A Conceptual Model for Video Games and Interactive Media

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In this article, we describe a conceptual model for video games and interactive media. Existing conceptual models such as the Functional Requirements for Bibliographic Records (FRBR) are not adequate to represent the unique descriptive attributes, levels of variance, and relationships among video games. Previous video game-specific models tend to focus on the development of video games and their technical aspects. Our model instead attempts to reflect how users such as game players, collectors, and scholars understand video games and the relationships among them. We specifically consider use cases of gamers, with future intentions of using this conceptual model as a foundation for developing a union catalog for various libraries and museums. In the process of developing the model, we encountered many challenges, including conceptual overlap with and divergence from FRBR, entity scoping, complex relationships among entities, and the question of how to model additional content for game expansion. Future work will focus on making this model interoperable with existing ontologies as well as further understanding and description of content and relationships.

Introduction and Background

Last year, 58% of Americans played video games and spent more than $14 billion on game content (ESA, 2013;

NPD Group, 2013). More and more colleges and universities now offer courses in video game design and development (ESA, 2014), and in K-12 education video games are increasingly used as learning and literacy tools (Gee, 2003). Academic organizations like the American Culture Association and the Society for Cinema and Media Studies have legitimized video games as worthy of study. Video games are clearly important to American society as educational, economic, and cultural heritage objects, prompting institutions such as libraries, museums, and archives, to collect and preserve video games.

The Game Metadata Research (GAMER) Group at University of Washington Information School, in partnership with the Seattle Interactive Media Museum (SIMM), has been working on a research project to build a standardized metadata schema and controlled vocabularies for video games. Organizational needs of cultural heritage institutions with video game collections demand a robust, media-specific metadata schema to describe a variety of video games, from historical to contemporary, and serve a variety of use cases. In addition to SIMM, the conceptual model we report on here is expected to inform similar video game digital library initiatives at the Digipen Library Learning Resource Center and other venues.

Since the project's inception in 2011, GAMER group, SIMM, and students at the Information School have worked in close collaboration. Phase I of the research consisted of an

extensive domain analysis using empirical descriptive data about video games (Lee, Tennis, Clarke, & Carpenter, 2013b). Analysis of existing information sources (i.e., video game-related websites and catalog records) revealed how the domain has been shaped, how it is currently described, and where gaps appeared. Six different personas (archetypes representing the needs, behaviors, and goals of a particular user group (Cooper, 1999)) were also developed epitomizing the most common types of users interested in games (Lee, Cho, Fox, & Perti, 2013a). Based on these personas and several use scenarios, 61 metadata elements emerged, 16 of which were identified as CORE elements deemed to be most useful for all user personas. These elements were evaluated and further revised based on cataloging sample games. More detailed information on the research activity in Phase I can be found in Lee et al. (2013b).

Phase II saw the establishment of a recommended set of elements (Lee et al., 2013a) and development of encoding schemes (i.e., controlled vocabularies) for select elements (Donovan, Cho, Magnifico, & Lee, 2013). In addition to the CORE 16, 30 additional elements were recommended to describe video games to the level of thoroughness useful to the various user groups. During development and testing of vocabularies for these elements, many issues became evident. Differentiating among various editions of games was extremely challenging because of releases of the same game in multiple regions, for multiple platforms or systems, as well as special "collector's editions" or other limited special releases. For example, a game like *The Legend of Zelda: Ocarina of Time* exists for multiple platforms—from the original Nintendo 64 to the GameCube to Wii Virtual Console to Nintendo 3DS. These games are all *The Legend of Zelda: Ocarina of Time*, but are they *the same* video game? By the nature of the hardware, the games are very different: The Nintendo 64 version requires a controller whereas the 3DS version relies on touchscreen interaction with added 3D effects. This creates a very different gameplay experience, to the extent that some gamers consider them to be very different indeed. Different types of gamers and other user groups interpret video game editions and series in different ways, and these metadata elements currently do not accurately capture and represent the complex relationships among games. Test cataloging also revealed issues in describing digitally distributed video games (i.e., games accessed through digital means such as streaming or application stores that have no physical components like cartridges or discs) and their relationships to more traditional physical games (Lee, Clarke, & Perti, 2014a). Although user studies reveal that much of the descriptive information in the schema is useful to users (Lee, Clarke, & Perti, 2014b), the current schema lacks the ability to represent the complex relationships that exist among video games, warranting additional research. In order to further identify and represent relationships among video games, this article proposes a conceptual model for published video games designed to facilitate effective description, organization, and access from a user-centered perspective. This model decomposes the colloquial notion of a video game into analytically precise components, facilitating an effective and systematic reuse of information already available in the metadata of video game descriptions.

Review of Previous Work

The issue of determining conceptual boundaries is not unique to video games. *Functional Requirements for Bibliographic Records* (FRBR) is a conceptual model illustrating the boundaries of bibliographic resources by defining and describing attributes of and relationships among bibliographic entities (Kruth, 2001). In FRBR, there are four different classes of bibliographic entities: work (intellectual and artistic creation), expression (work realized in the form of notation, sound, image, etc.), manifestation (physical embodiment of an expression), and item (an exemplar of a manifestation). This structure was developed to be a generalized view of the bibliographic universe independent of any cataloging code or implementation (Tillett, 2004).

However, applying the FRBR model to video games presents fundamental problems: McDonough et al. (2010b) tried to apply the FRBR model to a classic computer game but could not easily determine how to distinguish and precisely characterize work, expression, manifestation, or item. Video games clearly diverge from the entities the FRBR conceptual model describes, although many descriptive elements deemed necessary in the current UW/SIMM metadata schema echo FRBR attributes. Despite FRBR's comprehensive set of attributes for describing bibliographic entities, there are still limitations because of missing characteristics germane to interactive media and other kinds of non-bibliographic entities. This is perhaps because of incompatibility of the established descriptions, definitions, and concepts with those emerging from the specific domain of video games. Attributes derived from the context of a cultural object, like a user's reaction to an object (e.g., mood) or similarity-based relationships—both of which can be significant in the context of video games—are also not represented in the FRBR model (Lee, 2010). Winget and Murray (2008) also argue for the necessity of describing the "context of use" for video games. Other bibliographic and cultural heritage standards, such as *Resource Description and Access* (RDA) and *Cataloging Cultural Objects* (CCO) do not explicitly address a conceptual model of video games as an entity for description.

