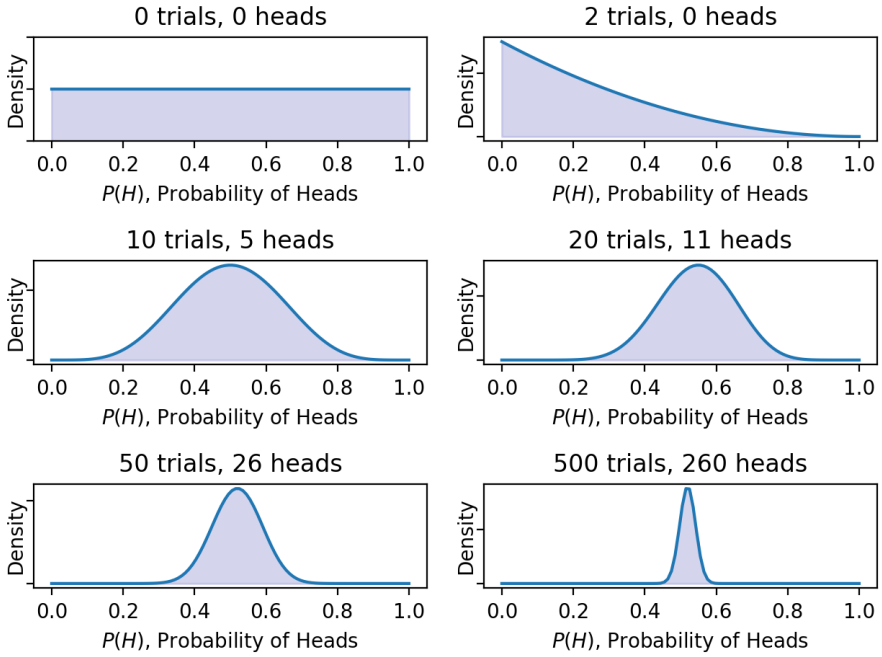
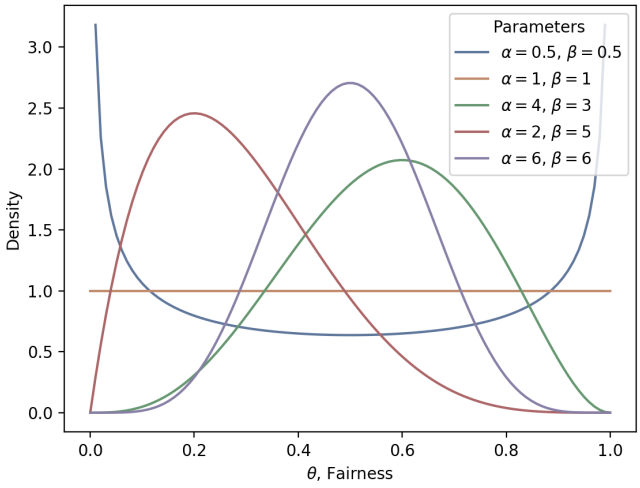
Feel free to work with other students, but make sure you write up the homework and code on your own (no copying homework *or* code; no pair programming). Feel free to ask students or instructors for help debugging code or whatever else, though.

1 Go through Chapters 2 and 3 of the textbook. Run the code in each of the chapters and reproduce the figures below.

For chapter 2,



For chapter 3,



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2 Find a paper that incorporates or discusses MCMC methods and also has code that can be run. Write a 1 page summary of the paper. Make sure the code you find can be run without too much difficulty since in your next homework assignment you will be expected to run the code.

Foreman-Mackey, Daniel, et al. "emcee: the MCMC hammer." Publications of the Astronomical Society of the Pacific 125.925 (2013): 306.

This paper implements the affine-invariant ensembler sampler for the MCMC method that was previously proposed, in python. It first discusses the advantages of MCMC method, which includes the fact that it can provide sampling approximations to parameters in large dimensions and can marginalize nuisance parameters. The traditional sampler algorithm used is the Metropolis-Hasting (M-H) method. However, the method is very sensitive to its hyperparameters and the process of tuning hyperparameters is extremely expensive. Then, the paper moves on to illustrate different variation of the M-H algorithm, which includes a single M-H MCMC step, a single strech move update step from GW10, and the parallel strech move update step.

Then, the paper moves on to the testing of its algorithm. This was done by using the autocorrelation time - "a direct measure of the number of evaluations of the posterior PDF required to produce independent samples of the target density". This method is chosen because time is an important consideration when sampling in practice and that autocorrelation time is affine invariant. Although the paper argues that autocorrelation time is the best measurement for the method, there are simpler measurements such as the acceptance fraction and large expected or mean squared jump distance (ESJD). The paper also addresses common mistakes when using MCMC. This includes taking too many samples and running the sampler for too few steps. Furthermore, the paper discusses situations that MCMC method might not work as well, such as when the target density is multi-modal. Finally, the paper describes the installation process.

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