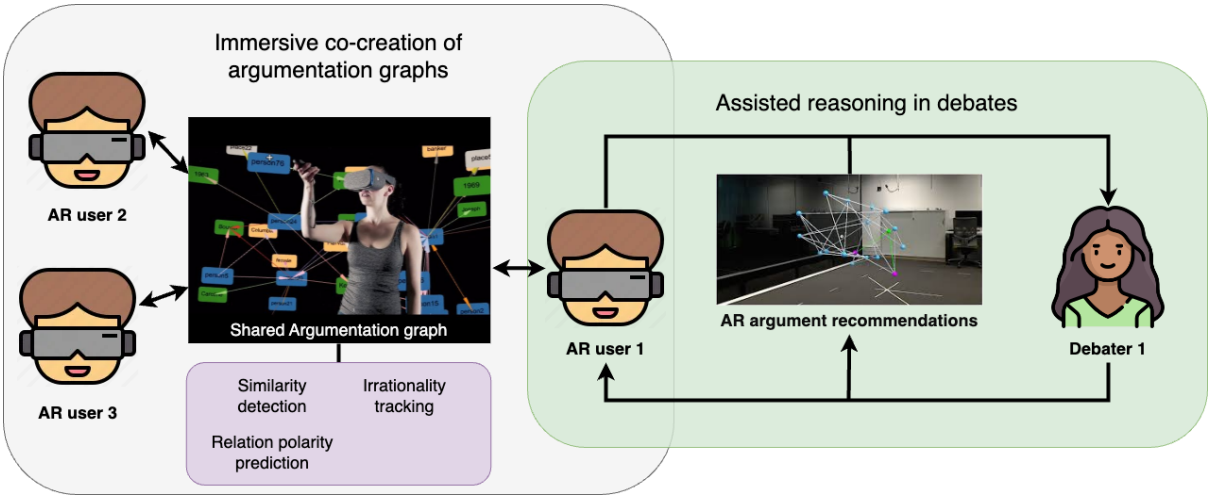
HAGARICE (Harnessing Argumentation Graphs in Augmented Reality for Immersive Co-Creation and Exploration) aims to develop the tools for an improved collaborative creation of argumentation graphs and their exploitation for assisted reasoning.

Argumentation [7] is a non-monotonic formalism that allows reasoning with a large number of inconsistent data and to manipulate abstract and unstructured knowledge. Existing online argumentation platforms[1,2] often depict a debate using a directed graph, offering a visual representation that enhances human grasp of the arguments and their interconnections. These platforms have various applications in domains such as education or e-democracy, where they facilitate broad public involvement in the development of laws. However, there are several problems preventing their adoption for assisted reasoning: **(1 - Information overload)** As these platforms become increasingly prevalent, the volume of arguments and options within these systems continues to grow exponentially. This poses a significant hurdle for human analysts, who struggle to manually track changes, understand the various arguments and their relationships, and make sense of the vast amount of information; **(2 - Lack of guidance)** Users are not assisted in constructing their various arguments within a debate. This deficiency can result in irrationality, omission of critical information, and the establishment of relationships with incorrect polarity [5], particularly when confronted with complex arguments; **(3 - Incomplete graphs)** Users introduce new support or counter arguments into the system in reaction to a specific local argument. Typically, these new arguments may be redundant or engage with remote arguments that users have not taken into account, resulting in incomplete graphs. Consequently, the conventional argumentation semantics [4,2] outlined in the literature become inapplicable; and **(4 - Asynchronous reasoning)** Current research in real-time assisted reasoning within real-life debates using argumentation graphs remains limited. Existing approaches predominantly involve manual argument formalization or users selecting arguments from dropdown menus [10], interrupting the natural flow of the debate.

