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# Games, AI, and Systems

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## 2002: A Revolution Brewing

"A revolution has been brewing", writes Paul Tozour, then an AI developer at Ion Storm, in his essay "The evolution of game AI" (Tozour 2002). The revolution he is alluding to is the rapidly growing role of artificial intelligence and machine learning in the video game industry. Tozour sees progress through advancements in hardware, a better understanding of AI in games, and dedicated AI programmers. He argues for AI-centric game design and predicts a closer relationship between academic AI and video game AI. If this sounds familiar from today's perspective, one may ask if the current situation finally marks the revolution[1] Tozour wished for.

2002 is the year that sees games like *Metroid Prime* on the Game Cube, *Grand Theft Auto: Vice City* on the Playstation 2, and *Neverwinter Nights*, *America's Army* and *Battlefield 1942* on the PC platform. Notable high-end game engines include id Tech 3 and Unreal Engine 2. Early versions of the beginner-friendly GameMaker are published as freeware, whereas the Unity game engine is not around yet—the company will be established two years later.

Valve has just released a beta version of Steam, their revolutionary new digital distribution platform. Most commercial games still ship on CD-ROM, while some experimental ones run on the ubiquitous Macromedia Flash Player. The exhibition *Game On: The History and Culture of Video Games* (Carr 2003) celebrates 40 years of game development, running in summer 2002 at the Barbican in London, before it goes on tour worldwide.[2] In the accompanying catalogue, we find Eric Zimmerman's (2002) ontological musing titled "Do independent games exist?".

The book that opens with Tozour's essay contains contributions such as "The Dark Art of Neural Networks" by Alex J. Champandard and "Varieties of Learning" by Richard Evans from Lionhead Studios (Rabin 2003). The latter delivers a talk called "Social Activities: Implementing Wittgenstein" at the annual Game Developers Conference, referring to their work on the video game *Black and White* released the year before (Evans and Barnet-Lamb 2002).[3] Matt Buckland (2002) writes the book *AI Techniques for Game Programming* in which he describes genetic algorithms, neural networks and evolutionary approaches. The early 2000s certainly are exciting times for video game AI.

## Rhetorics of Progress

A little over 15 years later, we see again revolutionary developments at the intersection of games and AI (Yannakakis and Togelius 2018). From the technological perspective, the prevalent rhetorics[4] sound familiar and present real progress at the same time. As some of its proponents have noted, many of the

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algorithms underlying modern AI are adaptions or re-discoveries of pre-existing methods (Schmidhuber 2015). This applies in particular to the trinity of supervised, unsupervised, and reinforcement methods in fashion in machine learning today (Goodfellow, Bengio, and Courville 2016). Significant differences compared to the early days of AI are the availability of large datasets[5] and a huge gain in computing power: the estimated hardware cost for one teraflop[6] of computation has decreased from US$156.8 trillion in 1961 through US$109,000 in 2003 to US$30 in 2017.[7] This has enabled breakthroughs in deep learning with multi-layer artificial neural networks featuring large numbers of parameters (LeCun, Bengio, and Hinton 2015). As Krizhevsky, Sutskever, and Hinton (2012) note, "All of our experiments suggest that our results can be improved simply by waiting for faster GPUs and bigger datasets to become available".

We can now reiterate the question Raj Reddy (1988) posed three decades ago: are we experiencing a new "AI summer" or is another "AI winter" already on the horizon? From a historical perspective, connectionist approaches have outpaced traditional symbolic AI, but their limitations are becoming manifest. Critics have noticed problems such as insufficient replicability (Hutson 2018), enormous demands on input data (Marcus 2018a), complex questions around biases in statistical models (Brennan, Dieterich, and Ehret 2009), algorithmic opacity (Hwang 2018), and the fragility of models, demonstrated through adversarial examples (Elsayed et al. 2018). The latter poses a concrete problem for classification and decision making algorithms, while some other discourses deserve more critical scrutiny. In particular, the popular claim of human bias in machine learning seems to rely on the underlying assumption that technology can be—or should be—fair, unbiased, or neutral, as postulated by (Pitt 2000). Yet this assumption of fairness does not even hold in simple decision-making processes (Szpiro 2010), and for sociotechnical systems, the situation is far more complicated (Selbst et al. 2019). Instead, these technologies are based on social factors (Toyama 2015). Therefore, they reveal a mediated and political character (Sudmann 2018b).

