Ontology Enrichment of Video Games with LLMs

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Abstract
Video games have evolved into a prominent cultural and economic phenomenon, increasingly recognized as a powerful medium across diverse domains, including art, education, and social interaction. This evolution has necessitated a more nuanced and systematic analysis of game universes, along with the development of methodological frameworks to facilitate their understanding. Ontology, defined as a formal representation of concepts and the relationships among them within a given domain—whether for human interpretation or machine processing—has been employed as a means to model and describe the structural and semantic components of video games. The primary objective of this study is to identify and articulate existing gaps in the literature like relations, roles, locations, tasks, and voice acting concerning the ontological modeling of video game universes and to address these gaps by proposing an ontologically grounded perspective for analyzing virtual worlds. This paper introduces ontological models for core game elements, including character relationships, role typologies, spatial representations, mission structures, and voice acting. Each proposed ontology is examined in terms of its capacity to enhance our understanding of the underlying dynamics of game worlds. Furthermore, the study explores the integration of Large Language Models (LLMs) as a means of enriching ontological structures, with an emphasis on moving beyond manual approaches to support scalability and semantic depth.

Keywords
Ontology, video games, video game universes, ontology enrichment, LLM

1. Introduction

Since the late 20th century, video games have emerged as a significant cultural and economic phenomenon, driven by rapid technological advancement. Initially characterized by rudimentary mechanics, video games have evolved into complex systems encompassing expansive virtual environments, sophisticated narratives, and online platforms that engage millions of users worldwide. Beyond their entertainment value, video games now serve multifaceted roles in domains such as art, education, and social interaction. This transformation has necessitated more rigorous conceptual frameworks and analytical methods to better understand the structures and dynamics of game universes. The industry's growth is exemplified by platforms like Steam, which, as a dominant force in digital distribution, has surpassed 40 million active users and 120 million registered users. Today, the global video game market commands an estimated value exceeding 200 billion USD, underscoring its substantial influence and reach [1,2].

An ontology constitutes a formal, explicit specification of a shared conceptualization, encompassing the definitions of concepts, their properties, and the interrelations that may exist within a given domain, whether for human understanding or machine interpretation [3]. Ontologies play a critical role in facilitating knowledge sharing, interoperability, and reuse

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across diverse systems and applications. While rooted in philosophical traditions, the concept of ontology has been extensively adopted in contemporary domains such as knowledge management, artificial intelligence, and information systems. In the context of digital infrastructures, ontologies provide a structured framework for representing domain-specific terminologies, their semantic meanings, and the logical relationships among them. By enabling the systematic organization, analysis, and reuse of complex knowledge structures, ontologies serve as foundational tools for enhancing semantic clarity and computational reasoning.

The intersection of video games and ontological modeling constitutes a critical avenue for comprehending the underlying structures and dynamics of virtual environments. Each video game encapsulates a distinct universe comprising interactive objects, characters, narrative elements, and rule-based mechanics. Systematically representing and analyzing the relationships among these components facilitates deeper insights into game design, player experience, and critical game studies. Within this context, a domain-specific ontology for video games offers a robust conceptual framework for modeling, analyzing, and comparing diverse game worlds. Motivated by this perspective, the present research seeks to identify the foundational constituents of video game universes and to advance the analytical discourse surrounding virtual worlds through an ontologically grounded approach.

1.1. Related Work

De Martino et al. prepared a detailed ontology of video games in their study. In general, there are classes on the genre, gameplay and mechanics of the video game. Regarding the universe, they added the character class and narrative class with 2 subclasses as playable and NPC [4].

In their study, Parkkila et al. approached video games through an event-centric perspective, decomposing gameplay into discrete in-game events. They conceptualized player interaction by formulating a range of SPARQL queries aimed at analyzing event-driven behavior—for example, identifying subsequent player actions following specific events, quantifying the frequency of event occurrences, and determining which games feature the highest number of in-game sales events. This modeling was achieved by associating players with specific in-game events. In terms of representing the game universe, their ontology includes classes related to in-game items and their respective functions or purposes within the gameplay context [5].

