COORDINATION GAMES

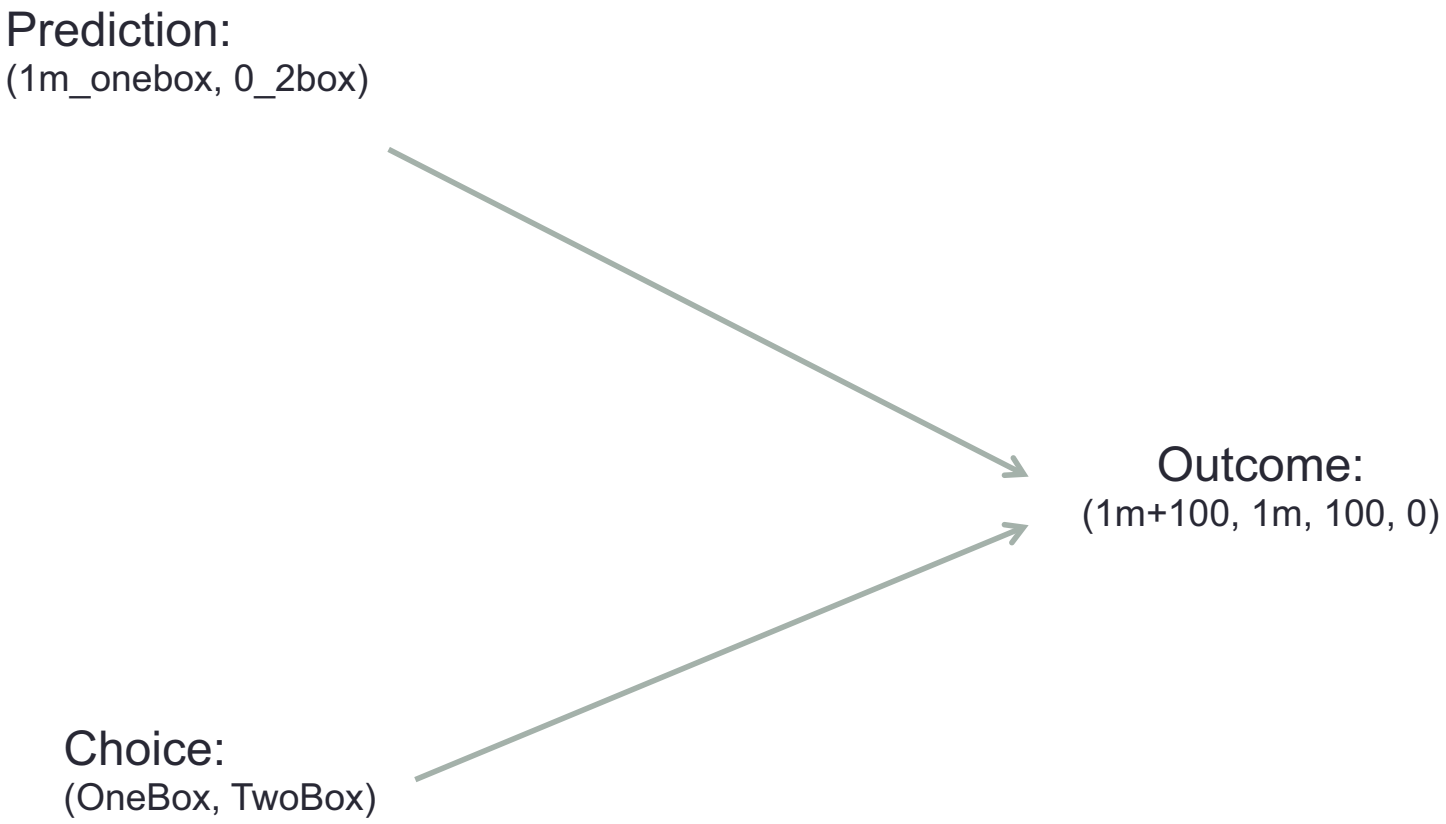
Nash Equilibria, Schelling Points and the Prisoner's Dilemma

Owain Evans, MIT Paradox, Monday 25 February 2013.