Work in academia defining the nature of video games is still nascent and frequently focuses on aspects of game design (Wolf, 2001) or aspects distinguishing video games from more traditional board games and sports (Crawford, 1984; Furner, 2007). Rather than considering video games as a unique form of media, contemporary cataloging practices in libraries frequently rely on reusing established models for traditional media when crafting metadata records for video games and interactive media. Such shoehorning of non-book objects, like video games, into existing bibliographic description standards creates less than useful
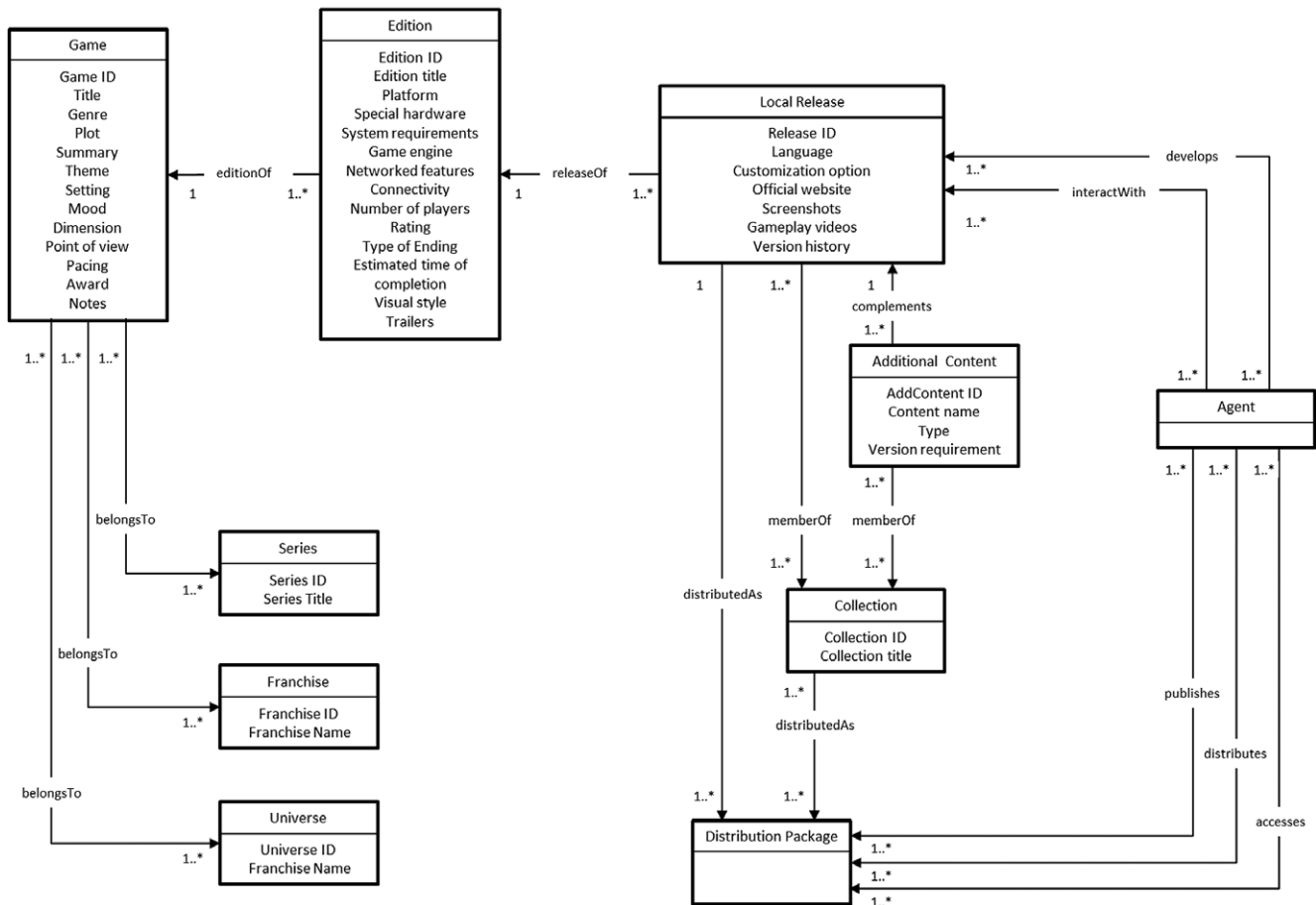
FIG. 1.   Proposed conceptual model.

descriptions (Hagler, 1980) and makes it harder for people to find what they seek. In the case of RDA, video games are considered containers of moving images and nothing more (CLA and ALA, 2010). In fact, there is no specific definition for video games in RDA. CCO is likewise agnostic with regard to the conceptual boundaries and definition of video games (Baca, Harpring, Lanzi, McRae, & Whiteside, 2006). Cultural objects, the purview of CCO, are left to the cataloger and her or his institution to define. Contemporary library description standards and practices leave ample room for a more specific conceptualization of metadata required for video games. For instance, there are many elements of interest to game users, such as the number of players that can interact with the video game, the franchise to which a game belongs, and the ability to play and connect with other users through online methods, that are not representable in current metadata standards.

Proposed Model

Overview

The model described in this article presents a series of entities and relationships designed to faithfully represent video games and their complex nature as cultural artifacts and consumer products. We propose a conceptual model (Figure 1) that describes video games in terms of precisely defined primitive entity types, properties and relationship types. The primary purpose of this model is to facilitate the effective description of video games, the efficient organization of those descriptions, and the development of tools to support the access of video game–related information. The aim of this conceptual model is to represent how these users perceive and think about video games at a high level. In the future, we envision this model will be used to inform logical and physical data models to develop a union catalog of video games for use by many cultural heritage organizations with video game collections. Therefore, the focus here is on common video game data that will be shared among organizations rather than administrative, local, and item-level descriptions.

