ImageMagick Examples -- Basic Usage

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Here we explain in detail the command line processing that IM follows, some of the new image processing abilities, the ideas, philosophy, and methodology, and what is actually going on, internally. With this background knowledge the rest of the examples provided pages becomes much clearer. Even if you only use the Application Program Interface (API), this section is well worth knowing and understanding.

ImageMagick Command Line Processing

Why did the command line style change! or...
The problem with previous versions of IM

In previous major version of ImageMagick (version 5.5.7 and earlier) the command line interface into the IM library has been prone to problems involving the order in which operations were performed. It was very haphazard, and confusing to anyone trying to make sense of what was actually going on. Also, what worked one time may not work in the same order another time, as the author of IM, constantly battled with the interface to get it to work as people expected. The cause of the problem was that ImageMagick followed a fairly standard UNIX command line style...

```
command  [options]  input_image   output_image
```

As time went on this started to produce problems, as images are complex objects with an enormous number of operations that can be performed on them often involving other images. As a consequence of this the above slowly expanded to become..

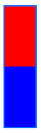
```
command  [options] image1 [options] image2 [options]  output_image
```

This worked, and is the basic style that was used in version 5.5.7. The various image operations such as "`-negate`", "`-resize`", and "`-crop`", etc, could appear either before or after the image it was meant to apply to. For example under version 5.5.7 the following two commands were equally valid and did the same thing.

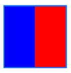
```
magick -negate  image.gif   output.gif

magick  image.gif  -negate  output.gif
```

The problem was what if you were dealing with two image processing operations! For example...

```
magick -size 40x20 xc:red  xc:blue \
        -append   -rotate 90    append_rotate.gif
```



The result (in IM v5.5.7) was that the two input images were rotated first, then appended together, producing an image like... That is, the "`-rotate`" operator would be applied BEFORE the "`-append`" which is probably not what the user intended.



With ImageMagick version 6, the operators will always be applied in the command line order as given by the user. As such the previous example in IMv7 will result in: the two images being appended together *first*, then that result will be rotated; producing this...

If the user actually intended to do the rotations before the append, he can explicitly ask IM v6 to do it in that order.

```
magick -size 40x20 xc:red  xc:blue \
        -rotate 90  -append    append_rotate_bad.gif
```

This sort of fine control was just beyond previous versions of IM, and would probably have required a pipeline, or intermediate save images to achieve it. The solution to the problem, unfortunately required a drastic measure and some incompatibility. On the other hand just about every 'simple' command that worked in IM version 5 work as you would expect IM version 6. In essence command line usage in versions before version 6 was ill-defined and in my thinking broken, producing numerous odd and unexpected results.

IMv7 command Syntax

Note that no 'operation' should be given, before at least one image is either read in or created. In fact you may like to consider a 'image read/create' also as an operation as well. Afetr all it really is image processing operation, that of translate an image in a file to an image in memory. So the correct way to do this in IMv7 is to read the image, process and then use the final 'implicit write' argument to write out the result. That is..

```
command  "image" { -operation }... "output_image"
```

Of course there are some settings that may be need to control the image reading which need to be given before actually reading the image (see below for the meaning of a setting). As such **IMv7 syntax** basically follows the following...

```
command { [settings] [operation] }...  "implict_write"
```

With the part in '`{...}`' being repeated with as many 'reads' or 'operations' you want or need. And '`[operation]`' being either an image read or create, or image processing operation that actually 'does something'. And you would do them in the exact order you want to process the images.

Types of Options - Operators and Settings...

A summary of the following is now also available from the ImageMagick Website on The Anatomy of the Command Line. All command line options will now fall into two basic groups: 'settings' and 'image operators'. Settings set values, Operators actually preform some action.

Setting Options

are command line options that only save information, that will be used later by other 'image operators'. That is, they do not do anything, except set some value, to be used later. Many of the options have both a '`-`' and a '`+`' style. The latter is generally used to turn off the setting, or reset it to its normal default state. This allow you remove the effect of a setting quickly and simply. For example "`+gravity`" will return the gravity setting to the initial 'gravity none' state. Settings can be further divided into a number of sub-categories... **Operator Settings** which control how later operators function. They set the colors, and fonts that may be used by an operator, control placement of images and text, the lookup of color from source images, control the method of processing by some of the more complex operators, etc., etc., etc..

`-dither -gravity -fill -background -bordercolor -stroke -font -pointsize -strokewidth -box -virtual-pixel -interpolate`

Most setting options belong to this category. **Input Settings** are specifically restricted to controlling the creation of images that are created or read in. Typically they are used to assign or override specific meta-data that is to be associated with the image(s) created after that setting was defined. they are created or read in from an external file.

`-label -delay -dispose -page -comment -size`

Remember, they are ONLY applied when an image is created or read in and are otherwise completely ignored. The special operator, "`-set`" has been provided to change the meta-data of images after they have been read into memory, or processed in some way. See Meta-Data below for more details. **Output Settings** which are only used during the writing or saving of images back to disk. While they can be given anywhere on the command line, they are only applied when the image is written, either as the default last image filename argument operation, or via a "`-write`", or "`-identify`" operation.

`-quality -loop -compression -format -path -transparent-color`

If not set, or turned off (using their plus '`+`' form), an appropriate default will be used. Generally this default is a saved value from the last image read in. A few 'operation settings' such as the current "`-background`" color, is also assigned to the image, if the file format requires. **Control & Debugging Settings** which control how IM, in general, performs its tasks. These includes...

`-verbose -debug -warnings -quiet -monitor -regard-warnings`

See IM Operation Controls below, for more information on these special settings.

Image Operators

Are command line arguments that will modify the image(s) in some way. They are performed **immediately** when seen, and may use other 'setting options' that have been given previously on the command line. These operators can be grouped into a few sub-categories... **Image Creation Operators** which will read images from a file or pipeline, or generate new images. These include...

`image.png xc: canvas: logo: rose: gradient: radial-gradient: plasma: tile: pattern: label: caption: text:`

As 'operators' they are also performed immediately when seen on the command line. They only add new images to those already in memory, but do not touch those previously read. Of course being operators, any previously defined 'settings' will be applied to them. Especially Input Settings, used to control the input from the file or file stream. For example "`-size`", which hints at the size of the image you want to create, or setting that define or override image meta-data such as "`-delay`", and "`-page`". **Simple Image Processing Operators** will modify all images that have already been read into memory. Each image is modified separately to every other image. They include operations such as...

`-crop -repage -border -frame -trim -chop -draw -annotate -resize -scale -sample -thumbnail -magnify -adaptive-resize -liquid-resize -distort -morphology -sparse-color -rotate -swirl -implode -wave -flip -flop -transpose -transverse -blur -gaussian-blur -convolve -shadow --radial-blur -motion-blur -sharpen -unsharp -adaptive-sharpen -adaptive-blur -noise -despeckle -median -negate -level -level-color -gamma -auto-level -auto-gamma -sigmoidial-contrast -normalize -linear-stretch -contrast-stretch -colorize -tint -modulate -contrast -equalize -sepia-tone -solarize -recolor -opaque -transparent -colors -map -ordered-dither -random-dither -raise -paint -sketch -charcoal -edge -vignette -emboss -shade -poloroid -encipher -decipher -stegano -evaluate -function -alpha -colorspace -separate`

`And probably many other operators I missed! (or have been added)`

Because all image operators are performed immediately when seen on the command line, they must be given *after* the images for which they are to operate, have been read into memory. If more than one image is present, *all* images are operated on, one at a time in sequence. As such you will have to be careful about what image(s) you have in the current image list. Note that it is possible that some of these operators can generate multiple images. For example "`-crop`" could generate multiple image 'tiles', or "`-separate`" which splits images into separate channel images. As such you may end up with more images in memory. But all of them only take one image at a time as input. Note that many API's only apply the

equivalent operation to just the first image in the image list given. That is, they may not loop over each image. The "magick" and other CLI (command line interface) commands, however apply the operator to each image in the current image list in turn. **Multi-Image List Operators** are special in that they modify the whole current list of images as a single entity. They could replace the whole list with a single combined image, or modify each image depending on the other images found before or after it. They are used for alpha composition, animation handling, color channel handling, etc...
`-append  -flatten  -mosaic  -layers  -composite  -combine  -fx  -coalesce  -clut  -evaluate-sequence mean  -evaluate-sequence`

Remember the whole list is treated as a single entity, and some images may be removed, or replaced. Most of the above operators merges all the given multiple images into a final single image. The Layers Composite method is currently the only operator that will spilt the current image list into two completely separate image lists, before merging them together to form completely new list of images. It makes the split by looking for the special '`null:`' image somewhere in the current image list. None of these operators can be used in a "`mogrify`" command, as that command processes a list of input images (given at the end) as an individual images. **Image Stack Operators** affects the ordering of the list of images currently in memory. Specifically they provide special 'on the side' processing of images. They are in many way similar to the previous Image List Operator, but they don't actual modify the images themselves, only how they are arranged in memory.
`(  )  -delete  -insert  -swap  -reverse  -duplicate  -clone`

Note that parenthesis '`(`' and '`)`' may require backslashing or quoting, to prevent any special meaning given to it by the Command Line shell Interface (CLI). None of these operators can be used in a "`mogrify`" command, as that command processes a list of input images (given at the end) as an individual images. **Miscellaneous Special Operators** are operators that do things in either an unusual or non-standard ways (compared to the above).
`-geometry  -version  -list  -bench  -concurrent  -preview`

The "`-geometry`" operator is special as it is the only operator that only affects one image (the last) in the image list, rather than affecting all of the images in some way. It is only provided for backward compatibility and special alpha composition requirements. See Geometry, resize just the last image for more details. The other two "`-version`" and "`-list`" are information generating operators, and causes IM to explicitly quit, after returning the requested information. See IM Special Controls below, for more information on these options. Some options could even cause the whole command to be run multiple times. Basically they are specially handled in some strange and unusual way. Generally these as not used except in special situations or to recover specific global information.

I hope the separation of options into settings and operators is clear as it is vital to the way IM now works. Remember under version 6 of ImageMagick...

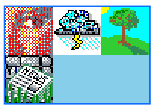
Settings are *saved* in some way for later use,
while Operators are applied *immediately* to the images.

This is what makes version 6 different from every previous version of IM. All options are defined to be a 'setting' or an 'operator' and the order will determine exactly when, and to what images, the option will be applied to. The IM Examples Options Reference can be used to identify what is an 'setting' and what is an 'operator'.

Working Example of an IM Command

Let's take a look at an example, and how it will be processed by IM version 6.

```
magick eye.gif news.gif -append    storm.gif tree.gif \
         -background skyblue +append    result.gif
```



Let's break this down and look at what IM v6 does...

Argument	Action Performed	Images
`magick`	Initialize and Create an empty 'image list'	empty seq
`eye.gif`	Read in image and add to end of current image list	1 image
`news.gif`	Add a second image into list (now with two images)	2 images
`-append`	Take all images in current list, and append vertically. All images are replaced by a single image.	1 (merged)
`storm.gif`	Add another image to the image list	2
`tree.gif`	And another	3

`-background skyblue`	Set a 'background color' to be used later. No changes are made to any images.	3
`+append`	Join all 3 images in the list horizontally Current background color is used to fill the empty space	1 (merged)
`result.gif`	As this is last argument, an implicit `-write` operation is performed with this argument. The single image in the current list is written using the given filename which also sets image file format to use.	written

As you can see the processing of the command line in ImageMagick version 6 is very straight forward, and logical, making the result predictable. And that is the point...

Legacy Command Line Style

Due to the fact that a lot of very old IM scripts out there use a command with a single image operator of the form...

```
command  -operator  input_image   output_image
```

That is, you specified an image operator before you actually read the image to which the operator will be applied. To handle this legacy situation, IM will save up all the image operators it sees, and apply them to the first image when it is finally seen on the command line. That is, the above will work as if you wrote the operation in the IMv7 way...

```
command  input_image   -operator  output_image
```

For example, this IMv5 legacy (UNIX option handling) command....

```
magick -flip  storm.gif   cmd_flip_legacy.gif
```

Will produce the same result as this IM version 6 command...

```
magick storm.gif -flip  cmd_flip_postfix.gif
```

The legacy command line style works, but has the same problems that plagued IM version 5 (see Why did the command line style change above). All settings are applied before the first read, and all the operators are just saved away to be executed when the first image is read (and only on the first image). There is also no guarantee of the order of multiple operators will be the same as the order you give, though it is likely they will be applied in that order. Also as operators are being save up until the first image is actually read, you may find repeating a command multiple times before reading the image may result in some of the earlier commands 'disappearing'. This is not a bug, but a miss-use of the legacy abilities of IM. This style of command line is for legacy support only, and as such is depreciated, so should be avoided if at all possible. Any scripts containing this old style, should also be updated to do image reads before the operators you want to apply to them.

Legacy support will continue into IM version 7, which includes a command that allows for single-pass processing of command lines. This allows it to actually read image processing options from script files and even a pipeline. However a single-pass processing technique will not allow for the saving of operators BEFORE reading an image to apply them to. In fact the "`magick`" command will produce 'no image' type errors, if you try to use an operator without an image in memory.

Command Line vs API

There is a couple of major differences between a command line IM, and using the Magick API's, such as PerlMagick, RMagick, PHP IMagick, and MagickWand.

Only one Active Image List

The command line only ever has one Image List which can be worked on at any one moment. You can 'push' or save an image list temporary (see Parenthesis and MPR: Named Memory Registers). You can even 'clone' (make an efficent copy) of images from the last 'pushed' list. But you can't really work on two such lists at the same time. Other language API's on the other hand allow you to have as many separate image lists or 'wands' as you like. In fact you typically save each image as a separate wand (image list and settings) for better processing and only merge the image into a list as needed or as part of the final step. You can also work on them in any order, and store them into databases or other data structures, for sorting or later comparison. On the command line however one single image list means you can not do operations in just any order, but generally try to do things in a more logical sequence, completely finishing each image processing step as you go. Basically it means is much harder to 'go back' or to change something later, using results from one set of operations to select or modify what set of processing operations should be performed next. It is especially more difficult to merge or interleave (shuffle) two completely separate lists of images into a logical whole. However some techniques have been worked out, to allow you to do this from the command line. For example see Multi-Layer Alpha Composition of Image Lists.

Direct Access to Pixel Data

Again you can do some math processing and merging of pixel data from the command line, but you can't easily look up attributes, or read and modify a specific pixel or area using the command line interface. You can merge and mathematically modify pixel data of images using the special FX Image Operator, but it is generally limited to transforming whole images, and is very very slow. To make it easier many common operations developed by users using the FX operator, have now been built into IM, creating things like Color Lookup Tables, Evaluate Math Functions, and Multi Argument Functions. As well as the General Image Distortion Operator, and some special Image Composition Methods. API's can manipulate images in a much more direct manner, alowing you to DIY an unique operation much more easilly, at the full speed provided by the API language.

Conditional Processing
The IM command line interface cannot easilly modify images based on some image derived attribute. For example it is very hard to process images differently depending on if the image uses a light background, or a dark background. Yes you can do some limited and specific conditional actions using the FX Image Operator, or ask IM to adjust (rotate) an image's Orientation based on certain conditions, or only shrink and never enlarge when Resizing Images. But these are only handling special well known and common processing conditions. The only truly practical way do conditional processing is to use separate commands and temporary files. For an example of this see the well commented Jigsaw Script. API's on the other hand can do this type of conditional processing, while holding all the images involved in memory, ready to continue processing based on the specific conditions, as and when you need it.

