

## **Hidden semi-Markov models for detecting reproductive status in cattle**

Jared O'Connell<sup>1</sup>

<sup>1</sup>Department of Genetics and Biotechnology, Research Unit of Statistics and Decision Analysis, University of Aarhus, P.O. Box 50, DK-8830 Tjele, Denmark

Accurate detection of reproductive status in cattle is critical to farm management. There currently exist a number of on-farm systems for this purpose. These typically involve either measuring "activity" (counts from a pedometer per hour) or the hormone progesterone (measured at the time of milking). Both measures are proxies for the reproductive status of a cow, with progesterone being the more expensive, but more accurate predictor. Little work has been done utilising both measures simultaneously, that is, analysing them as a multivariate time series. Combining the two measures should lead to improved prediction of reproductive status in addition to furthering the understanding of the reproductive cycle in cattle.

A hidden Markov model (HMM) would be a common solution to such a problem, with reproductive state as the hidden state in the model and a multivariate emission distribution (progesterone and activity). Such a model produces reasonable results. However, the implicit geometrically distributed sojourn time of HMMs is not consistent with the biological reality of a cow's reproductive cycle. Hence, hidden semi-Markov models are considered, which allow us to specify an arbitrary distribution for the sojourn time (at the cost of a more difficult parameter estimation procedure).