Social Computing Models

Moshe Tennenholtz
Al meets GT in the 50s: when John (McCarthy) met John (Nash)

Marvin Minsky: *I learned even more from my own generation of students at Princeton: Particularly John Nash, Lloyd Shapley, Martin Shubik, and John McCarthy* (the society of mind, Page 323)
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The (impossible?) Big Dream

• The design of game theoretic agents is an ultimate challenge for AI:

Agent design:
How should an agent reason / plan / learn in order to optimize decision facing other decision makers? --

   *no satisfactory answer*

Mediator Design:
How should a mediator lead a set of agents who “selfishly” reason/plan/learn to a socially efficient outcome?

   *very partial answer following the “equilibrium” paradigm.*
• Say we know probability distribution over pages that the user desires.

• Trivial greedy algorithm is optimal.
Which search engine is better for me?

I'll see which one ranks [http://movies.yahoo.com](http://movies.yahoo.com) (my favorite) higher?

From now on, I'll use Google.
Perils of greed

Search

movie reviews

prob. website
18% http://rottentomatoes.com
16% http://movies.yahoo.com
15% http://www.metacritic.com/movies
13% http://rogerebert.suntimes.com
12% http://www.movies.com/movie-reviews
9% http://moviereviews.com
8% http://www.imdb.com
8% http://netflix.com/reviews
7% http://mrqe.com
6% http://movies.msn.com

http://movies.yahoo.com
http://www.metacritic.com/movies
http://rogerebert.suntimes.com
http://www.movies.com/movie-reviews
http://www.moviefone.com/reviews
http://moviereviews.com
http://www.imdb.com
http://netflix.com/reviews
http://mrqe.com
http://movies.msn.com

http://rottentomatoes.com
Perils of predictability

Any deterministic algorithm can be badly beaten.

Search

movie reviews

prob. website
9% http://moviereviews.com
18% http://rottentomatoes.com
13% http://www.metacritic.com/movies
15% http://movies.yahoo.com
15% http://rogerebert.suntimes.com
8% http://www.movies.com/movie-reviews
9% http://www.moviefone.com/reviews
6% http://www.imdb.com
8% http://netflix.com/reviews
7% http://mrqe.com
12% http://movies.msn.com

http://rottentomatoes.com
http://www.metacritic.com/movies
http://movies.yahoo.com
http://rogerebert.suntimes.com
http://www.movies.com/movie-reviews
http://www.moviefone.com/reviews
http://www.imdb.com
http://netflix.com/reviews
http://mrqe.com
http://movies.msn.com
http://moviereviews.com
Optimization $\rightarrow$ Games

Ranking $\rightarrow$ Ranking duel

Binary search duel

Routing $\rightarrow$ Racing duel

Greedy is $(1 - \frac{1}{n})$-beatable

Binary search is 62.5\%-beatable

Shortest (expected) path is $(1 - \epsilon)$-beatable

Hiring problem duel

Compression duel

“Secretary alg.” is beatable

Huffman coding is 66-75\%-beatable

TSP $\rightarrow$ Parking duel

TSP is $(1 - \epsilon)$-beatable
Facility Location Games

• Customers are distributed in some metric space.

• A set of players, where a strategy of a player is a facility in that space.

• Each customer is attracted to the closest facility.

• The payoff of each player is the (expected) proportion of customers that are attracted to her facility.
Player's payoff is the sum of attractions to her facility.
Incentive Engineering

A mechanism is **strategyproof** if agents can never benefit from lying = the distance from their location cannot decrease by misreporting it.

- **Problem**: average is not strategyproof
Routing

Which route should an agent take?

Taking the route that goes through s is $\alpha$ slower than taking the route the goes through f, but service is splitted when shared among agents.
Pricing

Store based pricing
Pricing

Location based differential pricing
Display Advertising
Sponsored Search

Google search results for "games" showing sponsored links for "Free Racing Game" and "MyGame".
Ranking Systems
Trust Systems
Predicting and learning social structure – How are friendships structured?
Social Laws for Artificial Agent Societies

Given a multi-agent system, in an off-line phase provide constraints on agents’ behavior, which will allow each agent in the on-line phase to act individually, and succeed well, regardless of the behavior of others, as long as all agents conform to the pre-designed laws.

The main message: the way to design multi-agent systems is by formally addressing the above golden-mean problem.

(Karpas and T, 2016)
The Game of Coins

Every coin $c_i$ has a reward $w_i$

Every miner $p_j$ has mining power $m_j$
The Game of Coins

Miners choose where to mine
ERC AdG: Mechanism Design for Data Science

The project aims at building theoretical foundations, providing algorithms, as well as validating through experiments, a fundamental bridge between mechanism design and data science. The ultimate success of this research would be the replacement of classical relevance ranking, segmentation, on-line explore & exploit, and influencers’ detection algorithms by incentive-compatible ones, creating the next generation of data science algorithms.