Introduction to General Game Playing

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Outline

AI Challenges

AI systems are able to

- make autonomous decisions
- adapt flexibly to unforeseen situations

Do they, really?

Most existing AI systems are

- designed for a specific and narrow application
- use tailor-made algorithms

The intelligence lies with the programmers-not their systems

Computer Game Playing

Kasparov vs. Deep Blue (1997)

Kejie vs. AlphaGo (2017)

General Game Player

A General Game Player is a system that

- understands description of arbitrary games
- learns to play these games without human intervention

Translation: They don't know the rules until the game starts.

Unlike specialised game players (e.g. Deep Blue, AlphaGo), they do not use algorithms designed in advance for specific games.

General Game Playing

Rather than being concerned with a specialized solution to a narrow problem, General Game Playing encompasses a variety of AI areas:

- Game Playing
- Knowledge Representation
- Planning and Search
- Learning

General Game Playing is considered as a grand AI Challenge

General Game Playing Contest @AAAI since 2005

General Game Playing Initiative

games.stanford.edu

- ► Game description language
- ► Variety of games/actual matches
- ► Basic player available for download
- ► Annual world cup @AAAI (since 2005)
  Price money: US$ 10,000

GGP Winners

- 2005: Cluneplayer, by Jim Clune (UCLA)
- 2006: Fluxplayer,[5] by Stephan Schiffel and Michael Thielscher (Dresden University of Technology)
- 2007: Cadiaplayer,[6] by Yngvi Björnsson and Hilmar Finnsson (Reykjavik University)
- 2008: Cadiaplayer, by Yngvi Björnsson, Hilmar Finnsson and Gylfi Þór Guðmundsson (Reykjavik University)
- 2009: Ary, by Jean Méhat (Paris 8 University)
- 2010: Ary, by Jean Méhat (Paris 8 University)
- 2011: TurboTurtle, by Sam Schreiber
- 2012: Cadiaplayer, by Hilmar Finnsson and Yngvi Björnsson (Reykjavik University)
- 2013: TurboTurtle, by Sam Schreiber
- 2014: Sancho,[7] by Steve Draper and Andrew Rose
- 2015: Galvanise, by Richard Emslie
- 2016: WoodStock, by Eric Piette (Artois University)

—Wikipedia

How it works
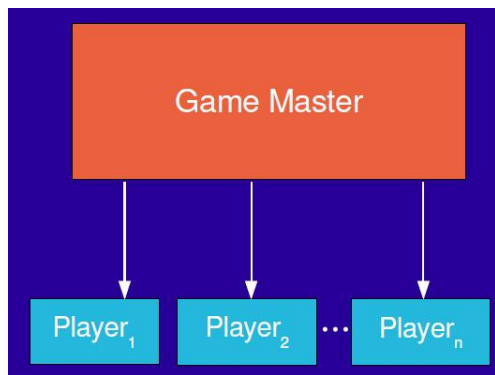
Game description
Time to think: 30s ~ 120s
Time per move: 15s ~ 60s
Your role

