

Introduction to Game Theory

General Principles

Dante Yasui

2024

Outline

- What is theory?
- What is a Game?
- Who are the Players?
- What are the different types of games?

Activity 1: Guess 2/3rds of the average

- You will each choose an integer between 0 and 100.
- The winner is the person who's guess is closest to the **average of all guesses times 2/3**
- Submit your guess on [Canvas](#)
- Backup [Google forms version](#)

Activity 1

- This is a simple example, but illustrates how complicated strategic reasoning can be.
- The theoretical solution to this game says that anyone who is *rational* and knows that *everyone else is rational* (Common Knowledge of Rationality) should only choose 0 or 1.
- However, Nagel, R. (1995), “*Unravelling in guessing games : An experimental study*” showed that over 12,000 answers, the average is 35.24.
- Is Common Knowledge of Rationality a ‘bad’ assumption? How can we connect our theories with experimental evidence?

Theory in a data-driven world? ¹

“The theory of economics does not furnish a body of settled conclusions immediately applicable to policy. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking which helps its possessor to draw correct conclusions.” — Keynes

Why is theory useful?

helps us simplify and understand complex systems

- Social systems are really hard, game theory helps us focus on small parts at a time

lets us generate *falsifiable & testable* hypotheses

- Good econometrics is informed by good theory

gives us common ground to analyze important questions

- I often see debates devolve into people arguing on differences of definitions.
- How can we focus on the details that really matter?

What are the limits to theory?

- Our models will never be perfect representations of reality
- But we should know how well they *approximate* the parts of the world we want to understand
- Theory is very useful for generating *falsifiable hypotheses*, which we can then use to guide experimental or statistical tests
- As we play games in class, we will observe the data and compare to our theoretical predictions

What is a Game? Definitions

Examples of some questions:

- When should the Ducks play a running play or passing play?
- Why is a pdf textbook so expensive?!
- Does adding more highway lanes really result in shorter commute times?
- Why did the US and USSR adopt Mutually Assured Destruction?
- Why do people give engagement rings?

What do all these questions have in common?

- They all involve people making choices which depend on the choices of others
- In other words, they are questions of **strategy**:

Strategic interdependence is present in a social situation when what is best for someone *depends* on what someone else does.¹

A definition of a game ¹

A **Game** consists of:

- a collection of decision-makers, called **players**;
- the set of **information** available to each player;
- the **strategies** available to each player in each information state;
- a mapping from the intersection strategies of all players to outcomes;
- **preferences** of the individual players over all possible outcomes

Who are the players?

What defines a player?

- **Preferences:** Everyone has certain things they *want*.

But you usually can't get everything you want; economics is all about *constrained choices*.

So its important to have priorities and to understand which things people prefer to others.

- **Information:** Some people might be better informed than others.
- **Beliefs:** What do I think about when I have to make a strategic choice?

Preferences

Preferences describe the subjective ranking that we put on different alternatives.

For example, on the set of Eugene boba stores, my preference ranking goes like this;

1. Day & Night - they have mango sago, cute location
2. Tea 4 - major chain, good quality and selection
3. Bobahead - no more campus location 🙄
4. No boba
5. Rabbit Hole - no hate, just not for me

Rational Preferences

The **rational model** of choice is the foundation of all economics.

Its assumptions are that:

- People have **complete preferences**
 - for *every* pair of options, you can either tell me which you prefer or that you are *indifferent*
 - for any pair of deserts, $\{ \text{🍦}, \text{🍩} \}$, either $(\text{🍦} > \text{🍩})$, or $(\text{🍩} > \text{🍦})$, or $(\text{🍦} \sim \text{🍩})$
- Preferences are **transitive**
 - if $(\text{☕} > \text{🍵})$ and $(\text{🍵} > \text{🍺})$, then $(\text{☕} > \text{🍺})$ (for any $\{ \text{☕}, \text{🍵}, \text{🍺} \} \in \text{☕}$)

Rational Preferences (cont.)

Another key assumption of rationality is that we can represent preferences by real numbers.

A **utility function** maps a choice to a single number.

For example, let $u(\cdot)$ be the utility function from emoji to utils

- I can have $u(\text{🍺}) = 5$, $u(\text{🌮}) = 10$, $u(\text{🤸}) = 25$
- I can also have $u(\text{🍺}, \text{🌮}) = 20$, $u(\text{🍺}, \text{🌮}, \text{🤸}) = 15$

Ordinal vs. Cardinal numbers

- **Cardinal:** amounts which can be measured in meaningful units are *cardinal numbers*
 - examples: \$9.99, 80 students, 500ml
- **Ordinal:** all that matters is the *relative ranking*
 - examples: utility; what does 100 utility mean? (it's less than 200)

Don't worry!

- For this class, you won't need to worry about utility functions (if you want to, take EC311).
- I will almost always give you specific values of utility which we will call **payoffs**.
- The table on the previous page is a good example.

Strategic Choice vs. other types of choices

- Economics is the study of **constrained choice**; in EC311, we introduce the *utility maximization problem* as the workhorse model
 - These types of problems usually only involve one agent; the consumer, who is only constrained by their budget
- We use the term **strategic games** to distinguish from these single-agent optimization problems
- A **game** is a type of problem featuring multiple agents, called **players**, in which their optimal choice **depends on the optimal choices of other players**.

State-dependent utility table

- Sometimes my enjoyment of a thing depends on the *state* of the world

socially-dependent preferences

My choice	My friends' choice	My utility
Duck's game	Duck's game	3
Duck's game	Stay home	2
Stay home	Duck's game	1
Stay home	Stay home	2

- Is this an example of a **strategic** or **non-strategic** choice?

Taxonomy of Games

Information and Beliefs

This is where it starts to get tricky. For most situations, as game theorists we have to take a stand on what people **know** and what they **believe**.

- Many games contain *perfectly informed* players who know not only their own preferences, but also the preferences of other players. In sequential move games, they can also perfectly observe the moves that players before them made.
 - this is a very strong assumption
- We can relax that last part in games of *asymmetric information* in which some players' strategies (or types) cannot be observed by all players.

Examples

The Battle of Wits (*The Princess Bride* - 1987)

Baseball, I¹

Good pitching will always stop good hitting and vice-versa. -Casey Stengel

Batter	Pitcher	Batting Average
Right	Left	.255
Right	Left	.274
Left	Right	.291
Left	Left	.266

- Rank each player's preferences over strategy profile intersections

Baseball, I¹

It is the bottom of the ninth inning, and the game is tied between the Orioles and the Yankees. The pitcher on the mound for the Yankees is Masahiro Tanaka, who is a right-hander, and the batter due up for the Orioles is Adam Jones, who is also a right-hander. The Orioles' manager is thinking about whether to substitute Chris Davis, who is a left-handed batter, for Jones. He would prefer to have Davis face Tanaka in order to have a lefty-righty matchup and thus a better chance of getting a hit. However, the Yankees' manager could respond to Davis' pinch-hitting by substituting the left-handed pitcher Cesar Cabral for Tanaka. The Orioles' manager would rather have Jones face Tanaka than have Davis face Cabral. Of course, the Yankees' manager has the exact opposite preferences.

Baseball, I

- Draw the extensive form of this situation:

