Understanding Pervasive Games through Gameplay Design Patterns

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ABSTRACT
This paper reports on a cluster analysis of pervasive games through a bottom-up approach based upon 120 game examples. The basis for the clustering algorithm relies on the identification of pervasive gameplay design patterns for each game from a set of 75 possible patterns. The resulting hierarchy presents a view of the design space of pervasive games, and details of clusters and novel gameplay features are described. The paper concludes with a view over how the clusters relate to existing genres and models of pervasive games.

Author Keywords
Pervasive Games, Game Design, Gameplay Design Patterns

INTRODUCTION

Examples of games that challenge the traditional notions of games have lately become increasingly common: *Botfighters* [44] allows players to chase each other in order for their virtual robots to duel; the live-action role-playing game *Prosopopeia* [19] casts players as themselves possessed by ghosts for a month; *Can You See Me Now?* [4] lets players' avatars chase hired performers in the real world; and *GeoCaching,* a treasure hunt where players hide and seek caches using GPS coordinates. These games, which typically use communication or information technology to provide gameplay, are only samples of a new type of games that offers novel experiences to players and often makes the act of playing part of other activities.

Although commercial ventures have created several of these new games, e.g. *Mogi Mogi* [25] and *Botfighters*, most examples come from various different research fields and have therefore been given many different names, e.g. ubiquitous computing games [7], pervasive games [34], and mixed reality games [14]. As reported by Nieuwdorp [37], no consensus regarding the ontology of these games can be said to exist and that a differentiation between technological and cultural perspectives of pervasiveness may be necessary. However, for the purpose of collecting all these games under a common heading the motto "anytime, anyplace" from pervasive computing [17] can be adopted to signify the concept of pervasive games.

Designing any type of game is typically a demanding task but for pervasive games this is increasingly so since the design area is new and unexplored. Part of being able to design a game comes from understanding what can be done through knowledge of previous work, something which can be described as knowing the field's design space. This paper reports on a bottom-up approach, taken with the goal of understanding pervasive games, based upon explicit game examples.

Avoiding definitions of games, some top-down approaches to understand games and differentiate between them are relevant to set the context of studying pervasive games. Looking at video games, Wolf [53] reports 42 overlapping genres based upon interactivity but does not provide support for understanding the relation between genres and why overlaps occur. Exploring pervasive games specifically, Montola [34] uses spatial, temporal and social expansions as the game type's defining characteristics. These aspects of pervasive games could offer a basis for understanding the design space. However, the three different characteristics are not orthogonal (they "tie in" with each other) and additional characteristics could arguably be added (e.g. interaction [10] or technology [37]). Furthermore, they do not explicitly use the specifics of any game's gameplay which would restrict the feasibility in supporting design processes.

METHOD

Instead of basing an exploration of pervasive games on theoretical models such as the ones described above, a decision was made to take a grounded approach. This would allow the understanding of the design space to rely on observable gameplay characteristics from sample games. By doing so the design space would support design work through giving examples of important gameplay characteristics once games relevant to a design had been identified. To further support design, clusters of similar

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games can then chart regions of the design space between the specific examples. However, the use of gameplay here does not include all aspects of the activity of playing a game. Rather, we use the definition "the structures of player interaction with the game system and with the other players in the game" [9].

This method of understanding games through clustering is very similar to Latent Semantic Indexing [1] and Latent Semantic Analysis [41], methods used to study texts. For texts, these methods can make use of the presences of words (or rather their stems) as text characteristics. For games, a similar way of identifying characteristics was needed that was based upon gameplay. Gameplay design patterns [8] fit this requirement, being a way of documenting gameplay characteristics that had been used to find ~300 common gameplay characteristics [9]. Although these patterns provide a basis for having sufficiently many characteristics to create distinct "fingerprints" for each game, the process of determining their presence cannot be automated. Thus, a phase of manual pre-processing of the games was introduced.

The following activities constituted the specific phases of the work method. The work progressed through iterating between these phases although how phases followed each other depended on the current state of the collection. All games and patterns examined will not be discussed due to space limitations, nor will references be given to commercial games.

Identifying Example Games

The initial set of games came from a report on gameplay design patterns for mobile games [15]. This report included 40 games with a basis in mobile phone games (e.g. *Snake* but also mobile phone versions of games like *Prince of Persia – Sands of Time* and *Tom Clancy's Ghost Recon: Jungle Storm*), portable console games (e.g. *Donkey Kong*, *WarioWare, Inc*), and PDAs (e.g. *PacMan Must Die!* [42]). Taking mobility in a more general perspective than just handheld information technology the set also included augmented reality platforms (e.g. *AR-Quake* [46], *Human PacMan* [13]) and games using custom-built systems and technologies (*MyTHeme* [26], *Backseat Playground* [11], *Tim's World*, *Uncle Roy All Around You* [3], *Can U See Me Now?*). For games such as *Killer Virus*, *Mogi Mogi* [25], *Botfighters*, and three Photophone Entertainment games: *Storyteller*, *Colorado*, *Mosaic* [47], their use of sensors makes them fit within both the category of mobile phone games and pervasive games. Similarly, the Gameboy Advance game *Boktai* uses a daylight sensor and can therefore be categorized as a pervasive game. Only one game was removed; *Supafly* which turned out to be vaporware.

