# How Human Centered AI Will Contribute Towards Intelligent Gaming Systems

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### Abstract

A paradigm shift towards human-centered intelligent gaming systems is gradually setting in. Such intelligent gaming systems with embedded machine learning algorithms would explain player motivations, help design more personalized single and collaborative player experiences, transfer and generalize the learning from game to game. The multi-modal user behavior trajectories, both in-game and across various platforms, incorporate heterogeneous information and graph structures. These gaming modalities range from text, audios, video demos, activity replays, and social networks to psychological questionnaires. Identifying decision-making patterns and strategies by observing in-game behavior actions and mining heterogeneous sources could construct a more holistic representation of the gaming community. Human priors publicly available on the World Wide Web would inspire the modeling for human-like non-player characters, adaptive recommendation systems, automatic game design, testing, and human-AI collaborations. My doctoral research goal is to mine, represent, and learn from human priors existing in the interactive entertainment community's heterogeneous sources and introduce ways to model single and multi-agent interactive behavior patterns.

## Introduction

The gaming industry is moving into an era where re-engineered systems replace old-style game engines with embedded machine learning technologies for the operation, analysis, and understanding of gameplay. Human-centered AI takes a path that bridges the interest of both the gaming industry and the artificial intelligence research community. In this statement, I divide my research on constructing intelligent gaming systems into three sub research topics: representing social and collaborations, heterogeneous data and reasoning, and interactive and explainable AI in gaming. My research primarily focuses on building graph and natural language representations of players, leveraging multi-modal machine learning to extract insight from heterogeneous sources, and building explainable reinforcement learning frameworks to model the community's human decision-making process.



### Representing Social and Collaborations

Social gaming, such as the Battle-Royale genre and Animal Crossing, recently has gained increasing popularity. Combined with heterogeneous data provided on social media and streaming platforms, understanding and predicting players' behavior patterns considering graph structures becomes increasingly important. What's more, complex real-world challenges are often solved through teamwork and collaborations. Research in gaming teamwork (Sapienza et al. 2018; Zeng et al. 2020b) might inspire a broader research audience. One part of my current research focuses on understanding the social dynamics and collaboration strategies in the gaming community.

### Heterogeneous Data and Reasoning

Human priors in gaming exist primarily in four sources: replays and gaming logs records the detailed in-game behaviors; walk-through blog posts and gaming Wikipedia shows the summarized strategies; social media uncovers the myth of gaming networks, crowd, and marketing; video streaming with its multi-modal feature is both informative and interactive. The second part of my current research focuses on mining and learning from heterogeneous data to reason the human's decision-making process with multi-modal machine learning.

### Interactive and Explainable AI

The third part of my research feature human interactions with the bots or the automated gaming and broader AI system. The motivation is to leverage human priors in interactions to improve the learning algorithms.

These three parts all contribute to the broader domain of human-centered AI (Riedl 2019) in gaming, with the general goal of understanding players, which will benefit the construction of intelligent gaming systems.

## Completed Research

In this section I will briefly describe research I published separately featuring graphs in a MOBA games and actions replays in a first shooter game called CS:GO.

**The Influence of Social Ties on Performance in Team-based Online Games (Zeng, Sapienza, and Ferrara 2019)** Social ties are the invisible glue that keeps together

human ecosystems. This research aims to elucidate the influence of social ties on individual and team performance dynamics. The research focus on a popular *Multiplayer Online Battle Arena* (MOBA) collaborative team-based game, *Defense of the Ancients 2* (Dota 2). The research reveals that, when playing with their friends, individuals are systematically more active in the game as opposed to taking part in a team of strangers. However, we find that increased activity does not homogeneously lead to an improvement in players' performance. Despite being beneficial to low skill players, playing with friends negatively affects performance of high skill players. Our findings shed light on the mixed influence of social ties on performance and can inform new perspectives on virtual team management and behavioral incentives.

**Learning to Reason in Round-based Games: Multi-task Sequence Generation for Purchasing Decision Making in First-person Shooters (Zeng et al. 2020a)** Sequential reasoning is a complex human ability. With extensive previous research focusing on gaming AI in a single continuous game, round-based decision-making extending to a sequence of games remains less explored. Leveraging Counter-Strike: Global Offensive (CS:GO), a round-based first-person shooter game, this research aims to learn from top tier players' virtual digital currencies' sequential spending strategies and reason the decision impacting component. This research shed light on modeling and reasoning broader temporal virtual purchasing behavior in gamified online systems for both solo and team users. Specifically, we propose a Sequence Reasoner with Round Attribute Encoder and Multi-Task Decoder to interpret the strategies. The model adopts few-shot learning to sample multiple rounds in a match and modified the agnostic meta-learning algorithm Reptile for the meta-learning loop. We formulate each round as a multi-task sequence generation problem. Our state representations combine action encoder, team encoder, player features, round attribute encoder, and economy encoders to help our agent learn to reason under this specific multi-player round-based scenario.

## Current Research

My current research revolves around multi-modal machine learning and reinforcement learning. My research extracts useful insight into player interaction patterns, leveraging benchmarked tasks in natural language, graphs, and vision.

Players demonstrate different in-game behavior patterns, social interaction habits, and commentary feedback driven by various internal or external motivations [1] . One of my current research analyzes the top 50 free-to-download games on Apple's App Store. The project utilizes Aspect Based Sentiment Analysis (ABSA) task to extract fine-grained information related to each game. We then use this information to investigate the same games' cultural differences in three other English speaking countries: United Kingdom, Australia, and Canada.

[1]Zeng, Y.; and Srisopha, K. 2018. Aspect Sentiment and Cultural Bias Mining from Reviews with User Profiling for Mobile Games on App Store

In line with the above Natural Language Processing research, my other research features Esports community, a coordinated representation learning method leveraging three modalities: written natural language, visual signals represented with images, and graphs shown by social media interactions is proposed. We choose multi-modal social-media-based user profiling as our downstream task to predict team affiliations. Our multi-modal embedding space can be visualized by T-SNE and reveal higher quality and better prediction than uni-modal representations.

How to leverage human priors in reinforcement learning is a heated and established open question. (Hofmann 2019) In one of my undergoing projects, we created a platform that enables users to interact with the agent online, via manipulating the task difficulty. We investigate the effect of human prior on the designing general reinforcement learning curriculum and compare it against existing approaches on automatic curriculum generation. In the extension of this project I will learn from established research field of human robot interactions and extend it to human virtual bot interactions.

## Future Work

Understanding user behaviors will attract more attention and bridge both the gaming industry and the AI research community. My future research will keep focusing on these three main interests: Representing social and collaborations; Heterogeneous data and reasoning; Interactive and explainable AI. I will leverage my interests' intersections to build more personalized recommendation and adaptive human-centered algorithms. In the remaining time of my Ph.D. study, I plan to broaden the human-centered AI from gaming research towards helping build more explainable, safe, and robust intelligent gamified online systems.

## References


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