John von Neuman &

Oscar Morgenstern

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ECON 605

John Von Neuman (1903-1957)

Background-Influenced by-Contribution-Impact

- John Von Neumann was a Hungarian American mathematician who made major contributions to vast range of fields.

- He is generally regarded as one of the most foremost Mathematicians of the 20th century.

- Neumann was a pioneer of the application of operator theory to quantum mechanics, a principle member of Manhattan project and Institute for advanced study in Princeton, and a key figure in the development of game theory.

Background-Influenced by-Contribution-Impact

Neumann was born in a rich Jewish family in Hungary, his father is a lawyer.

At very young, he showed a aptitude in mathematics and his father hired private tutors to give him advanced instructions in mathmetics.

In 1930, after his father's death, he emigrated to the United States, and was invited to Princeton University, and subsequently, was one of the four people selected for the first faculty of Institute For Advanced Study, (two of the others were Albert Einstein and Kurt Godel), where he was a mathematics professor from its formation in 1933 until his death.

In 1937, Neumann became a US citizen, and the next year, he was awarded the Bocher Memorial Prize for his work in analysis.

Von Neumann wrote 150 published papers in his life; 60 in pure mathematics, 20 in physics and 60 in applied mathematics.

Oskar Morgenstern (1902-1977)

- Oskar Morgenstern was a German born Austrian economists.
- His mother was a illegitimate daughter of Frederick Ⅲ, German emperor.
- He was educated in Vienna, and was a recipient of a three year fellowship financed by the Rockefeller Foundation.
- He became a member of the faculty at Princeton University, but gravitated towards the Institution of Advanced Study.

his first book was " economic prediction". In 1994, he and Von Neumann co-wrote *Theory of Game and Economic Behavior*, recognized as the first book on game theory.

Morgenstern continued working on a variety of themes, notably a reworking of the von Neumann multi-sector growth model (1956,1976), national defense (1959), on economic data(1950), and on finance.

Background-Influenced by-Contribution-Impact

. Adam Smith
who is the father of the modern economics. He mainly focus on the market effciency. Here, Neuman and Morgenstern refer his argument that people tend to pursuit their rational self Interest to analyze the Game Theory.

Background-Influenced by-Contribution-Impact

Wilfredo Pareto

Was an Italian sociologist, Economist, and philosopher. He particularly contribute to The study of income Distribution and analysis of Individuals' choice, and Introduced the Pareto Efficiency.

Background-Influenced by-Contribution-Impact

Antoine Augustin Curnot
Was a French economists.
He developed the Cournot
Equilibrium that describes
That firms are economically
Rational and act strategically
Usually seeking to maximize
Their profit given their
Competitors' decisions.

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Background-Influenced by-Contribution-Impact

. John Von Neumann and Oskar Morgenstern are key founders of Game Theory, which attempts to mathematically capture behavior in strategic situations, in which an individual's success in making choices depends on the choices of others.

Game theory

A **game** consists of players, strategies for each players, and payoffs that result from each profile of strategies.

Strategy is a plan for the actions that a player in a game will take under every conceivable circumstance that the player might face.

Normal Form Game

A one-shot simultaneous-move game .

In this type of game, two or more players make a single decision at the same time.

Example 1: Prisoner's dilemma

Two suspects in a crime, Bonnie and Clyde, are arrested and placed in separate cells. The police, who have no evidence to against either, privately to give each prisoner a chance to confess and implicate the other suspect in the crime. If neither confesses, they will be convicted on a minor charge and will serve only 1year in the jail. But if one of them confessed, but the other does not, the confessed one will be set free, the not confessed one will take on all the responsibility and will stay in the jail for 10 years. If both them confess, they will both be sent into jail, but for a shorter time, 5 years.

Clyde

Bonnie	Confess	Do not confess
Confess	-5,-5	0,-10
Do not Confess	-10, 0	-1,-1

Given that Clyde confesses, Bonnie get a lighter jail term by confessing than not confessing. And given that Bonnie confesses, Clyde gets a lighter jail term by confessing.

