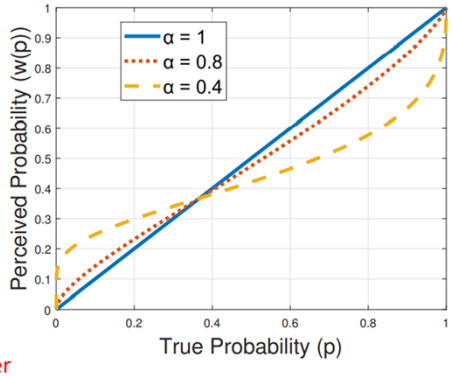
The Impacts of Human Decision-Making on Security and Robustness of Interdependent Systems

PURDUE UNIVERSITY

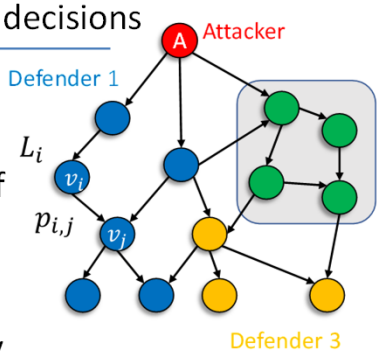
Challenge:

- People behave only *partially* rationally when making security decisions
- Interdependent systems, such as the energy or the transportation infrastructure, consist of a large number of assets managed by multiple stakeholders (i.e., defenders)
- Existing work on game theoretic security treats the players as behaving perfectly rationally; such models lead to sub-optimal security decisions

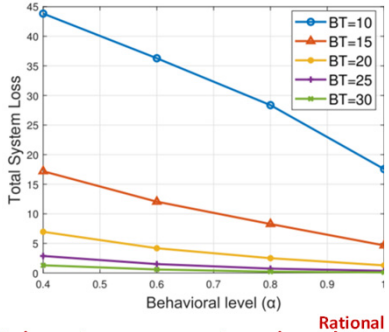


Solution:

- Introduced mathematical models of human decision-making into a game-theoretic framework for interdependent security



- Developed general formulations of attack probabilities, response actions, attack graph models of system interdependencies
- Using these formulations we created optimal design of networked systems to mitigate security vulnerabilities introduced by human decision-making



Risk misperception leads to suboptimal security investments, causing higher security loss. We show how to mitigate this through incentives and central planning.

Scientific Impact:

- Our work enhances understanding of the security of large-scale systems by explicitly analyzing the impacts of behavioral decision-making on the security investments and resource utilization by humans
- It expands understanding of the vulnerabilities that arise in large-scale systems due to human decision-making and corresponding mitigations
- It pioneers use of behavioral game theory in systems security and quantifies policies in cyber insurance

Broader Impact and Broadening Participation:

- Created a simulation game with modeled interdependent systems to teach public about investing in security
- Results presented at top Security and Economics venues, including BoF and workshops at Usenix Sec and DSN
- Results shared with multiple relevant corporations and government agencies
- 4 PhD students trained on this project have joined academia

CNS-1718637: Saurabh Bagchi (ECE & CS), Timothy Cason (Econ), Shreyas Sundaram (ECE)