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HENRIK WARPEFELT AND MAGNUS JOHANSSON

Video games continue to rise as one of the frontiers of Artificial Intelligence (AI) applications. The games industry now makes extensive use of AI technologies including machine learning to understand player bases and AI driving Non-Player Characters (NPCs) to provide a compelling gaming experience (Yannakakis 2012). However, the use of AI in games face some of the same difficulties as the AI community at large, where an understanding of AI system behaviors are seen as central in controlling their actions, also indicating a need for the perspectives and methods of scholars originating outside of the disciplines that traditionally produce intelligent machines (Rahwan et al 2019). In recent years, however, we have seen increasing need for more user-focused approaches to understand the experience of AI artifacts in games. For example, Cardona-Rivera's call for a more cognitively focused approach (Cardona-Rivera 2017), Smith's call for a more value-oriented view on procedurally generated content (Smith 2017), and Mateas's (1999) and Loyall's (1997), and later Warpefelt's (2016) and Johansson's (2013) discussions on believable NPCs. Each of these authors has called for and provided research into specific topics aimed at increasing the believability and user friendliness of AI, but so far there are few attempts at contextualizing these disparate theories as a whole. Additionally, as explained by Johansson, Eladhari, & Verhagen (2012), one cannot simply add technology in the hope that it will solve these problems. Instead, the application of AI technologies must be done with careful consideration. Thus, there exists a need for a common framework that allows this community to discuss how the gaming experience of the user is affected by the design of AI. This framework needs to take into account the design of AI artifacts and the user's gaming experience. In short, it needs to describe the user experience (UX) of AI.

In this paper, we present a set of heuristics to set a standard framework and guide the gaming and AI communities in deconstructing and improving the UX of AI, and to better understand how this influences the player's perception and interpretation of the game. These heuristics will be informed by related theories such as the ones created by Cardona-Rivera (2017), Warpefelt (2016) and Johansson (2013). They will be created by framing central game studies theories in terms of UX theories derived from the field of Human-Computer Interaction (HCI), and by relating this theoretical construct to current issues in the field of games AI.

In particular, we are focused on how users perceive and interpret games AI, the importance of which was made apparent by, for example Johansson, Verhagen & Eladhari (2013), Smith (2017), and Cardona-Rivera (2017). We will use the concept of *character* (Janlert and Stolterman 1997), which describes how users understand artifacts based on their characteristics and what the user knows from previous experience. We will also use the concept of situation (Hassenzahl 2003), which allows us to reason about how the user's process of understanding happens. These

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theories from HCI, however, do not by themselves account for the special nature of games as hedonic entertainment artifacts (Stråat and Verhagen 2018) and thus need to be informed by knowledge from the game studies domain. As our entry point into that field, we will use the study of game narratives using the theory presented by Jenkins (2004), as well as the concept of alterbiography (essentially the narrative as perceived by the player) described by Calleja (2011). By then contextualizing games AI using this broader theory of game experiences, we can describe how games AI as a technology needs to be applied to have a positive impact on the UX of the game. Concretely, we will be using these theories to describe how the narrative helps situate the player's experience in regards to the character of the game, we will then create a set of heuristics for understanding the player's interpretation of the AI driven components of the game. By applying these heuristics as tools for user-centered design in both development and evaluation, we as designers and builders of AI experiences can more precisely tweak the player's experience to create more user-focused, value-oriented, and believable games that afford a better UX of AI. One way of understanding this is to elucidate how players interact with the game, which presupposes that the game must provide some facility for providing ways for the player to interacting with it. We will describe these by examining the affordances provided by the game.

Affordances

In this paper, we assume Gibson's (1977) perspective on affordances. As described by McGrenere and Ho (2000), this includes the key component that affordances are perceived and interpreted by the player, rather than existing independently of the player. Thus, the player can only utilize the affordances that they are able to perceive. Affordances are in turn signaled by the game in some manner, be it by providing actual user interface (UI) buttons and controls or by subtle hints in the game world. The interpretation of these affordances is thus predicated on the player being able to perceive them. This makes affordances a concept of key importance in our framework for reasoning about the UX of AI.

