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Asterism: an integrated, complete, and open-source approach for running seismologist continuous data-intensive analysis on heterogeneous systems

We present Asterism, an open source data-intensive framework, which combines the Pegasus and dispel4py workflow systems. Asterism aims to simplify the effort required to develop data-intensive applications that run across multiple heterogeneous resources, without users having to: re-formulate their methods according to different enactment systems; manage the data distribution across systems; parallelize their methods; co-place and schedule their methods with computing resources; and store and transfer large/small volumes of data.

Asterism’s key element is to leverage the strengths of each workflow system: dispel4py allows developing scientific applications locally and then automatically parallelize and scale them on a wide range of HPC infrastructures with no changes to the application’s code; Pegasus orchestrates the distributed execution of applications while providing portability, automated data management, recovery, debugging, and monitoring, without users needing to worry about the particulars of the target execution systems. Asterism leverages the level of abstractions provided by each workflow system to describe hybrid workflows where no information about the underlying infrastructure is required beforehand.

The feasibility of Asterism has been evaluated using the seismic ambient noise cross-correlation application, a common data-intensive analysis pattern used by many seismologists. The application preprocesses (Phase1) and cross-correlates (Phase2) traces from several seismic stations. The Asterism workflow is implemented as a Pegasus workflow composed of two tasks (Phase1 and Phase2), where each phase represents a dispel4py workflow. Pegasus tasks describe the in/output data at a logical level, the data dependency between tasks, and the e-Infrastructures and the execution engine to run each dispel4py workflow.

We have instantiated the workflow using data from 1000 stations from the IRIS services, and run it across two heterogeneous resources described as Docker containers: MPI (Container2) and Storm (Container3) clusters (Figure 1). Each dispel4py workflow is mapped to a particular execution engine, and data transfers between resources are automatically handled by Pegasus. Asterism is freely available online at http://github.com/dispel4py/pegasus_dispel4py.
Docker Container 1
Pegasus and dispel4py

List of stations

preproc

D4py

Preprocessed data

postproc

Cross-correlated results

Docker Container 2
OpenMPI cluster

List of stations

Read Traces

Trace Prep

Write Prep.

Preprocessed data

Docker Container 3
Storm cluster

Preprocessed data

Read Prep

xCorr

Write xCorr Results

Cross-correlated results

dispel4py postprocess workflow
Automatic translation: Storm topology

Automatic translation

MPI application

decim

detrend

demean

remove resp

filter

white

calc fli