Development of Real-World Agent System for Werewolf Game

Demonstration

Bohao Wang
University of Tsukuba
1-1-1, Tenno-dai, Tsukuba, Japan
hiroforccat@gmail.com

Hirotaka Osawa
University of Tsukuba
1-1-1, Tenno-dai, Tsukuba, Japan
osawa@iit.tsukuba.ac.jp

Takuya Toyono
University of Tsukuba
1-1-1, Tenno-dai, Tsukuba, Japan
tkytyn1993@gmail.com

Fujio Toriumi
The University of Tokyo
7-3-1 Hongo, Bunkyoku, Tokyo, Japan
tori@torilab.net

Daisuke Katagami
Tokyo Polytechnic University
2-9-5 Honcho, Nakano, Tokyo, Japan
katagami@cs.t-kougei.ac.jp

ABSTRACT

The authors propose a robotic agent system for a werewolf game to serve as a human-agent interaction method for studying the social behavior of subjects in communication. We developed a robotic agent with a spherical display on the head and created a system that allows people to compete against our robotic agents. We used the AIwolf project framework for our implementation, and applied algorithms extracted from a previous game competition.[1]

KEYWORDS

Human-agent interaction; werewolf; robot

ACM Reference Format:
B. Wang, H. Osawa, T. Toyono, F. Toriumi, and D. Katagami. 2018. Development of Real-World Agent System for Werewolf Game. In Proc. of the 17th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2018), Stockholm, Sweden, July 10–15, 2018, IFAAMAS, 3 pages.

1 INTRODUCTION

"Werewolf" is a party game of worldwide popularity with several variations including, "Are You a Werewolf?" and "Lupus in Tabula." Dmitriy Davydov, the creator of Werewolf game (knows as "Mafia"), described the game as a conflict between an informed minority and an uninformed majority [1]. Although mathematical analysis of the game reveals a theoretical optimal solution based on simple conditions [2][3], most Werewolf games include more communication factors that are not covered by theoretical solutions.. Some researchers have attempted to detect a player's role by using the length of utterances and number of interruptions of a speaker [4], nonverbal facial cues [5], motions of the hand [6], words used in discussions [7], influence of cultural differences [8], and intimate touching [9]. The Werewolf game has been used as a good sample for evaluating cooperative behavior within the parameters of the game.

The authors propose to implement the game with robotic agent to study the effect of social behavior on conversations in repeatable conditions. Different from previous Werewolf game studies with human-based analysis, an AI robot-based game analysis provides repeatability. While it is difficult for a human to behave similarly in multiple Werewolf games, it is possible for an AIwolf robotic agent to repeat game strategies or conditions.

We developed a robotic agent with a spherical display on the head and created a system that allows people to compete against our robotic agents. We applied the AIwolf project framework for our implementation.

2 DESIGN

2.1 5-Player Werewolf

Werewolf is a reinvention of a multi-player conversation game, Mafia [1][2]. The regular version, based on free-flowing conversation, asks players to find werewolves who hide from them. Every player is assigned a role known only to himself/herself. The roles are mainly divided into werewolf and villager groups. Based on discussions in the day phase of the game, the villager group attempts to guess who the werewolves are, and subsequently excludes them from the game by a majority decision vote. The werewolves attempt to hide their identity while participating in the discussions by pretending to be a member of the villagers' group. If successful, they attack the villagers in the night phase.

We modified Werewolf as a minimized 5-player game. There are 4 roles in 5-player Werewolf games, as listed in Table 1. The game is played by 2 villagers, 1 seer, 1 possessed, and 1 werewolf. Villagers and seers are in the villagers' group, while possessed and werewolves belong to the wolf's group. As in Table 1, a villager has no special talent, but a seer is able to know whether one other player is a villager or wolf. A possessed is a spy who wins the game if a werewolf wins. When a seer checks the identity of a possessed, the result will be a villager.

Proc. of the 17th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2018), M. Dastani, G. Sukthankar, E. André, S. Koenig (eds.), July 10-15, 2018, Stockholm, Sweden.

