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PhD Topic
Bio-Terrorism, Epidemiological Modelling and Public Policy

Background. The world today faces serious and credible threat of the use of biological disease agents against civilian populations. Governments must formulate policy for both strategic preparedness and tactical response to such attacks. Policy tools include immunization of first-responders and the public, extensive surveillance, control of population movement, assumption of extraordinary police powers and other suspension of civil liberties. The policy maker must choose a combination of tools which is effective, reliable and acceptable.

The problem. The formulation of tactical and strategic policy for bio-terrorism preparedness and response is based in part on computational models of the spread of disease. The epidemiological phenomenon is extremely complex and poorly understood, so these models are accompanied by tremendous *uncertainty.* This uncertainty is both aleatoric and epistemic. *Aleatoric uncertainty* is represented by probability distributions of model parameters. *Epistemic uncertainty* is plain old-fashioned ignorance: we simply do not understand the dynamics of disease transmission well enough to accurately and reliably model a bio-terrorism event. The *research questions* are, (1) how to model the epistemic uncertainty of epidemiological models and (2) how to compare and select policy alternatives in terms of effectiveness and robustness to both aleatoric and epistemic uncertainties?

Outline.

1. *Literature survey* of (1) epidemiological models and (2) models of epistemic uncertainty. The latter will include info-gap models of uncertainty.[1]

2. *Formulation of strategies* for evaluating policy tools which account for effectiveness as well as aleatoric and epistemic uncertainties. This will include both classical strategies (e.g., expected utility) and info-gap decision methods.

3. The *theoretical research question* here is to improve our ability to model and manage the impact, on policy selection, of aleatoric and epistemic uncertainty of the epidemiological dynamics. The goal is to characterize the relative strengths and weaknesses of alternative policy-selection strategies. This involves both *analytical and numerical* exploration. The analytical goal is to discover theorems which compare the policy-selection strategies. The numerical approach entails simulation to discover these strengths and weaknesses.

4. The *practical development question* is to develop algorithms and software for efficient policy evaluation.

Funding. Full scholarship as well as travel and research money is available.

Interested students are invited to contact me by phone or e-mail.

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[1] Yakov Ben-Haim, 2001, *Information-Gap Decision Theory: Decisions Under Severe Uncertainty,* Academic Press.