Looped Processing
You also cannot just simply loop over images in a controlled manner, or easily modify the process based on which image in the sequnece is being handled. that is you can not simply do something different to each image based on the image 'scene' number, or the results of previous images. For example draw text at different sizes, or gradually blur an image, or generate an animation list in the one single command. Yes you can modify specific images in an image list. For example see Frame by Frame Modification of an Animation. But you must know how many images are in the image list, and 'un-roll' the loop to process each image in the list separately. The only truly practical way to loop over images from the command line is to write out the individual images as separate image files (see Writing a Multiple Images) and process them one at a time in an external scripted loop. For example see the shell script that is designed to Divide an Image Vertically. Alternatively, you can generate the images using a shell script loop, and pipe the result into a final command to merge them into the final image or image sequnece. For example of this see Layered Images Examples, or the various Warped Image Animations shell script generators. API's however have no problem with looping over multiple images, either in a single image list, or even multiple image lists, or even with a whole array or data structure of image lists. It can also hold all the images in memory ready for the final combining step, without pipelining, or using temporary files.

If your application needs to be able to do any of these things (though few applications actually need to go this far) then an API may be a better choice. The "`magick conjure`" program (see below) was originally designed to allow better scripted use of ImageMagick, allowing the use of multiple image lists. The improvements made to IM v7 "`magick`" has seen this experimental API fall into disuse, though it is still available and still being developed.

Argument Handling

Beyond the filenames and options on the command line there are only a few basic styles of option arguments that are used.

- Constant Names (for specific settings and method types)
- List of Contant Names (for example two colors, or Channels)
- Geometry Argument (a special formated list of numbers with flags)
- Floating Point Lists (sometimes with Percent Escapes)
- Free Form Text Strings (with Percent Escapes)

Constant Names

Constant Names are specific string constants that are used to look up an internal library of allowed settings that may be used by an option. For example, the "`-gravity`" setting can take any of nine different settings. Once set that setting is then be used by all the image processing operators that follow the setting on the command line. For example: settings such as '`North`', '`East`', or '`NorthEast`'. You can get a list of all valid settings by using the List Operational Option (see below). For example using the command...

```
magick -list gravity
```

Only those specific settings are allowed and if you attempt to use some other setting you will get an error. For example...

```
magick xc: -gravity Invalid   null:
```

```
convert: unrecognized gravity type `Invalid' @ error/convert.c/ConvertImageCommand/1611.
```

The setting can be specified in a number of different ways, all of which are perfectly valid. IM is very forgiving about this. For example a setting can be specified in uppercase, lowercase, or any combination of the two. The individual words (specified by uppercase letters in the "`-list`" output) can have extra spaces, hyphens, or underscores included, and which are then simply ignored (but only between words). Consequently all the follow arguments are valid to set "North East" "`-gravity`"...

'NorthEast', 'northeast', 'NORTHEAST', 'NorTheAst', 'north east', 'north-EAST', 'NORTH_EAST', ' North East ', '___North___East___'.

But an argument of 'Nor The Ast' is not valid, even though the letters are all correct, as it uses spaces within the declared words of the setting. These constant names are not just for settings, but also to declare the operational method to use in some of the more complex image processing operators, such as "-layers", "-distort", and "-morphology". Some of the constant names are read from external configuration files. For example, color names such as for "-fill", "-stroke", "-background" and "-mattecolor". Or the special 'threshold' maps used for "-ordered-dither". Again "-list" can be used to look up what names your currently installed version of IM knows about.

Constant Name List

This is a little used argument and is most commonly used in settings that need one or two colors, such as Level Adjustment by Color. The "-level-colors" option can take any of the following argument styles.

```
color    color1,color2    color1-color2
```

It is also used for Image Selection, for operations that make use of multiple image indexs, for example Duplicate and Clone. The indexes start with zero for the first image, while negative indexs can be used to denote image indexs starting from the end of the image list. For example '-2-1' means take the second last image (index '-2'), to the second image (index '1'). And yes this actually means take the images in the reverse order specified!Another option that makes heavy use of this is Channel Selection where you can specify a list of specifically named channels. For example: 'Red,Green,Blue,Black,Alpha'. However the Channel Setting can also use a shorthand using a string of single letters (Eg: 'RGBA')

Geometry Arguments

This is the most common form of option argument, and is typically used to specify sizes, rectangles, and offsets for various operations. But it is also used by any option that needs any list of 1 to 5 numbers, whether they are integers, or floating point. For example, options such as "-crop", and "-resize" will use the full syntax of a geometry argument, while others like "-border", "-level", and "-gamma", may only use a small part of the full geometry syntax. This type of argument is so common that a special (and complex) parser has been written to magick such string arguments to numbers and flags, for use by any operator that needs a geometry argument. A geometry argument basically allows an user to specify a single string argument containing up to 5 floating point values (though most operators only use integers). All the following string forms are understood the geometry argument parser...

```
WxH+X+Y    WxH    +X+Y    A    A/B/C    A,B,C,D,E
```

Users could specify the small list of numbers in ANY of these forms, but typically which form is used depends on the operation the argument is being used for. The first few is typically used for the specification of a rectangle of specific size and location, or just an offset for some purpose. Offsets are always decoded to different numbers, those on either side of an 'x' in the string. That is, a "+X+Y" is always decoded as a 3rd and 4th numbers while it flags that the 1st and 2rd are undefined (or zero). The last few forms will allow up to a maximum of 5 posible input values, and are typically used for specifying a value for each of the standard RGBKA image channels. On top of these numbers, the parser also reports if any special 'flag' characters are present (any of '%', '^', '!', '<', '>'). The Parser however only reports if the characters is present. It does not report where they were found in the argument. IM for example does not remember that '% was attached to a specific number. It also does not report if it appears multiple times either. This means that a geometry argument of '%50' has exactly the same meaning as '50%' though the latter is preferred for readability. Also '50%x30' will probably actually mean '50%x30%' and NOT 50% of the images width, and 30 pixels high as you might think.

As a geometry arguments can contain special '%' flags, you currently can not use Percent Escapes to set its values based on image attributes.

There is a Future Proposal about exactly when a percent escape will be expanded that could fix this problem with geometry arguments. And hopefull will be part of IMv7.

Floating Point Lists

If more than 5 floating point numbers are needed, perhaps even an unknown number of values, then a **Floating Point List** argument, is used, though at the moment these are generally parsed by individual options, as they can vary slightly from option to option. Generally they consist of a string (typically quoted) of comma or space separated floating point numbers. The Distort Operator is probably the most well known operator to use a list of floating point numbers. Others include User Defined Morphology and Convolution Kernels, though it also has extra syntax specific to defining an array of numbers (kernels). One variant of floating point numbers is used by "-sparse-color", allowing you to substitute colors for some floating point values. Internally these are still converted to floating point values when the resulting array is passed into the core library function.

Freeform Strings

Other options just take a string as an argument. Either for generating labels, annotating text, or saving as image meta-data. These will typically include Percent Escapes in the string which are replaced (substituted) at some point before the string is used. It may be an immediate substitution, or the substitution may be performed later, just before the arguemnt is actually used. (See Delayed Percent Escapes below.

Arguments with Percent Escapes

Because of their nature, either of last two types of arguments are often pre-processed so as to expand Image Property Percent Escape within the string. That means that specific sequences of characters will be expanded (string replaced or substituted) into some other string, or value that is looked up or calculated from the image(s) being processed. This typically is done just before the argument is actually applied by the operator to a specific image, so that settings specific to that image can be used.If percent escapes are allowed in an argument, you can instead prefix the argument with a '`@`' so that the whole argument is instead read from the given external file (or standard input). For example '`@filename`' will be replaced with the contents of the file '`filename`'. If this happens, *no percent or other special escapes is applied*. That is, string read from the file will be taken as literal, and used without modification.

WARNING: that file could be anything, including system and password files that may be readable by the program. As such web users should pre-check input strings for this special case, or better still feed that string to IM using the '`@filename`' clause, as a security measure.

If the string is not read from a file or input stream, then any '`\n`' strings are replaced with a 'newline' character, and any '`%`' prefixed label is replaced with the appropriate value. See Image Property Percent Escapes for the complete list of replacements. The use of Percent Escapes in arguments, means that for growing list of operators that allow the use of such escapes, such as "`-set`","`-sparse-color`", "`-distort`", or "`-morphology`", you can generate arguments based in various image attributes and meta-data. ImageMagick version 7 allows the use of Percent Escapes in just about EVERY argument, (a key feature of IMv7!). Not only that but you can even calculate different arguments depending in the content or index of the image! You can even pre-calculate some complex settings using per-image or predefined global settings.

Before IM v6.6.9-0 Percent Escapes and more specifically FX Percent Escapes involving image indexes, such as '`%p`', '`%n`', '`%[fx:t]`' and '`%[fx:n]`' were broken. Typically they would only return unhelpful values of either '`0`' or '`1`', and not the actual index and number of images in the current image list.

Delayed Percent Escapes

Note that for some setting options Percent Escapes are not be expanded immediately they are seen, but simply stored AS given. It is only later when the text is actually used, that any Percent Escapes found in the string should be expanded, when the image they will be used with are finally known. That is, these arguments must delay the substitution of Percent Escapes until the argument is actually used. These options include the Input Settings such as: "`-label`", "`-comment`", as well as the "`-format`" setting, and global "`-define`" values. This means you can specify a "`-label`" containing image specific Percent Escapes long before the image it is to be applied to is actually read in. Only when the label is actually attached to the image (just after it is read in) is the Percent Escapes expanded, so that it can make use of the attributes of the image to which it is being applied.

The major limitation to the more wide spread use of Percent Escapes is that it is currently only applied to a limited set of option arguments. For example we currently can not use them with Geometry Arguments, which also use 'percent' characters, but for a different purpose.

This problem is one of the major problems that IMv7 will be fixing.

ImageMagick Commands

While the bulk of these ImageMagick example pages use the "`magick`" command to process images, there are a number of other ImageMagick commands, which I'll briefly introduce here. Some of these commands however can not be demonstrated properly on a web page. However I will try to give you hints and tips involving those commands here, even if I can't actually show their output directly, here.

Convert -- Convert and Modify Images

The "`magick`" command is the main workhorse of ImageMagick, and as such just about every set of examples in these pages uses this command. As such I will not cover the use of this command much here, but look at a little history instead. The commands original purpose when IM was first created was for the conversion of images in one image format into another. In fact it is still used for this purpose, and why it is called "`magick`". Because of this the command may not even read an image into memory, but may use secondary Delegate programs outside IM proper to do the conversion directly. This completely external aspect however has fallen into disuse over time, and lack of need, except as a means of reading in and writing out complex images file formats. Over a long period of time some extra image processing features was added to make minor changes to images as they were transferred between formats, or even the same format. These were generally simple options, but as of IM version 5 the use of these processing features had become extensive, and a far more important aspect to the "`magick`" command than just image conversion. As options multiplied, multiple options started to be used, the order of the options started producing weird and uncontrollable results. To users IM became known as unstable and uncontrollable when multiple image processing options was used, and it started to fall into disfavor. IM version 6 saw the switch from a simple 'options' style, to a 'do it as you see it' style for image processing, and as a result, image processing abilities become stable, predictable and IM's command line abilities became many orders of magnitude more useful. As a result of this, "`magick`", is no longer so much about 'converting' images from one format to another, but as a command line API for accessing image processing functions, to create, and modify images in very complex ways, without needing a degree in image processing, or programming in a computer language (such as Perl, PHP, or C). Of course some shell scripting knowledge is helpful, though not strictly required.

identify -- Print the details of images, that IM sees

The "identify" command is designed to return information about an image in a simple and useful way. By default it outputs a simple compact summary, detailing the images name, file format, image size, virtual canvas size and offset, color depth, internal format type, and if known the original size of the image on disk in human terms. For example...

```
magick identify  tree.gif
```

```
tree.gif GIF 32x32 32x32+0+0 8-bit PseudoClass 8c 235B 0.000u 0:00.000
```

Note that the '8c' in the above result is not the number of colors within this image (which is actually 6), but the 'pseudo-color' palette size (see later example for actual number of colors). Also note that the image 'virtual canvas' is the same size as the actual image with a zero offset, meaning it is currently not being used. Adding a -verbose, Operational Control, will produce as much information about the image that IM knows about or can easily calculate. This includes color statistics, color counts, profile information, internal image save type of the image, etc. etc.. However be warned that the output really is... *verbose*! Specific information can be obtained and output in specific ways by using the "-format" setting, and IM special percent ('%') escapes to output Image Properties. However typically you need to specify an EOL (newline under UNIX or MacOSX) as part of that argument (changed in IM v6.8.5-8). For example you can just extract a count of the number of colors within an image.

```
magick identify -format '%k\n' tree.gif
```

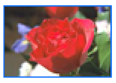
```
6
```

Before IM v6.8.5-8 "-format" would automatically add an end-of-line character(s) to the output, so as to separate multiple image results. This is no longer done, so you may need to add your own appropriate EOL characters to the "-format" string.

Identify, to Ping or not to Ping

IM "magick identify" by default only reads minimal basic information about an image, using a technique know as "-ping". This means identify only reads enough of the image file to determine simple image information, such as size, without trying to read the whole image into memory. See Ping, Operational Control below. This is a big advantage of "magick identify" has over "magick". However, most image meta-data will not be available. For example, image labels from a PNG image file. For example, here I create an image with a 'label', and attempt to use a simple format setting to print out that label.

```
magick rose: -set label "rose with a label" rose.png
magick identify -format '"%l"\n' rose.png
```



```
""
```

However this only happens for very specific cases. Any "-format" that has more complex escapes will automatically disable the use of a minimal 'ping' read.

```
magick identify -format '"%[label]"\n' rose.png
```

```
"rose with a label"
```

Or you can specifically disable this minimal 'ping' read, and force identify to read in the image 'in total' so it gets the desired information.

```
magick identify +ping -format '"%l"\n' rose.png
```

```
"rose with a label"
```

Generally you do not need to worry about it too much. Unless you are dealing with very large images such as photos.

Identify as a floating point Calculator

You can do some floating point mathematics using FX Escape Expressions...

```
magick identify -ping -format 'double_width=%[fx:w*2] PI=%[fx:atan(1)*4]\n' tree.gif
```

```
double_width=64 PI=3.14159
```

Note that the math does not even need to be related to the image itself, allowing you to use IM as a simple floating point calculator for use within your scripts. As we are only needing basic information we used the Ping control to prevent identify from reading in the whole image. It has no effect on the outcome in this case, but can speed up the command enormously.

Extra Cavats about Identify

Specific Format Details

Normally IM reads in the image into memory (which is essentially into own internal data format), using various image library APIs and delegate programs, before outputting the results it sees using identify. That is "`magick identify`" analyzes the image/data content it has read in and stored. It does not analyze how the specific file format stores or handles the image data. This is important as there can be very specific aspects of specific file formats that "`magick identify`" will not report on. For example while it lists the contents of a GIF image color table for each image present (multiple images are possible), it will not tell you if all the images in the file share the same color table or not. If you need specific info about specific image file format, it may be better to use a tool designed specifically for that format. For example "giftrans" for the GIF file format, and "jpegtrans" for the JPEG file format.

