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Visualisation in Intelligence

Many of the key problems facing modern society are being addressed by the development of complex computer models that feed upon disparate data sets, for example predicting the pathways an epidemic will use to spread[1], crime prevention[2] or risk management for mitigation of a terrorist attack[3]. Common to all this work is the need to manipulate disparate data sets in new and novel manners to provide useful information to form intelligence upon which a decision can be made.

Intelligence production is a complex process and as the number of different intelligence feeds that must be manipulated to infer pertinent intelligence grows it becomes increasingly taxing for a human resolve uncertain data and make informed decisions. There is an increasing need to develop tools and techniques that facilitate the discovery of salient information within data, as well as for the consistent manipulation, storage and representation of uncertain information. But, can visualisation technologies effectively assist in these tasks and can unified visualisation technologies work effectively across the different modalities of information, i.e. images, text etc?

Visualisation can be used to provide the analyst with the facility to display a selectable variety of intelligence sources. Data having a strong geographic component are typically visualised as overlays, where human spatial abilities can support interpretation of multiple levels. Information with no geographic aspect obviously cannot form a map overlay, but if it can be presented as spatial patterns (e.g. social networks) can similarly be viewed as overlays in an abstract space given sufficient commonality of elements. Where no obvious common space can be seen the next step may be to apply transformations to the data to fold a number of dimensions into a common framework. This can reveal patterns that otherwise would be impossible to detect, but has the drawback that the re-organised space may be hard for anyone but a dedicated expert to interpret. The ultimate goal of an effective intelligence operation is perhaps the search for the common dimension above those of disparate data and to operate and visualise in this space. The idea here is to assist the analyst to ask the question “How are these things related in the real world?” and is in large part a problem solving or model building issue.

When information is presented visually, efficient natural human capabilities can be used to perceive and process data. Orders of magnitude more information can be seen and understood in moments when presented visually rather than by any other known means. Information visualisation techniques accelerate

cognition by transforming non-visual data into a visual format because this is the format most readily processed by human mental resources. This has the beneficial effects of:

- reducing search times
- improving recognition of patterns
- increasing inference making
- increasing monitoring scope.

The problems are thus the practical ones:-

1. Whether there are topologies available that are robust to real world issues and whether there are methods that support the practical mapping together of topologies and real world intelligence data. Are there methods to automate, or at least speed up, the mapping of what can be expected to be large quantities of data onto topological representations, or will these tasks be so large as to be prohibitive?
2. Are there topologies that are robust to imprecise scaling of probabilities and sparse data, and is it possible to evaluate the impact of imprecision and sparseness on any inferences undertake?
3. Are there, or can there be, metrics to automatically assess the worth of knowledge associations and can these be represented to the analysts to aid their understanding?
4. Can the knowledge be represented in a form that is familiar and usable to the different types of analyst (e.g. image, humint), and in what forms should these be? Thus, in the case of a unified multi-modal tool, can information be presented flexibly to meet the preference of the analyst; is there such flexible technology in existence?
5. Can topologies be reused for different problems?

The effectiveness of any visualisation in the intelligence problem depends on the close involvement of the intended users from the conception, development and evaluation of the system. There are metrics and guidelines available for assessing generic problems. What are the issues that must be taken into account when assessing the performance of the users and the effectiveness of the displays in intelligence problems?

References

1. Academics tackle epidemics. Scientific computing world. Aug/Sep 07.
2. www.i2.co.uk
3. www.rms.com