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Final Paper

Game Theory and Computer Science:

Analysis of the Russia-Ukraine Conflict and US Involvement

**Introduction –**

The Russia-Ukraine conflict involving the West (United States, NATO, and EU) has been a significant geopolitical issue, impacting global stability and regional dynamics. The involvement of the West further complicates the situation. To understand and potentially mitigate the conflict's effects, a multidisciplinary approach is required. This proposal aims to leverage game theory principles and computer science tools to analyze conflict dynamics and propose strategic interventions. By applying game theory concepts, this paper aims to focus on the negotiations, incentives, and potential outcomes for the West’s involvement in the Ukraine-Russia conflict.

To systematically approach this analysis, the paper is structured into several key sections, each addressing different facets of the conflict and the theoretical models used to understand them:

The *Core Idea and Concept (1)* section lays the foundation of our analysis by introducing the application of game theory models to simulate the decision-making processes among the conflict's primary stakeholders: Russia, Ukraine, and the West.

*Expanding Core Idea and Concept* *(2)*: Building upon the foundational models, this section delves into additional elements crucial for a comprehensive understanding of the conflict. The discussion also introduces the possibility of exploring more complex models, to incorporate uncertainty about the intentions and capabilities of the involved countries.

*Background (3)*: Providing a historical context, this section traces the origins of the conflict to Russia's annexation of Crimea in 2014 and the subsequent armed conflict in Eastern Ukraine.

*Motivation/Goals and Approach (4)* The final section before diving into the analysis, this part underscores the motivation behind using game theory to analyze the Ukraine/Russia conflict. We articulate the aim deepen the understanding of the underlying dynamics driving the Russia-Ukraine conflict and to assess the role of the United States in shaping its outcomes.

*Key Tools and Components* *(5)* This section describes the methodological framework of the study, detailing the game theory concepts, models, and computational modeling techniques employed.

*Analysis (6)* and *Conclusion (7)* finish the paper, and by structuring the paper in this manner, we aim to provide a clear roadmap for our analysis, offer insights into the complex interplay of strategic decisions, geopolitical dynamics, and the potential pathways toward resolution or escalation in the Ukraine/Russia conflict.

1. **Core Idea and Concept**

The core idea revolves around applying game theory models to simulate the decision-making processes of key stakeholders involved in the conflict, including Russia, Ukraine, and the West. By representing the conflict as a game with multiple players, each pursuing their interests, we can gain insights into potential outcomes and strategies.

The concept involves developing computational models that incorporate key variables such as; military capabilities, economic sanctions, diplomatic relations, and public opinion. These models will simulate various scenarios and assess the likely consequences of different actions taken by the involved parties.

**Prisoner’s Dilemma**

The Prisoner's Dilemma is present with U.S. involvement in the Ukraine-Russia conflict. Some decisions are simultaneous, but the majority are sequential. For the Ukraine; they can continue to fight with U.S. support, cooperate and negotiate with Russia for diplomatic solutions, or cooperate with Russia and escalation dynamics to analyze strategic interactions between the United States, Russia, Ukraine, and other relevant actors.2 In this model, each country (Russia, Ukraine, and the US) is represented by a player in a repeated Prisoner's Dilemma game. The choices available to each player could be cooperation (e.g., respecting borders, diplomatic negotiations), or defection (e.g., military aggression, economic sanctions). The payoffs for each country could be tailored to represent the strategic interests of each player. For example, cooperation might yield mutual benefits such as economic stability or security, while defection could result in short-term gains (e.g., territorial expansion) but long-term costs (e.g., international isolation or further economic sanctions). The model can be extended over multiple rounds to analyze how strategies evolve over time and how cooperation or conflict patterns emerge.

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*Figure 1*

Although the Prisoner’s dilemma is good for understanding the incentives and payoffs in games where trust and betrayal play critical roles it oversimplifies complex geopolitical dynamics with binary choices (cooperate and defect). Prisoner’s dilemma also assumes that all players act rationally and has similar payouts for all players. In real-world situations historical, cultural, and emotional factors introduces uncertainty where not all players act rationally, and not all payouts are known.

