A Human-AI Collaboration Study using the Geometry Friends Game*

Inês Lobo
INESC-ID, Instituto Superior Técnico, Universidade de Lisboa
ines.lobo@tecnico.ulisboa.pt

Inês Batina
INESC-ID, Instituto Superior Técnico, Universidade de Lisboa
ines.batina@tecnico.ulisboa.pt

Jennifer Renoux
Cognitive Robotic Systems Lab, Örebro University
jennifer.renoux@oru.se

Janin Koch
ExSitu Lab, Inria Paris-Saclay, Université Paris-Saclay
janin.koch@inria.fr

Rui Prada
INESC-ID, Instituto Superior Técnico, Universidade de Lisboa
rui.prada@tecnico.ulisboa.pt

ABSTRACT

What do humans think and expect of themselves, the AI partner, and the team in a human-AI collaboration setting? To address this, we will conduct an in-person study using Geometry Friends, a two-player cooperative physics-based game in which subjects will play with agents presenting different levels of initiative and adaptability.

KEYWORDS

Human-AI Collaboration; Computer Game; AI partner; Initiative; Adaptability

1 INTRODUCTION

Human-AI collaboration has been extensively applied within the fields of education, healthcare and art [11], whether through virtual assistants or collaborative robots. The existing success in this area enabled the emergence of the human-AI teaming sub-field, in which "humans and intelligent agents coordinate with each other and perform high-complexity tasks as an integrated unit" [11]. Previous studies show that AI agents in cooperative games [2–6] may help better understand human-AI teams and their dynamics, as well as improve gameplay experience.

Nonetheless, little research has been conducted on the human perspective of AI partners. Zhang et al. [11] used surveys and interviews in the context of multiplayer online games to provide guidelines for the design of collaborative AI agents. For this purpose, we will use Geometry Friends [9, 10], a two-player easy-to-configure computer game that presents several collaborative and cooperative challenges concerning level planning, motion control and situational awareness.

Our main research goal is to explore the human perception, mental models and expectations of the self, the AI partner, and the team, in a human-AI collaboration setting. In specific, we would like to answer the following questions: 1) How do different initiative levels of the agent affect this perception? 2) How does the adaptability level of the agent regarding these roles influence this as well? Attempting to answer these questions, we propose a within-subjects in-person study using the Geometry Friends game.

2 GEOMETRY FRIENDS

Geometry Friends [9, 10] is a two-player cooperative physics-based puzzle game in which the goal is to collect diamonds in a level as fast as possible (see Figure 1). Players control one of two characters with different abilities: a circle that can jump and roll, or a rectangle that can morph and slide. The game presents collaboration challenges related to task and motion planing [10]. It has been used in an AI competition to foster research on collaborative agents, and therefore, there are several agents available that can play the game.

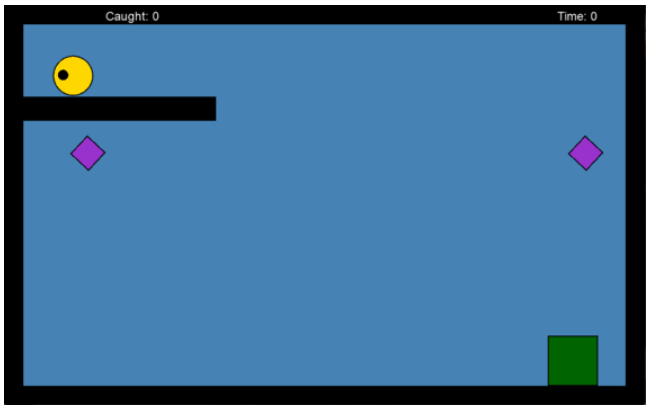

Figure 1: Snapshot of Geometry Friends level: the yellow circle and the green rectangle have to collaborate to collect the purple diamonds.

3 HUMAN-AI COLLABORATION STUDY

The study will be conducted with three distinct conditions based on two variables: the agent's level of initiative (follower or leader) and its willingness to shift initiative. The three conditions are: 1) follower without shift - the agent will always follow the human player's plan, never taking the initiative, 2) leader without shift - the agent will always act as a leader, following its own plan, 3) adaptive behaviour - the agent starts as a leader but if the human

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does not follow, it will give them initiative after a while. For all conditions, the agent will play as the circle character, while the human will play as the rectangle.

We will run an in-person within-subjects study with 20 participants per condition. The levels for each condition will be different but comparable in terms of task complexity, and will be balanced across conditions to avoid ordering effects. Game levels will be designed with more than one solution so that the leader-follower roles and behaviours can be perceived as clearly distinct by the subjects. Additionally, players will be able to communicate with one another through their characters' actions to guide their partner to a specific position (e.g., jumping up and down for the circle, changing shape for the rectangle).

Prior to the main session, where subjects play the game for each of the three conditions, participants will fill a questionnaire with demographic information, including gaming habits and experience with AI. Next, they will play a single-player level to practice the game controls. The main session will be recorded in video and audio and we will collect in-game metrics, such as score, actions, and positions in the level as well. Following each condition, participants will complete a post-game questionnaire that includes questions about self and AI partner evaluation (intelligence, likeability, creativity) [3], as well as trust, group satisfaction, and team performance [1]. We predict that when playing with the agent displaying more initiative, subjects will feel less accountable for the team's performance, similar to the findings of Lei et al. [7]. Furthermore, based on the work of Nikolaidis et al. [8], we also anticipate that when the agent shows more willingness to shift initiative, subjects will perceive it as more trustworthy, and possibly, more likeable and intelligent. A questionnaire or a semi-structured interview on human expectations and mental models will also be conducted, which may help explain unexpected results.

4 CONCLUSION

The proposed study aims at gaining insights from the human perspective when collaborating with AI. We will explore the strategies people use when collaborating with agents with different levels of initiative and get information about the mental models that they build when interacting with such agents. This information will be used to improve the collaboration abilities of the agents to make them work more effectively with humans, but also to identify patterns from human behaviour when collaborating with AI.

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