

Game theory in CS

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About me



Colchester, UK (2019-2020)



Changchun, China (2008 - 2019)

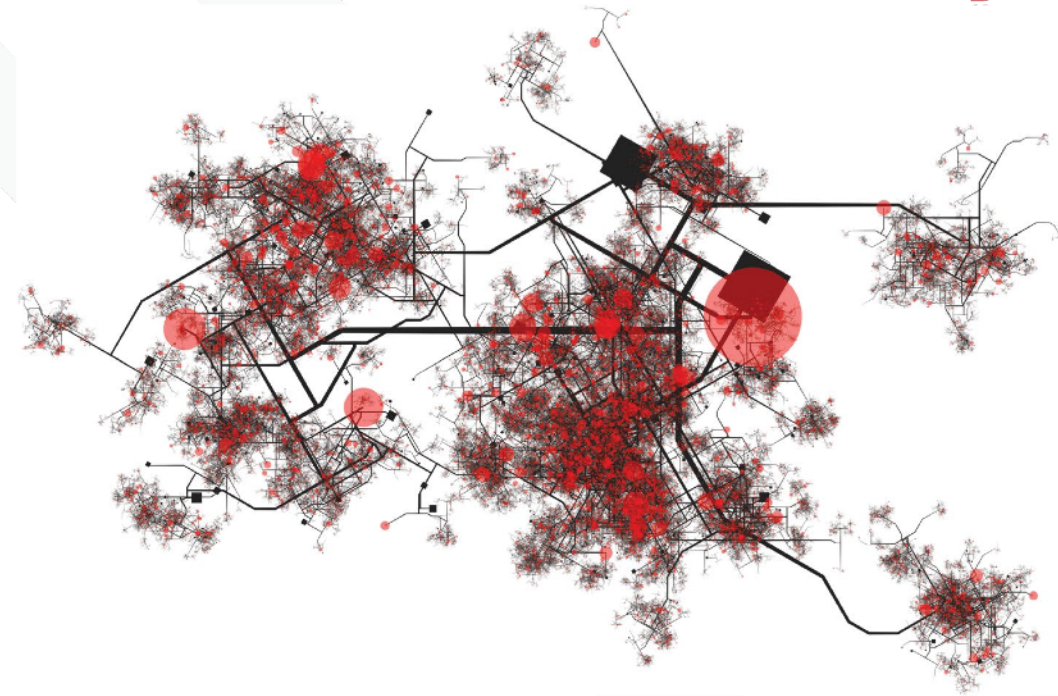


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Agenda

- Game theory in Computer Science
- Reveal the impact of new tech in decision-making
- Why theoretical research is important?



First point of contact

- Origins of game theory
 - “Zur Theorie der Gesellschaftsspiele” (1928)
 - Theory of Games and Economic Behaviour (1944, with Morgenstern)
- Early contributions to computing:
 - ENIAC (UPenn, 1945)
 - IAS machine (1945-1951)



Games and Nash Equilibria

- Nash's Theorem (1950): every finite noncooperative game has at least one (Nash) equilibrium
- 1994 Nobel Prize Recipient in Economics



An equilibrium



Games and Nash Equilibria



	Rock	Paper	Scissors
Rock	0, 0	-1, 1	1, -1
Paper	1, -1	0, 0	-1, 1
Scissors	-1, 1	1, -1	0, 0

Turing and unsolvable problems

- Importance:
 - Formal model of computation: Turing Machine
 - Existence of unsolvable problems
 - E.g., the “halting problem”

ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO
THE ENTSCHIEDUNGSPROBLEM

By A. M. TURING.

[Received 28 May, 1936.—Read 12 November, 1936.]



File Transfer Game (BitTorrent)

- **Players:** Alice and Bob
- **Action:** upload / not upload (simultaneously)
- **Payoff:** Benefit of download 3; Cost of upload 1
- **Question:** better to upload, or not?

	Upload	Not upload
Upload	2, 2	-1, 3
Not upload	3, -1	0, 0

BitTorrent

- Strategy: breaking big files into many pieces (10 MB)
- User exchange file pieces: resembles repeated prisoner's dilemma
- Default client:
 - Broadcast which files you have;
 - Request download from all peers with selective file pieces;
 - Split upload capacity equally across s peers;
 - Choose the peers that are nice to you! tit-for-tat