The model has been developed by combining a bottom-up approach based on actual metadata schemas and descriptions (in particular the video game metadata schema developed by the GAMER group in collaboration with SIMM) with a conceptual analysis of the video game domain, including, but not limited to:

1. Ontological analysis of video games as cultural artifacts;
2. System analysis for effective information organization, retrieval, and access;
3. Context analysis to situate video games in the sociotechnical contexts of their production, distribution, and use.

Our modeling perspective is grounded in an analysis of how video games are perceived by gamers in their interactions and gameplay, but also addresses the nature of video games as cultural artifacts that are created, published, and distributed. Unlike other approaches to video games that focus on changes in source code to determine what qualifies as a new game (see McDonough, Kirschenbaum, Reside, Fraistat, & Jerz, 2010a), our model reflects how video games relate to each other in terms of content, structure, and context from the perspective of the general user. The former source-code based approach is likely to be more relevant to game designers and developers, who work directly with code, or to curators establishing practices for long-term digital preservation. However, underlying source code is often invisible to game players, who are more interested in the manifested performance of the code rather than the code itself.

A more thorough investigation of the nature of relationships that hold among video games appears in Clarke et al. (2014) and Lee et al. (2014c). The conceptual model presented here was developed as part of the same research agenda as these studies, using the same research inputs. We used the following complimentary techniques during the course of our research:

1. Harvesting and reviewing the relationship classes and types from existing metadata standards and domain-specific resources (both online and offline);
2. Consultation with both professional and amateur video game experts with deep domain knowledge from SIMM and local game companies in order to map and make explicit the manner in which they conceptualize the entities and relationships in the domain (further discussed in Lee et al., 2014b);
3. Examination of video games themselves to understand both how they have been characterized in the past, and potential ways in which they could be characterized in the future.

We began our modeling exercise by first reviewing the metadata schema work accomplished by the GAMER group at Washington and SIMM. The original work was an iterative process; the methods of its development, including collaborative review, schema testing, user interviews, and survey instruments, are documented in Lee et al (2014b). After the initial round of work, student researchers Jett and Sacchi joined the GAMER group at Washington to begin work on producing a more formal account of video games as cultural heritage objects resulting from a complex and iterative publication cycle. The resulting output from the GAMER group, the conceptual model we present here, redistributes the metadata schema elements of the initial GAMER schema to the entities they best describe as properties.

After our initial examination, we began an iterative process of examining various video games in great detail, including *Bejeweled*, *Civilization*, *Disgaea*, and *Final Fantasy*, among others, and verifying that the properties truly described the specific entity to which they were attached finally arriving at the model in Figure 1 (presented earlier). We attempted to include games of diverse genres, platforms, and distribution methods in our analysis in order to create a model that better represented the entire video game domain.

The core model develops around five entity types: Game, Edition, Local Release, Additional Content, and Distribution Package. These entity types, along with their properties and relationship types, support a thorough user-centered description of a video game as a cultural artifact in a way that is useful for gamers interested in understanding what similarities, differences, and relationships exist among what they actually play.

These entity types analytically decompose the colloquially holistic notion of *video game* according to the principle that instances of a game, in the most abstract sense of the term "game," typically manifest variations in characteristics at different levels of interpretation and granularity, while still remaining instances of the same game. Figure 2, which visually depicts the publication history of the popular video game *Final Fantasy*, also shows how a disparate collection of related things might be considered to all be examples of a single instance of a video game.

The model proposed in this article keeps track of these variations in an efficient way by establishing networks of hierarchical relationships among entities at every level. These entities also function as nexuses to bundle significant properties in such a way that avoids unintended category mistakes and is consistent with the 1:1 principle of metadata description (Woodley, 2001). The following sections describe each entity type in more detail.

Game

The first entity type in this conceptual model is the Game entity type. The Game entity type is an abstract entity that describes features that are shared among different editions of a video game: the characteristics that are typically recognized by users when they say "we played the same game" even if they played it on different platforms (e.g., PC and PlayStation 3). An example instance of the Game entity type is *Super Mario Bros. Super Mario Bros.* is a widely recognized game that has editions available for multiple platforms, including but not limited to Nintendo, Super Nintendo, Nintendo GameBoy, and Wii. The Game entity type allows these different editions of a video game to be associated under what consumers will readily recognize to be a single entity, namely, the same game. Features attributed to the Game entity type also support distinguishing between games by genre, mood, theme, setting, plot, etc.

One goal of the Game entity as a conceptual entity is to provide sufficient vocabulary to distinguish games with
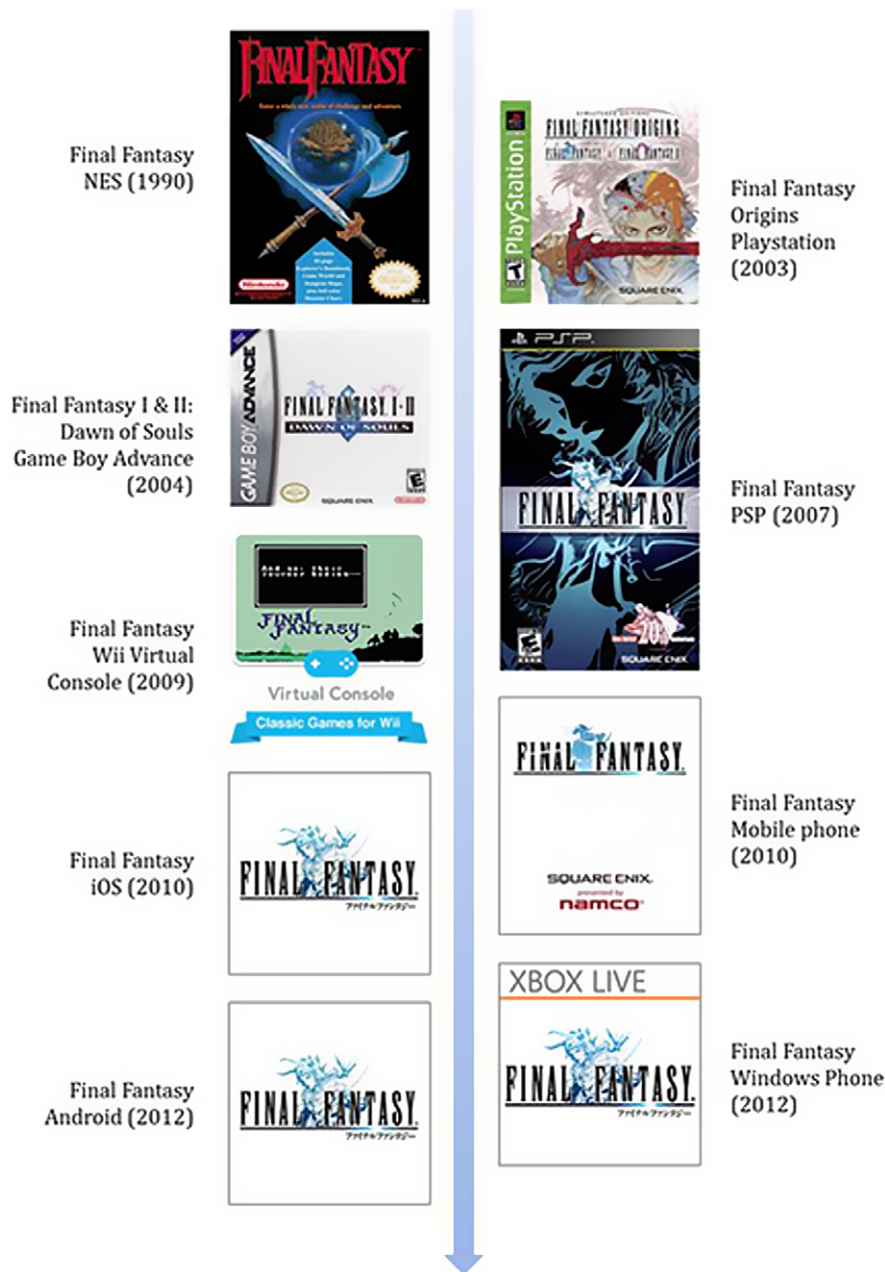
FIG. 2.   *Final Fantasy* publication history. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

