Digital Image Processing II: Bilateral Image Filtering

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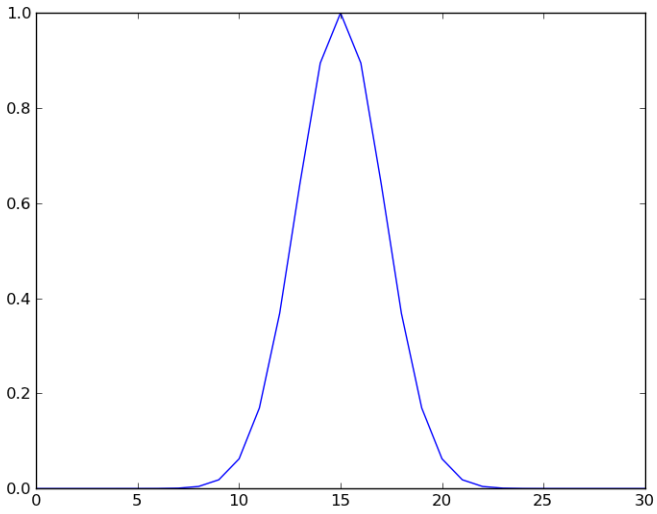
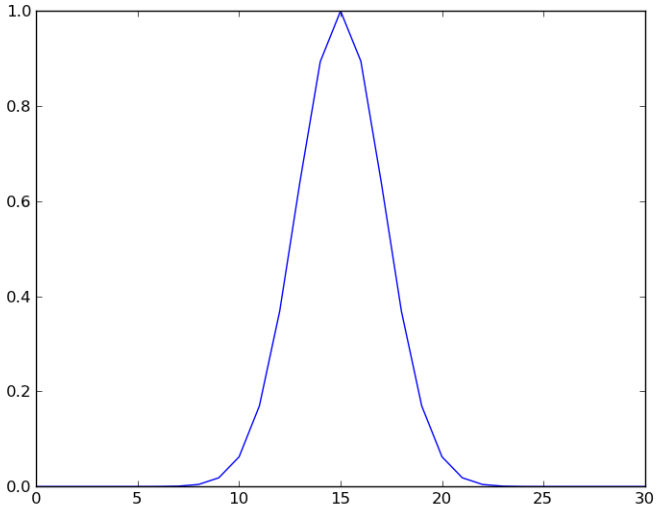
1 Bilateral Filter at specified points of a 1D image