Color Histogram Output

Note that if image has more that 1024 colors, no histogram or color tables will be included in the verbose output. To force the generation of this information you can use the special '`histogram:`' file format which includes everything as a large image comment.

Exit Status

The identify program returns a non-zero exit status if a corrupted image is encountered and you add a Regard Warnings Control.

```
error=`magick identify -regard-warnings image 2>&1 >/dev/null;`
if [ $? -eq 0 ]; then
  echo "The image is good"
else
  echo "The image is corrupt or unknown format"
  echo "$error"
fi
```

Identify Output Alternatives

As of IM v6.2.4 you can also produce identify output from the "`convert`" command using the special "`info:`" output file format.

```
magick ../images/k* \
        -format 'image \"%f\" is of size %G\n'  info:
```

```
image "knight.gif" is of size 32x32
image "knight.png" is of size 100x100
image "koala.gif" is of size 75x75
```

You can use a Write Operator to write to "`info:`" in the middle of a sequence of operations, say as a debugging tool. You can also have it write that output to a specific file (or file stream). A simplier method would be to use an "`-identify`" option to write to the normal 'standard output'.

```
magick ../images/k* \
        -format 'Image #%p named \"%f\" is a %m\n' -identify \
        null:
```

```
Image #0 named "knight.gif" is a GIF
Image #1 named "knight.png" is a PNG
Image #2 named "koala.gif" is a GIF
```

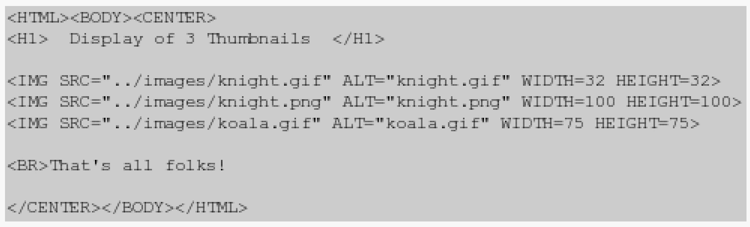
This can be also combined with another option, "`-print`" to output other information.

```
magick null: -print ' (50 + 25)/5  ==>  %[fx: (50+25)/5 ]\n' null:
```

```
 (50 + 25)/5  ==>  15
```

The main difference between "`-identify`" and "`-print`", is that first will be run once for every image in memory, while the later will only run once. That means we can generate just about any text file we want about the images in memory, completely from within a single ImageMagick command. For example, here I generate a HTML file of same set of images I have used in the previous example...

```
magick ../images/k* \
     -print "<HTML><BODY><CENTER>\n" \
     -print "<H1>  Display of %n Thumbnails  </H1>\n" \
     -print "\n" \
     -format "<IMG SRC=\"%i\" ALT=\"%f\" WIDTH=%w HEIGHT=%h>\n" -identify \
     -print "\n" \
     -print "<BR>That's all folks\!\n" \
     -print "\n" \
     -print "</CENTER></BODY></HTML>\n" \
     null:
```



```
<HTML><BODY><CENTER>
<H1>  Display of 3 Thumbnails  </H1>

<IMG SRC="../images/knight.gif" ALT="knight.gif" WIDTH=32 HEIGHT=32>
<IMG SRC="../images/knight.png" ALT="knight.png" WIDTH=100 HEIGHT=100>
<IMG SRC="../images/koala.gif" ALT="koala.gif" WIDTH=75 HEIGHT=75>

<BR>That's all folks!

</CENTER></BODY></HTML>
```

You can see the result of the above output as a HTML Web Page showing the images. One final word about these options. All of them by default will print to the 'standard output' of the "`magick`" command. You can not specifically output to some other 'pipeline' or to a specific file, unless you previously re-directed 'standard output'. Writing the output using "`info:`" will let you direct the output to a specific file, just like you can to an image file. You can also direct the output to a previously prepared file descriptor, using the special "`fd:`" output file format. Of course that writes once per image, so some juggling of images may be needed to arrange for it to output once only.

Mogrify -- in-place batch processing

The "`magick mogrify`" command is in many ways like "`magick`" except it is designed to *modify images in place*. That is, it's primary purpose is to read images (or animations), one file at a time, and modify them, before save the image back into the *exact same filename* the image was read from. Because of this...

Mogrify is dangerous, as it can easily destroy the original image!

As such, before you do anything final, test "`magick mogrify`" with a separate copy of your images. Do not do use it on an original image that has no backup. Now while "`magick mogrify`" normally saves a modified image into the same filename, it has two special options which allows it to save images into a different file. The "`magick mogrify`" specific setting "`-format`", defines a different format and suffix to use when saving files. As such a command like...

```
magick mogrify    -format jpg   *.png
```

Will allow you to convert, or batch modify images, without destroying the original image. In this case converting all PNG files into JPEG files with that same filename but a different suffix. However be warned that if there is an existing file with the same name, it will be *over-written*. So let me re-iterate...

Think and check before you Mogrify

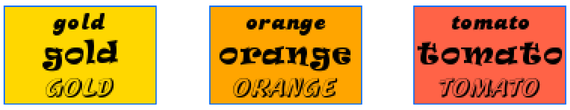
or you may find you just overwrote something you wanted to keep. As of IM v6.2.0 you can also use a new "`-path`" option to specify a different directory in which to output the processed images. This makes it safer, however it will still overwrite any images of the same name that may already be in that directory. Also any old images that was left in that directory will not be removed. As such you can have IM save the results (say image thumbnails) into an existing sub-directory, using something like this...

```
magick mogrify   -path thumbnail-directory   -thumbnail 100x100   *
```

Before IM v6.3.4-3 the "`-format`" and "`-path`" settings were mutually exclusive. From that version you can change formats and output directory location.

Due to the multi-image processing capability the "`magick mogrify`" command can not use any of the Multi-Image List Operators or Image Stack Operators. That means you can not use image processing operators like "`-fx`", "`+swap`", "`-composite`", "`-append`", "`-flatten`", and "`-layers`" in a "`magick mogrify`" command. As some setting options are needed to be set before the first image is read in (for example (for example "`-size`", "`-label`" and "`-density`"), these options are processed and set before the first image is read in. After this each image is read in and the operators applied to them in command line order before the image is saved and the next image read in. It is important to keep this in mind as if you change one of these settings later in the sequence you can make IM forget a previous setting. For example..

```
magick mogrify -format gif  -size 200x200  -pointsize 18 \
        -font Candice -gravity north  -annotate 0 "%f" \
        -font Ravie   -gravity Center -annotate 0 "%f" \
        -font Gecko   -gravity south  -annotate 0 "%f" \
        -size 100x64   xc:gold  xc:orange   xc:tomato
```



As you can see the size of the above images generated was determined by the second "-size" input setting with the first larger setting being ignored completely. On the other hand the operational setting "-font" is set correctly for each of the individul "-annotate" operations. This added complexity means that it is probably a good idea to...

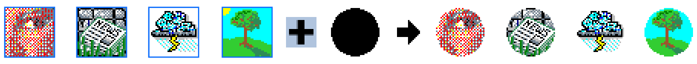
Mogrify images simply.

Do not attempt to do very long and complex "magick"-like operations in a batch operation using "magick mogrify", it will probably have 'setting' issues. If you are really wanting to do complex processing, write a shell/dos/perl script to use "magick" to process each image one at a time, or go to an ImageMagick API interface. For examples of modifying lots of images using a script see Advanced ImageMagick Examples. Just remember, "magick mogrify" is a dangerous command, and should always be thoroughly tested on backup images, before putting into production. Actually I also recommend that scripts include a quick 'tests' on things like "magick mogrify" to make sure the command does not break anything (due to version changes or differences in computer installations) before processing a very large collection of images. That is, do a small 'test case' and abort if it fails to produce a correct, before proceeding. This is actually a good idea for any large scale image processing project, so as to protect users from unforeseen consequences. I do this myself in IM Examples, and it has saved me a lot of trouble.

Alpha Composition using "magick mogrify"

Because "magick mogrify" can not use Multi-Image List Operators it can not easily overlay thing like logos, or mask images using Alpha Composition. There is one exception to this, using "-draw" to perform image alpha composition. This allows you to specify the second image, as part of the operators arguments, outside of the current image list. For example, here I first make a copy of the original images I want to process using a special "cp_perl" script. I then create temporary circle 'mask' image, which I then use to cut out a circle shape from all those images, using "magick mogrify" with a 'Dst_In' alpha composition method.

```
cp_perl  's/^/mogrify_/'  eye.gif news.gif storm.gif tree.gif
magick -size 32x32 xc:none -draw 'circle 15.5,15.5 15.5,0'  circle.gif
magick mogrify  -alpha Set -draw 'image Dst_In 0,0 0,0 "circle.gif"'  mogrify_*.gif
```



Note that any Alpha Composition method can be used in this way, but only with a constant 'source' or 'overlay' image being applied to all the images. Also as "magick mogrify" will be reading the 'source' image multiple times, I suggest you use the special IM specific "MPC:" file format to reduce the overhead of decoding the image when reading it over and over. This image file format does not need to be parsed by IM as it will be mapped directly from disk into memory (for the same machine it was created on). This saves a lot of processing time, especially in dealing with a large number of images.

Using Convert Instead of Morgify

Using a special technique to modify the output filename using Percent Escapes, (see Filename Percent Escapes), you can replace "mogrify" with a more versatile "convert" command. Not only that but it will provide you with a more control of the final destination name of the image. and let you better handle multi-image processing such as compositions and animations. For example, here I create thumbnails of images in the current directory, inserting a "_tn" string into the input filename, to create the appropraite output image filename.

```
magick *.jpg   -thumbnail 120x90 \
        -set filename:fname '%t_tn' +adjoin '%[filename:fname].gif'
```

Warning, do not include a different file suffix in the filename setting itself. IM will not see it when deciding on the image file format to use. Note that IM can't decide from the filename it will fall back to the original file format that was read in, so a clear suffix, or a coder prefix can be important, when using this technique. To get the exact original filename the source image came from use "%i", "%d/%f" or "%d/%t.%e". Of course these all have the filename suffix, in the filename setting, whch IM does not use, but that should be okay as it is the same image file format. The real problem with using "convert" instead of "mogrify" is that ALL the images are read into memory first! Mogrify takes great pains to only read/modify/write one file (though that file could contain multiple images) at a time. But "convert" does not. As such you can very easily exceed memory limits if you are not careful. Though there are ways around this. See examples in Read Modifiers and Thumbnails. Also as all the images are in memory as a single image list, you will need to be careful on how you process those images. For example you can not directly use Alpha Composition as you normally would, but may need to use the specialised Multi-Image List Composition to do the job. Of course just as with "magick mogrify" this method of using "magick" can be dangerous, as it could easily overwrite and destroy the original image files.

Batch Processing Alternatives

If batch processing images using "magick mogrify" is not practical, especially if you are copying the images rather than modifying them in place, then it may be better to use some other non-IM looping solutions. These include...

```
# Use a simple shell loop, to process each of the images.
mkdir thumbnails
for f in *.jpg
do   magick $f -thumbnail 200x90 thumbnails/$f.gif
done

# Use find to substitute filenames into a 'convert' command.
# This also provides the ability to recurse though directories by removing
# the -prune option, as well as doing other file checks (like image type,
# or the disk space used by an image).
find * -prune -name '*.jpg' \
       -exec  magick '{}' -thumbnail 200x90 thumbnails/'{}'.gif \;

# Use xargs -- with a shell wrapper to put the argument into a variable
# This can be combined with either "find" or "ls" to list filenames.
ls *.jpg | xargs -n1 sh -c 'magick $0 -thumbnail 200x90 thumbnails/$0.gif'

# An alternative method on linux (rather than plain unix)
# This does not need a shell to handle the argument.
ls *.jpg | xargs -r -I FILE   magick FILE -thumbnail 200x90 FILE_thumb.gif
```

And so on. I recommend the use of both "find" and "xargs" for doing recursive or even non-recursive file processing. Read their man pages. For a quick introduction see this IM Discussion Post, as well as the guide Xargs - Wikipedia which includes information on the dangers involved. If your commands start to get more complicated than this, it may be time to go to a shell script, or API program, to read in multiple images, gather information, calculate appropriate arguments, and process the images. I also recommend a good look at the "parallel" command (typically a drop in replacement for "xargs"). This can not only let you run multiple commands simultaneously, but can with a little work run each command on different computers, allowing you to do network distributed processing of a very large number of tasks. For Windows Users I refer you to the Windows Usage section, and in particular Windows, Batch Processing Several Files.

Remember "mogrify", and all other IM commands will also expand all filenames containing shell meta-characters such as '' and '?'. This is done to allow the use of these meta-characters on the old DOS command line shell. However this could cause a bug, repeated magick mogrify execution, or possibly even a 'hack' from a some evil source that provided the filename to use. Caution and complete understanding of security issues is advised.*

Composite -- overlaying images in special ways

The "magick composite" command is designed specifically for simple alpha compositing (overlaying) of two images together in various ways. This includes limiting the area in which images are combined together, though the use of a third masking image. Unlike "magick" the "magick composite" command is a very traditional command in that it will read all its options and settings, before it actually performs the single image processing operation it was designed to do. The "magick composite" command also provides simple access to some of the more complex alpha composition modes. For example "-dissolve", "-blend", and "-watermark" image composition. If any of these arguments are given, they will override any other "-compose" setting that was (or will be) given for that command. Note also that the "-tile" setting also works differently to that of either "magick" or "magick montage" and "magick display". In "magick composite" this will cause the overlaid image to be tiled across the whole of the background image. Something not yet available in other IM commands. While these special features makes "magick composite" an useful command, the alpha compositing is now also available for use in the "magick" command. (For details see Alpha Composition in IM). For a summary of multiple different ways of overlaying two or more images together see the examples in Compostion of Mutliple Pairs of Images. For more information on the method by which two images can be merged together see the Alpha Compositing examples page. The overlay limiting or 'Masking' abilities is also detailed in the above examples page in Using a Compose Mask to Limit the Composed Area.

Montage -- generating arrays of thumbnails

The special IM image indexing command "magick montage" also followed the same 'do it as you see it' style of command line structure, as "magick". The only difference is that when the end of the command is reached (other that the final output image filename argument), "magick montage" will start to process the image list into a thumbnail image index page(s), according to the settings that are currently set. This makes "magick montage" much more versatile than it was in IM version 5, as you can now process the images just as you would in "magick", then set all the "magick montage" settings you want, and let it finish the job. For more details about "magick montage" see Montage, Arrays of Thumbnails.

display -- Slideshows of Images

The "magick display" program is designed to display an image, or list of images in the form of a looped slideshow. It is not designed for a carefully orchestrated and timed animation of images, for that use the "animate" command. Each image will be displayed in a window sized appropriately for the image, unless other options (like window "-geometry", see below) override this behaviour. The image will also generally be displayed on a checkerboard background so as to show the effects of any transparency the image may have (see below). Remember this is NOT designed for the display of an animation, but as a slideshow of actual images. As such some caution may be needed when using display in a scripting program. **Image Display Time, Loop, and other options**By default a delay of approximately 2 seconds is used on top of whatever delay the user specifies using the "-delay" setting. However you can make it wait for user input (spacebar) by using the option "-delay 0". However defaults can be overridden by the images themselves, depending on there file format. As such animation formats like GIF and MIFF could result in either a pause, or a 2 second plus the images meta-data delay setting. It is thus recommended that you always set a "-delay" as appropriate (remember "-delay 5x1" will delay 5+2 or about 7 seconds) for your script and needs. The same goes for the "-loop" setting. By default "magick display" loops forever ("-loop 0") but image formats like MIFF or GIF can override this so as to cause it to exit after last image in the loop. See the "-loop" option appropriately for your situation. Note that "magick display" will not handle any GIF Animation Settings so frames are not disposed of, and virtual canvas sizes and offsets are ignored. In other words you will see the raw partial images in a GIF animation, not the correctly overlaid image. It does provide a "-coalesce" option to clean up such animations for display purposes.