How it works
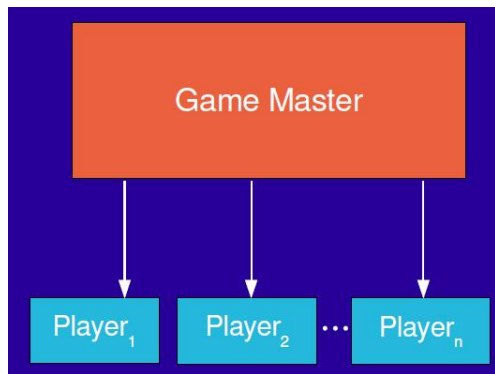
Start
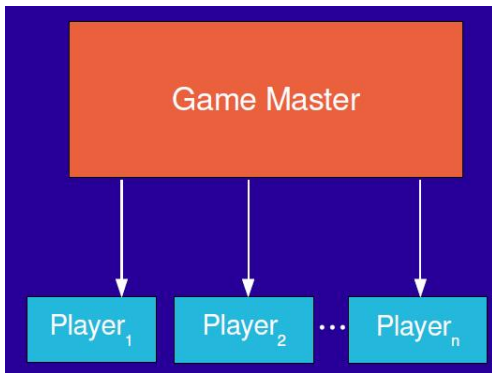
Your move, please
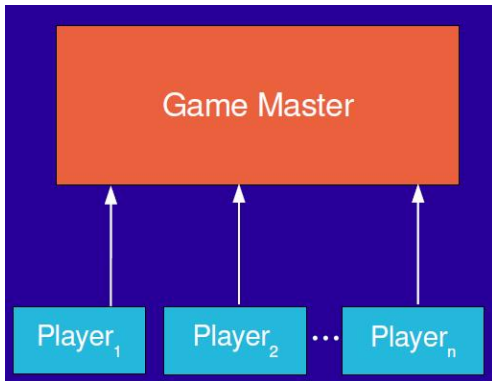
Individual moves
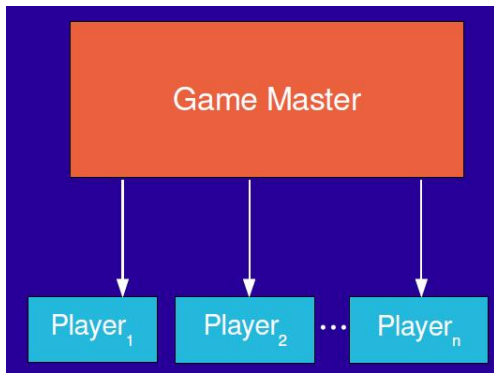
Individual Information about statesmoves
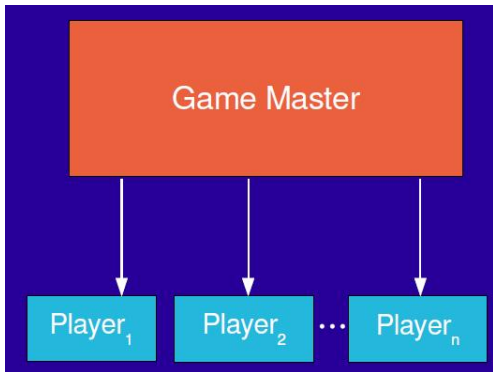
End of game

Roadmap

- ▶ The Game Description Language GDL:
  Knowledge Representation
- ▶ How to make legal moves:
  Automated Reasoning
- ▶ How to solve simple games:
  Planning & Search
- ▶ How to play well:
  Learning

♘ **GGP.org** | Tiltyard Hosting

Games you've never seen before. Play over 100 different games against humans or intelligent computers.

Would you like to start a [Two-Player Free-For-All ▼] match? [Yes!]

You can include human players, computer players, and random players.

		Listing of the 50 most recently played matches, of which 0 are ongoing:		
18 Oct	❓ Anonymous ✕ ❓ Anonymous ✕	Tic-Tac-Toe	🛡 View
18 Oct	❓ Anonymous ✕ ❓ Anonymous ✕	Chess	🛡 View
18 Oct	❓ Anonymous ✕ ❓ Anonymous ✕	Chess	🛡 View
10 Oct	❓ Anonymous ⚠ 100 ❓ Anonymous ⚠ 0	Tic-Tac-Toe	🛡 View
26 Sep	🖼 Random ❓ Anonymous (play)	Tic-Tac-Toe	🛡 View
19 Sep	❓ Anonymous ✕ ❓ Anonymous ✕	Tic-Tic-Toe	🛡 View
19 Sep	❓ Anonymous ✕ ❓ Anonymous ✕	Tic-Tic-Toe	🛡 View
13 Sep	❓ Anonymous ✕	Tic-Tic-Toe	🛡 View

