An integrated software solution for improving neuroimaging data archival, management, and processing

- The experience from the Queen Square MS Centre

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Why was such a solution required?

- There were increasing numbers of methods available for processing neuroimaging data.
- Additionally, increasingly larger datasets were being acquired in clinical trials and research projects.
- It was difficult and cumbersome to manually manage and process such large datasets with different, and often linked, processing methods.

Figure: Irons, tele-aliens, and chairs.

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Why was such a solution required?

- Often, data and processing efforts were duplicated by researchers and it was difficult for a new-starter to make sense of what data and results were already available to him/her.

- Furthermore, variations between software versions and pipeline parameters used by researchers could bias the results.
    - Controlling for inter-operator variability required time and effort.

Figure: Needle in a haystack. Copyright © Jolyon Trochianko.

Background

Tree structure for imaging data management:

- Adequate for small projects
  - Project root
    - Patient A
      - Visit 1
        - DICOM files
        - NIFTIs
        - Files resulting from processing
        - …
      - Visit 2
      - …
    - Patient B
    - Patient C
    - …

Figure: Needle in a haystack. Copyright © Jolyon Trochianko.

Background

- Becomes troublesome for larger projects or in multi-user environments

Figure: Needle in a haystack. Copyright © Jolyon Trochianko.

Example

0801_T1vol/

0901_DTI/

0902/

1001_b0/

1101/

1201/

1301_MT/

A1120130_B7033991-2010-00475_344776560_000601_000006-DC-Gm.roi

cortcomp_475/

DTI_analysis_FSL/

fill_t1_lesions/

FlairasDIR.nii

FlairasPSIR.nii

mtr-vbm/

outputResult.nii

PSIR-lobar-masks/

roi_varun/

T2_222_bet.nii

- The directories starting with numbers appear to be individual scans but it is pretty much anybody's guess what the rest of the files/directories are.

B0060473-2012-01536/0801_T1vol:

20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008.nii.gz

B0060473-2012-01536-T1vol_axial.roi

B0060473-2012-01536_T1vol_ROImask.hdr

B0060473-2012-01536_T1vol_ROImask.img

co20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_mixeltype.nii

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_mixeltype.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pve_0.nii

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pve_0.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pve_1.nii

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pve_1.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pve_2.nii

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pve_2.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pveseg.nii

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_pveseg.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_seg_0.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_seg_1.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_seg_2.nii.gz

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_seg.nii

o20120305_101354MR001SAGT13DGRE1mmisoSENSEA9380733s801a1008_seg.nii.gz

- Inside a sub-directory, there appear to be many files that are either duplicated or look very similar.

B0060473-2012-01536/fill_t1_lesions:

Which scan is this?

B0060473-2012-01536_t1vol_axial.nii

B0060473-2012-01536_t1vol_bet_mask.nii

B0060473-2012-01536_t1vol_bet_mixeltype.nii.gz

B0060473-2012-01536_t1vol_bet.nii

B0060473-2012-01536_t1vol_bet_pve_0.nii.gz

B0060473-2012-01536_t1vol_bet_pve_1_c100.nii.gz

B0060473-2012-01536_t1vol_bet_pve_1.nii.gz

B0060473-2012-01536_t1vol_bet_pve_2.nii.gz

B0060473-2012-01536_t1vol_bet_pveseg.nii.gz

Also exist in the upper level directory

B0060473-2012-01536_t1vol_bet_seg_0.nii.gz

B0060473-2012-01536_t1vol_bet_seg_1.nii.gz

B0060473-2012-01536_t1vol_bet_seg_2.nii.gz

B0060473-2012-01536_t1vol_bet_seg.nii.gz

B0060473-2012-01536_T1vol_ROImask.hdr

B0060473-2012-01536_T1vol_ROImask.img

new_lfill_analyze/

PROBLEMS

- Data duplication
- Carrying out processing which has been done before
- Making sense of the data, and processing results that are available
- Processing/using wrong files

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In essence,

- Having a tree structure for imaging data and processing results is good practice but it is much better if it is actively managed…

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I will,

- Present the Queen Square MS Centre XNAT Platform
- Highlight our pleasant experience with it

Figure: Needle in a haystack. Copyright © Jolyon Trochianko.

Methods

- Details to be presented by Dr Marc Modat later this afternoon.

