

# Split Processing

Last Updated: 14-May-2024

Note: the information in this document is preliminary.

# Contents

The Problem.....	3
Differential Processing of Subject and Background.....	3
Background Replacement.....	4
What is Split Processing.....	5
Overview .....	5
The Split Transformations.....	6
Split/Trimap.....	6
Trimap .....	6
White and Black Maps.....	7
Status Line .....	7
Split/Image.....	8
Trimap .....	8
Split .....	8
Split/Mask .....	8
Trimap .....	8
White Image .....	8
Black Image.....	8
Split Processing Workflows .....	9
Current Status .....	10

## The Problem

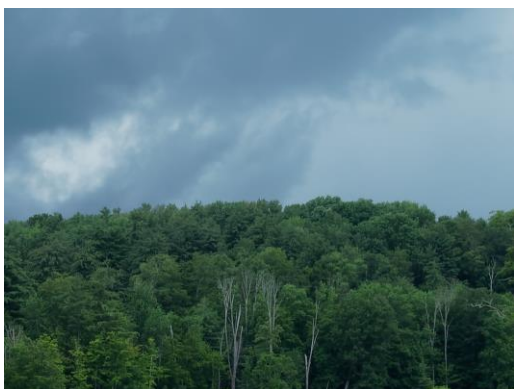
There are a couple of problems that arise from time to time when editing images that are difficult or impossible to solve without split processing.

### Differential Processing of Subject and Background

This photograph was taken on a day when a thunderstorm passed through, and the sky was dark and moody while the foreground river and trees were still illuminated by the sun.



While the image captures some of the drama of the lighting, I wanted to darken the sky even more and lighten the foreground to increase the contrast between the two. The first approach that comes to mind is to create a mask to isolate the sky from the rest of the image and apply different tonal corrections to the black and white areas of the mask. The first problem is that it is pretty much impossible to create a mask that cleanly separates the sky from the trees, especially on the left hand side. Even if we crop out the complicated parts of the boundary between sky and trees, another problem emerges when you use the mask to darken the sky and lighten the trees:





However, if you examine the boundary between the sky and the trees, you can see the transition looks unnatural.



This happens because even with a good mask, the edge pixels are a combination of subject and background and are not processed correctly. While you can feather the mask, the boundary will likely still have a light or dark halo or both.

### **Background Replacement**

If the boundary of the subject is complicated, with wisps of hair for example, it can be impossible to create a mask to fully isolate the subject from its background.

# What is Split Processing

Split processing is a term that refers to splitting an image into two regions – typically a subject and a background – so they can be processed independently and then optionally merged back together. This technique is an alternative to simple masking which can give rise to visible artifacts at the boundary between the two regions, no matter how carefully the mask is constructed, especially if the subject has a complicated edge. This problem occurs because pixels at the edge of the subject are contaminated with background and vice versa.

Split processing works best when the subject and background can be clearly distinguished by color and/or brightness. While it works best on color images, it can also be used on black and white images where there is adequate tonal separation between subject and background.

For example:

In portrait photography, to separate a person from their background so the object or person can be placed against a different background.

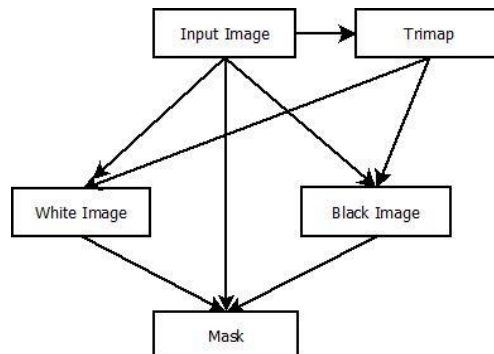
In landscape photography, to apply different operations to the sky and whatever is in front of the sky, such as trees, rocks, buildings, or mountains.

## Overview

The first step in applying split processing to an image is to create a so-called trimap. This is simply a mask for the image that is white for pixels that are definitely subject, black for pixels that are definitely background, and gray in the transition area at the edge between the subject and background. For the best results and the fastest performance, the gray transition area should be as narrow as possible.

The next step is to create a white and a black image. The white and black images are the same as the input image where the trimap is pure black or pure white, but the area where the trimap is gray is filled by extrapolating the subject or background. This step can be very slow and produce poor results if the area where the trimap is gray is too wide.

Finally, a mask is computed from the input, white and black images such that blending the white and black images via the mask comes as close as possible to the input image where the trimap is gray.



