



# *The Werewolves of Miller's Hollow* Game Simulation

IS590PR2 Final Project

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# INTRODUCTION



- In a basic *Werewolf* game, there are two opposing groups and they aim to kill each other:
  - the **Werewolves**
  - the **Villagers**,
- The game is divided into two parts:
  - **Nights**: during which werewolves take action to kill a villager and some special villagers to perform their special action;
  - **Days**: when all players open their eyes, debate and vote a player they think is werewolf, and remove him or her out of this game.

# INTRODUCTION



- In the beginning of this game, **players know nothing but their own roles**. As the game progresses, **werewolves can recognize their teammates** during their first action in the first night, while villagers have to guess others' roles based on deaths in nights and debates in days.
- There are two special villagers with talents:
  - **Seer**: who can check other player's role every night;
  - **Guard**: who can choose a player to protect every night, to make sure this player won't get killed.

# INTRODUCTION



- During voting processes in days, all players would vote one of them as ***Sheriff*** if there is none, to break tie in votes, since Sheriff's vote is counted as 1.5 times as the others'.
- We can see that for every player in this game, two important steps to win is to **guess other players' roles** and **make a plausible speech in debates**:
  - **Werewolves**: they have to pretend to be Villagers, or even the Seer in debates, and the sooner they kill the real Seer, the more likely they win this game.
  - **Seer**: convince other players that he is the real Seer, and point out the Werewolves he found in debates, to remove them out of game.
  - **Guard**: find the real Seer, and keep him alive as long as possible.

# Simulation



- In the real game, players use their observation and logic thinking to guess other players' roles and try to convince or mislead others in debates. However, whether they can guess others' real roles and whether they can make others believe them depends on numerous things that are hard to simulate: **their tactics, communication skills, facial expressions, body languages** and so on.

What's more, even with the same information, *people with different characteristics would make different decisions*, let alone the various tactics players take in games, all of these make the simulation progress difficult to complete.

# Simulation



- To solve the problem, we use Monte Carlo Simulation:
  - **Credit**: an attribute of every player, denoting the chance that this player successfully convince others.

At the beginning of a game, the credit of all **Villagers** are set as **0.5**, while credit of all **Werewolves** are set as **0.6**, since they got more information than villagers(who are Werewolves and who are not).

Seer's credit increase **0.05** when he discovers a **Villager**, and **0.1** when he discovers a **Werewolf**, since the latter one gives him more information. Seer's **maximum** credit is set as **0.8**.

**Assumption 1**: *With more information, a player is more likely to convince others, i.e., his credit becomes higher.*

# Simulation



- **Sheriff**: we take player with this title as a player who is thought trustworthy by others. As a result, whoever earned this title will have his credit increased by **0.1**. To simplify the simulation, we only consider the situation that **Seer and a Werewolf** run for the sheriff title when the real Seer is alive and let one **Villager take the Seer's place** when the actual Seer is dead.

**Assumption 2**: Though Villagers also get their chances to make speeches in debates, only the **Seer and the Sheriff's accusations** are possible to convince others, that is, we only consider their accusations, and let others vote.

# Night: Who is protected by Guard



Guard chooses someone to protect

- If the **Sheriff** exists, Guard will protect the Sheriff at the probability of the Sheriff's credit  
→ Bernoulli distribution
- If **NO Sheriff** exists, Guard will protect someone randomly.



# Night: Who is killed by Werewolves



Werewolves choose someone to kill

- Randomly choose an **alive non-werewolf**.
- If the Sheriff is not a Werewolf, Werewolves will kill **the Sheriff** first.  
Replace the player to kill with the Sheriff.

# Night: Who is checked by Seer



Seer checks someone's identity

- Special attribute: knowledge
  - Check someone out of the knowledge randomly
- If there is a Sheriff and Seer is not the Sheriff, Seer will check the identity of the **Sheriff**.
  - Replace the player to check with the sheriff
- Update Seer's knowledge
- Update Seer's credit
  - Checked player is a werewolf, credit += 0.1
  - Checked player is not a werewolf, credit += 0.05

# Night: Determine who is killed successfully



- Compare the protected player and the killed player to determine who is killed.
  - *If ‘**the player to protect**’ is ‘**the player to kill**’, nobody would be killed successfully.*
  - *If not, the player to kill is killed successfully.*

# DAY SIMULATION



- Statement: Who is dead
  - ◆ Based on the results from **last night**
- Decision: Who is the Sheriff
  - ◆ Only occur when **NO Sheriff** exists
- Accusation & Vote: Who will be eliminated

# Day: Who is the Sheriff



- Candidates chosen from **EACH** side (*Werewolves / Non-werewolves*)
  - ◆ The ones with the highest credit
- Credit comparison between each side
  - ◆ Randomly choose one from all the candidates
  - ◆ Use the highest one as the p-value of Bernoulli Distribution
    - **1**: the side w/ the highest credit
    - **0**: the other side

# Day: Who will be eliminated



→ Three conditions for Sheriff & Accusation

◆ Seer

- Only **ONE** accusation from the Seer

◆ Werewolf when Seer is still alive

- Accusations from the Sheriff & the Seer

◆ Non-Werewolves (Villager / Guard)

- Only occur when **Seer is killed** in the game

# Day: Who will be eliminated



- Accusation: who to be accused (Seer )
  - ◆ Depends on the checked person's identity from last night
    - Werewolf: accuse him
    - Non-werewolf:
      - Randomly accuse the other Alive Werewolf checked in previous nights
      - Randomly accuse NOT checked players

# Day: Who will be eliminated



- Accusation: who to be accused (Werewolf)
  - ◆ Randomly choose one from alive non-werewolves to accuse
  
- Accusation: who to be accused (Villager / Guard)
  - ◆ Randomly choose one from alive players to accuse



# Day: Who will be eliminated



- Vote: only one accusation
  - ◆ Use sheriff's credit as the p-value of Bernoulli Distribution
    - 1: vote for the accused player
    - 0: randomly choose one from the other alive players
  - ◆ Vote again if there are multiple players with the **same highest votes**
  - ◆ The only one w/ the highest votes will be eliminated

# Day: Who will be eliminated



→ Vote: two accusations from Seer & Werewolf (Sheriff)

◆ **Credit comparison** between Seer & Werewolf

- Equal credit: **randomly vote** for one of the two accused players
- Use the highest credit as the **p-value of Bernoulli Distribution**
  - **1**: vote for the player accused by the one w/ highest credit
  - **0**: use the other credit as the p-value
    - ◆ **1**: vote for the other accused player
    - ◆ **0**: randomly vote for one from the other alive players

# Conclusion



- Output: activity log & announcement of the winning side
- Possible findings:
  - ◆ How number of players affects the winning side
  - ◆ How certain tactics affects the winning rate

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**THANK YOU!**

**Q & A**