Transparency Handling

Images containing a full alpha channel (EG PNG and MIFF formats) will be overlaid onto a 'checkerboard' background pattern, so as to let you see the effects of any semi-transparency, such as shadow effects. You can change that by selecting a different background with "-texture" such as...

```
magick display -texture granite: test.png

magick display -texture xc:black test.png
```

Images with a palette (or boolean) transparency, such as GIF and PNG8 formats, is displayed with a the current 'transparent color' that was used to represent transparency in the color table. That is, a generally random color may be used (typically black) rather than the default checkerboard pattern. This could be regarded as a bug, though technically it isn't. However if you like display to handle such images in the same way as other images containing transparency information, you can remove the palette meta-data before feeding the image to "magick display" using the following commands to change the internal style for the image output format.

```
magick image.gif -type truecolormatte miff:- | display -
```

Alternatively, just about any operation that modifies the image being displayed will also remove the existing palette meta-data. As such some "magick display" options can be used to remove the palette. For example using "-coalesce".

```
magick display -coalesce image.gif
```

This has the added bonus of cleaning up GIF animation optimizations that may be present. Though for multiple, unrelated images it could have other undesirable side effects. Yes these methods are clumsy, but they work.

Display Using Convert

An alternative display method (other than using "magick animate", see next) is to use the simpler "x:" output image format (See display output format).

```
magick image.png x:
```

This method does not provide a backdrop window, menu options, or other controls. It just simply displays the images one image at a time. If you do want to just simple 'display' the resulting image the special 'show:' or 'win:' output Spawning Delegate will do the same thing by runing the "display" command on the output image, and exiting without waiting for that window to be closed.

```
magick image.png show:
```

Display Output Size

Display will not scale an image to fit it to the X window display. The window size will be adjusted to fit each image, unless set using the "-geometry" setting. That setting can also be used to fix the windows position on the X window display. Images which are larger that the screen, will also not be resized, but will overflow the screen, display will however also provide a 'scroll window' to let the user slide around the image. This can be painful when viewing a modern high resolution digital photo. To limit display to say a 800x600 pixel area (only resize smaller, never larger), use...

```
magick display -resize 800x600\> photo.jpg
```

For JPG images you can speed up the image read by using a special jpeg input size hint setting. See Reading JPEG Control Options.

```
magick display -define jpeg:size=1600x1200 -thumbnail 800x600\> photo.jpg
```

If the image is from a modern digital camera you can also use "-auto-orient" to correct the camera rotation of the displayed image, using the EXIF meta-data in the image file format. If you don't want menus, you can turn them off using the "-immutable" setting to "magick display", so it knows not to allow editing.

Scripted use of Display

With these options in mind, the following is my recommendation for using "magick display" to display results from a complex shell script...

```
magick display -delay 0 -loop 1 -coalesce -resize 800x600\>   some_random_image
```

Display with X Windows

The option "-window root" can be used to display an image on the X window background (root) window. In this case the "magick display" program automatically exits. By default an image is tiled across the background. For example try this..

```
magick display -window root pattern:checkerboard
```

For many other examples of image tiles, and generating them see Tiled Canvases, and Background Image Examples. If you want to use a single image for your X Windows background, you may need to know the size of your X window display. The "xdpyinfo" program while not part of ImageMagick, can give you that information.

```
xdpyinfo | grep dimensions:
```

And here we use the output of "xdpyinfo", to resize an image to fill the X window background completely.

```
screen_size=`xdpyinfo | sed '/dimensions:/!d;s/^[^0-9]*//;s/ pixels.*//'`
magick display  -resize $screen_size! -window root photo.jpg
```

Display Remote Control

Display does provide a special "-remote" option. This will look for an already running "magick display" command and will then pass the given arguments to it. For example...

```
magick display wizard: &
sleep 5
magick display -remote logo: &
```

Will display the built in "wizard" image in a backgrounded command. The script will then wait 5 seconds before replace it with the built-in "logo" image.Note that if no "magick display" command is running, the current command will open a window and not exit. As such you should also background the "display -remote" commands as a precaution. At this time you can not request a remote "magick display" to exit. As such the best way to close the remote display is to either kill the running process, or 'delete' the display window using some X window command. For example (using the non-IM command "xdotool")...

```
xdotool search -class "display" windowkill
```

animate -- Show an animation of images

In many ways "magick animate" and "display" are extremely similar. However "display" only shows the images in the given image file 'as-is' without change, adding an minimal 2 second pause between each frame for user input. "magick animate" on the other hand will apply any GIF Animation Settings that are saved with the image, and only display each image according to its 'time delay' settings, looping back to the start to repeat the animation. In other words "magick animate" 'animates' animation formats properly where "display" does not. However because of this, the virtual canvas of the first image will control the output image size, and other image will be overlaid into that image area. Of course as the images are animated, you do have a fine control of the image display timing, using options such as "-delay". The command also has an extra argument "-pause" to add an extra pause at the end of the animation loop, beyond whatever the final frames "-delay" setting specifies. For example you can use "magick animate" to generate a Flicker Comparison of two very similar images, using something like..

```
magick image1.png image2.png -scale 400% miff:- |\
   magick animate -delay 50 -loop 0 -
```

I have written a script to take advantage of this method called "flicker_cmp", and find it extremely useful to pickup very subtle changes in pixel intensity that I would otherwise miss.

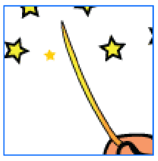
compare -- Look for Differences

All current information on this is on the Image Comparison Page section of IM Examples.

stream -- pipeline processing of massive images

"magick stream" is a special program that is designed to handle extracting a portion of a very large image file. It is the only such program within ImageMagick, all others read the images completely into memory before processing (the exception is JPEG images via the "-size", as this option is passed to the JPEG delegate library).You can select a portion of the image with the "-extract" setting. And you can specify the depth of the raw bytes with "-depth" setting. And finally, you can select which color channels to extract using the "-channel" option. However "magick stream" will only output the raw color bytes of the image (RAW format) as defined by the image depth, as such you may need to pipe the output of the extracted segment into convert.
For example...

```
magick stream -map rgb -storage-type char -extract 100x100+200+100 logo: - |\
  magick -depth 8 -size 100x100 rgb:-   magick stream_wand.gif
```



For more information and examples see Really Massive Image Handling.

import -- read images from the on screen display

The "magick import" command is a special program that can be used to grab and extract images from an X windows display. For example lets get it to grab and print a window you select from your display...

```
magick import -page A4 -gravity center ps:- | lpr
```

It is actually rarely used as the special file format "X:" also provides exactly the same functionality from within the magick command. The only difference between the two is that "magick import" has more X window specific settings than the "X:" format, such as specifying the display, screen, and/or window ID, the image is to be grabbed from. Other options include controls display 'beeping' and repeated snapshots. If no specific window is specified, the mouse can be used to select what parts of the display the user wants to grab as an image.

- If a single mouse click is used the whole window clicked in is grabbed and returned as an image. Note that if any other windows on the display is obscuring part of the window selected, then you will grab an image of the obscuring other windows are obscuring the selected window being grabbed.
- A click in the root window, or selecting "-window root" will return the whole screen.
- If a mouse click and drag is used a Cropped section of the whole screen is returned, which of course also means the location (virtual canvas offset) on the whole display (virtual canvas, or page, size) is also returned.

Other options allow you to avoid human interaction with the mouse by grabbing the whole screen ("-window root"), or a specific window, given a window title, or a X window ID, which you can find using the X window utility "xwininfo". You can also cut down the area of the selected window using "-extract". See also the special input format, "X:" as an alternative to using "magick import".

```
Note to import from the Windows clipboard use
  magick clipboard:myimage image.png
and not "import"
```

conjure -- IM experimental scripting language

Was originally designed to allow scripted Imagemagick use, with the use of multiple image lists, but the improvements made to IM v6 "magick" has seen this experimental API fall into disuse. It is an XML based language. Though if you want XML, SVG may be better for your needs. In my opinion, using the "magick conjure" script is probably better and easier when dealing with multi-image list. And is being used, though not very widely, due to lack of examples and support by users.

Image Lists...

One of the most important points to remember with ImageMagick, and one that confuses both new users and experienced users, is that...

ImageMagick works with Ordered Lists of Images, not single images

That is, IM deals not with just one image, but potentially an ordered list of images, be they separate individual images, a set of images that layer on top of each other, or the frames of an animation. Also in general all image operators will be applied to *all the images in the current list*. As such if you use a "-draw" operator, it will not only draw on the last image in the list, as many new users would assume, but it will draw onto *all* the other images in the current image list, and does so to each image in turn. Image Layering Operators, such as "-coalesce" and "-layers" will replace each image in the list with a new image modified according to the other images in the list. It may even add or remove extra images! Also Image List Operators, like "-append", "-mosaic", and "-fx", will replace ALL the images in the current image list with the resulting combined image. That is, it will destroy all the images, unless they were previously saved using Parenthesis, and Cloned Images were used. See Image List Operators below for practical examples. Finally when a new image is read in or created, IM only adds that new image to the end of the current image list (which always exists). Some formats (like GIF) may actually add multiple images to the current image list, unless a special Indexing Read Modifier is added to the input filename, to limit what is read in. When saving images, IM will save the whole image list that is in memory at the time of writing. If image format allows it IM will write ALL the images into a single file. If the format does NOT allow multiple images (for example JPEG), it will write the images into separate files (See Writing a Multiple Images).

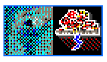
Parenthesis -- processing images 'on-the-side'

With the formalization of the command line options, the processing order is now exactly predictable, and it has also become possible to add parenthesis (or brackets) to the image processing. This has been a desired feature by IM users for a long time, and allows you to do things never before possible in a single command. The opening bracket '(' will in affect start a new image list, that all enclosed operators will work on. The matching close bracket ')' will then add the resulting image list (which may be more than one image, or none at all) to the end of the previous image list. In other words, using parenthesis means...

"I need to do a bit of work in a separate image list
before adding the results to the end of previous list."

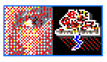
It allows you to work on a sub-set of images, like a scratch pad, than add the result back into the main image list without affecting the images you have already previously read in or have been working on. Let's look at some simple examples...

```
magick  eye.gif  storm.gif  -negate  +append  cmd_negate.gif
```



As you can see the "-negate" operator, color negated both images, as both were in the current image list in memory at that time. But by adding parenthesis we can limit the negation to just the second image...

```
magick  eye.gif \(  storm.gif  -negate \) +append  cmd_bracket.gif
```



Because the "storm.gif" image is read into a separate image list to that of the first image (generated by the "(" image list operator), it can be negated without affecting the first image. Then we can add the result to the main image list (that is the ")" operator), before appending the two images together as before.

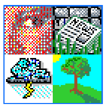
Parenthesis must be given as a separate argument. That is, you must separate them from the other arguments by spaces. You can not add them hard up against neighbouring arguments. In other words in the IM command line argument " \(+clone " is wrong, while " \(+clone " is correct.

Also in the last example I needed to put a backslash '\' before the parenthesis. That is, because when using IM on an UNIX (linux) machine, parenthesis has special meaning to the command line shell. As such I need to escape, or quote the bracket symbols, when I use them.

Windows DOS scripts do not require parenthesis to be escaped with backslash. See Windows DOS Scripts for this and other differences to linux scripting.

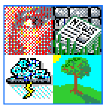
Parenthesis also make it possible to do something not previously possible to do in a single "magick" command. Generating arrays of images!

```
magick eye.gif news.gif  +append \
       \( storm.gif tree.gif +append \)   -append  cmd_array.gif
```



Arrays like this were of course possible using "`magick montage`" (see [Montage Concatenation Mode](#)), But using a separate command makes image processing scripts more complex. Of course if you like to make the command look more array like itself, you are free to add some extra parenthesis.

```
magick \( eye.gif    news.gif  +append \) \
        \( storm.gif  tree.gif  +append \) \
        -append  cmd_array2.gif
```

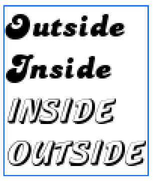


The first set of parenthesis aren't strictly needed, and do add a tiny amount of extra work to IM's internal processing, but it does make it clear what the command is doing by separating the processing steps. It may also be easier for image processing scripts to perform each processing step as a separate parenthesis, as a means of separating the processing steps, it is applying.

Parenthesis and Settings

Option 'settings' are not affected by parenthesis, and will continue across the parenthesis image operators, until the setting is changed or turned off.
For example...

```
magick -pointsize 24 \
        -font Candice label:Outside \
        \(              label:Inside \
           -font Gecko  label:Inside \) \
        label:Outside       -append   cmd_settings.gif
```

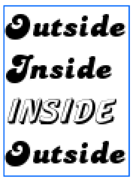


Note how the first "`-font Candice`" setting is NOT reset back to its default setting when the parenthesis is entered, while the second "`-font Gecko`" is not replaced by the original font setting when you leave parenthesis. In other words...

Parenthesis only create a separate Image Sequence.
They do not limit settings, only the images being worked on.

As of IM v6.4.1-4 the new operational control option "[`-respect-parenthesis`](#)" can override this behaviour. When given at the start of an IM command, it will cause parenthesis to also save and retrieve the previous settings that have been given. That means any settings given within parenthesis, will only remain set, until the end of the parenthesis.
For example...

```
magick -respect-parenthesis   -pointsize 24 \
        -font Candice label:Outside \
        \(              label:Inside \
           -font Gecko  label:Inside \) \
        label:Outside       -append   cmd_settings2.gif
```



As you can see, when the parenthesis ended, the font setting was restored to the previous 'Candice' font, instead of the 'Gecko' font that was set within the parenthesis. This can be most useful when you have to change a lot of setting, for just a short time...

```
magick -respect-parenthesis \
        -font Arial   label:"This is a line of plain text." \
        \( -font Candice -pointsize 16 -fill red -undercolor lightblue \
            label:"A line using a lot of different settings." \) \
        label:"Text is back to normal -- like Magick\!" \
        -append  cmd_settings_lots.gif
```

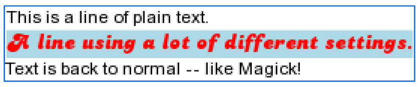

This is a line of plain text.
A line using a lot of different settings.
Text is back to normal -- like Magick!

