Proposal for a Dagstuhl Seminar on Artificial and Computational Intelligence in Games : Human-Game AI Interaction

1 Metadata

1.1 Organizers

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Dan Ashlock of University of Guelph, Canada, is also one of the organizers, but he passed away in April 2022.

1.2 Abstract

People interact with semi-intelligent machines during their daily lives. They desire systems to respond intelligently to requests. While improvements to the interaction between humans and AI have been made over the years, these systems are a long way from responding like a human partner.

Virtual (game) worlds are an ideal environment in which to experiment with the interaction between humans and AI, because (1) virtual worlds approach the complexity of the real world, while still being under the researcher's control ; (2) virtual game agents are supposed to represent "real people" and are approached as such by players ; and (3) interactions of players with virtual worlds are highly diverse, presenting a high challenge for AI.

In recent years, the number of ways in which players can interact with games have increased considerably. Beyond the traditional mouse, keyboard, and controller, nowadays games can potentially respond to natural movements and facial expressions captured by a camera, spoken language, eye movements, brain signals, signals captured by a variety of sensors, and movements of players in natural space.

Research into the possibilities for AI to show natural responses to interactions is still sparse. This seminar will bring together scientists, researchers, and industrial developers who specialize in intelligent interaction between humans and computer agents in virtual (game) environments. The goal is to boost the research in this area by exchanging knowledge and ideas, fostering collaborations, and creating prototypes for intelligent game interactions using a variety of input devices and technologies.

2 Proposal Text

2.1 Research Area

Over the past decades, artificial intelligence has evolved from esoteric techniques used mainly in computer science research to an integral and ever-growing part of the daily lives of most humans. People regularly interact with semi-intelligent machines during their daily lives, whether it is via smartphone applications, embedded systems in cars and household electronics, client support systems, or helpful technology installed on personal computers. People wish and expect systems to respond intelligently to their requests, and even to anticipate their actions. While improvements to the interaction between humans and intelligent systems in this respect have been made over the years, there is still a long way to go before these systems exhibit a level of understanding and intuition which can be expected from a human partner.

Human-computer interfaces (HCI) are a well-established scientific research domain. We noted that HCI research generally neglects the use of artificial intelligence as a integral part of an interface. Almost any person that uses computers can quickly recall multiple frustrating interactions with the current state of the art in artificial intelligence in interfaces. Since annoyance and apparent incompetence can derail the adoption of otherwise promising and potentially transformative technology, research into improving interfaces using AI is timely.

An AI assistant is broadly recognized as being a key factor in increasing human productivity, but it must be an AI assistant that the user either enjoys working with or that the user barely notices, not one that must be bludgeoned into useful behavior or constantly fought with. Perfection of assistants, companions, and even opponents that correctly anticipate and collaborate in the relatively controlled domain of games provides a smooth path to such developments in broader contexts.

We argue that virtual worlds, as found in computer games, are an ideal environment in which to experiment with the interaction between humans and artificial intelligence. There are at least three reasons for this. First, virtual worlds often approach the complexity of the "real world," while still being under the control of the researcher and completely observable. Second, the agents in virtual worlds are supposed to represent "real people" and are approached as such by the humans who "play" with the virtual world. Third, the potential interactions that players have with the virtual worlds are highly diverse and wide-ranging, which presents a substantial challenge for artificial intelligence to respond to in a reasonable fashion.

In recent years, the number of ways in which human players can interact with games have increased considerably. While ten years ago interaction was almost exclusively through mouse and keyboard or controllers, nowadays games can potentially respond to natural movements and facial expressions captured by a camera, to spoken language, to eye movements, and to signals captured by a variety of sensors. Brain-computer interface (BCI) technology has become more mainstream, offering possibilities for games to respond to a users' brain activity. Using VR technology, games can respond to movements of players in natural space. AI that can use all these interface elements to make game agents a natural and appreciated partner or opponent for humans can form the basis for advanced AI agents that interact with humans not only in games, but also in the real world.

The research area in which the proposed seminar is rooted is the interaction between humans and game AI, aiming for natural and appropriate responses of computational agents in virtual worlds to human behavior, making use of both traditional interaction technology as well as modern sensor and interaction technology.

