

**THE CHINESE UNIVERSITY OF HONG KONG**  
**Department of Mathematics**  
**UGEB2530C Games and Strategic Thinking**  
**2022-2023 Term 2**

## **Introduction**

From the simple “rock, paper, scissors” game to the complex buy-and-sell financial decisions, we encounter many games in our everyday life. While you are trying to figure out what your opponents are doing, they are trying to figure out what you are doing too. To maximize your outcome, you may want to cooperate or compete with all or some of them. Game theory is a way to analyze what rational people like you and I should do under these circumstances, and what the expected outcome will be if optimal strategies are followed.

The aim of this course is to provide students with a non-technical exploration of game theory. Mathematical background in addition, subtraction, and multiplication is required. (Well, we may need to do a few divisions somewhere in the course.) Required mathematics materials will be covered at the beginning of the course.

We will start with very simple parlor games and move on to more realistic problems in economics, social psychology, biology, and business, where optimal strategies that are against intuition will be epitomized. There are many movies that relate to game theory, e.g., “Sophie’s choice and the Dark Knight”. In particular, the celebrated “Nash equilibrium” glossed over by Russell Crowe in the movie “A Beautiful Mind” will be explained in full detail in simple mathematical terms.

We also create a few interactive and interesting games. For the descriptions, regulations and highlights of each game demo, please click the links below:

### [Different Games](#)

and

### [Sports Games](#)

Try them and have fun!

## **Instructor**

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## Assessment

- Homework Assignments = 15%
- In-class Activities, e.g., exercises/games = 10%

There are thirteen in-class activities; we will take the best ten in-class activity scores out of the thirteen).

- Mid-term exam = 30%

Saturday, 18 March 2023, 1:45 PM - 3:00 PM

- Final exam = 45%

Tuesday, 25 April 2023, 11:15 AM - 1:15 PM

## Teaching Schedule

All teaching materials will be found in [CUHK Blackboard](#)

Please note the topic/text/reference should not be treated as a substitute for the lectures. The lectures may present the material covered in the text in a different manner, or deviate from it entirely. You should take your own notes in class.

- Week 1: Introduction Game Theory

Examples of games in daily life, simultaneous non-cooperative two-player games, chicken game, normal form, Nash equilibria for pure strategies

- Week 2: Matrices and Probability

Arithmetic of matrices, random variables, expected values

- Week 3-5: Zero-sum Games

Zero sum game, minimax theorem, value of games, graphical method, applications of zero sum games.

- Week 6-8: Bimatrix Games

Nash equilibrium, prudential strategies, security level, Pareto optimality.

- Week 9-10: Games in Extensive Form

- Week 11-12: Cooperative Games

Threat strategies, threat differential, coalitions, characteristic function, superadditivity, Shapley value

- Week 13: Voting Games  
Social choice, apportionment

## References

### 1. General Game Theory

- Philip D. Straffin: Game Theory and Strategy, Mathematical Association of America, 1993
- Peter Morris: Introduction to game theory, Springer-Verlag, 1994
- Michael Maschler, Eilon Solan, Shmuel Zamir: Game theory; translated from Hebrew by Ziv Hellman ; English editor, Mike Borns Zamir, Shmuel Cambridge: Cambridge University Press 2013
- Martin J. Osborne: An introduction to game theory, 2003.  
<http://www.economics.utoronto.ca/osborne/igt/index.html>
- Avinash K. Dixit and Susan Skeath: Games of Strategy, 2004
- Roy Gardner, Hoboken, NJ: Games for business and economics, c2003
- Ken Binmore: Fun and Games - A Text on Game Theory, 1992.

### 2. Game Theory and Economy

- Bierman, H. Scott, Fernandez, Luis: Game theory with economic applications, Addison-Wesley Pub. Co. c1993
- Baye, Michael R.: Managerial economics and business strategy, New York: McGraw-Hill c2010
- Aumann, Robert J. and Hart, Sergiu: Handbook of game theory with economic applications, Amsterdam: North-Holland
- Meunier, Franc and Carre, James: Game theory : economics, theoretical concepts and finance applications, New York: Novinka 2013
- Montet, Christian: Game theory and economics, Basingstoke, Hampshire; New York: Palgrave Macmillan 2003
- Webster, Thomas J: Introduction to game theory in business and economics, Armonk, N.Y.: M.E. Sharpe c2009

### 3. Other Applications

- Dufwenberg, Martin: Game Theory, Wiley Interdisciplinary Reviews: Cognitive Science, March 2011, Vol.2(2), pp. 167-173
- Bramer, M.A.: Computer game-playing: theory and practice, Chichester: Horwood New York: Wiley
- Leyton-Brown, Kevin and Shoham, Yoav: Essentials of Game Theory: A Concise, Multidisciplinary Introduction
- Griffin, Peter A: The theory of blackjack: the compleat card counter's guide to the casino game of 21, Las Vegas, Nev.: Huntington Press 1999
- McMillan, John: Games, Strategies, and Managers, Oxford University Press