similar gameplay, function, and mechanics. This issue affects historical games, such as Mattel Electronics *Football* and Mattel Electronics *Auto Race* (Figure 3), as well as more contemporary games like PopCap Games's *Bejeweled* and *Candy Crush Saga* by King.

Football is a handheld electronic game first released by Mattel, Inc. in 1977. *Football* is one of a series of electronic games built around the Rockwell 6100 processor using integrated circuits, read-only memory, and a series of seven-segment displays (SSDs). The SSDs are arranged to form three lanes of nine rungs. The player advances from one rung to the next, traversing from lane to lane, to avoid randomly generated obstacles, simulating the advance of a

running back across the football field. Chang and Klose's patent (1979) refers to the game as an obstacle game and Mattel Electronics *Football* was only one incarnation. In terms of the functionality and mechanics, the exact same "game" was also marketed as Mattel Electronics *Auto Race*. The same issue of functional and mechanical overlap can also be seen in contemporary games as well. As games become increasingly digital, mechanics no longer hinge on the physical construction of a game as in the *Football* example. However, the mechanics of game functionality are expressed through patterns of game tasks and interactions. In both *Bejeweled* and *Candy Crush Saga*, the player earns points by horizontally or vertically swapping the positions

FIG. 3. Mattel electronics *Football* and *Auto Race*. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

FIG. 4. Variance in graphics between editions: *Final Fantasy* for NES (left) in comparison to iOS (right). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

of two adjacent items to create sets of three (or more) items of the same color. Like *Football* and *Auto Race*, *Bejeweled* and *Candy Crush Saga* are functionally the same game. However, despite being the same game mechanically, users perceive these as quite separate games because of the presentation layer, graphics, marketing materials, and branding.

A core requirement for the conceptual model is that the features of the Game entity type must be expressive enough to capture the differences between two games with similar or identical mechanics. Often the differences are primarily in regards to the naming and marketing of the game and genres that act as a presentational layer. In the *Football* example, the obstacle game is presented as placing the player in the perspective of a running back, advancing down the field. In the *Auto Race* example, the player is placed as a car driver racing around the track, passing other drivers as he or she proceeds. In *Bejeweled*, the player swaps colored gems, whereas in *Candy Crush Saga* he or she swaps candies of various colors and shapes.

Edition

The Edition entity type denotes a particular instantiation of a video game. An edition may be a particular release of a game that is in some way different than another release of the same game (e.g., *Assassin's Creed IV Black Flag Limited Edition, Persona 4 Golden, Dark Souls II Black Armor Edition*). This may be because it has been adapted for release on a new platform (e.g., PS4, Microsoft Windows 8, etc.), or because it has fully integrated content that was previously available only as separate expansion material or additional content/features not available in the regular release of the game (e.g., *Shin Megami Tensei: Persona 3 FES*). The Edition entity type bundles together such features as platform, special hardware, system requirements, online features, etc. Each instance of an Edition entity type is always an "edition of" an instance of the Game entity type. The relationship type *edition of* is a 1:*n* relation between a Game and *n* Edition instances. In some cases, such as when a new game is published for a specific platform, there might only be a single instance of an Edition entity for that video game. An example of this is the video game *8 Eyes* for the Nintendo

Entertainment System (NES), which was never released for any other platform or with any additional features. In other cases, the same edition of a game might be repackaged and distributed through multiple instances of Distribution Packages. An example of this latter phenomenon can be seen in "day-1 digital releases," which are video games distributed electronically through online game networks such as the PlayStation Network and physically through the publication of disc media on the same day. The video game *Diablo III* is one such instance of a "day-1 digital release."

In contrast to the examples just given, an example of a video game with multiple editions is *Final Fantasy* (previously illustrated in Figure 2). *Final Fantasy* was first published for the NES in 1987. It quickly became popular, and editions for several personal computer systems were created for the Japanese market. *Final Fantasy* has remained popular for the past 25 years, inspiring the creation of new editions for newer platforms such as PlayStation, Gameboy Advance, and iOS, among others. Newer editions of the game have frequently exploited the expanded capabilities of the newer game platforms, especially with regards to graphics (see Figure 4).