Additional Examples

The focus on pervasive games led to a significant increase in the number of games studied. This included games predating the previous report, e.g. *Pirates!* [6], *Real Tournament* [32], and *Songs of the North* [23], but also several games developed recently, e.g. *M.A.D. Countdown* [52], *Hitchers* [5], *Feeding Yoshi* [2], *Prosopopeia I* [19] *& II*, *Epidemic Menace I* [38] *& II*, and *Insectopia* [40].

Some of the chosen games required players to be in certain places similar to non-pervasive games, but made use of unusual interfaces and locations, e.g. *Toilet Entertainment System* [48] and *You're in control: a urinary user interface* [29]. Likewise, many games required a physical game board but made use of pervasive (or ubiquitous) computing technology through sensors, e.g. *PingPongPlus* [21], *MINDWARPING* [45], *False Prophets* [28], *Brainball* [20], *KnightMage* [27], *TARBoard* [24], and *Wizard's Apprentice* [39].

In some cases games were added that were not seen as pervasive games. This was to provide potential clustering candidates for newly identified patterns which either would quickly merge into an "ordinary game" cluster or they would cluster with a pervasive game and provide a challenge to differentiate the pervasive game from the "ordinary" games. Examples of such games included web based games like *The ESP game* [49], *Peekaboom* [50], and *Phetch* [51] but also games such as *World of Warcraft*, *Wii Sports*, and *Grand Turismo*. This use of non-pervasive games, and in some cases activities that can be argued if they are games at all (e.g. *Whirling Dervishes* [30], *Virku* [33] and *Parkour*), is in line with Wolf's approach for video game genres, where he included examples with game-like elements but were not clear-cut games.

Acknowledging the difference between pervasive games and games using pervasive technology (as argued for by [35] and described by [37]) several games not using technology were among the example games. Specifically, the game *Killer* [22] (also known as *Circle of Death* or *Assassin* and later popularized as *DeathGame*) and the *Mind's Eye Theatre* rule set for vampire live-action role-playing was used.

Identifying Gameplay Design Patterns

Similar to the example games, the initial patterns was taken from the gameplay design patterns for mobile game report [15]. This report had identified 24 new patterns.

Unsurprisingly, several of the new patterns were related to proximity (*Player-Location Proximity*, *Artifact-Location Proximity*, *Player-Player Proximity*, *Player-Artifact Proximity*, and *Artifact-Artifact Proximity*), or navigation (*Physical Navigation, Player Physical Prowess*, and *Configurable Gameplay Area*). The changes in social setting for the games compared to ordinary games revealed patterns existing in most games (*Social Rewards*, *Common Experiences*, *Unmediated Social Interaction*, and *Social Skills*), necessity to support social interaction (*Chat Forum*) or managing play sessions (*Interruptible Gameplay* and *Late Arriving Players*). The possibility of the game ownership being spread between players spawned several patterns (*Heterogeneous Game Element Ownership*, *Game Element Trading*, and *Memorabilia*).

The research area of *Augmented Reality* was directly adaptable as a pattern besides generating the more specific pattern *Hybrid Space*. The remaining patterns depended on sensory input in some form (*Extra-Game Input*, *Coupled Games*, and *Real Life Activities Affect Game State*).

Wanting to focus upon the pervasive aspects of pervasive games, these new patterns were chosen as the starting set of gameplay design patterns. One pattern, *Pervasive Games*[1], was removed since having it present to some level was a prerequisite for games to be in the example set.

New Gameplay Design Patterns

There was a given assumption at the start of the process that new gameplay design patterns would be identified given that the set of example games had been expanded and the focus shifted towards pervasive games. Some patterns were more or less implicitly suggested by the games' designers through their descriptions. This was the case when design goals or gameplay characteristics were clearly described e.g. *Crossmedia Games* [38], *Seamful Games* [12], and *Self-Reported Positioning* [3]. All three of these concepts became patterns although the two first ones were renamed (*Crossmedia Gameplay* and *Seamful Gameplay*) to distinguish that a gameplay characteristic was indicated and not a genre of games.

Others were taken from concepts already in use in academia, e.g. *The Rabbit Hole Invitation* (c.f. [36]). Refinement of the granularity of patterns led to the identification of *Player-Avatar Proximity* through interaction between the proximity patterns and *Hybrid Space*.

As is the usual case when creating pattern collection, several pattern suggestions were removed. For example, the pattern candidate *Player-Driven Gameplay System* was identified as being the inverse of the already existing pattern *The Show Must Go On*.

