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IDENTIFYING RISK FACTORS IN SPACE MISSIONS: AN AI-BASED APPROACH

Abstract

Risk management is a risk assessment and analysis method aimed at identifying and assessing risk factors in critical technological systems for the purpose of improving their safety and performance. There are, however, only a handful space mission-level risk classification methods in the literature. NASA was the first to develop such a method considering eight classification parameters. In all the classification methods in the literature, the parameter selection is done by experts in the field, thus requiring a lot of human effort and rendering the processes prone to subjectivity and misidentification of critical parameter errors.

In this paper, we use natural language processing and machine learning (ML) for detecting the critical factors of a mission. Our automated ML method, namely Latent Dirichlet Allocation (LDA), is a statistical technique, widely used for topic discovery in text documents. A topic is considered to be a set of similar terms that taken together form a critical factor. A corpus of 6375 scientific papers related to space and risk management, extracted from the Scopus platform, was selected to evaluate the topic quality of LDA. As a result, LDA achieved a coherence score of 0.525 and delivered a set of eight meaningful factors. Among them, six are identical with those manually decided by the experts, while two (manned mission and mission destination) are currently omitted by the existing frameworks.

The contribution of this work is two-fold. On the one hand, we provide an automated way to detect the most relevant and critical factors of space missions. Our method can be used to minimize the time and subjectivity of the process of determining missions risks, an auxiliary tool to the panel of experts traditionally tasked with it. Also, our methodology is not tied to space missions specifically, but it could be potentially generalized for critical systems in other sectors as well. On the other hand, we provide an evaluation of the parameters considered for space mission risk assessment. The results show that our automated approach provides quite similar results to the current parameter set which has been manually decided by the space agencies experts increasing the confidence to this work's validity. Finally, our analysis shows that there might be extra parameters that could be potentially relevant, which are not currently considered by existing methods.