Mapping the Mental Space of Game Genres

J.P. Lewis* Stanford Computer Graphics Lab
Morgan McGuire Williams College
Pamela Fox University of Southern California

Abstract

The gaming community currently uses an informal classification of games into genres such as first-person shooters, real-time strategy games, etc. While this classification is generally accepted, producing a more formal taxonomy of game types directly from data has several scholarly and commercial advantages. These include providing a basis for analysis of age- and gender-related data, statistically meaningful grouping in critical literature, improved game recommendations on retail websites, and better evaluation of a game's market potential *before* production.

Mapping the mental space of game genres is challenging, both because it involves subjective evaluations and because there are many axes on which games can vary. We collected pairwise similarity metrics of games from game players through an online survey to build a large similarity matrix that is the projection of a high-dimensional space representing the unknown and hypothetical true mental space of game genres. We then applied previous techniques in manifold learning and psychology to the problem of reconstructing the most significant dimensions into maps that can be meaningfully interpreted. We believe this is the first application of these techniques to games and one of the first to work with conceptual (instead of physical) data.

The resulting maps arrange related games into spontaneously arising clusters that sometimes contradict current marketing genres. We analyze several of these clusters and propose both interpretations for these "true genres" as well as axes that game players appear to use in discriminating between them. Our initial results indicate that game players tend to primarily distinguish games not by traditional genres but instead by aesthetic and mechanics, which is closely related to how developers construct games.

Keywords: games, genre, mental map, manifold learning

1 Introduction

Most people have a subjective sense that *The Sims* is a different sort of game than *Quake*. This is reflected in the industry classification of *Quake* as a "first-person shooter" (FPS) and *The Sims* as a "life simulation." These classifications are called genres, and they are used when analyzing games in academia, proposing new game designs in industry, and for shelving and promotion decisions in retail. Typical genres include: Strategy, Action, FPS, Role-Playing (RPG), Fighting, Racing, Sports, Simulation, Family, Child, and Adventure [Fullerton et al. 2004; ESA 2005]. This classification system is informal, fuzzy, and haphazard. Yet the purpose of a classification system is to group like objects for meaningful analysis.

*jplewis@stanford.edu

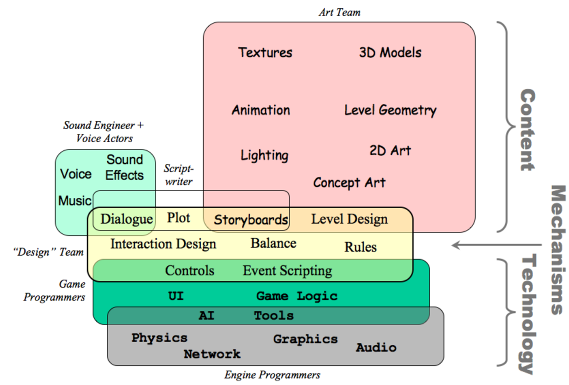

Figure 1: Internal decomposition of games into content, mechanisms, and technology within a development company.

The goal of such analysis in industry is often to identify hot spots in the market from sales numbers. Academics instead seek evidence of positive behaviors (such as learning and emergent culture) and negative behaviors like violence, obesity, and gender discrimination. In all cases, the analysis is limited by the accuracy of the classification system and many increasingly question the validity of the traditional genres for classification, e.g., [Rollings and Morris 1999; Fullerton et al. 2004; Cukier 2006; Juul 2005].

The music industry measures audience response in order to predictively cluster songs and identify potential hits before release [Broadcast Data Systems 2007; Alcalde et al. 2006; Chon et al. 2006], a practice that has been spreading to other areas of product marketing [Farrell 2000]. We hypothesize that a similar data-centric approach to identifying genres will also prove superior to the traditional genres for games.

