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The Role of Game Theory and Artificial Intelligence in International Relations

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Abstract

Politics might be the most challenging behavior among human behaviors for being automated. Politics is, in nature, a complicated affair that reflects human behavior considering both individual and social dimensions. Such complexity seems more real in international relations. Artificial Intelligence (AI) is an effective and inclusive area that covers technical and engineering disciplines and human sciences, especially international peace and security. Game theory has been used as a component of AI in politics and international relations, focusing on the framework of some common areas, including equitable distribution, political economy, public choice, bargaining model of war, positive political theory, and public choice theory. Researchers have discussed game theory models in the abovementioned areas. In this model, players perform as voters, governments, special interest groups, and politicians. Therefore, the extant study examined the role of game theory in international relations.

Keywords: International Relations, Rules of The Game, Game Theory, Computational Intelligence, Artificial Intelligence

INTRODUCTION

No considerable association seems to exist between the new scientific AI field and international relations and security science; however, the ascending attempts of some countries in this area reject such an assumption. The recent AI developments imply that this newly-emerged technology will markedly and potentially influence military power, strategic competition, and world policy on an extensive scale.

In this lieu, theories of international relations may soon face a crisis of explanation power (Slaughter & Hale, 2011). This crisis will change the world when determining policymakers to make political decisions matched with political goals (Burchil et al., 2013). When governments trust information technologies to analyze policies, advise, and implement them, theories of international relations should consider the consequence of new players within the same information technologies of robots, AI. Other information (Scott, Heumann & Lorenz, 2018: 19). Technologies that can make decisions through the policy-making process must treat individuals, states, and other players in a similar ontological and epistemological way (Langhelle et al., 2019).

On the other hand, AI contributes to producing machines that can learn and understand complicated conditions, think, reason and present responses, and acquire knowledge without human

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help and interference (Ullah et al.,2020: 314-315). Therefore, those countries that own such machines and systems can change the balance of power in the international system in their desired way and create new alliances to dominance over other nations and countries (Schrodt, 1998: 71). In other words, countries with excellent AI have a specific competitive advantage that can exceed less-developed countries depriving them of gaining revenue and different political, economic, and military advantages. Countries that use AI have a competitive advantage over countries since they employ a large processed information volume and broad analytical power obtained from smart machines. Therefore, these countries can use this advantage to fulfill their diplomatic, economic, business, and military goals more successfully than others that rely on human capabilities and instruments to analyze information and decide on their profit and loss (Kiggins, 2018: 19).

AI and game theory (GT) are two developed research scopes stemming from similar roots within different trajectories. However, a deep and fundamental association exists between AI and GT, so developing and searching these associations can contribute to considerable achievements in both scopes. Three main notions (learning, representation, and reasoning) exist in the deep relationship between AI and GT, which are common in two representation and reasoning areas (TEMA, 2014: 1).

In GT, learning is a descriptive tool that explains how Nash equilibrium occurs or agents behave (Assaad, 2021: 3), while this notion, especially reinforcement learning in AI, means learning some algorithms that can generate a high profit for an agent under uncertain environmental conditions based on the received feedbacks (Tembine, 2019). Agents are represented as profit maximizers in GT (Shafiei & Farah Gol, 2019: 1), while other forms of decision-making, including competition analysis or maximizing security level (worse mode), also exist in AI (Ahmadi et al., 2014: 13). Finally, agents must infer in both scopes considering the rational and communicational constraints in a distributed space (Mirza Momen, 2011: 5).

Game theory can be applied in different AI scopes, including multi-agent AI systems, imitation and reinforcement learning, and adversary training in Generative Adversarial Networks (GANs are algorithmic architectures that put two neural networks against each other). Therefore, the term "adversarial" is used to create new synthetic samples from data that can be transferred for real data and widely used to generate video, film, and audio (Zhang, 2019: 2).

According to the mentioned points, the extant study aims to examine the role and effect of AI on future international relations (IR), considering US status in the investment rate, application of AI in the international area, and AI investment in future wars. Moreover, game theory considerably affects the configuration and design planning of an AI model. The core method of GT should be understood to find how GT improves power to AI models. To do this, the present paper first examines AI and its role in IR and then addresses the definitions, concepts, and applications of GT in IR. This study also examines the advantages and specifications of AI in IR and threats raised by using AI in military areas and the security of countries.

Literature Review

Artificial Intelligence (AI)

AI includes a wide area of knowledge, which is the intersection of other important knowledge such as computer sciences, electronics, psychology, biology, linguistics, logic, and philosophy (Acemoglu & Restrepo, 2019). We can name more than 20 AI subdisciplines, including learning machine (Alimadadi et al., 2020), pattern recognition (de Souza et al., 2019), natural language processing (Steinkamp & Cook, 2021), robotic (Dirican, 2015), expert systems (Bahrammirzaee, 2010), neural networks (Kumar & Thakur, 2012), fuzzy logic (Milčić et al., 2007), and genetic algorithm (Ansari & Bakar, 2014).