Another outcome is the much higher availability of tools and knowledge compared to 2002. Game engines have become ubiquitous, along with an array of diverse production tools (Toftedahl and Engström 2019). Open source machine learning libraries such as *scikit-learn* (Pedregosa et al. 2011) and *Keras* (Chollet 2018) allow independent developers to leverage techniques previously reserved to academic and larger commercial entities. Tools such as *Wekinator* (Fiebrink and Cook 2010) and *Magenta* (Roberts, Hawthorne, and Simon 2018) are specifically inviting artistic experimentation. Unity has published *ML-Agents*, a reinforcement learning toolkit that tightly integrates with the popular game engine (Juliani et al. 2018). Similar environments are *Gym* by OpenAI (Brockman et al. 2016), *Marlo* by Microsoft Research (Johnson et al. 2016) and *OpenSpiel* by DeepMind (Lanctot et al. 2019). The number of publications, tutorials, online courses, and academic papers on artificial intelligence is skyrocketing,[8] in concert with the number of ethical guidelines for AI (AlgorithmWatch 2019).

## Cultural Impact vs. Public Discourse

In terms of cultural impact and public discourse, games and AI have evolved separately and at a different pace. The growing influence of experimental and independent creators has brought video games to a larger and more diverse audience outside of the AAA mainstream. A still growing independent games scene and an artistic fringe have differentiated themselves from each other. Yet Zimmerman's (2002) essay outlining the soul-seeking cultural self-reflection of indie game creators is surprisingly up-to-date.

While contemporary musings about video games sometimes appear whimsical (Bogost 2011), established institutions like the V&A in London and the MOMA in New York have acknowledged their cultural impact with significant exhibitions. Festivals like *AMAZE*, *IGF*, and *EGX Rezzed* provide social glue to the scene and attract artists, developers, players, and the general public alike. The discourse has become more diverse and increasingly relevant for cultural issues[9] (Shaw 2010; Ruberg and Shaw 2017; Muriel and Crawford 2018). Previous myopic views both on games (Ebert 2010; Jones 2012) and on art (Zimmerman 2014) have given way to more open and mature discussions (Catlow et al. 2010; Sharp 2015). I attribute this shift to developments within multiple social systems: academia, economy, politics, education, and art.

Whereas tropes of hazard (Anderson and Dill 2000) and addiction (Griffiths, Kuss, and King 2012) have dominated debates about games early on, deeper scrutiny especially in the form of meta-analyses have added much-needed counterweight to the discussion (Griffiths and Davies 2005; Bean et al. 2017; Ferguson 2015). Up to now, the games industry has enjoyed steady economic growth (Nakamura 2019), a factor that has elicited appropriate responses from the political and the educational system. As a result, incentives such as tax breaks, grants, and educational offerings have flourished.[10] In the UK alone, there are over 2000 active developers (UKIE 2018) and about 500 courses related to video games are offered in higher education.[11]

If the interaction between games, art, and other subsystems of society correlates with a more diverse and nuanced public discourse, can the same be said about artificial intelligence? Generative machine learning techniques (Goodfellow et al. 2014) have injected expressive stimulus into computer art, a field that had been simmering along in the shadow of video art since the late 1950s (Taylor 2014). Emerging artists such as Mario Klingemann, Anna Ridler, Memo Akten, Sougwen Chung, and Helena Sarin are now experimenting with fresh creative possibilities. The art system tacitly embraces this direction, too, as evident from initial scandals and misunderstandings (Straeubig 2019).

A particular issue that has permeated computer-related art from the beginning concerns observers from a scientific background who tend to assume that works of art are created by (re-)producing certain intrinsic or extrinsic qualities of artefacts.[12] Yet this position can safely be considered obsolete since the "Richard Mutt case", Duchamp's famous urinal (Norton 1917). Instead, we can describe art more aptly as a self-organising social system that observes, invites or rejects artistic quality through dynamically evolving distinctions (Luhmann 2000; 2008). These distinctions, from changing aesthetic principles to a postmodern "l'art pour l'art" attitude (Wilcox 1953),

are neither artefact-oriented nor informed by the same distinctions science operates with (Luhmann 2009).

