VRKG-CollaborativeExploration - Data-driven Discussions in the Metaverse

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Abstract. The metaverse is an immersive, multi-user, virtual world where humans, represented by avatars, can entertain, socialize, and collaborate. This demo proposes VRKG-CollaborativeExploration, a Virtual Reality application that enables users to join thematic and collaborative data-driven discussions in the social metaverse where data are retrieved from Knowledge Graphs via SPARQL queries.

Keywords: Knowledge Graph \cdot Collaboration \cdot Exploration \cdot Virtual reality \cdot SPARQL queries

1 Introduction & Background

The term metaverse was first coined by the novelist Neal Stephenson in 1992 in his science fiction novel "Snow Crash" [4] to denote a virtual universe created beyond the real one where humans could freely access a 3D space that reflects the real world through digital agents (avatars) and interact with each other. As a new term, researchers discussed the metaverse with broad insights without reaching a consensus [7]. Mark Zuckerberg defined the metaverse as an embodied online world where people can work collaboratively and socialize with avatars, often in the form of headsets or glasses [10]. Common metaverse features are persistent, multi-user, immersive environments [4,7], where immersion is achieved by digital technologies such as augmented reality, virtual reality (VR), and mixed reality [3], avatar-based platforms [6], where humans spend time performing their day-to-day activities, such as entertaining and socializing [5], where any user can create virtual rooms freely accessible to others.

This demo proposes VRKG-CollaborativeExploration, a VR application where users can join thematic virtual rooms and perform collaborative datadriven discussions supported by structured data. We achieved this by exploiting Knowledge Graphs (KGs) as the data source and SPARQL query results to model topics of interest. The proposed application, tested on Meta Quest Pro, relies on VR technologies by using a lightweight head-mounted display to give the user a sense of visual and audio immersion. Users will be immersed in a meta world of knowledge represented by 3D sphere of knowledge (SK) (a.k.a. the nodes of the KG induced by SPARQL query results) and may navigate this world using relations between SK (a.k.a. the links of the KG induced by SPARQL query results). During an exploration session, users may have realtime interaction with other users (represented by avatars) using gestures and voice communication.

Our proposal grounds on the literature of 3D visualization of ontologies and KGs, such as Ontodia3D [2], that leads to the possibility of representing data interactively and entertainingly. Thanks to the collaborative dimension, the opportunity to freely author publicly available and persistent virtual rooms via SPARQL queries, and an avatar-based representation of users able to mimic hands and head movements, our proposal moves a step forward in the direction of enabling thematic collaborative discussions in the social metaverse. While research combining metaverse and KGs mainly focuses on the interoperability issues and data modeling aspects [1,5,8,9], we focus on the collaborative exploration and data-driven discussion enabled by a 3D representation of the Semantic Web data in the metaverse. A video of our proposal is freely available¹.

2 VRKG-CollaborativeExploration

VRKG-CollaborativeExploration is a VR application where users can join data-driven discussions enabled by a 3D representation of a KG induced by SPARQL query results that determine the topic of the thematic virtual rooms. Instead of proposing a VR application bounded to a specific data source, VRKG-CollaborativeExploration lets users choose the topic of interest from a publicly available and persistent repository of virtual thematic rooms determined by SPARQL query results.



Fig. 1. Approach to enable data-driven discussions in the metaverse by querying KG.

The proposed workflow at the basis of VRKG-CollaborativeExploration is graphically represented in Figure 1. A publicly available web application² lets

¹ Video presenting the demo: http://www.isislab.it:12280/submission/VRKG.mp4

² Web application http://www.isislab.it:12280/applications.html

users author a virtual room by performing a SPARQL query on a user-defined working SPARQL endpoint. The SPARQL query results is constrained as it serves as an input for the visualization step, and it must retrieve subject, property, object, with their respective labels and subject description. While labels will be used on nodes and edges in the metaverse to improve readability, textual descriptions will provide further details on demand based on users' interactions.

Any executed query stores a persistent virtual room modelled by a CSV containing query results and a JSON file to configure the VR application in a public repository. Each room in the metaverse has a topic strictly connected to the retrieved SPARQL query results. For example, figure 2 shows users who joined the thematic virtual room dedicated to stars and constellations available in DBpedia. In each virtual room, users can collaboratively discuss with others using a 3D representation of the KG as evidence. Hence, users can manipulate



Fig. 2. Example of the demo in action while exploring the *stars* room in the metaverse. The screen projects what each participant joining the metaverse can explore via the Meta Quest Pro. The two avatars reflecting the real users and the KG on the background modeling starts and constellations retrieved by querying DBpedia are observed by a third user out of the scene. Users can see each other in the metaverse even if they join the same room from geographically distant physical places.

the KG induced by SPARQL query results where nodes and edges are referred to by English labels, focus on nodes and visualize node details on dedicated panels, and perform a data-driven discussion enabled by the possibility to manipulate the graph in the same virtual place and discuss each other about the explored content using real-time voice streaming, overcoming any geographical distance.

Users can also customise the graphic room profile. At the moment, authors can choose between *Universe* and *Blue sky*. The source code is publicly available on GitHub with an Open License³.

Technical details. Our implementation of VRKG-CollaborativeExploration is developed using the Unity game engine 2021.3.2fl version. The main packages used are Mixed Reality Toolkit 2.8 to handle the input from the headset touch controllers, Photon Unity Networking 2.39 to implement the multi-user capability. The application has been tested on Meta Quest Pro headsets. The resulting graph is limited to a maximum of 50 nodes total and 16 edges per node. This limit has been handpicked to both avoid performance issues (due to the complexity of the graphics and physics simulation in VR) and to not create complex and overcrowded graphs which are difficult to navigate for the users.

3 Demonstration and Conclusions

The metaverse is in an early developmental stage but is promising to occupy prominent space in the next phase of the Internet [5]. This demo focuses on enabling data-driven discussions in the metaverse implemented by the VR technology exploiting KGs as a data source. It represents an opportunity to entertain and engage users in data-driven thematic discussions and KG exploration without requiring any technical skills in SPARQL query language. SPARQL knowledge is only required when users want to author virtual rooms in the metaverse. In future directions, we will support Prezi-like presentations by predefined navigation of nodes and edges configured by a presenter.

Demonstration. During the demo, we will show how to configure the VR application⁴ to join a virtual room, such as the stars room, by accessing to a publicly available SPARQL query results repository, and how to author a data-driven discussion room in the metaverse. The demo will take place by exploiting the Meta Quest Pro and by collaboratively exploring KGs with remote users.

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 $^{^3}$ Source code: https://github.com/DanieleBubb/VRKG-CollaborativeExploration

⁴ APK link: http://www.isislab.it:12280/submission/VRKG.apk

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