Approximation Methods for Infinite Bayesian Stackelberg Games: Modeling Distributional Payoff Uncertainty

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Game theory is fast becoming a vital tool for reasoning about complex real-world security problems, including critical infrastructure protection. The game models for these applications are constructed using expert analysis and historical data to estimate the values of key parameters, including the preferences and capabilities of terrorists. In many cases, it would be natural to represent uncertainty over these parameters using continuous distributions (such as uniform intervals or Gaussians). However, existing solution algorithms are limited to considering a small, finite number of possible attacker types with different payoffs. We introduce a general model of infinite Bayesian Stackelberg security games that allows payoffs to be represented using continuous payoff distributions. We then develop several techniques for finding approximate solutions for this class of games, and show empirically that our methods offer dramatic improvements over the current state of the art, providing new ways to improve the robustness of security game models.