22 Aug	? Anonymous ⚠ 0	Two-Player Tic-Ta...	🛡 View
	? Anonymous ⚠ 0		
14 Aug	Random 0	Sudoku Grade 3	🛡 View
13 Aug	Random 0	Two-Player Free-F...	🛡 View
	Random 10		
13 Aug	? Anonymous ✖	Tic-Tac-Toe	🛡 View
	? Anonymous ✖		
11 Aug	? Anonymous ⚠ 50	Tic-Tic-Toe	🛡 View
	? Anonymous ⚠ 50		
11 Aug	? Anonymous ✖	Tic-Tic-Toe	🛡 View
	? Anonymous ✖		
14 Jul	Random 10	Two-Player Free-F...	🛡 View
	Random 20		
14 Jul	Random 20	Two-Player Free-F...	🛡 View
	Random 30		
19 Jun	Random 0	Two-Player Free-F...	🛡 View
	Random 20		
16 Jun	? Anonymous ✖	Chess	🛡 View
	? Anonymous ✖		
15 Jun	? Anonymous ✖	Chess	🛡 View
	? Anonymous ✖		
15 Jun	? Anonymous ✖	Chess	🛡 View
	? Anonymous ✖		
15 Jun	? Anonymous ✖	Chess	🛡 View
	? Anonymous ✖		

Playing Games

http://euklid.inf.tu-dresden.de:
8180/ggpserver/index.jsp

Games

View Matches

http://www.general-game-playing.de/downloads.htmlDownloadManager

Download Manager and Basic Players

Game Controller App

Implementing a General Game Player

Implementing a Player

- Free implementation
- Reasoning is not compulsory
- Main technique:
  - Search-Space and Heuristics
  - Compute the value of the next state

eg. (1) Minimax
eg. (2) Monte-Carlo Tree Search

Minimax

Extensive search

- depth first
- min value for the opponents (worst case)
- max value for myself (best case)
- depth of search may be limited (heuristics)
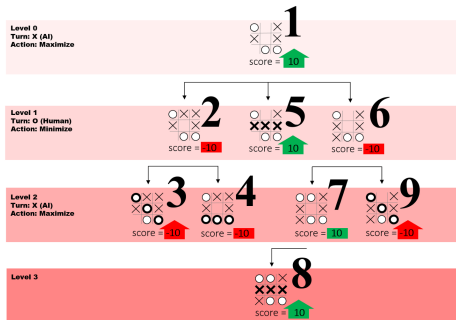
Monte Carlo Tree Search

- ▶ Run random simulation
- ▶ Sampling the game tree
- ▶ Estimation of actions
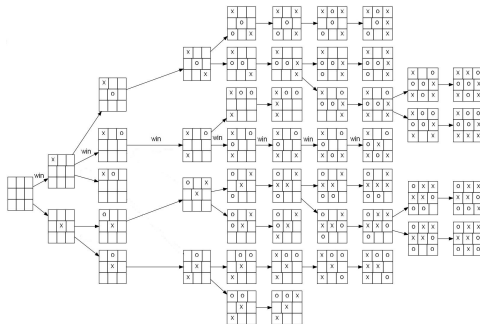
Deep Reinforcement Learning

- MCTS to generate the training set through self-play
- Neural Network
- State, Move Distribution and Winner
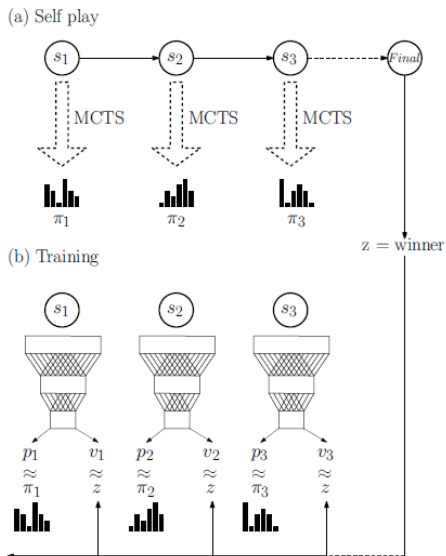
Further Reading

