

MATHEMATICS AND STATISTICS

LANCASTER UNIVERSITY

STUDENT'S PROGRESS REPORT FOR THE FOUR MONTH APPRAISAL

This form should be completed by the Student BEFORE the 4 month meeting of the Higher Degree Committee (after the student's registration into the Probationary MPhil/PhD program. A copy should be uploaded to the PGR Appraisals area in Moodle.

AFTER the meeting a paper copy with signatures should be submitted to Sharon Bryan.

Student: Joshua MacDonald

ID number: 35063593

Registration date: 08/10/2018

Full time

Supervisor(s): Prof. Peter Neal, Dr. Christopher Jewell

Chair: Dr. Chris Sherlock

Representative of the Associated Sponsor (if applicable):

Technical account of the research progress and the research plan for the next appraisal. (PhD confirmation due at 10 months)

I began my research by consolidating theoretical knowledge of Poisson processes, and more generally Point processes, in order to apply this to the SIR epidemic model.

Following on from this I worked on understanding two different constructions of the Likelihood for the SIR model. One case where infection and removal times are paired, focusing on events happening to specific individuals in the population. The other where the epidemic is seen as a continuous time Markov process, where states and transition rates are dependent on the number of people who are susceptible and infected at each time point.

Moving forward, I focused on the paired infection/removal time approach. This approach allows for an appropriate choice of distribution for the infectious period of the epidemic. I wrote an algorithm which simulates epidemics with a chosen population size and infection and infection process parameters based on the General Stochastic Epidemic process described by Neal and Roberts (2002). Being able to

simulate epidemics provided a way of assessing the performance of different MCMC algorithms.

I learnt about different Bayesian frameworks for the epidemic likelihood, derived from centering, non-centering or partially non-centering the missing infection times. These different approaches can account for the dependency between the missing data and the parameters of the epidemic when using MCMC to generate samples.

The plan for the following months is to investigate heterogeneity in epidemics, in terms of spread of infection, and how MCMC algorithms perform when heterogeneity is added and as the complexity of the heterogeneity increases. Furthermore, investigation will be done on some more realistic situations such as unfinished epidemics (Unknown number of infected and future removal times) and snapshots epidemic data (Particle sampling methods).

In addition to the statistical work I have been doing, I have developed my coding style to be more clear, concise and less repetitive by using functions more effectively. I have also learnt how to store/load code and test datasets conveniently by building an R package. I am keen to continue my development in coding by refreshing my knowledge of Python and learning Java, which will give me the option of building a user-friendly application for epidemic inference.

I will be attending the following APTS courses:

- University of Southampton, 8-12 April 2019
- Durham University, 8-12 July 2019
- University of Oxford, 2-6 September 2019

Other relevant training or activity (e.g. courses taken, participation in seminars or reading groups, teaching assistance done by the student)

- Took a GTA Training course in order to partake in teaching
- Assisted teaching in a range of Modules (Linear Algebra, Stats in Practice, CIM II, Stats Methods)
- Attended meetings for Computational Statistics and Machine Learning, Epidemics reading groups

Optional comments for supervisory panel. (Any confidential comments should be passed on to the relevant Postgraduate Tutor.)

Student's signature and date:

J MacDermid

04/02/19