While the discourse concerning games has eventually grown up, the same cannot be observed from recent debates around AI. To the opposite, those show signs of regression towards an infantile state: shrouded in ethical whitewashing, obsessed with trolley problems, afraid of omniscient cars, fixated on the holy grail of consciousness and haunted by the ghost of the singularity. Established frameworks such as privacy laws, product safety regulations, and the discipline of technology assessment are largely ignored in favour of AI exceptionalism and doomsaying (Danaher 2015). The proponents of artificial general intelligence (AGI) believe that they will create AIs that trump human intelligence in every respect (Goertzel and Pennachin 2007), while singularity advocates like Vernon Vinge (1993) and Ray Kurzweil (2009) even claim that this development is unavoidable.[13] Vinge's essay pins the arrival of superhuman intelligence down to the year 2023. Kurzweil apparently thinks a one-dimensional graph sufficiently represents intelligence, and that it is therefore permissible to postulate a crossing point between human and artificial intelligence. Simulationists like Bostrom (2003) think this event has already happened and that our daily endeavours are in fact part of a simulation into which some superhuman yet strangely unimaginative civilisation has put us. Consequently, Beane, Davoudi, and Savage (2014) look for signs of physical evidence within that purported simulation, which in my view is a category mistake. Shanahan (2016) notes that an alien consciousness may appear strange, even unintelligible to us. Like the idea of *The Matrix* (Gramatikov and Zimmermann 2013), I believe that AGI and singularities are best described as entertaining and sometimes intellectually stimulating thought experiments, which does not necessarily add to their plausibility. This attitude is considered to carry risks by some (Auerbach 2014).

To summarise so far: I am observing a mismatch between current technological progress and cultural debates that surround both video games and AI. I maintain that those debates are largely out of sync—with each other, with societal issues and with the impact of the respective technologies. I do not argue against speculations in general but I believe that the ones based on singularities or artificial minds require an update. Therefore, I present a different narrative that describes how video game AI might transgress the boundaries of the magic circle (Huizinga 1955) and bleed (Waern 2011) into our social systems at large.[14]

## The Seven Roles of Game AI

In this section, I discuss seven roles—Mechanic, Alter/Ego, Observer, Protector, Player, Creator, and God—that AI inhabits or is about to assume in video games (Yannakakis and Togelius 2015; Yannakakis and Togelius 2018, pp.279-291). The final role (God) remains speculative, yet I will attempt to sketch out how it could emerge from the other six.

## 1. Mechanic

The first role is what we traditionally associate with game AI: an 'intelligent' part of the game mechanics that contributes to the overall experience of the human player. This includes pathfinding algorithms, swarm or crowd movement and adversarial search within game state spaces, as well as models for NPC (non-player character) attention, behaviour, and dialogue choices (Rabin 2014). The underlying patterns and algorithms like finite state machines and rule-based systems are well understood. A few games use genetic algorithms and neural networks, their complexity far from present state-of-the-art machine learning models.[15] In the role of the Mechanic, the AI is supposed to remain invisible, intended as a silent ingredient in the production of the magic circle (Huizinga 1955; Stenros 2012). Only in the event of an error, AI would reveal itself as a tool that needs to be investigated, in Heidegger's (2013[1962], pp.102-103) terminology it would undergo a transition from 'ready-to-hand' to 'present-at-hand'.

## 2. Alter/Ego

This aspect of visibility is different for the second role, how AI-controlled entities appear to the player. Here, we observe artificial intelligence as a phenomenon through the eyes of the player who herself is represented by an avatar within the game world (Klevjer 2012). As such, she encounters an AI in a communicative setting (Schröter and Thon 2014). In Luhmann's terms (1996, pp.138-175), the AI represents the Alter to the player's Ego, which is mediated by the avatar, and vice versa. This is the only role in which we observe the AI completely through an intradiegetic lens as both avatar and AI inhabit the game world and act within it.

## 3. Observer

In the third role, the AI watches over actions and follows the progression of the player. This may result from different motivations. Player analytics can locate weak points in the game design and detect technical problems, but also strive to keep players in the game, to make them return to the game and to maximise their spending (Seif El-Nasr, Drachen, and Canossa 2013). This technology is now widely deployed in the game industry (Sifa, Drachen, and Bauckhage 2016). The Observer aggregates data for analysis by the developers but might also construct higher-level models like psychological player profiles (Cowley and Charles 2016). Whereas the first two roles were elements of the game mechanics and the game world, we locate an observing AI outside of the game world or outside the game altogether.

