

NeuroGrid Portal: A Web Interface Providing Processing Tools For Neuro-Imaging Research

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INTRODUCTION: In many collaborative, multidisciplinary medical imaging research projects, image analysis involves combining multiple image processing algorithms to form sequential image processing pipelines. For example, in neuro-imaging studies, the analysis steps might be segmentation to exclude extracranial material, then alignment of all images to an atlas, then transformation followed by statistical calculations. Multidisciplinary collaborative imaging research projects do not just require sharing of data and computer resources, but also require several teams of specialists to work together closely. The most common solutions to the analysis of data collected in these collaborations is either for all data to be transferred to a central location for analysis, or for analysis to be performed at each site separately. Neither of these approaches provides true sharing of data between collaborators nor close interworking. The challenge is to devise an easy-to-use shared resource that facilitates data sharing and collaborative analysis. An obstacle to building such systems is that many types of analysis software used in imaging research (many of which can be freely downloaded) run on specific Operating Systems and require high technical expertise to get installed and customised.

We have devised a flexible integration framework focused on the needs of the neuro-imaging research community. It takes advantage of Service Oriented Architecture on Grid infrastructure to provide a platform for collaborative imaging science, which is provided to users as the NeuroGrid web portal. Users can share data and perform analysis using this portal through a web browser, without the need to install and configure complicated medical image analysis software. A key emphasis of the portal is to facilitate common tasks that often get in the way of efficient collaborative work.

DESIGN AND METHOD: Most of the image analysis applications are provided as C programs, binaries or Matlab [5] scripts that are configured by a parameter file and/or some command-line arguments. Consequently, to integrate them into the Service Oriented Architecture, we have embedded them in a wrapper service. A wrapping approach is used to make a piece of code such as image segmentation available as a self-contained reusable object to some glue layer. The glue layer is written in a high level language. It could be a Grid fabric layer such as Web services, allowing interoperation of components running on different machines across a network. At the moment about a dozen algorithms are accessible through the Portal, some of them requiring their specific environment to run. However, all of this is hidden from the end user behind a user friendly interface. All the options for each algorithm are available to the user to be set, which gives the same flexibility to fine tune the output, without the difficulties of command-line execution [Fig. 1]. Since most of the medical data are subject to patient privacy and confidentiality, the NeuroGrid Portal has been designed with high security in mind. All the Portal's transactions on the web use HTTPS protocol. Data is held on secure Webdav folders, which can be shared between registered users, if they want to.

USABILITY: The portal has been tested on a distributed info-structure by a dozen users. The users ran the Portal on systems running Linux, Windows and Mac OS, using various web browsers. User feedback has been very positive, with the portal being able to perform the required tasks in all cases. Even a user with very little technical knowledge can use the portal satisfactorily. One further benefit of the Portal is that jobs submitted to it run on remote servers, thus not requiring the user to be constantly online. The user can retrieve the results of the completed jobs by logging into the Portal again. We use this facility on other programs like our emails, but it is frequently not available for image analysis software. This is in a way similar to the concept of Cloud Computing [1]. Some of the algorithms on the Portal are from the FSL library [2], e.g. BET and FAST. The image in Fig. 2 is an Axial Re-Slicer workflow that uses FSL fslswapdim in an interactive interface to correct the data orientation in a Nifti image. Other services include image converters (Analyze, Nifti, DICOM and Minc), and some algorithms from the ITK library [3]. SPM5 tissue classification [4], which uses Matlab [5], is also included, with the advantage that the user does not need to have Matlab installed locally.

CONCLUSION: We have devised a portal to provide user-friendly analysis of medical imaging data. It incorporates some commonly used medical image analysis algorithms, and also useful tools e.g. for file format conversion. User testing has verified that it provides an effective solution to common image analysis tasks, and that it avoids the need to download, configure, install and maintain numerous different algorithms and libraries on a researcher's local machine. It is especially well suited to tackling small but frequent problems like converting image formats and fixing them, and also runs some standard workflows like registration and segmentation. It can potentially be extended to include more algorithms and workflows. At the moment we are enhancing our computing resources in order to provide more services and faster response. The portal is available at <http://ngportal.doc.ic.ac.uk:5555/>

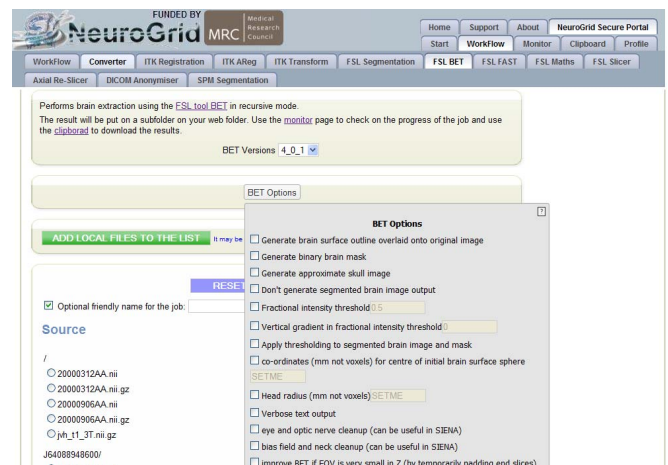


Figure 1. BET workflow options

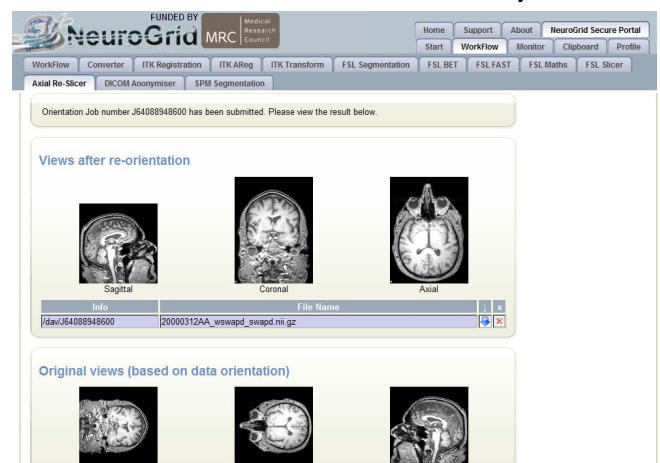


Figure 2. Axial Re-Slicer workflow

- [1] http://en.wikipedia.org/wiki/Cloud_computing
- [2] <http://www.fmrib.ox.ac.uk/fsl>
- [3] <http://www.doc.ic.ac.uk/~dr/software>
- [4] <http://www.fil.ion.ucl.ac.uk/spm/>
- [5] <http://www.mathworks.com/>