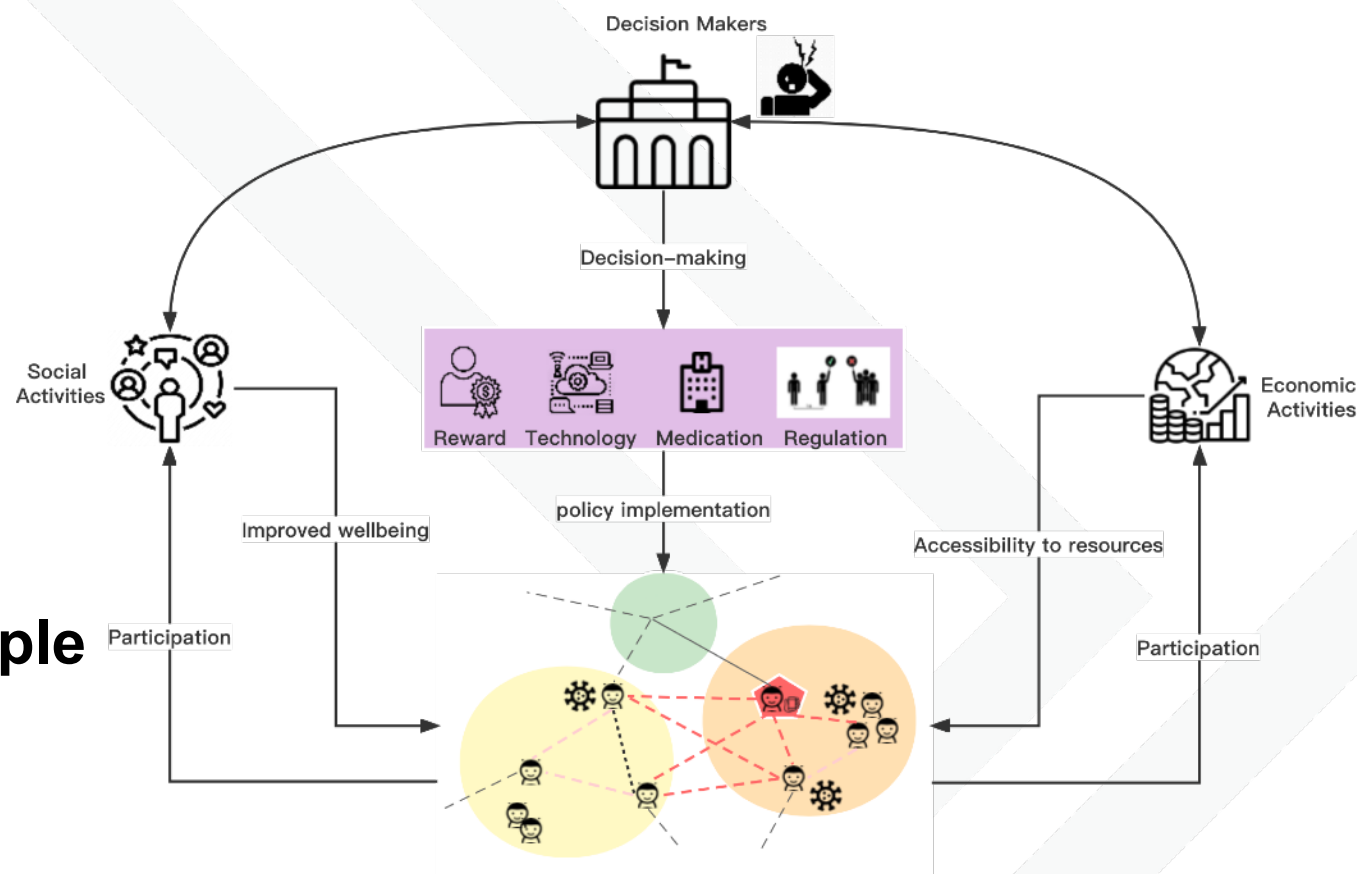
When Economics and Computer Science Meet

- Amazon: make an existing market better
- Google/Facebook: market for advertising
- Uber: market for ride sharing
- Airbnb:
- Ebay: a union of garage sale
- Tinder