**Dijstra’s Shortest Path Algorithm 3**

Another way to look at the conflict would be creating a one player “obstacle course” type game where Russia acts as the only player finding the shortest paths between weighted nodes in a graph. Dijkstra’s algorithm can be used to find the shortest path for Russia in this conflict as the instigator in attacking Ukraine. It can be used to model scenarios where decisions lead to different outcomes based on the path chosen. here The West acts as weights and Ukraine acts as chance.

1. **Expanding Core Idea and Concept**

There are several elements of the conflict that will also be examined in this paper. Cyber Warfare, global economic implications, information warfare and propaganda, NATO’s role, humanitarian considerations, and deeper global energy implications.

Another more complex model that could be explored is the Bayesian game model. In this model, uncertainty about the intentions and capabilities of other players (countries) is explicitly incorporated. Using Bayesian game model

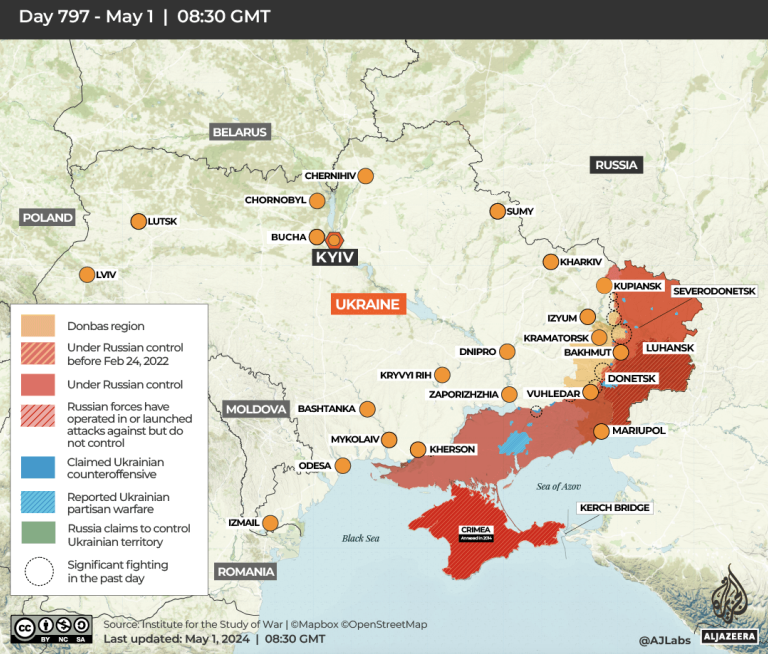
1. **Background**

In 2014 a conflict began in Eastern Ukraine after Russia’s annexation of Crimea, and armed conflict broke out between Russian-backed forces and the Ukrainian military. Negotiations were attempted in 2015 but were unsuccessful.1 Both Russia and the Ukraine claim Crimea, and as an ally to Ukraine the United States is obligated to offer support. However, the United States wants to avoid direct conflict with Russia.

Since 2014 the conflict has been on and off with periods of intense fighting and periods of ceasefires. The negotiation attempts were not effective as thousands of people died and many more were displaced.4 The international community led by the US, European Union (EU), and other countries including NATO have imposed economic sanctions against Russia and provided military aid to support Ukraine.

In February 2022 Russia launched a full-scale invasion of Ukraine which was met with further international condemnation, sanctions against Russia, and more support for Ukraine. The increased tension has led to millions of Ukrainians displaced, and a wide range of geopolitical impacts including global politics, security, economics, energy supplies, and agricultural exports. Asides from the humanitarian crisis suffered by Ukraine, the global community has been widely affected by the conflict.

As of right now the situation is fluid with ongoing military engagements, diplomatic efforts, and international scrutiny. There are websites that show daily updates4, experts that claim Russia is sure to lose5, sources that say Ukraine is headed for defeat6, and other sources that claim there is no end in sight.7



*Figure 2 shows current status of conflict.*5

In conclusion the Ukraine/Russia conflict is a multifaceted and dynamic issue that involves national sovereignty, territorial integrity, and international law. The geopolitical ambitions for Ukraine and Russia and the global community creates a very complex situation to foresee a definite outcome.

