High Performance Computing Job Outcome Prediction By Mining System Logs

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Introduction

As the high performance computing (HPC) community anticipates the exascale computing era, automated computer maintenance and error prevention becomes increasingly important. In this work we apply machine learning techniques to automate computer job monitoring. We draw from system logs to extract features and use these feature sets to create models for predicting job state. We evaluate the feature set viability and the models on a variety of classification tasks.

Background

High Performance Computing (HPC)

A high performance computer is a powerful computer consisting of many compute cores called “nodes”. HPC machines and facilities provide massive amounts of monitoring data regarding system health.

System Logs (Syslogs)

Syslog messages are an inhomogeneous collection of computer error messages that are recorded by the job scheduler and are a critical component for failure analysis. The syslog from each compute node are combined into a single file. Syslog messages give insight to system health and are crucial for failure analysis.

Job Logs

A job is an allocation of resources to a user for a specified amount of time. Jobs are recorded by the job scheduler (e.g. Moab, Slurm) in a job log file. Each entry in the log file contains information related to the job, such as the user, the start and end time, the nodes that the job ran on, and the job state.

Feature Extraction | Numerical and Temporal

We use the following from each syslog group:

- Average of numbers
- Standard-deviation of numbers
- Average time between messages
- Standard deviation of time between messages
- Count of numbers
- Total time between first and last message

Evaluation

For each feature combination, we evaluate the model on three tasks: predicting each class, predicting ok/problem, and one vs. rest. We use precision, recall, and F1 score as our evaluation metrics.

Results

We have addressed our research questions of job state prediction accuracy and feature set viability. As seen below, all feature set models performed the best on the ok/problem classification task. Overall, the job state can be predicted with an F1 score of above 95% with the ok/problem classification task and above 70% with the multiclass and one vs. rest classification tasks (excluding the Infomap cluster feature set). The model feature set which performed the best was the term frequency-inverse document frequency (TF-IDF) cluster distribution with the numerical and temporal analyses.

Acknowledgements

We thank Sean Blanchard and Nathan DeBardeleben, both at USRC and LANL, for domain expert input. We also thank Professors Julie Carrington, Daniel Myers, and Mark Anderson at Rollins College for supporting this work as an honors thesis.

References