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An advanced Grid data management for distributed analysis of neuroimaging studies

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The SPM software package, based on the comparison of the candidate case to normal cases through a Statistical Parametric Mapping (SPM) algorithm, is largely used by the neurological research community to quantify ipometabolic patterns in brain PET/SPECT studies for the early diagnosis of Alzheimer's Disease (AD). Since the accuracy of ipoperfusion maps is strictly related to the number of normal studies compared to the test image, a large set of images of normal patients is required for an accurate statistical analysis. However, due to ethical issues and to high costs of neuroimaging technologies, PET/SPECT studies for normal patients are very rare. Moreover, because of privacy and security issues, the images of normal subjects cannot be freely moved between sites or published by the centre that collected them. As a consequence, only doctors working at very large institutions, locally owning large databases of normal images, can usually carry out SPM-based analyses. With our application, doctors from small peripheral hospitals can remotely access large sets of normal PET/SPECT images provided by different medical research institutes and extract the information needed for the statistical analysis without moving the original image files. Grid technologies allow easy access to distributed data as well as to distributed computational resources. In order to provide a user friendly interface, remote access to SPM is being made available through the Italian Portal of Neuroinformatics. The portal contains a section entirely dedicated to the statistical analysis of PET/SPECT images, accessible by authorized users only. Directly from the

portal, any authorised user can upload the suspect AD image, select normal cases for statistical calculation, and eventually collect the results of analysis.

The basic steps of the Grid implementation of the SPM portal service are listed below:

1. Acquisition of the test image on the user node
2. Transfer of the test image to the management node
3. Query on DB catalogue of normal images on the management node
4. Transfer of a small software executable for information extraction to the repository nodes
5. Extraction from normal images of the information needed for the statistical analysis
6. Transfer of the extracted information to the management node
7. SPM statistical analysis on the management node
8. Transfer of SPM results to the user node

In many eHealth Grid applications, the crucial point is a reliable and efficient data and metadata management. In our application this is needed for identifying suitable normal images across hospitals. From a data management point of view, the mandatory requirements for the Grid implementation of the above described SPM application are the following:

- resources and services for the storage of PET/SPECT images on different Grid sites;
- data management services for the registration in a catalogue and the association of metadata to images.

Two different environments (gLite and AliEn) have been experimented, especially as regards their functionalities concerning the management of metadata, enabling institutions to choose the deployment that better fits their needs and resources. In both environments, integration with the portal allows seamless GUI interaction with the available functionalities from the catalogue, the analysis software and portal services. Through the portal users can transparently exploit both systems. Both environments have provided satisfactory results.

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