Reputations and Games

Sampath Kannan
Department of Computer and Information Science
University of Pennsylvania
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Reputations and Games

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Reputation – A game-theoretic view

• Need repeated (pair-wise) interactions between agents = repeated games

• What does an agent do in a game? She plays a (mixed) strategy ... which may change over time, depending on opponent, etc.

• Her “reputation” should be a function of this time-varying mixed strategy.
Repeated vs One-Shot Game: Example

• Prisoner’s Dilemma

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<thead>
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<th></th>
<th>Defect</th>
<th>Cooperate</th>
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<tbody>
<tr>
<td>Defect</td>
<td>-6</td>
<td>-1</td>
</tr>
<tr>
<td>Cooperate</td>
<td>-9</td>
<td>-2</td>
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</tbody>
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Payoffs to row player; Symmetrically to column player

• Game-theorists talk about “type” of player – defecting type or cooperating type
• Reputation: inferred type of a player based on repeated observation
To study value of reputation manager...

- Consider a 2-player game:
- Assume player Alice plays Bob repeatedly
- New twist: A does not know the payoff matrix
- Instead she must balance exploration and exploitation to minimize regret
- Exploration: A seeks to learn new matrix entries
- Exploitation: A seeks to profit from known entries
- Regret: A’s lost payoff compared to the situation where she knows the matrix to start with
If A knew B’s type …

- In zero-sum games she can identify her optimal strategies and learn payoffs for them with very little regret - $O(n)$ regret where $n$ is the number of strategies available to her. (This is best possible!)
- If instead she doesn’t know B’s type, best we can do currently is $O(n^2)$ regret. Probably can’t be beaten in general.
- Thus in this model, a reputation manager makes a big difference!
More ways RMs can help

- Use player’s behavior to estimate distribution of their types and their utilities for various outcomes.
- If we assume a Bayesian prior on types, then we can design mechanisms [Z. Huang and Bei] that
  - Cause players to tell the truth about their types
  - Produce approximately optimal social welfare in some important resource allocation problems
- Reputation managers can give us these Bayesian priors
More on Zhiyi-Bei result

• Mechanism design in Bayesian model for many optimization problems:
  – Combinatorial resource allocation
  – Submodular maximization

• These problems are known to be difficult to solve even approximately in worst-case model

• But in the Bayesian model (realized by having a reputation manager) there are good approximate solutions
Future Work

• Explore other possible definitions of reputation in the game-theoretic context
  – Altruism: Each player has an altruism parameter $a$ that corresponds to their reputation
  – Player gets payoff which is their own + $a \times (\text{everybody else’s})$
  – Player’s reputation is $a$ and must be discovered

• In games with multiple equilibria: reputation is a way of describing which equilibrium a player prefers.
Conclusions

- Game-theoretic frameworks can be used in two stages of our Trust Management infrastructure:
  - Defining and computing reputations
  - Making decisions based on these reputations
- While problems are still challenging, intractable problems assuming a worst-case adversary, could become tractable in this game-theoretic setting
- To use this idea one needs a more complete set of models for adversaries seeking to optimize their own objective functions