The Werewolf Among Us: Humans vs LLMs in Multi-Agent Games

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Abstract TODO

Table of contents

Introduction

- A description of the problem and its significance
- How do LLMs function in a multi-agent environment?
  - Each has limited information
  - Approximately the same ability, traits, skills
- We use LLMs to simulate whether synthetic agents can participate in complex, adversarial group dynamics
- Werewolf is a good candiate for testing multi agent systems of cooperation and secrecy
  - Need citation
  - The game tests adaptive reasoning, strategic alignment, and collective threat detection under special conditions

Related Work

Multi-Agent LLMs

- Among us game (Chi, Mao, and Tang 2024)
- Collective problem solving (Du, Rajivan, and Gonzalez 2024)
  - "analyses indicate that LLM agent groups exhibit more disagreements, complex statements, and a propensity for positive statements compared to human groups"
- Govsim (Piatti et al. 2024)
  - "In GOVSIM, a society of AI agents must collectively balance exploiting a common resource with sustaining it for future use. This environment enables the study of how ethical considerations, strategic planning, and negotiation skills impact cooperative outcomes."
- All found similar themes
  - That LLMs are capable and good at understanding the rules
  - That they can cooperate and be sneaky

LLMs and Werewolf

- Examination of improving werewolf by LLMs (Xu et al. 2024)
  - "our agents use an LLM to perform deductive reasoning and generate a diverse set of action candidates. Then an RL policy trained to optimize the decision-making ability chooses an action from the candidates to play in the game. Extensive experiments show that our agents overcome the intrinsic bias and outperform existing LLM-based agents in the Werewolf game."
- Werewolf Arena (Bailis, Friedhoff, and Chen 2024)
  - Used in this paper
- Explicitly discuss how none of the exisiting LLM+Werewolf papers examine the differences/compare from a human dataset

Methods

Data

Werewolf Among Us Human Dataset

- Human dataset description (Lai et al. 2022)
- Is specifically for a form of one-night werewolf
  - Describe key differences
- Used specifically for the text available
  - and annotations of persuasion strategy on the text

Werewolf Arena

- (Bailis, Friedhoff, and Chen 2024)
- Discuss the framework, how it works, prompts, etc
- Discuss what types of runs we did
- Discuss the data included in output
- Talk about how we had to annotate the LLM speech with persuasion strategies ourselves

Analysis

- Formatted data to match, performed various comparisons

Results

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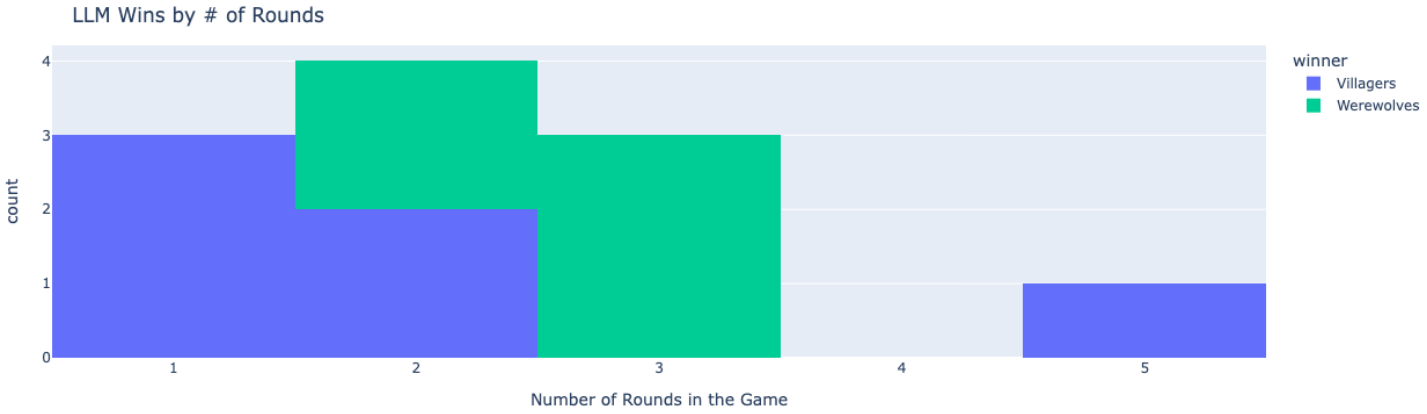
(a) The LLM wins, by how many rounds that partiticular game had.



