Cloud-based Quality Assessment Platform for Neuroscientific Imaging

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Abstract

Neuroscientific research is increasingly based on image analysis methods. Dependend on the imaging method, the quality of the generated image data can vary greatly. In this paper an automatic quality assessment platform for neuroscientific imaging is presented. It is based on the *QMROCT* project [1] – a research collaboration between Charité Berlin, Beuth University of Applied Sciences Berlin and HTW Berlin – which is focused on quality management for retinal optical coherence tomography (OCT). Retinal OCT is – compared to the established magnetic resonance imaging (MRI) – a relatively new method, allowing for non-invasive visualization of anatomical structures in the human eye.

Requirements for this platform are image storage and automatic processing of quality measure algorithms. Since it is designed for multicentric studies with huge amounts of patient data, scalability and security are crucial attributes of the platform.

The Extensible Neuroimaging Archive Toolkit (XNAT) provides storage capabilities for medical images, as well as arbitrary files and meta data. The data structures are designed to support typical research collaborations with researchers, projects, subjects and experiments. Users can be assigned to projects with fine grained access rights. New data structures for quality measures and improved OCT support have been added to the system. XNAT also provides a pipeline engine for executing external applications, so that quality measure algorithms can be accessed.

To support huge amounts of data, it is vital to process patient data in a secure and scalable way. A system which incorporates these features is our private OpenStack based cloud environment. Cloud computing is a model

allowing on-demand requests for computing resources as virtual machines. Virtual machines start full operating systems on virtualized hardware, like memory, processors and networking. OpenStack employs several physical compute nodes, which are used to run virtual machines on them. The system is easily scalable by adding more compute nodes. For security reasons the cloud system is encapsulated in a private network. In order to process image data, XNAT sends a request to a gateway server, which is the only entry point to the private network. The gateway server starts a new virtual machine for every incoming job and forwards the request parameters to the machine, which downloads the files from XNAT, processes the data and sends the results back to XNAT. The virtual machines are deleted afterwards, leaving no traces of data on the server. All communication between XNAT and the private network is encrypted.

The downside of using virtual machines is the huge amount of memory and a long start time for each machine. To avoid these problems we investigated Docker, which uses Linux containers and namespaces to encapsulate processes – instead of operating systems – in a secure way. OpenStack can be configured to start Docker containers, leading to a secure and resource-efficient platform.

[1] Jie Wu, Christoph Jansen et al. – Extending XNAT towards a Cloud-based Quality Assessment Platform for Retinal Optical Coherence Tomographies – CCGrid, Chicago, USA, 2014

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