We can utilize Gaver's categorization of affordances (Gaver 1991) to further elucidate the nature of affordances. Gaver divides the identification of affordances into four categories, spread along the axis of perceptual information and the existence of affordances, as seen in Table 1. These four categories are thus: *false affordance, perceptible affordance, correct rejection,* and *hidden affordance*.

perceptual information	false affordance	perceptible affordance
	correct rejection	hidden affordance
	affordance	

Table 1: Gaver's categories of affordances, adapted from (McGrenere and Ho, 2000).

In Gaver's parlance, a false affordance is when the player perceives an affordance that does not exist. Conversely, if the player correctly perceives affordance it is considered a perceptible affordance. If the player correctly discards a possible affordance that was in fact not designed to exist, it is a correct rejection of the potential affordance. If the player fails to perceive an affordance this is called a hidden affordance. Perceptible affordances and correct rejections are the desirable state for how the player interacts with the game, but problems will arise if the player falsely perceives affordances or if they fail to perceive an affordance (making it hidden). Gaver, however, has been criticized by McGrenere and Ho for confusing the perception of affordances with the affordances themselves, and McGrenere and Ho advocate that the affordance should be considered as separate from how it is made perceptible to the player. Stråat, Rutz & Johansson (2015) have previously studied the effects of false affordances in particular, and found that they are especially problematic in games, since they will often cause frustration and lessen the player's feeling of enjoyment. The examples discussed in (ibid) primarily concerned false affordances seemingly not intended by the designer, not providing the player with an interesting challenge, not connected to game mechanics, and rather created an obstacle standing in the way of enjoying the game.

However, the existence of affordances must somehow be signaled to the player, and understanding how this is done is a critical issue for this paper. To this end, we will describe how affordances arise not only from our preconceived notions of the game we are playing, but also how the game can (and will) alter how we perceive affordances by providing us with new ways of understanding the game. Thus, the following sections will describe how affordances arise from the *character* (Janlert and Stolterman 1997) and from situation (Hassenzahl 2003).

Affordances from Character

The concept of *character* was introduced by Janlert and Stolterman (1997) and represents the high-level abstract descriptions that we apply to various artifacts. For example, we are prone to describing houses as being "nice" or "big". This need not necessarily be detailed descriptions (returning to the previous example it would be difficult to quantify what makes a house "nice"). Instead, these descriptions are usually very abstract and fuzzy. The definition provided by Janlert and Stolterman (1997) is as follows:

> "A character is a unity of characteristics. That is, one character combines several characteristics, not as a simple collection, but with related characteristics integrated into a relatively coherent whole. As an implication: knowing some, but not all, characteristics of a given character, we may be able to make plausible inferences about the remaining characteristics."

From this we can discern that we project this notion of character onto any sort of artifact with which we interact, and that we base that projection on our previous experience with similar artifacts. If we are unable to discern all the characteristics of an artifact, we'll extrapolate what the rest of them are based on our previous experience.

As stated by Janlert and Stolterman (1997) the library of previous experiences from which we draw upon previous experiences is called our *repertoire of character*. It contains the various combinations of characteristics that we have previously encountered, and help us associate certain characteristics in artifacts with certain characters. As we encounter more artifacts and new characters, we build this library and mutate the existing collections of characteristics. This also allows designers to utilize our *repertoire of character* to help us deduce the function of various artifacts, for example by using familiar iconography or allowing similar manipulations of the artifact. If we find that an artifact works in a certain way, we are liable to apply the same understanding to similar artifacts. Designers can also attempt to intentionally disrupt our understanding of an artifact by providing us with combinations of characteristics that clash with our current repertoire of character, in an attempt to enhance or alter the game experience by making us question our assumptions about the game world and its proclivities.