The book entitled “game theory in international relations” by Mehdi Reza Darvishzadeh and colleagues is a relevant work. This book argues that politics and IR are significant areas in which game theory is used, while this scope has received less attention in Iranian academic associations due to its mathematical basics. Hence, this book introduces titles and main models of non-cooperative games to express models so that all readers with different levels of mathematical

science can understand the topics. Moreover, each chapter presents some examples of politics and international relations. Another reference entitled “quantitative methods in futurology of time series and artificial intelligence” by Mohsen Bahrami and Payam Abbaszadeh examined a relatively complete range of linear-to-smart models. However, the mentioned works have not considered the role of GT or AI in all economic, political, cultural, and military aspects of IR.

AI Functions in IR

AI can play three analytical, predictive, and operational roles in IR and policy-making. The mentioned roles have been explained herein:

Analytical Role

AI systems are found in analytical roles assessing large datasets and concluding based on pattern recognition. These roles are tedious tasks generally known as the highest priority for automation. Monitoring the output of adjusted sensors to verify the accuracy of, for instance, a nuclear, chemical, or biological arms control treaty that provides jobs for human analysts. However, they require specialized and professional training. On the contrary, a training machine learning system set up to the same deed does not get tired of its task, while it might employ human specialists to oversee and correct the system's accuracy, especially in the learning process.

Similarly, however less dramatic, AI processes might be very useful for optimizing the procedures of simpler political exchange' aspects. Given the increased volume of data immediately generated by industrial and commercial operations through the "internet of things (IoT)," it is not difficult to imagine the AI systems that monitor trade and feed decision-making processes around the economic policy. In other words, AI will only become important in how policymakers see and perceive the world. Doing so will effectively enhance their information processing capacity while causing new uncertainties and complexities in decision-making protocols (Cumming et al., 2018: 2-3).

Predictive Role

Another set of AI roles can be prediction rather than analysis. In other words, whereas analytical applications of AI have been considered to simplify current operations, AI systems may provide opportunities for policymakers to understand possible future events. One such example in the IR arena is the possibility of modeling complex negotiations. Besides using AI systems to monitor compliance and improve the efficiency of complex international documents, negotiation parties (whether economic or strategic) might use sophisticated machine learning methods to predict others' positions and tactics. However, some moderating factors should be considered.

Considerably, for example, while predictive algorithms have been shown in some capacities successfully, they are not necessarily more accurate than their human equivalents. Time, accumulated knowledge, and computer hardware that become increasingly powerful may make them as accurate as human predictions. However, the nature of prediction causes a lack of a clear success standard in this field. Moreover, as seen in Tesla's fatal accident in 2016, the interface between machine and human understandings of the world creates a new potential for wrong calculations without necessarily providing a compensatory advantage. The truth amplifies the potential that complex negotiations are multi-party by definition: the machine system and human operator do not only try to obey a set of rules more effectively. They try to forecast or match measures of one or more rivals (who may themselves use predictive algorithms). There might be some advantages arising from machines operating in such predictive capacities-particularly the fact that the ability of an artificial system to store and compare a large number of historical data is almost certainly higher than a human or a group of humans.

To share these advantages equitably, the underlying technology should be available- and, in this regard, strict measures must be taken to protect personalized data that enter the algorithms. It is indeed difficult to create the right balance. Furthermore, it is worth noting that AI may play other predictive roles with geopolitics that contribute to the more accurate forecast of elections, economic performance, and other relevant events. However, such areas are functions less than machine learning and more than the quantity of available data but must mainly be considered in this context (Cumming et al., 2018: 3-4).

Operational Roles

The last category is somewhat different and covers autonomous systems in the traditional meaning of robots. Implications of this application are probably scattered and indirect, but their potential importance receives attention alongside analytical and operational functions. Autonomous logistical systems likely have significant indirect implications for international politics.

If truck drivers, ship crews, or pilots are replaced with autonomous systems, no considerable change is expected to be observed in the daily functioning of the international system. However, an extensive replacement of existing human labor in these capacities may cause a widespread economy.

Autonomous weapons are another significant case, although it is further from wide acceptance than is generally recognized. A considerable public debate exists about ethics, the legality of the development, and the use of such weapons. The main principle of this debate is the autonomy that distinguishes it from what is concerned about unmanned drones. These systems are remotely piloted compared to fully autonomous systems. Ethical questions aside, autonomous weapons do not necessarily change the balance of power.