Variances between editions of a video game are not limited to platform or graphics. Video games frequently have title alterations when new editions are published, especially if the new editions feature added game content such as extra levels or alternate play-through modes. The video game *Disgaea* is an example of this latter phenomenon. When originally released for the PlayStation 2, the full title of the game was *Disgaea: Hour of Darkness*. A subsequent edition was released for Sony's PlayStation Portable (PSP) with the altered title *Disgaea: Afternoon of Darkness*. *Disgaea: Afternoon of Darkness* contained additional content in the form of an extra play mode allowing players to replace the game's main character with one of the secondary characters and experience a series of game levels that could not be accessed through normal gameplay in the original PlayStation 2 edition.

Local Release

Each edition of a video game is made available and accessible in a particular region and in a particular language as a local release. We model the relationship type "release

of" as a 1:*n* relationship to admit variances in different local releases of the same edition. These variances typically include, but are not limited to, language, graphics localization (frequently through the censorship of religious iconography or nudity), and the customization options for both difficulty levels and characters that vary from release region to release region. An example of cosmetic variation in graphics is the video game *La Pucelle: Tactics*, a tactical role-playing game released for PlayStation 2 in 2002. In the original local release for the Japanese market, the game's character sprites and background graphics contained large amounts of Christian iconography. In 2004, a localized version of *La Pucelle* was released for the North American market. Because of the legacy of strong censorship of children's media, virtually all of the Christian iconography was removed from the game's graphics (1UP.com, 2004).

The Local Release entity type allows the model to capture both cosmetic graphical and narrative variances along with substantial linguistic variances evinced in copies of a game specific to the linguocultural region in which it is released (e.g., Japan, North America, Europe, etc.). The conceptual model is thereby equipped to preserve some information about censorship but also captures the market-to-market variances in how video games are published. The properties bundled into the Local Release entity also allow us to express the absence or presence of customization options available to players in specific linguocultural regions, as well as the range of those customization options where present.

An example of games with multiple local release entities is the aforementioned *Final Fantasy* (Figure 2). Well documented by online resources such as Wikipedia, the original edition of *Final Fantasy* on the NES received localizations for both the Japanese and the U.S. markets, with the U.S. market receiving its release about 3 years after the Japanese market release. Editions for the Sony PlayStation and Nintendo's GameBoy Advance received local releases for the Japanese, U.S., and European markets. These editions were followed up with additional editions for the PSP, the Nintendo Wii, and for pre-smart mobile phones. Each of these editions received localized releases in the Japanese, U.S., and European markets. Like the Edition entity, it is possible that a specific edition might only have a single instance of a Local Release entity. This was the case for iOS, Android, and Windows Phone editions of *Final Fantasy*, where costly localization processes were combined directly with each of the three editions' development costs. In these cases, in the context of the model, the "locality" of the Local Release instance is the world. Every locality worldwide has access to the same customization options, the same game experience, and so these instances of the Edition entity type only have a single pertinent instance of the Local Release entity type.

Additional Content

The Additional Content entity type is used to model content that is made available separately from a specific
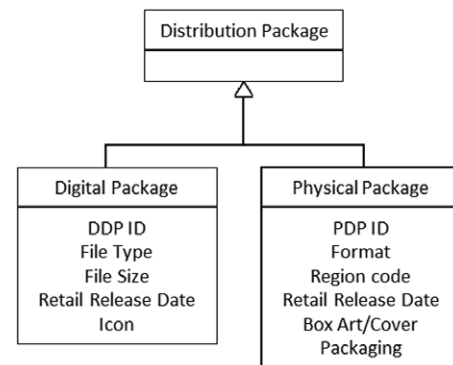

FIG. 5.   Distribution package entities.

local release of a game. It is intended to be implemented in conjunction with a specific local release in order to alter and enhance a gamer's experience of that game in a specific linguocultural region (e.g., downloadable content [DLC], modification ["mods"]). This entity type does not apply to simple bug fixes, patches, or updates that are automatically pushed to gamers and installed on a platform in order to play the game, such as a version update of an iOS game app or an automatic update of a PS3 game.

Our model does consider patches as additional content if they exist independently and are not included with the original game files, which is frequently the case for older, PC-based games. This is because users are required to obtain the patch files separately and install them on top of the original game code, which means that the patch file bundle is an instance of a separate entity that is typically sought directly by users, making it particularly relevant to our user-centered model. A video game may or may not have any additional content, although it is becoming increasingly common for PC-based video games, especially digitally distributed games, to have additional content.

Distribution Package

The Distribution Package entity type is a superclass of two disjoint subentity types: Physical Distribution Package and Digital Distribution Package (Figure 5). These two entity types model all of the properties necessary to describe the media through which individual copies of a game are distributed.

In particular, they are designed to provide enough expressivity to capture the variances in how a video game is distributed to gamers, as any local release of a video game is frequently distributed in a variety of ways. With the growth of digital distribution platforms (e.g., Valve Steam, Sony Entertainment Network, etc.) and the smartphone gaming industry, simultaneous distribution through physical and digital media is becoming the norm (e.g., day-1 digital releases).
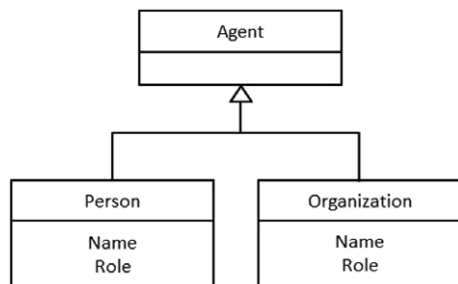
FIG. 6.   Agent entities.

Grouping Entities

Two of the four remaining entities are designed to aggregate instances at the Game or Local Release levels into specific groupings according to common features and publication bundles. In the case of the Collection entity, the intent is to provide an entity that allows multiple Local Release entities to be aggregated into a single Distribution Package entity. Although we decided to name this entity "Collection" because of user warrant, the entity type more closely reflects an anthology of games. A recent example of this phenomenon is the Humble Sid Meyer Bundle, which includes *Sid Meyer's Civilization III*, *Civilization IV*, *Ace Patrol*, *Ace Patrol: Pacific Skies*, and *Railroads!*.

The Series entity type also performs a grouping function. Unlike the Collection entity type that reflects distribution-based groupings, the Series entity type is intended to allow Game entities to be aggregated together on a conceptual basis. The Series entity type allows for the expression of ordered and hierarchical groupings of video games belonging to a particular series as established by game companies or by users. For example, the *Super Mario Bros.* series includes *Super Mario Bros.*, *Super Mario Bros. 2*, *Super Mario Bros. 3*, and *Super Mario World*, among many others.