The task of the designer is, however, rarely simple. As explained by Hassenzahl (2003), and applied to games by Stråat (2017), there exists a gap between the designer's intention and the player's perception of the game's character. Thus, the designer needs to consider the target audience when designing the game. Hassenzahl (2003) uses the terms *intended product character* and *apparent product character* to distinguish between the what the designer envisioned and what the player perceived. Furthermore, Hassenzahl discusses the characteristics of the product in terms of *pragmatic* and *hedonic* attributes. Pragmatic attributes are those that are needed for the player to be able to manipulate the game. Hedonic attributes, however, invoke some kind of feeling in the player. Continuing the car analogy, having a steering wheel that turns as expected is a pragmatic attribute, whereas having a steering wheel covered in supple and soft-feeling leather is a hedonic attribute.

However, games are not like utility applications. In a word processor, the focus is on providing a productive and effective product that will provide the user with the optimum working environment. In games, however, the hedonic characteristics of a game is of critical importance to the game experience, as explained by Stråat and Verhagen (2018). Furthermore, they must also be constructive to a positive game experience, and be presented in cohesion with other characteristics. That said, the pragmatic aspects cannot be completely disregarded in game design. As identified by Stråat, Johansson and Rutz (2015) the game must be usable and provide the player with a working mode of interaction and the affordances to achieve their goals in the game. When these criteria are fulfilled, the player will be able to appreciate the "softer" values of the game, for example a deep and complex story.

That said, the interaction design and usability of the game, especially in terms of affordances, is not fully disconnected from the narrative. As will be explained in the following sections, there is a high level of interconnection between the hedonic and the pragmatic attributes of a game, and it is very difficult to completely disentangle them.

To summarize, it is critical that we consider the gap that exists between the designer's intended design and the design as interpreted by the player. This gap may cause the player to misunderstand how they should interact with the game, and could

potentially be devastating for the game experience. In order for to better understand how the hedonic and pragmatic aspects of the game are interconnected, we will continue this paper by discussing how game narratives can be used to provide interaction affordances to the player, while considering how the player situates their understanding of these affordances.

Affordances from Situation

Hassenzahl (2003) describes a concept called *user situation*. This describes the state of mind and level of knowledge the user has when they first encounter the system, in this case when the player first encounters the game. As mentioned by Kultima (2010) the game experience starts before the player even plays the game. The concept of the game helps set expectations on what the game will entail, and what type of game the player can expect. This places requirements on the game designer to account for variance in situation among the prospective users of the game. For example, some users may be very familiar with the basic premise of the game series or genre (say the *Bioshock* franchise or first-person shooters) whereas others have never encountered these things, or even games as a medium, before. It is therefore critically important that users be brought into a basic understanding of what the ground rules are for this type of game - for example if normal gravity applies or if bullets hurt. Additionally, some users may enter the game with preconceived notions from similar games (or even from the real world) which may or may not be true. The difference in user situation is partly what creates the gap between the intended and apparent product characters (Hassenzahl 2003). In essence, the player's situation is how they delimit their repertoire of character when trying to understand a game that they have just encountered.

Examining this in terms of affordances using Gaver's typology we find that players who are situated differently than intended by the designer of the game are more likely to find false affordances or to have affordances hidden from them. Simply put, they may not fully understand how to interact with the game, and this may have a strongly detrimental effect on their game experience. Games currently do significant work into bringing people into the gaming experience, called *onboarding.* This involves providing tutorials and tooltip help for actions, and letting players progressively become more skillful at playing the game. However, the situation of the player is constantly evolving as new parts of the game's character is revealed to them. Hence, the player's situation is ever mutable, and has a circular dependency with their repertoire of character. The process of understanding stems from many parts of the game, both pragmatic (such as user interaction and interfaces) but also from the hedonic parts of the game. Of particular interest to the hedonic aspect of games is the narrative, which provides us with a conduit into the player's own interpretation of the game, and allows us to help the player more correctly identify the game's affordances based on the content that is presented through the various media channels in the game.