Once you have created a white image, black image and mask, you can process the white and black images separately and then use the mask to recombine them. Or you can process the subject (white image) and composite it onto a different image or background using the mask.

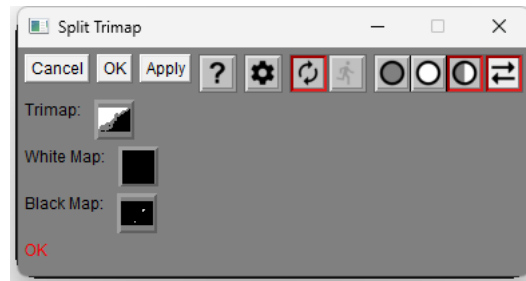
## The Split Transformations

There are three transformations within the Split submenu of the Transformation menu that correspond roughly to the steps mentioned above:

### Split/Trimap

This transformation lets you create and refine a trimap for an input image. The trimap separates pixels in the input image into three categories: subject, background and the transition area between the subject and background. The trimap is white for pixels that are definitely in the subject, black for pixels definitely in the background, and gray everywhere else. A really good trimap is key to getting good results from split processing. The more you can reduce the gray parts of the trimap, the better it works and the faster the white and black images are generated.

The Trimap transformation starts with an initial rough trimap and then tries to refine it by expanding the subject and background areas as much as possible so as to narrow the transition regions.



### Trimap

This Amount control lets you create the initial trimap. The general procedure is to first make the entire mask solid gray using the corresponding button in the Mask dialog box.

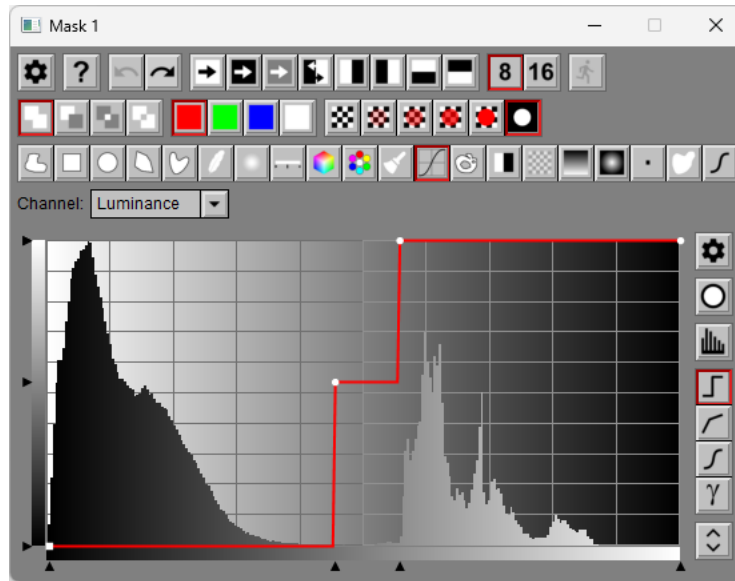


Next, use the freehand mask tool, the color range mask tool, or some other mask tool to make the mask white for pixels that are definitely in the subject. Then switch to subtract mode so you can identify the background pixels.



Now use one or more mask tools to make the mask black for pixels that are definitely in the background. This should leave the transition region between subject and background gray.

For images that separate cleanly based on brightness alone, a simpler way to create a trimap is using the Mask Brightness Curve tool. In this case, you use a stair-step curve to identify what parts of the image will be white, gray or black based on the brightness histogram of the input image.



Once you have created the initial trimap, Picture Window attempts to refine it, if possible, by adding pixels to the subject and background regions based on their color range. First it determines the color ranges of all the subject and background pixels in the trimap. Then, it examines each pixel in the transition region. If the pixel is within the subject range and outside the background range, the trimap is changed from gray to white. If the pixel is within the background range and outside the subject range, the trimap is changed from gray to black. For this technique to be effective however, the subject and background color ranges should not overlap.

### White and Black Maps

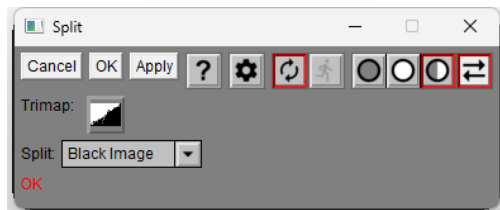
The optional white and black maps are masks you can use to further refine the trimap. In the case where the color ranges of the subject and background overlap, you can use white and/or black maps to help separate the ranges. If you specify a white map, the subject color range is determined just by the colors in the input image where the white map is white. If you specify a black map, the background color range is determined just by the colors in the input image where the black map is white.