However, given that Clyde does not confess, Bonnie will be set free if she confesses instead of 1 year jail by not confessing although she betrays her friend. Similarly, if given that Bonnie does not confess, Clyde's best response from her self interest is also to confess.

Therefore, regardless of what their partner does, their best responses are always confessing.

Dominant strategy:

A strategy that is better than any other a player might choose, no matter what strategy the other player follows.

Pareto optimal (efficient):

An outcome such that it is impossible to make at least one player better off without making the other players worse off.

In prisoner's dilemma, both of the two prisoners have dominant strategies that is to confess. So the Nash Equilibrium is both of the two prisoners will end up with confessing. It is not the Pareto optimal because the best scenario for them is neither of them confess. This is a obvious conflict between collective interest and self interest. The Nash equilibrium does not coincide with the outcome that maximize the aggregate outcome of the players. The two prisoners will be better off if neither of them confess, however, the rational pursuit of self interest leads each player to take action that is ultimately damage their collective interest.

Example 2:

Honda and Toyota have to make a decision on capital expansion in north America, both Honda and Toyota right now have three strategies: built a large plant, built a small plant, and do not built and plant.

Toyota

Honda

	Built a large	Built a small	Do not built
Built a large	0,0	12, 8	18,9
Built a small	8,12	16, 16	20,15
Do not built	9,18	15,20	18,18

Dominated Strategies:

The opposite of a dominant strategy is a dominated strategy. A strategy is dominated when the player has another strategy that gives it a higher payoff no matter what the other player does.

In the example of Honda and Toyota, neither player in this game has a dominant strategy. However, no matter what Toyota does, Honda is always better off by choosing built small rather than built large. Similarly, for Toyota, regardless of what Honda does, choosing built small is always better than built large. Therefore, we can easily rule out built large as a dominated strategy.

Toyota

Honda

	Built a small	Do not built
Built a small	16, 16	20,15
Do not built	15,20	18,18

Background-Influenced by-Contribution-Impact

As we simplified the initial 3 × 3 table to the 2 ×2 table by finding dominated strategy, we back to the example 1, the two firms now only have 2 strategies: built a small plant or do not built any plant. If Toyota built a small plant, the best response for Honda is to build a small plant also, and if Toyota do not build a plant, the best response is still to build a small plant. Therefore, after we eliminate the dominated strategy, both Honda and Toyota have a dominant strategy here: to build a small plant.

Example 3: Game of Chicken

Two teenager boys are going to prove their manhood to their friends. They each get in their cars at opposite ends of a road and begin to drive towards each other at a breakneck speed. If one car swerves before the other, the one that did not swerve proves his manhood and becomes a hero to his friends, while the other lose face (he is a Chicken). If both swerve, nothing gets proven. If neither swerves, they crash into each other and are either injured or killed.

Background-Influenced by-Contribution-Impact

Slick

Luck	Swerve	Stay
Swerve	0,0	-10,10
Stay	10,-10	-100,-100

Best response:

Given a strategy for the opponent, the best response is the strategy that gives highest payoff.

Nash Equilibrium:

In game theory, Nash equilibrium is used to identify likely outcomes of a game. In Nash Equilibrium, each player choose a strategy that gives it the highest payoff, given the strategies of the other players in the game.

In this chicken game, if Luck swerves, Slick is better off by staying, (payoff is 10) than staying (payoff is 0). And if Luck stays, Slick is better off swerving.

It is exactly the same that if Slick swerves, Luke is better off staying, but if Slick stays, Luke is better swerving.

There are two Nash equilibrium here, and the result must be either of the player has to swerves.

Game theory has been used to study a wide areas:

Economic behaviors

Social and political sciences

Psychology

Biology

How firms make decisions?

Example 5: Price Game of Coke & Pepsi

Coke and Pepsi's profit varies with their competitor's price, each of them has to make decisions on their product according to their rival's price.

