

ICMS WORKSHOP REPORT – PARAMETER ESTIMATION IN CONTINUOUS TIME *Gavin Gibson, Gareth Roberts and Andrew Stuart*

- *Part 1* There was no significant deviation from the original proposal.
- *Part 2* Continuous time models arise very naturally in the modelling of a variety of phenomena where random fluctuations are present. The models covered by the workshop fell broadly into two categories, those driven by stochastic differential equations (SDEs) and those described by point processes. Applications for both types of model come from diverse fields such as econometrics and finance, molecular modelling and the atmosphere/ocean sciences and modelling the spread of infectious diseases. As part of the overall modelling strategy in such application domains, it is frequently desirable to fit parameters driving the continuous time dynamics to data, in order to optimize predictive capability. As the generation and gathering of data in all application domains has gathered pace over the last decade, and as computational power has increased similarly, so the possibility of making reliable estimates of parameters has increased.

The subject has been developing in many exciting ways in many different fields, both methodological and application specific, and the workshop brought together researchers engaged in different aspects of the field. The primary importance of the workshop was in exposing researchers from this variety of fields to the work of one another, together with the resulting identification of important areas for future research.

- *Part 3* The researchers represented at this meeting included statisticians, applied mathematicians, physicists, engineers, climatologists, epidemiologists and biological scientists. The level of communication between these different researchers was good and there was a diverse and large audience consistently throughout the meeting.

The following areas were identified as being of interest for future research activity in the basic theory and methodology underlying this area:

1. Perfect sampling of diffusions.
2. Parameter estimation when data is low frequency.
3. Dealing with missing data in an effective fashion.
4. Confronting statistical methodology and theory with large-scale applications.
5. Developing approximate particle filters which can handle high dimensional problems (such as arise in atmospheric science).
6. Sampling conditioned diffusions.

7. Dealing with the estimation of state-dependent diffusion co-efficients especially when data is not high frequency.
8. The construction of fixed (but unknown) parameter particle filters.

The following application areas were identified as being ones which could benefit from further systematic development in the context of parameter estimation:

1. Biomolecular conformations; DNA modelling.
2. Rare events in molecular systems and climate/atmospheric systems.
3. Neuro-physiology.
4. Systems Biology.
5. Econometrics and Finance.
6. Epidemiology.
7. Hydrology.

The workshop seems to have been greatly appreciated by attendees. Many commented on the high quality and diversity of the talks; it is often difficult to succeed by both of these measures simultaneously. A typical quote is: "The scientific programme was of the best possible quality, bringing together scientists from different horizons, interested in the same problems but with different background." The academic value was uniformly thought to be high, with quotes such as "an exceptionally high number of first class talks" and "this was really mostly cutting edge".

Several researchers have developed new collaborations, including at least one between participants that did not know one another before. Here are just some of the links we know about. PhD student Yvo Pokern (Warwick) has initiated collaboration with Pavliotis (Imperial College). Pokern and Voss (Warwick) will visit Schuette (Berlin) to discuss overlapping interests. Stuart (Warwick) has initiated a collaboration with Vanden Eijnden (Courant Institute). Kalegoropoulos (Athens) initiated a collaboration with Godsill (Cambridge). Roberts (Lancaster) and Stir (Imperial) are now involved in a DEFRA project on modelling the risk of Avian Influenza in the UK poultry industry.