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tranSMART-XNAT Connector - Image Selection Based on Clinical Phenotypes and Genetic Profiles

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Abstract

Motivation: TranSMART has a wide range of functionalities for translational research and a large user community, but it does not support imaging data. In this context, imaging data typically includes 2 or 3 dimensional sets of magnitude data and metadata information. Imaging data may summarise complex feature descriptions in a less biased fashion than user defined plain texts and numeric numbers. Imaging data also is contextualised by other data sets and may be analysed jointly with other data that can explain features or their variation.

Results: Here we describe the tranSMART-XNAT Connector we have developed. This connector consists of components for data capture, organisation and analysis. Data capture is responsible for imaging capture either from PACS system or directly from an MRI scanner, or from raw data files. Data are organised in a similar fashion as tranSMART and are stored in a format that allows direct analysis within tranSMART. The connector enables selection and download of DICOM images and associated resources using subjects' clinical phenotypic and genotypic criteria.

Availability: tranSMART-XNAT connector is written in Java/Groovy/Grails. It is maintained and available for download at https://github.com/sh107/transmart-xnat-connector.git
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1 Introduction

The phrase, "A picture is worth a thousand words", well captures the notion that complex ideas can be conveyed with images. In the process of conducting translational research, researchers investigate image data for better or richer characterisations of their experimental results. Image data and its imaging functionalities are the consolidated features that represent information in a way that is easier to understand than plain texts and numbers.

tranSMART (Athey et. al, 2013) is one of the most popular open source translational research platforms with a large user community. It adopts the modular structure that allows developers to implement plugins. This potentially enables easy integration of imaging functionalities from existing imaging based software.

XNAT (Marcus et. al, 2006) is one of the most popular open source imaging informatics platform. It allows generation of scalable image archiving repositories for imaging data. It is known to be highly configurable and provides the ability to store new data types in order to meet the requirements of every project. It also supports DICOM image retrieval and storage. The DICOM tags of DICOM images can be used to denote a number of different properties about an image, such as the owner of the image, the time taken of the image and other meta-data information about the image.

We have linked the tranSMART and XNAT platforms to allow tranSMART to integrate imaging, clinical and phenotypical data, based on support from imaging functionalities provided by XNAT, including importing, archiving, processing and securely distributing imaging and related study data.

2 Integrating Imaging Functionalities

Since tranSMART has a wide range of functionalities for translational research for a very large user community and it has a well-developed modular structure that allows developers to implement plugins, tranSMART is an ideal software platform for supporting imaging data. XNAT is an excellent open source imaging informatics platform that has extensive APIs in order to help researchers to perform imaging based research.

By integrating a well-developed imaging platform to tranSMART as a plugin, the cost and time can be kept to the minimum. The integration of XNAT as a plugin can enable tranSMART to integrate image, clinical, high-dimensional data, and correlating genetic and phenotypic data. Image analysis results can be stored as clinical data, so researchers are able to run analysis by combining both imaging and non-imaging parameters.

A unique capability is that the tranSMART-XNAT Connector enables researchers to select images and resources from XNAT using the clinical parameters stored in tranSMART. For example, researchers are able to perform cohort selection based on a combination of imaging and clinical variables. They are then further able to download images from subjects who meet these clinical requirements. This allows a convenient, flexible approach to filtered selection of images based on phenotypic concepts, such as gender, age, race, treatment response, lab findings or clinical outcomes.

XNAT is chosen to be the imaging repository because XNAT is an open-sourced and well-tested imaging platform, with extensive support from the imaging community. As imaging requirements grow, the imaging community has taken advantage of the extensibility of XNAT to build plugins to meet their needs. For example, the DICOM C Store connector can be used to send images directly from the imaging device to XNAT. Plugins such as XNAT-Slicer enables images to be stored within imaging software such as 3DSlicer, and for scene data from 3DSlicer to be stored back to XNAT to form accompanying resources for an image.

tranSMART is a data exploration tool that enables integration of different data types, including information from image analysis. This enables researchers to search across multiple heterogeneous data domains. In addition, this connector also enables the inclusion of image results in the cohort selecting parameters. The images can be selected to meet parameters from any of the other clinical domains.

2.1 Components

The steps required to link image to pheno- and genotypic data are data capture and organisation. Data capture of neuroimagery is performed through XNAT, which pulls from PAC system or directly from MRI scanner. Phenotypic and genotypic data capture is performed using project specific methods but loaded and organised into tranSMART using open-sourced tranSMART loading scripts. The connector maintains a map which links subjects in XNAT to respective subjects in tranSMART.

2.2 Dual Storage

Dual storage of imaging data is enabled in the tranSMART-XNAT plugin, i.e. imaging data have been stored in tranSMART and XNAT respectively. Images collected from devices are stored in XNAT while the meta-data of the imaging data, such as treatment, clinical events, and image morphology are stored in tranSMART. Storage of meta-data in tranSMART allows tranSMART users to perform cohort selection based on image-derived data. In addition, as XNAT offers excellent imaging data storage solution and extensive APIs, imaging data are stored in the XNAT storage and can be accessed from tranSMART via the APIs of XNAT.

3 Conclusion

XNAT, tranSMART and tranSMART-XNAT Connector are open-sourced software. Public instances of XNAT and tranSMART can be found at https://central.xnat.org and https://public.etriks.org/transmart/RWG. Code, documentation and installation guides to the connector are published and made available for download from the GitHub repository. We welcome and encourage developers to make contribution to this plugin.

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References

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