Astronomy 598 Topics in Theoretical Astrophysics (Bayesian Statistics for Computational Science)

Spring 2017 Problem Set 3

Due Date, April 21, 2017

Use a command line terminal on Hyak to do this problem. On Hyak, you can get an interactive session using qsub -I. Use your favorite programming language for below problems.

Do all your work in a directory called

`abcxyz_hw3`

(replace abc with your first name and xyz with your last name). The directory should contain at least these files: your programs, plots and README. (Do not include data files or text editor backup files). Use below command to tar the files and e-mail me your tar file with e-mail subject line ASTRO 598 HW3:

```
tar -cvf abcxyz_hw3.tar abcxyz_hw3
```

This problem is about MAP (Maximum a posteriori) estimates and credible intervals.

As seen in HW2, Bayesian methods gives us the complete posterior pdf. However, we may want to summarize the information contained in the posterior pdf by using just two numbers: a best estimate and an error bar.

We will use the file `kpost.out` from HW2 (h).

(a) A MAP estimate of θ is the value of θ for which the posterior pdf is maximum. Write a program `findMAPestimate` which reads the file `kpost.out` and prints the value of θ for which `kposterior(theta, y)` is maximum. Note that the θ_0 found by maximizing `kposterior(theta, y)` may be different from the true θ used to generate the data. (In practice, one does not know the true θ.)

(b) Run `findMAPestimate` and write the MAP estimate in your README.

(c) A 95% equal-tailed credible interval is a interval that encloses 95% of the area under the curve of the posterior pdf with 2.5% of the area above the interval and 2.5% below the interval. Write a program `findCredibleInterval` which reads the file `kpost.out` and prints the value of θ_1 and θ_2. Here θ_1 and θ_2 are such that the area under the curve from $\theta = \theta_1$ to $\theta = \theta_2$ is 95%of the total area under the curve .

(d) Run `findCredibleInterval` and write the values of θ_1 and θ_2 in your README.

(e) Write a program `findMeanEstimate` which reads the file `kpost.out` and prints the mean and standard deviation of θ.

(f) Run `findMeanEstimate` and write the values of the mean and standard deviation in your README.

(g) Write a README file with answer to parts (b), (d) and (f). The README should show how to use your programs. If you are using a compiled language, it should contain instructions for compiling the program.