### Status Line

Error messages are displayed in the status line if there is a problem with the trimap. If everything is good, OK is displayed in the status line.

## Split/Image

This transformation creates a white or black image from an input image and a trimap. The white or black images are copies of the input image where the trimap is white or black. Where the trimap is gray, the images are extrapolated to fill the gray region by starting at one edge and working toward the other edge. The current implementation of this transformation can be very slow if the trimap has a lot of gray pixels. Future versions may include significant performance enhancements.



### Trimap

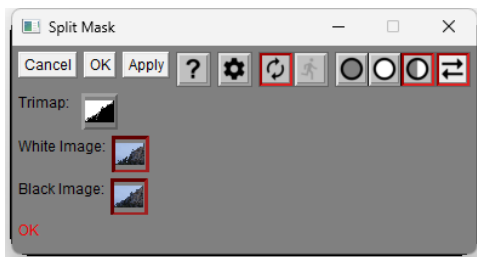
Use this control to select the trimap created by the Trimap transformation (see above).

### Split

Use this control to select whether you want to create the white image or the black image.

## Split/Mask

This transformation creates a mask from a set of input, white and black images. The mask is white where the trimap is white, black where the trimap is black. Where the trimap is gray, the mask corresponds to the blend of the white and black images that most closely matches the input image.



### Trimap

Use this control to select the trimap created by the Split/Trimap transformation (see above).

### White Image

Use this control to select the white image created by the Split/Image transformation (see above).

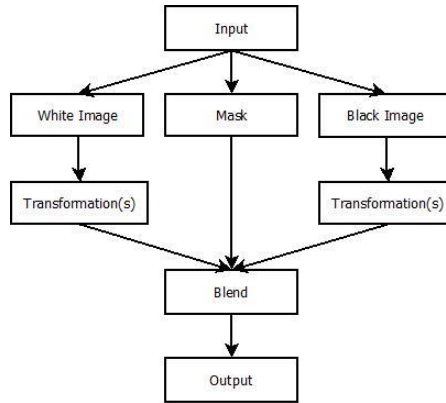
### Black Image

Use this control to select the black image created by the Split/Image transformation (see above).



# Split Processing Workflows

If you are using split processing to modify subject and background separately, the workflow looks something like this:

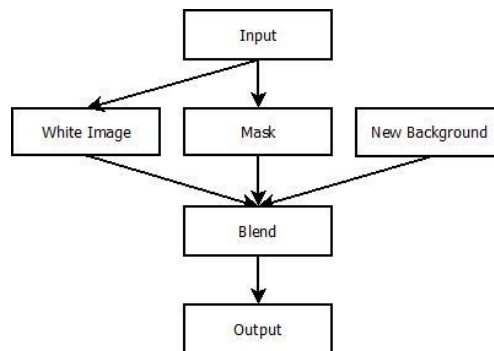


Starting with an input image, you first use the split transformations to create white, black and mask images. This factors the input image into a subject (white) image and a background (black) image.

Next perform whatever operations you want on the white and black images, such as darkening the background and lightening the foreground.

Finally, blend the two processed images using the split mask.

If you are using split processing to replace the background behind a subject, the workflow is similar:



In this case it is not necessary to generate the black (background image) since the background will be replaced.

## Current Status

There is still a lot of work to do.

The trimap generation process is still a work in progress. Ideally, it would be generated automatically or semi-automatically.

The extrapolation process in Split/Image can be very slow for large image with broad areas where the trimap is gray. Once I determine the right extrapolation algorithm I will work on speeding it up. There may also be some minor problems with the extrapolated image that I am still trying to track down.

Currently the transformations do not work well for certain images where the boundary between subject and background varies in color. I am not sure at this point if fixing this will require a totally different approach or if the problems are resulting from minor bugs in the current algorithm.

It would be a lot easier to use Split if Picture Window supported transformations with multiple output images so it could be combined into a single transformation. However, keeping them separate makes it easier to debug and allowing multiple output images would be a major change that affects many other parts of the program.

Finally, I would like to fold these transformations into a new version of the Brightness Curve and Composite transformations so the three Split transformations would not be necessary.