ASTRONOMY 16 - SUMMER 2020
Exercise Sheet 3
DUE by Wednesday, July 15, 2020 by 11:59pm
300 points

A. Bayes' Theorem 1

There are N red balls and M white balls in a box; we know the total $N + M = 10$. We draw $T = 5$ times (putting the balls back after drawing them) and get $R = 3$ red balls. Calculate the posterior probability of how many red balls there are in the box, and plot it as a function the true number of red balls. *Hint: you already know what the posterior probability as a function of the true number of red balls is from the class notes. Make sure that your results are consistent.* Repeat for $T = 50$ and $R = 30$.

B. Bayes' Theorem 2

Before 1987, four naked-eye supernovae had been recorded in 10 centuries. Using the Bayes' theorem, calculate the posterior probability of the supernova rate per century ρ. Assume that our prior on ρ is uniform between 0 and 1 supernovae per century. Plot the derived posterior probability distribution for ρ as a function of the number of supernovae per century. Calculate the peak and mean of the posterior probability *Hint: you've already seen this in the class notes, so please make sure that your results are consistent.* Repeat adopting a Haldane prior instead of a uniform prior.

C. Gaussian distribution 1

Given a standard Gaussian distribution with mean $\mu = 0$ and standard deviation $\sigma = 1$, calculate the probability that a measurement will deviate from the mean by less than 1.5σ. *Hint: You need to numerically calculate an integral.*

D. Gaussian distribution 2

Given a Gaussian distribution $prob(x)$ with mean $\mu = 2.5$ and standard deviation $\sigma = 0.4$, calculate the value x_{15} such that 15% of measurements are at $x < x_{15}$, and the value x_{85} such that 15% of measurements are at $x > x_{85}$. Express these values both in absolute units, and in units of standard deviations.