Lecture 1 problems

1. The significance of a certain conclusion depends very strongly on whether the most luminous known quasar is included in the dataset. The object is legitimately in the dataset in terms of the pre-stated selection criteria. Is the conclusion robust?

2. We have $N = 10$ measurements of a variable $x_i = (7.6, 5.8, 8.0, 6.9, 7.2, 7.5, 6.4, 8.1, 6.3, 7.0)$. Estimate the mean, variance and median of this variable. What are the errors in your estimates?

3. I observe 100 galaxies, 30 of which are AGN. What is the best estimate of the AGN fraction and its error?

4. In the HST guide star catalogue, 60% of the objects are binary stars. How large a sample should be chosen to ensure that the probability of the sample containing at least 2 non-binary stars is at least 99%?

5. The density of quasars on the sky is known to be 20 deg^{-2}. What area of sky would we need to survey to ensure a 99% chance of finding a quasar?

6. A galaxy of absolute magnitude $M = -20$ is observed to have apparent magnitude $m = 20.0 \pm 0.2$. What is the luminosity distance D_L in Mpc, and its error? [Assume $m - M = 5 \log_{10} D_L + 25$].

7. The total mass of a binary star system (in solar masses) is given by Kepler's law $M = a^3/P^2$, where a is the mean separation in A.U. and P is the period in years. The α Centauri system has a period of 79.9 ± 1.0 years and mean separation $a = 23.7 \pm 1.0$ AU. What is the total mass and its error?

8. We have $N = 5$ measurements of a quantity: $(7.4 \pm 2.0, 6.5 \pm 1.1, 4.3 \pm 1.7, 5.5 \pm 0.8, 6.0 \pm 2.5)$. What is the optimal estimate of this quantity and the error in that estimate? A further measurement 3.0 ± 0.2 is added. How should our estimate change?