Other Entities

The remaining two entity types are designed as hooks for further expanding the expressive power of the model and connecting other external entities that might be related to particular video game descriptions. The goal of the Franchise entity is to facilitate connections between a specific game entity and other kinds of media entities, such as art books, original soundtracks, etc. The Agent entity (Figure 6) is designed to supply relationships detailing specific roles that agents play in a video game's lifecycle, such as producer, publisher, developer, player, etc. The simple superclass–subclass relationship allows for distinguishing between human agents and corporate agents without affecting the agent role. These extension points are intended to allow interoperability with a variety of models and metadata standards, such as foaf (www.foaf-project.org).

Specific Modeling Challenges

There are many approaches to and ways to conceptualize the domain of video games. This model, as any modeling effort, represents just one particular view of the video game domain and its information objects: that of users' perceptions of video games as published products. We acknowledge that not all perspectives are represented in this model and that our particular perspective will surface unique issues.

Relationship with FRBR Entities

We specifically aimed at representing video games from the perspective of published cultural artifacts that are played by gamers. The model is intended to support the development of information systems tailored to how gamers might want to satisfy their information needs, for example, by finding relevant information about different video games and relationships among them; discovering new games to play according to specific features, etc. Differences in scope and purpose notwithstanding, one of the key issues was the model's potential for overlap with FRBR's Group 1 entities (IFLA, 2009). For this reason, it is important to make evident the relevant aspects that differentiate this model from FRBR and why we believe FRBR is not optimal for the purpose of modeling video games in this particular modeling context.

First, as a conceptual model of the bibliographic universe, FRBR is designed to be flexible in its interpretation and implementation (Coyle, 2014). However, video games arguably do not belong to a bibliographic universe; that is, to a universe of documents originally described based on bibliographic (book-based) characteristics. Yet the assumption seems to exist that bibliographic description—and by extension the FRBR model—is adequate and appropriate for all library materials, including those beyond text-based materials. However, studies show that FRBR breaks down upon application to alternative media collected by libraries, such as visual art (Furner, 2007), hand press materials (Jonsson, 2005), oral histories (Nicolas, 2005), and performing arts (Miller & Le Boeuf, 2005). Baca and Clarke (2007) point out that for many types of art, architecture, and material culture, FRBR Group I entities do not apply. Video games have more in common with these types of alternative media and material culture objects than with traditional printed materials.

Previous application of FRBR to video games has led to understanding these cultural objects in terms of differences in encoding—with variations in the code modeled at the expression level, and packaging at the manifestation level. This approach does not capture the user perspective where users are typically more interested in differences in the gaming experience rather than the underlying technical levels of representation and encoding. In organizing information about video games for gamers, we found that an approach based on what they see as relevant differences and

commonalities among games was better captured by a model that reflects the natural "cognitive biases" of the general audience, who are mostly exposed to video games as published products with which they interact. We believe that the application of FRBR used in this context to date does not capture this cognitive perspective.

Second, the entities in our model differ from FRBR's Group 1 entities. Although the Game entity type can, in some limited senses, be potentially aligned with FRBR's Work entity type, and the Edition entity type with the FRBR Manifestation entity type, none of the entity types in our model corresponds to FRBR's Expression or Item entity types. If we attempt to parallel our conceptualization with the FRBR model, we suspect that average gamers who are seeking information about games will most likely be concerned with a FRBR manifestation level description. However, we feel that variations in platform, interactive content, and localization cannot be expressed in a manner compatible with users' conceptualizations with only a single level of a Manifestation entity. If we must compare to FRBR, both our Edition and Local Release entity types would reflect Manifestation-level descriptions. Expression-level descriptions reflecting variations in encoding as defined by FRBR may be more relevant to game developers, designers and digital curators. FRBR Item-level descriptions will certainly be relevant to specific organizations such as museums or libraries because they need to provide direct user access to materials and describe unique artifacts. However, FRBR Items are ambiguous with respect to what they might actually denote when describing video games, that is, it is not clear whether a FRBR Item should be used to denote a digital object or the physical carrier for video games published in physical cases. We also conjecture that some distinctions in the FRBR model will have less impact on general users seeking game information online. For example, a gamer wanting to know if *Call of Duty* is available for the XBOX 360 is not concerned with the condition of a specific game disc. Similarly, we expect that these distinctions also have less impact on webstores providing descriptions of games to customers.

Third, our model includes several entities that do not exist in the FRBR model that are crucial to representing video games from a user perspective (e.g., additional content, distribution package). In our model, distribution package is intended to be treated as a container rather than an exemplified manifestation as in FRBR. Although Group 1 entities described in FRBR can complement other entities through the specification of relationships, (e.g., adaptations, translations, derivations and successions), there is no straightforward way of representing relationships unique to video games, like the relationship between a game and its available DLC or mods.

Entities versus Attributes

A second key challenge for us that reflected typical issues in data modeling was whether to model the properties

assigned to the core entities as attributes or as relationship types with other entity types. As tempting as it was to explicitly and precisely define the individual properties bundled together by each entity, much of that work has been reserved for the future. Many of the properties within the bundles might be better modeled as relationships among entities in their own right rather than attributes. However, such a specification needs substantial ontological development before its true breadth and depth can be understood.

Matching attributes to the entity that best captured variances across them was also a struggle. Some attributes seemed appropriate for multiple entities within the model. Subjective attributes, such as visual style, were at first attached to the Game entity but were subsequently moved to the Edition entity when evidence of substantial graphical variation between editions was revealed, as noted earlier with the *Final Fantasy* example (see Figure 2). Similarly, several attributes that were originally thought to best fit the Local Release entity were also subsequently shown to better fit the Edition entity. These included attributes like number of players and online features.