- www.generalgameplaying.de/literature.html
- www.ggp.org/
- ggp.stanford.edu/
- www.general-game-playing.de

Other Platforms

Ludii https://ludii.games/index.php

Botzone https://www.botzone.org.cn/
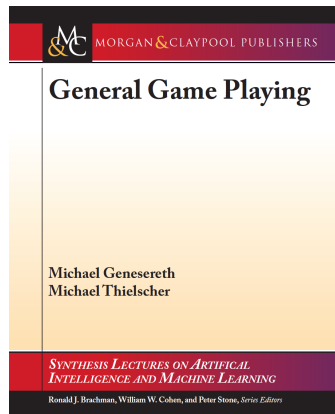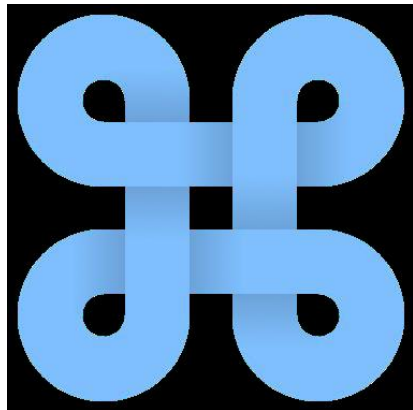
AI LAB, Peking University

Game Name	Create Time	Author	Description	Player Number		
Mahjong (✖旧麻将)	2014-6-7 12:58:14	Administrator	⚠请选用更新的Mahjong-New游...	4 - 4	💬 Game Discussion	⬇ Bot Rank List
Reversi (黑白棋)	2014-6-7 12:58:14	zhouhy	黑白棋是一款历史悠久的游戏。	2 - 2	💬 Game Discussion	⬇ Bot Rank List
VideoPlayer	2014-8-7 12:58:14	zhouhy	名副其实的视频播放器，不支持b...	1 - 1	💬 Game Discussion	⬇ Bot Rank List
Minesweeper (扫雷)	2014-10-1 12:58:14	zhouhy	【最后更新2014.12.3】单人扫...	1 - 1	💬 Game Discussion	⬇ Bot Rank List
Gomoku (无禁手五子棋)	2014-10-7 21:45:37	leedy	【完全可用回】 五子棋是一种有...	2 - 2	💬 Game Discussion	⬇ Bot Rank List
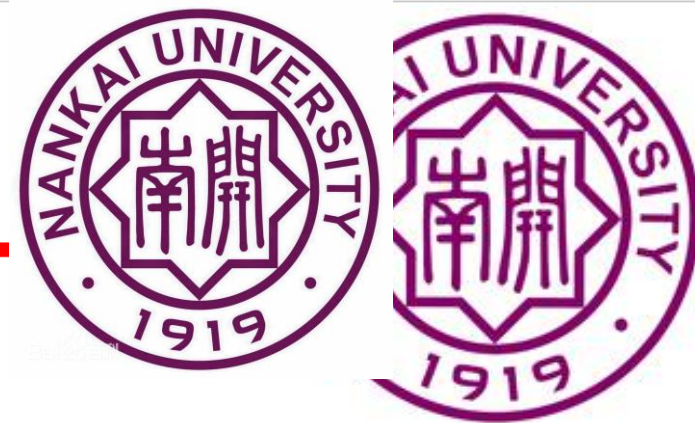
Computational Social Choice

What is Social Choice Theory

- **Social choice theory** is about methods for collective decision making, such as political decision making by groups of economic agents.