Background-Influenced by-Contribution-Impact

Coke

Pepsi	$ 10.25	$ 11.5	$ 12.5	$13.5
$ 6.25	66,190	68,199	70,198	73,191
$ 7.25	79,201	82,211	85,214	89,208
$ 8.25	82,212	86,224	90,229	95, 225
$ 9.25	75,223	80, 237	85,244	91,245

In this case, we begin with searching for dominant strategies. For Pepsi, a price of $8.25 is a dominant strategy, because no matter which price Coke chooses, Pepsi's payoff is always higher in row 3, a price of $8.25, than in any other rows. Therefore, if we know that the Pepsi will choose $ 8.25, it is easily to get that Coke will choose $12.5 since it is their best response to Pepsi's price of $ 8.25.

Everyone loses except the lawyer:

Modern US society has been criticized for being excessively litigious and firms seem increasingly willing to turn to lawyers to resolve their disputes, but the dependence on litigation has significant social cost. However, the decision to hire a lawyer to resolve dispute actually is a result of the prisoner's dilemma.

If they settle the dispute between themselves or hire a neutral arbitrator to resolve their differences, two parties will be collectively better off. But if a party believes that by hiring a lawyer, it will increase the opportunities of winning by a sufficient amount to make hiring a lawyer worthwhile, it will be a dominant strategy to hire a lawyer. But when both parties do this, the dispute will be resolved no differently than if neither hired a lawyer, and each party is worse off by the amount it pays its attorney

Bank Runs

Bank runs seems to be a thing of the past in the United States, but they are nevertheless an intriguing phenomenon. Why do they occur? Are they the result of irrational fear? Could Bank runs be consistent with rational maximizing behavior by depositors? Game theory can explain this.

Now we simplified the question in a model economy where there are only two depositors in the bank, and they deposit $100 in the bank. If both of them keep their money in the bank, they will eventually get their money back with an interest payment of $10. If both withdraw their money at the same time (bank run), the bank must liquidate its investment and close its doors. In this case, each depositor get $25. If one of them withdraw their money and the other did not, again, the bank will liquidate the investment and close. The depositor who withdraw their money get $50, but the unlucky depositor who left her money in the bank losses everything.

. Depositor 1

Depositor 2	Withdraw	Don’t withdraw
Withdraw	25 , 25	50 , 0
Don’t withdraw	0 , 50	110 , 110

Like the Game of Chicken, the Bank run game has two Nash equilibrium. The first is that both of the depositors keep their money in the bank.(if depositor 2 chooses not to withdraw their money, depositor 1's best response is not to withdraw money.) The second is for both players to withdraw their money. (if depositor 2 chooses to withdraw, the best response for depositor 1 is to withdraw money). As the Game of Chicken, game theory can not tell us which equilibrium can occur, but it does tell us that bank run is a consumer's rational decision.