- Heiko Hotz: A Short Introduction to Game Theory  
[https://www.theorie.physik.uni-muenchen.de/lsfrey/teaching/archiv/sose\\_06/softmatter/talks/Heiko\\_Hotz-Spieltheorie-Handout.pdf](https://www.theorie.physik.uni-muenchen.de/lsfrey/teaching/archiv/sose_06/softmatter/talks/Heiko_Hotz-Spieltheorie-Handout.pdf)
- Gates, Scott and Humes, Brian D.: Games, information, and politics: applying game theoretic models to political science, University of Michigan Press c1997

#### 4. Articles

- How to beat the Prisoner's Dilemma in the TV game show Golden Balls  
<https://mindyourdecisions.com/blog/2012/04/24/how-to-beat-the-prisoners-dilemma-in-the-tv-game-show-golden-balls/>
- Why do competitors open their stores next to one another?  
[https://www.youtube.com/watch?v=jILgxeNBK\\_8](https://www.youtube.com/watch?v=jILgxeNBK_8)
- Oxenham, Simon: Why Politicians All Seem The Same, Gas Stations Come In Pairs and Twitter is Turning Into Facebook  
<https://bigthink.com/neurobonkers/why-politicians-are-all-the-same-gas-stations-come-in-pairs-and-twitter-is-becoming-facebook>
- G. Kolata: What if They Closed 42d Street and Nobody Noticed?  
<http://www.nytimes.com/1990/12/25/health/what-if-they-closed-42d-street-and-nobody-noticed.html>
- Game Theory 101: The Hawk-Dove Game  
<https://www.youtube.com/watch?v=RAKjII7xCdk>
- Friedman Daniel: On economic applications of evolutionary game theory, Journal of Evolutionary Economics, Springer-Verlag 1998
- The Iterated Prisoner's Dilemma and The Evolution of Cooperation  
<https://www.youtube.com/watch?v=BOvAbjfJ0x0>
- Bhuiyan, Bellal Ahmed: An overview of game theory and some application, Philosophy and Progress 2016
- Billingham, John: Bluffing and exploitation: An introduction to poker maths  
<https://plus.maths.org/content/bluffing-and-exploitation-introduction-poker-maths>
- Lucas Husted: Game theory challenge: Can you predict human behavior?  
[https://www.ted.com/talks/lucas\\_husted\\_game\\_theory\\_challenge\\_can\\_you\\_predict\\_human\\_behavior](https://www.ted.com/talks/lucas_husted_game_theory_challenge_can_you_predict_human_behavior)
- Saxenea, Sharoon: Decision Making in a Competitive Scenario using Normal Form Games  
<https://www.analyticsvidhya.com/blog/2019/12/game-theory-101-decision-making-normal-form-games/>
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<https://www.e-ir.info/2018/12/18/game-theory-and-disarmament-thinking-beyond-the-table/>
- Fosner, Ajda: Economics and Mathematical Theory of Games  
[http://www.fm-kp.si/zalozba/ISSN/1581-6311/10\\_245-256.pdf](http://www.fm-kp.si/zalozba/ISSN/1581-6311/10_245-256.pdf)

## Learning outcomes

After the course, students will be able to:

- understand the basic notions, e.g. non-cooperative games, prisoner dilemma, Nash equilibrium, and principles of game theory.
- solve problems in game theory, e.g. zero sum games, minimax problems, cooperative game
- apply game theory to daily life problems.

Grades	Descriptors
A	Demonstrates well integrated knowledge and a deep understanding of the basics of game theory and strategic thinking; able to completely solve unfamiliar and nonstandard problems, provide innovative approaches to challenging ones, and apply knowledge and skills to new and unfamiliar real life problems with strong and convincing explanations.
A-	Demonstrates good knowledge and a strong understanding of the basics of game theory and strategic thinking; able to provide highly accurate solutions to unfamiliar and nonstandard problems and apply knowledge and skills to new and unfamiliar real life problems with good explanations.
B	Demonstrates essential knowledge and a good understanding of the basics of game theory and strategic thinking; able to provide solutions to unfamiliar but standard problems, and apply knowledge and skills to standard real life problems with adequate explanations.
C	Demonstrates satisfactory knowledge and an understanding, perhaps with gaps, of the basics of game theory and strategic thinking; able to solve slight variations of routine problems and apply knowledge and skills to standard real life problems.
D	Demonstrates disconnected knowledge and only a limited understanding of the basics of game theory and strategic thinking, provides sketchy arguments with barely rigorous logic and can apply knowledge and skills to only simple and standard real life problems.
Fail	Unable to demonstrate sufficient knowledge and understanding of the basics of game theory and strategic thinking, unable to solve the simplest type of problems and shows little ability to apply knowledge to simple real life problems.