Simultaneous Games

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A. Introduction

We have already discuss about a kind of strategic situations in which players moves simultaneously. Let come back one more time back to the same kind of game to think more carefully about what we are assuming.

Consider the following scenario involving two neighboring countries, Country A and Country B, each with valuable natural resources along their shared border. Both countries are undergoing economic difficulties and urgently need to exploit these resources to boost their economies.

Country A and Country B have had historical territorial disputes over the border region where these resources are located, leading to tensions but no outright conflict. Besides, both are now facing a decision: they can either negotiate to share the resources, which would likely result in a stable but potentially unequal distribution, or they can attempt to assert full control over the resources unilaterally.

If both countries choose to negotiate, they might settle on a compromise that is less than what each might hope for but avoids conflict. If one country decides to assert control while the other seeks to negotiate, the assertive country could potentially gain a larger share of the resources, gaining economically but increasing political tension and possibly inviting international condemnation. However, if both countries decide to assert full control simultaneously, it could lead to a military standoff or conflict, risking international isolation and severe economic sanctions, thus harming their economies even more.

The leaders of Country A and Country B must now decide their course of action without knowing the decision of the other, understanding that their choices will significantly impact their nations' economic and political futures. This situation involves strategic decision-making where each country's choice affects the outcome for both, reflecting the interdependent nature of their decisions.

We are going to think on this situation on the basis of four relevant assumptions:

1. Individual's decisions are **interrelated**. In the sense that what each do affects the other. This is the least controvertial of all the assumptions.
2. We are going to assume that rationality is a **common knowledge** among the players (in this case, two players). This means that each player is rational and knows that the other players are rational as well. Moreover, everyone knows that everyone is rational, and everyone knows that everyone knows this, and so on.
3. The players make their decisions (or moves) **at the same time**, or at least without knowing the moves of the other players beforehand. This aspect is crucial in distinguishing simultaneous games from sequential games

And finally, the assumption about which we are going to think more carefully later:

4. Although the moves are made simultaneously, the structure of the game, including the strategies available to each player and the payoffs for each combination of strategies, is known to all players. If this is not the case, and players have private information, then the game would typically be modeled as a game of incomplete information. In other words: we assume **complete information**.

Figure 1: map

These 4 features are what we calla **Simultaneous Game**.

Here there are four big conceptual areas in which simultaneous games can be applied:

