DATA SOURCES AND THEIR CHARACTERISTICS

Before developing a statistical model from CIPRES, we performed a basic exploratory analysis. The results of this analysis suggest that no single feature (or simple combination of features) in the data is likely to predict job failure.

**CIPRES Database**
Between November 2011-April 2015, roughly 450K CIPRES jobs were submitted to HPC resources at the San Diego Supercomputer Center (SDSC). Of these 450K jobs, 93% were marked by the CIPRES software as successful whereas the remaining 7% were marked as failed.

**XSEDE Central Database**
The XSEDE Central Database (XDCDB) is a PostgreSQL database that contains job accounting data for all jobs submitted to XSEDE resources and allows us to get more details about the CIPRES jobs.

**Inca**
Inca is a user-level monitoring tool used to verify cyberinfrastructure software and services. There are more than 780 Inca tests running on XSEDE at different frequencies to monitor HPC deployments, grid software and services, and management services.

JOB FEATURES AND CLASSIFICATION
We model the prediction of job outcomes as a problem in binary classification. Let $x_i \in \mathbb{R}$ be a vector of features that have been collected for the $i$th job in our science gateway and let $y_i \in \{0, 1\}$ denote the label indicating whether the job has failed ($y_i=0$) or succeeded ($y_i=1$). Given a set of training instances $(x_1, y_1), \ldots, (x_n, y_n)$ and the corresponding labels $(y_1, y_2, \ldots, y_n)$, the task is to learn a model $M$ that can predict the conditional probability $P(y|x)$ that a new job $x$ fails to complete ($y=0$) or terminates successfully ($y=1$).

**CIPRES**
- resource: (0 for trestles, 1 for gordon)
- tool name: (t1, t2, …, t46) where $t_i=1$ for tool used in job, otherwise 0
- last job result

**XSEDE Central Database**
- wall-clock-time duration
- number of nodes
- number of processors
- queue type (0 for normal, 1 for shared)

**Inca**
- test results: {T1, T2, …, T780} where $T_i = 0$ if last test failed or 1 if last test passed
- error messages: bag-of-words (# of times words occur in the error message)

FUTURE WORK
- Continuing to explore additional data for our model such as user identifiers, machine load data, and other monitoring data.
- Using our predictions to inform CIPRES users and developers of the likelihood that their jobs will successfully complete. Eventually, when CIPRES adds more resources, we can also guide users to schedule jobs on the resources where they are most likely to succeed. Our goal is to enable CIPRES users to conduct more useful research by wasting less cycles on failed jobs. For example, in 2014 a 50% prediction of failed jobs would have saved 900K compute core hours that were used on failed jobs.
- Reviewing our caching strategy for a better time-memory trade off. To optimize the processing time of the algorithm, we load large portions of the data in memory. However, since the dataset is large, this often leads to memory issues.
- Building an automated monitoring analysis service and applying it to gateways like the Neuroscience Gateway and GridChem.