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# **Prediction of game theory on Russia and west on Russia and Ukraine**

# Saeed seyed agha banihashemi

school of International relation of MOFAS IRAN

**Abstract:** Game theory is one of the trends in mathematics that has had a great impact on other branches of science, but for the first time John Neoman used the subject I of game theory in economics and won the Nobel Prize, and now from the Armed Forces to International relations and other trends in other sciences have played a role. In this article, while trying to briefly introduce the theory of games with and try to discuss the role of this branch of mathematics on prediction of Russia and Ukraine war that due to the new technology of artificial intelligence and supercomputers, there is no room for error. In these breathtaking competitions, it helps not to lose. If the research departments do the right thing and collect the right information, game theory can determine up to 90% of the best strategy for winning the war. Now and with the information given, what strategy will the Russia and Ukraine adopt in war and which is best for them in war, which is the unique advantage of game theory, which is very important in the fate of a country. The feature of this article is that with the least knowledge of mathematics in high school, you can read this article. This article introduces two parts of game theory and in the second part practical we try to predict the future of Russia and Ukraine war.

Keywords: game theory , ,war ,Russia, Ukraine

#### I. Part 1: Game theory

**Definition**: Any time we have a situation with two or more players that involve known payouts or quantifiable consequences, we can use game theory to help determine the most likely outcomes. Let's start out by defining a few terms commonly used in the study of game theory:

• **Game**: Any set of circumstances that has a result dependent on the actions of two or more decisionmakers (players)

• Players: A strategic decision-maker within the context of the game

• **Strategy**: A complete plan of action a player will take given the set of circumstances that might arise within the game

• **Payoff**: *T*he payout a player receives from arriving at a particular outcome (The payout can be in any quantifiable form, from dollars to utility.)

• **Information set**: The information available at a given point in the game (The term *information set* is most usually applied when the game has a sequential component.)

• Equilibrium: The point in a game where both players have made their decisions and an outcome is reached

• The Nash Equilibrium: is an outcome reached that, once achieved, means no player can increase payoff by changing decisions unilaterally. It can also be thought of as "no regrets," in the sense that once a decision is made, the player will have no regrets concerning decisions considering the consequences .4]

## II. Types of Game Theory

Although there are different types (e.g., symmetric / asymmetric, concurrent / sequential, etc.)of game theories, cooperative and non-cooperative game theories are the most common. Cooperative game theory deals with how coalitions, or cooperative groups, interact when only the payoffs are known. It is a game between coalitions of players rather than between individuals, and it questions how groups form and how they allocate the payoff among players.

Non-cooperative game theory deals with how rational players deal with each other to achieve their own goals. The most common non-cooperative game is the strategic game, in which only the available strategies and the outcomes that result from a combination of choices are listed. A simplistic example of a real-world non-cooperative game is Rock-Paper-Scissors.

In Grade game me and opposite side are players and  $\alpha$ , $\beta$  are strategies in game .We may have several strategies we need matrix form for keeping our data means according to my action and opposite side it is most important part of game theory if we give rung number or value to actions sure we will not take correct output if our value to action are correct up to 90% our prediction will be correct ,rest is so essay only to compare the numbers and values consider first matrix which belong to me explanation of this matrix is such as fallow 7 If I choose  $\alpha$  strategy opposite side choose  $\alpha$  strategy I will get  $B^-$  and if I choose

 $\beta$  strategy I will take A and if I choose  $\alpha$  strategy and opposite side choose  $\beta$  i will get C and if I choose  $\beta$  and opposite side choose  $\beta$  I will get  $B^+$ . In same way we can do foe Matrix form of opposite side.



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Then we to stick together two matrix we get



Game theory can not say what should your goal be. If we know your goal game theory can help you. We show possible pay off by Utility by = U

In this part we conclude in this manner: comparison between B and C which one has bigger value sure  $B^-$  and among A and  $B^+$  sure A is better which we will show by blue mark .in conclusion for me best strategy is  $\alpha$ . Now for opposite side between  $B^-$  and C which one is bigger value sure  $B^-$  and between A and  $B^-$  which one has greater value sure A which we will show by red in matrix. We can conclude that best strategy for opposite side is  $\alpha$  in this way we predict the action of our opposite side. Specialist in Human science Criticism the game Theory that we cannot digitize human action which is completely rung consider flowing axis.8

Hate action	normal action	love action	
<b></b>			<b></b>
-10	0	10	
so one can easily use	Game Theory in social science.		

In this game dominated strategies for both side is  $\alpha$  that means if they do  $\beta$  will lose in relation, economy, international relation, war and so on. Software which can help applicant is Gambit which work with it is easy which we show bellow the Gambit answer to this game.