An autonomous strike aircraft makes certain tradeoffs relative to piloted aircraft more endurance and expendability compared to flexibility and adaptability- but is not an inherently more powerful and game-changing weapon.

In the long term, the ability of autonomous systems to react with greater speed than humans can make a difference in some environments. Autonomy may also make it possible to develop new classes of weapons; for instance, the swarm of small and interconnected robotic vehicles can create new military capabilities paradigms. However, the logistical and ethical questions arising from such potential systems indicate that we cannot declare that technology is ready for deployment, let alone game-changing.

One possible expectation can be cyberweapons with autonomy and machine learning, with the potential to make them more effective and adaptive compared to their counterparts. However, like a non-military autonomous vehicle, the real impact probably is indirect for a while. A military with autonomous systems may be more capable than a military without a system- at least in the short term. However, even if the autonomy of an instant prospect does not cause a fundamental change in war, the consequences of changing norms and standards in policymakers' attitudes and reactions to threats probably change markedly (Cumming et al., 2018: 4-5).

Game Theory (GT)

GT is a notion that has been widely used in different branches of sciences, including economics, politics, military sciences, biology, computer sciences, and so forth, over recent decades (Myerson, 1997). GT is a mathematical theory for designing, analyzing, and describing conflicting situations in which the involved players are exposed to several choices based on certain rules. The GT is a study instrument used in different levels of analysis- from economic, political, and military strategies of governments to individual and group relations (Golparvar & Shahabi, 2011). It is possible to use GT to analyze the logical behavior of players and their strategies, recommend some rational methods to improve choices, and gain maximum profit and minimum loss (Khakestari et al., 2018). Moreover, this theory introduces some relevant concepts that can be used to design a framework for complicated phenomena (Nobakht et al., 2011). Rational human behaviors and choices are the most underlying assumption of GT (Mahmoudinia et al., 2016). GT is used in social and political contexts, including election competitions and AI (Ghahraman & Mohammad Javad, 2009).

Individuals face interactive situations in decision-making, so the implications for every person or group depend on their personal and group decisions and behaviors and others' decisions and behaviors (Mahmoudi et al., 2016: 2).

GT Concept

Scholars have expressed various definitions for GT. For instance, Bruin (2005) defines game theory as a branch of applied mathematics used to investigate humans' social behavior, strategic interaction, and logic of conflict between humans. Carmichael (2005) explains that GT is a technique used to analyze situations where two or more individuals, the outcome of an action by one of them depends not only on the action taken by that individual but also on the actions taken by the

others. Osborne and Rubinstein (1994) define GT in their book as a bag of analytical tools designed to help us understand the phenomena we observe when decision-makers interact. Maschler, Solan, and Zamir (2013) define GT as a methodology that uses mathematical tools to model and analyze situations where several decision-makers (players) exist. According to the abovementioned definitions, there is a consensus in these definitions explaining GT as a decision theory under interactive conditions, and this is the concept defined by theorists for GT (Mahmoudinia, 2016: 3).

GT framework pursues the analysis within three steps: metaphor, allegory, and modeling. Metaphor is the first step to GT. Metaphors are used not only in literature but also in mechanics, biology, and social knowledge. Because metaphor cannot reveal all game subjects, the second step (allegory) is used to correspond to different situations to express similarities. Allegory creates a guide for empirical observation in GT to enable comparison. Since allegory cannot solve the game analysis problem that is empirical data-based, the third model of modeling is taken. The simplest definition of the model is the streamlined form of reality, and game theorists analyze the games through the modeling process (Attar, 2018: 92). The last goal of GT is to design some prescriptions and advice for the rational behavior of players in conflicting situations, i.e., to determine the optimal strategy for each player (Shakibaei et al., 2021: 219). In GT, the optimal strategy for a player is a strategy that ensures the highest average privilege in repetitive cases. In other words, this strategy is less likely to lead to loss. This strategy is selected based on the reasoning that a rival is as rational as us and does anything to prevent us from achieving our goal. The mentioned two principles generate all advice in GT (Khatami, 2020: 184-185). As a result, hazard-seeking that inevitably exists in all strategies, miscalculations, or possible mistakes of players are not considered (Wenzel, 1994: 17).

In general, game theory comprises three concepts: assumptions, game components, and context. Assumptions express hypotheses that have created the theory. The elements and components required to shape a game are categorized as "game components," and the circumstances on which the game is modeled are called "game context." The rationality of players is a significant assumption in GT; it means decision-makers look for good exogenous defined objectives and consider strategic reasonings (Hosseini Dehaghani & Basirat, 2016: 95).

Constituents of GT

Every game has three underlying elements: players, tactics (strategies), and implications (outcomes).