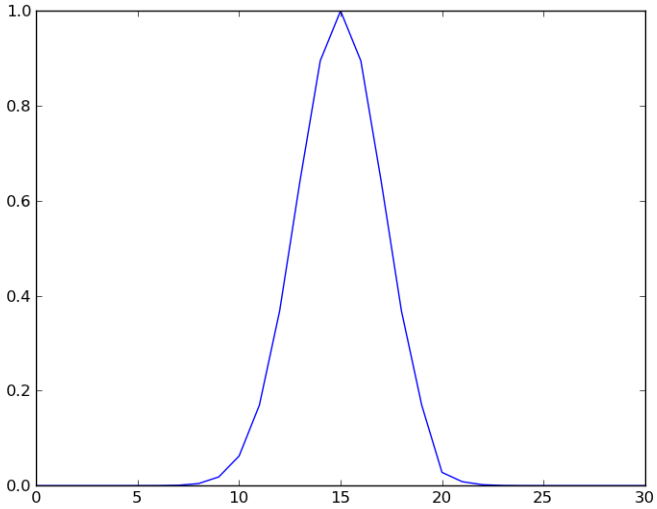
Plot with x = 90



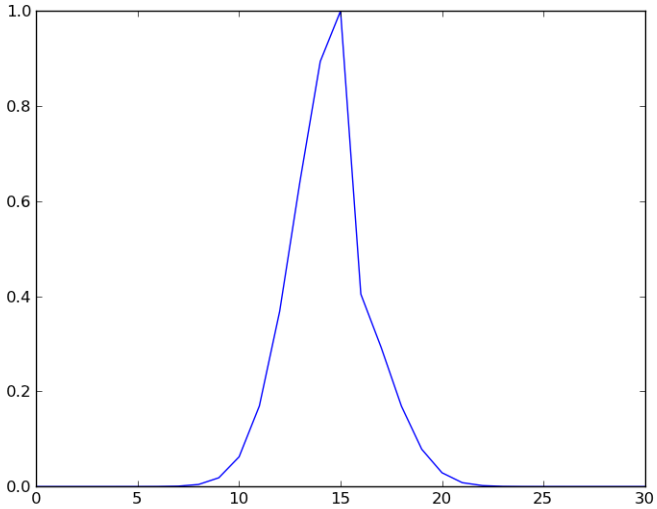
Plot where x = 119



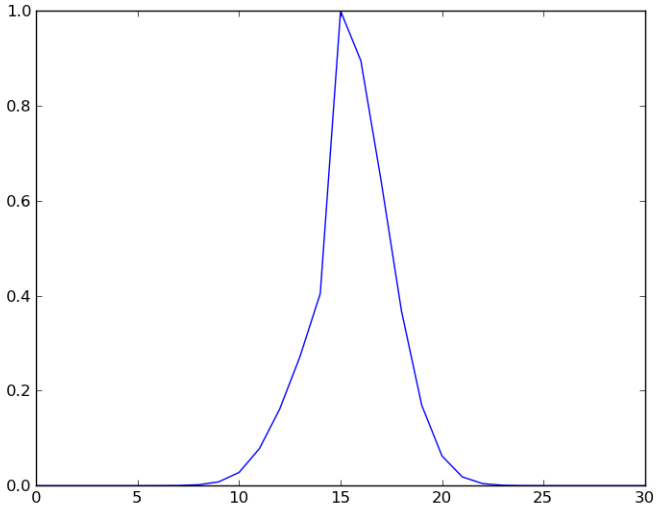
Plot where x = 123



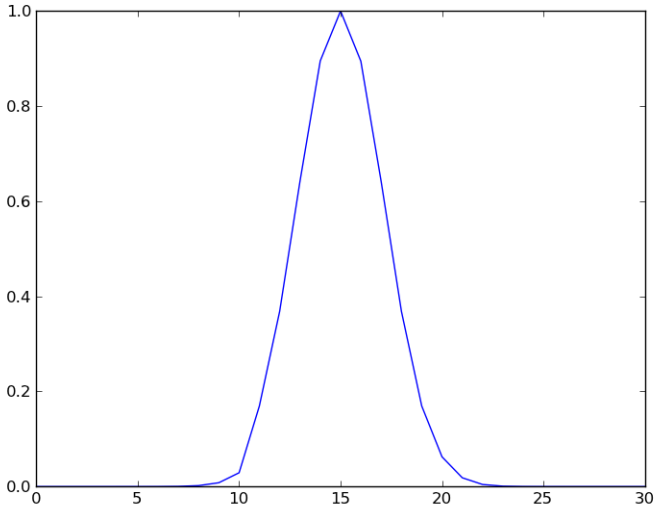
Plot where x = 127



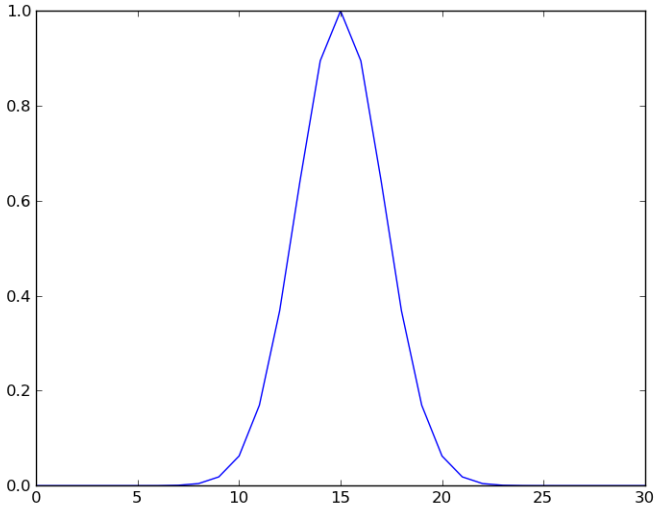
Plot where x = 128



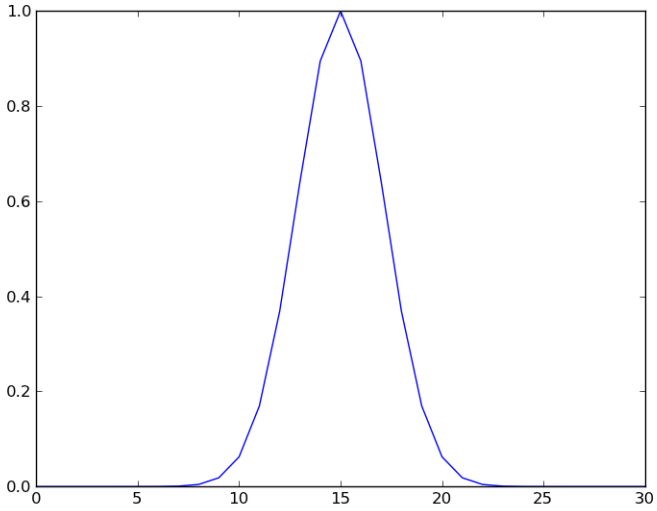
Plot where x = 132



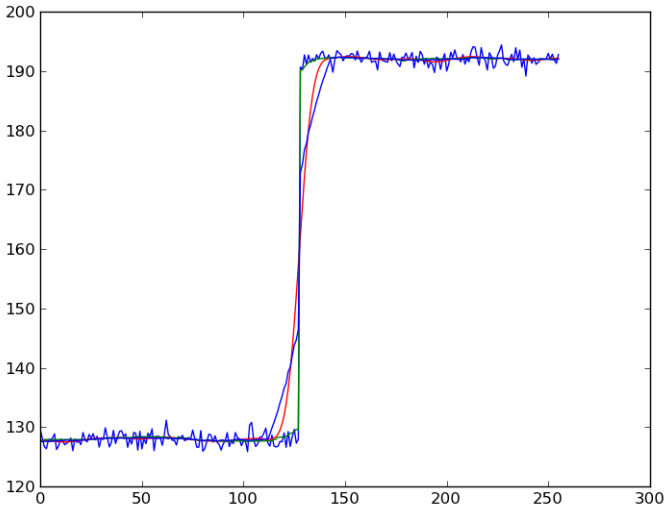
Plot where x = 136



Plot where x = 160



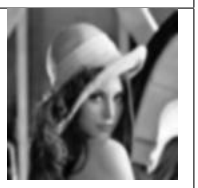
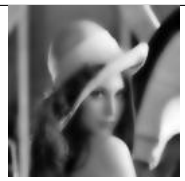
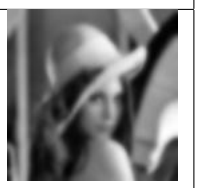
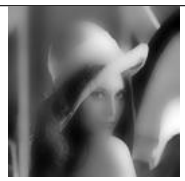
2 Comparison of Filters on a 1D image



We can see the original image function in the blue jagged line, a gaussian filter with a width of 31 and $\sigma = 5$ in red, a median filter with a width of 31 in green, and a bilateral filter with a width of 31 and with $\sigma_d = 5$ and $\sigma_r = 50$ in the smooth blue line. We can see the gaussian smoothing filter

has a softer transistion to the new values, which makes sense as it is a normal blurring filter. The median filter is much harsher on edges, which is shown with the sharp transistion from one luminance to another. And finally the bilateral filter, which is something of a combination of both a smoothing filter which is sharp around edges, starts off like a gaussian but soon becomes sharp like a median filter.

3 Bilateral filter on a normal image

	$\sigma_r = 10$	$\sigma_r = 30$	$\sigma_r = 50$	$\sigma_r = 100$	$\sigma_r = 300$
$\sigma_d = 1$					
$\sigma_d = 3$					
$\sigma_d = 5$					
$\sigma_d = 10$					

We can see that the lowest values of σ_d and σ_r have very little actual impact on the image. We can also see that a σ_r value of over 100 makes the image too blurry to be usable in most cases. The most interesting results occur with σ_r between 30 and 50. With $\sigma_d = 3$, the noise has been basically eliminated from the image, however it still retains the sharp edges and most of the rest of the image remains intact and unblurred. These images, along with $\sigma_r = 10$ and $\sigma_d = 10$, are probably the best representations of the power of the bilateral filter for noise reduction. However, we also see an interestin effect with $\sigma_r = 30$ and $\sigma_d = 10$, where the edges remain sharp, however the backround as well as most uniform areas become very soft.