2.2 Topics to Be Discussed in the Seminar

The research area lends itself for a wide range of research topics. We aim to focus on the following :

— **Personalized Human-Game AI Interaction :** Humans have different backgrounds, interests, and goals. As such, there is no "one-size-fits-all" interference and interaction form. Under this topic, we explore game adaptation as a type of automatic game design. The goal is to permit the AI to adapt the game environment to the player based on the observed features and received feedback. Instead of fully automatic game design, a sophisticated game design

leaves scope for an AI to adapt to a broad variety of players. Such personalized adaptation could be extended to adaptation of the actual game interface – in games, usually complex interactions are possible, which novice players are not capable of employing. Therefore, automatically adapting the interface to the observed experience level of the player may be a valid approach to effective personalization.

— **Human-Game AI Interaction for People with Disabilities :** People with disabilities require special attention when designing interfaces, to mitigate adverse effects of disabilities, so that a suitable experience is ensured for everyone. Game AI can potentially help to diagnose disabilities, both physically and psychologically. There is also the potential for game AI to create awareness of issues faced by those with disabilities, by intelligently adapting the interface in such a way that the player experiences it as a person with disabilities would.

— **Multimodal Interfacing and Interaction :** Multimodal systems offer a flexible and efficient interaction environment that consists of several input/output possibilities including text, speech, and vision. How to effectively use these possibilities in game design is still an open problem. A compelling application of artificial intelligence is to rapidly learn which modes a given player finds natural and enjoyable. The type of interface a user is comfortable with is likely to cross boundaries between different applications, meaning that an "interface fingerprint" may be derivable that can be carried with the user, permitting the re-use of information gained.

— **Enhancing Human Creativity with Artificial Intelligence :** Computational Creativity is a field of AI where automatic AI systems design and create various forms of art, which may include images, drawings, poetry and music. In the broader sense, these systems create new content either completely by themselves, or with the human providing input at specific points. Research into this fusion of the creative skills of humans and AI systems would move the state of the art a step forward : from being inferior content creators the AI systems would become a tool for amplifying and augmenting the superior creative abilities of a human being, in a bi-directional collaboration process. AI systems should be able to learn from the human, anticipate what they intend to do, and understand the domain of discourse. They would provide advice on content creation and help when the user struggles with certain techniques or creative methods. By learning the skills of the human, AI systems would be able to propose alternatives that lie outside their expertise, allowing the humans to learn, refine and improve their capabilities. The users would experience a system that adapts to their skills, needs and pace, and becomes a personalized companion in their learning process.

— **Trustful and Reliable Human-Game AI Interaction :** We often observe that humans feel uncomfortable with AI recommendations. Moreover, mistakes made by humans are deemed more tolerable than those made by an AI. While there is no objective rationale for this difference, it is hard to justify the use of AI for humans by arguing that AI offers a lower mistake probability compared to humans. It is therefore imperative to find new ways to convince humans to interact with the game AI and to take its advice seriously. Moreover, it is crucial to minimize any effect that might harm such trust, regardless of its origin.

— **Information Flow in Human-Game AI Interaction :** A game AI must observe the human player and, in turn, provide players with information that they find helpful, valuable, or interesting. Even the most potentially helpful information is not actually helpful if the player cannot understand it or if it is not useful to their particular style of play. The flow of information is particularly important between the human player and an AI companion. Reliable metrics that ascertain if the human uses information offered by the AI, that check if the AI fails to provide information that the human tries to find in other ways, and assessment of defects in the human's play that suggest which information is needed, are potential goals of research in this area.

— **Believable Human-Game AI Interaction :** In the last decade, contests have been held at several conferences where human judges voted on the "humanity" of both human game players and AI players in an effort to score the ability of the AI players to behave in a plausibly human manner. Attempts to make AIs interact in a way that is indistinguishable from human interaction are a natural way to structure research into human-game AI interaction. We

note that the believability of game AI often suffers because it fails to recognize that it misunderstands the human player, or that the human player misunderstands the AI. How to recognize misunderstanding, followed by how to correct for misunderstanding, are important steps in making game AI more believable.

— **Ethics of Human-Game AI Interaction :** Several of the aforementioned research directions rely heavily on big data analysis. Acquiring such a massive amount of data is a challenging task. Perfect anonymization is hard to achieve, and often undesirable as multiple parties are involved in data collection and integration. To what extent is it ethical to collect personal interaction information ? Are there ethical restrictions to the extent to which an AI is allowed to analyze a player's personality and demographics ? These questions need answering even if a player gives permission to collect and use such data.

