Machine learning technique for complex systems behavior prediction and anomaly detection for distributed data processing and management.

WLCG demonstrator R&D Project Proposal

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Project participants

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- LHC Experiments
  - [A] ATLAS
  - [B] LHCb
- Institutes
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Duration 1.5 year, 2016-2018
RF team contribution 4 FTE/year

R&D Project Motivation and Status

- We propose a one and half year (2016/06 – 2017/12) R&D project to evaluate how machine-learning techniques could be used for complex systems behavior prediction and anomaly detection.
- We will investigate the behavior of two vital systems for (at least) two LHC experiments: Data Management and Workload Management in Distributed Computing infrastructure.
- ~3 FTE will work on it from ATLAS and ~2 FTE from LHCb, the effort will be funded from grants received for R&D projects in Russia, USA and Europe.
- R&D will be conducted not only for tuning different predictive models such as artificial neural networks or gradient boosting trees, but also for optimization of analytical scheme.

Motivation for the Production System

- Production System is a large, complicated, distributed system (up to 30M jobs/month, up to 2M jobs/day running on 250K cores);
  - *Hard to automatically detect anomalies*
  - *Hard to simulate;*
  - *Hard to predict its behaviour*
- Very thorough logging;
  - we shall review and improve the strategy to get data into ES/HADOOP.
- Machine learning (ML) algorithms are computationally intensive, using them on raw logs (database rows) is infeasible.
- However, it is possible to use machine learning algorithms if we limit their input to some aggregated metrics of production system;
- The most important metrics are :
  - Time To Complete for tasks
  - resource utilisation
  - percentage of failed tasks/jobs
  - running/pending jobs ratio.

R&D Research Plan 2016-17 (preliminary)

- Creation of experiment-agnostic ontology of distributed computing related entities
- Definition of mapping (dictionaries) between experiment-specific terms to that ontology (LHCb, ATLAS)
- Collection of anonymized historical data for experiments involved and they will be used to define common rules for WMS and DDM systems
- Identification of storage scheme for metadata (topology, state and log activity) and implementation of the API for storing / accessing the data
- A wide range of quality metric for anomaly detection / prediction will be compared and set of the most relevant will be selected
- A set of predictive models will be constructed and evaluated. Several prospective models will be selected (prototype) and evaluated against chosen metric over collected data
- Specification of guidelines for creation and evaluation of new predictive model