Several pattern candidates needed to be changed (and merged) to fit the criteria of being gameplay related. For instance, the suggested patterns *Raise Awareness of Technology Penetration* and *Understanding the Hidden Context* did not directly relate to gameplay but rather to the overall experience of playing the game and the game designers' intentions. However, players who learn from the intended experiences that the patterns imply can have advantages in a game based upon those experiences which allowed the synthesis of a new pattern, *Real World Knowledge Advantages*, that incorporates the gameplay related aspects of the other patterns.

[1] Defined as "The play session coexists with other activities, either temporally and spatially."

Identifying Relations between Patterns

As part of identifying new pattern candidates, the relations between patterns were explored. In some cases this led to merging of overlapping candidates (e.g. *Interruptability* with *Interruptible Gameplay* and *Incorporating Game Activity into Other Activities* with *Activity Blending*) while in other cases more general patterns were found (*Social Adaptability* as a parent pattern to *Possibility of Anonymity*, *Actor Detachment*, *Minimalized Social Weight*, *Decontextability*, and *Activity Blending*; *Critical Gameplay Design* as parents to *Gameplay Changes Perception of Real World Phenomena*).

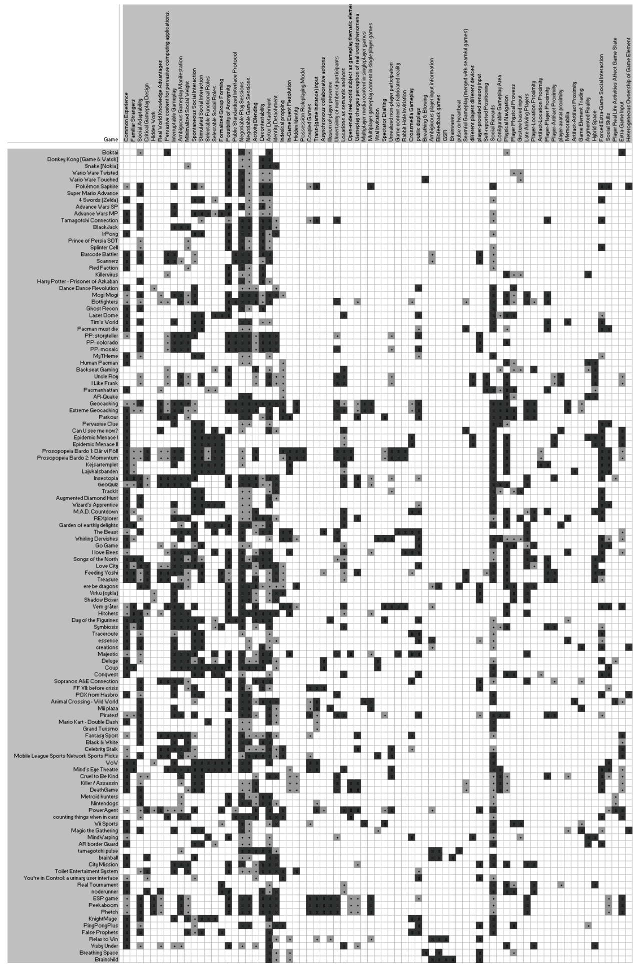

Figure 1: The game and pattern collections with correlating presences mapped.

The act of identifying more abstract patterns which were instantiated by other patterns can be likened to the clustering of games. However, the relations between patterns form a graph structure instead of a hierarchical tree structure, and do therefore not lend themselves directly to clustering algorithms.

Scanning Specific Games for Presence of Patterns

The first step after adding a game to the samples was to go through all patterns to determine which were present. To allow a certain level of granularity strong, weak, and no presence was used. Whenever possible people involved in the design process of the example games, or directly knowledgeable about it, were asked to describe the games and shown the current state of the analysis (examples of games where this happened include *Prosopopeia* [19], '*Ere be Dragons* [16] and *Symbiosis*). Due to the highly iterative process, with patterns continuously being added or revised, several informal discussions were preferred over recorded interviews. Besides providing valuable information on the game designs these discussions led to several patterns being added, e.g. *In-Game Event Resolution* and *Hidden Identity*.

Due to the introduction of new patterns, the redefinition of patterns, and the new insights gained through studying new found descriptions of games, it was a practically impossible to guarantee that all games were up to date at all times. As a method to address this shortcoming, games that had few identified patterns were re-examined whenever the set of patterns changed. The hypothesis behind this approach was that a low pattern count was an indication of that game needing more detailed study. This line of reasoning was latter encouraged when an identified cluster was primarily characterized by low pattern counts in all its' example games, and that cluster disappearing after re-examination of those games.

Scanning Specific Patterns for the Presence in Games

To supplement the scans of games with low pattern count, patterns with a low game count were re-examined as well. Besides supporting the consistency of the relations between patterns and games, this enforced stricter definitions of the patterns as previously unknown aspects were brought into the limelight.

