Paper ID: 79692
student

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Engineering - Methods, Processes and Tools (1) (4A)

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LEVERAGING LANGUAGE MODELS SEMANTIC SIMILARITY CAPABILITIES TO FACILITATE INFORMATION REUSE IN SYSTEM ENGINEERING

Abstract

Model-Based System Engineering (MBSE) is a powerful approach for designing complex engineering systems, which also generates valuable data after each conducted study. However, currently there are few to no approaches for reusing this information in a systematic way. In this paper, we propose using state-of-the-art Natural Language Processing (NLP) methods and a graph database to analyze data from past missions and facilitate the design process of new missions. More specifically, the capabilities of language models are leveraged to determine semantic similarities between text inputs, to fine-tune them to extract domain-specific concepts, or to classify text input into specific categories. In particular, we develop techniques for analyzing a database of past mission requirements, as well as the physical and functional architectures of past missions. The methods include the ability to identify similarity and logical traceability with requirements from past missions, as well as propose possible verification methods with a trained classifier, for a given new requirement. We also investigate the physical and functional architecture of an engineering system in form of an unified engineering model. The engineering model then provides a decomposition of the single components in the engineering system and the functional dependence between them. Based on input from a new design, these can then be queried for similar designs choices and functionalities from past designs by again leveraging the abilities of semantic similarity. Finally, we investigate how these approaches can be used to control if the provisions defined in the requirements are actually upheld in the physical architecture. A trained language models is used to extract the core information from associated requirements and compare it to the information defined in the engineering model. By leveraging NLP and graph search techniques, we believe that this approach can lead to more efficient and effective design processes for complex engineering systems by reusing information from past designs. The proposed techniques have been developed and tested on real mission studies requirements and design datasets in collaboration with Thales Alenia Space.