Image List Operators

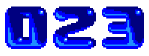
With the stronger emphasis by IM on image sequences, especially within parenthesis, it is no surprise that a set of new image operators have been provided to manipulate the image lists.
The arguments to these operators are numbers indexing the image list, starting with zero ('`0`') for the first image, and one ('`1`') for the second image, and so on. However if you give a negative index, the images are referenced from the end (last image

added) of the image list. That is, an index of '`-1`' is the last image in the current image list (generally the last image read or created), '`-2`' for the second last and so on.

`-delete {index_range_list}`

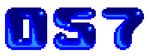
The "`-delete`" list operator is the simplest of the image list operators, it just deletes images from the current image list.

```
magick font_[0-3].gif -delete 1 +append  seq_delete.gif
```



The 'plus' form of the operator, "`+delete`" does not take an argument, and just deletes the last image in the current image list. The "`-delete`" operator will also accept a comma separated list of numbers, or a number range to be deleted.

```
magick font_[0-7].gif -delete 1-4,6 +append  seq_delete2.gif
```



Or delete everything (and add a new image)...

```
magick font_[0-7].gif -delete 0--1  tree.gif seq_delete3.gif
```

The '`0--1`' argument means delete images from first image (index 0) to the last image (index -1). In other words ALL images in the current image list. The tree image was then added to give IM an actual result, so as to avoid a 'no image' type error. A "`NULL:`" output image could also have been used, to produce no output. If an image index does not exist, or a number range is reversed, "`-delete`" will silently ignore that specific image deletion. For example, the argument '`-25`' will attempt to delete the last 25th image in the image list, but will silently do nothing if less than 25 images are present. As such you can generate a rolling animation of 24 images using a sequence like...

```
magick animation.gif  new_frame.gif  -delete -25  animation_new.gif
```

However no image will be deleted if the number of images was 24 or less. As a result the animation will grow by one frame, every time the command is run, until a maximim of 24 frames is reached. After that the oldest (first) frame will be delete while a new frame is added. As of IM v6.3.4 "`-delete`" will not delete images that result in the numbered range being reversed. That means that last example could be re-written like this...

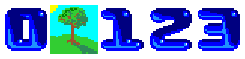
```
magick long_animation.gif  new_frame.gif  -delete 0--25  animation_new.gif
```

This time the "`-delete`" will delete all images between the first, to the last 25th image, leaving at most 24 images in the list. If only 24 or less images are present, the given range of images to be deleted will be effectively reversed, and the "`-delete`" operator will not delete anything.

`-insert {index}`

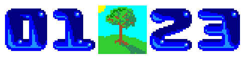
The "`-insert`" operation is sort of the opposite of "`-delete`". It will take the last image in the current image list and insert so that it is positioned at the given index.

```
magick font_[0-3].gif tree.gif -insert 1 +append seq_insert.gif
```



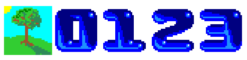
You can think if the insert index as the number of images that should appear before the point where the image was inserted. Of course the image that was at that index (and all the images after it), will be bumped up into the next index position to make room for the new image. If a negative index position is used, the insert position is calculated after the image being inserted is removed from the end of the list. That is, it will act as if the image being inserted was not part of the original image list. As such "`-insert -2`" will 'roll' the last three images, placing two images between the newly inserted image and the end of the image list.

```
magick font_[0-3].gif tree.gif -insert -2 +append seq_insert2.gif
```



The plus form "`+insert`" will move the last image to the front of the image list (index `0`), effectively rolling the whole image list by one frame.

```
magick font_[0-3].gif tree.gif +insert +append seq_insert3.gif
```

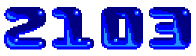


To do the inverse of the above (move an image to the end of the image list), can be done by first using "`-duplicate 1,0`" to copy the first image, then use "`-delete 0`" to delete the first image.

`-swap {index}[,{index}]`

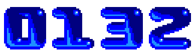
Simply put "`-swap`", will swap the positions of two images in the current image list. For example "`-swap 0,2`" will swap the first and the third images in the current image list.

```
magick font_[0-3].gif  -swap 0,2  +append  seq_swap.gif
```



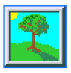
The plus form of this option "`+swap`" will swap the last two images in the current image list. In other words, it is equivalent to "`-swap -2,-1`".

```
magick font_[0-3].gif  +swap  +append  seq_swap2.gif
```



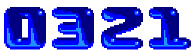
Probably the most common use of this operator is to swap two images before being used by an image layering operator such as "`-composite`", "`-flatten`", "`-append`", or "`-fx`".

```
magick tree.gif  frame.gif   +swap \
        -gravity center  -composite   framed_tree.gif
```



As of IM v6.4 a "`-swap`" with a single number will swap the last image with the number given. That is "`-swap 1`" is equivalent to a "`-swap 1,-1`".

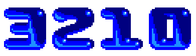
```
magick font_[0-3].gif  -swap 1  +append  seq_swap3.gif
```



`-reverse`

The "`-reverse`" operator (added to IM v6.3.4) will quite simply reverse the order of the whole image list.

```
magick font_[0-3].gif -reverse  +append seq_reverse.gif
```



It is basically an ultimate Swap Operator.

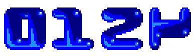
`-clone {index_range_list}`

This image list operator is a little different. Given an image list number "`-clone`" will make a copy of an image that has been saved by the 'open bracket' or 'parenthesis' operator. That is...

Clone should only be used within parenthesis

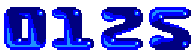
The reason for this is that it allows you to extract a copy of an image from the last saved (pushed) image list, so you can process it further. For example.

```
magick font_[0-2].gif \( -clone 1 -rotate 90 \) +append  seq_clone.gif
```



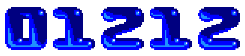
The 'plus' argument-less form "`+clone`" will just make a copy of the last image of the saved (pushed) image list so that you can process it further

```
magick font_[0-2].gif \( +clone -flip \) +append  seq_clone2.gif
```



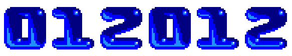
As of the release of version 6.2.2 "`-clone`" operator will take a comma separated list of images, or a range of indexes of the form '*`{index}-{index}`*'.

```
magick font_[0-2].gif \( -clone 1-2 \) +append  seq_clone_range.gif
```



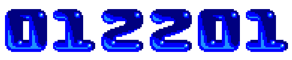
Of course negative indexes still behave just as you would expect. For example to duplicate the whole image list you can specify it using numbers '`0`' (first image) and '`-1`' (last image), that is by using the range '`0--1`'. It may look strange but it makes sense and works fine.

```
magick font_[0-2].gif \( -clone 0--1 \) +append  seq_clone_all.gif
```



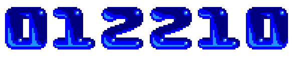
When you use a comma separated list of indexes, the images are extracted in that order you specify.

```
magick font_[0-2].gif \( -clone 2,0,1 \) +append  seq_clone_list.gif
```



If the images in a range are reversed (after negative indexes are converted to an actual image index), the extracted images is also reversed, as part of the process.

```
magick font_[0-2].gif \( -clone 2-0 \) +append  seq_clone_reversed.gif
```

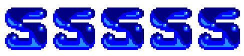


The Clone Image Operator can be used without parenthesis, and will just copy images from the current image list and directly append them. However this is not its intended use and is to be discouraged as it will produce a different result if you later surround that set of operations by parenthesis. Also in the examples above I am generating clones and appending them to the current image list, to demonstrate the operator. In reality I should be using the Duplicate Image Operator to duplicate images in the current image list. So should you, as it will make it clearer what you are trying to do. The MPR: Image Memory Register, can also be used to clone images and was available in IM v5. It is actually still an useful method for cloning and storing a whole image list (of unknown length) for later use, and not just a single individual images as the above image list operators do.

-duplicate {count}[,{index_range}]

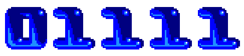
You can use "`-duplicate`" to generate an extra copies (clones) of an image, from the current image list (added IM v6.6.8-7). The new images are added to the end of the list. Unlike the previous (and older) Clone Operator it does not require the use of parenthesis. For example to make N extra copies an image (to a total on N+1) you can do this...

```
magick font_5.gif   -duplicate 4   +append seq_duplicate.gif
```



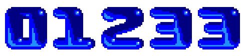
Note that this operator can generate hundreds of images very quickly, however until the images are processed, the images are simply 'clones' of each other, sharing the actual image data between them. As such duplicated images are very memory efficent. If more than one image is present, the last image is duplicated N times...

```
magick font_[0-1].gif   -duplicate 3   +append seq_dup_n.gif
```



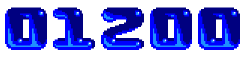
If you just want to duplicate the last image once, you can use the 'plus' form of the argument.

```
magick font_[0-3].gif  +duplicate   +append seq_dup_last.gif
```



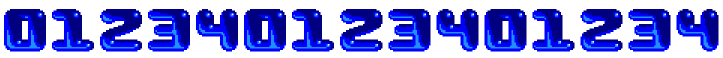
If you want to select a particular image mutliple times duplication you can specify image index as a second argument.

```
magick font_[0-2].gif  -duplicate 2,0  +append seq_dup_index.gif
```



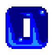
The index part of the argument can contain a list or range of image indexes to be duplicated N times. For example duplicate the whole list twice to create three times the original number of images...

```
magick font_[0-4].gif  -duplicate 2,0--1  +append seq_dup_list.gif
```



A Patrol Cycle type of animation list is also easy to create by using an image list that is reversed.

```
magick font_[0-9].gif -duplicate 1,-2-1 \
        -set delay 50 -set dispose previous -loop 0  seq_reverse_anim.gif
```



Note that I did not copy the whole image list, but skipped copying the very first (`0`) and last (`-1`) image, making the image indexes `-2` to `1`. If your version of IM is older than v6.6.8-7, you can still generate duplicate images, Clone Image Operator, but only one set of images at a time. Or by using a technique that basically mis-uses the Color Morph Operator, generate multiple duplicate images. The trick is to first make one clone to generate two identical images, then use "`-morph`" to generate in the last N-2 images between them.

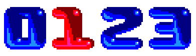
```
magick font_7.gif \( +clone \) -morph 3  +append seq_dup_morph.gif
```

Note however that by mis-using the Color Morph Operator the images are actually being processed, as such it takes time for morph to actually process the images (producing no change). Also the images created will contain actual copies of the original data, and are not simple, memory saving clones.

Combining Image Sequence Operations

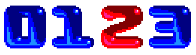
Using these operators, you can extract a copy of a specific image, modify it, and return that image back where you got it from. For example, here I make a "`-clone`" of the 2rd image (image index '1'), rotate the images colors from blue to red, then replace the original image with the modified one by first "`-delete`" it and "`-insert`" the new one.

```
magick font_[0-3].gif  \( -clone 1  -modulate 100,100,166 \) \
        -delete 1  -insert 1    +append seq_update_1.gif
```



Another way that seems to have become more common is use "`-swap`" to replace the original image, then "`+delete`" the old image that is now on the end. This only requires you to give the image position twice, instead of three times. Once to clone, and once to replace the modified image.

```
magick font_[0-3].gif  \( -clone 2  -modulate 100,100,166 \) \
        -swap 2  +delete     +append seq_update_2.gif
```

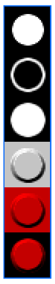


These techniques are continued below in the next section on Complex Image Processing and Debugging.

Complex Image Processing and Debugging

Thanks to the addition of Image Sequence Operators (see above), you no longer need to process images one step at a time, saving the image and re-reading it again each time. Instead you can now simply hold the intermediate image in memory and continue processing it. This saves a lot of time, both in the converting of images to a file format, and in the actual IO to save the image to slow disk. This type of image processing commands can become very long and complex. As such it is better to write the command in scripts, and try to place each major operation on a line by itself for easier programming and editing. See Hints for Better ImageMagick Shell/PHP Scripts.
For example, here I go though a whole complex processing sequence to generate a red button on a black background.

```
magick -size 30x30 xc:black -fill white  -draw 'circle 15,15 5,15' \
        \( +clone -shade 110x90 -normalize -negate -alpha Off \) \
        \( +clone -clone -2 -compose Plus -composite \) \
        \( -clone 0 -shade 110x50 -normalize -alpha Off \) \
        \( +clone -gamma 1,0,0 \) \
        \( -clone 2,-1  -compose Multiply -composite \) \
        -append  seq_process_fx.gif
```



Each line of the magick command generates a new image, except the last line where I just Appended all the working images together to output the results of all the processing steps, rather than just the final image. This technique lets you follow what each step (wrapped in parenthesis) the very complex command produced, and allows for easier debugging of each step in of a process. Note how it only uses the initial image's size and shape to generate the initial shape of the button, so you are free to use any shape or image you like! The rest of the command will process it just like before. Of course you would normally Delete all the temporary working images. That is, I would replace the last line in the above with something like this...

```
        -delete 0--2  seq_process_result.gif
```

Other ways of checking the results is to pipe the result into the display command, so as to view the results on screen, instead of save it to an image file. That is, use something like this for the last line...

```
        +append  miff:- | display -
```

Alternatively instead of "`display`" you can use '`show:`' which will display the resulting image on screen, and then allow the original command to continue or exit. See Show, Display Image Output for more information.

```
        +append  show:
```

You actually don't even need the "+append", in which case IM will show each image in sequence, by pressing 'spacebar'. You can even get fancier by using "montage" command to view the results in a nicer way...

```
        miff:- | montage - -bordercolor blue -border 1 -geometry +2+2 show:
```

This type of image processing also allows for easy viewing of intermediate images, immediately the image has been created. Basically you can insert lines this in between "`\( ... \)`" statements.

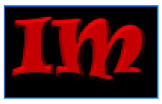
```
        \( +clone -write show: +delete \)\
```

IM will automatically continue processing once that intermediate image has been output for display purposes. See Show, Display Image Output. Alternatively, by inserting this line instead, you can display all the current images generated so far at that point in the processing...

```
        \( -clone 0--1 -append -write show: +delete \)\
```

After you have the image processing steps debugged and settled then you can optimize the code, so that you don't use as many parenthesis steps, as well as fewer Cloned Images, and resulting in less intermediate images to Delete at the end. Remember also that "Image Composition", and or "Layer Flattening" merges multiple images together, to leave just the one resulting image, which can reduce the overall number of intermediate images in memory.

```
magick -font Ravie -pointsize 48 -background black -fill white \
        label:'IM' -bordercolor black -border 5  seq_label.gif

magick seq_label.gif -alpha Off \
        \( +clone  -shade 110x90 -normalize -negate \
           +clone  -compose Plus -composite \) \
        \( -clone 0 -shade 110x50 -normalize -gamma 1,0,0 -alpha Set \) \
        -delete 0 +swap  -compose Multiply -composite  seq_button.gif
```



The ability of ImageMagick, to process any image, in a standard, programmed, and automated way, using multiple steps all in the one command is what makes IM such a powerful tool. You can script up a very complex operation, then apply it to many images. Image list operators, and parenthesis just made IM an order of magnitude more powerful, allowing you to write more complex image manipulation programs, with fewer commands. For another example of scripting a complex images process together see the example Scripted 3-D bullets from Shapes. Also see Hints for Better ImageMagick Shell/PHP Scripts, on ways of improving your image process scripting, both for easier editing, understanding, and for others to be able to follow what you have done.