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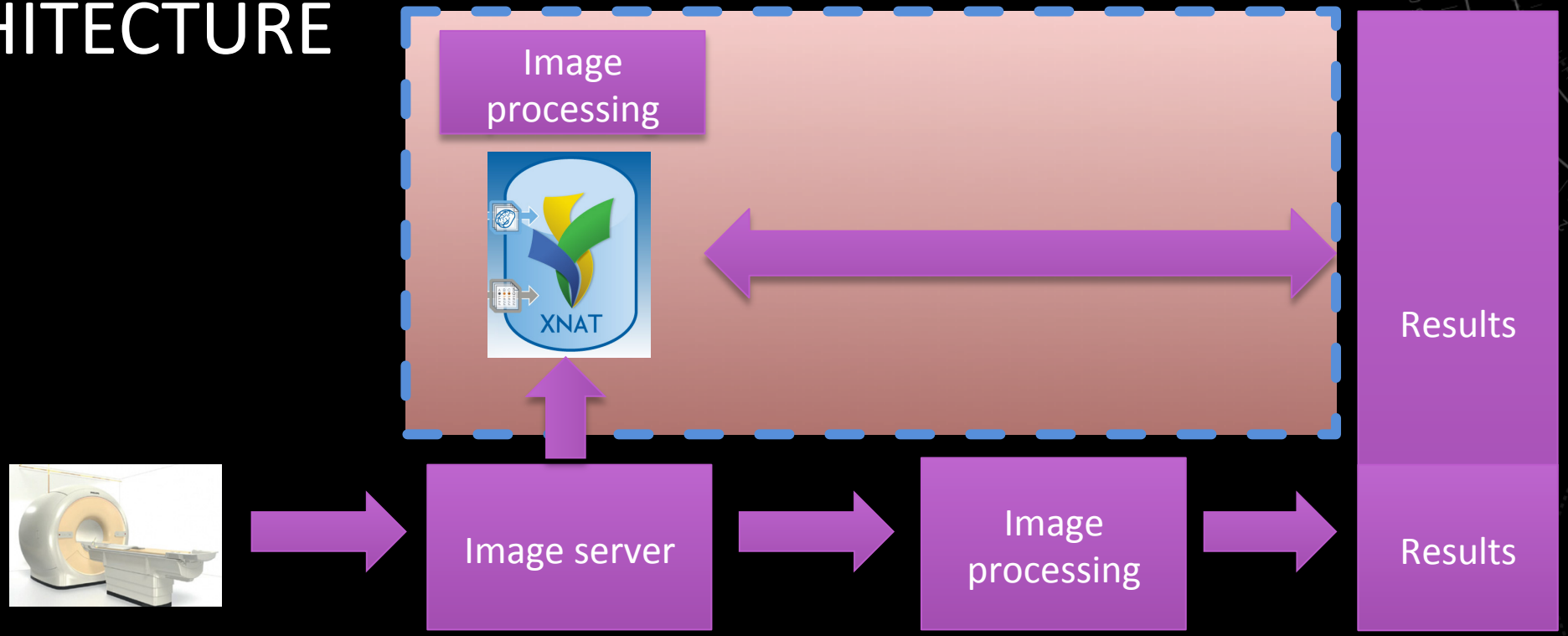
ARCHITECTURE