1. **Motivation, Goals, and Approach**

The motivation for this paper is to use the application of game theory to the Ukraine/Russia conflict by taking an analytical approach to understanding the dynamics of the conflict, predicting outcomes, and forming decision-making strategies for policymakers and stakeholders involved.

The Ukraine/Russia conflict is geopolitical and doesn’t just affect those two countries. There are obvious humanitarian issues with the invasion of Ukraine including loss of life, poverty, prolonged displacement, and food shortages.8

The humanitarian issues of Putin’s war in Ukraine have caused a severe economic crisis in Ukraine, that also threatens the global economy.9Cost of living and food insecurity across the globe have been affected by the war immediately, but the soaring energy prices and impacts on financial markets will only be compounded the longer the conflict lasts.

Another immediate area of interest is how this conflict will affect the upcoming 2024 elections. It is known that Russia interfered in the 2020 presidential elections by using social media to sway voters in favor of President Trump.10 Currently Russia is spreading disinformation to damage President Biden to undercut military aid to Ukraine.11However, as the election date grows closer it appears that Putin is in favor of having Biden as President. 12 It is unknown how genuine Putin’s comments are, but the war in Ukraine will mostly likely have an impact on the 2024 United States election through social media in favor of Russia’s interests.

Ultimately, the motivation for this paper is to apply game theory to analyze the Ukraine/Russia conflict in order to either expedite or put an end to the suffering and loss of life, improve the outlook on the global economy, and gain insights into other geopolitical issues.

**Goals**

There are several goals of this paper. Researching and gaining a deeper understanding of the underlying dynamics driving the Russia-Ukraine conflict is the first goal. Conducting a thorough review of existing literature on the Ukraine/Russia conflict, game theory applications in international relations, and relevant computational models will be crucial to figuring out the role of the United States in shaping its outcomes. Then consider the potential outcomes and whether the conflict will end in resolution or escalation.

The next step would be to provide evidence-based policy recommendations to stakeholders and promote conflict resolution. By leveraging these tools and methodologies, the proposed project aims to contribute to a better understanding of the Ukraine-Russia conflict and to inform more effective and strategic decision-making by the United States and other stakeholders involved.

**Prior work in this area, and related activities**

There are many articles that have been written about the Ukraine/Russia conflict that describe the humanitarian and impacts on the global economy.

1. The Organization for Economic Cooperation and Development (OECD) has information on policy challenges for the war in Ukraine as well as data on the war’s effect on global food security.19
2. Effect of Ukraine crisis on the United States.20
3. Effect of war in Ukraine across the globe.21

There have also been several papers that describe the use of game theory on the Ukraine/Russia conflict.

1. Game theory paper from Concordia University Master’s (economics) student.22
2. Opinion piece from.23
3. Opinion piece in LA times by professor at UC Berkeley.24
4. Blog from Cornell student.25
5. Published paper from Skararya University Ph.D. candidate.26
6. Prediction of game theory on Russia and west on Russia and Ukraine.27

Youtube video: Putin Unleashed: A Game Theory Analysis of the Ukraine Conflict | David Woo.28

There is also the live site with all updates from Al Jazeera **4**

**Work in other areas that should be leveraged**

There are several areas of knowledge that should be leveraged while using game theory analysis in the Ukraine/Russia conflict.

1. Having a broad understanding of the current international relations and geopolitical issues that can shed light on the dynamics of alliances, and power balances that influence the Ukraine/Russia Conflict. This includes the history and historical context of geopolitical issues across the globe, but also how the conflict is dynamic.
2. A deeper look into energy politics and economics. The conflict has had a huge impact on food supply and soaring energy costs that have already had global impacts. In 2021 Russia was the largest exporter of oil and natural gas to the European Union, (90%).29
3. Media communication: Examining the use of propaganda and shaping public opinions does have an impact on foreign policy and strategic decisions. In this conflict Russia’s true intentions are a little blurry. Putin claims he wants to restore the Russian Empire.30

However, “Putin’s annexation of Crimea (2014) was very much driven by undermining Ukraine’s energy and gas diversification strategy.”31

1. The history of human rights and humanitarian studies should also be considered. Understanding human rights law, humanitarian assistance, and response strategies are important in this case.

