Expert Elicitation of Adversary Preferences Using Ordinal Judgments

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Abstract

Obtaining probabilistic judgments from subject-matter experts is a difficult task, especially when those experts are not quantitatively trained. In this paper, we introduce a simple elicitation process where intelligence experts express their knowledge about adversary preferences by rank ordering the attractiveness of a collection of possible terrorist targets (or attack strategies), where the attractiveness or utility of each target to the terrorist(s) is assumed to involve multiple attributes. The probability distributions over the various attribute weights are then mathematically derived using either probabilistic inversion (PI) or Bayesian density estimation (BDE). This elicitation process reduces the burden involved in traditional methods of attribute-weight elicitation, and explicitly captures the existing uncertainty and disagreement among experts, rather than attempting to achieve a potentially misleading consensus. This work also makes broader methodological contributions to the fields of utility assessment and expert elicitation, by allowing the use of "unobserved attributes" to ensure the feasibility of PI, by showing how to apply BDE to ordinal data in a rigorous manner, and by elucidating the relationship between PI and BDE.

Biography

Chen (Mavis) Wang is a Ph.D. candidate in the Department of Industrial and Systems Engineering at the University of Wisconsin-Madison. She holds a bachelor’s degree in Industrial Engineering from Beihang University in China, and two master’s degrees in Industrial Engineering and Statistics from the University of Wisconsin-Madison. During her doctoral studies, Mavis has also worked as a research assistant in the Infrastructure Assurance Center at Argonne National Laboratory, and in the Integrated Modeling Environment group at the International Institute for Applied Systems Analysis.

Mavis' dissertation work extends game-theoretic models for homeland security in three different methodological directions. Her research consists of proposing a realistic representation of the uncertain and multidimensional adversary preferences, exploring rigorous and practical approaches for quantifying those preferences using ordinal judgments from domain experts, and developing sufficiently powerful computational tools for solving Bayesian games of defender-attacker interaction. Mavis' primary long-term goal is to continue extending the literature on how uncertainty should be taken into account in decision making -- for example, by merging game theory with probabilistic methodologies such as risk analysis, Bayesian statistics, and expert elicitation.