Decision-makers are called players in a game. A player is a person who decides in the game's strategic space, and these decisions are based on the player's rational behavior to achieve the best outcome considering rivals. Tactic or strategy includes a set of decisions and measures taken by each player. The payoffs gained by players are named outcome or implication (Souri, 2007: 5). According to the basic definition of GT, this theory is applied to model strategic situations. In other words, these situations include interaction, confrontation, and conflicting interests that require awareness. Players should cooperate and interact and have supplementary interests. This theory is an uncertain environment for each player, so players' behavior influences others' behavior (Hosseini Dehaghani & Basirat, 2016: 96).

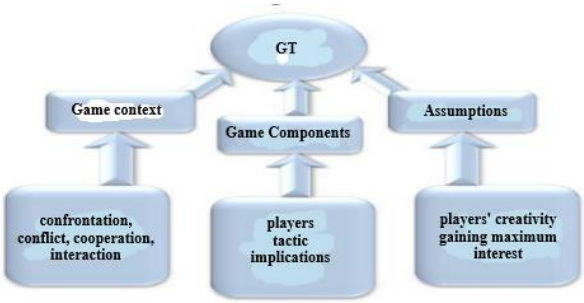

Figure 1. GT analysis tools
Source: Authors

Every game is determined based on the following elements:

Players: the player is defined as each participant or competitor that can choose a strategy and influence the game conditions and other players' choices (Ahmadi, 2006: 18). In other words, every game has several rational decision-makers called players. Governments are the main players in international relations, and two exist in all international conflicts and cooperation.

Rules of the Game: in GT, a game includes a set of known rules for all players that set what appointment can do or what can be the results or outcome (Souri, 2011: 388). Rules of the game can become public knowledge; each player can know the rule of the game, and each player must know that another player also knows the rule of the game, and each player knows two former cases. In this case, the rule of the game is the general awareness or knowledge between players (Abdoli, 2011: 12). Each player can have perfect or imperfect information about the play. In some games, players can make aware of other players' outcomes and strategies, while such a case is not possible in other cases (Hatami, 2010: 1).

Outcomes: win or loss rates and/or the result gained at the endpoint of players are called outcomes. Although the utility is an abstract notion, it should be quantified in GT. Everyone might prioritize the game in different forms (Poundstone, 2007: 218). Two points should be mentioned about outcome rates: first, interest is a mental concept, and outcome rates should fulfill the mental satisfaction in an ideal case; second, other players, theorists, or both consider outcomes uncertain (McCain, 2013: 43). The authors who have written about game theory distinguish between the result of a game (win, lose, draw) and outcome (the value every player gives to the result). The relationship between outcome and motivation is important which is inevitable. Outcomes may have different meanings for players, given their values, position in the international system, and domestic circumstances (Doherty, 1997: 788).

Strategy: strategy is a mental skill used to play well in a game. In other words, strategy means the optimal application of skill in the game (Abdoli, 2011: 3). Moreover, strategy can be defined as a player's plan or action choice under any possible circumstance. In other words, strategy is a sorted chain of measures that a player can choose in different steps. Therefore, it is a complete program of measures and decisions that might be taken in the game. Although some strategies may comprise only one decision or measure, other strategies can include numerous decisions and measures. The general plan means a plan that considers the probability of any measure occurrence (Moosavi Jahromi, 2012: 21).

GT in AI

In AI scope, GT formulates the framework to study cooperative and strategic interactions within multi-agent systems. Moreover, GT is used in those AI and deep learning systems in which various agents should interact with each other. The traditional GT provided mathematical basics and powerful equilibrium concepts while allowing GT to be applied in sophisticated and large systems in terms of computational and demonstrative contents. Computational GT covers a range of modeling, presentations, and algorithms that try to simplify and remove constraints in traditional GT (Mirza Momen, 2016).

Many games like poker, solitaire, chess, ludo, etc., are some games that are played digitally on laptops, phones, tablets, etc. All games have a clear set of rules and instructions, so you should follow the game's rules to win it. You have to create some algorithms that consider the number of players and rules if you want to make these games digitally; therefore, the game theory will be developed. The majority of popular games that we play digitally have been developed using AI and GT; GT is not just confined to games but has considerable applications in AI, such as Generative Adversarial Networks (GANs), machine learning algorithms, manipulation-resistant systems, multi-agent AI system, imitation, and reinforcement learning, etc. (Tyagi, 2019).

GT concept is necessary to solve many dynamic problems. In this case, GT assists AI so that one can improve traffic flow in a region by using AI-controlled self-driving cars and implementing GT in multi-agent reinforcement training. Each car perfectly interacts with the external environment; now assume that the case gets more complicated if cars think in a group way.