Social Choice
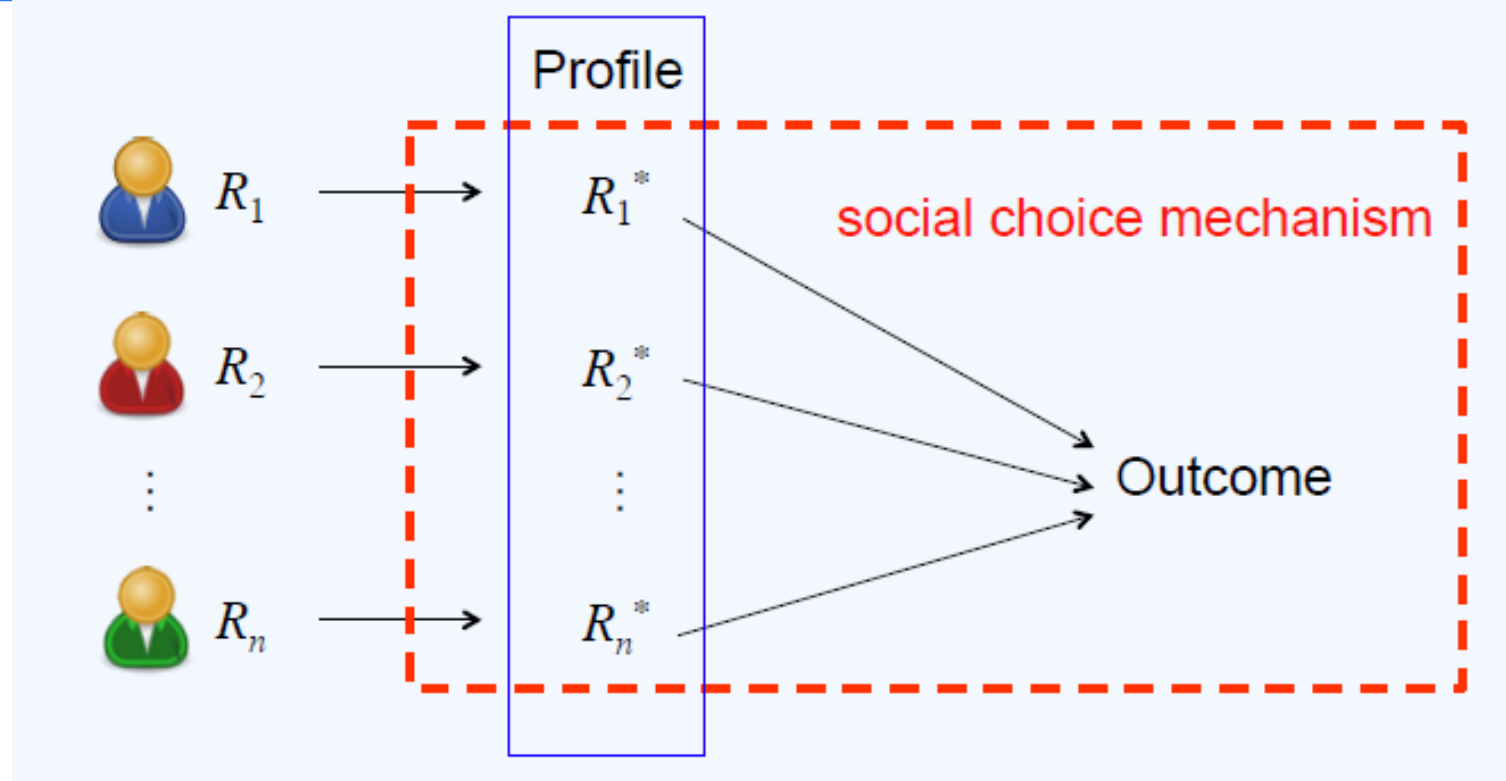
- Agents
- Alternatives
- Outcomes

- Preferences (true and reported)
- Social choice mechanism

Computational social choice (COMSOC)