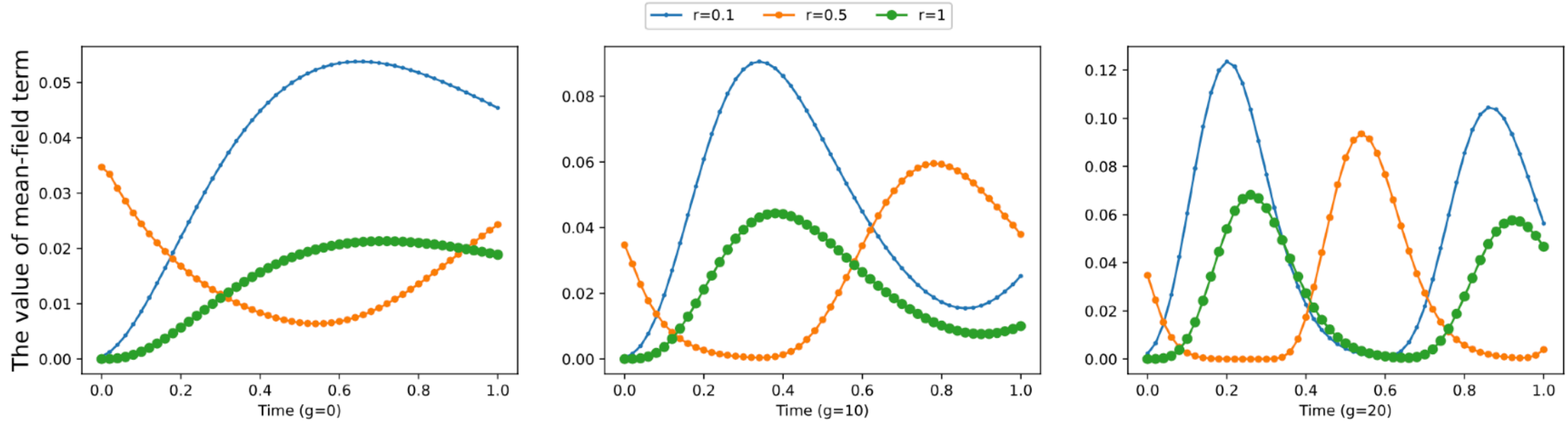
When decision making meets incentive ...

- Large-scale
- Time-dependent
- Dynamic

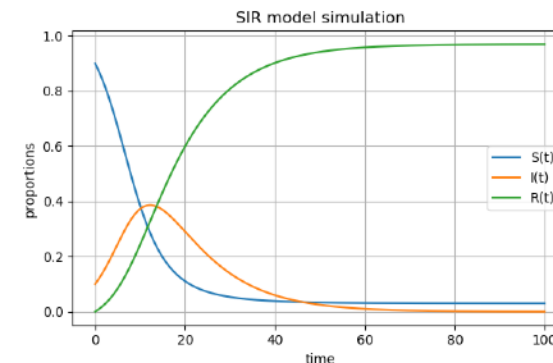
- **Is it possible to incentivise people to make sound decisions?**



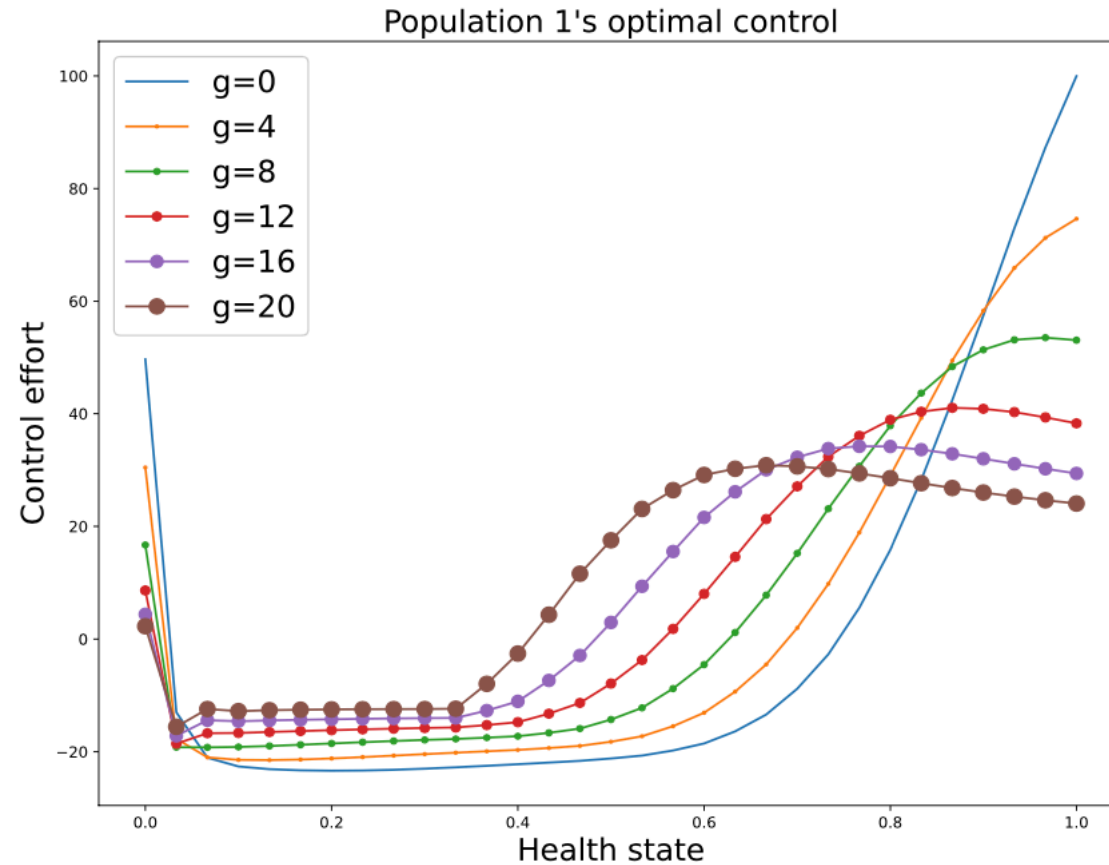
Result 1: echoing SIR model



- Low risk (recovered): $r = 0.1$;
- Mediocre risk (susceptible): $r = 0.5$;
- High risk (infected): $r = 1$