**Key challenges**

The main challenge to overcome in this project is the complexity of the conflict. There are more than just two players (Russia, Ukraine, US, EU, Middle East etc.), and identifying all players true preferences is difficult.

Incomplete information is another challenge because game theory assumes that players have complete information about the game. In the Ukraine-Russia conflict information is either incomplete, intentionally hidden, or subject to manipulation.

Rational thinking, non-cooperative behavior, and trust issues are also challenges in using game theory for the Ukraine-Russia conflict. Unknown emotions and beliefs could come into play amongst all players. In real-world conflicts not all players act rationally, and mistrust and deception are possibilities.

**Statement of impact**

This paper plans to use the application of game theory to analyze the Ukraine-Russia conflict and understanding the complex dynamics of this ongoing geopolitical struggle. By leveraging game theory models, in depth research on the strategic interactions, incentives, and decision-making process of the involved parties we can provide valuable insights for stakeholders. With comprehensive analysis we can identify potential escalation, negotiation strategies, and possible opportunities for conflict resolution. Our findings could potentially inform diplomatic efforts and peacebuilding interventions that promote economic stability/security and relieve humanitarian concerns.

**Approach**

Solving static and Dynamic games by solving for Nash Equilibrium, the minimax algorithm with alpha beta pruning, and other methods, has high time complexity and leaves us with games that are either too simple to be representative of reality or too complex to solve. A very complex two player game, like the Ukraine-Russia conflict could instead by modeled as a single player “Obstacle Course” game, where the strong player, i.e. the West (United States, NATO, Europe) sets the weights, and the weak player, Russia, attempts to try to solve the game with the best possible outcome.

An ”Obstacle Course” is modelled as a Directed Acyclic Graph (DAG)32 with vertices and edges (V,E), such that every edge is considered an action that would take the player from starting node to terminal node and the weight on each edge (0<w≤1) is considered to be the probability of success. The terminal node is a dummy node that signals the end of the game.

Nodes that are one distance from the terminal node are outcome nodes, and the weight on the edge from them to the terminal is the payout of that outcome. The payout of an outcome weighted by its probability of success is the product of the edges on the path from start to terminal, going through that outcome node.

By transforming every weight w-> log(w), we can then find the path with maximum expected payout by running Djikstra’s shortest path algorithm 3, which is relatively good time complexity compared to Nash.

The war in Ukraine is happening in real time where every day there are updates like the progress of fronts for Ukraine and Russia, economic sanctions, financial aid, and military aid. In this case weights on each edge may be updated by chance, or the stronger player (West) to make the game harder for the weaker player (Russia).

**Design**

The “Obstacle Course” game that models the Ukraine/Russia conflict is setup as a single-player game, Russia (the weaker player) will navigate through a directed acyclic graph (DAG) that represents various actions and outcomes. The West (the stronger player) will set the weights on each edge, and Ukraine will introduce chance elements.

The first thing to do is define the vertices (actions) and edges (transitions) based on real-world events, and then assign initial weights to the edges (representing probabilities). The second step is to periodically update edge weights based on changing circumstances (military developments, diplomatic actions) with the West influencing these weights strategically.

Russia’s strategy is to maximize its expected payout by choosing paths through the graph. Then we will use Dijkstra’s algorithm with transformed weights (-log(w)) to find the optimal path. The West sets the weights to favor its interest, and the stronger player can adjust weights to make the game harder for Russia.

1. **Key Tools and Components**

In this section of the paper, we delve into the critical tools and components underpinning our analysis, with a particular focus on Python, NetworkX, network\_viewer, and Dijkstra's algorithm as foundational elements.

We explore game theory concepts and models, including strategic games and extensive form games, which are instrumental in understanding the dynamics of strategic interactions and decision-making processes. To simulate these complex interactions and model the decision-making mechanisms effectively, we employ advanced computational modeling techniques and algorithms. Among these, Dijkstra's algorithm stands out for its utility in finding the shortest paths within a network, a critical aspect when analyzing strategies and outcomes in conflict scenarios.