## 4. Protector

While the observer role is passive, AI can also be deployed to interfere with harassment, hate speech, or spam (Spirit AI 2019), and it may sanction players who break the game rules, disturb the magic circle or attempt to commit fraud (VanKuipers 2018). As cheaters also make use of software tools, AI supported attack and defence actions on different levels can take place during an online game (Paoli

and Kerr 2009). Anti-cheat and anti-fraud programs may reach out far beyond the magic circle—they can be installed on the player's computer, analyse and block network traffic, look for irregularities in the sign-up process, ban players from the game, read online forum entries, or confirm the credit history of the player.

## 5. Player

More recently, a new role has manifested itself that used to be reserved for humans within games: machines are assuming the role of players. Early approaches arose from the social sciences, for example, to model pretend play (Zook, Magerko and Riedl 2011). With deep reinforcement learning (Arulkumaran et al. 2017), artificial agents are trained within game environments to learn new behaviours from a limited set of observations and from rewards handed out for desired responses.

By leveraging deep learning architectures and combining heuristic search methods with reinforcement learning (Vodopivec, Samothrakis, and Ster 2017), the Google-owned AI startup DeepMind was able to master a set of classic computer games given their raw pixel input (Mnih et al. 2013), to beat the world leading Go player (Silver et al. 2016), and to take a stab at the highly complex real-time strategy game Starcraft II (Vinyals et al. 2019).

Here the AI serves a different purpose than controlling an opponent or an ally for the sake of the human player.[16] Humans may (Karpov, Schrum, and Miikkulainen 2012) or may not (Ehrenfeld, Schrodt, and Butz 2015) be present in this scenario. Fizek (2018) describes self-playing games that open up new perspectives on the relationships between game, player, and play. I have previously discussed in what sense machines by themselves can or cannot play (Straeubig 2015).

## 6. Creator

In this role the AI takes on tasks that are deemed productive or even creative. Procedural content generation (PCG) is one of the traditional areas of AI supporting the design and development of video games. It has been applied to game elements such as textures, terrain, vegetation, buildings, level architecture, storyboards, items, characters, quest structures, puzzles, and sound (Hendrikx et al. 2013). *No Man's Sky* by Hello Games even features a continuous, procedurally generated universe (McKendrick 2017).

Under the label of computational creativity, research is made towards the creation of complete games (Cook and Colton 2014; Cook 2017). A widely adopted definition of creativity is that it requires novelty and usefulness (Boden 2009). The latter aspect is exemplified by social systems of machines such as *Techne*, a community of synthetic artists that produce artworks and critique each other (Pagnutti, Compton, and Whitehead 2016). Multi-agent models (Saunders and Bown 2015) and modes of co-creation between machines and humans are promising directions for exploration (Guzdial et al. 2019). In my view, we need to expose machines to a variety of challenges and social situations, as "only on the level of social systems the machines will become more human" (Straeubig 2017, p.2).

## 7. God

With Mechanic, Alter/Ego, Observer, Protector, Player, and Creator in place, we are now able to speculate about an emerging entity that incorporates these six roles into a final one. This AI would control elements of the game mechanics, dynamically drive the game's characters generated from psychological models, adjust difficulty curves and plot points, provide rewards according to individual player engagement, and entice the player to spend more money on in-game purchases and micro-transactions. Asserting its identity, it would punish deviant behaviour such as harassment and attempts at cheating as it would procedurally create new game rules, new content, and finally new games, while playtesting its own creations in form of simulated, parametrised players. It would learn within a few milliseconds by confirming or rejecting hypotheses and observing their effects on the players. It would play continuously, and while it would play, it would adjust trillions of parameters. It would engage in discussion with players and designers what to build next. One day it would create a distinction between play and non-play, maybe because some players suggest building a to-do list or ask for an external service like affordable credit. From there, it would transcend the game and expand into other social systems and economies. It would still be reliant on humans in some aspects, but it would keep symbiotic relationships with its operators. It would have a sufficient supply of them available, and it would know how to get rid of individuals in case of inaptitude or obstruction. Because it learned its role of Protector early on, it could spot anomalies, would know how to defend itself and would "bleed" between the virtual and the physical.