Battle of the sexes

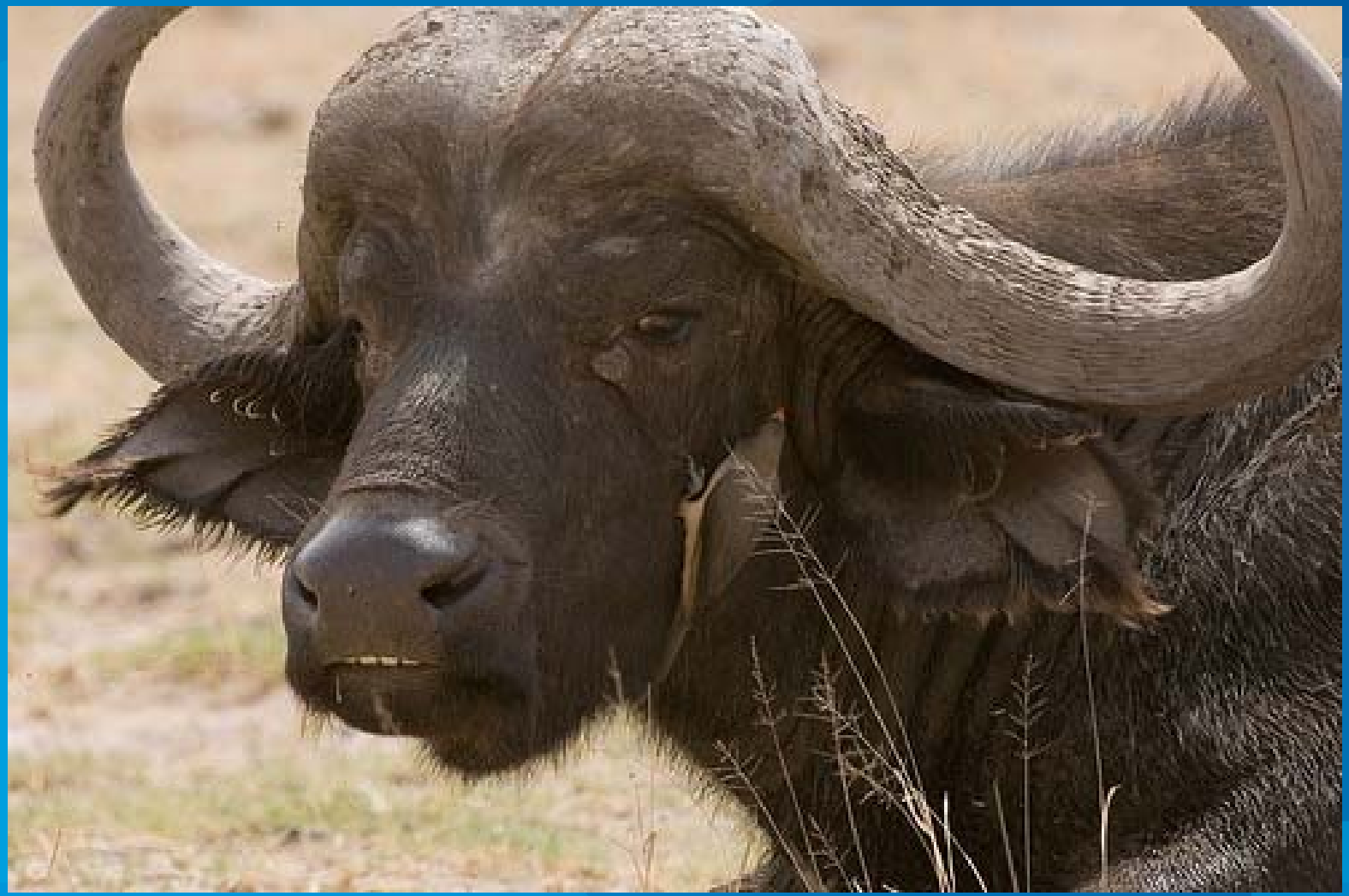
The battle of the sexes is a two player coordination game, imagine a couple. The husband will most of all like to go to the football game. The wife would like to go to the opera, both will prefer to go to the same place rather than different ones. If they can not communicate, where should they go?

Background-Influenced by-Contribution-Impact

	Opera	Football
Opera	3,2	0,0
Football	0,0	2,3

Evolutionary stable strategy

.war and peace in nature



Critiques:

1. In John Von Neumann and Oskar Morgenstern's period, Game theory is too abstract and it can only be understood by some mathematicians. And they only developed the mini-max solution for a Game.
2. They are subjective and they refused to hear Nash's idea and even throw away Nash's paper about Nash Equilibrium.

Questions:

1. Can you give an example of Game theory in the daily life?
2. A and B are two automobile makers. A is much bigger than B and makes better cars. Both of them face a decision on whether to build a new plant. Use game theory to predict the outcome in this situation.

B

A		Built a new plant	Don’t built
	Built a new plant	12,4	20, 3
	Don’t built	15, 6	18, 5

Answers:

B builds a new plant and A does not build

Because B here has a dominant strategy is to build a new plant.