Running the Clustering Program

The pattern and example game data was clustered using a custom built program which took an XML-based file as input and produced the result in the same format. This allowed for running the program iteratively starting with a low clustering threshold, increasing it with each run and naming clusters as they appeared.

The clustering program was run iteratively, slowly increasing the threshold values. By looking at the suggestions for clusters, simple hypotheses were created that could either be accepted or rejected based upon the available descriptions of the games. When the cluster was rejected it provided two immediate questions:

- Is the presence and absence of patterns given for the games correct?
- Is the difference between the games due to a previously unrecorded pattern?

The first question helped catch possible inconsistencies due to the shifting sets of patterns and games. While few clusters existed, this was done through going through all patterns but as the number of clusters grew (or rather, as most examples became part of the biggest cluster) differences to other clusters could be used as well. Whenever this led to changes in the relations between patterns and games the clustering was restarted as other clusters may be affected. A specific such example was when changes in *Black Jack* and *Black & White* resulted in a new cluster being formed (*Collecting Games* from the clusters *Picture Input Games* and *Barcode Games*).

Naming Clusters

An interim name was given to each cluster as soon as it was suggested and accepted. This was done without observing which patterns were dominant to encourage hypotheses of similarities independent of specific gameplay patterns. Instead game mechanics (that could have been described as non-pervasive gameplay design patterns), genres, used technology, and social aspects were the primary concepts behind cluster names. In one case, *Blast Theory games*, the cluster name was the artist group behind the games' designs (but not all the groups' games did belong to this cluster). Unless this naming strategy had consciously been enforced the cluster names would simply have become logical combination of the most characteristic patterns.

Basically, each cluster name was a hypothesis about what was its' core aspect. When the program suggested a cluster with an individual game this raised the question if the cluster name also described the new game. Whenever this was the case, a greed approach was applied and the game was simply added to cluster. Whenever the game did not fit this indicated that a novel and larger cluster was needed. The same approach was used for smaller clusters against larger clusters.

Stop Criterion

Given that the iterative process could continue indefinitely as new patterns were identified and new games discovered, a stop criteria was used that depended on several sub criteria.

The first criterion was that all known games with interesting pervasive qualities had been analyzed. Since new examples easily could be harvested through references in academic descriptions of games this criterion was not enforced when sufficiently similar games already existed in the analysis.

The second criterion was that no games or patterns needed to be re-analyzed. The number of games and patterns that needed this constantly shrank during the process providing feedback that the analysis was stabilizing.

The third and final criterion was that no strange clusters existed. In this context, strange meant that it was difficult to name the cluster or that the cluster was primarily identified through references to the process itself (i.e. the cluster candidate *Low Pattern Count*). Related to this criterion was that the cluster names should be meaningful. The reason for this was that as the number of clusters became fewer, the naming of merged clusters tended to become more and more generic to the point where they said little about the games they contained.

Observations during Iterations

The clustering result was volatile. For example, at one point several patterns candidates were incorporated (of whom most were eventually rejected) based upon an evaluation of *Insectopia*. This led to that game temporarily being the most distinct as the patterns were detected from that game and therefore were guaranteed to exist in that game but not in other games.

COLLECTED DATA

The final data collection held a total of 120 games and 75 patterns of which 53 were new. The average number of patterns for a given game was 16 with a low of 5 and a high of 33. The average number of games that a pattern was represented in was 25, with 2 and 98 as minimum and maximum respectively.

Three levels of pattern presences were used: none, weak and strong. This was to acknowledge the fact that the presence of patterns in a game never is a dichotomy between true and false but rather a continuous grade and in many cases it is more feasible to discuss a pattern's impact on the overall gameplay rather than whether it is represented or not.

A first initial analysis of pattern presence in all games showed that the top patterns *Negotiable Play Sessions*, *Actor Detachment*, and *Common Experience* held their dominating positions through the entire clustering. However, other patterns that were seen in many games became much less prominent after clustering indicating that many although these patterns existed in many games, their presence was weak and other more fundamentally used patterns survived the clustering.

CLUSTER ANALYSIS

With the iterative approach that the program utilized, it was easy to follow how new clusters were created and already existing clusters grew. Games with few pervasive components, often none except being portable, quickly clustered together and formed the base for the cluster *Normal Games*. At the end of the clustering process several large clusters formed. The largest of these became *Obvious Games*, games where it is obvious for both the player and non-players that a game is being played. An example of a cluster were this was not the case is *Location Based Games*, where playing the game may not be detected simply because players' movement fit in with other types of movement. Both these clusters later became parts of *Aware Input Games* signified by the gameplay potentially being undetectable bystanders but players were aware of how they interacted with the game, something which could not be said for all other clusters, e.g. *LARP ARGs*. It should also be mentioned that a number of games which intuitively seemed to belong together did not end up in the same clusters. The most notable examples were games that utilize mobile phone cameras to generate content to the game which ended up to two separate clusters, *Picture Input Games* and *City Camera Games*.