Python emerges as a pivotal programming language in our toolkit, offering the flexibility and robustness required for developing and implementing sophisticated computational models. Within the Python ecosystem, NetworkX is a key library that facilitates the creation, manipulation, and study of complex networks of interactions. This is complemented by network\_viewer,

<https://github.com/jsexauer/networkx_viewer>

an essential tool for visualizing these networks, thereby providing intuitive insights into the intricate web of strategic interactions.

To ensure the accuracy and relevance of our models, we rely on a variety of data sources for parameter estimation and validation. This includes historical data on the Ukraine-Russia conflict, economic indicators, military capabilities, and geopolitical events. Such data not only enriches our models but also grounds them in real-world scenarios, enhancing the validity and applicability of our findings.

In summary, by integrating game theory models, computational algorithms like Dijkstra's, and the powerful programming capabilities of Python with NetworkX and network\_viewer, we establish a robust framework for simulating and analyzing strategic interactions. This approach is further strengthened by the careful selection of data sources that provide a solid foundation for our computational models.

**Example**

In terms of complexity, I was initially considering using Nash equilibrium and minimax algorithms that were too challenging for the Ukraine/Russia conflict. The “Obstacle Course” approach simplifies the problem and captures the dynamic nature of the conflict allowing for real-time adjustments that can easily be made in the model.

1. Starting Node is Russia’s current strategic position.
2. Action Nodes:
   1. Diplomatic Engagement – Edge weight: 0.7 (Probability of successful engagement)
   2. Military Escalation – Edge weight: 0.4 (Probability of escalation leads to favorable outcome.
   3. Economic Sanctions – Edge weight: 0.6 (Probability of sanctions impacting West)
3. Chance Node (Ukraine’s influence) will be node D. Ukraine’s defensive actions. Edge weight: Determined by a chance move, ~0.5
4. Outcome Nodes E and F:
   1. Node E negotiated settlement - Edge weight to terminal node: 0.8 (Probability of successful negotiation)
   2. Node F prolonged conflict – Edge weight to terminal node: 0.3 (Probability of conflict dragging on)
5. Terminal Node is the end of the game representing the final outcome.

Let’s say the selected path by Russia is: Starting Node -> Node A -> Node D -> Node E -> Terminal Node. Meaning the probability of success is the product of edge weights = 0.7\*0.5\*0.8 = 0.28 with the transformed weights being (-log(0.7), (-log(0.5), (-\log(0.8).

This path is a simple example representing a strategy where Russia opts for diplomatic engagement, navigates through the uncertainty of Ukraine’s defensive actions, and aims for a negotiated settlement. It is a hypothetical scenario with a probability of success at 28% and the expected payout would be based on the payouts assigned to the outcome nodes. However, this geopolitical conflict is more complicated and the model I built with

**Visualisation/Discussion**

In the network diagram below, the strategy of Russia is highlighted as “Take Ukraine, Quickly, and Cheaply” is depicted as the outcome amongst other alternatives. This strategy while theoretically optimal in terms of speed, cost, and military perspective, is unrealistic when considering geopolitical and international responses/consequences. A diagram of a network

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<https://github.com/jsexauer/networkx_viewer>

If we further analyze this strategy by Russia, the options by the West could be expanded to include the following responses after Russia’s potential first move. These responses are categorized into four main areas as Russia’s initial action: aggressive escalation, which includes economic sanctions and military aid; strategic de-escalation/negotiation, focusing on diplomatic dialogues and sanctions relief; hybrid actions, which enhance intelligence and counter-disinformation efforts; and information war or proxy strategies, aimed at bolstering media integrity and cybersecurity.

Each strategy is crafted to manage the immediate crisis while also considering long-term regional stability and global security. The outcomes of these complex interactions are uncertain, with scenarios ranging from a quick Russian victory to prolonged attrition or even a potential escalation to a global conflict.

