**MATHEMATICS AND STATISTICS LANCASTER UNIVERSITY**

**REPORT ON THE INITIAL MEETING OF**

**THE HIGHER DEGREE COMMITTEE**

*This Form should be completed and returned to Azadeh Khaleghi electronically. A paper copy with signatures needs to be submitted to Sharon Bryan.*

Student: Joshua James MacDonald ID number: 35063593

Registration date: Full time Part time (*circle one*)

Supervisor(s):

Prof. Peter Neal

Dr. Christopher Jewell

Chair:

Dr. Christopher Sherlock

Representative of the Associated Sponsor (if applicable):

**Summary of the proposed project:**

Title: Optimal surveillance design for parameter inference in hidden-Markov epidemic models

Summary: Bayesian inference on the parameters of dynamical infectious disease models is an established methodology for outbreak forecasting and decision support. These approaches propose a dynamical state-transition model for disease

progression, in which an individual's infection hazard is a function of the number of infected individuals at any given time [e.g. Jewell et al. (2009)]. These models assume that all infected individuals are eventually detected, and that case detection is intrinsically linked to the development of clinical signs of disease.

(Continued overleaf)

A common situation, however, is where samples of individuals from a population are subject to a regular disease screening programme which is independent of the infection process -- so-called 'panel data' -- with the aim of estimating disease

transmission parameters to inform both further disease surveillance and also disease intervention policy. Though methods for state-transitions models given panel data are well-established for static models [e.g. Jackson (2011)], the time-

inhomogeneous nature of transition rates for epidemic models presents a significant inferential challenge. Moreover, optimal design of a disease surveillance programme to inform epidemic models is currently under-developed [Herzog et al.

(2017)].

This PhD project will focus on developing statistical methodology to fit epidemic models in a hidden-Markov framework, and develop principles to ensure that the spatiotemporal design of sample-based disease surveillance is optimal for both

parameter inference and epidemic forecasting.

\* Jewell CP, Kypraios T, Neal P, Roberts GO (2009) Bayesian analysis for emerging infectious diseases. Bayesian Analysis.

4:465–496.  
 \* Jackson CH (2011) Multi-state models for panel data: The msm package for R. 38(8):1–28  
 \* Herzog, SA, Blaizot S, Hens N (2017) Mathematical models used to inform study design or surveillance systems in

infectious diseases: a systematic review. BMC Infectious Diseases. 17:775–785.

**Summary of the student’s background:**

**Undergraduate Degree: BSc. Mathematics, University of Leeds (1st Class)**

**Postgraduate Degree: MSc. Statistics, Lancaster University (Distinction)**

**Details of any courses or training to be undertaken during the first year as part of 10 days of training:**

The student will be attending the following *Academy for PhD Training in Statistics* (APTS) courses,

* Southampton 8-12 April, 2019
* Durham 8-12 July, 2019

Oxford

**Is Faculty ethical approval needed for this project? (YES/NO).**

**If yes, please attach the application to the Faculty ethics committee.**

**(see** [**http://www.lancaster.ac.uk/sci-tech/research/ethics/**](http://www.lancaster.ac.uk/sci-tech/research/ethics/) **for information on which projects need approval).**

**Signatures:**

Student: Date:

Supervisor: Date:

Second Supervisor (if applicable): Date:

Chair: Date:

Representative of the Associated Sponsor Date: