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Numerical Simulations and Databases in Astronomy and their integration in Grid: FRANEC and BaSTI as a practical example

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Overview

Stellar evolutionary computations are extremely important to face a wealth of astrophysical problems, but they are also extremely demanding in terms of computing power and data storage. The Bag of Stellar Tracks and Isochrones (BaSTI) is a theoretical astrophysical catalogue that collects fundamental data sets involving stars formation and evolution. To create this database it is necessary to run a large number of stellar evolutionary computations.

The Grid seems to be a promising answer for data storage and processing needs of BaSTI, so we managed a number of experiments aimed at designing and defining an application specific environment for the stellar simulation software and its interaction with the BaSTI database. We demonstrated that the "gridification"of stellar evolution code is not only possible but even extremely convenient in terms of data processing speed and data sharing; it can be a valuable instrument to support Astrophysical research.

Impact

The most part of Astronomers still perceive the Grid as a tricky technology, hard to approach and use; the learning curve is felt to be too steep to be worthwhile for astrophysical research. This perception is in principle influenced by two factors: a) Grid e-Infrastructures are currently unable to fully meet the requirements coming from A&A applications; b) the lack of user-friendly interfaces like Grid Portals able to hide the complexity of the Grids. As illustrated above, the results achieved through this work contribute to fill in this gap. Services developed on top of the gLite middleware are those specifically requested by the stellar evolutionary code and by the BaSTI integration in Grid; the integration in P-GRADE hide the complexity of the underlying infrastructures and services, enabling users to access and exploit all provided functionalities through a few mouse clicks; in this way the barriers currently hampering the wide adoption of the Grid to solve astrophysical problems are lowered.

As illustrated above, the planned activity will adopt a modular approach; instead of producing a monolithic portal starting from the current version of P-GRADE, separate re-usable portal components will be developed; each of such components, therefore, can be re-used several times to serve other astrophysical applications in the future. The positive implication of this modular approach, therefore, is an easy and quick production of new astronomy-specific portals for the benefit of other astrophysical applications.

In conclusion, the work illustrated brings an important contribution for a quick expansion of the adoption of Grid platforms in Astronomy. Astronomers can effectively exploit the Grid technology for their scientific work. In return, the Grid engages an important community able to contribute with new services and resources for the benefit of all end users of the Grid.

Description of the work

The work carried out so far focused on the porting in Grid of FRANEC, the stellar evolutionary code used to populate BaSTI. To allow users to run FRANEC simulations we created some specific services on gLite general environment. These services were used to submit both Synthetic Model Runs (SMRs) and Full Isochrone Runs (FIRs). We designed these Grid tools to be modular and to foster the integration with new software components; in this way subsequent upgrades of the system are eased (this is necessary if we want to allow users to develop new code).
We plan now to refine these services starting form these first successful experiments. The most important step is the integration of the already implemented services in the P-GRADE Grid portal for the benefit of end users. Further improvements of the FRANEC code will be implemented allowing the automatic computation of some parameters necessary to run the FRANEC pipelines. The necessary components of the P-GRADE portal have been identified and some of them will be modified to answer the requirements of our applications. What we want to do is to extend the portal with a tool enabling users to provide only data requested to run a FRANEC simulation without worrying about the provision of other data structures requested to port the job in Grid (configuration file, input, output, etc...). The construction of an appropriate workflow for P-GRADE, therefore, is in charge of the application. The user, thereafter, will submit the workflow as usual through the tools provided by the portal.
At last, the BaSTI database will be integrated in the portal. Thanks to this integration, end users will be able to discover if the database already includes a given stellar evolutionary model; if not a new appropriate simulation can be run in Grid and the related results will be temporarily stored in a hidden version of the BaSTI database to be validated and normalized to be subsequently inserted in the official in-production version of BaSTI.

URL

http://albione.oa-teramo.inaf.it/

Conclusions

The work carried out so far demonstrated that a Grid environment can be successfully used to run numerical simulations, that can be used to create and update a community service; the BaSTI catalogue and its feeding FRANEC evolutionary code are clear examples of such simulations. The implemented system hides some of the complexity in the use of the Grid; it was expressly designed to be similar to the one used by Astronomers to submit jobs on a workstation. This strategic choice proved to be successful, as end users are not requested to acquire know-how on the Grid technicalities to run their jobs on the Grid Infrastructure.
It is now necessary to complete this activity to: a) produce a complete set of stable, full-functional services to fully address the requirements coming from this kind of simulations; b) allow astronomers to make their own computations of evolutionary predictions by accessing the Grid computing resources from a dedicated Grid web portal based on P-GRADE.

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