Result 2: effectiveness of reward

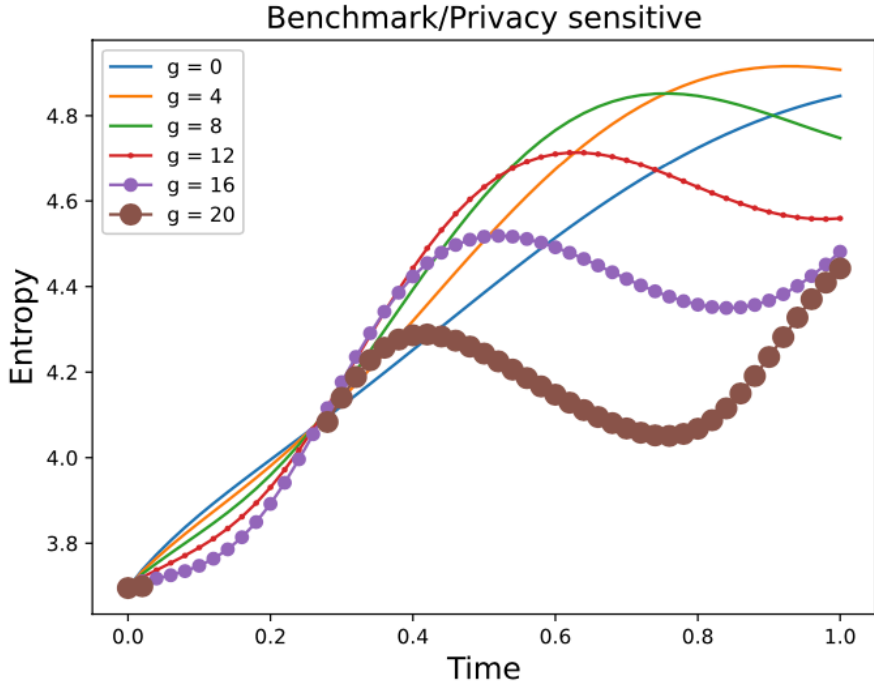
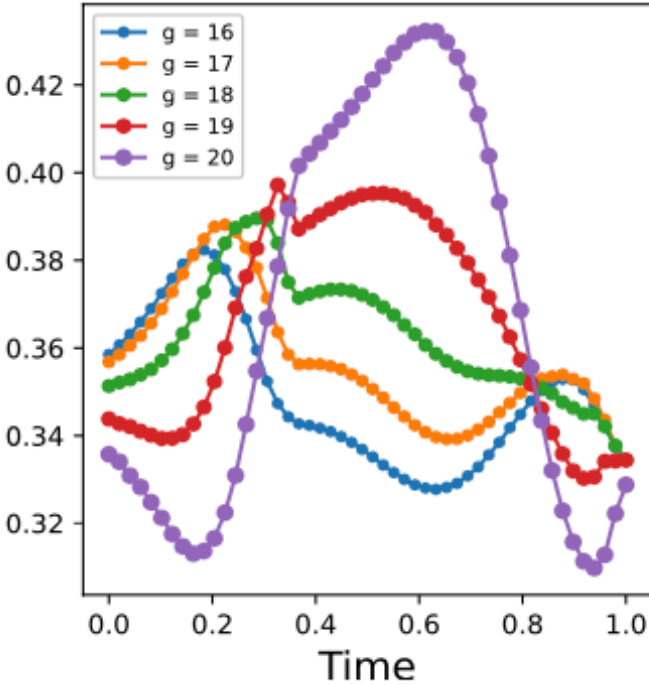


Result 3: Equilibrium & stability

- Entropy equation:

$$E = -\kappa \sum_{i=1}^N p_i \ln(p_i)$$

- 3 stationary points
- Why not sync?



Why collab with theorists?

- It's fun to interpret the world in an elegant way
- Technology is tangible, but the theory is under the water.
- Theoretical research can reveal the fundamental problem
- Test hypotheses and predictions
 - Building a human-centred autonomous system
- Giving ideas about how the real system operates

Thank you!

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