Coding in advance of the Apr 9, 2018 class

For this coding exercise, the goal is to write your own affine-invariant MCMC sampler, following the prescriptions in equations (9) through (11) in Lecture 10. Part of the idea is for you to explore various choices, including:

- How many walkers should you have?
- What are the consequences of changing the parameter a in equation (10) in the lecture?
- What is your convergence criterion? As a first step, I might suggest picking a fixed number of burn-in steps (say, 50 or 100 or 1000), followed by a fixed number of steps that you read out, figuring that your walkers have converged. This isn't actually a convergence criterion per se, but it's easy to implement.
- How many independent runs do you need to perform to ensure that you are converged? In particular, how do the results of those runs compare with each other?

I recommend that you do your analysis on the following three distributions:

$$P(x,y) \propto e^{-x^2/2} e^{-100y^2/2} \ , \tag{1}$$

the Rosenbrock density

$$P_{\rm rosen}(x_1,x_2) \propto \exp\left(-\frac{100(x_2-x_1^2)^2+(1-x_1)^2}{20}\right) \ , \tag{2}$$

and then finally, on the same model, with the same data set, that we used in Lectures 6 and 7 (data reproduced in the file associated with this lecture). One thing to note about that is that previously you used a grid to search for the best values and uncertainties in θ and b. But when you use the entire data set, the favorable region is so small that you would need to regrid. Your affine-invariant sampler should be able to get to that small region automatically; does it? Also, given the speed of your sampler, you could, if you like, include as another parameter an intrinsic scatter; for example, you could add that intrinsic scatter in quadrature to the uncertainties provided with the data, and assume that the intrinsic scatter in $\log_{10} M_{\rm bary}$ is a constant independent of the rotation speed.

Good luck!