Perhaps even more than music, games represent a very high-dimensional space. Games are distinguished in many independent attributes including view perspective, artistic style, music, theme, plot, number of players, pace, interaction schemes, platform, and gameplay. To understand the significance of gameplay, consider the breakdown that game developers internally use for their functional teams (Figure 1). The teams are divided into content (art, music, story), technology (code), and mechanics (design, rules, constants). Examples of mechanics include aiming, bidding, item collection, time limits, and puzzles. Gameplay is the poorly-understood emergent property of interaction between individual mechanics. We believe that traditional game genres arose from marketing considerations and reflect a *mixture* of technology (e.g., first-person, 3D, touch-screen, real-time) and mechanics (e.g., shooter, racing, sports). These distinctions were historically important when few mechanics had been explored and rendering was so crude that all content was similar. The primary finding of our experiments is that players today discriminate along *independent* content (aesthetic) and mechanics axes, creating some clusters that match traditional genres but many that do not. This makes sense, since today high-quality content is very expressive and players are fairly sophisticated about the different mechanics available to them.

The format that we develop for exploring game genres is called a mental map. It is a 2D plot where each game is a point and distance between points is a measure of similarity in a holistic sense. Ideally the map is amenable to intuitive interpretation, such as "games on the left are more reaction-based than those on the right," although reducing similarity among the many dimensions of game evaluation to only two axes may produce complex relationships.

We choose this map of game space as a basis for analysis for several reasons. It provides a visual framework for discussion and categorization. The map suggests unexplored game opportunities corresponding to the empty spaces. Finally, humans are sometimes more adept at absorbing and remembering information presented in spatial formats such as maps, although this is a complex subject [Richardson et al. 1999; Satalich 1995].

This paper addresses four challenges of producing such a map:

1. Collection of pair-wise similarity data between many games,
2. Quantification of subjective evaluations by game players,
3. Resolution of high-dimensional data data into significant hybrid axes,
4. Identification of meaningful clusters from among the many possible 2D maps.

We collected data using an (ongoing) online survey. In working with this data we follow the psychology literature, which has shown that valid visual maps of mental models can be produced in some cases [Russell 1980; Lokuge et al. 1996]. To identify significant axes we adapt manifold learning techniques from the neural information processing and computer science communities, which have produced algorithms that successfully discover mappings from high-dimensional data to lower-dimensional maps. Finally, we build on the growing critical game studies literature for our own interpretation of the maps that we produced. We consider our primary contribution to be the approach of operationally identifying game genres. Although we present results identifying potential genres and axes, we have only scratched the surface of this approach and do not claim that the sample maps that we advance in this paper will necessarily remain representative in the presence of larger data sets and further exploration of the mental space.

2 Related Work

The notion of game "genres" is generally accepted, but there are differing theories as to how games might be classified into genres. In the introduction we described the industry's genres. A body of critical work summarized by Juul [Juul 2005] classifies games along theoretical axes such as progressive (story based, like *King's Quest*) versus emergent (rules based, like *Chess*). Other classifications have been proposed, such as Cukier's [Cukier 2006] criteria, which include number of players, synchrony, and realism. Whereas these analyses are based on top-down reasoning and to some extent represent a single author's opinion, we provide a bottom-up analysis of how a population actually perceives game similarities.

Multidimensional scaling (MDS) techniques provide the basis for our approach. These techniques attempt to place points in a reconstructed Euclidean space of specified dimensionality (typically a plane) so that inter-point distances are similar to given distances between points in a (potentially unknown) space. When the given distances correspond to points of potentially high dimensionality but lying on a linear manifold of the same dimensionality as the desired reconstruction (such as inter-city distances measured from a planar map), MDS can reproduce the original configuration of points, subject to an arbitrary rigid transform.

MDS has been used in psychology research to produce visual representations of mental maps and concept relations. Although the true "distance" between concepts is not known, an approximate distance can be obtained from a population average of rated pairwise similarity (or dissimilarity) between concepts. Russell [Russell 1980] applied MDS to similarity ratings of human emotions, resulting in the well known circumplex model in which emotions are radially arranged in a two-dimensional space having axes that have been labeled as 'pleasure/displeasure' and 'high/low arousal' (Fig. 3). In this map, an emotional state such as "relaxed" is on the 'pleasure' side of the first axis, but has a low value on the second (arousal) axis for example, whereas "bored" also has low arousal but is located on the displeasure portion of the first axis. Although this model is not universally accepted, it has been independently derived from rated pairwise similarities of emotion words in a number of languages, as well as from rated similarities of facial expressions [Plutchik and Conte 1996]. More recently, [Lokuge et al. 1996] applied MDS (as well as an alternate trajectory mapping technique) to reconstruct a "tourist content map" of Boston. The reconstructed locations provide a 'map' suitable for overlaying tourist site information such that similar types of destinations are clustered.

