WHAT TYPES OF IMAGE SCALING ARE USEFUL?

When we refer to *grayscale* images, we intend to include *color* images as well. The color images used in Leptonica are either colormapped grayscale (where each gray value refers to a specific RGB color), or they are full 24 bpp RGB images. Likewise, the images in Leptonica that are strictly grayscale are either colormapped grayscale (where each RGB value in the colormap is actually gray, with R=G=B), or grayscale without a colormap. RGB images can be handled as three separate 8 bpp grayscale component images. Leptonica provides functions for separating the component images out so they can be processed as grayscale 8 bpp images, and combining the components back to form a color RGB image. Some of the fastest color operations do not perform this separation, but instead operate on the R, G and B components *in situ*, pulling them out of the 32 bit pixels and replacing them after the operations are completed. Leptonica also provides functions for converting a colormapped 2, 4 or 8 bpp image to grayscale or full RGB color images. For all scaling operations except simple subsampling or pixel replication, it is necessary to convert a colormapped image to either grayscale or full RGB before applying the scaling operation.

There are four main classes of image scaling:

1. grayscale --> grayscale
2. binary --> binary
3. binary --> grayscale (typically downscaling)
4. grayscale --> binary (typically upscaling)

Class 1 (grayscale --> grayscale) can be done crudely by sampling, or more accurately by low-pass filtering followed by sampling, by area mapping, or by resampling with linear interpolation. The issues are explored in detail below.

Class 2 (binary --> binary) can be performed with different goals for image reduction (*downscaling*). If the goal is to have an image without aliasing, a lowpass filter must be used. But if the goal is to analyze the texture, or to prepare for morphological analysis at lower resolution, a variety of nonlinear filters can be used before subsampling. The special case of a power of 2 reduction can be implemented very efficiently with word parallel operations. Of most interest are situations where the filtering and subsampling are combined, so that a filtered image at full resolution does not need to be produced before subsampling. When the image resolution is increased (*upscaling*), it may be desirable to smooth the boundaries to avoid large, visible stair-steps.

The details are given below.

Class 3 (binary --> grayscale) is also known as "scale-to-gray." It is typically used when the image is being dowscaled from a high resolution binary scan for viewing on a lower resolution grayscale or color display, and for typical scan and display resolutions, the 3x and 4x reductions are the most useful. We provide fast scale-to-gray reductions for 2x, 3x, 4x, 8x and 16x reduction, all implemented efficiently with lookup tables. For best results at intermediate scale factors, use binary upscaling before fast scale-to-gray reduction. See below for details.

Class 4 (grayscale --> binary), which is the inverse of scale-to-gray, can be called "upscale-to-binary". It is useful when a lower resolution (e.g., 100 ppi) grayscale image is to be printed on a higher resolution binary device, such as a laser printer. If we were to use pixel replication, the blocks representing the original pixels would be easily visible on the printed page. However, the blocks are much less noticeable if the edges are smoothed, using an interpolated grayscale scaling routine followed by binarization.

Source: http://www.leptonica.com/scaling.html