One thing that helped us choose and scope the current entities in the model was being able to identify several tiers of variances. For example, the Edition entity arose from the need to distinguish programmatic variances between games in different operating systems or electronic architecture environments. The need to account for the complex nesting chains of variation was a primary concern. These chains of variation are frequently driven by the video game industry's publication cycles. For example, all of the instances of *Super Mario Bros.* games are members of the *Super Mario* series, which also includes instances of the games *Super Mario Bros. 2*, *Super Mario Bros. 3*, and *Super Mario World*, among others. In total, the *Super Mario* series encompasses 19 different instances of Game entities. Table 1 specifically contains the publication history of *Super Mario Bros.* categorized according to our conceptual model.

Super Mario Bros. was released for both the Japanese and North American markets at the time it was first published. During the 1980s and 1990s, new editions were made: *Super Mario Bros. Deluxe* for GameBoy Color in 1999 in the North American and European markets and in 2000 in the Japanese market. In recent years, older video games like *Super Mario Bros.* have developed into a mature market based on the nostalgia of older players. This inspired large numbers of new editions and releases for the Wii and Nintendo 3DS, among other platforms, as noted in the table. The conceptual model we have presented in this article is designed to faithfully preserve these publication events.

Relationships Among Game Entities

The tiered publication relationships are not the only relationships between the entities within the model. *Super Mario Bros.* was first published in 1985 as what Wikipedia calls a "pseudo-sequel" to *Mario Bros.* (itself a spin-off of the popular *Donkey Kong* video game on the Atari game

TABLE 1.   *Super Mario Bros.* publication history.

Game	Edition (variation of title)	Local release	Distribution package
Super Mario Bros.	NES/Famicom	Japan (Sept-13-1985)	Cartridge
		North America (late 1985)	Cartridge
		Europe (May-15-1987)	Cartridge
		Australia (1987)	Cartridge
	SNES (*Super Mario All-Stars*)	Japan (1993)	Cartridge
		North America (1993)	Cartridge
	Game Boy Color (*Super Mario Bros. Deluxe*)	North America (1999)	Cartridge
		Europe (1999)	Cartridge
		Japan (2000)	Cartridge
	Nintendo GameCube (as a part of the *Animal Forest*+ anthology)	Japan (Dec-14-2001)	Disc
	Nintendo GameCube (as a part of the *Animal Crossing* anthology)	North America (Sept-15-2002)	Disc
	Game Boy Advance (*Super Mario Bros.*)	Japan (2003)	Cartridge
	Nintendo GameCube (as a part of the *Animal Forest* e + anthology)	Japan (June-27-2003)	Disc
		Australia (Oct-17-2003)	Disc
		Europe (Sept-24-2004)	Disc
	Singapore Airlines (*Super Mario Bros. Deluxe*)	Singapore (2006)	In-flight system
	Wii Virtual Console (*Super Mario Bros.*)	Japan (Dec-2-2006)	Digitally distributed
		North America (Dec-26-2006)	Digitally distributed
		PAL Region (Jan-5-2007)	Digitally distributed
	Nintendo 3DS Virtual Console (*Super Mario Bros.*)	Japan (Jan-5-2012)	Digitally distributed
		North America (Feb-16-2012)	Digitally distributed
		Europe (Mar-1-2012)	Digitally distributed
	Nintendo 3DS Virtual Console (*Super Mario Bros. Deluxe*)	Europe (February 2014)	Digitally distributed

platform). An open question in our model is whether or not this implies a larger *Mario Bros.* series that encompasses multiple *Super Mario Bros.* series (in a super-class/sub-class type of relationship). One possible solution would be to model *Mario Bros.* as an instance of the Franchise entity type. The potential for multiple relationships to exist among the entity types in our conceptual model complicates the proposed solution for *Mario Bros.* Because of the existence of additional relationships, alternate interpretations for the relationship of *Mario Bros.* to *Super Mario Bros.* can be put forward. One such alternative is that *Mario Bros.* is actually the 20th member of the *Super Mario* series despite being published before the first *Super Mario Bros.* We make this mapping through a relationship called hasPrequel. The hasPrequel relationship, and its symmetrical twin, the has-Sequel relationship, are both relationships that can stand between instances of the Game entity type that are also individually members of an instance of the Series entity type. There are many other relationship types between the entities in the model. For instance, *Super Mario Bros.* has spawned not only sequel games but many spin-offs such as the popular *Mario Kart*, and cross-over games such as *Super Smash Bros.* From these examples we surmise that there are additional relationships between the entities. Surveys and interviews show that relationships like series and universe or franchise are important to gamers when playing games as well as seeking new games to play or purchase (Lee et al., 2014b; Lee et al., 2014c). We are currently in the process of identifying and defining all of the relationships between the various entities within the conceptual model.

Game Expansions

Another lingering issue surrounds the notion of game expansions. The Additional Content entity type was developed in response to conceptual issues concerning expansion content for video games. During the course of our analysis, it was difficult to discern at which point expanded content and functionality cause the creation of an entirely new game edition. For instance, the latest entry in the popular computer game series *Sid Meyer's Civilization* was released in 2010 as *Civilization V* (*CiV*). Our model would designate *CiV* as an instance of the Game entity type. In 2012, a substantial expansion for *CiV* called *Gods & Kings* was released that introduced several new game play features, such as systems to simulate religion and espionage within the game. Because *Gods & Kings* is an example of a separate expansion (it is sold separately and independently from the game) it does not fit the model's definition of an instance of the Edition entity type. Further complicating matters, in late 2013 a new "edition" of *CiV* called *Civilization V Gold* was released. *Civilization V Gold* combined the core *Civilization V* content with the *Gods & Kings* expansion content.

We were left with a dilemma of how to best describe *Civilization V Gold*. Is it a new Edition entity, a new Local Release entity, or a new Distribution Package entity? After much discussion, we decided that it should be represented as a new Edition of the game *CiV*. This is because we do not believe that adding the expansion content to the game, at least in most cases, is going to significantly change the core

user experience with the game itself, and thus necessitate a new instance of Game Entity. According to the way our model defines a new instance of an Edition entity, the new edition *Civilization V Gold* also then results in new instances of the Local Release and Distribution Package entities that serve to capture the more finely grained aspects of the newly published edition.