Image Meta-data: Attributes, Properties and Artifacts

So far we have look at images and the actual content or data that makes up the image. But images are more than just 'image data'. There are many attributes or meta-data that is also part of an image, and affect its image processing and how other programs should handle the image. For example an image could have an 'offset' or be part of a larger 'virtual canvas' (page). That is, a single image may only be a small part larger picture, made up of a series of other images, to form 'layers' or and 'animation'. IM also attaches has a lot of special 'settings' that is used by many image processing operators to modify how they work. For example, the 'background color' to use. Some of these are global setting, which are the same across a whole list of images, while others may be different for each image within the list. So what sort of things are also part of an images? Lots of things...

- Image meta-data that are typically (though not always) saved with the image in image file formats. For example: profiles, labels, captions, and comments, and virtual canvas information (page). These are all per-image settings, and can be different for each image in the current image list.
- Global settings used by many different image processing operators, but generally not save with the image: Colors such as background, bordercolor, fill, and mattecolor, also font, and pointsize, gravity, compose method, color channel handling, read/write bit depth of color values.
- Expert settings and defines, used to control the deeper lower level operation of specific image processing operators. For example: distortion viewport, special compose method arguments,
- How the image is actually to be stored in memory within ImageMagick: for example as RGB or CMYK. Whether an alpha channel is present, and enabled or not, also the palette an image might have had when read in. However some of these storage settings are hard coded at compile time (such as in memory color value Quality).

- Some general IM operational settings, such as debugging or verbose settings, typically controlling information output or error handling.

That is, a lot of information that can be saved, and/or affect how images are processed. And while they can fall into a number of groups, how well ImageMagick handles each of these things and if they are global, or image specific, depends a lot on the specific thing involved. Yes I am being vague, because until you get to specifics it is very hard not to be. It can also be very confusing. All these values are stored with the in memory images in three different ways...

Attributes
These are stored as special data structure items for each image, generally so as to allow fast and direct access by the various image processing operators. For example: image size, virtual canvas geometry, background, fill, stroke, matte colors, pointsize, density, font, compose, interpolate, virtual-pixel method, profile blocks, time delay and disposal settings; and many more things. Note that some of these are 'specific' to each image, while others are treated as a 'global' setting that is set to the same value across all images by the CLI interface, even though they are still stored as part of each individual image. Attributes are typically modified using the many options, as part of the normal image processing, or more generally using Set.

Properties
These are a freeform set of key-value strings that are attached to each image on an individual basis. Each image can have a completely different set of strings. Essentially they are meta-data items that do not need to be accessed or decoded regularly, or are used in some special way. Typical examples of this are: label, caption, and comment strings; creation and modified dates; user defined strings; results from some operators. Users can use Set to set or change these, as long as the 'key' does not correspond to some known 'attribute'.

Artifacts
This is a global set of freeform strings that is common across all images. It is used to hold freeform global settings that define or modify the reading and image processing of all the images. An example of which is the "`verbose`" setting that causes some operations to output general information about there actions, including more verbose magick identify output. Users can modify these global values using Define (see below), or with a special case of the Set, (see Using Set "Option:" to Define and Artifact).

Understanding these three storage methods is the key to knowing how settings and meta-data handling works within ImageMagick. And allow you to do some very advanced and normally difficult to achieve image processing techniques.

Setting/Changing Image Attributes/Properities

Simple Meta-data are image attributes that are often have the greatest importance to image processing. So important they are decoded and made available in the image data structure to allow fast use by image processing operators. Such data is generally modified in two ways. A direct changing of the image meta-data as an image is read or created. Or as a modification of meta-data to an image that is already in memory. **For example,** "`-label 'string'`" will set the comment in every image that is read in or created *after* that setting has been set. However "`-set label 'string'`" will change the 'label' meta-data of all images the current image list, already in memory. The reason for the two methods is due to historical backward compatibility and convenience. Basically "`-label`" has traditionally been set BEFORE the image it is applied to has been read in. It only affects the images that are read in (or created) *after* it has been set, or changed. For example....

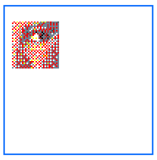
```
magick -label one  image_one.png \
        -label two  image_two.png     output_image_list
```

On the other hand "`-set`" operator changes ALL the images that are in the current image list, including the ones previously read in. Thus you must generally use parenthesis to limit what image you are applying the option to, unless you want to apply it to ALL the images read in so far.

```
magick \( image_one.png -set label one \) \
        \( image_two.png -set label two \)  output_image_list
```

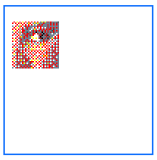
You can un-define the setting using "`+label`", in which case the label meta-data will be left alone as the image is read in or created. If the image read in also doesn't have a label, IM will fall back to some logical default. For label that is just the empty string. You can see more detailed and specific examples of both methods Montage Labeling of Images which make heavy use of this for labeling purposes. This 'duality' of setting image meta-data, also exists for other options. This includes... "`-comment`", "`-caption`", "`-page`", "`-dispose`", and "`-delay`". The virtual canvas size and image offset setting (page) however also has a third method, using a special operator "`-repage`" (see Virtual Canvas below).
For example, here I use all the setting methods available to set the 'virtual canvas offset' or 'page' of the individual images, as I create a Animation from them...

```
magick -delay 100 -dispose Background \
          -page 100x100+5+10  eye.gif  \
          -page +35+30        news.gif  \
          \( storm.gif  -set page +62+50 \) \
          \( tree.gif   -repage   +10+55 \) \
        -loop 0  animation_page.gif
```



As you can see the traditional (non-set) method is simpler when creating multi-image list from separate image files. But "-set" or the specialized "-repage" operators are better when you need to change an image that has already been read into memory, or was created by come complex image processing methods. For example to change the image offset of the third image (image index '2', or the 'tree') in the last example...

```
magick animation_page.gif \
        \( -clone 2 -set page +55+10 \) -swap 2  +delete \
        animation_mod.gif
```



For a more extreme example of extracting and modifying individual images in a image list see Frame by Frame Modification of an Animation. Here is another example using "-set" to specify a comment on all the images, and then modify one specific image.

```
magick xc: -duplicate 9 \
          -set comment 'T minus %[fx:n-t]' \
          \( -clone 7 -set comment 'We have ignition!' \) -swap 7 +delete \
          -format "image #%p : %c" info:
```

```
image #0 : T minus 10
image #1 : T minus 9
image #2 : T minus 8
image #3 : T minus 7
image #4 : T minus 6
image #5 : T minus 5
image #6 : T minus 4
image #7 : We have ignition!
image #8 : T minus 2
image #9 : T minus 1
```

You can use "mpr:", as an alternative way of setting attributes to in memory images. For example, here we take an image with a 'Bad' comment, that is in memory, and replace the comment with a 'Good' one...

```
magick -comment 'Bad Comment' rose: \
        -write mpr:rose +delete \
        -comment Good   mpr:rose  rose.jpg


magick identify -format "image comment = %c" rose.jpg
```

```
image comment = Good
```

This works, but is extremely awkward and painful to use, especially when dealing with multiple images such as an animation. In fact this is the only way to change meta-data in images in IM version 5. (Yuck!)

General Global Attributes

Under Construction

```
Most of these attributes are generally set globally either before or after
reading images into memory (it makes no difference).  They are typically used
as a general control of the later image processing operations.

 * Many settings are simpley globally saved for use as needed
     -fill  -background  -bordercolor  -strokecolor  -mattecolor  -quantize
     +dither  -channels  -size  -gravity  -units  -density  -font  -pointsize
     -tile

 * Some settings affect the way an image is saved to disk, or the meta-data
   saved with the image.  This includes
     -loop  -compression  -quality  -depth
     -density  -background
 * -compose is awkward, as it can only be set globally. But if unset
   then individual images can have a different setting (for layering).

   Most of these however can be turned off, (using a + version) which
   causes the operator to retrieve the setting from image meta-data
   (eg: +background falls back to the original images meta-data if present)
   but more generally it falls back to some default value. (eg:
   +gravity falls back to 'None' to mean no gravity has been set).

   A few of these also get saved with images when written. Specifically
   the GIF format will save an the -background and -bordercolor as part of the
   images attributes, however these are normally ignored by programs which
   read these images.

You may have noticed that some settings are used in multiple places.
for example  -density

  * used in reading in many vector format images like
    Postscript, PDF, and WMF image formats.
  * also in special image generators such as label: caption: and text:
  * used as part of font drawing in -annotate -draw and -polaroid  operators.
  * And finally some formats save the density or resolution as part
    of the the image file format. For example postscript wrapped raster
    images, JPEG, and TIFF.

Is it any wonder then why settings can be so confusing.
```

Virtual Canvas, and the Page and Repage Operators

The 'page' or 'virtual canvas' settings primary purpose within IM is to define how a the 'real' part of an image, (the part that actually contains color pixel data), fits in a larger context of a 'canvas'. This is especially important when multiple images are involved and need to be positioned relative to each other for Layers of Multiple Images and in GIF Animations. It is also used, (and hence its name of the term 'page') to define where an image fits on a larger physical piece of paper or 'page', in Postscript or in generating image of a 'page' of Text. While it is most often used for Layers of Multiple Images and in GIF Animations, it is also involved with remembering the original positions of images when Cropping, and Trimming Images, as well in Multi-Image List Composition, and in General Image Distortions. Now the 'page' defines two separate parts: a 'virtual canvas' or area, defining a larger space in which the image exists, and the 'offset' or location within that 'canvas' where the actual image is positioned.

While negative 'offsets' are allowed, the 'canvas size' is limited to an area from 0,0 to the given width and height. That is, only a positive canvas can be specified.

These two aspects, 'size' and 'offset' are closely related, but usually you want to handle these aspects separately, or in a more controlled fashion. So in addition to the normal "`-page`" and "`-set page`" methods, a separate option "`-repage`" has also been provided to allow a finer control. Specifically...

+repage
Without and arguments, will reset the image virtual canvas to the actual image itself. That is, just clear any virtual canvas information that the image may have. This often important after applying the image sub-diving operators such as Cropping, and Trimming. It is especially important in removing virtual canvas size and offsets before saving to the GIF or PNG image file formats, as many browsers use the canvas/offset information as part of the image display.

-repage WxH
Change the existing images virtual canvas size, but do not reset the image position on that canvas. Note supplying this argument to either "`-page`" or "`-set page`" will reset the images location to '`+0+0`' which is probably not wanted..

-repage +X+Y
Just move the image on the virtual canvas to this absolute location without changing the images canvas size.

-repage +X+Y\!
Do a relative move of the image on the virtual canvas by adding the given numbers (positive or negative) to the images existing offset position.

-repage 0x0
Attempt to find the best virtual canvas size that contains the whole image. This however will fail for images with a negative offset as there is no way to specify a virtual canvas with negative components. To avoid problems it will use the size of the actual image as the smallest canvas size possible. That is, it will never assign a virtual canvas with a zero dimensions.

-repage 0x0+X+Y
Move the images offset, then resize the virtual canvas to best fit the images new location.

-repage 0x0+0+0

Equivalent to a "+repage" or "+set page" or a "-set page 0x0". All virtual canvas and offset information is removed.

-repage WxH+X+Y
Equivalent to a "-set page WxH+X+Y". That is, just assign the given values directly.

Note the use of a '!' flag will make the given offset a relative displacement to the images current offset. That is, a '-repage +5+0\!' will move the images offset 5 pixels to the right, without modifying the virtual canvas size. It is currently not posible to directly specify a relative resize of the virtual canvas size. However it can be done by using FX Percent Escapes. But this is not commonly needed. One example is given in Trimming with a Specific Color. Caution is required in giving an image a final negative offset position as the GIF file format can not handle this, and resets it to zero if negative. Also some browsers go crazy when given PNG images with negative offsets. What virtual canvas information is saved with an image is format dependent.

JPEG Like many image file formats, JPEG images do not save virtual canvas information at all. The information is just ignored and lost.

GIF The size of the virtual canvas and offsets will be saved as part of its GIF animation handling. However it will not handle negative offsets. Any negative offset will be reset to zero on save.

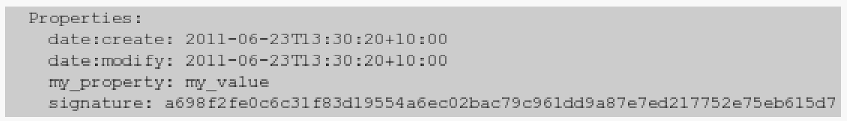
PNG Offsets and even negative offsets is saved, but the PNG file format does not normally save the virtual canvas information. However PNG images saved by IM will include the virtual canvas size information, but is only used by other IM commands. If IM does read a PNG image without this IM specific attribute, it will set the image virtual canvas to an appropriate size to ensure the image is visible on the virtual canvas (as per a "-repage 0x0"). For images without an offset that means the virtual canvas is the same size as the actual image.

Some formats like GIF and PNG save virtual canvas information, others like JPEG do not. All of the above formats have there own limitations for virtual canvas information. Only the internal MIFF file format does not have any such limitations. Note that "-page" has special meaning for "text:" and "ps:" image generator operators (See Text: Multi-line Text Files and PS: Postscript formatted Text and Graphics). As such its normal canvas size and offset meaning are not used during the creation of these images.

Set and Per-Image Properties

However IM can not make an option for handling every possible setting that an image can have. That would be just impossible. Not only that users often like to add or define their own settings. Because of this the "-set" option can actually define ANY setting with ANY value. If the setting is not a specifically known attribute of an image (to be saved in a way to allow fast acceess by operators), it is saved into the image as a '**Property**' (an array of strings), and will be listed near the bottom of a verbose "magick identify" output, or retrieved and expanded using Percent Escapes. The built in rose image for example automatically generates three 'properties': two date strings, and a 'signature hash'. To this I have also added my own user defined 'property' setting.

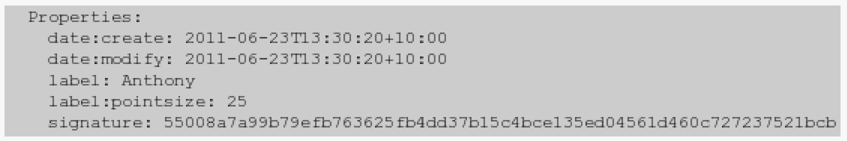
```
magick rose:  -set my_property my_value   -verbose info: |\
  sed -n '/Artifacts/q; /Properties/,$ p'
```



```
  Properties:
    date:create: 2011-06-23T13:30:20+10:00
    date:modify: 2011-06-23T13:30:20+10:00
    my_property: my_value
    signature: a698f2fe0c6c31f83d19554a6ec02bac79c961dd9a87e7ed217752e75eb615d7
```

Some image processing operators even return values of special interest as image 'properties'. They are not needed by other operators, so are not stored as a 'attribute', but are saves as a 'property' string for posible use by the user. For example the final pointsize selected by a Best Fit Label, will be saved as a special image property.

```
magick -size 100x label:Anthony  -verbose -identify  property_label.gif |\
  sed -n '/Artifacts/q; /Properties/,$ p'
```



```
  Properties:
    date:create: 2011-06-23T13:30:20+10:00
    date:modify: 2011-06-23T13:30:20+10:00
    label: Anthony
    label:pointsize: 25
    signature: 55008a7a99b79efb763625fb4dd37b15c4bce135ed04561d460c727237521bcb
```

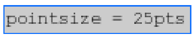
Note that the label: generator itself also sets a 'label' attribute, which happens to be saved as a property string.