— **Novel Forms of Interaction and Interfaces in Game AI :** New technology gives rise to new possibilities in game interaction and interfacing. While developers often try to restrict themselves to small adaptations in tried-and-true forms of interaction, it makes sense to consider the interaction possibilities originating with novel technology, such as virtual reality and brain-computer interfacing. Beyond those, there may be ways for humans and AI to interact with each other that has not yet been imagined, or which can benefit from re-imagining. Player-AI interaction can be implemented in many forms, such as (1) cuing a player with environmental information from music to decor, (2) influencing a player by adjusting game elements such as local architecture, opponents, and rewards, and (3) making a player respond to the social tone of non-player characters. Such alternate forms of player-AI interaction warrant investigation.

2.3 Outcomes

The proposed seminar will bring together computer scientists, cognitive scientists, and industry experts with the common goals of gaining a deeper understanding of human-game AI interaction, in particular in using AI in to make the interaction between humans and game agents more natural.

During the seminar we intend to not only have discussions which investigate the topics theoretically, but also spend part of the seminar on trying to achieve practical results. We did the same in the previous seminars in the series, which was met with great enthusiasm and led to some strong follow-ups. As in the previous seminars, these practical sessions will be partly to test out new ideas, and partly competition-based, where different approaches are used to implement AI for new problems, which are then compared to each other by running a competition.

In line with previous seminars, we expect that as outcomes we will produce several prototypes that demonstrate new ideas of research, several collaborations on papers and book chapters to be published in the coming years, and a number of ideas for new research directions. A major outcome tends to be that newcomers in the field, which we aim to have about 20 participants to be, get integrated in the research community, which tends to be rather tight.

2.4 Seminar Structure

This seminar will bring together scientists, researchers, and industrial designers and developers who specialize in the intelligent interaction between humans and computer agents in virtual environments, in particular game environments. The goal is to boost the research in this area by the exchange of knowledge and ideas, fostering collaborations, and by creating prototypes for intelligent game interactions using a variety of input devices and interpretation technologies.

The seminar will mostly focus on working groups, where small groups of participants work on a particular topic for half-a-day or a full day. This exploration may consist of a discussion or of the building of a prototype, but should always produce some results. Every day will start with a plenary session in the morning in which a few 10-minute talks are given and working groups are formed, and end with a plenary session before dinner in which all working groups report on their results.

The first day of the seminar will start with a half-day plenary session, in which participants quickly introduce themselves in a game-like setting, in which the goals of the seminar will be outlined,

in which a few speakers give a short introduction to a particular topic, and in which the first working groups are formed. From the afternoon of the first day the working groups will be active. New working groups can be formed each day in the morning, and people may switch working groups whenever they like. When a working group has reached a tangible result, it will usually be discontinued. In the previous seminars, in total 25 to 30 working groups were active during the whole seminar, usually with 5 to 8 participants in each working group.

While this seminar series does not encompass presentations which are common for conferences, in 2019 we experimented with another format in this regard, which proved to be very successful, and which we will continue to use : on the evenings of day 2, 3, and 4 of the seminar, starting around 8PM, one participant will give a longer, more intensive presentation or tutorial on a particular topic where they are specialized in, followed by questions and discussions. Attendance for these sessions is optional ; if participants rather interact socially that is fine. We found that these sessions tend to last about 2 hours, and were wildly popular and instructive, giving rise to new ideas for both the presenter and the attendants.

In previous years we found that, while participants very much appreciated the way the seminar was organized, there seemed to be a need for a bit more relaxation. In particular the afternoon walk that we held one of the days was very much appreciated. For the proposed seminar, we actually want to have such a walk immediately after lunch most days, weather permitting, lasting about half an hour.

2.5 Related Conferences / Projects

Research on games is communicated within several communities and via dedicated conferences (e.g., IEEE Conference on Computational Intelligence and Games, IEEE Conference on Games, AAAI Artificial Intelligence in Interactive Digital Entertainment, and the Foundations of Digital Games) as well as workshops co-located with other events (e.g., Computer Games Workshop at IJCAI). Since 2009 there is also a flagship journal, the IEEE Transactions on Games (previously the IEEE Transactions on Computational Intelligence and AI in Games). Several IEEE task forces and networks have been formed to guide the development of the field.