**Russia moves and West responses**

1. Aggressive escalation
   1. Economic Sanctions – The West can tighten economic sanctions against Russia, disrupting financial systems, trade, and energy exports. Causes economic pain to Russia.
   2. Military aid to Ukraine – advanced weaponry, intelligence support, and personnel training. This strengthens Ukraine and deters Russian aggression.
   3. NATO allies (not including U.S. – deploy troops, conduct military exercises, and reinforce defense mechanisms of Ukraine. Clear indication to extend the war.
   4. Coordinated International response: The West including US condemn Russian actions.
   5. Diplomatic efforts for De-escalation and negotiations – attempt to find common ground.
   6. Cyber and information warfare – Attempt to counter Russian disinformation campaigns, cyberattacks, and propaganda. Helps improve global support for Ukraine.
   7. Crisis management – anticipating Russian aggression and having plans to make decisions rapidly and coordinate actions accordingly with allies.
2. Strategic De-escalation/negotiation
   1. Diplomatic Engagement and dialogue/negotiation: Can explore avenues for de-escalation, ceasefire agreements, and finding ground on common issues.
   2. Sanctions Relief: Ease economic sanctions in hopes for Russia to De-escalate.
   3. Monitoring systems: ensures compliance with negotiated agreements. Includes on-the-ground inspections, reporting, and transparency measures.
   4. Humanitarian assistance: Aid to affected civilians and conflict zones to foster stability and recovery for Ukraine. actions.
   5. Security Guarantees: Can deter Russia from taking further action against Ukraine if there are reaffirmed commitments to sovereignty and security.
   6. Coordinated International response: The West including US condemn Russian actions.
   7. Crisis communication channels: prevent misunderstandings, manage crises, and avoid accidental escalation. (Has been an issue on frontlines)
3. Hybrid actions
   1. Enhanced Intelligence and Surveillance: The West will improve surveillance to monitor Russia’s hybrid activities. Such as cyber operations, disinformation campaigns, and unconventional (illegal, or ignoring negotiations) military movements.
   2. Counter-disinformation: exposing false narratives.
   3. Strengthening cyber security: Securing critical infrastructure, improving cybersecurity, and educating the public about disinformation.
   4. Diplomatic Engagement/negotiations: Emphasize international norms and rules that can deter further aggression from Russia.
   5. Support Ukraine: economic sanctions, military aid, and economic support. Strengthens Ukraine.
   6. Coordinated economic sanctions with NATO and EU that target individuals (Oligarchs) and key Russian economic sectors.
   7. Crisis management – anticipating Russian aggression and having plans to make decisions rapidly and coordinate actions accordingly with allies.
4. Information war or proxy
   1. Counter-disinformation: exposing false narratives.
   2. Support for Independent Media: Fact-checking organizations get setup in Ukraine to strengthen reliable information.
   3. Enhanced Intelligence and Surveillance: The West will improve surveillance to monitor Russia’s hybrid activities. Such as cyber operations, disinformation campaigns, and unconventional (illegal, or ignoring negotiations) military movements.
   4. Support Ukraine: economic sanctions, military aid, and economic support. Strengthens Ukraine.
   5. Economic pressure on Russian allies: Impose economic sanctions on countries or entities supporting Russia’s proxy efforts. Targeting financial networks and trade partners to weaken Russia’s position.
   6. Diplomatic isolation of Russian allies: Isolate countries or organizations supporting Russia’s proxy war. Targeting financial networks and trade partners to weaken Russia’s position
   7. Crisis management – anticipating Russian aggression and having plans to make decisions rapidly and coordinate actions accordingly with allies.