It is interesting to note that some clusters contain games with an obvious relation that still took a significant threshold to be clustered together, and did so without any other games being part of that cluster. For example, although *Killer* [22] and *DeathGame* quickly were clustered together, the structurally similar game *Cruel 2 B Kind* by McGonigal and Bogost was first added to the cluster after other clusters had tens of members and less than 30 individual samples existed. This strengthened the hypothesis that the common denominator of the cluster was the Killer gameplay style. In the same fashion, the game *Vem Gråter* was added very late to the *LARP ARGs* cluster further confirming it.

The most distinct cluster, i.e. the cluster that last was merged with all other examples, was *GPS Games* with *LARP ARGs* as runner up.

Notes on Specific Clusters

To understand the clustering in more detail individual examinations of clusters were performed when the clusters had been finalized. Below the two most distinct clusters are described to exemplify the results obtained in this fashion.

GPS Games

GPS Games was separated from the cluster consisting of all other games through a strong presence of a small set of patterns that was very weak or non-existing in the other clusters. Among these was the use of *Indexical Propping* and *Player-Location Proximity*, but also the support for *Late Arriving Players* and *Memorabilia*. At the same time, the large cluster had a strong presence of patterns that had to do with social interaction, both inside and outside the games, something which the *GPS Games* cluster lacked.

LARP ARGs

There are several reasons for the cluster to be one of the most distinct. Alternate reality games tend to blur the presentation of the game to non-players so they do not know that a game is being played, and this was reflected with strong presence of *Unrealized Non-Player Participation*, *Game Context as Fabricated Reality*, and *Rabbit Hole Invitation* (of which only *Game Context as Fabricated Reality* was also present in the *ARG* cluster). The games in question also had a clearly developed design goal of *Critical Gameplay Design*. Although the *LARP ARGs* cluster shared very strong presence of *Indexical Propping* and *Hidden Identity* with the *GPS Games* cluster, its additional presence of patterns like *In-Game Event Resolution* and *Possession Role-playing Model* kept them from merging.

Notes on New Gameplay Design Patterns

As has been shown, the process proved to be fruitful regarding the identification of new gameplay design patterns. Naturally most of these dealt with pervasive aspects but, as was the case for game design patterns that came from earlier work [15], several patterns (e.g. *Social Adaptability* and *Real World Knowledge Advantages*) were highly relevant for pervasive games in general.

surprising that many games still clustered with games that featured the same game mechanics e.g. *Predict Games* or *CCGs*[2], even though these mechanics were not present in the form of gameplay design patterns. This suggests that the game mechanics used in the games manifested themselves