In their study, Leon et al. sought to formalize the mechanics of a mobile video game through the development of an ontology. This ontology is intended as a conceptual tool to support the analysis of games and to facilitate structured discussion and exploration within the field of game design. Rather than prescribing normative guidelines for designing successful games, the ontology aims to identify abstract design patterns, commonalities, and differences across diverse game examples. As a case study, the authors modeled the mechanics of Pac-Man, which serves as the foundational basis of the ontology. However, due to its reliance on a single, highly specific game, the ontology presents challenges in terms of generalizability and adaptability to other game genres or design contexts [6].

In his study, Michael Debus conducted a critical analysis of existing video game ontologies in the literature, identifying several key limitations and gaps. In response, he developed a new ontology designed to address these shortcomings. This ontology organizes game mechanics under six principal categories: time, goals, space, randomness, entities, and disconnected aspects. Each of these categories is further refined through detailed subcategories, allowing for a more granular and comprehensive representation of game mechanics. In terms of modeling the game universe, the ontology includes dedicated classes for both Location and Time [7].

Galanina et al. proposed a novel ontology for video games, incorporating a diverse set of classes to capture the multifaceted nature of game design and player experience. The ontology includes conceptual categories such as **Platform**, **User Interface**, **Atmosphere**, **Gameplay**, **Features**, **Narrative**, and **Player Needs**, thereby offering a holistic framework for analyzing video games. As a case study, the game *Braid* was integrated into the ontology to demonstrate its applicability and expressiveness. In terms of modeling the game universe, the ontology specifically includes classes related to **Atmosphere** and **Narrative** [8].

In his study, Alexandre Delcos critically examined a range of theoretical approaches to the ontology of video games, each of which seeks to establish the identity conditions of these digital artifacts. While acknowledging the strengths and contributions of these perspectives, Delcos contends that none of the existing theories offers a fully satisfactory account. However, this critical stance does not imply that the identification of robust identity criteria is unattainable. Rather, he suggests that more sophisticated iterations of these theories may overcome the limitations of their current formulations. Delcos concludes that the field remains in a formative stage, with considerable potential for further exploration and multiple promising directions for future research [9].

For remaining literature, a brief information provided in Table 1.

Table 1
Literature overview

Name	Classes	Evaluation
Modeling the Video Game Environment: the VideOWL Ontology [4]	Classes on the genre, gameplay, and mechanics of the video game.	Character and narrative classes.
Ontology of Video Game Virtual World [8]	Classes for platform, gameplay, user interface and player needs.	Atmosphere and narrative classes.
Unifying Game Ontology: A Faceted Classification of Game Elements [7]	The most detailed ontology. There are many classes	There are location and time classes.
An ontology for video game interoperability [5]	A class for video game events. SPARQL queries from the player events	Classes about items in the game and their usage.
An ontology for mobile video games [6]	Based on the Pacman game.	Not generic

2. Method

We propose a set of ontology enrichment strategies aimed at addressing the identified limitations and conceptual gaps present in the existing literature. Strategies are listed below:

1. Relationship
2. Role
3. Location
4. Task
5. Voice acting

By using taxonomy, we proposed here, we prompt the LLM to generate instances. We prompt it to use WikiData and Dbpedia, which is public and open to access. We obtain video game universe ontology by using Middle-out approach. Because we design taxonomy. Then we want to link to concrete data (Wikidata, DBpedia). We need both conceptual clarity (ontology structure) and scalability (adding new games easily).

Circles are classes, bold circles are instances, and squares are properties in the following figures.

2.1. Enrichment of relationships

One of the most vital components contributing to the vitality and continuity of a game universe is the presence of its characters. These entities not only inhabit the virtual world but also engage in dynamic social interactions, forming alliances and rivalries that reflect the complexities of real-world relationships. Such relational dynamics are essential for constructing and interpreting the narrative structure of a game. A notable characteristic of these relationships is their potential to evolve over time, often shifting across different installments within a game series. For instance, Kiryu and Nishiki are depicted as close allies in *Yakuza 0* (Sega, 2015), whereas their relationship transitions into one of rivalry in *Yakuza 1* (Sega, 2005). This temporal variability renders a static classification—such as ‘friend’ or ‘enemy’—inadequate for capturing the full complexity of their interactions. To address this ontological limitation, the model proposed in Figure 1 introduces a dedicated **Relationship** class, instantiated separately for each game. Each instance encodes the relationship’s participants, its nature (e.g., friendship, rivalry), and its contextual linkage to the specific game in which it occurs. This approach enables the representation of temporally and contextually contingent character relationships, allowing for more accurate semantic modeling across narrative timelines.