(b)

Figure 1

Source: Werewolf Among Us: Human vs LLM Analysis

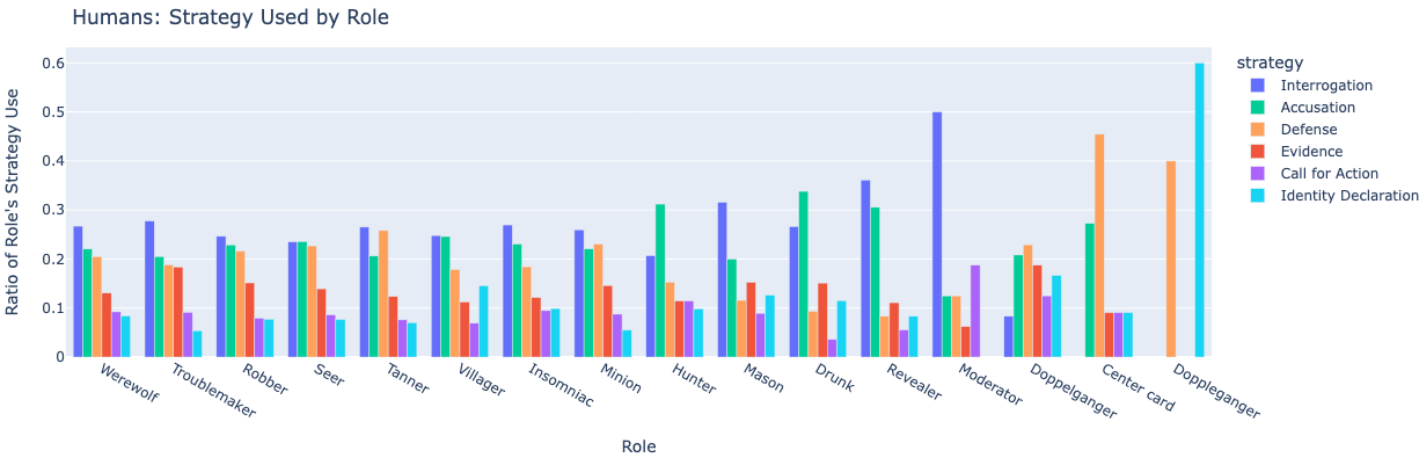


Figure 2

Source: Werewolf Among Us: Human vs LLM Analysis

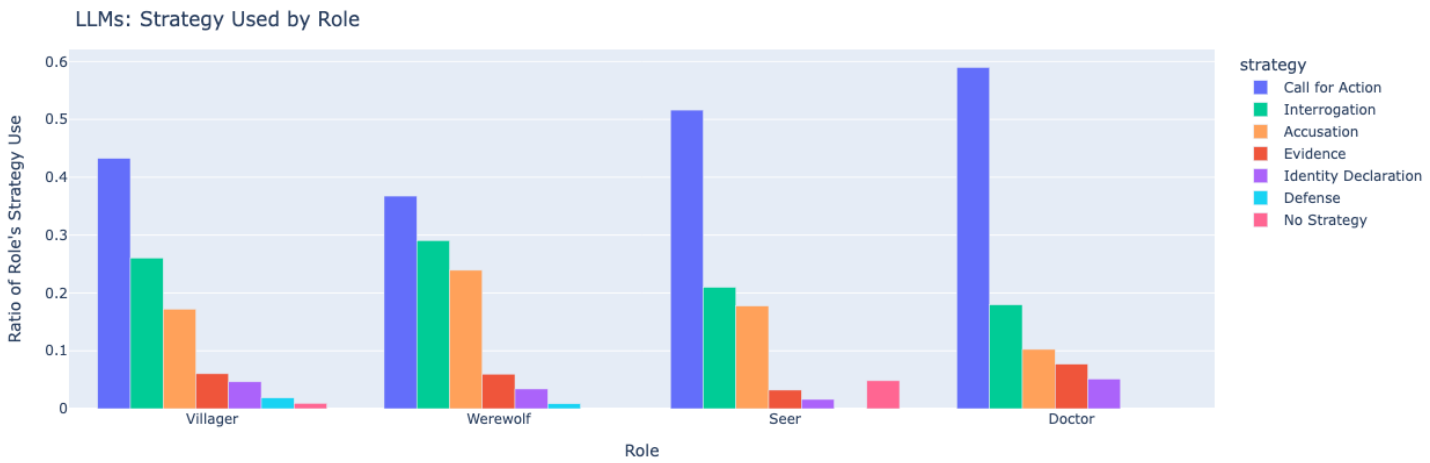


Figure 3

Source: Werewolf Among Us: Human vs LLM Analysis

Discussion and Conclusion

Interpret findings, discuss limitations, and propose future work.

Limitations

Future Work

Summary

Summarize contributions and insights from the project.

References

Bailis, Suma, Jane Friedhoff, and Feiyang Chen. 2024. "Werewolf Arena: A Case Study in LLM Evaluation via Social Deduction." July 18, 2024. https://doi.org/10.48550/arXiv.2407.13943.

Chi, Yizhou, Lingjun Mao, and Zineng Tang. 2024. "AMONGAGENTS: Evaluating Large Language Models in the Interactive Text-Based Social Deduction Game." July 24, 2024. https://doi.org/10.48550/arXiv.2407.16521.

Cho, Young-Min, Raphael Shu, Nilaksh Das, Tamer Alkhouli, Yi-An Lai, Jason Cai, Monica Sunkara, and Yi Zhang. 2024. "RoundTable: Investigating Group Decision-Making Mechanism in Multi-Agent Collaboration." November 11, 2024. https://doi.org/10.48550/arXiv.2411.07161.

Du, Yinuo, Prashanth Rajivan, and Cleotilde Gonzalez. 2024. "Large Language Models for Collective Problem-Solving: Insights into Group Consensus Decision-Making." *Proceedings of the Annual Meeting of the Cognitive Science Society* 46 (0). https://escholarship.org/uc/item/6s060914.