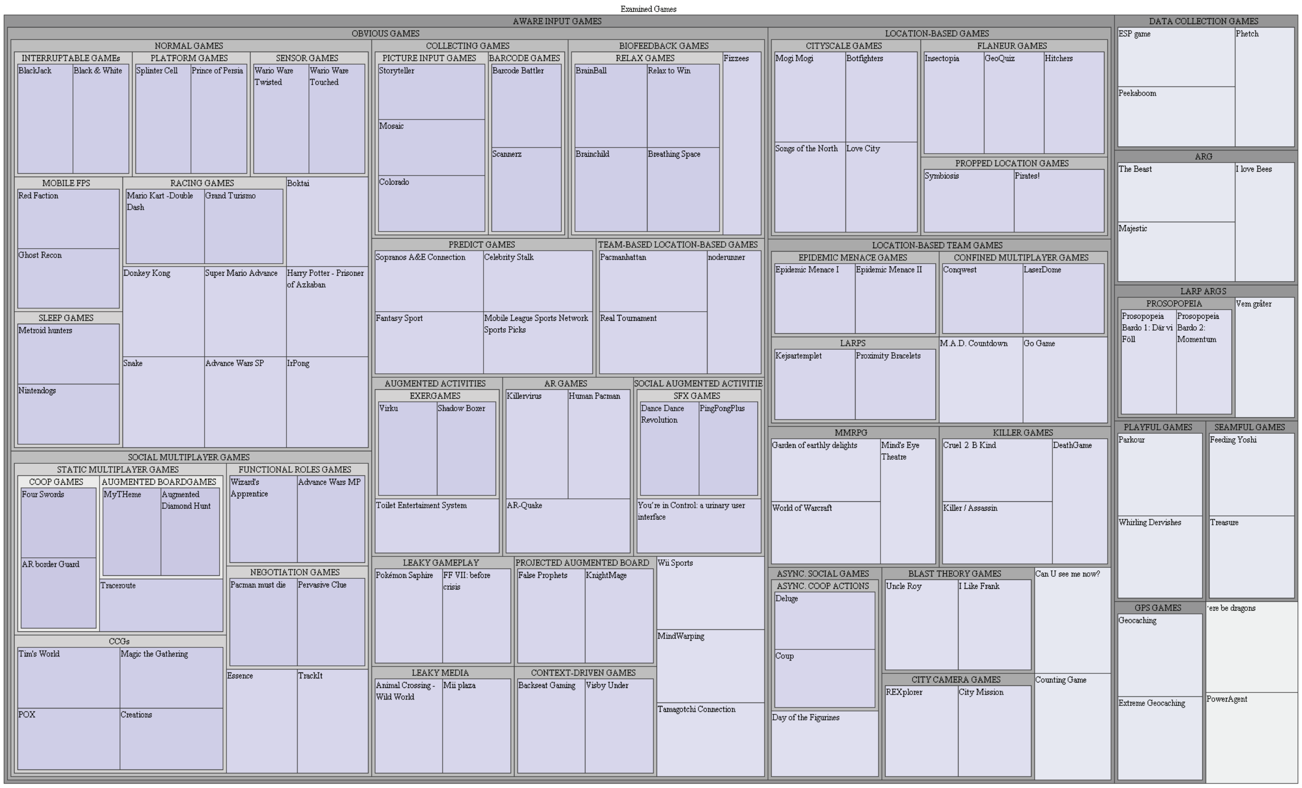

Figure 2: A Treemap visualization [43] of the identified clusters and examined games.

In some cases groups of patterns could easily be seen as being part of a common concept without that concept fitting as a pattern. For example, several patterns have relations to the concept of *Serious Games* (c.f. [31]) but this is not directly suited as a gameplay design pattern; the concept points to the use of games for another purpose than entertainment rather to details of gameplay.

The pattern *Critical Gameplay Design* comes from *Critical Design* [18] within Interaction Design. Although critical design can most easily be realized through thematic aspects, the examples given to describe the concept are based on interaction. Given that gameplay is a form of interaction this makes the concept feasible as a gameplay design pattern, especially since the thematic aspects can be integral to the design through the use of artifacts and people in the real world.

DISCUSSION

The clustering did not use the existing collection of gameplay patterns distilled from ordinary games. Therefore the expectation of the clustering was that games would be mainly clustered together by similarities in pattern presences dealing with pervasive aspects. It was therefore

as dynamics in the pervasive patterns, something which can also explain why games built upon the camera functionality of mobile phones did not end up clustered – they simply did not share the same game mechanics.

Although the presented clusters form a hierarchy, they are unsuitable as a basis for interaction-based genre definitions. Like Wolf's genres, the clusters do overlap but more importantly they do not represent the whole gameplay correctly since they are based primarily upon gameplay design patterns related to pervasiveness. That given, there are overlaps between the identified clusters and potential genres. Some clusters, e.g. *Racing Games*, *CCGs* and *Platform Games*, clearly map to existing genres but other clusters point towards new areas of the design space of games, e.g. *Flaneur Games* and *Predict Games*. In this perspective the clusters have more in common with the three expansions proposed by Montola [34] in that they describe various aspects of pervasiveness. Looking at the largest clusters, *Aware Input Games* and *Obvious Games*, these both relate to blurring of the social boundaries of

[2] Collectable Card Games.

games. Similarly, smaller clusters can easily be correlated to temporal blurring (e.g. *Asynchronous Social Games* and *Social Augmented Activities*) or spatial blurring (e.g. *Location-Based Games* and *GPS Games*). However, these clusters do not neatly organize into larger clusters related to the same type of expansion, a possible indication of the interrelationship of the expansions. The clusters can also be seen as an argument for Nieuwdorp's distinction between perspectives of technology and culture since clusters can in many cases be partitioned into one or the other, e.g. the technology-oriented *AR Games*[3] and *GPS Games* or the culture-oriented *ARG*.

It could very well be that pervasive genres run vertically across already established horizontal genres such as Gambling or Target. One could argue that a layer of pervasiveness could be given to a game of any genre and at the same time say that a pervasive game still needs to have non-pervasive game mechanics in order to function as a game. This means that designers of pervasive games can re-use their knowledge from other types of games given keys into how pervasive gameplay relate to these.

The analysis cannot be said to be objective since patterns were probably more likely to be detected in games specifically designed to explore the design space of pervasive games. Also, the amount of information of the games can have affected the process, i.e. games which have been reported in academic contexts usually provided more patterns than others. Still, the clustering does point to differences and similarities possible in pervasive games. As such they chart the design space of the pervasive aspects of games by providing specific examples and identifying those games that are within their immediate proximity. More interestingly, the examples point out the voids between them, i.e. the areas which have not yet been explored are expressible through their neighbors in the design space. By doing so, clusters and gameplay design patterns can offer to provide keys for design of pervasive gameplay.

