Student:
Trying to calculate uncertainties in our B-V magnitudes now and our first source of uncertainty is photon counts according to Lecture 8. I think we should be able to use \sqrt[n] for the uncertainty but I'm not sure how to obtain the actual photon counts for each star from our data (as we only have the aperture sum in adu).

Duncun:do you have a gain value that relates ADU to no. of photoelectrons? That might give the *n* you need

Michael:
For bright stars the uncertainty will be dominated by the uncertainties in the calibration.
For faint stars you should be in a regime where the sky background noise dominates. While one can determine photon counts from first principles, this gets messy if you have shifted images (by non-integer amounts), scaled images and then combined.

An empirical way of measuring the sky background noise is to define some sky positions and measure the photometry. This could literally be a series of ~20 sky positions such as x=1000 y=1000, x=1000 y=1100, x=1000 y=1200.... (while making sure you don't land on stars). If you measure the fluxes in these apertures you will get a mix of positive and negative numbers - and the standard deviation of these gives you the noise in ADU.

Below is an example of such a sky background noise calculation.

Background noise

positions=[[1000, 1000], [1000, 1100], [1000, 1200], [1000, 1300], [1000, 1400], [1000, 1500], [1000, 1600], [1000, 1700], [1000, 1800], [1000, 1900], [1000, 2000], [1000, 2100]]

apertures = photutils.CircularAperture(positions, r=12.0)

phot_table = photutils.aperture_photometry(tempim, apertures)

print(phot_table[:]['aperture_sum'])

print('Mean:', np.mean(phot_table[:]['aperture_sum']))

print('Standard Deviation:', np.std(phot_table[:]['aperture_sum']))

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   aperture_sum
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 -524.7060085316699
 1004.9104148651401
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-280.18579942519415
 476.21307462347204
 -381.9761968276357
-137.57412395514922
 372.66072136333077
 -684.8367928759378
 -50.25910314060985
 -298.2503807201072
  661.1550742005253
 -574.6278626510207
Mean: -34.78974858957135
Standard Deviation: 516.9971609387854
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One you have a background noise estimate in ADU, you would like to change it to magnitudes.

Lets say your flux in ADU is ``Flux" and the uncertainty you've measured is ``Skynoise". In case the uncertainty in the magnitude "magerr" resulting from the sky background noise is:

magerr = 2.5 * (Skynoise / Flux) / ln(10)

As you can see, if the uncertainty in the flux corresponds to 10% of the flux then the magnitude uncertainty is going to be close to (but not quite) 0.1.

If you need to add the photometric calibration error to this, then you can do that in quadrature.

CRITICAL: Do not let uncertainties derail getting preliminary results and writing up your report. One can spend a lot of time trying to determine uncertainties (which in general is a good thing) but then find that the scatter in the data (due to the scatter of the physical properties of the stars) is far larger than the uncertainties determined from photon statistics.

Student:
Hi Michael
For our distance estimates, we have a lower and upper bound determined by the scatter in the data, which we were using as our distance uncertainty prior to going through and adding in the calibration uncertainty as described above (since it is much less than the standard deviation (~500pc) of distance values). This "scatter" uncertainty is on the order of ~100pc, but we now have propagated the calibration uncertainties for the distance estimate and the upper/lower bounds and the uncertainty from these is on the order of 300-400 pc for each bound. I'm wondering where these propagated uncertainties fit into the final value we should present in our