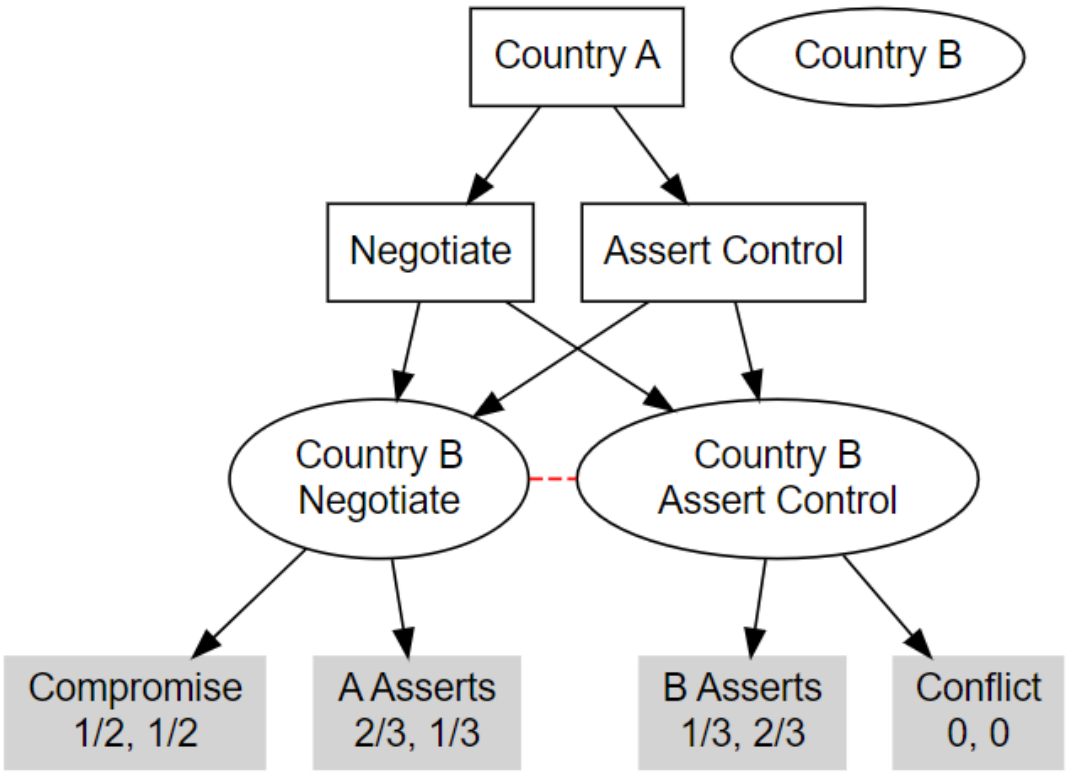

Figure 2: Diagram

B. Exercises

Case 1

As you can see in the diagram. There dashed red line connect both alternative decisions for Country B. Why? Because of the third assumption.

Let consider a different situation. Prepare a diagram for the following case: Imagine two political candidates, Candidate X and Candidate Y, who are in the final weeks of a very contested election campaign. Polls are in a technical tie, and each is considering how to spend the remainder of their campaign budget to boost their chances of winning.

Candidate X is known for their aggressive campaign strategies and is contemplating a major ad blitz that targets the weaknesses of Candidate Y, aiming to sway undecided voters. Candidate Y, on the other hand, is considering focusing on their strengths in a series of positive ads but is also prepared to retaliate if attacked directly.

The candidates face a strategic decision:

If Candidate X launches the negative ad blitz while Candidate Y remains positive, Candidate X could capture the undecided voters, likely securing a win. However, if Candidate Y retaliates with their negative ads, it could damage both candidates' reputations, potentially turning voters away from the polls or towards a third-party candidate, which might lead to a loss for both.
If both candidates choose to stay positive, they maintain their reputations, but neither gains a significant

advantage, leaving the race as tight as it was.
If both candidates resort to negative campaigning, the resulting mutual destruction could alienate voters, possibly leading to a low voter turnout and a victory determined by the core supporters of each, which could be a risky gamble for both candidates.
The political stakes are high, and the candidates must carefully consider their actions and the potential reactions of their opponent. Each candidate's decision is critical, and the campaign strategies will unfold based on these last strategic moves.

Case 2

Think in a particular political situation (a diplomatic affair, an election, a lawmaking process, etc). Then go into ChatGPT or Bard or Gemini or any other LLM and write the following prompt:

"*Today you have the role of an expert on political game theory. I will give you a context and a type of game and you are going to produce a game theoretical situation. Then I will try to figure out who are the relevant players, their preferences, the rules of the game, etc... The context is [put your input here] and the type of game is some of the following. Important: Do not tell me which one are you going to choose: (i) Prisoner's Dilemma, (ii) Battle of the Sexes, (iii) Chicken Game, (iv) Stag Hunt, (v) Hawk-Dove Game, (vi) Matching Pennies, (vii) Public Goods Game, (viii) Cournot Competition, (ix) Bertrand Competition, or (x) Asset Voting Game*"

The above games can be summarized as follow:

(i) Prisoner's Dilemma
Main Concept: Individual rationality leads to a worse collective outcome.
Players: Two criminals.
Actions: Cooperate or defect.
Nash Equilibrium: Both defect.
Political Example: Two political parties or countries might refuse to cooperate (e.g., on climate change policies), even though cooperation would lead to a better outcome for both.

