3rd Year Project Topics

1. Efficient Algorithms for Cluster Enumeration on Regular Lattices

It is common in nature for a large number of similar elements, (e.g. molecules, animals), to interact in such a way that "collectively" they exhibit large-scale behaviour, not seen at the basic level. This collective behaviour can be quite varied and complex, e.g. magnetization, percolation, turbulence etc. and may involve both space and time features. A basic requirement of many of these problems is the enumeration of "clusters" of similar elements in regular spatial arrays, such as a lattice. The efficiency of the enumeration algorithm frequently determines the quality of the overall result obtained for the system of interest. This project is concerned with implementation and comparison of enumeration algorithms for selected tasks.

2. The Spatial Factor in Modelling Epidemics by Cellular Automata

Cellular automata are stylised, synthetic universes defined by simple rules, much like those of a board game. They have their own kind of matter and time. Given a suitable recipe, this simple operating mechanism is sufficient to support a whole hierarchy of structures and phenomena. In particular, cellular automata supply useful models for many investigations in the natural sciences. One such application is the modelling of epidemics and this project is designed to employ cellular automata models to investigate spatial clustering effects in the spread of a simple epidemic.

3. Foam mechanics at the bubble scale

(Molecular dynamics simulation for linear elastic properties). Foams behave as elastic solids for small applied shear stress and flow like viscous liquids at large applied shear stress). A simple bubble-scale model, proposed by Durian (1995), is to be implemented in which randomness, dimensionality and liquid content can all be easily varied. Of particular interest are graphics representation of the avalanche-like topological rearrangements under shear strain and the exhibition of self-organized criticality, (i.e. natural rearrangement).

4. Ageing, Competition and Mutation

This project looks at the spatio-temporal evolution of finite populations of organisms under growth curtailment or enhancement due to mutation, competition and ageing. The parameters of Mutational Meltdown will be explored for asexual populations of organisms using simulation techniques, Inghe (1989), Penna and Redfield (1994), and a suitable GUI designed.