Consider that one car conflicts with another because you may follow a certain route for their travels. This mode can be simply modeled using GT. Regarding GT, cars perform as players, and Nash Equilibrium is the point of cooperation between different cars. Reinforcement learning requires interacting with the real or virtual environment and augmented reality. Assume that

an agent interacts with a random environment and learns a policy through reward or punishment; that environment teaches one agent. This is not possible no longer. The reason is that interaction now exists between different agents and the environment. Therefore, modeling a system with several agents is difficult. The increasing number of agents leads to an exponential increase in possible routes the agents use to interact with each other. GT can solve this problem.

In other words, AI and GT work on intelligence agents embodied in a complicated world. These agents may interact with other agents and use learning and reasoning techniques to improve their conduct. AI and game theory (GT) are two developed research scopes from similar roots within different trajectories. However, a deep and fundamental association exists between AI and GT, so developing and searching these associations can contribute to considerable achievements in both scopes. Three main notions (learning, representation, and reasoning) exist in the deep relationship between AI and GT, which are common in two representation and reasoning areas (Tennenholtz, 2002: 58).

Game theory can be applied in different AI scopes, including multi-agent AI systems, imitation and reinforcement learning, and adversary training in Generative Adversarial Networks (GANs are algorithmic architectures that put two neural networks against each other). Therefore, "adversarial" is used to create new synthetic samples from data that can be transferred for real data and widely used to generate video, film, and audio (Ippolito, 2019). Ian Goodfellow introduced GNAs in 2014. This network is developed based on the GT, and a deep learning network competes with an adversarial trend. This network is also used to generate audio and video content, amplify videos, convert audio, or synthesize speech (Soltani, 2018).

One fake video from Nancy Pelosi indicates how much a deep fake can be risky in political issues. This video shows the house speaker of the US presenting a speech, but in the fake version, her speech speed was reduced by about 25% and she appeared drunk and abnormal mood. Deepfake videos have violated the privacy of politicians leaving them with numerous problems. The Defense Advanced Research Projects Agency (DARPA) has spent millions of dollars on detecting deep fakes. This is not the only research center; Facebook and Google have also spent money to find methods that can detect fake content. News agencies, such as Reuters set Factenchecker to fight against any deep fake in the United States Presidential election, 2020. However, a responsible employee of UGC and the UGC verification department of Reuters states that good deep fakes can even mislead professionals. Reinforcement learning training can be mentioned in Multi-Agents Reinforcement Learning. Reinforcement learning learns to create an agent through interacting with an environment that can be real or virtual. Reinforcement learning is used to detect correctness or wring cases, learn from signals, and do implicit measurements for indirect learning (IRIB News Agency, 2020).

Since AI is based on four assumptions (systems that think rationally, systems that perform rationally, systems that think like humans, and systems that perform like humans), it consists of three general parts of neural, evolutionary computations, and fuzzy systems (Russell & Norvig, 2021: 20-22).

Therefore, AI can understand the environment and take a measure based on this understanding to maximize the chance of fulfilling an objective. This resembles the rational player model in decision-making theory. The outcome of GT indicates that humans are rational creatures that want to maximize their profit. On the other hand, mathematical optimizers, statistic and probability-based techniques, and computational intelligence are applied in AI and GT. GT is not a part of AI and vice versa; these two methods are not interconnected; they can overlap each other so that one can use AI to solve or analyze a game.

International Relations (IR)

International relation is a branch of politics pertained to relations between governments and their foreign policies (Webster Dictionary). As the realm of social life at the global level, international relations are attractive for educated classes that are interested in public issues (Moshirzadeh, 2017: 1). International relations study the relationships between countries, the role of independent countries, interstate organizations,

international non-governmental organization, NGOs, and multinational firms. International Relations is an academic discipline that can be normative and evidential since it analyzes the foreign policy of a government (Hajizadeh, 2018: 1).

International Relations appeared in the Wets and USA after its power and influence were enhanced at the beginning of the 20th century. While the study of international relations was damaged in the newly-established Soviet Union and Communist China due to formally imposed Marxism ideology, this discipline could eliminate ignorance, provide human progress, and make political issues, such as foreign affairs, public. Success stories in the West included increased demand for finding effective tools to make relations between people, communities, governments, and economies. Numerous studies and papers were also inspired by this belief that regular research and observation can destroy ignorance and develop human communities.

Woodrow Wilson, president of the United States from 1913 to 1921, introduced this new view about relations between great powers after the settlement of the First World War. The first point of his fourteen points was the contact after his plan was outlined. In the case of "open covenants of peace," instead of confidential treaties that were the reason for war, the devastating aftermath made political leaders believe there was insufficient information about international relations. Accordingly, universities had to promote research and education on international collaborations, war, and peace issues.