(2) Battle of the Sexes
Main Concept: Coordination problems with conflicting interests.
Players: Two partners deciding on an activity.
Actions: Choose activity A or B.
Nash Equilibrium: Mixed; each plays their preferred activity part of the time.
Political Example: Coalition governments deciding between two policy priorities, each preferred by one part of the coalition.

(iii) Chicken Game Main Concept: Brinkmanship, where showing vulnerability can be advantageous.
Players: Two drivers in a game of chicken.
Actions: Swerve or straight.
Nash Equilibrium: One swerves, the other goes straight.
Political Example: Nuclear arms race where neither side wants to 'swerve' first but doing so might prevent mutual destruction.

(iv) Stag Hunt Main Concept: Safety in numbers and the need for trust to achieve the best outcome. Players: Two hunters. Actions: Hunt stag (requires cooperation) or rabbit (individual choice). Nash Equilibrium: Both hunt stag or both hunt rabbit. Political Example: Economic agreements where trust is needed to commit to mutual investment rather than pursuing individual economic policies.

(v) Hawk-Dove Game
Main Concept: Conflict escalation and resolution through power displays.
Players: Two animals (or nations).
Actions: Display aggression (Hawk) or retreat (Dove).
Nash Equilibrium: Mixed; each occasionally plays Hawk.
Political Example: Territorial disputes where aggressive posturing (hawk) can lead to escalation, while conciliatory approaches (dove) may lead to peaceful resolutions.

(vi) Matching Pennies
Main Concept: Zero-sum game where the interests of players are directly opposed.
Players: Two players.
Actions: Choose heads or tails.
Nash Equilibrium: Mixed; each player randomizes their choice.
Political Example: Election strategies where parties adopt opposing policies to appeal to distinct voter bases.

(vii) Public Goods Game
Main Concept: Free-riding problem where individual rationality leads to under-provision of a beneficial good.
Players: Citizens in a community.
Actions: Contribute to or free-ride on public goods.
Nash Equilibrium: Minimal contribution by all.
Political Example: Funding for public infrastructure where individuals or states may hesitate to contribute hoping others will cover the cost.

(viii) Cournot Competition Main Concept: Firms choosing output levels affect market prices and profits. Players: Two firms. Actions: Choose quantity to produce. Nash Equilibrium: Each chooses a quantity where making more or less would not increase profit. Political Example: Countries deciding on the quantity of a shared resource to extract, affecting global prices and individual profits.

(ix) Bertrand Competition
Main Concept: Price competition can drive prices down to marginal cost.
Players: Two firms.
Actions: Set prices for identical goods.
Nash Equilibrium: Prices set at marginal cost.
Political Example: Countries competing in lowering tax rates to attract businesses, potentially resulting in a 'race to the bottom'.

(x) Asset Voting Game
Main Concept: Strategic voting can lead to non-sincere voting behavior to avoid worse outcomes.
Players: Voters.
Actions: Vote for the most preferred candidate or a less preferred one to prevent the worst option from winning.
Nash Equilibrium: Voters strategically voting for a less preferred but more viable candidate.
Political Example: Electoral strategies in a two-party system where voters might vote for their second choice to prevent their least preferred candidate from winning (strategic voting).

C. A roadmap

We can consider 4 criteria to organize simultaneous games.

1: On cooperation: Cooperative vs. Non-Cooperative Games
Issues: Importance of cooperation, impact of free-riding, and mechanisms to encourage collaborative efforts in politics.

Cooperation underpins much of political interaction, be it in forming governments, passing legislation, or international treaties. The **Public Goods Game** exemplifies the challenge of collective action, where individual contributions to a common good are essential but not guaranteed. Historical instances like environmental agreements demonstrate the dilemma; every nation benefits from a healthy environment, yet the cost of achieving it might deter individual effort.

