Tools for Modelling Dynamic Target Systems

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Information Operations Target Dynamics

The Information Operations Target Dynamics (IOTD) project is being conducted within the Policy and Capability Studies Department of Dstl. IOTD aims to support Information Operations by assessing the social and technical aspects of target systems. The project objectives are:

- to develop a relevant science base to support this aim;
- to demonstrate the utility of specific selected models.

This work is funded by the Human Sciences Domain of the UK Ministry of Defence Scientific Research Programme

Ariadne

As Greek Mythology would have it, Ariadne provided the means through which her love Thesius was able to escape from the Labyrinth in which he had been imprisoned.

The aptly named 'Ariadne' database tool created within the IOTD project serves a similar purpose, allowing a user to navigate through the abundance of information contained to find specific, utilisable entries.

The Ariadne tool was designed to store information on models relevant to the field of Network Modelling. It was set up as a database to allow easy search and retrieval of information. Figure 1 contains a sample of the data contained in Ariadne.

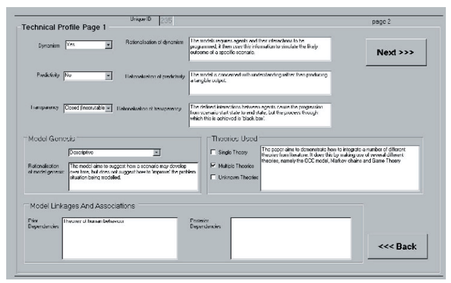


Figure1: Example of Data Stored in Ariadne

Each entry in Ariadne contains all the information that a potential user may need to know in order to understand:

- What the tool is;
- What capabilities it possesses;
- When and where usage is appropriate;
- How to contact the developers;
- Where to obtain the software.

Ariadne has been used by the IOTD project team to down-select from the totality of models entered to just those which possess certain criteria that make them suitable for the project. Through this process, models that are **dynamic** (as opposed to static models such as in Figure 2), **transparent** to external scrutiny, **predictive** to some degree and **available** were identified. PS-I and Blanche have been chosen from this subset for further, more detailed analysis.

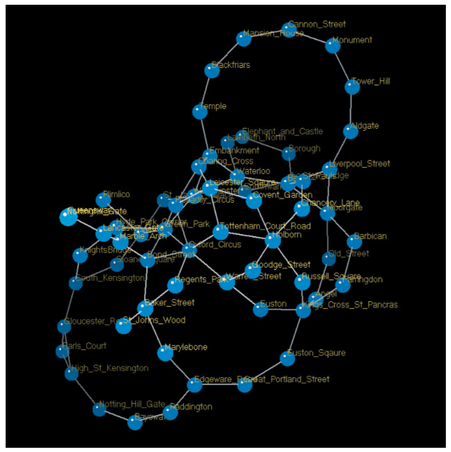


Figure 2: Screen Shot of Static Model

PS-I

PS-I (Political Science Identity) has been under development in various guises since 1997; current developments are being funded through a 3 year grant from the National Science Foundation. PS-I originates from Professor Lustick and Dr Dergachev at the University of Pennsylvania.

PS-I is an environment for running agent-based simulations. Based upon the concept that people have multiple **'identities'** which they present to the world, agents in the model similarly possess a number of alternative identities which they may switch between. Each identity causes an agent to **interact** with other agents in varying ways and so behave differently.

The creator of a specific simulation defines **rules** governing how and when agents change their identity. The **parameters** that relate to these rules are displayed on a separate page where the user can manipulate them (see Figure 3). Through these parameters, "what-if" type analysis may be undertaken upon simulation of the scenario.

Parameter	Value	Description
Actor A	2	Level of influence of Actor B
Actor B	4	Level of influence of Actor B
Comms_AB	5	Strength of communications between actors A and B
Comms_AC	5	Strength of communications between actors A and C
Comms_BC	5	Strength of communications between actors B and C
Resource	100	Availability of resource X

Figure 3: Screen Shot of Parameters Page

The simulation can be run as an experiment (a series of runs) and the outputs exported to either Excel or SPSS for statistical analysis. The data to be collected are specified when the simulation model is created.

By running a series of experiments which each simulate a slightly different scenario, it is possible to explore how changing a particular aspect of a situation may impact upon future events. For example, the sample outputs in Figure 4 show the impact of intervention strategies on rumour spread through and office.

