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Thursday 6th December 2007: Evening Lecture

MODELLING CONFLICT

Lectures will be held in Central London. 57-58 De Morgan House – Russell Square.

5:00pm – 7.00 pm: Professor Timothy Hackworth & Philip Treleaven (Computer Science UCL)

Computational Science has already had an immense impact on the life sciences. We now try to assess its effectiveness on social and political modelling and, in particular, in thwarting terrorism. We started our study some years ago in a very successful attempt to forecast the outcome of disputes between nations, not only if there might be a conflict, but also when that might take place. Our data came from forty-five years' worth of financial records taken from the archives of the United Nations and the International Monetary Fund. We based our reasoning on Richardson's theory of arms races which was originally formulated in the 1940s. Richardson basically said that if there are two nations X and Y whose annual defence expenditures are $\$x$ billion and $\$y$ billion respectively, then the rates of change of defence expenditures, dy/dt and dx/dt are given by $dy/dt = ax - by$ and $dx/dt = cy - fx$, where a and c are called the *defence coefficients* and b and f are the *expense and fatigue coefficients.* These two first-order ODEs are sufficient to show that there may be a conflict one day between X and Y, but when? While working quite separately on the avoidance of canard explosions in factories manufacturing plastics (a system of equations as it happens which are remarkably similar to those of arms races), Peng, Gåspår and Showalter showed that any change in the direction of curvature of the limit cycle $d(dy/dt / dx/dt) /dt = 0$ is crucial for it marks a likely instability in the system. It can be proved rigorously that the difference $a - c$ gives the direction of curvature of the limit cycle. In a Richardson context we treat *conflict* and *instability* as synonymous. Using Richardson modified by Peng *et al.* we applied these arguments to military conflicts between countries (amongst others India and Pakistan, the Middle East and Greece and Turkey). We plotted $a - c$ for different values of percentage defence expenditure obtaining at the time, and obtained very distinctive graphs in which there were a number of dramatically sharp drops and rises between consecutive readings. When these drops were set against time we discovered a strong correlation

between the drops and the dates on which conflicts had occurred historically. Using this technique, we were able to 'predict' historically recorded conflicts in the period 1955 to 2000 with an accuracy of 83%, the remainder being mainly false-positives. Heartened by these early predictive results (which we argued were capable of more general application), we have modified Richardson's original arms race theory to cater for terrorism. By this time we had the advantage of a paper by Roach, Ekblom and Flynn from UCL's Jill Dando Institute of Crime Science which lists eleven factors thought to be common to all terrorist incidents. Since a major problem in modelling is finding appropriate and feasible parameters and of locating some parameters which can act as proxies for others, the Jill Dando paper has significantly eased our modelling problem. Nevertheless, it does not wholly solve the problem for we are still forced to argue from the particular to the general, and somehow we have to translate the characteristics of individual terrorists — about which there is now a lot of data — into generic terrorist traits, and this means assigning metrics to qualities (like "zeal" and "hatred" and "climate of terrorism") normally handled qualitatively.

We also look at two quite different alternative approaches, a 'bottom-up' agent-based model by Epstein and Axtell, and one by Farley and Petersen which uses lattice theory (i.e. ordered sets) to determine the effectiveness and battle-worthiness of a terrorist cell. Finally, we bring this all together by touching on the philosophical limitations of modelling human action and reaction, and close by listing the sort of results which we aim to achieve.

Frank Smith
and the LIMS Committee

Entrance is Free and Event Open to All
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