The **Stag Hunt Game** provides another perspective, representing situations where mutual cooperation leads to high payoffs (hunting a stag), but the risk of defection (settling for a smaller rabbit) can undermine the collective effort. This game mirrors political alliances where trust and assurance are crucial, as seen in coalition governments or military alliances.

2: Symmetry: Symmetric vs. Asymmetric Games
Issues: Power imbalances, conflict resolution, and the role of brinkmanship in international relations.

Symmetry and asymmetry in games reflect the balance of power and interests among players. The **Battle of the Sexes Game**, for instance, illustrates a conflict of interest where coordination is necessary yet challenging due to differing preferences. This is akin to bipartisan negotiations where parties must find common ground.

The **Hawk-Dove game** is pivotal in studying conflict resolution and brinkmanship, demonstrating how aggressive (Hawk) and conciliatory (Dove) strategies play out. This model helps analyze international standoffs, such as the Cuban Missile Crisis, where the threat of escalation and the benefits of retreat were weighed by the superpowers.

3: Time: Dynamic vs. Static Games
Issues: Long-term vs. short-term strategy, importance of reputation and trust in diplomacy.

Dynamic games consider the evolution of strategies over time, unlike static games which are confined to a single, isolated decision moment. The **Chicken Game** captures the high stakes of political brinkmanship where neither side wishes to yield, evident in legislative standoffs or during electoral campaigns.

The **Repeated Prisoner's Dilemma** addresses the importance of reputation and trust, with its implications far-reaching into diplomatic negotiations and peace treaties, where countries must repeatedly interact and choose between cooperation and defection.

4: Payoffs: Zero-Sum vs. Non-Zero-Sum Games
Issues: Competition vs. cooperation, the influence of strategic voting on electoral outcomes.

Zero-sum games occur when one player's gain is another's loss, as in **Matching Pennies**, reflecting direct electoral competitions where two candidates vie for a win, impacting electoral strategies and campaign tactics. Conversely, non-zero-sum games, like the **Asset Voting Game**, involve scenarios where the outcomes are not strictly opposing, encouraging strategic collaborations and coalition-building, particularly visible in proportional representation systems where multiple parties may benefit from forming governments together.

D. Practical lessons for using these tools for political analysis

1. **Identify the Type of Interaction**: Distinguish between cooperative and non-cooperative scenarios in political events. This aids in understanding the underlying motivations and potential for joint action or conflict.
2. **Analyze Power Structures**: Assess whether interactions are symmetric or asymmetric. Researchers can better understand and predict the dynamics of political influence and the flow of negotiations by recognizing the distribution of power.
3. **Examine Temporal Context**: In dynamic games, consider historical precedents and potential future scenarios. This perspective helps analyze how past actions influence present decisions and future strategies.
4. **Evaluate Potential Outcomes**: Determine if the political scenario is zero-sum or non-zero-sum. This distinction helps in anticipating whether political strategies will be competitive or collaborative.
5. **Recognize Strategic Posturing**: Understand the strategic moves inherent in brinkmanship situations, like in a Chicken Game. Researchers can evaluate the likelihood of political actors backing down or escalating a conflict.
6. **Consider Strategic Voting Implications**: Investigate how electoral systems influence voting behavior. Recognizing strategic voting patterns can offer insights into electoral outcomes and party strategies.
7. **Assess Coalition Dynamics**: Explore the formation and stability of coalitions within political frameworks. This can reveal how political power is amassed and the trade-offs involved in maintaining alliances.

8. **Address Collective Action Challenges**: Study the mechanisms that enable or hinder collective action. This informs analyses of policy-making, social movements, and international agreements.
9. **Understand the Role of Reputation**: Investigate how repeated interactions and reputation impact political negotiations and alignments, offering a more nuanced view of long-term political strategies.
10. **Stay Adaptable in Analysis**: Be prepared to revise hypotheses and models as new data emerges. Political landscapes are fluid, and the ability to adapt theoretical frameworks is crucial for accurate analysis.