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Game and Decisions in Reliability and Risk

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Editorial: Games and Decisions in Reliability and Risk

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The aim of this special issue is to bring together recent advances in the use of game and decision theoretic methods in reliability and risk analysis. Due to the interdisciplinary nature of the theme, the special issue involves novel applied and methodological research from diverse disciplines such as economics, engineering, mathematics, national security, probability, and statistics. The special issue contains nine papers. Three of these papers were presented at the Fourth Symposium on Games and Decisions in Reliability and Risk which was held in Istanbul, Turkey on June 17-19, 2015.

The first article, "A graphical method for simplifying Bayesian games" by Thwaites and Smith shows how chain event graphs (CEGs) can be used in representing and solving Bayesian games. The authors point out that CEGs, which were introduced recently for Bayesian learning and model selection, provide an effective alternative to multi-agent influence diagrams for games with highly asymmetric trees.

The next three papers deal with issues of national security involving multiple decision makers (agents) who have an adversarial relationship. The paper by Shan and Zhuang is on "Modeling cumulative defensive resource allocation against a strategic attacker in a multi-period multi-target game". The authors consider an extension of sequential defender-attacker games, which have been previously analyzed for a single target, by allowing for multiple targets. In so doing, they develop optimal allocations for the defender under different scenarios and present numerical illustrations using real data. The second paper is by Quijano, Ros-Insua and Cano on "Critical networked infrastructure protection from adversaries". The authors present a new perspective using the adversarial risk analysis (ARA) framework to deal with the protection of critical networked infrastructures. The ARA framework relaxes the "common knowledge" assumption of the game-theoretic approaches which have been considered for protection of infrastructure networks. The authors illustrate their approach by

considering the protection of a section of the Spanish railway network from potential terrorist attacks. The next article is by Monroe, Ramsey and Berglund on "Allocating countermeasures to defend water distribution systems against terrorist attack". The article focuses on implementing countermeasures to discourage and reduce occurences of attacks to water distribution systems. As a result, the emphasis is on "first line of defense" policies rather than developing "secondary lines of defense" to mitigate the consequences of an attack. The authors present a simulation-based approach to model the attack-defense dynamics and to evaluate different allocation of countermeasures.

Our next two articles involve stochastic optimization problems that arise in risk analysis. The article by Ekin on "Integrated maintenance and production planning with endogenous uncertain yield" presents a simulation based stochastic programming (SP) approach to solve production and maintenance planning problems. The problem is formulated as a two-stage SP with recourse where second stage decisions are made after the joint production and maintenance decisions of the first stage and uncertainty is resolved. The paper considers the "decision dependent uncertainty" type of SP problem which is solved via the augmented probability simulation approach. The next article is by Zhang, Zhuang and Behlendorf on "Stochastic shortest path network interdiction with a case study of Arizona-Mexico border". The authors consider a stochastic shortest-path network with adversarial components. In doing so, they look at the scenario where an attacker attempts to minimize the traveling time between the source and target wheras a defender attempts to maximize the attacker's travel time by placing sensors to detect the attacker. The proposed approach and the solution procedure are applied to the case of Arizona-Mexico border.

The paper "A framework for risk management decisions in aviation safety at state level", by Rios-Insua, Alfaro, Gomez, Hernandez-Coronado and Bernal, proposes a comprehensive risk management framework as an alternative to risk-matrix based methods used for aviation safety. The proposed framework is based on principles of decision and risk analysis and uses more sophisticated tools such as risk maps for screening of occurences (accidents) and Bayesian forecasting methods for predicting occurences as well as different classes of occurences.

The last two articles involve stochastic modeling for reliability and risk assessment. The paper by Hermann, Ickstadt and Muller is on "Bayesian prediction for a jump diffusion process with application to crack growth in fatigue experiments". The authors extend the Paris-Erdogan equation by including a nonhomogeneous Poisson process for the jumps in the crack growth process. They introduce a novel Bayesian methodology for inference and prediction for the proposed jump diffusion process using Markov chain Monte Carlo methods. The proposed methodology is illustrated by using actual crack growth data from prestressed concrete beams. The next paper is by Ali and Pievatolo on "Time and magnitude monitoring based on the renewal reward process". The authors develop a new control chart based on renewal-reward processes which is capable of monitoring cumulative damage (or deterioration) of a system over time. The proposed control chart involves monitoring of the first passage time (FPT) above a threshold and therefore, is referred to as the FPT chart. The

authors provide the necessary probability expressions to obtain the control limits for the FPT chart using renewal theory and present a simulation study to analyze the performance of the FPT charts.