Before analysis



# opposite side



In this matrix in red (me) one can find that 0 is grater than -1 mad 3 is greater than -1 so best strategy for me is a and in blue (opposite side) 0 is grater than -1 and 3 grater than -1 so again strategy of opposite site is a.in conclusion we can fond that a is best strategy foe me and game theory predict that a is the strategy which apposite side will do action against me

another version of tools are extension form which is available in Gambit:



now in red in two reaming strategy sure 0 is greater than -1 so dominated strategy will be  $\alpha, \alpha$  for both player when so many strategy is there we use extension form . Again I emphasis that these digit are very important for making decision , these digits will be made from information which one have about the subject we must collect these information or help from an expert in that field . 10

In next example we view another condition which is different from last example.

Definition: we say my strategy  $\alpha$  strictly dominate my strategy  $\beta$  if my pay off  $\alpha$  is strictly greater than  $\beta$ . Lesson 1: do not play a strictly dominated strategy.

Lesson 2: Rational choice can beat to outcome that suck.

Possible Payoff:



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in this example one will proceeds as before but here there is not dominated strategy since red are not in one horizontal line and blue are not in one vertical line. In game theory we say that there is Nash equilibrium that means none of player will not get maximum out put something in the middle for example if it is trade we say there is not maximum benefit for both side in this trade but one things is very important is that if the not following Nash equilibrium the will not get this middle output also. But in this example we have two Nash equilibrium which one is better ?9



In the last section we observe that there is no dominated strategy and no Nash equilibrium

# opposite side

Players strategies	α	β
α	0,0	-1,1
β	-3,3	1,1

In this example we use from Best response (BR) form that means if my opposite side choose  $\alpha$  I must choose and if he choose  $\beta$  strategy I must use  $\beta$  otherwise I will lose the game. Up to her is enough for those how want use Game m ry for daily life for more complicated problems one must go for Game theory course .10

# 2-Prediction of Russia and Ukraine war

In this part we simulate the Russia and Ukraine war .

So, we have two players Ukraine+west and Russia

Russia's actions are as follows:

2-1:strategies

Russia actions

 $S_1$ : Completely give up invading Ukraine and let it join NATO without any interference.

 $S_2$ : Impose sanctions on Ukraine and the West to paralyze their economy with the intention of not letting Ukraine join NATO.

 $S_3$ :Send military troops to Ukraine and declare war to end its desire to join NATO forever.

#### The West's actions are as follows:

 $S_4$ : Leave Ukraine alone and do nothing against Russia's invasion. In other words, give up Ukraine as one of its potential allies and leave it for Russia's insatiable thirst for power.

 $S_5$ ; Impose sanctions against Russia to hinder their progress in Ukraine, yet not directly interfere in the war.

 $S_6$ : Declare war against Russia in Ukraine and send its military troops to aid the Ukrainian people.

#### Ukraine's role .

The role of Ukraine in this model is somewhat controversial. In essence, Ukraine only has two choices: to resist Russia or give up joining NATO. As the actual situation in the world indicates with the new president, Zelensky, and also its determined people who showed real interest in joining NATO throughout history, it very much chooses to resist Russia, and turning back has less value. The second point is that militarily Ukraine does not have enough forces to confront Russia's troops. Therefore, it needs the aid of the West. Accordingly, the situation of the ongoing war is in the hands of two of the most powerful countries in the world.

