Computing Optimal Randomized Resource Allocations for Massive Security Games

Background Presentation
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LAX airport resource allocation
Randomization

- To protect against possible threats, all the airports resources need to be allocated efficiently.
- A smart attacker would gather information about their site for attack in order to plan a more effective attack.
- A better approach is to use a randomization method to allocate resources to increase uncertainty of attacker.
- Use game theory to incorporate predictions on how attacker responds to given security policy.
Stackelberg Games

- A leader moves first and the follower observes the leader’s strategy before they act.
- This is due to the capability of the attacker to plan his attack against his opponent (best respond to defender’s mixed strategy)
Stackelberg Vs Nash Equilibrium

Stackelberg

Defender (Leader)

Site 1

2, 2

3, 0

Site 2

0, 0

1, 1

Attacker (Follower)

Site 1

Site 2

Nash
Strong vs Weak Stackelberg Equilibria

**Strong**
- When follower is indifferent, it will choose optimal strategies for leader

**Weak**
- Leader and follower both play best-response
- When indifferent, follower will choose the worst strategy for the leader
Compact Security Game Model

- Targets → attacker’s strategies
- Resources available to cover targets → defender’s strategies

example:
- Flights = targets
- resources = air marshals

- Compact model decreases payoff to 4 for attacked targets:

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<thead>
<tr>
<th></th>
<th>Covered</th>
<th>Uncovered</th>
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<tbody>
<tr>
<td>Defender</td>
<td>5</td>
<td>-20</td>
</tr>
<tr>
<td>Attacker</td>
<td>-10</td>
<td>30</td>
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Algorithms

- This paper 4 new algorithms to help randomize resource allocation
  - ERASER, ORIGAMI, ORIGAMI-MILP, ERASER-C

- Mixed Integer Linear Program (MILP)
  - Subset of a math program
  - have a set of variable and some constraints
  - Objective: try to minimize some variable
  - Linear program needs variables to be linear functions that are continuous
  - Integer program requires variables to be integers
  - MILP could have variables as either integers or linear functions