Project 3: Bayesian Hierarchical Modelling with JAGS

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1 Description

JAGS stands for Just Another Gibbs Sampler and is one of the most popular packages for Bayesian modelling. It's key advantages are that it's very easy to install, works on a wide variety of platforms, and runs very quickly (often faster than more advanced software such as Stan). The purpose of this project is to learn how to use JAGS to perform Bayesian modelling and write some new code.

A while back I noticed that there were relatively few good worked examples of JAGS code out there so I created a GitHub repository at github.com/andrewcparnell/jags_examples. The idea of this repository is that each file would correspond to a single type of statistical model, and that each set of code would have the following structure:

1. Some introductory text and boiler-plate code
2. A mathematical description of the model
3. R code to simulate data
4. JAGS code to fit the model
5. Some printing out of the results
6. A real data example
7. Some further tasks or code that go with the real example

The idea is that other JAGS users can take this code and adapt it to their own needs. However, many of the examples are incomplete, with poor notation, or no real world examples.

Your task in this project is to tidy up this repository and make it more complete for those looking for good JAGS examples.

2 Goals

- Learn how to fit Bayesian models in JAGS
- Get used to using GitHub to push and pull code from the web
- Add some examples using the Python `pyjags` package
- Try some different statistical models which are currently not included

(Another optional possibility is to turn some of these R scripts into R or Python notebooks)

3 Prior work

I suggest starting with the linear regression example and making sure you understand all the code. Then work your way through the different models making a list of the ones you understand and the ones you don't. You might need to do some background reading to make sure you understand the results from the models, though we will go through the mathematical details in more detail in later projects.

4 Resources

The main websites for this project are:

- The GitHub repository: github.com/andrewcparnell/jags_examples
- the JAGS web page (and the manual: mcmc-jags.sourceforge.net/

If you need to do some reading on the background to these models I would suggest either Bayesian Data Analysis by Gelman (just the chapters on MCMC) or Data Analysis using Regression by Gelman and Hill.

5 Justification

JAGS is a really useful thing to learn it you want to very quickly test a basic idea out without having to create hundreds of lines of R code. However, more complex models cannot be fitted using JAGS.

6 Methods

There's lots of mathematics behind the fitting of these models (mostly creating full conditionals of the probability distributions) but writing these out is the job for the next project.

7 Outcomes

Main outcome are:

- Code in R (using `R2jags`) adding details to the GitHub repository
- Similar code as above but using `pyjags`
- A few more example models in the repository
- A report detailing tidy-ups required, the new data sets used to illustrate results, any new models included, and an outline for any future work still required
- A presentation on the work based on the report

8 Out of scope

You are not expected to code up any of the models yourself using R, nor should you use any of the other Bayesian packages out there (`pymc`, `stan`, `nimble`, etc, etc)

9 Timeline

To be completed by Monday 12th November

10 People

Roles for this project (provisional)

- Lead and document write-up - Estevao
- Maths and algorithm design - Bruna (focus here is on writing out some new models)
- R code - Ahmed
- Python code - Alan