Mixed-Media Game AI

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Over the last decades, digital technologies have moved away from the personal computer (PC) into cloud computing, ubiquitous computing, intelligent robots and smart devices. From wearable technologies to remote-controlled household items and from sensors for crowd control to personal drones, there is a broad range of sources which can be exploited for artificial intelligence in games. While artificial intelligence (AI) is already a big part of the Internet of Things, raising concerns in terms of ethics and politics [1], games have been relatively partitioned away to PCs. Relevant work on wearable technologies as game controllers [2], mixed- or virtual-reality rendering [3], or technology-enhanced play in playgrounds [4], social robots for games [5] or board games [6], has largely not taken advantage of artificial intelligence for controlling or mediating the experience. Using the term *mixed-media* to refer broadly to any media, digital or otherwise, outside the game data within a PC or a game-specific database, this working group attempted to map out the broad topic of mixed-media in terms of its applications for game AI.

AI-based games which take advantage of mixed-media could do so in two principal ways: use input from non-game sources within the game, and move elements of play or gameplay outcomes into non-PC outputs. The usefulness of non-game information as *input* to gameplay is primarily in the identification of *context*. Context can be personal (e.g. information relevant to this particular player) or broader and anonymous (e.g. number of people in the player's vicinity or trending topics on Twitter). Context can come from the actual environment of a player via sensors (e.g. temperature sensors on a player's mobile phone, or surveillance logs in public spaces such as museums), from a variant game controller (e.g. speech detection or face detection as an explicit part of gameplay), from social relationships (e.g. based on social media profiles, real life proximity, or a history of social interaction), from game histories (e.g. past gameplay habits in other games), from cultural histories (e.g. players' demographic data linking to cultural heritage databases), or from temporal context (e.g. the current time of day or date, or the time passed since the user interacted with the game).

On the other hand, the *output* of such applications (playful or not) can also be delivered in non-traditional media beyond digital screens of a PC or mobile device. Closer to traditional digital outputs, mixed- or virtual-reality devices could be considered, along with environmental projections (such as large screens or projections on different parts of a building, in the case of multiplayer games played in a shared environment). On a similar (and familiar) direction, output or intermediate states of a long-lasting game can be shared on social media, potentially soliciting other users' feedback as additional input (to provide even more context, as discussed above). A game's final output, such as a drawing in a collaborative drawing game [7] or an AI-assisted drawing tool [8], could be printed out in paper, fabric [9], or via 3D printing [10, 11], or sonified into a musical piece [12]. More ambitiously, the intermediate states of such a game could be used to control robots, wearable actuators worn by the players, or even smart home devices. Obviously, the further the output is from traditional game output, the more challenging the design problem of making such an appplication a seamless, playful experience while ensuring that the game output is understood as such and —when moving into the real world— remains safe to use and respects players' privacy.

Following an initial mapping of the possibility space for mixed-media game AI, including possible audiences, purposes and challenges, the working group focused on three specific use cases. The first use case focused on textile input to physical output for MEND, a platform where people contribute to a communal art piece (projected on a wall) by scanning quilted physical objects, one

person at a time. The second use case focused on physical input to virtual output, for a game designed around the use of a sensor able to detect laughter in groups [13] as a mediator for when a game session is won and by whom. The final use case problematized the topic of input more broadly, trying to identify context within player's game data; the main question revolved around whether there are signals or log data which can be assumed to be independent of the game context [14] but able to capture the player's context in terms of experience. The broad nature of the topic of Mixed-Media Game AI was thus mapped out, and a small part of the design and problem space it can afford was explored.

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