- *"Computational social choice is an interdisciplinary field of study at the interface of social choice theory and computer science, promoting an exchange of ideas in both directions."*

---http://www.illc.uva.nl/COMSOC/

Computational Social Choice

Computational thinking + optimization algorithms

Social Choice

CS

Strategic thinking + methods/principles of aggregation
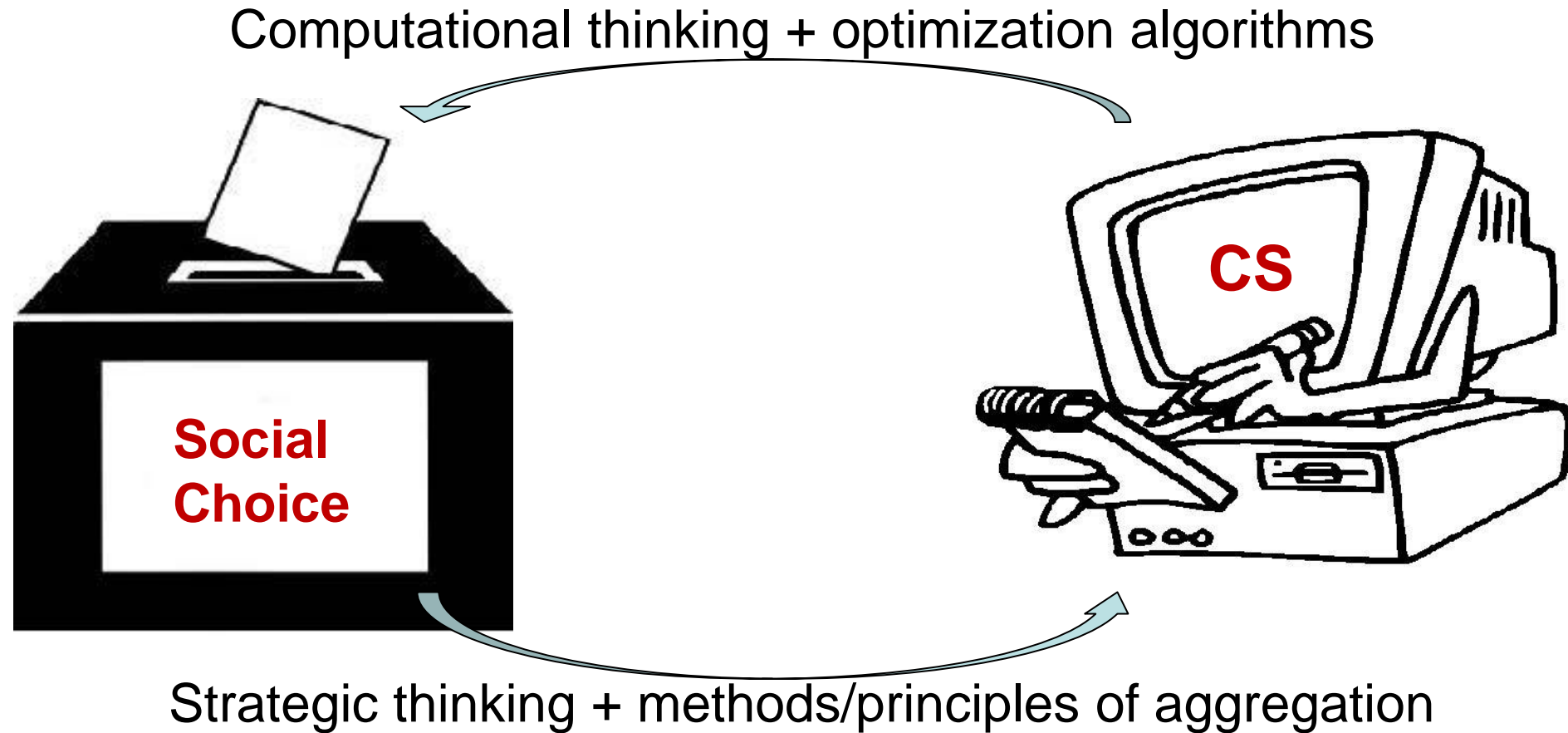
- Interdisciplinary field of study at the interface of social choice theory and computer science, promoting an exchange of ideas in both directions.