Our aim is to address these challenges by providing new solutions and delivering a prototype tool. *Leveraging augmented reality (AR), we seek to enhance collaborative creation and utilization of argumentation graphs during debates, specifically restricting ourselves to assisted reasoning in the e-democracy domain* (see Figure 1). Dr. Srdjan Vesic, as the principal investigator of the 2023 AGGREEY ANR project[3] (ANR-22-CE23-0005) and a key member of HAGARICE, will contribute his extensive expertise and guidance in crafting relevant use-cases. Dr. Frédéric Armetta, member of the SyCoSMA team (LIRIS), will also contribute his expertise in multi-agents reasoning systems, particularly focusing on integrating large language models and speech-to-text modules.

The integration of AR within argumentation remains unexplored, yet we anticipate numerous advantages compared to screen-based interfaces, particularly for *identified issues 1, 2, and 4*. Specifically, we hypothesize that AR will enable spatial representation of argumentation graph and enhance comprehension of intricate discourse relationships; it will facilitate precise tracking of user interactions within the graph, enabling accurate localized feedback; and importantly, it will offer superior assistance by seamlessly overlaying information during real-time user interactions, elevating the overall user experience.



The HAGARICE project will also make many concrete contributions to knowledge and advance research in domains including cognitive psychology, human-computer interaction, and computing science disciplines such

[1] https://www.kialo.com/
[2] http://debategraph.org
[3] https://aggreey.github.io/index.html

as multi-agent systems, explainable AI (XAI), machine learning, and argumentation. The overall work plan is split into four work packages which are described below.

WP1: Immersive co-creation of argumentation graphs. We will develop custom machine learning models to track user irrationality, detect similarities, and predict the polarity of relations to ease the user's burden during the argument elicitation phase. Our newly developed models will be evaluated against existing methods based on transformer models (such as hierarchical BERT [11], RoBERTa [1], Longformer [9]). This strand of research will assist the user during the co-creation of the argumentation graph while the automatic predictions of the relation polarities and the detection of similarities will greatly increase the completeness of the argumentation graph. Although the prototype will mainly be used in the e-democracy domain, we plan to study the generalization performance of the developed models compared to zero/one-shot capabilities of large language models (such as Llama 2 70B, OpenAI GTP4, or Mistral 7B]). This research will benefit researchers working in machine learning, especially argument mining and natural language processing experts.

WP2: Real-time assisted reasoning. We will provide automatic techniques to highlight arguments of interest within the argumentation graph and alleviate user information overload. While gradual semantics [2] for argumentation graphs can efficiently score arguments with respect to their acceptability (i.e., how much they are contested), we plan to develop semantics that score with respect to other characteristics like values, beliefs, and vote among others. We will leverage Shapley value, drawing inspiration from [3], to craft more comprehensive *impact measures* [6] that explain gradual semantics to the user, and set up a principle-based framework to compare impact measures. To provide real-time assistance to the user during a debate, we will craft a recommendation framework based on the state of the debate and the argumentation graph. The theoretical models of this work package will be invaluable to XAI, HCI, and argumentation researchers .

WP3: Implementation. This WP will develop an AR application that combines the ML models for co-creating argumentation graphs of WP1 and the techniques for real-time assisting reasoning of WP2. Resource-intensive models such as Distil-Whisper [8] (for speech-to-text) and custom large language models will be deployed on a virtual machine equipped with an Nvidia A40 GPU. This GPU is currently available to the SyCoSMA team and will be accessed through APIs. The mock-up of this platform will be created in the early phase of the project and two iterations of the prototype will be implemented and used for the evaluation in WP4.

WP4: Evaluation of benefits. Following the previous work of Dr. Bruno Yun [12] showing how graphical representation of argumentation graphs enhances human compliance with principles, we hypothesize that these benefits will persist or improve in an AR environment. To evaluate the co-creation abilities of our prototype, we will perform human experiments while recording metrics for user engagement, completion time, complexity of the arguments, completeness of the graph, or irrationality among others. For the reasoning assistance, we will track the relevance of the recommendations, the latency, and the impact on the debate.

Other details. We are planning to publish several articles in local/international conferences (e.g., COMMA, IJCAI, AAAI, AAMAS, or KR). We will establish a project website to provide updates and news regarding the project's progress and developments. The code produced during this project will be uploaded on GitLab. The methodologies and results of user trials will be published on the OSF[4] website.

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[4] https://osf.io/