Abstract submitted for Celebration of Women in Australian Mathematical Sciences

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Title: The problem of modelling sleep: 2 analytic approaches via DPMMs and MTD models
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Session: Statistics

I shall discuss ongoing research to model sleep via 2 approaches:
[1] Dirichlet Process Mixture Models (DPMMs) to model sleep, mortality and morbidity in a cohort of very old women (Leigh, Hudson, Byles 2016; 2014) and [2] use of a multivariate extension of the mixture transition distribution (MTD) model, accommodating covariate interactions to study Australian railway drivers (RDs) sleep patterns by creating RD networks of sleep/wake /duty/break feature parameter vectors of between-states transition probabilities (Hudson, Leemaqz, Kim, Darwent, Dawson, 2016).
[1] The development of Dirichlet Process Mixture Models (DPMMs) goes back to the work of Antoniak (1974) and of Ferguson (1983). The Dirichlet process is a stochastic process used in Bayesian nonparametric models of data, particularly in Dirichlet process mixture models (also known as infinite mixture models). The most common application of the Dirichlet process is in clustering data using mixture models (Escobar & West, 1995). A novel extension is being refined to allow the inclusion of a survival response. Our approach to date is applied to self-reported sleep quality data collected over 5 waves, from the 1921-1926 cohort of the Australian Longitudinal Study on Womens Health (ALSWH) (www.alswh.org.au). The ALSWH is one of the largest longitudinal studies on womens health in Australia, with women still in the study 88-93 years and initially sampled N= 12,432 women. Variable selection procedures are employed to determine which covariates (among sleep measures, disease, BMI, Quality of Life measures, and demographics) drive the clustering of women. Predictions are made for various profiles to determine the hazard of death associated with specific sleep behaviours. There is some evidence that the presence of sleeping difficulty may be associated with better survival, with obvious ramifications to healthcare of the aged (Leigh, Hudson, Byles 2014; 2015; and 2016).
[2] Two SOM ANN approaches were used in a study of Australian railway drivers (RDs) to classify the RDs sleep/wake states and their sleep duration

time series profiles over 14 days follow-up. The first approach was a feature-based SOM approach that clustered the most frequently occurring patterns of sleep. The second created RD networks of sleep/wake /duty/break feature parameter vectors of between-states transition probabilities via a multivariate extension of the mixture transition distribution (MTD) model, accommodating covariate interactions. SOM/ANN found 4 clusters of RDs whose sleep profiles differed significantly. Our models confirmed that break and sleep onset times, break duration and hours to next duty are significant effects which operate differentially across the RD groups. Sleep is governed by the RD's anticipatory behaviour of next scheduled duty onset and hours since break onset, and driver experience, age and domestic scenario. This has clear health and safety implications for the rail industry. More recent work has also shown the impact on sleep of RDs hours to next break, hours to their next duty, in addition to anticipated duration of the RDs next break (Hudson, Leemaqz, Kim, Darwent, Roach, Dawson, 2016; IEEE 2016, BDVA).