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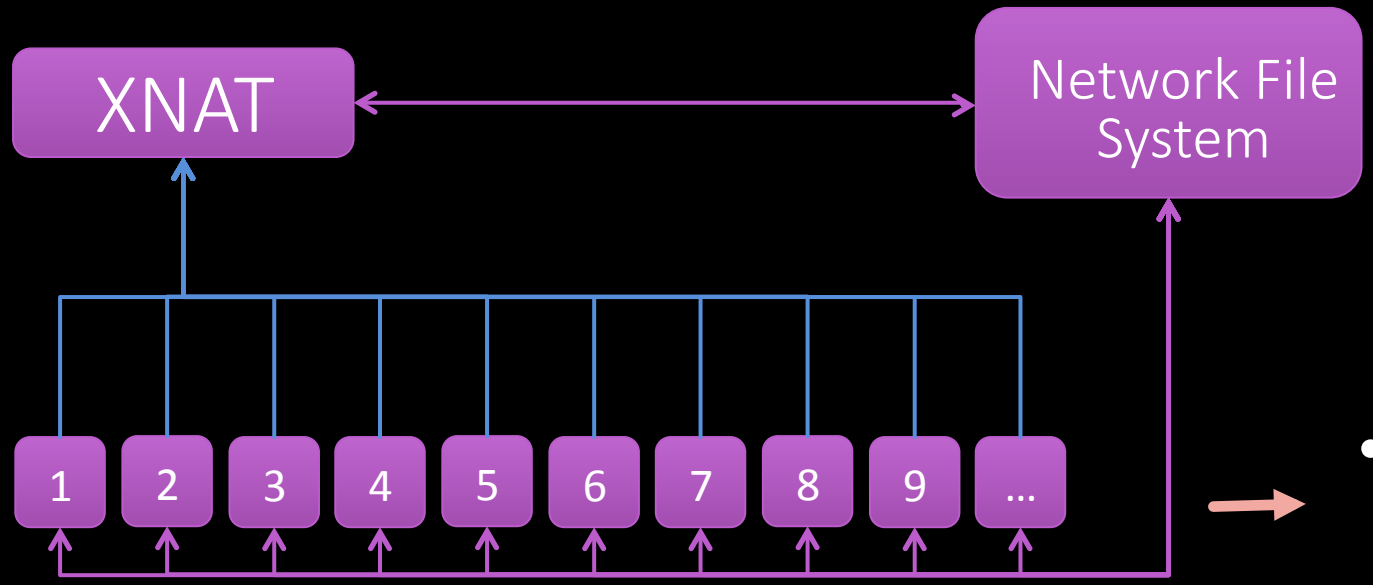
AUTOMATED PROCESSING SYSTEM



Processing Nodes (minimal Linux, 8GB Memory, 40 GB disk)

- We can use:
  - A dedicated cluster, or
  - Existing workstations

Communications link

Data link

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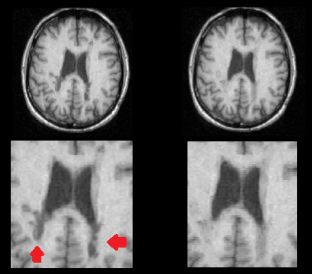
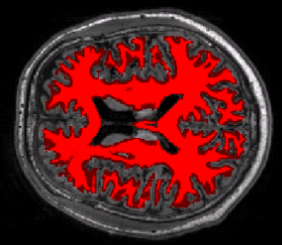
Queen Square MS Centre XNAT

- We currently have 20 projects, 1123 subjects, and 3953 MRI sessions.
- ~10 users.

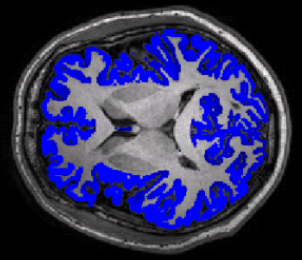
- Examples of automated processes we carry out:



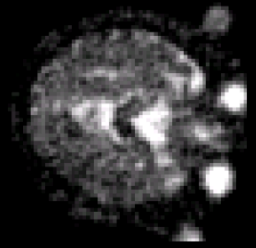
lesion filling



brain parcellations and tissue segmentation



cortical thickness mapping



brain sodium concentration maps

segmentations of hippocampi

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The experience

- We no longer experience the problems commonly encountered in manual processing methods such as the processing of the wrong data, the use of wrong flags or parameters.

- We are saving a lot of time: during the automated processing, we use our time to work on other things.

Other benefits

- A central repository for everyone
- Avoids duplication of data and efforts
- Users can be assigned appropriate access rights to individual projects
- Ability to also store non-imaging data (e.g. clinical data, spreadsheets)

Other benefits

- Setup and run pipelines depending on project and requirements
- View data online, download or upload
- Can be searched easily

Overall,

- The automated system for cataloguing, archiving, and processing neuroimaging data has been more time- and resource-efficient than the manual methods that were previously in use.

Finally,

- Introduction of this service has helped to standardize results across studies, as the same processing pipelines, software versions and parameters are used for all the processing.
- We now have a centralised location for all the data and processing results for new studies.
- New starters can easily get access to the existing results, which has increased the speed and efficiency of this process.
- This has been very cost-effective: we used the existing computational resources in the MS Centre.