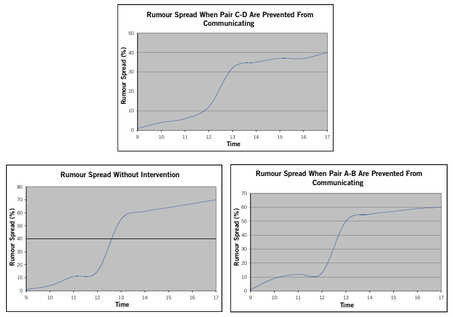


Figure 4: Graphs of Rumour Spread According to Intervention

Ongoing work is using case studies to assess the modelling and data requirements of PS-I and to explore the potential that it has for future utilisation in the IOTD project.

Blanche

Blanche is a multi-agent based computational modelling environment. It can be used to specify, simulate and analyse the changes that occur within and between actors in an evolving network.

The development of Blanche is funded by the National Science Foundation and run by Professor Noshir Contractor of the University of Illinois at Urbana-Champaign.

Blanche models start with a set of **actors**. For each actor, the user defines a set of **attributes** that contain details about that actor such as whether it is male or female. For each pair of actors, the user defines a set of **relations** that define how that pair of actors interact with each other.

In addition to basic attributes and relations, Blanche has the ability to represent **cognitive attributes** (what each actor thinks the attributes of the other actors are) and **cognitive relations** (what each actor thinks the relations between the other actors are).

The values of attributes, relations, cognitive attributes and cognitive relations are represented numerically and mathematical equations are then used to define how these values change over time.

Blanche has a number of visualisation tools that aid with the interpretation and analysis of results. For example, the output in Figure 5 shows a situation in which five actors start with different amounts of respect for their leader but all share the same view after a period of communicating with each other.

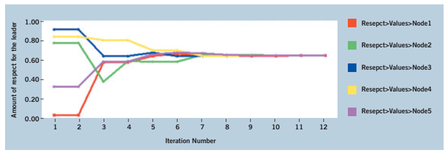
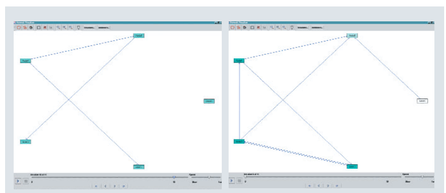


Figure 5: Blanche Graph Showing Converging Opinions

It also allows dynamic visualisation of the network. Figure 6 shows the network, initially and after ten iterations. The lines between the nodes represent communication between them during an iteration and the shading of the nodes represents their amount of respect for the leader.



(a) Communication at Iteration 0 (b) Communication at Iteration 10

Figure 6: Dynamic Visualisation in Blanche

Ongoing work will use case studies to assess the modelling and data requirements of Blanche and to explore the potential that it has for future utilisation in the IOTD project.

Case Study Data Collection

Dynamic social network modelling is a relatively new discipline and as a consequence the models being investigated have little or no track record to demonstrate their validity or utility for this purpose.

In order to assess the models' suitability for modelling Information Operations, they were tested with a carefully selected case study.

Case Study Requirements

- Sufficiently small so that problems could be identified;
- Sufficiently large to present a challenge;
- Include attribute, relations and behaviour data;
- Monitor the network over time.

These demands proved too challenging for the use of an historic case study and so a data collection exercise was set up to provide data specifically evaluation purposes.

Thirty members of Dstl from a group that work together were selected and asked to fill in an online survey once a month for five months. The survey asked about the individuals' communication habits and expertise amongst other things.

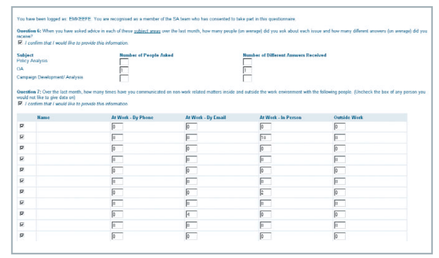


Figure 7: Screen Shot of the Online Data Collection Survey.

The data collected was designed to meet the requirements of both PS-I and Blanche. By collecting over a period of time, the dynamics of the groups could be observed and the ability of the models to replicate this assessed.

The Way Ahead

Although it is recognised that making explicit predictions about the actions of humans is unlikely to ever be possible, research is ongoing within Dstl to develop a science base capable of providing support to decision makers in this area.

For more information on this work, you can contact Emily Keefe at emkeefe@dstl.gov.uk and Jackie Offord at jfofford@dstl.gov.uk.