Game Theory
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Stephen Lovelady

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Slides available at
go.warwick.ac.uk/slovelady

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What is Economics?

- A way of thinking
  - Not just a set of rules or graphs
  - The process can be more important than the outcome!
- You will learn technical skills
  - Maths, Econometrics, Game Theory
- You will learn to apply Economics as a type of "science" anywhere in "society"

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Courses

- The Department of Economics offers 3 undergraduate courses
  - **L100** Economics
  - **L112** BSc Economics and Industrial Organization (EIO)
  - **LLD2** BSc/BA Economics, Politics and International Studies (EPAIS)
- We also administer PPE, but admissions are handled separately

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What will you study?

- You will study a very broad range of concepts
  - Topics
    - Microeconomics
    - Macroeconomics
    - Economic History and Development
  - Tools
    - Maths
    - Econometrics
    - Game Theory....

What is Game Theory?

- Game Theory is a tool used in economics to study **strategic interaction**
  - Contrasts with **decision theory**
- Modern game theory was founded by John von Neumann
  - A mathematician
  - Game theory is rooted in mathematics

What's strategic interaction?

- Imagine walking into a supermarket
  - There are 10 apples on the shelf
  - How many do I want to buy?
    - Given the price?
  - This is decision theory
- Imagine a new type of supermarket
  - I write down a "bid" for an apple
  - As does everyone else in the supermarket
  - The bids are collected together

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Strategic Interaction

- The 10 apples are given to the people who bid the 10 largest amounts
  - The price they pay is what they bid
- The question is not how many apples do I want, but how much am I willing to bid?
  - One is independent of other people
  - One crucially depends on other people

What's my strategy?

- I could just write down how much I value the apple
  - I'm not willing to pay more than it's worth
- But it might be the case that I value apples the most
  - In which case I would be paying the most
  - When someone else is getting apples for a lower price!

What's my strategy?

- Ideally, I want to bid just more than the 10th highest bid
    - I become the new 10th highest
    - I get the apple for the lowest possible price
- But everyone else is playing the same game!
    - What happens when everyone wants to bid the 10th highest amount?!?

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What about the supermarket?

- This isn't just a game for the customer
  - It's also a game for the supermarket!
- Should they sell apples via this system?
  - What about a "second price" mechanism?
  - What about a "descending price" mechanism?
  - What would give them the highest profits?

Best response function

- Game Theory uses the idea of **best responses** to analyse these problems
  - What is the best thing I can do, given what you will do?
  - What is the best thing you can do, given what I can do?

- In lots of situations we will see convergence towards **mutual best responses**

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Nash Equilibria

- If we are in a situation of mutual best response, we have a Nash Equilibria
  - Nobody wants to move from here!
- These outcomes are famous not just in economics
  - In politics
  - In biology
  - In computer science

Politics Example

- Consider two political parties
  - One is considered "left wing"
  - One is considered "right wing"
- They have ideology, but really care about winning elections!
  - People will vote for the party with an agenda closest to their own viewpoint
  - What campaign should each party run?

Politics Example

- Suppose the population are evenly distributed across the "left right" line
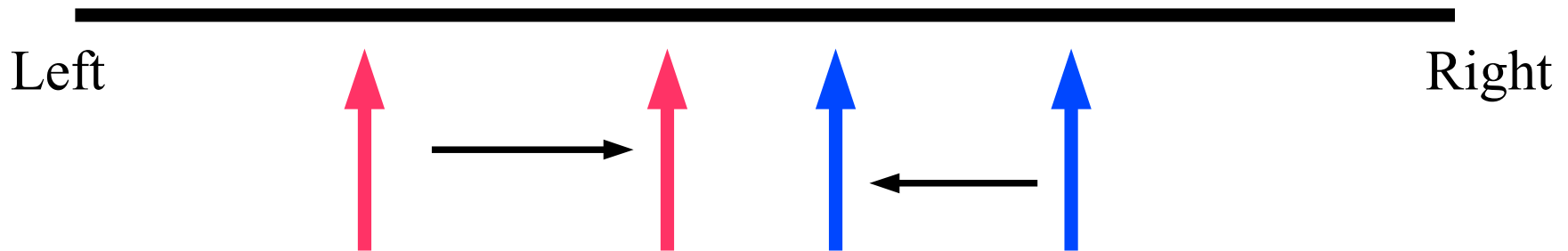
Left

