

# Unsupervised Machine Learning Methods for the Analysis of Extravehicular Activity by Lakshmi Kanikkannan

Abstract:

## **MOTIVATION**

Since 1965, there have been 246 total US extravehicular activities (EVA) in low earth orbit. Typically, EVAs are considered successful if they accomplish all the scheduled tasks. A data-driven approach to defining EVA profiles could help us better understand factors that contribute to EVA success. With renewed interest in deep space exploration, such understanding could aid in mission planning.

## **HYPOTHESIS**

Unlike conventional scientific inquiries in which we seek to falsify a null hypothesis, this analysis is largely exploratory. By using unsupervised machine learning techniques, we seek to discover patterns of EVAs that may lead to insights about EVA efficiency and effectiveness.

## **METHODS AND RESULTS**

Available data included information on EVA phased elapsed time (PET), number of planned tasks completed and uncompleted, number of get-ahead tasks completed, and the number of anomalies recorded. We used information about the calendar year of the EVA to reflect the progression of technology over time and the number of the EVA in the overall US sequence to reflect agency experience over time. We performed k-means cluster analysis to illuminate EVA profiles in the data. Owing to the strong correlation between PET and the other variables, we conducted the clustering both with and without PET. Based on scree plots and heuristic analyses, we determined that four clusters optimally characterize the data. This finding was independent of whether or not we included PET in the clustering.

## **CONCLUSIONS**

Unsupervised machine learning techniques, particularly k-means clustering, proved useful in the exploration of EVA data, allowing us to develop data-driven EVA profiles. Clustering demonstrated that EVA profiles are defined by more than PET and suggest that other factors, such as task difficulty and the ability to adapt to anomalies, should be taken into consideration. Future directions include incorporation of data from other space agencies, information about the astronauts who performed the EVAs, as well as addition of other features in the data.