Application of GT in Politics and IR

Politics uses GT in some scopes, including political economics, public choice, positive political theory, and social choice theory. Researchers have developed GT models differently in the mentioned scopes so that voters, interest group situations, and politicians are players. Generally, this theory is applied in all political aspects, especially in intra-government and minor competitions between leaders when game rules do not exist and personal competitions dominate the legal relations. No law can serve as a political conduct framework in the mentioned case. Hence, this game will become an illegal case influenced by personal decisions. The game will get more complicated in the absence of certain rules. In such games, that part wins the game that can mobilize maximum resources timely, although the increased mobilization cost occurs (Abdoli, 2008: 247).

In GT, mathematics and logic are added to the underlying principles of Balance of Power to better analyze the economic, political, and international coercion of governments and their interest-centered financial thoughts. The mentioned analysis will be beyond the assumption of governments' rationality, logic, and authority (Pourkazemi et al., 2014: 27-28). In other words, GT considers an international arena where each player must rationalize their behavior to achieve success. The global environment is a computational space where no irrational conduct can be shown, although some friends act against their national interests and international game rules and framework (Taklif, 2014).

The international scene is a multi-player arena where payoffs obtained by some parties do not equal the loss of other players, so it is a non-zero-sum game. For instance, the development of different aspects of a country is not necessarily conflicting with the interests of other players. It is possible to reach national demands and goals in the framework of dual or single interests of countries or multiple interests of international arena players. The first factor for entering the game and taking action in the scene is accepting the rule of the game in the international arena based on logic and computational measures. This necessarily does not mean avoiding nature and national principles and values but is only a rational and independent game in interactions. Lack of totality is the main environmental characteristic of the mentioned interactions (Ghahremani & Mohammad Javad, 2016: 15). Therefore, each government should provide its vital and national interests, welfare, and security for the nation in an arena consisting of both conflict and cooperation. The best result of GT is the scene of international interactions that include game rules, framework, skill, bargaining, computational tools, rationality, utility, professionality, and capabilities. Those players capable of professional games based on the mentioned properties and think of rational success can win the game (Gibbons, 1992).

Main Principles of GT in International Arena

GT provides clear information about the diversity of competitive circumstances. GT points to five aspects of strategic behavior in terms of application in competition between commercial organizations: cooperation, deterrence, commitment, changing game structure, and signaling. A firm can use the mentioned aspects to improve its competitive results (Strategy Office of Sharif University, 2019: 1).

GT provides clear information about extensive diversity of competitive circumstances, such as the Cuban Missile Crisis of October 1962, competition between Boeing and Airbus, NASCAR Racing tactics, TV and Radio Spectrum Auctions, Financial Crisis in 2008. GT points to five aspects of strategic behavior in terms of application in competition between commercial organizations: cooperation, deterrence, commitment, changing game structure, and signaling. A firm can use the mentioned aspects to improve its competitive results.

Cooperation

The ability to compete and cooperate is one of the main criteria in GT. One shortcoming of the Five Forces framework is that this framework considers the nature of inter-firm relations completely competitive. Consideration of dual competition-cooperation relation is the main point of Adam Brandenburger and Barry Nalebuff's perception. Although some relations are perfectly competitive (Coca-Cola and Pepsi) and others are completely cooperative (Intel and Microsoft), no branch exist between competition and cooperation. All commercial relations have elements from both. Despite the close competition between Coca-Cola and Pepsi, they cooperate on different fronts, including shared policies on selling non-alcohol drinks in schools, environmental topics, and health concerns. Moreover, they might coordinate their pricing and product introduction (Rahimian, 2020: 22).

In another case, Exxon and Shell's companies fought for world oil leadership for over a century while cooperating in joint investments. Rivals' tendency to merge (sellers in London antique market or filmmaking studios in Hollywood) refers to the joint interests of rival companies to enhance their market size and develop infrastructures. The research author believes that this principle of GT indicates that competition leads to worse outcomes than cooperation in many commercial circumstances.

Deterrence

Deterrence is a way to change the equilibrium of a game. Deterrence means taking action or a set of actions to exceed the enemy's hostile actions. Deterrence theory means trying to influence another party to prevent it from doing any action that causes damage or cost for the first one (M Elliott & Reginald, 1999: 370).

The notion of "deterrence" in GT has created a significant area in international relations. Nuclear arms racing between America and the Soviet Union was based on the logic of "definite bilateral devastation." However, the ability of deterrence to create a sustainable and peaceful equilibrium depends on the enemies' willingness for deterrence. One of the main shortcomings of George W. Bush's "war on terrorism" was that deterrence does not threaten terrorists with ideologic motivations (Rahimian, 2020: 20).