Figure 1: Relationship part

2.2. Enrichment of role

The number of playable characters in video games is typically limited to one; however, this design choice is often closely associated with the game's genre. For instance, PlayStation All-Stars Battle Royale (Sony, 2012), which belongs to the fighting game genre, features multiple playable characters. In this context, the player selects a character to control in combat scenarios, resulting in a diverse roster of playable entities. Conversely, in God of War (Sony, 2005)—part of the original series from which one of the Battle Royale characters, Kratos, originates—Kratos is the sole playable character, with rare exceptions. Thus, Kratos functions as a playable character across two distinct game franchises. A similar situation arises in the Yakuza series: Saejima, who is a playable character in Yakuza 5 (Sega, 2012), reappears as a non-playable character (NPC) in Yakuza 6: The Song of Life (Sega, 2016). These examples demonstrate that a character cannot be rigidly categorized as either a playable or non-playable entity without consideration of contextual variation across titles.

To address this ontological ambiguity, the model illustrated in Figure 2 is proposed. In this design, Playable Character and Non-Playable Character (NPC) are defined as subclasses of a more general Role class. Each role instance includes metadata specifying the role type, the associated character, and the game context in which the role is instantiated. This structure enables a more flexible and semantically accurate representation of character roles, allowing for variability across different games within a franchise.