All 'properties' are saved as a free form string data type, and stored as image meta-data.

Because of this, not all 'attributes' are saved as 'properties', as many attributes need to be saved and used directly as numerical data by image processing operators. An example of this is the virtual canvas 'page' attribute.

Here I use an identify "-format" setting to get IM to output the pointsize of the label it created and discarded.

```
magick -size 100x label:Anthony \
        -format 'pointsize = %[label:pointsize]pts' info:
```



```
pointsize = 25pts
```

Using this information to generate a new label image is trick and will be looked at below. One of the most useful user defined settings you can use is the "`filename:`" setting. For example...

```
magick rose: -set filename:my_area '%wx%h' 'rose-%[filename:my_area].png'
```

The above will generate an image named "`rose-70x46.png`". Only user defined settings prefixed with the "`filename:`" string can be used inside the output filename, as a security measure, though any name can be used. For more examples of this see Filename Percent Escapes.

Define and Global Artifacts

Defined values are known as '**Artifacts**' and are defined globally across all images, and are set using the special "`-define`" operator. The primary purpose of such '**Artifacts**' are as special settings that can be used as extra (or out of band) settings by *Image File Format Coders*, or *Image Processing Operators*. Basically it allows the addition of free-form settings for specific requirements without needing to create another 'attribute'. Also being globally set, they are not attached to specific images, but to all images in an Image Sequence, and are available when no images have been read in or created yet.

Note that API's can have multiple image list, with different sets of 'artifacts' attached, but the command line interface (CLI), only has one active image list, as such 'artifacts' really are global.

In other words 'defined artifacts' provide a way for expert users to modify the normal or standard operation of specific operators, beyond normal argument usage. For example, JPEG Coder Settings, for both Reading and Writing such images...

```
-define jpeg:size=300x200
-define jpeg:preserve-settings=1
-define jpeg:optimize-coding=true
```

Image Distortion Options, such as...

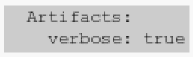
```
-define distort:scale=2
-define distort:viewport=44x44+15+0
```

Resize Filter Controls, such as

```
-define filter:blur=0.75
-define filter:support=1.25
```

Some artifact defines have shortcuts because they are used very regularly by users. For example the "`-verbose`" operational control (see below), is really equivalent to using "`-define verbose`", and thus creating a '`verbose`' artifact. For example...

```
magick xc: -verbose info: |\
  sed -n '/Tainted:/q; /Artifacts:/,$ p'
```



```
  Artifacts:
    verbose: true
```

It follows then the plus form "`+verbose`" just removes the '`verbose`' artifact, and is thus equivalent to "`+define verbose`".

Artifacts and Delayed Percent Escapes

Artifacts are also often used to hold special attributes that should be assigned to images that are read in, after the define has been given. The "`-label`" setting also just sets an artifact with the argument provided by the user. This artifact is then converted into a '`label`' Setting or Propriety after a new image has been read in or created. For example creating a "`rose:`" image with a label set

```
magick -label "%wx%h"  rose: -verbose info:  |\
    sed -n '/Tainted:/q; /Properties:/,$ p'
```

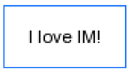
```
 Properties:
   date:create: 2011-06-23T13:30:22+10:00
   date:modify: 2011-06-23T13:30:22+10:00
   label: 70x46
   signature: a698f2fe0c6c31f83d19554a6ec02bac79c961dd9a87e7ed217752e75eb615d7
 Artifacts:
   label: %wx%h
   verbose: true
```

That is, "-label" first defined the 'label' artifact shown. Later when the rose image was created (and its size attributes was known), IM converted that global artifact into an image specific 'property' and only then expanding any Percent Escapes at that time. This is known as a Delayed Percent Escapes. The same thing happens with a few other setting options, such as "-comment" and "-caption" as well. It is because of Delayed Percent Escapes that "-define" will only save the strings, while the "-set" operator will do the expansion.

Using Set "option:" to Define an Artifact

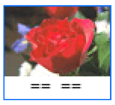
We showed above how you can "-set" special purpose personal Proprieties, on a per-image bases. For example...

```
magick -size 80x40 xc:  -set myinfo 'I love IM!' \
        -gravity center -annotate 0x0 '%[myinfo]' \
        property_annotate.gif
```



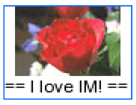
But as Proprieties are attached to specific images, you can't use them in the creation of new images. For example this will fail...

```
magick rose: -set myinfo 'I love IM!'  label:'== %[myinfo] ==' \
        -gravity center  -append   property_append_fail.gif
```



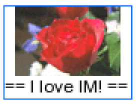
As you can see the 'myinfo' property was for found or included in the appended label. On the other hand globally defined Artifacts are available to the image generators. They have to be so that the image generators or image file coders can read them for various control settings. As such as using a "-define" will work as expected.

```
magick rose: -define myinfo='I love IM!'  label:'== %[myinfo] ==' \
        -gravity center  -append   artifact_append.gif
```



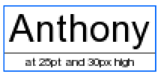
So how can use you create a label using an image property or attribute? The "-define" option does not currently allow the use of image properities! The trick is to use a special prefix "option:" when using the "-set" option. This addition causes "-set" to define a 'artifact' with the name that follows the prefix. For example, this is equivelent to the last example.

```
magick rose: -set option:myinfo 'I love IM!'  label:'== %[myinfo] ==' \
        -gravity center  -append   property_option_append.gif
```



More importantly the "-set" option will expand Percent Escapes. Which means if we have some per-image Propriety, we can magick it to a global Artifact. For example, here I create a label, then magick the 'label:pointsize' property the "label:" image generator created, into a global artifact 'my_pointsize'. As an artifact, this information is available when I create a second label image. I then append the two labels together (with a separating 'gray' line). *A very tricky example*.

```
magick -size 100x -gravity center label:Anthony \
        -set option:my_pointsize '%[label:pointsize]' \
        -set option:my_height '%h' \
        -size 100x1 xc:gray \
        -size 100x label:'at %[my_pointsize]pt and %[my_height]px high' \
        -append  property_append.gif
```



Note the placement of the "-set option:..." in the above. If you were to place it AFTER the creation of the "xc:gray" it would be that image that would be used to set the global artifact. That is, because only the properties of the last image define the value stored in the global artifact. The reason is that only the last image is used to define the artifact. Actually what realy happens is that "-set" is applied to every image in the current image list, even though it is generating a globel artifact. As such each image will assign its own properties into the global artifact, replacing the previously assigned values. When finished, only the last image will have 'defined' the artifact.

⚠ *At this time the 'FX escape' has no way of reading properties or artifacts. And as such you current can not do arithmetic on such values.*

Image Type when Reading and Writing

The "-type" operator/setting defines the style or color space to use when an image is being read in or written out, to ensure the resulting image (in memory, or in the image file) is what you expect it to be. As part of this, it may do some Color Space modifications at the time of the file I/O, though only to ensure the image is in a form that was expected. For example "-type" has a special 'bilevel' setting that can be used magick and save images as a two color monochrome image for some image formats. Similarly 'TrueColor' and 'TrueColorAlpha' can be used force a TIFF image to be saved as a full color RGB image even if the image is actually purely gray-scale. Other settings include 'GrayScale' and 'GrayScaleAlpha' which will ensure the written image is gray-scale only (without or with transparency, respectively). Or 'Palette' to force the use of an indexed color map in formats that support this option. During reading of image file formats, a "-type" setting of 'TrueColorAlpha' will force a JPEG image being read, to have a 'Alpha' channel added to its in memory storage, even though the JPEG format itself can not handle transparency. When writing to a PNG file format setting a "-type" of 'Pallette' will force it to use a color indexed "PNG8' internal image format. Simularly using "BiLevel" will force IM to dither color images to black and white for most image file formats. Unfortunately the exact meaning and capabilities of "-type" depend on the specific image format you are reading or writing. See the various Image File Formats example areas. For specific PNG examples see PNG output formats.

Controling the Quality of Images

Depth - File Format Bit Depth

Quality and Depth are two terms are often talked about in Mailing Lists and in these example pages, so I'd like to explain them a little. *Quality* is a compile time setting in ImageMagick, and is used to determine the size of the values use to store images in IM memory and during processing. Basically it means the **Quality of Processing** that a specific IM was compiled for. The *Depth* is the size of the values used when an image is either read or saved to/from an Image File Format. It is as such more highly variable. and controlled by the "-depth" setting, or by the original 'depth' of the image that was read in. More on this in a moment. Remember...

Quality is 'in memory' value size, and is compiled into IM.
Depth is file format value size, and is variable.

Now most image formats are of depth 8. That is, they use 8 bits (or a value from 0 to 2^8-1) to hold each color value used in the image. That is a value of 0 to 255 for red, 0 to 255 for green, and 0 to 255 for the blue channel. More usually this type of image is referred to as 24 bit images (that is "bits per *pixel*", NOT "bits per *value*" as used by the "-depth" setting). This includes such formats as such as JPEG). If the alpha channel is also involved than you get 4 x 8 bit values, or a 32 bit/pixel image. This is what a PNG image will typically use, though such images can also save using 16 bit per value too. What a lot of people refer to as 8 bit images (8 bit/pixel), are really images with an 8 bit palette or color map (giving a maximum 256 color limit over the whole image). The actual pixel data is a 8-bit index value (0-255) which is then used to look up the color for that pixel from the color table. That is the 'raster' (pixel array) is just an index used to lookup the actual pixel color from a separate table of colors. In other words while an 8-bit images also have a 8 bit depth, the 8-bit is an index into a color lookup table and not an actual color. GIF images are a good example of this. Transparency in such images are usually handled either by specifying a specific color as representing transparency (set using the "-transparent-color" meta-data setting) as in GIF format, or using a special profile for a specific number of colors in the color table, (as used by some PNG8 images (which is also a color imaged image like GIF). In general...

24 bit images are : 3 x 8 bit values - 3 color channels only

32 bit images are : 4 x 8 bit values - 3 colors + Alpha channel

8 bit images are : 8 bit color indexed image, with a 256 color limit

Because most image formats only save color values at an 8 bit/value depth, a lot of people have installed IM using a 'Q' or Quality level of depth 8, which requires far less memory and processes images faster than a more normal Q16 version of IM. Often 3 or more times faster. These Q8 versions work well for general image processing (cropping etc) and converting between formats, and can also work well for generating simple images, annotating, or overlaying images. However while a low quality IM is faster and more memory efficient, it does not work work well when you start using complex sequences of operations involving multiple color changes, resizing, darkening, lightening, gamma or histogram color correction, etc.. At Q8 the intermediate images in memory will remain stored as 8 bit quality, and thus multiple operations will each introduce small incremental color distortions. The result can be rounding effects, especially for extreme colors near white and black. (see below).

Quality - In Memory Bit Quality

Remember, *Quality* is a compile time setting in ImageMagick, and is used to determine the size of the values use to store images in IM memory and during processing. It can not be changed, except by re-compiling ImageMagick from sources. A 'Q16' ImageMagick (the IMv7 default) thus will use at least twice as much memory to hold the same amount of image data as a 'Q8' version of ImageMagick, and depending on your CPU, be a lot slower, though on today's processors that is not very likely. Similarly you can compile 'Q32' and 'Q64' versions, though these are not very common, and are typically only used in very high end image processing. Also see the new HDRI compilation quality option below. A 'Q16' ImageMagick also allows you to save more bit information for each pixel value. That is, color values are saved as integers ranging in values from '0' to '2^*quality*-1'. That last value is known in IM programming as the current 'QuantumRange' (or the older obsolete name 'MaxRGB'). The higher the Quality Setting, used when compiling IM, the more precise the color values are when storing the image in memory. That means that if in processing an image you generate a lot of very small, slight variations in color, then those variations will be preserved in the in-memory storage of ImageMagick, and can be used in later processing steps. Operations such as resizing, noise filters, blurring, sharpening, averaging, global color, gamma, and histogram modifications, or lots of complex image composition operations, can all produce unwanted color errors in a Q8 IM, creating very distinct color artifacts on the resulting image. Of course saving the final image to a 8 bit 'depth' image format will 'quantize' those color values back to 8 bit, but during the processing of the image in memory, the intermediate quality of the image is preserved. Some formats are available that preserve the higher quality level information used by IM. For example the MIFF IM format, the enumerated pixel TXT format, as well as the NetPBM image formats. However while a Q8 version of IM it will let you output a 16 bit depth images, such image will still only have information equivalent to 8 bit depth as the quality is just not present in memory, to be saved.

If IM reads an image using 8 bit values (many image formats do), the images 'depth' will be set to 8 bit, and when saved IM will normally save the image at that same 8 bit value depth, even if you process the image using a Q16 version of IM. You can override this setting or clearing the "`-depth`" setting for that image, so IM will save it at the best depth posible for the image to match the IM in-memory quality.

Also note that many operators that generate extra colors such as Image Resizing, will also reset the 'depth' of the image in memory to the compile time quality setting, so that IM will then try to save it at a higher depth, if possible.

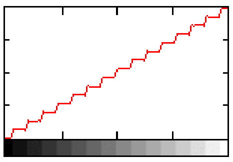
HDRI - floating point quality

HDRI, or High Dynamic Range Imaging, was originally designed to more naturally represent our eyes ability to see both bright and dark areas of a scene simultaneously. In practical image processing terms it does a lot more than that. A HDRI version of IM (the default build) is compiled to use a floating point values for images stored in memory, to allow you to perform more exact HDRI handling of image operations, so as to prevent such operations 'clipping' the image colors at the extremes. HDRI uses the same color range as the default compile-time Quality Setting for in memory storage. That is, values still range from '`0`' to the 'Quantum Range' as meaning black to white. But the values are saved using floating point ('`doubles`' in C programming terms) rather than integers, so that the 'quantum' effects from rounding off values into integers will not be seen. The values are also not 'clipped' when the values go beyond the 'Quantum Range' or into negatives. Basically you loose far less information between processing steps. HDRI is thus *vital* when you plan to use extremely heavy mathematical processing of images, involving the temporary use of negative values, or strong scaling to very small or very large values. It is especially important for users that want to make full use of Fast Fourier Transforms (FFT) capabilities, and it is here that you will see the most examples of a HDRI version of IM, in these pages. For information of compiling a HDRI version of IM see Enabling HDRI in ImageMagick on the main IM website, also for Windows and Ubuntu Linux specific information see Fourier Transforms Announcement Discussion on the user forums. One important operator that should be kept in mind when using HDRI is "`-clamp`". This option will clip the values in an image that fall outsize the normal range for images. That is, any negative value will be clipped to zero, and any value larger than 'QuantumRange' will be set to that value. It does NOT however 'round off' the floating-point values into integers.