Despite the success of these applications, classic MDS can be expected to fail when the data are not arranged on or close to a linear manifold (hyperplane). This limitation is addressed by recent *manifold learning* techniques that attempt to deduce an approximately distance-preserving mapping from a potentially curved submanifold embedded in a higher dimensional space to a visualizable low-dimensional representation. Note that this sort of mapping is familiar in computer gaming technology in the form of the map-

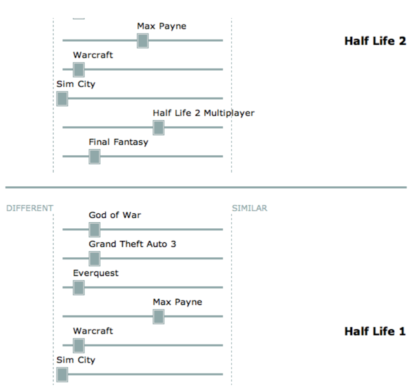

Figure 2: Survey participants were asked to rate the similarity of games using sliders, with no further instruction as to how "similarity" was to be interpreted. This screenshot shows *Half Life* titles being compared to other games selected by the user.

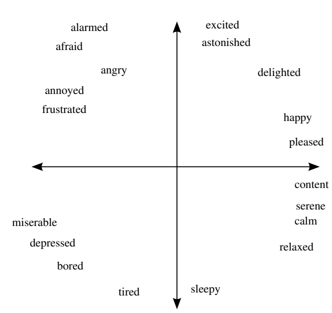

Figure 3: Schematic diagram of "emotion space" obtained from multidimensional scaling, simplified from [Russell 1980]. The horizontal and vertical axes encode displeasure/pleasure and low/high arousal dimensions respectively.

ping from a point on the curving surface of a model in 3D space to the s/t coordinates in a planar texture map, and manifold learning-related algorithms are now being employed to automatically define texture charts with minimal stretching [Zhou et al. 2004]. A fully survey of existing approaches is beyond the scope of this paper; see Sudderth [Sudderth 2002] for a broader discussion and underlying relationships among several approaches.

Although manifold learning is generally considered as a mapping from a higher-dimensional space, in several of the existing algorithms the original data are only used during calculation of pairwise distances. This is important, because it allows us to apply manifold learning to conceptual domains (such as this one involving the "space" of games) where the original points and their dimensionality is unknown, and only pairwise distances are obtainable.

In our experiments we use the *Isomap* algorithm [Tenenbaum et al. 2000]. This algorithm discovers data lying on a potentially curving lower-dimensional manifold embedded in a high-dimensional space. In our application the high dimensional space consists of the many dimensions along which games can differ, and the lower dimensional manifold arises when the variation among a group of similar games can be effectively approximated with a smaller number of dimensions. In general one expects that the shortest path between widely separated points may depart from the manifold, whereas the distance between nearby points approximates the distance measured on the manifold (for example, the three-dimensional distance between cities on opposite sides of the globe is much shorter than their geodesic distance, but the distance between nearby cities is similar to their geodesic distance). Isomap thus identifies the k-nearest neighbors of each point and assumes that the distances to these points are approximately the correct local geodesic distances. Geodesic (on-manifold) distances between distant points are obtained by accumulating the shortest path between neighbors, e.g. using Floyd's algorithm. Once all pairwise distances on the manifold are known, MDS is employed to reconstruct the lower dimensional manifold.