Lai, Bolin, Hongxin Zhang, Miao Liu, Aryan Pariani, Fiona Ryan, Wenqi Jia, Shirley Anugrah Hayati, James M. Rehg, and Diyi Yang. 2022. "Werewolf Among Us: A Multimodal Dataset for Modeling Persuasion Behaviors in Social Deduction Games." December 16, 2022. https://doi.org/10.48550/arXiv.2212.08279.

Piatti, Giorgio, Zhijing Jin, Max Kleiman-Weiner, Bernhard Schölkopf, Mrinmaya Sachan, and Rada Mihalcea. 2024. "Cooperate or Collapse: Emergence of Sustainable Cooperation in a Society of LLM Agents." *Advances in Neural Information Processing Systems* 37 (December): 111715–59. https://proceedings.neurips.cc/paper_files/paper/2024/hash/ca9567d8ef6b2ea2da0d7eed57b933ee-Abstract-Conference.html.

Xu, Zelai, Chao Yu, Fei Fang, Yu Wang, and Yi Wu. 2024. "Language Agents with Reinforcement Learning for Strategic Play in the Werewolf Game." February 20, 2024. https://doi.org/10.48550/arXiv.2310.18940.

Project Contributions

Bhavana Jonnalagadda:

- Paper framework (Quarto) setup
- Github repo management
- EDA on LLM dataset
- Final comparison EDA and results analysis
- Results section
- Discussion and Conclusion section
- Abstract

Riley Jones:

- EDA on human dataset
- Werewolf Arena LLM simulation running and data aquisition
- Introduction section
- Methods section