Quantum Effects, HDRI vs non-HDRI

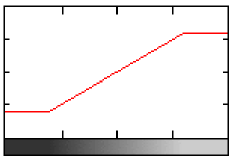
Quantum Rounding... For example, here I use the Level and the Reverse Level operators to compress the color range of a gradient image down so they only use the values from 0 to 15, then un-compress it again. The resulting gradient is also displayed as an image profile (using the script "`im_profile`") to make it easier to follow.

```
# Using a normal non-HDRI version of IM...
magick -size 20x600 gradient:  -rotate 90 \
        +level 0,15  -level 0,15  level_rounding.png
im_profile -s level_rounding.png  level_rounding_pf.gif
```



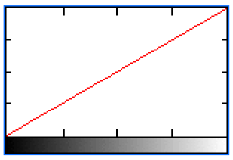
Notice the sever rounding (quantum effects) that is now visible, forming steps in the gradients profile. As only 16 gray-level values were used, you effectively converted the image to a color depth of only 4 bits! Note that this type of Quantum Rounding problem becomes very common in an IM Q8 version, just by doing multiple image processing tasks, beyond a basic resize, and cropping of images. Something that the more normal IM Q16 solves with its extra memory usage. Quantum Rounding only becomes a problem for IM Q16 when you use really heavy image processing such as, Fast Fourier Transforms (FFT) or merging of images containing different exposure times (light intensity) to generate High Dynamic Range Images. This is after all why HDRI was added to ImageMagick in the first place. **Burning and Clipping...** And here I 'stretch' the gradient so that the original black and white color values go well beyond the "Quantum Range", before being restored again.

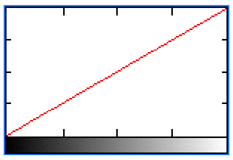
```
# Using a normal non-HDRI version of IM...
magick -size 20x600 gradient:  -rotate 90 \
        -level 20%  +level 20%    level_clipping.png
im_profile -s level_clipping.png  level_clipping_pf.gif
```



You can see that a normal IM looses the information at both ends. The lower end values gets 'burned' as values become negative, while the upper values become 'clipped' as they go beyond the maximum 'Quantum Range' limits of the integers used to store the values. **HDRI version of ImageMagick** result... Repeating these two operations using a HDRI version of ImageMagick will not produce any of the above rounding, burning, or clipping of the results, but will have an extra cost in terms of memory (doubles need more space than integers). Speed wise, it does not cost much, and may actually even be faster on many of today's modern computer hardware, due to floating point accelerators.

```
# Using HDRI version of IM...
magick -size 20x600 gradient:  -rotate 90 \
        +level 0,15  -level 0,15  level_rounding_hdri.png
magick -size 20x600 gradient:  -rotate 90 \
        -level 20%  +level 20%    level_clipping_hdri.png
im_profile -s level_rounding_hdri.png  level_rounding_hdri_pf.gif
im_profile -s level_clipping_hdri.png  level_clipping_hdri_pf.gif
```



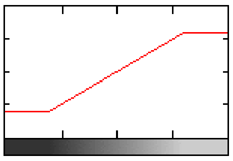


As you can see the gradient remains perfectly intact, even after heavy compression or stretching of the image and back again.

Clamp to Enforcing image bounds in HDRI

You can force HDRI image to be 'clipped' by the normal image value range by using "`-clamp`" between the two level options. For example...

```
# Using a HDRI version of IM...
magick -size 20x600 gradient:  -rotate 90 \
        -level 20%    -clamp    +level 20%   level_hdri_clamp.png
im_profile -s level_hdri_clamp.png  level_hdri_clamp_pf.gif
```



The use of "`-clamp`" in the above basically generated the same image as what I would have got with a normal non-HDRI version of ImageMagick. However this image would not be exactly the same as a non-HDRI result, as while "`-clamp`" will burn and clip the values in the image, it does not add quantum rounding effects. As such the values are only being rounded off to integers during the final save to a non-HDRI image file format. The "`-clamp`" option can be vitally important when using HDRI, to achieve the result you are wanting.

HDRI File Formats

Of course saving an image that contains very small, large or negative values into a normal image file format will also be clipped, quantized, and even color reduced, for the same reasons as above. As such if you need to save images that have not been 'normalized' back into a 0 to 'Quantum Range' scale, then you will need to use one of the rare floating point image file formats. Some image formats that can handle floating point values (without clipping or rounding) include, NetPBM PFM. This is the only image file format that does not require any extra special options.

Other image file formats can also be used, but require a special switch to specify that the file is to save floating point values. Specifically you need to specify the coder option "**`-define quantum:format=floating-point`**" to request floating point values in these file formats. The "`-depth`" setting can also be used to define what type of floating point values are used. If "`-depth 32`" or less (the default in most versions of IM) is used then normal "floats" are used. But if "`-depth 64`" is set then "doubles" are used for the floating point data written to, or read from, the image file format. The image file formats that can use with this special flag to save floating point values include... TIFF, FITS, and MIFF. The raw data file format RGB will also save (and read) floating point, though that format does not save image size, and you need to specify the floating point settings for reading too.

Another special coder option is is "`-define quantum:scale=65535.0`". This will be multiplied with value read from the image file, so as to scale the value from a normalized floating point value of 0.0 to 1.0, into the internal value range of 0.0 to 65535.0. So if you get a near pure black image when reading a floating point image, try adding this option to scale the values being read into the appropriate range.

The direct memory-to-disk file format MPC, will also save floating point values used by a HDRI version of IM, and will not need any special flags. But as with any MPC image file, only the exact same version (specific compilation) of IM on the same machine will correctly read such a file. As such it is only good for temporary 'quick read' files for scripted image processing, and not for long term storage.

What Q-level should I use

In summery what type of ImageMagick should I use? Q8, Q16, HDRI? **Q8** has a smaller memory foot print, as image values are saved in memory as 8 bit values, just like most image file formats. For basic composition, image format conversion, simple 'once off resize', or drawing on images, then Q8 is 'good enough'. **Q16** doubles the memory foot print as color values are saved in 16 bit values (higher precision). But if you plan on doing heavy image processing involving many levels of operations, such as 'color space changed (even just sRGB to/from RGB), resize, distortions, blurring, shadows, etc etc all to the same image, in the same command (which is recommended for the same reason), then having 16bit is better as it will preserves the lower precision of the images between processing steps. You can also then save in 16bit file formats (PNG, MIFF, PbmPlus) between commands, even if the final save is back to a 8bit image file format like ICO and JPEG. (This is the default for this reason) The next level is **Q16 HDRI**, that takes precision to 32 bit floating point values which allows you to deal with image values that become very small or very large without the rounding and clipping effects of images. You can even deal with negative values, especially in some colorspaces. Essentially it is used to prevent image data loss when processing images in extremes such as when using HDRI images, Fourier Transforms, or just high levels of compression, expansion you may get in mathematical processing of raw data. That is, it in a nut shell. Q16 is good middle ground for most operations involving distortions and multi-image compositions and image processing effects. Q8 if memory is tight but you are only doing simple operations, HDRI is you are doing extreme operations.

Image Density or Resolution

The *Density* of an image is the spatial (space) resolution of the image. That is, the density (generally expressed as dpi, or dots per inch) of an image define how far apart (or how big) the individual pixels, and thus the overall size of the image in real world terms, and generally used for display or printing of the image on a real world device. It is just some number stored with the image to tell output devices such as printers and displays how many dots (or pixels) per inch the image should be displayed at, OR for vector formats like postscript, PDF, MWF, and SVG the pixel scale to draw using any real world coordinates that may be used within the image. It is completely irrelevant to the actual images pixel size, or the in-memory Quality and save file format Depth that defines the color 'resolution' of the image. You can set the resolution or density of an image as it is being read into IM by using the "`-density`" function, *before* reading or writing the image, or using "`-set density`" after reading the image. A "`-units`" setting can be used to define if the density number is expressed in the default (traditional printing) terms of '`PixelsPerInch`' or in more modern metric units of '`PixelsPerCentimeter`' (PNG uses the latter). For example, a 200x200 pixel image at 600 dpi will thus be displayed in 1/3 inch square in real world terms. On the other hand a much smaller 72x72 pixel image at 72 dpi will display in a 1 inch square, in the real world, though its spatial quality will not be very good in comparison. The former being 'photo quality' while the later being 'display resolution'. In practical terms, a 72dpi image will look 'digital' or 'dotty' on a printer. On the other hand a large modern digital photo taken at 1200dpi image would probably need to be resampled to show it on a display, or you may only see tiny part of the image. For more information on Resolution and Density of images see the notes on the Resample Resize Operator. For information of Resolution and Density for Text and Fonts see Pointsize and Actual Font Size.

Photoshop and Density

The "Photoshop" image editor saves an extra copy of the images resolution into a separate profile (named '`8BIM`') in the image, which IM will NOT touch. Thus if you change the resolution of an image with IM, you probably should also strip the profiles from the image before loading it back into "photoshop", or you may not see any density changes.You can remove just that profile from an image using "`+profile 8bim`". From a IM Forum Discussion, Jesper Nilsson (aka *stroker*), suggests that you use the program "`exiftool`' to directly modify the Photoshop Tags of the image. For example

```
exiftool -g -Photoshop:XResolution=300 -Photoshop:YResolution=300 file.tif
```

Speed Tests based on Quality

Some speed tests were submitted to IM Forum, Q8 vs. Q16 speed (& HDRI). Rough results from the above article

- The amount of memory used per pixel per channel is as you would expect. Q8 - 1 byte, Q16 - 2 bytes, Q32 & any HDRI - 4 bytes, Q64 (HDRI) - 8 bytes.
- 64bit has significant precision improvements for floating point operations, but so does any other HDRI version of ImageMagick.
- Speed wise Q8, Q16 and HDRI all about the same speed (presuming computer has floating point MPU), Q32 about 25% slower and Q64 (HDRI) is about 50% slower.

Note that Q64 automatically uses "double long floats", rather than 64 bit integers. It is sort of a double precision HDRI, but while very precise is the slowest of all in-memory quality settings, and most memory intensive.

The actual speed will depend on your computer specifications, and if you have a Math Co-Processor or not. If it is not important using the default Q16, or standard HDRI, is probably best.

If it is important then you should do simular tests for speed, on your equipment, but using the operations you typically expect to use in your image processing.

ImageMagick Special Controls

IM also has a few special options that it uses to control its operational working, information reporting, and for debugging purposes.

-version
Output what version of IM, the image quality it is using, and when was it built. IM will implicitly exit after outputting this information.

In IMv7, "`-version`" will exit if it is the ONLY option on the command line. That is, it will make the final 'implicit write' argument, optional. If any other arguments are present, OR it was read from a script (file or pipeline), the magick command will not exit, but continue.

-list
This is an informational option only and will list the requested items, then exit. That is, you can not use this with any other option, or image processing. It is purely provides for informational purposes, especially in scripts to check input options and if IM has certain options implemented. The given argument defines what information you are wanting to list. For example a list of '`color`' names that you can use, (such as using by ("`-fill`", "`-background`", "`-mattecolor`", "`-bordercolor`"). While '`font`' lists the fonts that are specifically known to IM. Here are just some of the more interesting lists...

list	what lists can "`-list`" list!
font	Known fonts (IM also knows about X and PS fonts)
type	file image types ("`-type`")(after IM v6.3.5-7) or the font list (before that IM version)
color	known color names for various color options.
dispose	all the GIF disposal settings ("`-dispose`")
compose	alpha compositions are available (includes internal methods)
layers	what multi-image "`-layers`" methods has been implemented
distort	The image distortion methods available.
morphology	The image morphological methods available.
kernel	The morphological/convolution kernels that are available.
command	what command line options (both settings and operators) are available
configure	what were the configuration parameters used to build ImageMagick

That last 'list' setting '`Configure`' is very important, as it will tell you what libraries, and delegates were available when IM was built. It also includes the 'point' release number, which was missing from the normal "`-version`" output of older versions. (See Script Version Handling for one example of using this information. IM will implicitly exit after outputting this information.

In IMv7, "`-list`" will exit if it is the ONLY option on the command line. That is, it will make the final 'implicit write' argument, optional. If any other arguments are present, OR it was read from a script (file or pipeline), the magick command will not exit, but continue.

-verbose
Report extra info on some of the more complex operations.
For example "`-segment`", which outputs a lot of color quantization details.
And "`-distort`", outputting extra information and 'FX' equivalents to the requested image distortion. Also monitoring the number of changes when iterating a "`-morphology`" operation.This is especially useful for generating for more detailed image information from the "`info:`" and "`-identify`" outputs. You can turn off the setting using the 'plus' form of the option, "`+verbose`".

-regard -warnings
The '`-regard-warnings`', will make some informative warnings about some image file formats fatal. It also causes IM to return a proper exit status according to such error conditions. It can be used in scripts to 'sanitize' image file being provided from uncontrolled sources. That is, this option will make IM fail and exit, if when the JPEG or TIFF image was not correct, complete or contained 'unknown' profiles.

-precision *{number}*
Control the number of significant digits.
When IM outputs floating point values in response to various debugging, verbose, or formatting requests, this setting sets how precise you want that output. By default it will limit such numbers to 6 significant digits, but this operator will increase or decrease this default. The default setting of 6 can also be modified using the '`MAGICK_PRECISION`' environment variable. It affects output from...

- The verbose "`identify`" command or the "`-identify`", "`-print`" and "`-format`" settings.
- The '`debug()`' output from a "`-fx`" operator and the '`%[fx:...]`' string escape. (See FX, DIY Image processing Operator
- The floating point values of a "`-morphology`" kernel when "`-set option:showkernel 1`" has been enabled. See Displaying the Kernel.

-quiet
Don't report informational warning messages. Only proper errors such as I/O errors, or bad options, etc. This is especially useful for "`-crop`" or "`-trim`" and "`-layers optimize`" which normally report 'missed images' warnings, when the operator would produce no 'real' image as a result. This will also quieten the coders of

some complex image file formats that can contain 'unknown chunks' which IM would normally ignore. For example when IM is reading TIFF images, or strange MPEG (AVI) video formats.

-respect -parenthesis	Causes parenthesis to not only to save and restore the current image list but also all the current operational settings are saved and restored. Than means that when given, any settings set within parenthesis, will be reset when the parenthesis ends. See the examples in Parenthesis and Settings above.
-ping	For the "identify" command. IM will try to avoid completely reading and decoding the full image file format for basic information such as the images size.
-monitor	Report a percentage of processing during each stage of image processing, especially for very large or long image processing tasks. In a lower level API, you would use SetImageInfoProgressMonitor() or SetImageProgressMonitor()
-debug	Report verbosely exactly what IM is doing, in various areas. The argument is a comma separated list of options, such as...

exception	What is IM not understanding about the command
cache	See how much disk space IM is caching
configure	Show IM search attempts to find its configuration files.
trace	Report the trace points at the start of each library function
annotate	Report on font metrics when a font is used with "`-annotate`".
command	IMv7 -- show the command line options (or script) as they are being processed. EG: option processing.
all	Show every trace point during processing This is very very VERY verbose and not recommended

If "`-debug`" is used the location of the logging output is controlled by the "`log.xml`" file. This is by default set to "`console`". To have it save to a file change `<log output="console"/>` to `<log output="file"/>` For command line and API usage you can also define an environment variable to set the debug level using actions by IM.

```
export MAGICK_DEBUG=all
```

```
Limiting image size (quick note)

To prevent excess memory usage, set your memory limit to say 16GB. Now set
the disk limit to 4GB. ImageMagick will exit if the disk limit is exceeded,
with a "cache resource exhausted" exception.
```

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Examples Generated with:
URL: `https://imagemagick.org/Usage/basics/`