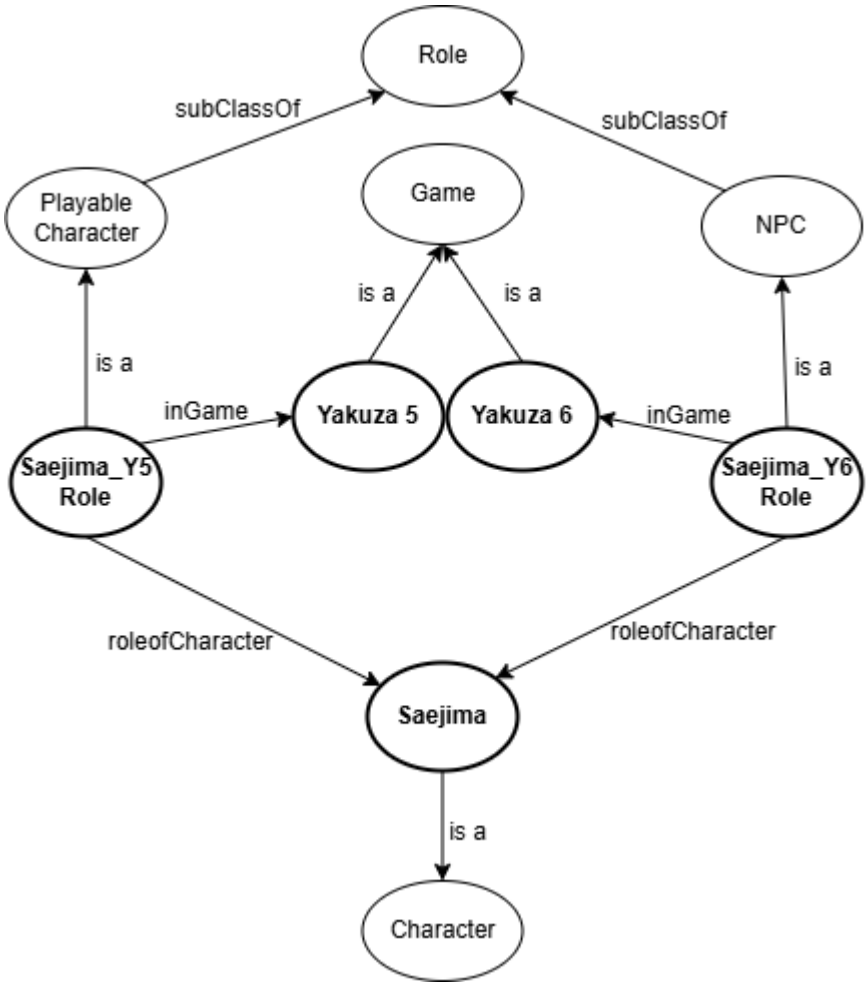

Figure 2: Character roles part

2.3. Enrichment of locations

Locations are undoubtedly among the most salient elements when conceptualizing a game universe. The memorability and distinctiveness of the environments in which gameplay unfolds significantly contribute to the immersion and perceived coherence of the fictional world. In many cases, video game locations are inspired by, or directly modeled after, real-world geographies. Kingdom Come: Deliverance (Warhorse Studios, 2018) features in-game architectural structures that closely resemble their contemporary real-life counterparts. According to the developers, the game's geography was intentionally adapted from present-day locations with the guiding question: “How would this place have appeared in the 1400s?”—thereby integrating historical inference into the virtual environment.

To formally capture this referential structure within an ontological framework, the model presented in Figure 3 is proposed. This ontology introduces a new GameLocation class, which contains semantic links to both the video game in which the location appears and the real-world location it references. The ontology also incorporates the dbo:location class from DBpedia to facilitate interoperability and integration with external linked data sources. This structure enables the retrieval of geospatial and historical reference data for in-game locations, thereby enriching the semantic representation of game environments within the ontology.

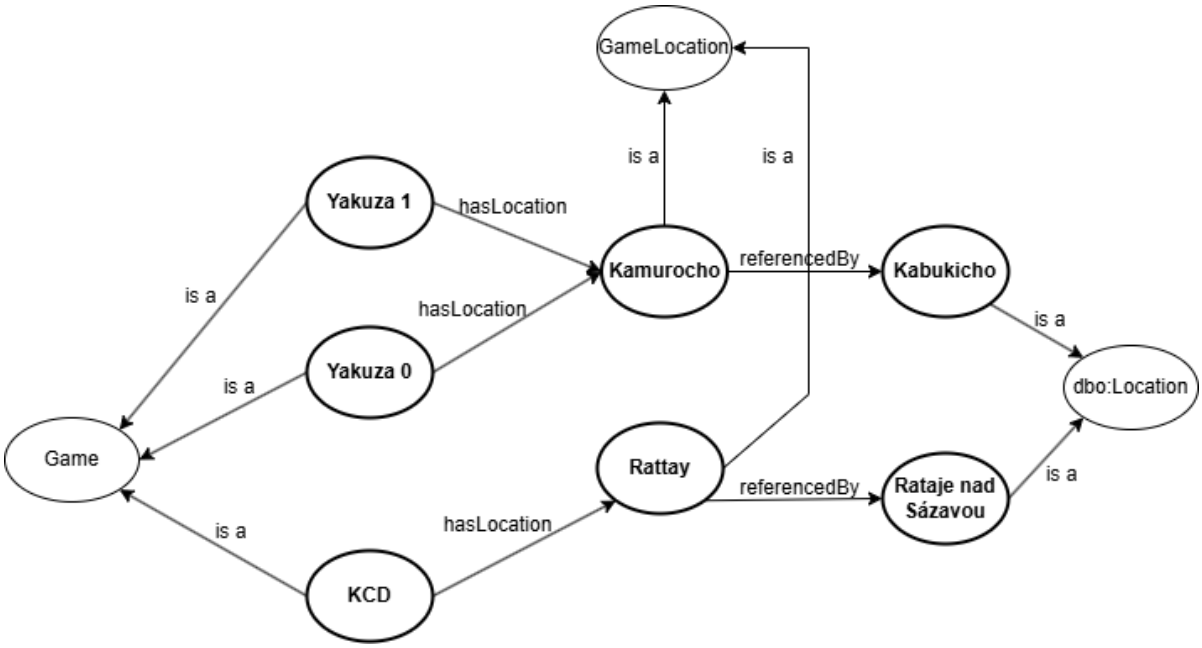

Figure 3: Game locations part

2.4. Enrichment of task

Video games frequently convey the narrative progression of their universes through structured mission systems, underscoring the significance of quest hierarchies and task dependencies within virtual worlds. Such systems not only drive gameplay but also serve as key mechanisms for world-building and player engagement. As illustrated in Figure 4, a segment of the main questline in The Witcher 3: Wild Hunt (CD Projekt, 2015) reveals a node-based structure in which access to certain quests is contingent upon the completion of preceding tasks. This dependency model reflects a directed graph or tree-like structure, where quests are interlinked through conditional logic.

