Monitoring Astronaut's Performance Based On Patterns Assessment

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Abstract

Nowadays, there are several health problems that we can encounter, and it is possible that we are experiencing some of these problems yet not aware of it. We are working on a smart system that is capable of monitoring astronaut's daily actions. On a daily basis, astronauts interact with a control panel to work and complete on some of their tasks. The objective of this work is to monitor astronaut's actions while using this interface. By monitoring their daily base actions, we can create statistics about the everyday performance using machine learning algorithms and learning which is the most appropriate for this problem, can help us achieve these results. By doing so we can determine if there is any abnormal action during their work hours, that can put in any harm these astronauts. Not all of the machine learning algorithms are most adequate for this problem, we determined that some of the most appropriate algorithm for this problem is K-Means Clustering. We can use this algorithm to demonstrate abnormal actions made by the astronauts, as well as, use K- Means to determine more than one problem at a time. After performing several tests, we have determined that this algorithm works properly for this particular problem.

Introduction

Astronauts have deep space missions to the moon, and eventually Mars and beyond. Long-term space missions will be more difficult to handle due to their duration which become a big challenge to the crewmembers. Intelligent systems are needed to maintain and control the space vehicle. These complex systems require to be controlled properly, therefore, demanding an efficient and effective Human-Computer Interfaces. Some of the approaches that we can consider is the use of machine learning in at least one of the Human-Computer Interfaces to help monitor crewmember's actions. It will analyze interaction patterns that could potentially lead to mental state problems and bad performance.

Human Computer Interfaces

The system can see a trend in usage degradation and provide caution and warning messages due to sub-performance display and control usage (based on know optimal usage from the user.) For critical events such as a fire, the system should be able to correct user errors that could lead to a hazard by initiating automatically the correct system command. To better understand the use of new human computer interface systems applications concepts, a means of developing and demonstrating said capabilities is needed.

Background

The Translational Research Institute for Space Health are working on a similar project that by using emerging technologies they can help astronauts stay healthy in space. With this on mind, I started to research on finding an efficient algorithm that can be implemented on computers or control panels that astronauts use daily to fulfill some of their tasks. This strategy will detect massive downfalls and provide warning messages due to lack in performance.

Problem Statement/Hypothesis

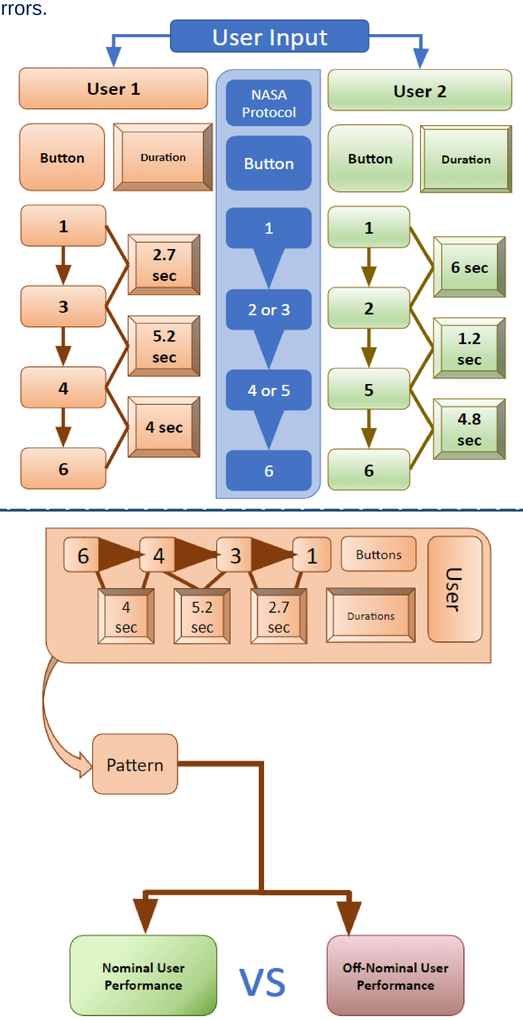
Problem: The problem resides that Astronauts must adapt to a very challenging environment, where they will be isolated, will face periods of heavy workloads, be away from friends and family, and they will not be able to breathe fresh air or even eat fresh food. This is not the end of their problems, they also experience sleep problems, due to the lack of natural light, as well as anxiety problems or depression.

Hypothesis: By analyzing their use of any human computer interface we can determine a drop in astronaut's performance and if necessary, provide warning messages to prevent any accident.

Algorithm Used: K-Means Clustering is a common data analysis technique that is usually used to get intuition about the structure of the data. It can be used to compare data points from different groups for example errors and delays of seconds on the use of the system. With this method We can verify old data points with newer data points to notice any major difference in the data.

Methodology

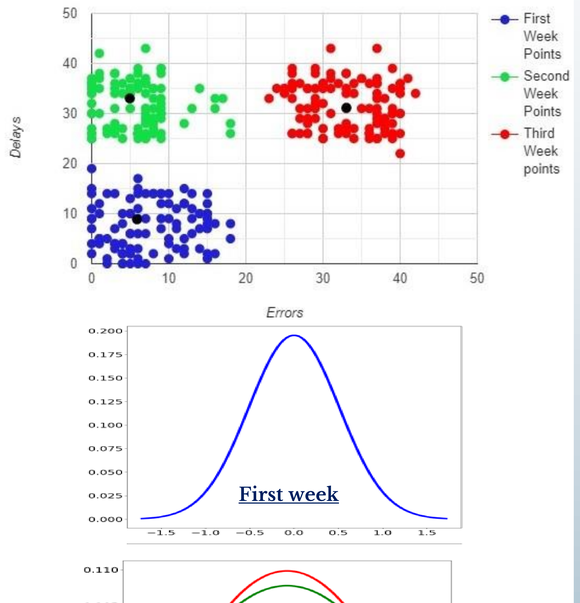
In this representation, it can be seen how we determine one of the variables, time taken, which is the time that takes to each user to move from one action to another, on the panel. The second variable, pattern execution, can determine if crewmembers are using the right pattern and not making any errors.

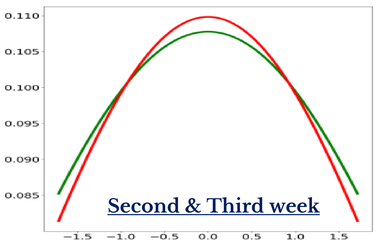


Results

PyCharm was used to obtain gaussian curve representation using the same type of data points but in different week periods. The first gaussian curve (blue) uses data points from obtained during the first week. The following gaussian curves (green and red) uses data points from the following second and third week. The two variables used are *Time Taken* and *Pattern Errors*, in here you can see how we can compare the difference between the two months.

Cluster Mean Data





Conclusion

Simulation results have shown that this algorithm is reliable and adequate for this problem. The representation of the Normal Probability Density Function shows how the gaussian curve changes as the performance of the astronaut decreases. The implementation of this type of strategy in current technology could prevent critical accidents in space.

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Sponsors/Acknowledgements:

This material is based upon work supported by the National Science Foundation under Grant No. 2034030. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation