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TOWARDS A RELIABLE OFFLINE PERSONAL AI - ASSISTANT BASED ON QUESTION ANSWERING MODELS AND SPACE KNOWLEDGE GRAPHS FOR LONG DURATION SPACEFLIGHT

Abstract

Future crewed missions to the Moon and Mars will have to contend with significant bandwidth and latency limitations, resulting in restricted delivery of ground support and lack of direct supervision. In search of a solution, AI-based personal assistants are attracting increasing attention for their ability to supply astronauts with contextually relevant information in real time. Notably, experimental deployments of the Crew Interactive MObile companion (CIMON) aboard the ISS have yielded promising results, with CIMON being praised for providing crew members with access to repair manuals and other media in an efficient and unobtrusive manner.

As recently demonstrated by ChatGPT, such AI tools drawing on large language models (LLMs) have the capacity to partake in a human conversation whilst finding answers to complex questions across a variety of topics. However, in order to produce correct responses, autoregressive language models (such as GPT-3.5 underlying ChatGPT) have to be trained on samples from a given text corpus. However, answers to questions where information is absent from training data are not fact-based and may contain incorrect information.

Yet, when considering AI-based personal assistant systems for astronauts, a low-latency internet connection is typically unavailable, necessitating local execution of the model on onboard hardware. Most importantly, answers must be trustworthy and directly available, which is not guaranteed by models such as ChatGPT while they are also reliant on an online connection.

To solve this gap, we propose using knowledge graphs as explicit knowledge representations that can be validated to contain only accurate information, thereby resolving the problem of incorrect or even false information that troubles assistants based on autoregressive language models.

Knowledge-graphs structure data by linking information into graph-like structures, but can usually not be directly queried using natural language; Instead, knowledge-graph question-answering models must be utilized in order to allow for natural interaction between knowledge-graph data and astronauts. Such models can be stored and executed on local hardware, thus bypassing issues stemming from low latency. Reflecting on these advantages, this paper proposes a new hypothetical approach based on space-knowledge-graphs and question-answering models as a means for overcoming the aforementioned drawbacks of systems such as CIMON and ChatGPT. In identifying and elaborating key technical challenges and proposing potential workarounds, we lay the foundation for AI-based personal assistants tailored to aiding astronauts during long-distance missions.