Modeling Influence and Deliberation in UN Climate Negotiations: A Computational Approach Combining Network Analysis, Argument Mining, and Multi-Agent Simulation

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Abstract

Describing how influence emerges in negotiations is a central challenge to understand the mechanisms of decision making and thus to decide what is a good environment to reach a satisfactory consensus. While existing studies focus on outcomes, alliances, or stated preferences, the micro-level dynamics of deliberation remain underexplored. The international climate negotiations is a relevant field of research to explore this question, as it is well documented and involve various parties with conflicting interests. This PhD proposes a computational framework combining **network analysis, argument mining, and multi-agent simulations** to study a decade of climate negotiations using in particular Earth Negotiations Bulletin (ENB) data and new datasets related to the "New Collective Quantified Goal" (NCQG) negotiations, which was the focus of a series of intense negotiations between 2022 and 2024. By reconstructing interaction networks, extracting argumentative patterns, and simulating negotiation dynamics, the project aims to provide a data-driven understanding of how influence, coalitions, and consensus emerge over time.

1 Research objectives

1.1 Mapping influence through dynamic interaction networks

One simple way to assess influence in negotiations is to compare initial positions of stakeholders and final outcomes. However this overlooks the dynamics of negotiations.

The first axis is based on a representation of interactions as a graph connecting the Parties involved and evolving through time.

- In the context of the climate negotiations, actors are states or groups of states, which directly take part in the discussions, but also indirect stakeholders such as companies, NGOs or scientists. The first step is to identify what is **a reliable and meaningful representation** of the interactions, and then extract it from the datasets, following existing processes used in other contexts [4].
- In standard graph analysis, centrality measures (degree, betweenness, PageRank) have been used to quantify influence, brokerage, and agenda-setting roles. However, describing social interactions as a sequence of static snapshots has shown limitations, in particular to gain insights about the dynamics of influence at various time scales. So, a second step is to define or adapt measures to a dynamic context [1], to correctly **characterize the position of actors in the debate** and unveil influence and coalition formation beyond formal alliances.
- Finally, we should also assess **how the positions of various stakeholders within the network affect decisions**, such as funding or mitigation, in order to identify if there is a measurable connection between the graph structure and the negotiation outcome, in a manner similar to what has been done in other types of debates [2].

1.2 Detecting argumentative patterns in negotiation discourse

The second axis shifts from who interacts to what is argued.

- Apply **text embeddings and clustering** to identify recurring argumentative frames (e.g., equity, responsibility, urgency).

- Use argument mining techniques to detect claims, positions, and alignment between actors.
- Track how argumentative patterns evolve over time and correlate with network position.

Goal: Understand how discourse structures negotiation dynamics and whether certain argumentative strategies correlate with influence.

1.3 Simulating negotiations with multi-agent LLM systems

The third axis introduces a **computational modeling layer** to test hypotheses about deliberation.

- Develop multi-agent systems based on large language models and formal argumentation [3] representing countries or negotiation blocs.
- Calibrate agents using empirical data (network position + argumentative profiles).
- Simulate negotiation scenarios to explore coalition formation, bargaining dynamics, and consensus emergence.

Goal: Evaluate whether observed negotiation patterns can be reproduced and explained through agent-based simulation.

2 Research Questions

- Do the structure and dynamics of interactions reveal anything about the power dynamics in negotiations and make it possible to predict their outcome?
- How do argumentative strategies shape coalition formation and outcomes?
- Can multi-agent simulations reproduce real-world negotiation dynamics?

3 Methodology overview

- **Data sources:** Earth Negotiations Bulletin (10+ years of COP reports), submissions and webcast of NCQG negotiations (https://unfccc.int/NCQG)
- **Pipeline:** PDF extraction or Webcast transcriptions → entity recognition → sentence classification → network construction.
- **Techniques:**
  - Network science (temporal graphs, centrality, community detection)
  - NLP (embeddings, clustering, argument mining)
  - Multi-agent simulation using LLMs and formal argumentation techniques

4 Expected contributions and productions

- A **novel dataset** of interaction networks and argumentative structures across COP and NCQG negotiations
- Empirical evidence on **how influence emerges in deliberative settings**
- A bridge between **political science and computational** methods
- A **simulation framework** for testing negotiation dynamics

The PhD would lead to publications in the field of computer science, as well as computational social science.

5 Context of the PhD and profile required

The PhD would take place at Sorbonne Université (Jussieu Campus, Paris 5). It is part of the PAC *AI for Augmented Deliberation*, in the context of the PostGenAI consortium led by SCAI (Sorbonne Center for AI).

Daily supervision would be provided by Ixandra Achitouv, Lionel Tabourier, and Carola Kloeck; with interactions with other members of the project.

We are looking for students whose primary interests are algorithmics and natural language processing, but a taste in interdisciplinary topics is essential.

References

[1] Nouamane Arhachoui, Esteban Bautista, Maximilien Danisch, Anastasios Giovanidis, and Lionel Tabourier. Scalable algorithms to measure user influence in social networks. In *Social Network Analysis and Mining Applications in Healthcare and Anomaly Detection*, pages 63–92. Springer, 2024.

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[3] Louise Dupuis de Tarlé, Elise Bonzon, and Nicolas Maudet. Multiagent Dynamics of Gradual Argumentation Semantics. In Piotr Faliszewski, Viviana Mascardi, Catherine Pelachaud, and Matthew E. Taylor, editors, *Proceedings of the 21st International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2022)*, Auckland (virtual), New Zealand, May 2022. Online.

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