3 Method

In order to apply manifold learning to map game genres, we need a matrix of pairwise similarities for various games. Because the goal is to let relationships arise as much as possible from the data, we obtained ratings on actual game titles rather than on pre-defined genres (such as FPS, etc.) that might unnecessarily influence the subsequent ratings. Defining similarity between even a large subset of the many existing games is clearly prohibitive however due to the $O(N^2)$ number of pairwise similarities, however.

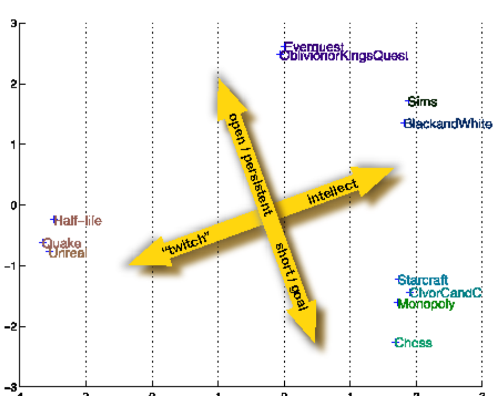

Figure 4: A two-dimensional projection of a three-dimensional map obtained during a pilot study of 11 games rated by 18 people.

3.1 Pilot

To approach this issue we proceeded in two steps. First we undertook a pilot study using only a representative subset of well-known games. In consultation with several gamers we identified the following set of nine games: *Quake*, *Oblivion*, *The Sims*, *World of Warcraft*, *Black and White*, *Starcraft*, *Half-Life*, *Unreal Tournament*, and *Civilization*. To increase the probability that survey participants would be familiar with most of the games, two alternate titles were identified: Oblivion or King's Quest, and Civilization or Command and Conquer. This choice was based on the judgment that these titles are sufficiently similar to the originals (relative to the granularity of our sampling of titles) that they would serve as an equivalent choice. We included *Chess* and *Monopoly* to provide two prominent non-computer games as landmarks.

The resulting set of 11 games required $N(N-1)/2 = 55$ questions to enumerate the pairwise similarities, a reasonable number. To obtain a sampling of these pairwise ratings, members of a college gaming organization were invited to complete a web-based survey in which each pair of games was rated on a 1..5 scale, 5 being most similar. The survey was implemented as a web browser form, and 18 people completed the survey. Pairwise distances between games were obtained by negating the averaged similarity rankings (specifically, distance $D = 1 + \max(S) - S$ with S being the matrix of averaged similarity rankings, and $D_{i,i} = 0$).

Figure 4 shows results from this pilot study. This figure shows a plausible grouping and partial clustering of games: FPS games (*Half-life*, *Quake*, and *Unreal*) are tightly grouped and separated from the fantasy-themed ones (*Everquest*, *Oblivion*, *King's Quest*), which are in turn separated from games with a strategy emphasis (*Civilization*, *Command and Conquer*, *Starcraft*, *Chess*), and from Simulation games (*The Sims*, *Black and White*).

As in Russell's mental map of emotions (Fig. 3), it is tempting to try to assign labels to the axes. With the reminder that the given orientation is arbitrary, several people familiar with games were able to assign interpretable axes to two-dimensional projections of this data (see Fig. 4). These early interpretations should be viewed with some hesitation, however.

3.2 Full Study

The pilot study suggested that Isomap might give reasonable results when applied in this fashion. On this basis we undertook a larger scale (and ongoing) survey. People were recruited from undergraduate classes, and using a posting to an on-line gaming site. The survey asks people to select 10 games from larger (and expanding) list that contained 110 games at the time of submission of this paper. Participants then rated the pairwise similarity between these games (Fig. 2). After removing problematic responses, 124 participants rated 92 games. (Due to a bug, two versions of the *Mortal Kombat* series had the same data tag, and participants who selected both had to be omitted. For other participants, both titles were treated as equal representatives of the series).