Table 1: Roles in 5-player werewolf game

Role	Instruction
Villager	Belong to villagers' group and have no special talent.
Seer	Belong to villagers' group and have a special talent to know one player's identity in night phase.
Possessed	Belong to wolf's group and have no special talent, but when identity of possessed is checked by seer, the result will be a villager.
Werewolf	Belong to wolf's group and werewolf is able to attack one other player in night phase.

2.2 Hardware

For development of the AIwolf robotic agents, we referred to a telepresence robot prototype of our previous research [10]. The AIwolf robot has a built-in projector and a spherical display as the head. The face of the robot is composed by OpenGL and projected onto the spherical display. 4 AIwolf robots are set in a circle with the participant as Fig. 1 left. All robots face the center of the circle. The human-player client is displayed in a 7-inch touch screen. The participant sits in front of a table where they can clearly see the face of the AIwolf robots and the information on the screen, simultaneously. The log is displayed on the screen so that participants can confirm the AIwolf agents' previous speech when they are not able to clearly hear what the agents have said. Generally, participants are required to play the game by listening to, and looking at the AIwolf robots, as though they were human players.

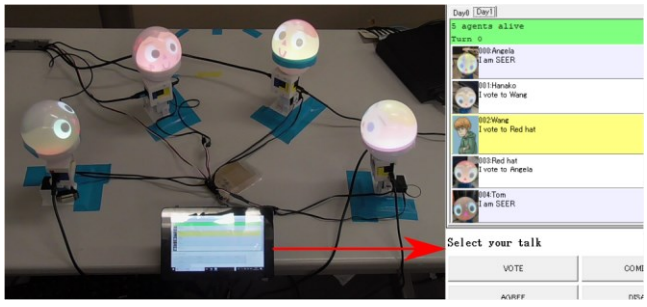

Figure 1: AIwolf robot (left to right: Tom, Hanako, Red Hat, Angela) and User interface of the game.

The user presses buttons to choose what he wants to say (see Fig. 2). The selection will be sent to the AIwolf game server by TCP/IP communication. Subsequently, the game server will send the log data to the AIwolf robot control client, also by TCP/IP. The robot control client analyzes the log data and composes the face of each robot. The speech of the AIwolf will then be played by a text-to-speech engine.

2.2 Software: AIWolf platform

We used the AIWolf Project developed in an open-source project as the foundation of the system. This platform works for building an agent that can naturally play werewolf games with humans. With the AIWolf platform, we were able to design the algorithm of an AIWolf agent and run an agent-only werewolf game [11]. In this paper, the authors develop a human-player client user interface for a human player to participate in agent-based werewolf games (Fig. 1 right). During the game, agents could communicate with other agents using the AIWolf protocol—a shortened communication protocol designed for the AI Wolf—shown in Table 2.

Table 2: Protocols

Protocol	Meaning
Estimate (Agent, Role)	An agent express estimation that [Agent] is [Role].
Comingout (Agent, Role)	The agent asserts that [Agent] is [Role].
Divined (Agent, Species)	The agent (implicated as a seer) gives the divined result that [Agent] is [Species (human or werewolf)]
Inquested (Agent,Species)	The agent (implicated as a medium) gives the inquested (investigated) result that the executed [Agent] is [Species (human or werewolf)]
Guarded (Agent)	The agent (implicated as a bodyguard) gives the result that [Agent] is protected.
Vote (Agent)	The agent claims that a player will select [Agent] for the execution vote.
Agree/Disagree (day, id)	The agent agrees/disagree with someone's statement at statement number [id] on [day].
Skip ()	The agent waits to listen to an opponent's speech and wishes to continue the discussion.
Over ()	The agent waits for the next turn, and agrees to finish the discussion the same day.

This communication protocol is determined by referring to the AIWolf protocol [11], and is expected to cover approximately 50% of the meaning between agents. This simple protocol permits only limited utterances, such as, "I declare as seer" and "I suspect that he is a werewolf." We evaluated the Werewolf BBS logs, in which 50% of the utterances are represented through 10 protocols. The algorithm of the AIwolf agent used in this paper was designed by Team m_cre. Team m_cre won in the AIwolf competition, GAT2017.

ACKNOWLEDGMENTS

This work was supported by JSPS KAKENHI Grant Number JP26118006, Artificial Intelligence Research Promotion Foundation, and Hayao Nakayama Foundation for Science & Technology and Culture.

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