Bachelor Project Proposal: Jump Proposal Mechanisms in Markov Chain Monte Carlo Simulations

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1 Project Description

Markov chain Monte Carlo (MCMC) algorithms are a powerful tool in computational statistics. They let us sample from distributions that we only know up to some normalization constant, without having to analytically solve often intractable integrals. This is particularly useful in Bayesian statistics, where we deal with posterior distributions that we only know up to proportionality.

For my thesis I will be researching jump proposal mechanisms for reversible jump Markov chain Monte Carlo algorithms (RJ-MCMC) applied to linear regression models. Where regular Markov chain Monte Carlo algorithms only jump across parameters in a fixed model, reversible jump Markov chain Monte Carlo also jumps across-model, adding in and removing variables from the model as it jumps. This means the algorithm is also exploring which model is best in predicting the data.

However, this does bring some difficulties in designing a proposal mechanism, since across-model jumps don't have the same concept of proximity that within-model jump proposals use. Without a proper jump proposal mechanism these algorithms may converge impractically slow.

For my research I will implementing RJ-MCMC algorithms for linear regression models. I will be comparing the different proposal mechanisms for jumping across-model, measuring convergence rates using convergence diagnostics, trace plots and other methods I may find in the literature. As my result I will write on the efficacy and applicability of these RJ-MCMC methods based on my research, the applications for which they have potential, where they are currently seeing use and how easy it is for non-experts to utilize.

2 Tentative planning

I have made a tentative planning that will help me structure my time efficiently, it is very much subject to change as the project demands, but this skeleton will be my guideline.

I will be spending the first few weeks going over the existing literature and writing the theory section that will go over everything a mathematics bachelor student would need to understand the rest of my thesis.
Around week 3 I want to concretely decide what RJ-MCMC methods I will be implementing and what data sets I will be testing with.
Working on these implementations will be the brunt of my work from week 4 to 8, but I will continue writing what I learn as part of the results section.
From week 8 to 10 I will write several drafts of my final thesis, taking into account feedback and prepare for my presentation.

Week	Planned activities
1	Research existing literature Start writing theory section (e.g., Markov chains, Linear Regression, basic MCMC, etc.)
2	Research existing literature Finish first draft of theory section, and ask for comments Start writing my method section, what methods I will be implementing and testing
3	Start on implementations (RJ-MCMC methods, convergence diagnostics) Generate or find existing data sets for the purpose of testing my methods Finish initial method section, and ask for comments
4	Continue implementing and testing
5	Continue implementing and testing Start writing results section
6	Continue implementing and testing Continue writing results section
7	Assess my progress: - Am I on schedule? - Do I have any results that require additional testing? - Does my supervisor have comments that I should adress? Make a plan to wrap up research this week or the next
8	Wrap up research this week Finish first rough draft of thesis, ask for comments
9	Finish second draft of thesis, ask for comments Prepare oral presentation
10	Oral presentation Hand in final draft