These 92 games yield 4186 possible comparisons, whereas the 124 participants each giving 45 responses yielded 5580 comparisons. However, the coverage is uneven, and some game pairs are not compared. We thus altered the Isomap algorithm to use an MDS method that provides for missing data (Matlab's `mdscale`). An additional issue is that, since participants are selecting different subsets of games, the meaning of "similarity" varies across participants. That is, one person might select a subset that contains only FPS titles, whereas a second person could select a more varied sample of games. A rating of "very different" from the first person reflects a smaller cognitive distance than a similar rating from the

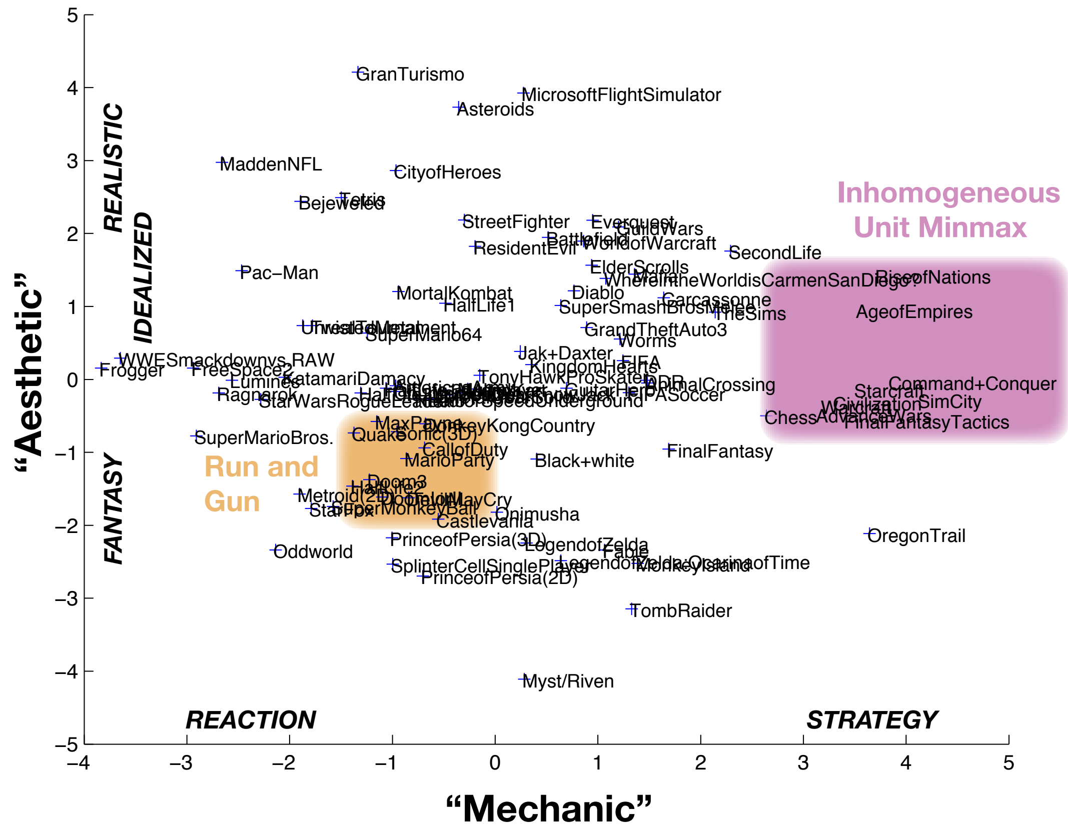

Figure 5: Projection of the eight-dimensional manifold on axes 2,4. The axes correspond to intuitive linear spectra.