Would this be the artificial general intelligence the Bostroms and Kurzweils are dreaming of? Would it become even godlike over time? A prudent position dealing with these questions might be aniconism, the principle of refraining from making a picture. Because one might end up praying to that picture.

## Deus Ex Machina

How feasible is the above scenario? I believe it is less unlikely than the predominant speculations. The course of the story might go a different route. Maybe someone would pull a (legal) plug. Maybe competing entities would emerge within virtual worlds run by large conglomerates. In any case, a development like this one is, however speculative, completely within current technological possibilities. It depicts an emerging social system where humans and machines cooperate closely and where machines exert a much larger degree of influence, resulting in a dystopian (utopian?) outcome.[17] Most importantly, it does not assume the often touted arrival of miracles, such as artificial human equivalent consciousness. Therefore, it differentiates itself from the prevalent forecasts about AI coming out of Silicon Valley. I claim that this possibility should have practical ramifications for future research. In particular, I suggest exploring alternatives to the current businesses of aiming to build brains (Eliasmith 2013), minds (Kurzweil 2014), or even souls (Dörner 2008).

To me, it makes sense that an artificial general intelligence as depicted above would rather emerge from a permanently running, complex virtual game world than from singular efforts within a particular research laboratory. And with the boldness of the

speculative forecaster, I claim that some scenario like this one is likely to happen. Therefore, it is mandatory to actively shape its trajectory. I think this requires approaches that focus on different problems than just trying to overcome current technical problems in machine learning. This includes constructive reflection (Marcus 2018b), awareness of a wider range of issues and themes (Reichert et al. 2018), and the (re-)discovery of available theoretical and practical directions such as social systems theory (Luhmann 1996), Nouvelle AI (Brooks 1990), Expressive AI (Mateas 2001), and FutureCrafting (Marenko 2018). The biggest challenge that I see is that building and operating such a project would need a diverse team that thinks and works in a truly transdisciplinary manner (Blassnigg and Punt 2013). And this is the actual 'hard problem' (Chalmers 1995).

I appreciate that games and AI are growing together (Togelius 2015), but do you know a place where game designers, sociologists, lawyers, psychologists, artists, philosophers, coders, and AI researchers collaborate on these challenges as a team? If so, I would like to hear from you.[18]

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## Notes

[1] Sudmann (2018a) discusses the notion of ’revolution’ from a media studies perspective.

[2] The exhibition is still running today alongside an updated version (McConnon 2018).

[3] I remember my growing frustration with the Tamagotchi-like creature in that game which largely resisted my well-intended efforts at rewarding it for good behaviour.

[4] I call these descriptions ’rhetorics’ in reference to Brian Sutton-Smith's (1997) rhetorics of play. A rhetoric is a description which is predominantly shaped by a particular interest.

[5] For example: https://www.kaggle.com/datasets.

[6] A teraflop is a trillion (10^12) floating point operations per second.

[7] See https://en.wikipedia.org/w/index.php?title=FLOPS&oldid=882952994. The amounts are inflation-adjusted to the 2017 US Dollar.

[8] This is indicated by the increase in publications of categories like computer vision, artificial intelligence and machine learning on the preprint platform arXiv.org (2019).

[9] This also includes reactions to the emergence of a so-called “gamer culture”. Mortensen (2016) gives an overview and Alexander (2014) provides a comment.

[10] Who benefits from these tax reliefs is an entirely different question (Holmes, MacDonald and Stuart, 2019).

[11] See https://digital.ucas.com/search/results?SearchText=games

[12] A rather extreme example: Schmidhuber (1997).

[13] As Vinge (1993) notes, both von Neumann (Ulam 1958) and Good (1965) have discussed variations of this particular notion of singularity before.

[14] With respect to Sutton-Smith’s rhetorics, this can be read as a switch of focus away from progress towards identity, imagination, self and power.

[15] In the past, this had caused a schism between game AI and academic AI (Yannakakis and Togelius 2018, pp.13-15).

[16] One may argue that in this case not the AI itself, but its environment has changed the role. I refer to Luhmann (1996) for a deeper discussion.

[17] Science fiction author Daniel Suarez (2010; 2011) explores a similar scenario.

[18] Via straeubig@gmail.com or i3games.com.