**Complexity Mini-Project**

**Title:** Understanding the Frequency of Extreme Events

**Supervisor**: Professor Stewart Robinson, WBS

**Background**

Extreme events are frequently reported in nature and human activity. For instance, we are regularly informed of new weather extremes (the hottest 3rd July on record for Lincolnshire!) or sporting achievements (cricket: the highest partnership between the 3rd and 4th wicket at the Oval since 1971). Such events are often commented upon and may be used, at least tacitly, to suggest underlying trends (e.g. global warming). Such extreme events, however, may simply be emergent phenomena from complex systems that fall within the range of expected behaviour.

**Research Objectives**

The purpose of this research is to explore the frequency of extreme events in complex systems. In this case, we aim to explore systems which consist of multiple stochastic variables that are dependent upon each other. We want to understand the frequency of extreme events under conditions of steady-state (constant variance for all variables) and under transition (steps and trends in variance).

**Approach**

The proposed approach is to develop a mathematical model of an n-dimensional polytope. Starting from an initial condition, the polytope will expand as a result of sampling new vertices outside of the its current bound (an extreme event). The rate at which extreme events are observed will be measured by simulating the expansion of the polytope through a series of sampling iterations. The dimensions of the polytope and the nature of the sampling distributions provide a measure of the complexity of the problem space being explored.

Research activities:

1. Literature research: related approaches and models
2. Develop a 2-D (polygon) model
3. Perform experiments with the 2-D model
4. Expand the model to an n-dimensional version
5. Perform experiments with the n-D model

It is only expected that steps 1-3 will be completed as part of the mini-project.

**Deliverables**

1. A model of the 2-D problem – probably based in Excel/VBA.
2. A dissertation including literature review, research undertaken and discussion of further research.

**Downstream Users**

All those with an interest in studying rare and extreme events.

**Follow-up PhD Project**

A follow-on PhD could explore some or all of the following:

* Expansion of the 2-D model to n-dimensions
* Validation of the model against empirical data (e.g. cricket scores and weather phenomena)
* Exploring alternative models of extreme events