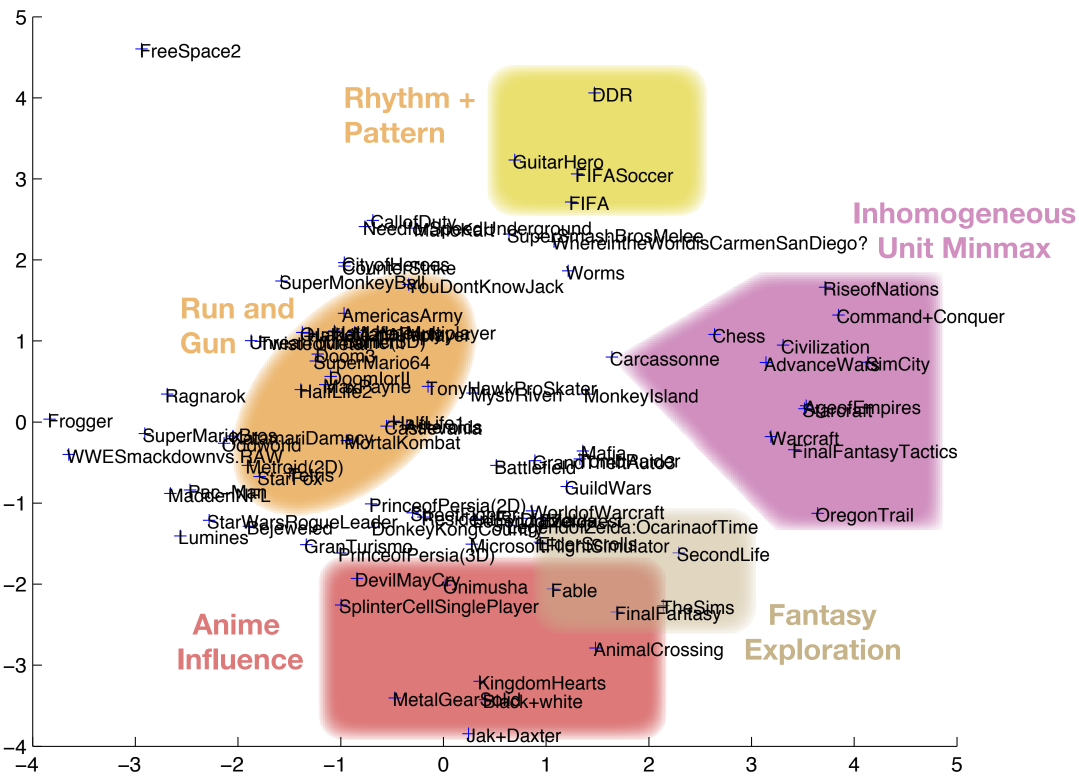

Figure 6: Alternative projection of the eight-dimensional manifold on axes 2,3. The axes are no longer intuitive, but meaningful areas emerge.

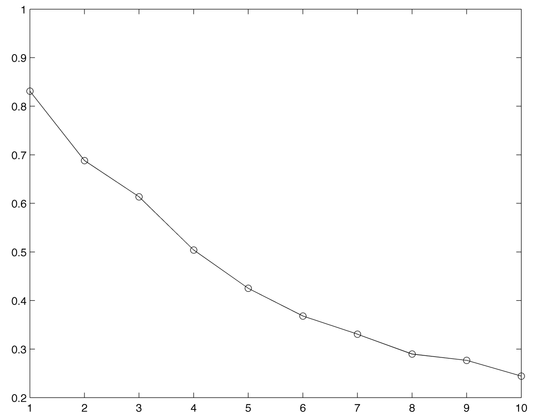

Figure 7: Embedding distance error (vertical axis) versus dimension for a set of 92 games rated by 124 people.

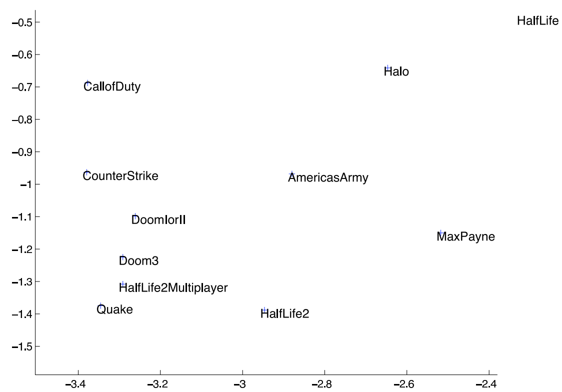

Figure 8: Clustering of FPS games appears clearly in this detail from the projection on axes 1, 2, confirming this particular traditional genre.

second person. While this issue increases the variance of the resulting visualizations, we treat the similarity rating for a particular pair, averaged across all people who rated that pair, as an (unbiased) estimate of the desired distance. This practice of averaging across people is commonly required with psychological data. We removed games that were selected by only one person becuase single-person ratings are entirely subjective.