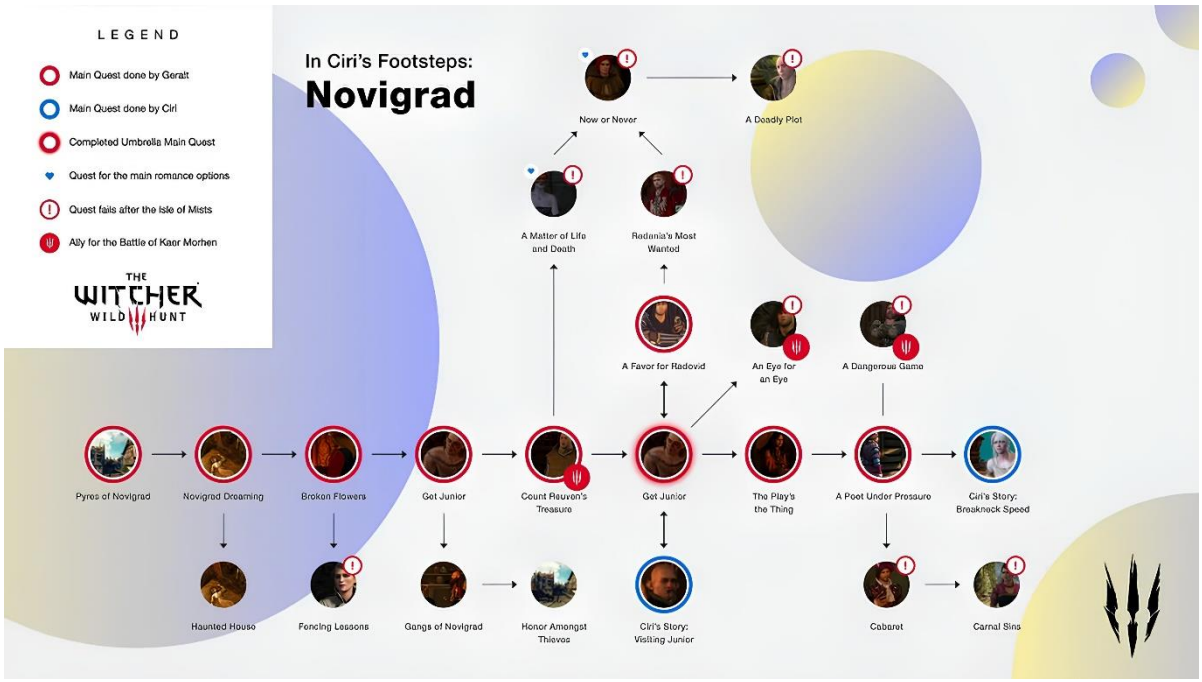

Figure 4: The Witcher 3: Wild Hunt (CD Projekt, 2015) main task series [10]

To formally represent this structure, the ontology presented in Figure 5 is proposed. In this model, the generic Task class is subdivided into two subclasses: MainTask and SubTask. Instances of these classes encapsulate properties such as the subsequent task (via a nextTask relationship), the characters associated with the task, and the game context in which the task occurs. Through traversal of the nextTask relationships, the complete quest tree of a given video game can be semantically extracted and analyzed. This ontological structure enables a formal and scalable approach to modeling narrative progression in complex game universes.

