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Ph.D. Research topic:

Process Safety: Reliability of Human Information Networks

Many institutions establish networks along which quantitative data and human reports are transmitted and interpreted, leading to operational decisions. Examples include hospital supervision of patient safety, military command and control, manufacture and distribution of commodities, surveillance disease transmission in human and natural populations, etc.

For instance, a good-sized hospital will typically perform tens of thousands of blood transfusions each year. Each transfusion is preceded by an information-flow network designed to assure fault-free transfusion. The consequences of error in reporting or interpreting the information preceding a blood transfusion can be severe. Typically, human error is detected in a small number of cases each year, and hospitals are concerned to eliminate even these few occurrences. The challenges, in this application as well as many others, are:

- Errors are very rare, idiosyncratic, and difficult to characterize.
- Errors can result from unique or surprising circumstances which historical data do not reflect. Consequently, statistical analysis and probabilistic modelling are not entirely adequate.
- Errors can result from human interactions whose origin are difficult to account for in specifying the information-flow requirements. For instance, synergy or antagonism within a team can make a large difference in the error rate, but how can one specify, quantify, or regulate the degree of good-will and cooperative behavior among members of a team?
- Some errors or "near misses" are not detected, so the true rate of successful information transfer and processing is poorly known. For instance, mistaken transfusion of a benign blood type—which will have no adverse effect—may go undetected.

The reliability of an information network is an assessment of how wrong the information and interpretations can be, without jeopardizing the outcomes of the decisions which are made. Evaluating the reliability requires a quantification of uncertainty. In human supervisory networks this uncertainty is complicated by unclear and variable motivational factors, by lack of crucial data, and by more conventional channel-related sources of random noise. These complications make the evaluation of the reliability difficult.

In this research we employ info-gap decision theory, together with probabilistic tools, to evaluate the reliability of information transfer in human supervisory networks. We use this evaluation in the design and evaluation of the network. Hospital patient safety will be a flagship example motivating and illuminating the research. This research is in collaboration with Dr. Cliff Dacso from the Methodist Hospital Research Institute, and the Abramson Center for the Future of Health, Houston, Texas.

The funding of this research enables full fellowship as well as ample logistical support and travel to scientific conferences.

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