Commitment

Deterrence should be rational to be effective; it means deterrence must be supported by commitment. Commitment or obligation requires removing strategic authorities: "connecting organization to the future solution." After Hernan Cortes destroyed his ships when he entered Mexico in 1519, he negotiated with Mendoza and his companions and explained that he had no way to defeat Aztec Empire. After Airbus decided to produce the giant A380 plane, project commitment appeared to be a significant case. Airbus invested in plane promotion between 2000-2002 before the design phase to encourage airlines to order and prevent Boeing from manufacturing a rival plane (Rahimian, 2020: 29).

Changing Game Structure

Creative strategies can change the structure of the competitive game. A firm may want to change the industrial structure where it competes, to enhance industry profitability potential or gain more share of available profit. Therefore, alliance and agreement with rivals can maximize the game value by increasing market size and joint power

against possible new rivals. Numerous opportunities may exist to change win-lose (or even loss-loss) games to win-win games.

For instance, the bidding war between Norfolk Southern- an American railway corporation established in 1982- and CSX was created in 1980 after merging Chessie System and Seaboard Coast Line Industries (two holdings that controlled several railways in East USA). After these two firms agreed on collaborating for railway transportation separation and purchase, the bidding war ended. In some cases, rivals may be useful for the firm. Intel assigned its potential monopoly over x86 microchips by presenting the production license of their products to AMD. Although Intel created a competitor for itself, this firm encouraged computer manufacturers (including IBM, concerned about over-dependence on Intel) to accept x86 chips.

Signaling

The competitive reaction depends on the rivals' perception of the competitor's action. The term "signaling" describes the selective exchange of information to competitors (with customers) designed to influence their perception, stimulate or prevent certain reactions.

Incorrect information is well used in military information departments. The Book “Operation Mincemeat" explains how Britain's military department uses a dead body outfitted in maritime military uniform and transfers fake secret documents to persuade senior German commanders that the allies' forces get off in Greece, not Sicily (Rahimian, 2020: 32).

The Role of AI in Foreign Policy

AI can be used in different fields of foreign policy in the current era that foreign policy is moving towards algorithms that aim to analyze data, predict events, and consult with governments. The most important applications of AI in foreign policy include managing public expectations in another country, deciding based on the scenario writing, and analyzing the signs received from speeches and positions of other countries' officials. However, an accurate understanding of foreign policy analysis is before the applied model selection and how AI tools are used. In this lieu, China introduced a new AI system two years ago that was structured for Chinese foreign policy. This system called the "geopolitical environment simulation and prediction platform,” provides Chinese diplomats with some recommendations for foreign policy after analyzing large data. According to an informed source, China used the same system to evaluate all foreign investment projects over the past years (Majidzadeh, 2020).

AI assists policymakers in decision-making and allows them to make the final decision. AI helps decision-makers by enhancing their ability to use this information technology. Moreover, AI helps decision-makers by doing more mundane activities that distract them from focusing on the vital element of a subject. Because the software industry prepares some plans for AI, it should make plans for it under certain circumstances. AI should look for approximate solutions without ensuring optimality to provide a human-like response. A system that can provide an 80% solution can repeat the human function more accurately and creates a 20% space for human interpretation.

The Role of AI in Trade and the International Economy

AI development affects international trade in different ways: effects of AI macroeconomics and its relevant business effects. If AI enhances productivity growth, it will increase economic growth and create new opportunities for international trade. The present rate of productivity growth is low globally for various reasons. One of the reasons for low productivity growth, especially in understanding the potential relationship with AI, is the economic effect of AI in the integration of the economy and the effective application of new technologies, particularly in complicated cases. The mentioned effects include a huge sufficient capital to have a total effect and complementary investments required for the perfect use of AI investments, such as access to skilled individuals and commercial techniques (Naghavian, 2021).

AI acts as the engine of productivity and economic growth. AI can increase the efficiency of actions and improve decision-making by analyzing numerous data. Moreover, it can create new products, services, markets, and industries, increase consumer demand, and create new income flow (Szczepański, 2019: 2).

AI affects the type and quality of economic growth by influencing international trade. For

instance, AI accelerates service-based economies. It also is used for production, and product value added. AI should contribute to a higher contribution of services in production and international trade.

Economic, Social, and Military Effects of AI

AI-based services will control and manage transactions to minimize errors and mistakes in future years because AI generates news without involving journalists and reporters, so many simple jobs provide services. This evolution leads to an economic revolution. According to forecasts, more than half of today's jobs will disappear within the one or two next decades, and smart robots and AI-based systems will control these jobs. According to professional predictions, AI development leads to the highest evolution in human life after the end of World War II. After producing self-driving cars and independent products without employing humans, most social processes will be automated (Movahedian, 2019).