Isomap also requires the manifold dimension as an algorithm parameter. As with other dimensionality reduction techniques, the true dimensionality of the data can be estimated by examining the decrease in representation error on the reconstructed manifold as its dimensionality increases (Fig. 7). In Fig. 7 we see that the embedding error for the full data set decays (slowly) with the embedding dimension. We chose an 8-dimensional embedding (this high dimensionality is not surprising considering the many different subjective dimensions along which games can vary).

4 Results

Figures 5-8 show several interesting projections of the eight-dimensional reconstructed manifold. Surprisingly, the decades-old scheme of grouping games by genre and platform does not appear to actually represent the mental categories into which modern game players consciously or subconsciously group games.

Instead, we find that players appear to group games first by content (setting or aesthetic) and second by the primary mechanic of the game. Technology is largely irrelevant, perhaps indicating either the commoditization of game engines and platforms or players' increasing appreciation of substance over flash. The content and mechanic directions are independent and distinct, unlike traditional combinations that did not span the full space and left out many possibilities. These results can be seen in Figures 5,6, described below, and appear to be independent of the genre within which a game was marketed. On the other hand, some traditional genres are represented by clear clusters when examining our maps on small scales (Fig. 8).

In Fig. 5 the vertical axis roughly corresponds to aesthetic and the horizontal axis to the primary mechanic. First examine the vertical axis. At the top of the figure are the relatively realistic simulation games (*Asteroids* was fairly representational compared to abstract contemporaries like *Pac-Man*). Below are a series of idealized, almost, comic-book like characters, including anime heros, fantasy warriors, and superheros (as well as football players). Below that are the goofy animated characters: frogs, gorillas, cows, and cartoon plumbers. Towards the bottom are the more family-friendly fantasy worlds of *Riven*, *Oddworld*, *Price of Persia*, and *Zelda*. The teen-rated *Tomb Raider* is an outlier on the family-friendly aspect, however it does exhibit a strong adventure-fantasy aesthetic that matches *Myst* and *Zelda*. Along the horizontal axis we see the primary mechanic of jumping and spatial puzzles (e.g., *Frogger*, *Katamari*, *Super Mario Bros.*) gives way to strategic puzzles (*Tetris*, *Prince of Persia*) and combat (*Zelda*, *Diablo*, *GTA 3*, *Everquest*) and finally to classic minimax planning with inhomogeneous units (*Age of Empires*, *Chess*, *Starcraft*, *Command and Conquer*). This intuitive interpretation is imperfect because these notions of aesthetic and mechanic do not really form linear axes.

This general conclusion is further supported when directly examining the clusters. In Fig. 5, the center right contains the traditional Real-Time Strategy games, supporting the idea of genre, yet *Chess*, *Oregon Trail*, and *Final Fantasy* come very close to the cluster because the primary mechanic is still minimax over inhomogeneous units, regardless of the "real-time", "combat," or "tech. tree" aspects that characterize the RTS genre. In the center bottom, *Splinter Cell*, *Prince of Persia*, *Tomb Raider*, *Zelda*, and *Castlevania* cover different settings from modern spy combat to fantasy, but all involve similar combat mechanics.

In Fig. 6, we see the "twitch", i.e., rhythm and pattern, games *DDR*, *Guitar Hero*, and *FIFA Soccer* clustered near the top. The 3D run and shoot games just above and right of the center—notice how Super Mario 64 becomes grouped with the traditional FPS games, as do third-person perspectives like *Max Payne* because the mechanic is the same. Near the center bottom we see the anime-influenced aesthetic of *Devil May Cry*, *Spinter Cell*, *Onimusha*, *Final Fantasy*, *Animal Crossing*, and *Kingdom Hearts*.