Affordances from Narrative

This article takes a broad approach to the concept of "game narrative", and in order to describe how this broad narrative helps situate the player's understanding of the game's character, we will provide a framework by which the narrative of the game can be understood. To this end, we have applied Bordwell's theory of cognitive narrative (1985). In his theory, Bordwell presents two concepts, derived from Russian narrative formalism, that allow for a constructivist understanding of narrative: *fabula* and *syuzhet.* Fabula is defined as the perceiver's understanding of the narrative they have experienced, and syuzhet is described as the things that are actually shown to the perceiver of the narrative. In this case, the perceiver would of course be the player of the game. Bordwell describes how this interpretation of syuzhet to fabula is performed by the perceiver by the use of various *schemata*, which are made up of details. These details come from many sources, for example the design of costumes and set, the music used in the piece, what lines are spoken, and many other sources.

The details that in aggregate make up schemata are similar in construction to the various forms of what we call *indicators,* which are the markers that tell us what affordances are carried by a product. They are described by many researchers in forms such as story elements, environmental details, behaviors performed by AI actors, and sounds (Murray 2017; Fernández-Vara 2011; Lucat and Haahr 2015; Back and Dez 1996). They are also similar to what Norman (2013) calls *signifiers*.

Each indicator is an atom of presentation that conveys some sort of understanding to the player, especially when used in concert. Together, these indicators form *speech acts* as described by Cardona-Rivera and Young (2014) and as adapted from Searle (1969) and Austin (1955). A speech act is a statement of the game's state that provides the player with the information they need to form an understanding of what is happening in the game and how they can interact with the game. These speech acts in aggregate can be said to form micro-narratives (Jenkins, 2004) which are short snippets of narrative that together form the greater whole. As a whole, the collection of indicators can be referred to the syuzhet of the speech act, and in aggregate as the syuzhet of the micro-narrative.

The keen-eyed observer will have noticed that the fabula described by Bordwell (1985) is functionally similar to the apparent product character described by Hassenzahl (2003). The collection of indicators that are conveyed to the player is thus the carrier of character described by Hassenzahl. The syuzhet could be thought to be similar to Hassenzahl's intended product character, but it is important to note that the designer's intent is of core importance to Hassenzahl's concept. Conversely, the syuzhet is the actual collection of characteristics (or indicators, in our parlance) and exists independently of intent - it is simply the output of the design process. Although the components of the syuzhet are likely included with a certain intent, it is fundamentally different in that the intended product character may differ from the design as presented.

It should be noted that this view of narrative includes a broader spectrum than just the story directly told to the player in the game, but also includes the various assets that make up the syuzhet of the game as a whole. Thus, the narrative as perceived by the player is colored not just by the story that is told, but by all the components of the syuzhet. If we transpose Bordwell's (1985) perspective on syuzhet to games, and

apply our definition of indicators we can perceive that there are numerous things that affect the narrative as it is perceived. Thus, the narrative is perhaps best discussed as how it has been perceived by the user. This has previously been touched upon by Jenkins (2004) who described emergent narratives - i.e. the part of the narrative that arises as the player plays the game. Jenkinesean emergent narratives, however, do not take the player's perception into account. Calleja (2011) introduced a concept similar to emergent narratives, called the *alterbiography*, which is the player's experience of the game narrative as told from the player's perspective. This encapsulates the emergent nature of the game narrative and also accounts for how the player interpreted this emergent narrative. In other words, the alterbiography is the fabula of the game, as interpreted by the player. This is in contrast to the fabula itself, which is simply the interpretation of the syuzhet of the game. The key difference here is that the alterbiography can be construed as the actions the player chose to perform, whereas the fabula is the choices the players perceived as having available to them. This brings about the question of how the game signals that the game affords these choices.

