Game Theory as a Mathematics General Education Course

Erich Prisner

Franklin University Switzerland

Sorengo-Lugano, Switzerland

FRANKLIN
UNIVERSITY SWITZERLAND

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

FRANKLIN
UNIVERSITY SWITZERLAND

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, ...

FRANKLIN
UNIVERSITY SWITZERLAND

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
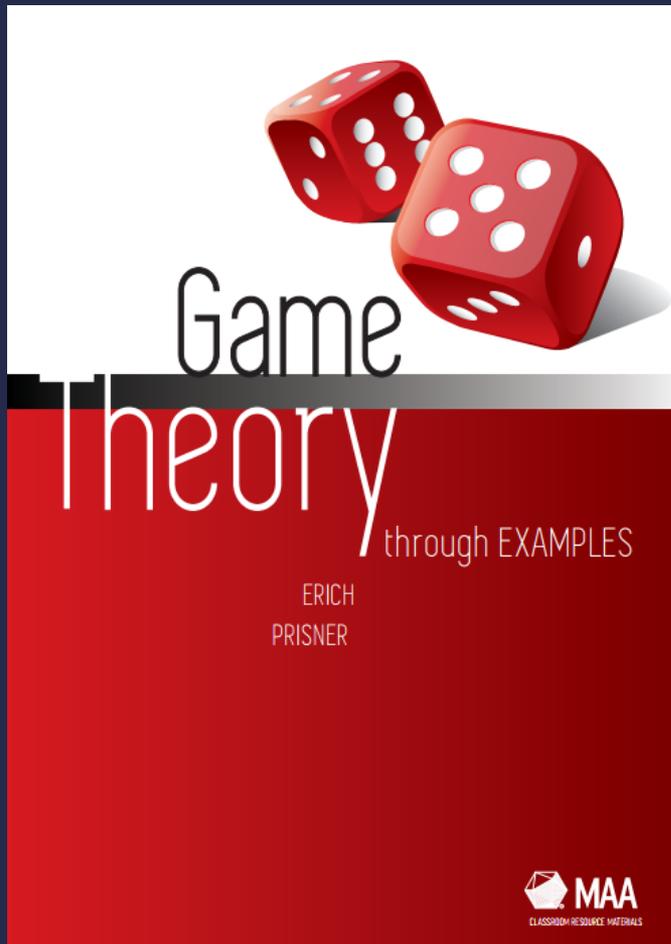 - Probability, Optimization, Game Theory

FRANKLIN
UNIVERSITY SWITZERLAND

What is needed?

No Calculus needed

Almost no Algebra needed

Some basic Probability is needed, but introduced in the Course

FRANKLIN
UNIVERSITY SWITZERLAND

ebook for the course

Prisner, Erich.

Game Theory Through Examples.

Mathematical Association of America, Classroom Resource Materials,

2014.

Electronic ISBN: 9781614441151

FRANKLIN
UNIVERSITY SWITZERLAND

Concept of Course and ebook

- Focus on Examples
    - Concrete and simple
    - But complex
    - also often with parameters

FRANKLIN
UNIVERSITY SWITZERLAND

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 bimatrices of size 21 times 21
    - Sheets for most chapter examples
    - Excel is not a black box
  - Student Projects (similar to chapter examples)

Concept continued

- Math is precise (true/false)
- but the world is fuzzy

FRANKLIN
UNIVERSITY SWITZERLAND

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 ficticious play](#) as only tool to calculate them
  - Behavioral Strategies (optional)

FRANKLIN
UNIVERSITY SWITZERLAND

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 ....

FRANKLIN
UNIVERSITY SWITZERLAND

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?

FRANKLIN UNIVERSITY SWITZERLAND

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? **Yes**
  - ➢ Should you attack in states where you are behind or rather defend states where you are ahead?

Model seems to say

FRANKLIN
UNIVERSITY SWITZERLAND
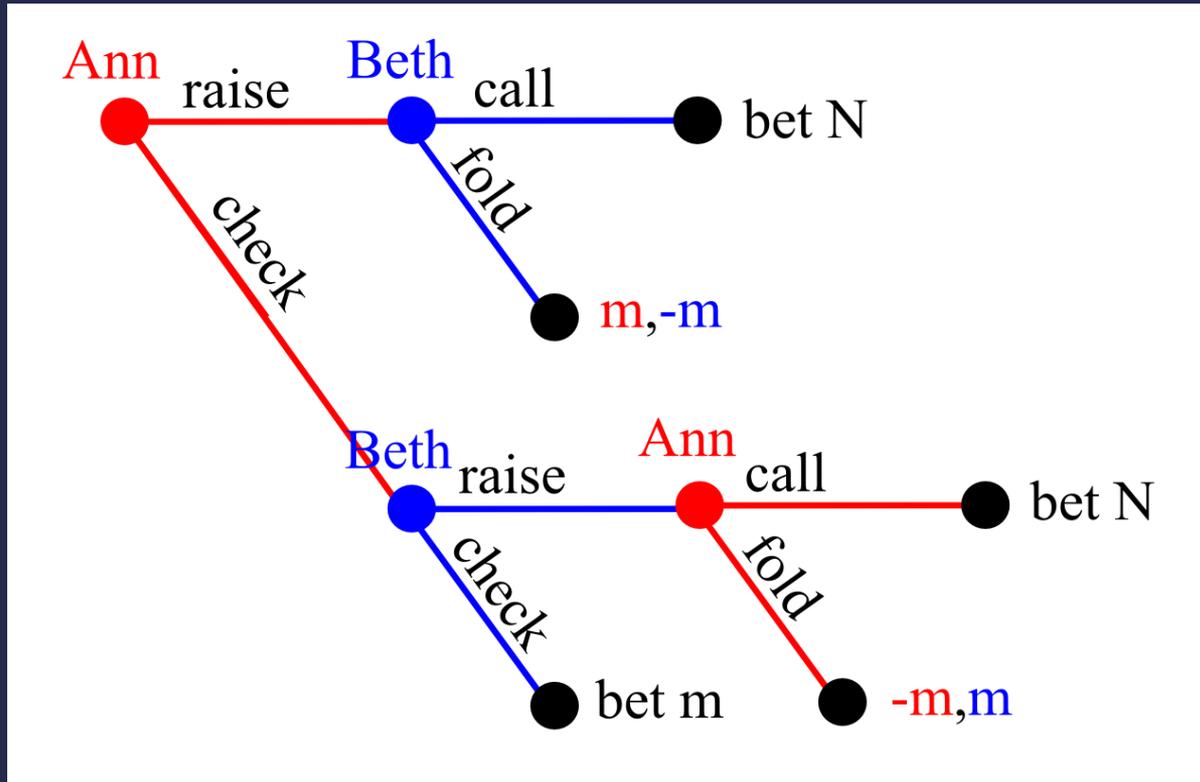
Kuhn Poker

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.

Franklin is here

Thank You

SIAM Conference
on Applied Mathematics Education (ED16)
Philadelphia, Oct 1, 2016