Social Computing Systems

Walter S. Lasecki

EECS 498, Winter 2016
(http://tiny.cc/socsClass)
[[ Quiz ]]
http://goo.gl/forms/fTnsBRe2Us
Today

- Methods for analyzing incentives in participation
Intro to Game Theory

(Just enough to impress your friends at parties)
What is game theory?

**Definition:** “the study of mathematical models of conflict and cooperation between intelligent rational decision-makers”

**Translation:** The study of *rational* motivation.

- A “rational” player seeks the biggest reward
Examples of a Social Computing “Games”
Coordination in Games

**Cooperative**: Contracts / communication allowed

- *Contract* = “we’re 100% committed to what we claim”

**Non-cooperative**: There is uncertainty in others claimed response
More Game Properties

**Simultaneous / Sequential**: Are decisions made at once or seq.?

**Temporal setting**: Is the setting discrete or continuous?
  - If continuous, is feedback (R) “separable”?

**Length**: Is the game played for 1 round, or 50? 1 minute or 10 days?
More Game Properties (Cont.)

**Perfect/imperfect info**: Do players know everything that is happening?

**Symmetry**: Are all players rewarded the same as each other?

**Zero-sum / non-zero-sum**: Does 1 player winning mean another loses?
What is the “Game” Configuration?
Cooperative/Non-Cooperative
Simultaneous / Sequential
Discrete/Continuous (separable?)
Length
Perfect/imperfect info
Symmetry
Zero-sum / non-zero-sum
What is the “Game” Configuration?
What does a solution look like?

A decision or policy. How do we get there?

- Compare outcomes
- Pick the best one

**Ex:**

**Prisoner’s Dilemma**

<table>
<thead>
<tr>
<th></th>
<th>Reveal</th>
<th>Hold Out</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reveal</td>
<td>(5yr, 5yr)</td>
<td>(10yr, Free)</td>
</tr>
<tr>
<td>Hold Out</td>
<td>(Free, 10yr)</td>
<td>(1yr, 1yr)</td>
</tr>
</tbody>
</table>
What does a solution look like?

A decision or policy. How do we get there?

- Compare outcomes
- Pick the best one

Ex:

Prisoner’s Dilemma

<table>
<thead>
<tr>
<th></th>
<th>Reveal</th>
<th>Hold Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>(5yr, 5yr)</td>
<td>(10yr, Free)</td>
</tr>
<tr>
<td>P2</td>
<td>(Free, 10yr)</td>
<td>(1yr, 1yr)</td>
</tr>
</tbody>
</table>
Dominant Strategies

One solution that is strictly better than all others

Can apply to one player, or many/all

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>($5, $5)</td>
<td>($100, $20)</td>
</tr>
<tr>
<td>P2</td>
<td>($20, $20)</td>
<td>($100, $5)</td>
</tr>
</tbody>
</table>
Dominant Strategies

One solution that is strictly better than all others

Can apply to one player, or many/all

P2

P1

($5, $5)  ($100, $20)

($20, $20)  ($100, $5)
Dominant Strategies

One solution that is strictly better than all others

Can apply to one player, or many/all
Nash Equilibria

Non-cooperative game setting
- Recall: players can’t make contracts/commitments to play a certain way

Stable state: even knowing other players’ strategies, everyone still sticks with the same choice.
Nash Equilibria: Example

**Stag Hunt Problem**: N hunters, N hares, 1 stag

Everyone is needed to shoot the stag

- Large reward

Anyone can shoot a hare alone

- Smaller reward
You have died of dysentery.

[Oregon Trail]
Nash Equilibria: Example

Stag Hunt Problem

- N hunters, N hares, 1 stag

P-Rest

Stag-All

<table>
<thead>
<tr>
<th></th>
<th>Stag</th>
<th>Hare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stag-All</td>
<td>(200lb, 200lb)</td>
<td>(1lb, 0lb)</td>
</tr>
<tr>
<td>P-Rest</td>
<td>(0lb, 1lb)</td>
<td>(1lb, 1lb)</td>
</tr>
</tbody>
</table>
Nash Equilibria: Example

Stag Hunt Problem

- N hunters, N hares, 1 stag

Why is this an equilibrium solution?
Nash Equilibria: Example

Stag Hunt Problem

- N hunters, N hares, 1 stag

\[
\begin{array}{ccc}
\text{Stag-All} & \text{Hare} & \text{Stag} \\
\text{Stag} & (200\text{lb, }200\text{lb}) & (1\text{lb, }0\text{lb}) \\
\text{Hare} & (1\text{lb, }0\text{lb}) & (1\text{lb, }1\text{lb}) \\
\end{array}
\]
Nash Equilibria: The WRONG way
Nash Equilibria: The WRONG way
Nash Equilibria: The WRONG way
Nash Equilibria: The WRONG way
Nash Equilibria: The WRONG way
Nash Equilibria: The WRONG way
Nash Equilibria: The WRONG way
What’s wrong with this “Nash” Equilibria?
Nash Equilibria in Practice

* Ex. for sellers/buyers, both-positive and both-negative reviews could be equilibria in some model formulations because of the desire to ‘retaliate’ for poor ratings.

Nash Equilibria in Practice?
Nash Equilibria in Practice?

* This claim applies to ‘peace’ and makes a lot of assumptions about the tensions at the time, rewards, etc. Remember that the equilibrium state promised by MAD (mutually-assured destruction) was a NEGATIVE reward outcome for all. This is why this setup actually helped us all to not blow up.
Nash Equilibria in Practice

* Our simplified model for ‘seeding’ versus ‘leaching’ for torrent files reduces this setting to a Stag and Hare problem. Adding uncertainty about the number of seeders required for a healthy torrent, and about the actions of other users gives us a probabilistic version of this model.
Today (recap)

- Methods for analyzing incentives in participation
  - Game theory helps us predict what will happen if our users are “rational” agents