Affordances for AI in Games

As previously mentioned in this article, the UX of games in general and AI in general has previously been touched upon by many authors, and has been addressed from many different perspectives. Based on the theory presented above, we propose that these theories can be organized according to the types of affordances for that they touch upon. The categories are as follows:

- Affordances from character
- Affordances from situation
- Affordances from narrative

These categories correspond to the headings of the previous sections, the theory of which will act as a framing for the research being integrated in the following sections. Each section will present relevant research into the UX of AI and games, as well as a set of heuristics relevant to that particular type of affordance.

Affordances from Character

Affordances from character deal with the affordances that arise from what the game signals to the player, or essentially the syuzhet of the game. As mentioned in the theory above, this may be induced from many sources, for example the appearance or behavior of NPCs within the game (Warpefelt 2015; 2016).

For this category of affordances, we have elicited the following design heuristics:

False affordances
This heuristic is based on a finding by Stråat, Rutz & Johansson (2015) who identified a lack in previous game heuristic systems. Essentially, the concept of false

affordances was found to be completely lacking in previous research. Stråat, Rutz & Johansson (2015) define the heuristic as follows:

> "[False Affordance] occurs when the player erroneously perceives that it is possible to interact with an object or area in a certain way. In most cases, the player learns how the interactive items and areas distinguish themselves from non-interactive, but in some cases, there is no difference. The problem is merely a bit annoying if the player eventually learns to recognize interactive graphics, but if it is inconsistent and remains throughout the game it becomes a major design issue."

Essentially, false affordances are a large source of consternation for players and can have a large negative effect on the game experience. Thus, AI artifacts need to be consistent and clear in how they signal affordances, and lack of clarity can be hugely detrimental. This creates a mismatch in the intended product character and the apparent product character as perceived by the player.

Visual complexity indicates importance

This heuristic draws on the work of Warpefelt (2016) who identified that a more complex visual representation of a NPC indicates that that NPC is more important to the game, compared to a NPC with less complex representation in the same game. For example, giving the NPC more elaborate clothing or gear, or making them bigger, indicates that they are somehow important and possibly a more substantial challenge if they are hostile. Conversely, faceless and less visually complex NPCs are likely to be less relevant to the larger story and may even be disposable enemies. Thus, a more complex NPCs affords more complex interaction and likely has more affordances than one with a simpler visual appearance.

Affordances from Situation

Affordances from situation deal with the affordances that arise from what the player brings with them into the magic circle of the game, and how that affects their interpretation of the game as presented. Essentially these are the affordances that are made accessible by the player's fabula. This is perhaps the most difficult type of affordance to control, but fortunately the player can to some extent be taught to situate things differently.

For this category of affordances, we have elicited the following design heuristics:

Values

This heuristic stems from the research of Smith (2017). In her paper, Smith critiques the implicit social values exhibited by systems for Procedural Content Generation (PCG) and calls for view on utility that go beyond the creation of capitalist value or making challenges in games. Instead, Smith advocates the creation of PCG artifacts that let us experience other perspectives on social issues (what she terms filter bubbles) and focusing less on challenge and difficulty, and more on reflective practice in mixed-initiative tools.

It is thus important that creators of AI artifacts consider what values the generative artifact professes, implicitly or explicitly. For example, how we treat violence in video

games (something discussed by Smith) or what we consider to be efficient behavior. The values signaled will also interact with how player situate the character of the game, by showing the characteristics of the game in a different light. Phrased differently, by espousing certain values the system can influence how the player interprets what they are being shown and thus alter their gaming experience.

Ludopolychotomy
This heuristic arises from the research by James and Fletcher (2015) and partly from the issues raised by Smith (2017). In their article, James and Fletcher describe how game preferences vary between cultures, with Americans, Europeans, and Asians seemingly preferring vastly different games. These different cultures will situate the character of games differently, and this will affect their gaming experience. Fundamentally, this is the other side to the *Values* heuristic - where that looks at how the player situates a game's character through the values espoused by it, this heuristic considers how the player's culture affects how they apply situate characteristics.