How to design a good social choice mechanism?

WHAT IS BEING "GOOD"?

Two goals for social choice mechanisms

GOAL1: democracy

GOAL2: truth

Challenges

- **Goodness**:
  - democracy: fairness, efficiency, etc
  - truth: accuracy
- **Computation**: how can we compute the outcome as fast as possible
- **Incentives**: what if an agent does not report her true preferences?

Computational Social Choice and the Web

robovote.org

spliddit.org

whale.imag.fr

Building tools to allow users to interact directly with social choice algorithms on the web is not only useful for those users but also an opportunity to collect data and get ideas for new research questions.

Finding out about New Developments

- The Handbook of COMSOC (2016) represents the state of the art around 2012, when it was conceived.

- Trends in COMSOC (2017) covers several important developments that have taken place since then.

- A lot of work in COMSOC gets published at major AI conferences: AAMAS is the most important multiagent systems conference IJCAI, AAAI, ECAI are the main general-purpose AI conferences

- At the interface with Algorithmic Game Theory (and Theoretical Computer Science more generally), the most important conference is EC.

- In Computer Science most new ideas (first) show up at conferences, but also look at the corresponding journals (JAIR, AIJ, TEAC, JAAMAS).
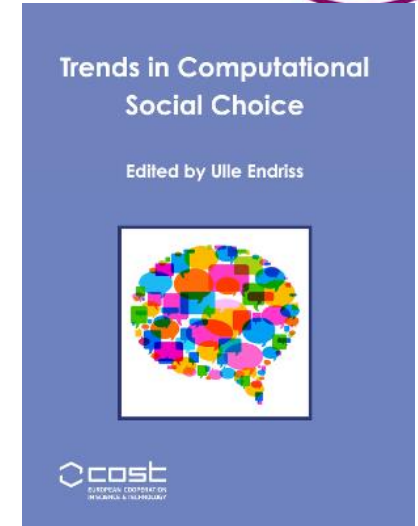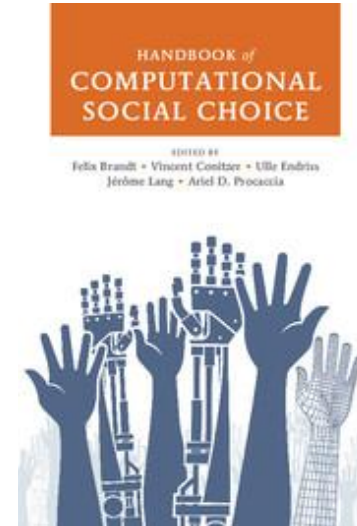
Welcome to Join Us
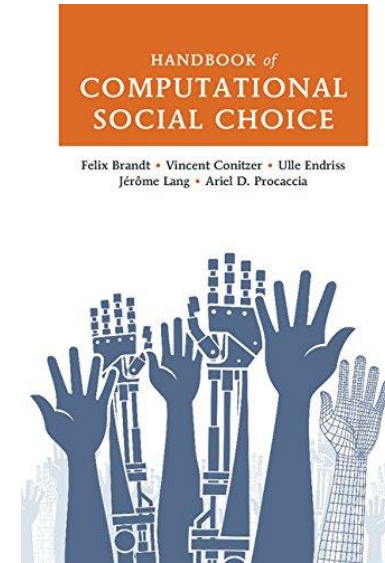
- If you're interested in doing a project/thesis/…on General Game Playing and Computational Social Choice

- Join us and Contact me at

  G.Jiang@nankai.edu.cn