This decision leaves the separate *Gods & Kings* expansion content nominally outside of the scope of the model. This is because it is content that is published separately but cannot be experienced directly by the gamer unless they already have the video game it expands. Because we felt it essential to represent separate add-on content and because we had additional examples of separate add-on content, such as *Persona 3 FES*, we developed the Additional Content entity type. As explained earlier, the Additional Content entity type explicitly captures information regarding expansions and similar add-on or aftermarket content that is published separately from any instances of an Edition of a video game. In many of the cases we examined (e.g., *CiV*, *Persona*, *Disgaea*, *Ultima*), expansion content provides a richer experience for players by adding additional narrative, new places to explore, minigames, and similar features; however, the core experience, (i.e., what gamers are supposed to take away from playing the game) does not deviate much across Editions of a game.

As noted, the Local Release entity is intended to capture variances in games because of both linguocultural region and time. The time dimension is intended to allow for distinct and known software patches to be represented in the model. Patches are a concern not just for video game archivists and scholars but also for players. Some patches add or delete content in addition to realigning a game's codebase to conform to system updates. An example of this can be seen with *Civilization V's* Fall 2013 Patch that introduces a series of changes, some radical in nature, to previous gameplay. The changes instigated by the patch are cataloged on the *Civilization* game's community forums at http://forums .civfanatics.com/showthread.php?t=511953. Among the changes made by the patch are the removal of certain gameplay features and the addition of entirely new gameplay features. This suggests that some patches may overlap considerably with the additional content entity.

Another challenge regarding patches is the lack of well-documented patch releases. Anecdotal evidence from a conversation with Nippon Ichi Software of America's customer service reveals that they do not keep a record of patches once released. Additionally, from a user's perspective, game patching on platforms such as PS3, Wii, and Android is an automated and opaque process. This implies that metadata on software patches and video game versioning may be highly volatile with little evidence beyond a recent version number to imply that a video game has been substantially altered through patches. A systematic survey of game publishers should be carried out to establish how and even if patch metadata is being preserved, especially for semiclosed environments like Sony's Entertainment Network, Microsoft's Xbox Network, and Nintendo's Network.

Like patches and expansions, Downloadable Content (DLC) presents several notable gray areas with which our team grappled during the design of the conceptual model. DLC is a relatively recent innovation. A notable issue with DLC is that it is not universally available—the availability of DLC is limited to certain linguocultural markets. There is also exclusive DLC available based on time or source of the original game's purchase: customers who purchase a new game early enough, or purchase a game from a specific retail store such as Amazon or GameStop, or who purchase other game-related media may be entitled to special DLC.

Because of the linguocultural limitations, our initial intuition was to model DLC as part of the Local Release entity; however, the fact that DLC is marketed separately, along with the exclusivity of certain DLC, caused a great deal of concern because of the possibility of proliferating Local Release entity instances to accommodate the numerous DLC instances. Because *Civilization V Gold* matches what we would define as an instance of the Edition entity type, the separate *Gods & Kings* expansion content is left without an adequate entity to describe it. This led to the development of the Additional Content entity, which allows us to separate optional content from integrated content.

The addition of the Additional Content entity also allowed us to accommodate modifications. Unlike DLC, which is created and released by game developers and distributors, mods are a form of user-generated content for video games. They most frequently occur for PC games with codebases that are more accessible to end users. Entire modding communities have emerged around games such as *Sid Meyer's Civilization*, *Ultima*, *Doom*, and *Warcraft*, all of which have very rich libraries of homemade additional content. Through mods, community members are able to radically alter the local instance of their video game. Some of these alterations change, delete, or add entirely new gameplay features, whereas others alter core narrative features in favor of alternate narratives. Examples from Steam's *CiV* community (http://steamcommunity.com/workshop/browse/?appid =8930) include such colorful mods as "Arnold Schwarzenegger Civilization," "DCU [DC (Comics) Universe] Civilizations," and a host of others. These mods add to or alter *CiV's* content to such an extent that it raises the question of whether or not a player using one of these mods is still playing what our conceptual model understands to be the video game *CiV*.

This issue of modification is not unique to the conceptual model we present here. It is also evident in other bibliographic conceptual models like FRBR, which must address modifications like derivative works. It may be the case that the Additional Content entity is an entity with relationships to each of the model's core entities (Game, Edition, and Local Release). Exploring this issue further will be a key part of our future work.

Future Work

The complex relationships among video games present significant challenges to data modeling. In this article we

presented a preliminary conceptual model attempting to represent the most important relationships among published and distributed video games from a user-centered perspective. As video game development and distribution technologies continue to evolve, it is increasingly common to have multiple releases and re-releases of a single game for numerous platforms, packaged in a number of different editions (e.g., ports, remakes, spin-offs). As previously noted, further in-depth study of these relationships is currently underway.

Many of the modeling challenges discussed here leave unanswered questions about the success of the model. As a model designed with users in mind, it is especially critical to solicit feedback. Evaluation of the conceptual model by end users through interview and survey instruments is ongoing. User feedback regarding the following six criteria (adopted and modified from Kesh, 1995, Moody & Shanks, 1994, and King & Reinold, 2008) is being gathered:

1. Accuracy: Are the entities and relationships accurately represented?
2. Understandability: Is it intuitive and explains the terms in a straightforward way?
3. Extensibility: Is the model easily extensible without requiring a major restructuring?
4. Conciseness: Is the model free of redundant information features and relationships?
5. Usability (users): Is the model convenient and useful for end users?
6. Usability (catalogers): Is the model convenient and useful for catalogers?

A great deal of work still remains to be done at the strategic level as well. In a union catalog, the data described using this model will certainly be shared among multiple organizations. Therefore, any data models developed from this conceptual model will need to conform to linked data standards. As this process evolves, many of the entity attributes in the current model can be removed in favor of directly linking to ontologies that best describe the phenomena that the conceptual model attempts to capture, for example, ontologies for narrative genres, settings, mood, etc.

Likewise, the matter of additional content for video games, like patches and mods, needs to be thoroughly explored to better understand how it affects video games, video game communities, and video game publishers. Keeping track of mods may not be a scalable practice for cataloging workflows. Adopting a linked data format presents one possible solution to the scalability issue. By adopting a linked data format, it may be possible to leverage end users' knowledge and expertise by allowing them to link and describe mods they have created, freeing catalogers to focus on other areas of description.

Acknowledgments

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