Right

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Politics Example

- The election will be decided by people *between* the two parties

  - The people on the extremes will always vote for their party

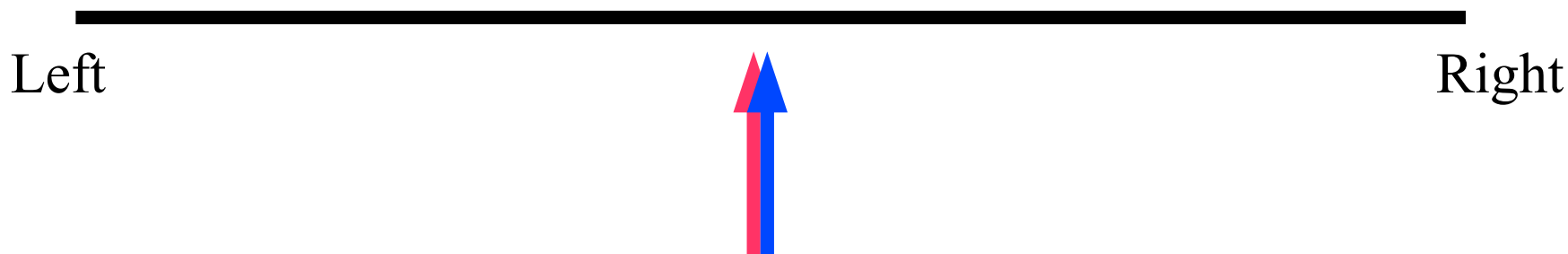- What can each party do to make themselves more attractive to the middle voters?

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Politics Example

- Both parties can make policies which appeal more to the middle

Politics Example

- At what point do we have **mutual best responses?**
  - When both are in the middle!
  - And have 50% of the vote each

Left   Right

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Politics Example

- In order to appeal to the middle voters
    - Both parties moved towards the middle
    - Compromising their principles
    - And moved away from their core support
- The result of a desire to win the election
    - Was a move away from politics driven by ideology
        - And one that only represented a very small proportion of the electorate

Other examples

- At university you will apply game theory to a wide range of situations
  - Politics
  - Public Goods
  - Advertising

- In order to gain an understanding of the driving forces in certain markets

Public Goods

- Public goods are a very important area of study in economics
- We rely on the state to provide certain services in society
  - National defence
  - Street lighting
- But why can't these goods be provided by the private sector?

Private provision

- Game Theory can help us understand why the state needs to intervene

- Public goods are a problem of **coordination**
    - How do I get everyone to pay their fair share?
    - You may have heard of the "free rider" problem?
        - What does this look like in action?

A Public Good Game

- I played a game with my second year students
  - Everybody has 10 tokens
  - You must decide how many you want to contribute to the "public project"
  - Once you have made your decision, you are placed in a group of 5 people
  - You receive back **the sum** of the tokens in your group
    - Plus whatever you kept for yourself!

A Public Good Game

- How many tokens did people contribute? A guess?
  - On average, only 2.89 tokens per person
  - Which means, the average person ended up with
    - $(10 - 2.89) + (2.89 \times 5) = 21.56$

- What would they have ended up with if everyone had contributed the full amount?

A Public Good Game

- Full contribution gives a payoff of
  - (10 – 10) + (10 x 5) = 50

- Thus the students were ending up with less than 50% of what would have been "optimal" in this society!

- But who were the real winners in this game?

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A Public Good Game

Uni ID	Tokens	Random #	Payoff	Winner
1012119	4	0.22	37	No
1004996	10	0.69	34	No
1006570	0	0.77	39	Yes
928921	10	0.44	34	No
1023863	10	0.01	34	No

- The winner in this game was the **free rider**

A Public Good Game?

- What happens if we repeat this game?
  - Nobody wants to be the sucker!
  - Contributions very quickly tend towards 0
  - And stay there
- We get everybody free riding **as a best response** to everybody else free riding
  - Everyone just ends up with their 10 tokens
  - Which is only 20% of the socially optimal point

A Public Good Problem

- Game theory helps us understand the problem of public provision of private goods
  - The only place where everybody is best responding to everybody else is where everybody is free riding!
  - We need the state to intervene to prevent market failure
  - And restore contributions back to the socially optimal level

Game Theory

- What types of "games" do we study?
  - Simultaneous move games
  - Sequential move games
  - Games which involve uncertainty
  - Games which are infinite
  - Games with limited memory
  - Even psychological games!
    - How can I stop my future self snoozing the alarm tomorrow morning!

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Game Theory

- You will see the Nash Equilibria concept applied in all these games

- But some of the most interesting research studies why we can get outcomes which are not Nash

  - What about giving to charity?
  - What about ultimatum games?

- Some of you may research new types of game theory!

If you are interested....

- Warwick offers lots of courses which involve economics
  - Economics, Economics and Industrial Organisation, Economics Politics and International Studies
  - Visit go.warwick.ac.uk/study or go.warwick.ac.uk/economics for more info
  - Warwick Economics is Top 5 in the UK
    - 3rd in The Times for 2013
    - 4th in The Complete University Guide for 2013

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Q&A

- If you have any further questions, you can post them on the **Official Warwick Economics Q&A Thread** on
  - **The Student Room** forum
  - www.thestudentroom.co.uk
    - Forums
      - Economics / University of Warwick
  - You can read our FAQ's and questions by other applicants and students

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