Affordances from Narrative

Affordances from narrative deal with the affordances that arise from the stories being told by the game. This may seem similar to affordances from character, but is different in that it deals with the ethereal narrative that is told as opposed to the actual syuzhet of the game.

For this category of affordances, we have elicited the following design heuristics:

Space for attention
This heuristic also draws from the work of Warpefelt (2016). In his research, he identified that NPCs that are intended to be found often have some kind of decorated or open space around them, which frames them as being of a certain role. In particular NPCs that provide services within the game, for example vendors or banking in a Role-Playing Game (RPG). This is essentially a specific case of environmental storytelling, as described by Fernández-Vara (2011) and the framing acts as an indicator that implies that the NPC is somehow interactable. It is likely that this also extends to other parts of the game, and covers more than NPCs, and is something that needs to be verified in further studies.

Speech acts
This heuristic draws from the research of Cardona-Rivera and Young (2014) and by extension on research done by Mateas (2001), Searle (1969), and Austin (1955). Cardona-Rivera and Young casts the interaction between the game and the player as a conversation, where messages are conveyed using speech acts. As previously mentioned, each speech act contains a number of indicators, and tells the user something about the character of the game, as well as possibly invoking narrative affordances. A narrative affordance is essentially an affordance that allows the player to modify their own narrative experience in the game, as described by Young and Cardona-Rivera (2011).

Put in the frame of AI artifacts in games, these speech acts are part of not only the behavior (including actual speech) of NPC, but also in the audiovisual design of the game. Everything in the game will contribute to these speech acts, and AI artifacts are no exception. Hence, it is important that AI artifacts contribute to the overall speech acts that are being conveyed by not presenting discordant or confusing indicators to the user. By failing to be in coherence with the rest of the design, AI artifacts can cause the player to interpret the micro-narratives (and by extension, entire narrative) of the game differently, and thus cause them to misinterpret affordances that are intended to be signaled.

Conclusions, Discussion, and Future Work

As shown in this paper, it is possible to understand the UX of AI for games based on how the narrative colors our perceptions of the affordances we find in games. In essence, AI artifacts in the game must contextualize, and be contextualized, by other content in the game, and must be designed so that they are conducive to a positive game UX. AI technologies offer many strong and distinct advantages for game development, and can enable game developers to create new and diverse experiences with comparatively little effort. However, a cohesive design vision is, as always, paramount for the success. Thus, this is not a problem where we can blindly apply technology in the hopes of finding a magical solution. Instead, the application of AI technologies needs to be carefully considered and applied with thought to how the technology will support the UX of the game. Building a game solely around the existence of AI technology is likely a recipe for disaster, as we have seen in recent years with the audience backlash against games with an over-reliance on generative content, such as *No Man's Sky* (Hello Games, 2016). The generative nature of a game cannot be a feature in itself, but instead act as a support for a deeper or richer gaming experience, and with care taken to not disrupt the UX of the game.

The typology of heuristics presented in this paper should help avoid some of the problems associated with generative content and AI-based content in games. Note that we make no claim at our typology being complete or exhaustive - we fully acknowledge that it is a small start to a grand project. The typology also intentionally covers a large spread of different characters, and provides insight into vastly different areas of the gaming experience, by bridging and contextualizing the various theories that exist within the field of games AI. The typology is still largely a theoretical construct (even if some of the source material is based on empirical studies) and thus needs to be verified further. In future studies, we aim to empirically verify the heuristics presented above, and utilize them to implement AI technologies in games, in particular focusing on improving the social experience of the game.

The theoretical framework and the affordance heuristics presented in this paper provide us with the tools we need to better understand how to apply these technologies, and help us understand what the pitfalls need to be avoided to not damage the game experience for the player. By starting from the perspective of the player's experience, seen through the lens of the player's narrative, we can better understand the effects these technologies have on the end result - namely the player's game experience.

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