7.3 Survey completeness and noise

The main point of this exercise is the addition of an actual detection algorithm to the analysis of ¶7.1. Fitting a Gaussian will always produce an answer for the brightness of a notional source; at low signal-to-noise, just noise spikes will be fitted. To determine the noise level for detection, it is essential to run the detection algorithm on empty fields, where the baseline has noise added at whatever level is appropriate for the experiment. This gives the noise level on "detections". It is then possible to add sources of gradually increasing brightness to the experiment, and see how often they are actually detected above the threshold we assign from the empty-field step.

Assigning the noise level from the empty field experiments takes some thought, as usually the location, width and height of the "sources" are free parameters. Most algorithms will veer between fitting narrow noise spikes, or extremely wide profiles which are really part of the baseline. If allowed to do this, the detection noise level will not be a realistic representation for sources which have a narrow range of widths, locations, or both.

This suggests that a more realistic estimate of noise level must be conditional on knowing something about the likely sources; the point-spread function will probably constrain the width,for instance, and we may know the location of the source from other data.

Many implementations of fitting algorithms will accept constraints on the range of parameters, or it is possible to add a home-made "penalty function" to the sum of squares. At worst, just "freeze" a parameter. Experiments along these lines will show how sensitively our confidence in our detections depends on assumptions about what we are looking for.