## The Approachable West's Payoffs

For the approachable West, preference rankings are as follows:  $S_4 - S_1 > S_5 - S_2 > S_4 - S_2 > S_5 - S_{3>}S_5 - S_1$  $> S_4 - S_3 > S_6 - S_3 > S_6 - S_2 > S_6 - S_1$ By looking at the West's preferences, when Russia's action is fixed on LG, business as usual is its top priority since Ukraine can join NATO freely without any cost. Imposing sanctions  $(S_5)$ , and military aid  $(S_6)$  are the second and third options for the West respectively. For the approachable West confronting Putin with military force in Ukraine brings chaos in the world and may lead to World War III, therefore, President Biden would want to avoid  $S_6$  at any cost, that's why even if Russia invades Ukraine the approachable West still prefers to do nothing in return instead of choosing $S_6$ . Accordingly, when Russia tries to force Ukraine to give up its independence by invasion or destabilization, the West's preferences are  $S_5 > S_4 > S_6$ . 13 By fixing the West's action on  $S_4$ , if Russia chooses  $S_1$ , it is preferred by the West against  $S_2$  and  $S_3$  espectively. That's because business as usual brings no cost for the West, and destabilization is also less expensive compared to sending military forces to Ukraine. On the contrary, when the West's action is fixed on  $S_5$ ,  $S_2$  is preferred to  $S_3$  since again it is the less aggressive state. It is clear that  $S_3$  has the lowest value for the West. The reason is that, by imposing sanctions against Russia, while Putin agreed to back down and let go of Ukraine completely, the West is practically declaring an aggressive manner against Russia and provoking it to change its move to  $S_2$  or possibly  $S_3$ . In other words, by choosing to impose sanctions against Russia, the West is putting Ukraine in more danger than before. The same scenario is true for the next ranking when the West's action is fixed on  $S_6$ . That is to say; if the West is supposed to bring its troops to Ukraine's soil, it is logical to do it for the better cause which is in response to Russia's direct assault. The same reasoning also goes for  $S_1$  here as well. For the approachable West, it seems that  $S_4 - S_1$  is the best possible outcome that could happen since Ukraine can easily join NATO without Russia's hostile response. The second best possible outcome for the West is  $S_5 - S_2$ . As  $S_6$  is the last preferred action for the West,  $S_6 - S_1$ ,  $S_6 - S_2$ , and  $S_6 - S_3$  are the worst outcomes respectively. In scenario 1 for the approachable West, we assume:  $S_4 - S_2 \succ S_5 - S_3$ ,  $S_5 - S_1 \succ S_4 - S_3$ ,  $S_5 - S_1 \succ S_4 - S_2$ . In these assumptions,  $S_3$  is the least preferred action for the approachable West. Also, it is better for Ukrainian as well since Russia's direct assault has lower payoffs. It is good to mention that in this paper the West's payoffs are correlated to Ukraine's avail.

#### **Russia's payoffs:**

Among the 9 possible outcomes of this game, Russia's preference rankings are as follows:  $S_4 - S_3 > S_5 - S_3 > .S_4 - S_2 > .S_6 - S_3 > .S_5 - S_2 > ..S_6 - S_2 > ..S_6 - S_2 > ..S_6 - S_1 > ..S_6 - S_1$  By looking at the preference rankings, Russia prefers invansion over Destabilizing and Letting Go respectively, while the West chooses Business as usual. The reason is obvious. If Russia does nothing and let's go of Ukraine, Putin will lose one of his most important allies to the West which is the last thing he wants. Additionally, because getting Ukraine back at any cost is Russia's priority, therefore, invasion is preferred over Destabilizing, even though the cost of initiating war might be higher. The same preference is true for Russia when the West chooses to impose sanctions or even bring military forces into Ukraine. Accordingly, we may conclude that no matter the West's strategy, Russia will always choose the ordering.  $S_3 > .S_2 > ..S_1$ . In other words,  $..S_3$  is a dominant strategy. On the contrary, when Russia's actions are fixed, Putin prefers a more passive West, which does nothing against Russia's actions. Thus, the ranking of

 $S_4 > S_5 > S_6$  is preferred by Russia for the West's actions. Amongst the possible states,  $S_6 - S_1$  is the worst outcome for Russia. Not only the West brings its troops to Ukraine's aid, but also Russia steps back and does nothing in response. The second and third-worst possible states for Russia are.  $S_5 - S_1$  and  $S_4 - S_1$  respectively. On the other hand,  $S_4 - S_3$  is the first, and  $S_5 - S_3$  is the second-highest preference for . Russia. At this point, I assume  $S_5 - S_3 > S_4 - S_2$  and  $S_6 - S_3 > S_5 - S_2$ . The ordering of such assumptions is based on the level of aggressiveness of Russia. Now, in Table 5 we can see the first scenario of the complete game with each player's payoffs. Underlined payoffs are the best responses for the two players. For instance, if Russia chooses  $S_1$ , the best response for the approachable West is to choose  $S_4$ . The same logic is true for the rest of the underlined payoffs.

			Russia	
		<i>S</i> <sub>1</sub>	<i>S</i> <sub>2</sub>	S <sub>3</sub>
	<i>S</i> <sub>4</sub>	<mark>9</mark> ,3	7,7	4,9
West	<i>S</i> <sub>5</sub>	5,2	<mark>8</mark> ,5	<mark>6</mark> ,8
	<i>S</i> <sub>6</sub>	1,1	2,4	3,6



:Best response

:Best response

# Calculation with Gambit and AI in strategic form

			S	2	S	3
S4	9	> <	7	$\rightarrow$	4	9
<b>S</b> 5	5	> <	8	$\searrow$	6	8
<del></del>	> <	$\geq$	$> \sim$	$\mathbf{X}$	$\rightarrow$	6

# Calculation with Gambit and AI in extension form





III. Conclusion

According to these calculation best strategy for West is S5(Sanction)and Russia will do strategy S3 (more invasion).

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