Statistics and Actuarial Science Seminar

Title: Bayesian Detection and Prediction of Disruptive Events using Twitter

Speaker: Theodore Kypraios

Date: Thu 25th April 2024 at 3:00PM

Location: E0.32 (beside Pi restaurant)

Abstract: The volume of tweets on Twitter is increasing exponentially, thus providing us with numerous opportunities for detecting the occurrence of major events in real-time. We develop a state-space model for detecting disruption on the National Railway in Great Britain in a timely fashion, by using the content and volume of tweets referring to delays and disturbance in the railway. A time-inhomogeneous Poisson process, $\lambda(t)$, is proposed to model the number of tweets whose time-dependent intensity function is parameterized such that it captures the observed periodic pattern in the data. A hidden Markov process that represents the state of the railway through time ('normal'/ 'abnormal') then modulates the Poisson process. We further extend the model allowing for dependence in the data by developing multivariate Markov-modulated Poisson Process and discuss how to overcome the inferential challenges posed by such a model.

We develop a computationally efficient MCMC algorithm to learn the parameters governing $\lambda(t)$ and infer the state of the railway through time by utilizing a Forward-Backward algorithm to efficiently update the unobserved process. We demonstrate through extensive simulation studies that (i) we can successfully recover the model's

unknown parameters, (ii) predict the unobserved state with high accuracy with robust results towards model misspecification. Finally, we illustrate via Bayesian filtering how to predict the future state of railway in real–time given the observed number of tweets.