CONCLUSIONS

We have presented a cluster-based view of pervasive games based upon gameplay design patterns. Clustering the data set to form hierarchal groups proved to create clusters that were intuitively logical and were possible to map to models of games based upon genres, expansions, and perspectives. We argue that the view displays a design space of pervasive games which is possible to navigate through the specific examples games as well as the regions defined through clusters. The created clusters also reinforce previous research that pervasive games need to be understood through many different characteristics. Further, the mosaic nature of the clusters indicates that pervasive games may best be understood as a complex property of games rather than a genre of games.

[3] Augmented Reality Games.

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REFERENCES

Due to the large number of games referred to in the paper, only references to those described in academic texts are given.

1. Barry, M.W., & Fierro, R.D. (1995). Low-Rank Orthogonal Decompositions for Information Retrieval Applications. Numerical Linear Algebra with Applications 3:4 (1996), pp. 301-328.

2. Bell, M., et al. (2006). Interweaving Mobile Games with Everyday life. In proceedings of CHI 2006.

3. Benford, S., et al. (2004). Uncle Roy All Around You: Implicating The City In A Location-Based Performance. In proceedings of ACE 2004.

4. Benford, S., et al. (2005). Can You See Me Now? ACM Transactions on Computer-Human Interaction, vol. 13 (1), pp. 100-133, 2005.

5. Benford, S., et al. (2006). Hitchers: Designing for Cellular Positioning. In proceedings of UbiComp 2006.

6. Björk, S., et al. (2001). Pirates! - Using the Physical World as a Game Board. In proceedings of Interact 2001.

7. Björk, S., et al. (2002). Designing Ubiquitous Computing Games - A Report from a Workshop Exploring Ubiquitous Computing Entertainment. In Personal and Ubiquitous Computing, Volume 6, Issue 5-6, pp. 443 - 458.

8. Björk, S., et al. (2003). Game Design Patterns. In proceedings of DiGRA 2003.

9. Björk, S. & Holopainen, J. (2004). Patterns in Game Design. Charles River Media.

10. Björk, S. (2007 Forthcoming). Illuminating Cracks and Drawing Illusionary Lines – Changing Urban Perspectives through Pervasive Games. In Borries, F. von, et al. (eds.) (2007), Space Time Play. On the Synergy Between Computer Games, Architecture, and Urbanism, Birkhäuser Publishing, Basel Boston Berlin.

11. Gustafsson, A., et al. (2006). Believable environments: generating interactive storytelling in vast location-based pervasive games. In proceedings of ACE 2006.

12. Chalmers, M., et al. (2005). Gaming on the Edge: Using Seams in Ubicomp Games. In ACE 2005, Valencia, Spain.

13. Cheok, A. D., et al. (2004). Human PacMan: A mobile, wide-area entertainment system based on physical, social, and ubiquitous computing. In Personal Ubiquitous Computing 8, 2 (2004), 71-81.

14. Crabtree, A., et al. (2004). Orchestrating a Mixed Reality Game ‘On the Ground’. In proceedings of CHI 2004.

15. Davidsson, O., et al. (2004). Game Design Patterns for Mobile Games. Project report to Nokia Research Center, Finland.

16. Davis, S.B., et al. (2006). ‘Ere be dragons: heartfelt gaming. Digital Creativity. 7 (3) 2006.

17. Dordick, R. (1998). The Convenience of Small Devices. How Pervasive Computing Will Personalize E-Business. Interview with Mark Bregman in IBM Think Research, no. 3, 1998.

18. Dunne, A. (1999). Hertzian Tales: Electronic Products, Aesthetic Experience and Critical Design. RCA Computer Related Design Research.

19. Jonsson, S., et al. (2006). Prosopopeia: Experiences from a Pervasive Larp. In ACE 2006.

20. Hjelm, S.I. (2003). The making of Brainball. Interactions 10, 1 (2003), 26-34.

21. Ishii, H., et al. (1999). PingPongPlus: Design of an athletic-tangible interface for computer-supported cooperative play. In proceedings of CHI’99, pp. 394–401.

22. Johnson, J.W. (1981). A Scholar Looks at Killer. Afterword in Jackson, S., (1998) The Game of Assassination, Steve Jackson Games, 1998.

23. Lankoski, P., et al. (2004). A case study in pervasive game design: the songs of north. In proceedings of NordiChi 2004, pp. 413 – 416, Tampere, Finland.

24. Lee, W., et al. (2005). TARBoard: Tangible Augmented Reality System for Table-top Game Environment. In proceedings of the PerGames Workshop 2005.

25. Licoppe, C. & Inada, Y. (2005). "Seing" one another onscreen and the construction of social order in a mobile-based augmented public space: The uses of a geo-localized mobile game in Japan. In: Proceedings of Learning in the Mobile Age Conference 2005.

26. Lundgren, S. & Björk, S. (2005). Forces, Clashes and Remnants: a Model for Event-Driven Iterative Multidisciplinary Game Design. Short paper at ACE 2005.