AI has been used in the military, and many countries are producing AI-based systems and weapons to minimize human presence in war and achieve the victory factor of information priority in wars. This requires designing advanced communication technologies-based network systems that provide information accessibility and accurate data analysis. Technical aspects of AI have been markedly developed in recent years. Like electricity, the internet, and steam engine, AI is a technology with a general goal that highly concentrates on machine learning and development. AI affects many significant variables, such as productivity, economic growth, inequality, market power, innovation, and employment in the economy (Jahangard, 2019: 4).

Conclusion and Data Analysis

Since AI is based on four assumptions (systems that think rationally, systems that perform rationally, systems that think like humans, and systems that perform like humans), it consists of three general parts: neural, evolutionary computations, and fuzzy systems. Therefore, AI can understand the environment and take a measure based on this understanding to maximize the chance of fulfilling an objective. This resembles the rational player model in decision-making theory. The outcome of GT indicates that humans are rational creatures that want to maximize their profit. On the other hand, mathematical optimizers, statistic and probability-based techniques, and computational intelligence are applied in AI and GT. GT is not a part of AI and vice versa; these two methods are not interconnected; they can overlap each other so that one can use AI to solve or analyze a game.

According to the abovementioned points, AI can be used in different fields of foreign policy in the current era that foreign policy is moving towards algorithms that aim to analyze data, predict events, and consult with governments. The most important applications of AI in foreign policy include managing public expectations in another country, deciding based on the scenario writing, and analyzing the signs received from speeches and positions of other countries' officials. However, an accurate understanding of foreign policy analysis is before the applied model selection and how AI tools are used. Under such circumstances in the current era, foreign policy will generally change because countries are using AI and algorithms to predict events. In this case, countries interact with each other while knowing that their actions might have been predicted in previous days, weeks, or months. The changing business world will transform geopolitical relations. In this case, AI helps to select the type of players and choices by determining the assumptions based on the professional panel of foreign policy experts (besides other essential disciplines, such as social psychology, political sociology, anthropology, etc.). Then AI calculates and prioritizes the different scenarios. Although the results of AI applications do not indicate their certainty, AI can reduce the uncertainty of foreign policies to take the best measures and strategies.

Furthermore, AI-GT integration in different forms and scopes implies that GT is a decision-making science, such as research in operation and engineering economics, with the difference that GT studies those problems where the results of a decision depend on the decisions made by two or more independent decision-makers. In other words, decision-makers cannot completely control their decisions' results. Determining competitive and cooperation strategies or a combination of them in all (commercial, industrial, social, political, military, etc.) organizations is an underlying cause. GT supports

its genius founders; it provides decision-makers and supporters with the required tools. Therefore, decision-making theory can be used to achieve the goal, and monitor the current status, monitor current status, and optimal future situation for any change in international relations. Action and reaction stem from affairs calculated by different governments in international relations. In this approach, governments are players that try to choose a method in which maximizer and minimizer players exist to reach an equilibrium point. Therefore, governments can apply "Normative Decision Theory" and "Descriptive Decision Theory" that analyze the results of decisions or determine optimal decisions considering constraints and assumptions. The mentioned theories examine how individuals decide on this process. in other words, one pays attention to the decision's results, while another considers how a decision is made.

Moreover, the conducted studies indicate that the performance of some governments implies sufficiently huge knowledge interest in AI. Investments done by some countries, such as France and China, indicate their expectations from considerable local knowledge interests of this technology. Many large private corporations in the world have invested in AI. Learning machine improves more data, so large corporations and larger countries will gain more benefits.

On the other hand, AI and GT all address intellectual agents embodied in a complicated world. These agents may interact with other agents and use learning and reasoning techniques to improve their conduct. This integration and technology have been brainstormed and used in military sectors.

AI increases exponentially and promotes its influence using some amenities, such as large databases, new data analysis technologies, and, more importantly, the interpretable data received from different sensors. The more free and unknown variables, the more sophisticated the decision-making will be. These systems help to enter more variables into the decision-making process. Moreover, one can consider the neural network of unknown variables, the unknown relationship between variables, and variables with an unknown effect on the outcome. Accordingly, these systems bring more accuracy to complicated decision-making processes.

In general, it is concluded that such changes, approaches, and positive or negative feedback have led to two types of strategies for AI development in the policymaking scope. One policy focuses on the disseminating and developing AI model, while another emphasizes the implications of such dissemination and development. The policy should consider the most relevant policies associated with AI dissemination and development, privacy, trade, and responsibility. The policy design focuses on social value for optimal balance between AI stimulation and dissemination without causing risk.

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