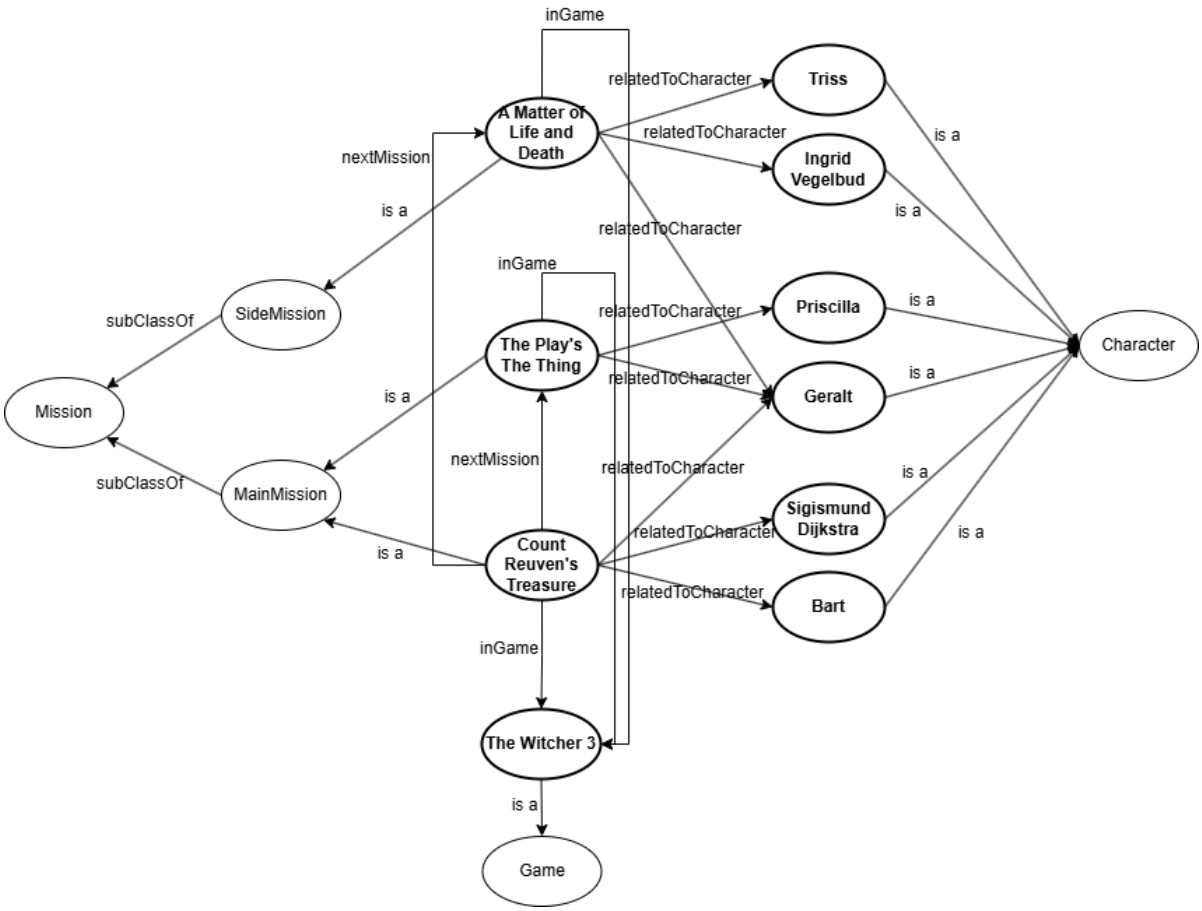

Figure 5: Task part

2.5. Enrichment of voice acting

One of the significant elements contributing to a character's identity and memorability in video games is the performance of the voice actor. The voice not only reinforces the emotional depth of the character but also enhances the player's immersive experience. For instance, Takaya Kuroda has consistently voiced the character Kazuma Kiryu throughout the Yakuza series and is also known for his work in anime. However, if a different actor were to voice the character in a future installment, the statement "Kazuma Kiryu's voice actor is Takaya Kuroda" would no longer be universally applicable across all instances of the character.

To address this issue, the ontology illustrated in Figure 6 is proposed. This model introduces a VoiceActing class, which includes semantic relationships linking the voice actor to the character voiced, the specific game in which the voice performance occurs, and other relevant contextual data. To support interoperability with external ontologies, particularly those related to anime, the model is further enriched with properties linking voice actors to anime characters and the corresponding series. This ontological structure allows for temporal and contextual variability in voice assignments, ensuring the model remains valid even as casting changes occur over time.

