CENS INSIGHT

A Review of Global Open Source Intelligence

(02/2007) (09 May 2007)

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Urban Disaster Management: What's the "PLAN"?

Researchers[1] from the Courant Institute of Mathematical Sciences and the New York City Poison Control Centre have jointly developed an urban disaster simulation and management system known as PLAN C (Planning with Large Agent-Networks against Catastrophes). The objective of PLAN C is to allow planners to simulate, analyse, and anticipate consequences of an urban catastrophe, and thereby improve the capabilities of both the government and the private sector to prepare and respond to large-scale disasters.

Agent-based Modelling

Recognising that the real-world catastrophe milieu is essentially a complex system whereby agents interact with the environment dynamically, PLAN C employs an agent-based platform to model the impact of a disaster. In other words, PLAN C reflects the existence of individuals with specific defining characteristics and needs by representing the disaster landscape as a collection of "affected" autonomous decision-making entities and their interactions with the available resources. From the characterisation of these individual agents and their resultant follow-on actions, emergent "macro-level" behaviours are then generated. PLAN C is therefore consistent with the fundamental tenet of disaster response planning: that is to simulate what people, individually and as a group, *is likely to do* in an exigency, rather than what the contingency planner *would like them to do*.

Scenario of a Point-Source Attack

In order to test the modelling power of PLAN C, one of the scenarios which the developers simulated is that of a sarin gas attack (a point-source strike) at a Port Authority Bus Terminal in Manhattan, New York. For this scenario, the affected population is modelled as a group of reactive selfish agents with "bounded" rationality and a certain degree of random behaviour to reflect the possibility of irrational or contrarian attitudes. Meanwhile, the health level of the affected agents is initialised according to the four main levels of illness infliction, defined respectively by the following probabilities: $dead_{pr} = 0.05$; $severe_{pr} = 0.2$; $light_{pr} = 0.3$ and $no\text{-}symptoms_{pr} = 0.45$. The inclusion of agents with mild or no symptoms is designed to simulate the effect of the "worried well"—that is people who do not actually require medical treatment but nonetheless consume available resources.

[1] Specifically, these researchers are Giuseppe Narzisi, Joshua S Mince, Silas Smith and Bud Mishra. More details of their work on PLAN C can be found at http://bioinformatics.nyu.edu/Projects/planc.

The simulation results of a disaster magnitude of 1000 exposed people reveal that around 70% of the population will receive treatment within the first 800 minutes of the attack aftermath. When the disaster scale is magnified by five and ten times, emergency response performance does not decrease dramatically (for 5000 people, the percentage that will receive treatment by the first 800 minutes drops to approximately 60% while for 10000 people, it is around 50%). The simulation results thus appear to suggest that New York's emergency response system is still relatively competent, in the sense that most victims would have been seen and treated with the first 24 hours of the attack.

Additionally, PLAN C also models the effects of varying the topology of available resources. In the case of the New York sarin gas attack, the resource being varied is the availability of the three closest hospitals to the disaster scene. When the closest hospital, St Vincent's Midtown Hospital (SVH) is removed, minimal impact on the overall treatment rate of the affected population is recorded. The subsequent removal of the second closest facility, Roosevelt Hospital (RH), on the other hand, reveals an interesting but paradoxical phenomenon: a significant increase in the number of agents receiving treatment early as well as an earlier overall recovery point. Further removal of the third closest facility, Bellevue Hospital (BH), results in a slight deterioration from the previous optimal pay-off.

Quite clearly, the simulation results demonstrate a counterintuitive emergent situation: the ceasing of the operations of the two closest hospitals (SVH and RH) to the disaster site actually results in an optimal recovery situation. Indeed, the closing of all three closest hospitals (SVH, RH and BH) will still elicit recovery performances that are more superior compared to one in which all three hospitals are in operation. The results of the PLAN C simulation therefore throw up the possibility of an interesting disaster recovery dynamic: that is the removal of the closest hospitals leads to a better distribution of agents among all the available city-wide facilities by removing the incentive for people to crowd the neighbouring hospitals in a counterproductive fashion.

Appraising PLAN C

Contingency planners usually rely on logistically complicated and human-intensive "live" exercises to test the robustness and integrity of current disaster management policies. While not suggesting that "live" exercises are not useful, the emergence of PLAN C as an urban disaster simulation technology represents the possibility that it may become a viable alternative tool to provide supplementary insights into the dynamics of disaster management and help refine existing policies.

That said, for all the promise of PLAN C, it is also evident that its current incarnation has much to evolve before it can be operationally applicable. For a start, the simulation results of PLAN C need to be validated with more instances of real-life occurrences to ascertain the ability of the system to accurately reflect reality. Too little of such validation work has been done.

Second, PLAN C needs to be tested with a wider variety of disaster locations—rather than primarily large North American-type cities—to demonstrate its level of importability to other parts of the world. While simulation of a disaster situation in the Brazilian state of Minas Gerais has been attempted before, this is certainly not enough.

Third, PLAN C also needs to incorporate a greater number of simultaneous interacting variables to reflect greater robustness in its complexity modelling process. In the case of the

New York sarin gas attack, for example, additional resource factors such as response time of first-responders as well as availability of ambulances may well qualify as concurrent intervening parameters.

Finally, the current agent-based framework of PLAN C assumes a configuration of independent, autonomous agents. This does not takes into account the fact that agents can actually interact with one another and thus form dependent social networks that may well alter the dynamics of their eventual responses. The modelling of agent networks should therefore be incorporated into the extant agent-based framework.

In sum, PLAN C has the potential to become a useful tool that may help contingency planners refine their disaster management policies. However, more work needs to be done before it can be in a position where it can present itself as a viable alternative to “live” simulations of disaster response.