**Outcomes:**

1. Quick Russian Victory (Expensive for Ukraine, Cheap for Russia):
   1. Russia increases military operations, launches devastating airstrikes, cyber-attacks, and indiscriminate strikes across Ukraine. Kyiv falls within days, and a pro-Moscow regime replaces the government. President Zelensky is either assassinated or flees. Thousands of civilians die, and Ukraine joins Belarus as a client state of Moscow.
   2. Time is quick, Russia wins (risk of insurgency), Ukraine loses sovereignty.
   3. Cost: Ukraine High (loss of lives, infrastructure, sovereignty), Russia Moderate (military resources and international reputation)
2. Long War of Attrition (expensive for both):
   1. The war becomes protracted. Russian forces get bogged down, and Ukraines defensive forces turn into an effective insurgency. The frontline stabilizes, and both sides suffer casualties over the years. The West continues to provide, equipment (weapons and ammunition, financial aid, and humanitarian support to Ukraine.)
   2. Time is long, Russia reaches a stalemate (withdrawal), Ukraine resilient insurgency (some territorial loss)
   3. Cost: Ukraine High (loss of lives and infrastructure), Russia Moderate (military resources and international reputation.
3. Russian Ceasefire (Through negotiations, high uncertainty)
   1. Putin surprises (low probability) with ceasefire. Russia pockets minor territorial gains and declares victory pressuring Ukraine to stop fighting. Talks begin, but conflict remains unresolved.
   2. Time is uncertain, Russia has tactical gain and narrative change, Ukraine gets temporary relief with an unresolved conflict
   3. Cost: Ukraine Moderate (loss of lives and territorial loss), Russia low (narrative shift)
4. Stalemate with Talks (moderate cost for both):
   1. Military action is useless, and talks begin political settlement. The frontline remains semi-permanent, and the war becomes a frozen conflict.
   2. Time is uncertain
   3. Cost: Ukraine Moderate (territorial losses and ongoing instability), Russia Moderate (stalled objectives)
5. World War 3 Escalation (catastrophic for all):
   1. Escalation triggers broader international involvement, potentially leading not a global conflict. Nuclear powers might engage causing widespread devastation
   2. Time: Catastrophic. Russian Pyhrrhic victory (global chaos), Ukraine catastrophic defeat.
   3. Cost: Unimaginable for humanity and civilization.
6. **Analysis**

The "Obstacle Course" model using Dijkstra’s Algorithm, allows for the dynamic adjustment of probabilities and weights, reflecting real-time changes in the conflict’s landscape. By adjusting these variables, we can simulate various scenarios and their potential outcomes. This method provides a nuanced understanding of how different actions by Russia and strategic adjustments by the West could influence the overall trajectory of the conflict.

**Adjusting Probabilities and Weights**

Military Escalation by Russia: Increasing the probability of military escalation reflects a scenario where Russia intensifies its military operations. This adjustment can help model the immediate and long-term impacts of such actions, including potential responses from Ukraine and the West. For instance, a higher probability of escalation might prompt increased military aid from the West to Ukraine, altering the conflict's dynamics.

Economic Sanctions by the West: Adjusting the weight of economic sanctions allows us to explore their effectiveness in deterring Russian aggression. Tightening sanctions could increase the economic cost to Russia, potentially influencing its decision-making process. Conversely, easing sanctions in response to de-escalation efforts can be modeled to assess the incentives for Russia to pursue diplomatic solutions.

Diplomatic Engagement: Modifying the probability of successful diplomatic engagement between the parties offers insights into potential pathways to resolution. A higher probability could simulate the effects of successful negotiations, leading to a decrease in hostilities and a move towards peace.

Cyber and Information Warfare: Adjusting the weights associated with cyber and information warfare activities can help evaluate their impact on public opinion, international support, and the strategic decisions of the involved parties.

1. **Conclusion**

Through the adjustment of probabilities and weights in our game theory model, we gain a flexible tool for analyzing the complex dynamics of the Russia-Ukraine conflict and the involvement of the West. This approach allows us to simulate a range of scenarios, from escalation to negotiation and de-escalation, providing valuable insights into possible outcomes and the effectiveness of different strategies.

The analysis underscores the importance of strategic flexibility and the need for continuous assessment of the conflict's evolving nature. By leveraging game theory and computational models, policymakers and stakeholders can better understand the potential impacts of their actions and adjust their strategies accordingly to promote resolution, mitigate humanitarian impacts, and safeguard global stability.

Ultimately, this paper contributes to the ongoing discourse on the Russia-Ukraine conflict by offering a structured approach to understanding and addressing one of the most pressing geopolitical challenges of our time. Through the application of game theory, we not only deepen our understanding of the conflict but also highlight the potential for innovative solutions to emerge from multidisciplinary research.

**Recommendations for Further Research**

Future research should focus on refining the model by incorporating more granular data and exploring additional variables that could influence the conflict's outcome. Collaborating with experts in international relations, military strategy, and economics can enhance the model's accuracy and relevance. Additionally, developing interactive tools based on the model could provide stakeholders with a practical resource for scenario planning and decision-making.

By continuing to explore and apply game theory to international conflicts, we can expand our toolkit for understanding and resolving complex geopolitical challenges, ultimately contributing to a more stable and peaceful world order.

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