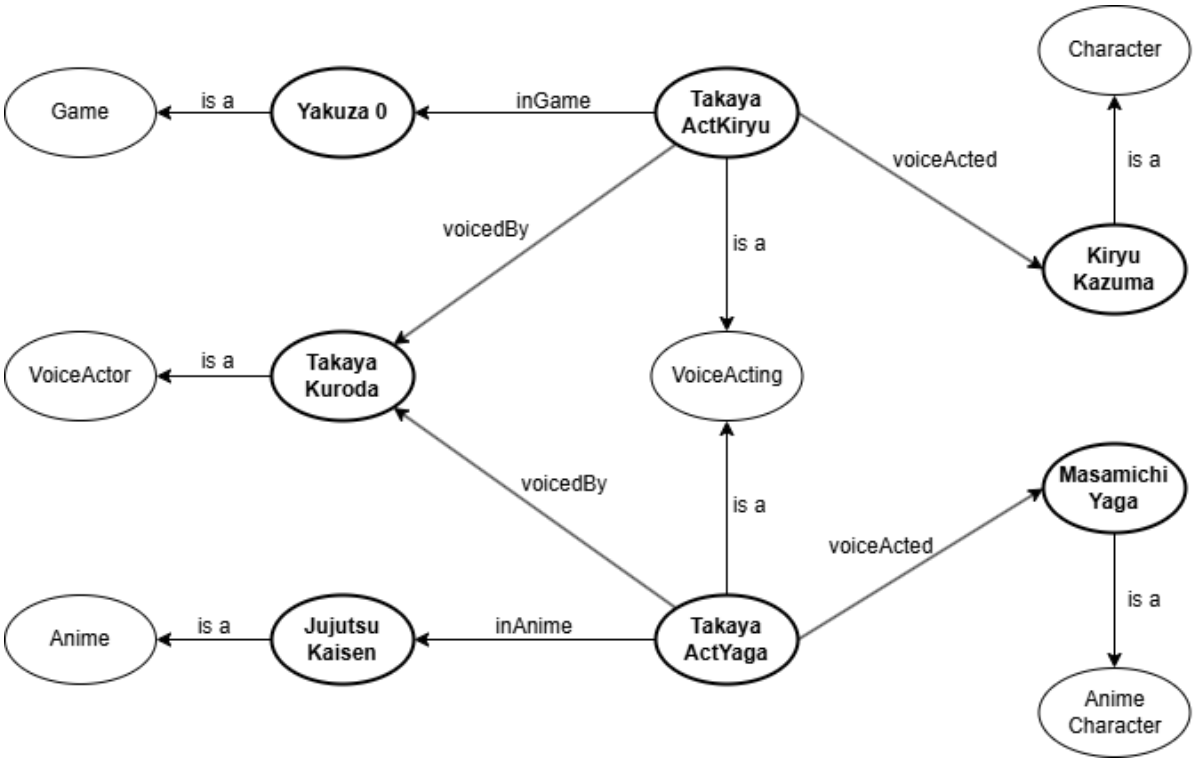

Figure 6: Voice acting part

3. Result and Conclusion

3.1. Result

The designed, created, and proposed ontology has released in the URL https://oguzhan.menemencioglu.info/video_game_universe_ontology.

The obtained ontology by using LLMs enrichment, manual and generated by LLM were also released in the same URL in different versions. Generative AI is used for top 10 selling video games to scale the research. We have tested the ontology and it's OOPS!-clean.

3.2. Conclusion

This study addresses existing gaps in the literature concerning the ontological representation of video game universes, with particular emphasis on the limitations and potential challenges these gaps may pose. As video games and their associated fictional worlds grow increasingly complex—both structurally and narratively, their influence on player experience becomes more pronounced, highlighting the necessity for systematic and semantically grounded methods of analysis. In response to this need, the study proposes a series of novel ontology designs, evaluating their contributions to the structured analysis and deeper understanding of video game universes.

The proposed ontologies aim to provide explicit formalizations of key components of game worlds, including characters, spatial environments, interpersonal relationships, character roles, mission structures, and voice acting. By modeling these elements with greater semantic precision, the ontologies support more robust interpretations of game content and facilitate cross-game comparisons. This ontological framework not only enhances analytical depth within individual titles but also contributes to broader comparative studies across game genres and franchises.

Created taxonomy is manual contribution to fill the gap in literature. In this research, Generative AI generated instances by using human created taxonomy. This approach is autonomy and partially hybrid.

Acknowledgments

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Declaration on Generative AI

In the text we have mentioned how ChatGPT was used. To highlight the usage under the declaration, we feed & prompt the ChatGPT with our contribution taxonomy and ask to create the instances with the public information in WikiData and Dbpedia for top selling video games, according to the taxonomy.

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