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Author: Mr. Naveed Naimipour
National Aeronautics and Space Administration (NASA), United States

Dr. Haleh Safavi
NASA, United States
Dr. Harry Shaw
NASA GSFC, United States
Prof. Mojtaba Soltanalian
University of Illinois at Chicago, United States

MACHINE LEARNING ALGORITHMS FOR ERROR CORRECTION IN SPACE OPTICAL COMMUNICATIONS SYSTEMS

Abstract

The advancement of machine learning algorithms for large scale real-time data has imminent applications in facilitating error correction systems. With the surging development of optical telecommunications for space applications, the importance of error correction has become more apparent than ever. Specifically, the exploration of forward error correction code (FEC) methodologies will be instrumental in developing the standards for optical communications in space. In this paper, we implement machine learning algorithms known as 2-Hard and 2-Soft Clustering to assist FEC coding while processing large amounts of data. The algorithms' effectiveness and precision with clustering big data facilitates the correction of errors in large data sets. Such a task is typically what FEC codes and conventional clustering struggle to accomplish efficiently.

The execution of the algorithms before encoding and after decoding allows for a simple cross referencing of clusters to determine the effective error regions. It should also be noted that conventional clustering techniques lack precision when processing missing or incorrect data, but 2-Hard and 2-Soft Clustering show great promise in overcoming such an obstacle. With the error regions in hand, it will no longer be needed to repeatedly check the entire data set for errors. Thus, error correction becomes immensely more efficient, especially with space communications where processing large data volumes has been a challenge.

A unique benefit of such a methodology is that there is no extra security risk since the clusters themselves have no influence on the data being transmitted. The clusters are arbitrary connections made by the algorithm that should remain consistent, but those connections mean nothing in relation to the data itself. In other words, the clustering data on its own, or even the comparisons, demonstrates the existence of an error, but does not reveal the data values.

Results of extensive MATLAB simulations are presented to show the ability of the algorithms to identify error regions that would increase the processing efficiency. The simulations show the original data before encoding and after decoding, the true clusters that result from that data using conventional clustering, and the resulting clusters from the machine learning algorithms to test the error regions that would be implemented for big data that needs correcting. Such algorithms demonstrate the potential of a real time self-correcting system that could precisely and efficiently identify and correct errors for large scale data transmission in space communications.