Game Theory as a Mathematics General Education Course

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Game Theory as a Core Requirement Course at FUS since 2007

- Small private College in Switzerland (US model, taught in English, accreditation both in US and Switzerland)

- Math taught for
  - Math Minors,
  - Courses needed for Economics, Management, ...
  - Core Requirement
    - College Algebra is not the best option for Core
What should a General Education Math course provide?

• Motivation/Message: Math is everywhere, important, and beautiful
  • Math is everywhere
    • Science, Technology
    • Optimization
    • Human Interaction
  • Math is important
    • Payoff (monetary or otherwise) is attached
  • Math is beautiful
    • Fibonacci Numbers, Euler’s Polyhedra Formula, Art Gallery Theorem, ....
What should a General Education Math course provide?

• Some key concepts
  • Equations, Matrices, Trees, Probability, Functions, Graphs
• Modeling and Limitations of Math
• Understanding more important than remembering formulas
• Mathematical way to approach the world
  • Probability, Optimization, Game Theory
What is needed?

No Calculus needed
Almost no Algebra needed
Some basic Probability is needed, but introduced in the Course
ebook for the course

Prisner, Erich.  
*Game Theory Through Examples.* 
Electronic ISBN: 9781614441151
Concept of Course and ebook

• Focus on Examples
  • Concrete and simple
  • But complex
  • also often with parameters
Concept continued

• Hands-on approach
  • About 80 Applets (Example: Applet to introduce sequential games with perfect information and without randomness
  • About 36 Excel Sheets
    • Avoid tedious repetitive work
    • Maximin, domination, best response, Nash equilibria for bimatrixes of size 21 times 21
    • Sheets for most chapter examples
    • Excel is not a black box
  • Student Projects (similar to chapter examples)
• Math is precise (true/false)
• but the world is fuzzy
9 Theory Chapters

- Simultaneous Games with cliffhanger
- Sequential Games with perfect information
  - First without randomness, backward induction
  - Probability
  - Then with randomness
- General Games (Sequential, imperfect information)
  - Extensive Form
  - (Pure) Strategies and Normal Form
- Mixed Strategies bring closure
  - Brown’s fictitious play as only tool to calculate them
  - Behavioral Strategies (optional)
Applets may also clarify concepts

- **Applet** to clarify the concept of Nash equilibria using repeated best responses
- Can also be simulated by 5 students during class---students usually find a Nash equilibrium through distributed computing rather fast.
23 Example Chapters

• More complex

• Usually require tools from different theory chapters

• I cover usually about 8 of them

• Applications from Economics, Politics, Parlor Games

• Simple but complex games that require most or all tools so far
23 Example Chapters

• Doctor or Restaurant Location Games in Graphs
• Airport Shuttle
• Shubik Auction with random deadline
• Election
• Multiple-round Chicken (for Cuba crisis)
• Mini Blackjack
• VNM- or Kuhn Poker
• A simplified Soccer game
• Quiz Show
• And others ..................
Simulation, Modeling and Limitations

• **Applet** for the Election Game

• Can we draw conclusions from solutions of very simple models?
  
  ➢ Should you put more effort into large states?
  
  ➢ Should you attack in states where you are behind or rather defend states where you are ahead?
Simulation, Modeling and Limitations

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Model seems to say **Yes**
Kuhn Poker

Applet, Excel Sheet for Analysis
The Poker Tournament

- Students create their own Poker ‘robot’ by fixing a behavioral strategy
- In this version of Kuhn poker (J,Q,Ks), 12 probabilities
- Many students create decent robots, none one drawing against a Nash equilibrium robot
- I submit a Nash equilibrium robot
- Applet to automatically play 200 rounds between these robots
The Poker Tournament

• Excitement, Competition!
• BUT: Luck is important too! The ‘best’ robot is not always winning (but often more often than others)
• To be precise: The Nash equilibrium does not always have the best chances! It depends on the population.
Thank You