5 Conclusions

For progression games, most developers prioritize content aesthetics first and mechanics second, while technology is a distant third (with the exception of companies such as id and Crytek that create games showcasing the engines they develop). Developers of emergent games prioritize mechanics first and content second, but technology remains a supporting consideration. Although most players are probably unaware of the developer's process and choices, the interpretation of our results strongly suggests that players' mental space of games matches the developers' priorities. Thus we find that the mental space of games is richer than the few combinations prescribed by traditional genres. Traditional genres are valided in only a few cases. For example, the combination of war/sciencefiction theme + first-person perspective + shooting mechanics corresponds so powerfully with an existing market (in this case, 18-25 year old males) that the standard FPS genre is justified.

And yet, although FPS is well-represented by a cluster, the traditional genre focusses on the technology (3D, first-person view) and thereby mis-classifies some of the cluster, missing important connections to other games. We instead call the cluster containing FPS games "run and gun." The mechanic and ultimately gameplay are more general: linear progression through a fixed world, fast-paced, run/jump/shoot movements, and protagonist against overwhelming waves of enemies. This describes the 2D platformer *Super Mario Bros.* as well as *Quake*, and suggests that fans of FPS games are likely to also find *Super Mario Bros.* engaging. Also note that *Splinter Cell* and *Tomb Raider* use only half of this mechanic and appear near the edge of the cluster, despite featuring similar 3D technology to the FPS games and commonly appearing near them on store shelves.

We can directly use this information to give recommendations that subvert the genre system. If you enjoy *Super Mario Bros.*, our data suggests that you are also predisposed towards *Quake* and less predisposed to enjoy *Tomb Raider*, even though *Tomb Raider* as a 3D platformer is considered a closer genre in the traditional system. Likewise, if traditional genres were accurate then one would expect *Super Mario Bros.* close to *Asteroids* as "classic" or 2D technology games, but instead our players ignored technology and focused on the gameplay, classifying *Asteroids* as the moral ancestor of racing and flying simulation games. Note that in a similar vein *Oregon Trail* is close to the RTS games, although the traditional would never make that connection because *Oregon Trail* is considered Edutainment. We also observe new clusters that publishers, retailers, and critics might do well to recognize parts of the space like "anime-aesthetic" and "idealized-character puzzle."

Empty space surrounding the cluster of cartoony-beat matching games like *Guitar Hero* in the map suggests that this is a market opportunity. It does not necessarily mean that there are few games in that part of the space—our survey was biased towards international releases and underrepresents this mechanic, which is heavily used in the domestic Japanese game industry. We note the upcoming international releases of several Japanese games (e.g., *Elite Beat Agents*) to take advantage of the market opportunity. More significantly, these games are clustered away from the rest of the space, suggesting that there is an opportunity to develop more games like *God of War*, which combine beat-matching with other mechanics and have more realistic or heroic characters.

6 Discussion and Limitations

A major issue in this work (as in any manifold learning or dimensionality reduction technique) is that of whether the discovered dimensions are interpretable and represent useful aspects of the overall variation between entities. Psychological applications of dimensionality reduction have the additional challenge that the possible meaning of the resulting "dimensions" (if any) must be independently interpreted. A map of game genres as derived here admits both of these issues. Certainly games differ in an enormous number of possible "dimensions," and it may be the case that the variation expressible in a low-dimensional map is too coarse to serve as a useful summarization.

On the other hand, some applications of mental maps (such as that in [Lokuge et al. 1996]) do not require complete success from the point of view of these dimensionality reduction criteria in order to be useful; rather, it is only important that distance on the map roughly correspond to psychological distance. A recommender system in the form of a spatial map would be one such application. More generally it is known that people can absorb information more efficiently when it is coherently structured than when it is arbitrarily scattered, and we speculate that maps should be an effective form of information visualization for the gaming community, given the strong spatial skills required in many forms of game play.

The work shown here might be regarded as a suggestive experiment and illustration of an approach to deriving visualizations of conceptual maps. The maps shown in Figs. 5,6 should not be regarded as a definitive representation, however, both because of the limited size of the survey and number of games surveyed, and because alternate choices of various design parameters (e.g. the specific algorithms used to convert similarity to distance, and to select the nearest neighbors) will lead to maps that differ at least slightly. Nevertheless we hope that this work is a small step toward applying research methods to the domain of games and might lead to further work on formalizing game concepts.

Acknowledgments
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