

PRF vs. PSF

David Makovoz

05/07/02

Disclaimer. This document is not meant to give a rigorous definition of either PRF (point response function) or PSF (point spread function), only to illustrate the difference between the two similar yet distinct concepts.

Suppose you observe a star with a detector with the pixel of a certain size a . You dither around and get several images of the same object (Figure 1)

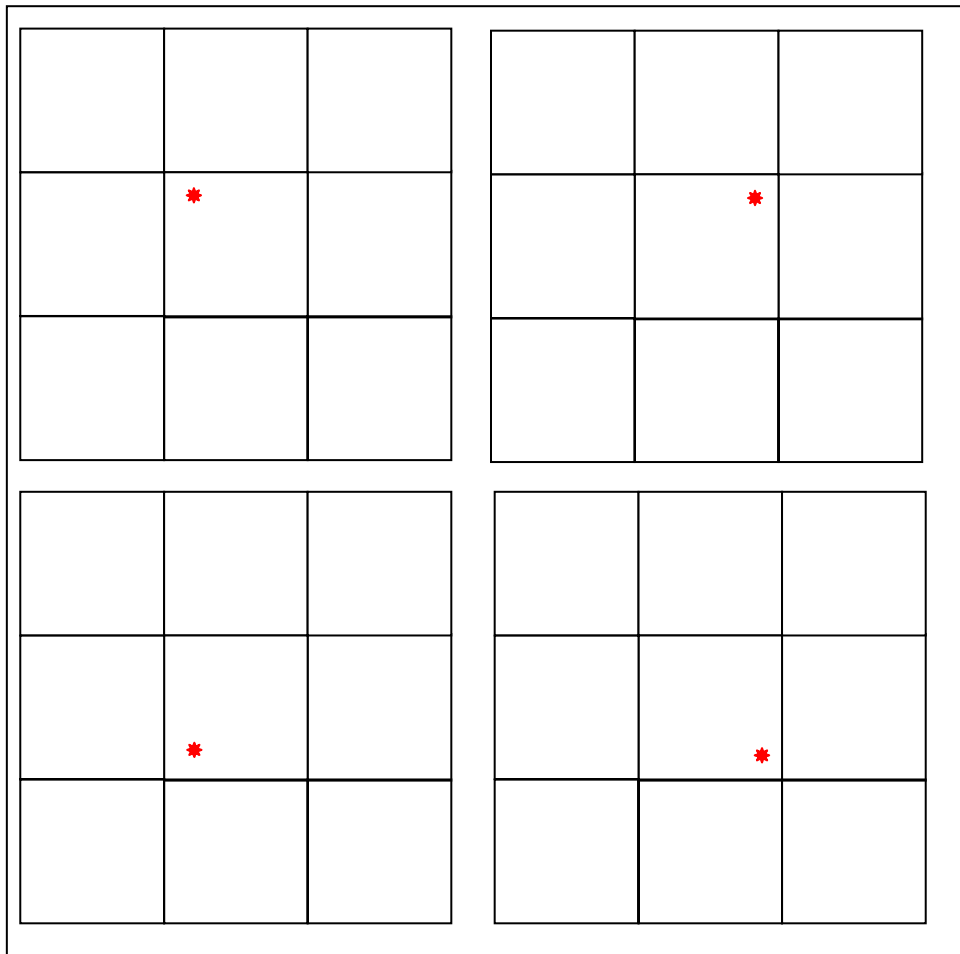


Figure 1 Four dithered images of an object observed by a detector. The detector pixel size is a .

Now you want to fit the observed data with a template. You use your favorite tool and create a PSF image. The image is oversampled, the pixel size is $a/3$. Yet, it is an image. It is the image of a point source placed in the center of the central pixel, as seen by a detector with the pixel size $a/3$.

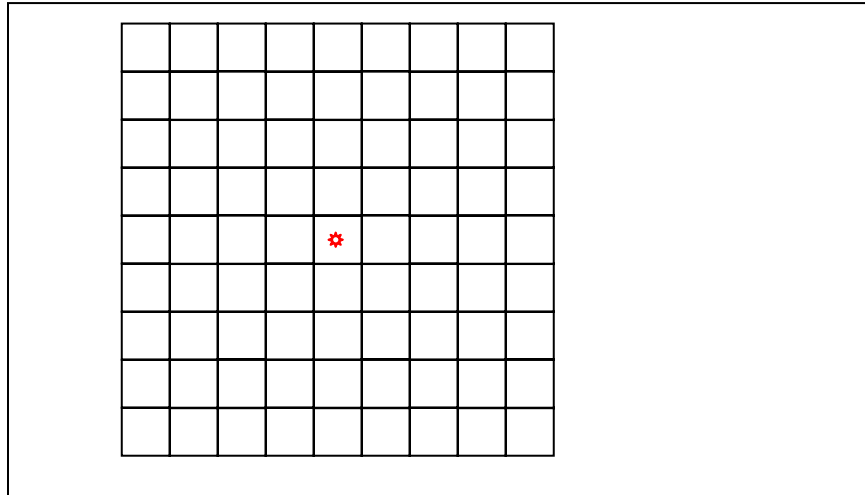


Figure 2 PSF is an image of a point source placed in the center of the central pixel of an imaginary detector with the pixel size $a/3$. The sampling interval is also $a/3$.

