual
January 21, 2021