Introduction to Game Theory

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A logic to think about interacting individuals.

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4. **Biology and evolutionary theory**: cancer cells competing with other cells.
5. **Computer science**: software agents bidding in online markets or auctions.

A bit of history

The birth of modern game theory is usually traced back to the publication of *Theory of Games and Economic Behavior* by von Neumann & Morgenstern in 1944.

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Later, von Neumann became involved in the development of nuclear weapons as part of the Manhattan Project, and with the US military in general.

In the 60–70's it started permeating into economics, and later into other fields.

Program for today

Discuss a simple example of a game: **the Prisoner's Dilemma**.

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Observe that the prisoner's dilemma helps understanding competition in markets.

The game-theoretic study helps us developing policies to improve collective welfare.

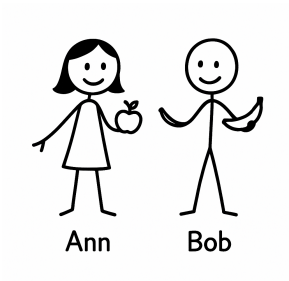
A simple example

Ann has an apple, Bob has a banana.

However, Ann prefers bananas over apples, and Bob prefers apples over bananas.

They can either choose to **Give** their fruit to the other person, or **Keep** it.

	Bob	
Ann	Give	Keep
Give		
Keep		



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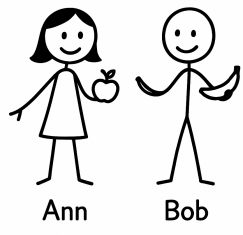
	Bob	
Ann	Give	Keep
Give	6, 6	
Keep		



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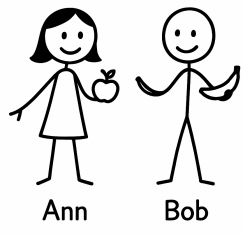
	Bob	
Ann	Give	Keep
Give	6, 6	2, 8
Keep		



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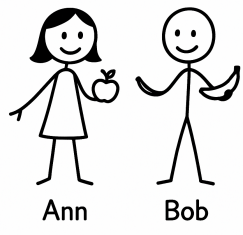
Ann	Give	Keep
Give	6, 6	2, 8
Keep	8, 2	



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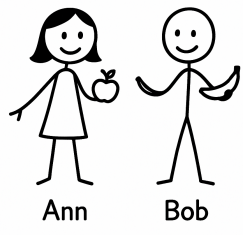
Ann	Give	Keep
Give	6, 6	2, 8
Keep	8, 2	4, 4



What should Ann do?

	Bob	
Ann	Give	Keep
Give	6, 6	2, 8
Keep	8, 2	4, 4

What should Ann do?

	Bob	
Ann	Give	Keep
Give	6, 6	2, 8
Keep	8, 2	4, 4

What should Ann do?

	Bob	
Ann	Give	Keep
Give	6, 6	2, 8
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What should Bob do?

	Bob	
Ann	Give	Keep
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Give	6, 6	2, 8
Keep	8, 2	4, 4

What should Bob do?

	Bob	
Ann	Give	Keep
Give	6, 6	2, 8
Keep	8, 2	4, 4

What happens then?

	Bob	
Ann	Give	Keep
Give	6, 6	2, 8
Keep	8, 2	4, 4

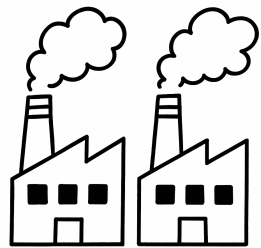
Innovate or not?

Two firms produce plastic bottles.

Each firm can either **Innovate** (invest in new technology to make biodegradable bottles) or **Not** (keep producing regular plastic bottles).

Innovating is costly, and makes the bottle more expensive.

	Column Firm	
Row Firm	Innovate	Not
Innovate		
Not		



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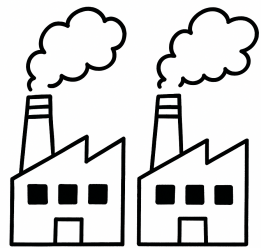
Row Firm	Innovate	Not
Innovate	6, 6	
Not		



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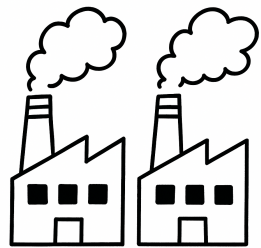
Not		



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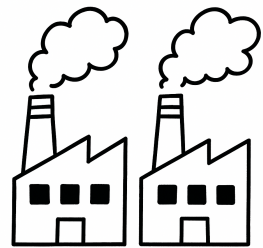
Not	8, 2	



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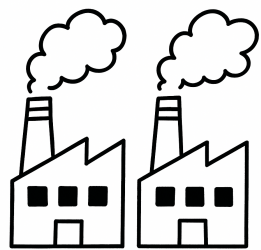

What happens?

The strategic interaction in the market leads to a lack of innovation.

Even if everyone would be better off if both firms innovated!

	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	2, 8
Not	8, 2	4, 4

What can be done?

Obliging firms to do something is usually not a good idea.

There are advantages in letting firms decide by themselves.

But we can try to change the **incentives** they face.

Taxing pollution is a common policy tool.

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Row Firm	Innovate	Not
Innovate	6, 6	2, 8
Not	8 , 2	4 , 4

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	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	2, 8−3
Not	8−3, 2	4−3, 4−3

After introducing taxes, the game looks like this.

	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	2, 5
Not	5, 2	1, 1

What does row firm do?

	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	2, 5
Not	5, 2	1, 1

What does row firm do?

	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	2, 5
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What does column firm do?

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What does column firm do?

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Innovate	6, 6	2, 5
Not	5, 2	1, 1

What happens now?

	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	2, 5
Not	5, 2	1, 1

What do people vote?

Recently, researchers studied what game people vote to play in experiments.

Before taxes and subsidies

	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	3, 8
Not	8, 2	4, 4

After taxes and subsidies

	Column Firm	
Row Firm	Innovate	Not
Innovate	6, 6	4, 5
Not	5, 4	1, 1

A lot of people vote to play the game before taxes and subsidies!

They are not able to predict the effect of changing incentives.

Summary

Game theory provides a framework to study strategic interactions.

It can help understanding real-world phenomena, and design better policies.

Today we saw a simple example: the Prisoner's Dilemma.

There are many more concepts and tools in game theory to explore!

References

von Neumann, J., & Morgenstern, O. (2007). *Theory of games and economic behavior* (60th Anniversary Commemorative ed.). Princeton, NJ: Princeton University Press.