You **cannot** use this image to fit the data directly, since the pixel size is different. You integrate over the detector pixel size.

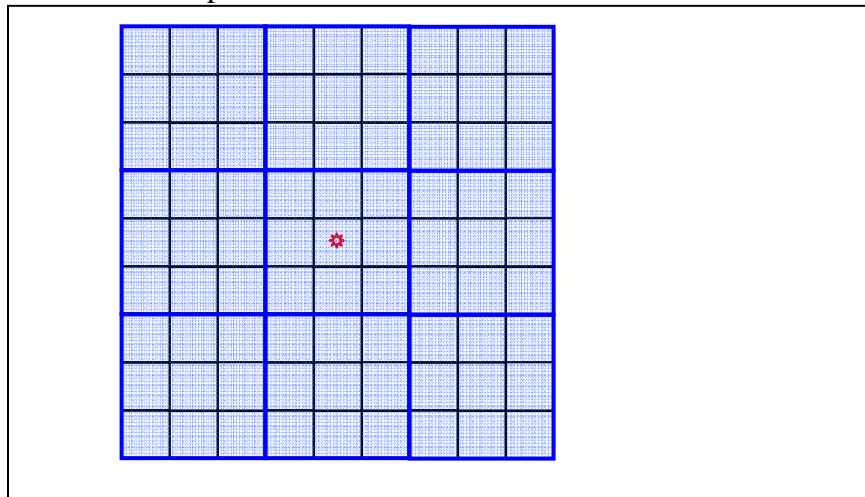


Figure 3 Original PSF (black) has been integrated over the detector size pixels(blue). The pixel size and the sampling interval for the blue pixels is a .

Now the pixel size is right, but the image is not oversampled anymore. At this point you realize that what you need is a PRF.

You go through the oversampled PSF image and integrate over detector pixel size, but this time you put the center of the detector pixel on the center of every PSF pixel. What you end up with is a set of fluxes “measured” with the pixel of size a , whereas the sampling interval, i.e. the distance between the centers of the pixels, is $a/3$. The pixels

overlap, so that what you get is not a real image, in a sense that it is not something you can observe with a detector. Nevertheless it is very useful for fitting purposes.

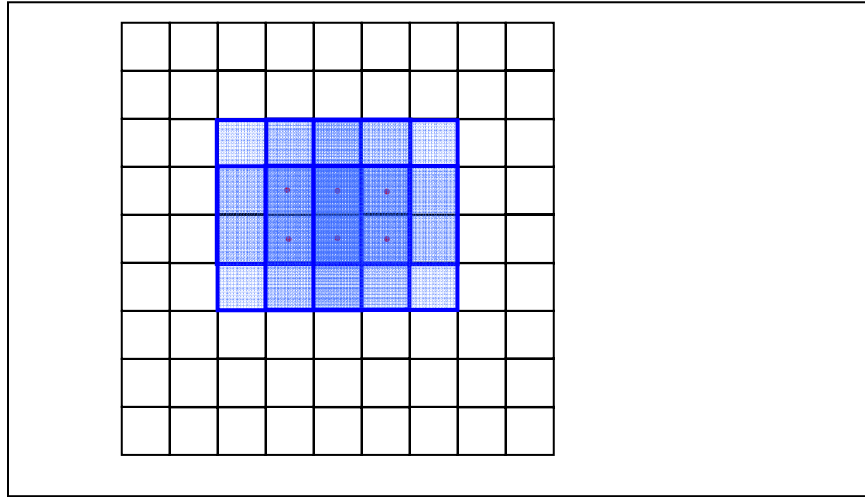


Figure 4 PSF image (black) is integrated over detector size pixels(blue) to create a PRF. The pixel size of the PRF is equal to the detector pixel size a , but its sampling interval is equal to that of the PSF $a/3$. The blue dots show the centers of the PRF pixels. Only 6 PRF pixels are shown to keep the figure relatively clear.

Note. Strictly speaking to find a response of a pixel one should convolve the PSF with the pixel response function. This convolution is the Point Response Function – PRF. Here for simplicity we assume that the pixel response function is a step function.