Newcomb's Paradox

Image by MIT OpenCourseWare.

Newcomb's Paradox: Causal Graph



Newcomb's Paradox: EDT problems

- EDT fails:
  - If Predictor perfect, then P($0 / OneBox) is undefined.
  - Assume I know I'm rational: conditional on any action, I must obtain the highest possible utility in this situation. So choose randomly.
  - Double transparent box Newcomb and other exotic problems.

Newcomb's Paradox: CDT problems

- Does Newcomb reward irrationality? Example of God who kills people for using "the best possible decision theory".
- Key observation: Reward for OneBoxing, but no dependence on how the decision is made. Best possible theory could succeed.
- Reflective-consistency:
  - CDT agent, given the chance to change DT before Newcomb
  - Or: CDT agent, enters an AI in a competition where one of challenges is NP
  - CDT will modify itself into a non-CDT theory.
  - Conclusion: CDT is not stable under intelligence and so no smart CDT agents will survive.

PD: Structure

	Cooperate	Defect
Cooperate	(4,4)	(1,5)
Defect	(5,1)	(2,2)

PD: Scenarios in Economics

Gains from Trade:

- Player 1 needs wool as much as Player 2 needs wheat.
- Trade is conducted by exchanging sealed boxes. By the time boxes can be opened, the other Player has left.

Cartel:

- Two sellers of a good. Prices are announced simultaneously and can't be changed.

Pivot: Coordination Games

- GOAL: Find a decision theory that “wins” on PD and NP and does well on standard problems.

- **Strategy**:
  - PD and NP are coordination problems. Study other coordination problems and find decision theories that solve them.

Why is game theory hard?

- One-player games are easy:
  - Work out the consequences of each action and take action with highest EV.
  - Example: Playing the lottery or 1-player casino games; betting on the weather.

Why is game theory hard?

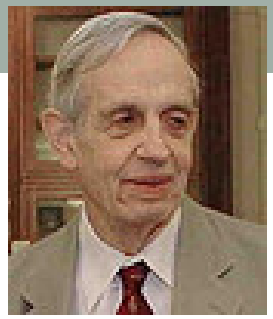
- Simple coordination game 1: (normal pset)

	Group Study	Cafe
Group Study	(1,1)	(0.5,0)
Cafe	(0,0.5)	(0,0)

- If players are symmetric, then simulation leads to infinite regress. (Can't happen with natural systems).

- With asymmetry, simulation is possible. Example: PD vs. religious law-follower.

Nash Equilibrium



- In physics and biology, you can sometimes make predictions even if simulation is intractable:
  - Complex slope, but easy to find the stable equilibria
  - Sex-ratio in biology
- Informal definition: A set of strategies/actions is a *Nash Equilibrium* if no player can do better by changing his strategy while everyone else's are held fixed.
- Idea: A non-Nash pair of actions is unstable because one of the players can do better by doing something else.

Nash Equilibrium

- Simple coordination game: we can predict outcome using NE, and if players each play NE, then they'll do well.
- PD: If each player plays NE, they both defect.
- Also for purely competitive games: e.g. Rock-Paper-Scissors. (No NE in pure strategies).

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- Extensively studied and applied in economics. Also studies of computational complexity of finding the NE by MIT's Daskalakis.

Schelling game: Rules

- You get a point if you and your partner provide the same answer.

- You should face away from each other and are not allowed to communicate in any way before writing your answer down.

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Multiple Equilibria Coordination Games

- Simple coordination game 2: (collaborative project)

	Group Study	Cafe
Group Study	(1,1)	(0,0)
Cafe	(0,0)	(0.5,0.5)

- Schelling game: (café is quiet)

	Group Study	Cafe
Group Study	(1,1)	(0,0)
Cafe	(0,0)	(1,1)

Schelling Games

- Many examples: Driving Problem, Rowing, Deciding on Linguistic Conventions

- How to resolve:
  - One player goes first
  - One player can simulate the other (asymmetric)

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