27. Magerkurth, C., et al. (2004). Towards the next generation of tabletop gaming experiences. In Graphics Interface 2004, pp. 73-80.

28. Mandryk, R.L., et al. (2002). False prophets: Exploring hybrid board/video games. In Extended Abstracts of CHI 2002, pp. 640-641.

29. Maynes-Aminzade, D. & Raffle, H. (2003). You’re in Control.: a urinary user interface. In extended abstracts of CHI 2003, pp. 986 - 987.

30. McGonigal, J. (2005). Supergaming! Ubiquitous Play and Performance for Massively Scaled Community. Modern Drama. Special Issue on Technology. Ed. W.B. Worthen. 48:3 (Fall 2005) 471-491.

31. Michael, D. & Chen, S. (2005). Serious Games: Games That Educate, Train, and Inform. Course Technology PTR.

32. Mitchell, K., et al. (2003). Six in the City: Introducing Real Tournament – A Mobile IPv6 Based Context-Aware Multiplayer Game. In proceedings of Workshop on Network and system support, pp. 91-100, 2003.

33. Mokka, S., et al. (2003). ‘Fitness computer game with a bodily user interface’, Proceedings of ICEC 2003, pp. 1-3, Pittsburgh, Pennsylvania, May 8–10, 2003.

34. Montola, M. (2005). Exploring the Edge of the Magic Circle. Defining Pervasive Games. In DAC 2005, Copenhagen, Denmark.

35. Montola, M., et al. (2006). Domain of Pervasive Gaming, Public IPerG Deliverable D5.3b. Available for download from http://iperg.sics.se (last visited 20070227).

36. Montola, M. & Waern, A. (2006). Participant Roles in Socially Expanded Games. In PerGames 2006, , Dublin, Ireland.

37. Nieuwdorp, Eva. (2007). The Pervasive Discourse: An Analysis of the Use and Definitions of the Term 'Pervasive' in Games Research. In ACM Computers in Entertainment, January 2007.

38. Ohlenburg, J., et al. (2006). Report about the Crossmedia Game Epidemic Menace. In proceedings of 3rd International Workshop on Pervasive Gaming Applications, Dublin, Ireland, 2006.

39. Peitz, J., et al. (2006). A. Wizard’s Apprentice - gameplay-oriented design of a computer-augmented board game. Paper at ACE 2006.

40. Peitz, J., et al. (2007 forthcoming). Insectopia – Exploring Pervasive Games through Technology already Pervasively Available. Forthcoming paper at ACE 2007.

41. Quesada, J.F., et al. (2001). A Computational Theory of Complex Problem Solving Using the Vector Space Model (part I): Latent Semantic Analysis, Through the Path of Thousands of Ants. In Cañas (Ed.) Cognitive research with Microworlds, pp. 43-84, pp. 117-131.

42. Sanneblad, J., & Holmquist, L.E. (2003). Designing Collaborative Games on Handheld Computers SIGGRAPH 2003 Sketches and Applications.

43. Shneiderman, B. (1992). Tree visualization with tree-maps: 2-d space-filling approach ACM Transactions on Graphics, Volume 11, Issue 1, pp. 92-99, 1992.

44. Sotamaa, O. (2002). All the World’s a Botfighters Stage: Notes on Location-based Multi-user Gaming. In

proceedings of Computer Games and Digital Cultures Conference, 2002.

45. Starner, T., et al. (2000). MINDWARPING: Towards creating a compelling collaborative augmented reality game. In IUI 2000, pp 256–259.

46. Thomas, B., et al. (2000). ARQuake: An Outdoor/Indoor Augmented Reality First Person Application. In Wearable Computers 2000, pp 139-146.

47. Thoresson, J. (2003). Photophone Entertainment. In extended abstracts of CHI 2003, pp. 896–897.

48. Thoresson, J. & Stenberg, P. (2003). The toilet entertainment system. In extended abstracts of CHI 2003.

49. von Ahn, L. & Dabbish, L. (2004). Labeling images with a computer game. In CHI 2004, pp. 319 – 326.

50. von Ahn, L., et al. (2006). Peekaboom: a game for locating objects in images. In CHI 2006, pp. 55 – 64.

51. von Ahn, L., et al. (2006). Improving accessibility of the web with a computer game. In CHI 2006, pp. 79-82.

52. Walz, S.P. (2005). Constituents of Hybrid Reality: Cultural Anthropological Elaborations and a Serious Game Design Experiment merging Mobility, Media, and Computing. In Buurman, Gerhard M. (Ed.): Total Interaction. Theory and Practice of a New Paradigm for the Design Disciplines. Basel: Birkhäuser. pp. 122-141.

53. Wolf, M.J.P. (2000). Genre and the Video Game. In Wolf, M.J.P. (Ed.) The Medium of the Video Game, University of Texas Press, 2000.