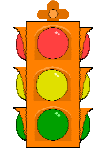


Visualising the Propagation of Uncertainties

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Rob Young

In support of effects based approach to CBRN capability audit

- The **policy maker wants** actionable information
- The **analyst wants** an ability to assess the confidence of the information used to reach the conclusion of the hypothesis
- This requires objective information
- Supported by a measurement of its subjectivity
- Therefore for a graphical representation of the network an ability to assess the subjectivity as it flows through the network is important

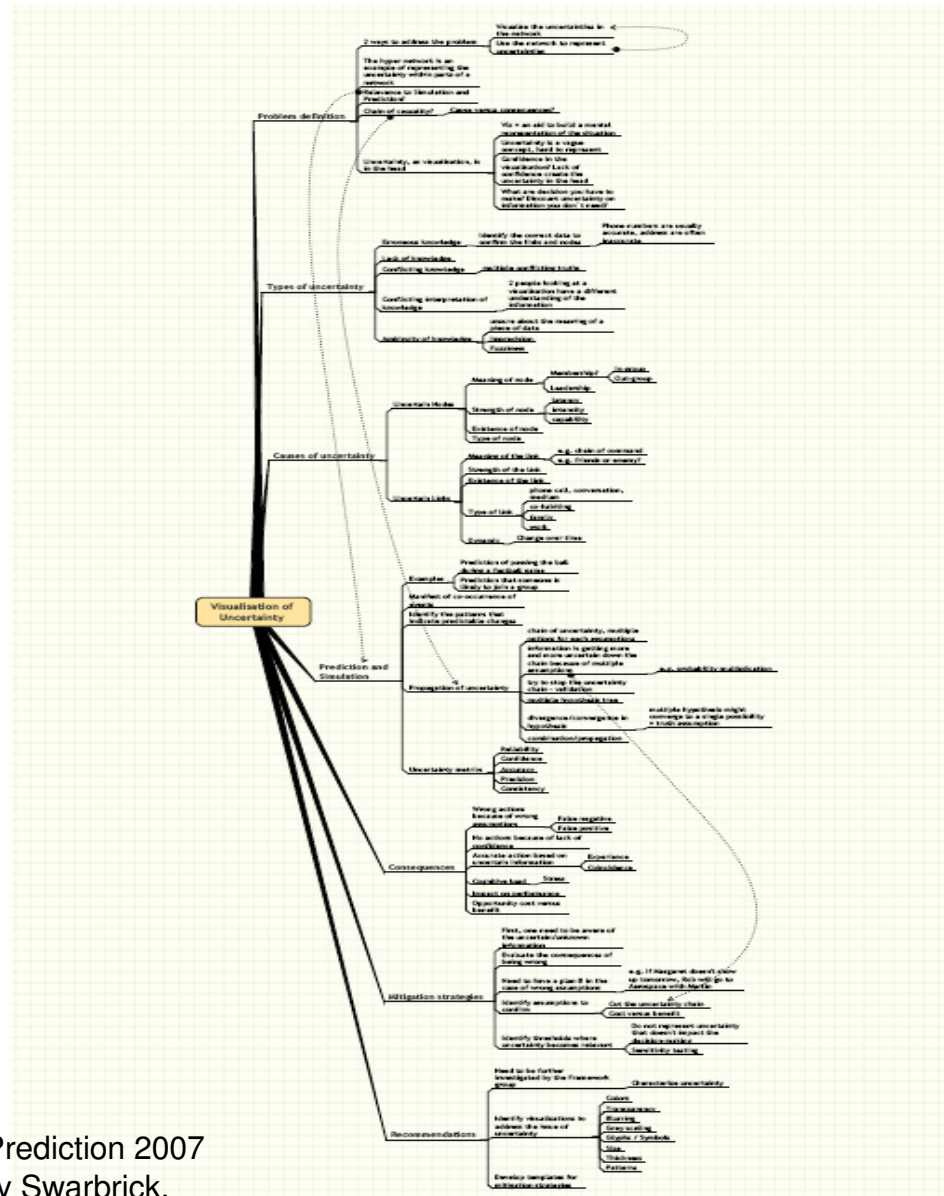


Visualising Uncertainty

- We know uncertainty can be visualised in a variety of techniques for example using line widths, shapes, colours etc..
- However to display any representation of uncertainty the uncertainty first needs to be quantified in some manner.

Visualization of Uncertainties

Uncertainty is the subjectivity of the **evidence** & its **propagation** through network



NATO Network Analysis and Visualisation for Simulation and Prediction 2007
 Workshop: Visualisation of Uncertainties, Alain Bouchard, Andy Swarbrick,
 Ed Palazzolo, Zack Jacobsen, Donna Nystrom and Margaret Varga

Bayesian Network

- Uncertainties exist in:
 - In input data
 - Interactions
 - Inter-relationships
- Bayesian approach can
 - Combine priori knowledge with statistical data
 - Manage causal relationships
 - Can be improved through observations

Evaluation of Subjectivity

The uncertainty that we are interested in is not the probability (likelihood) that arises from the resulting hypothesis from the capability audit but the *subjectivity* of the evidence in support of that hypotheses.

For example a Bayes Belief Network (BBN) populated by probability distributions of for example a Gaussian then this subjectivity propagating through the network can be calculated using the square root of the sum of the square of the standard deviations of the probabilities distributions.

We intend to show the flow of the subjectivity on a second network that mirrors the BBN but visualises the flow of subjectivity through the network.

Measure of the Propagation of Subjectivity

- The subjectivity (uncertainty) associated with the random variable (hypothesis) X is given by:

$$H(X) = -\sum P(x_i) \log P(x_i)$$

- Shannon entropy of the random variable X .
- Propagation of evidence flows from the information variables to the hypothesis variables

Propagation and Interaction of Uncertainties

