

The XNAT Imaging Informatics Platform

*RSNA/ACRIN Imaging Researchers Workshop
Wednesday, Sept. 21, 2011*

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Disclosure: Daniel Marcus, PhD

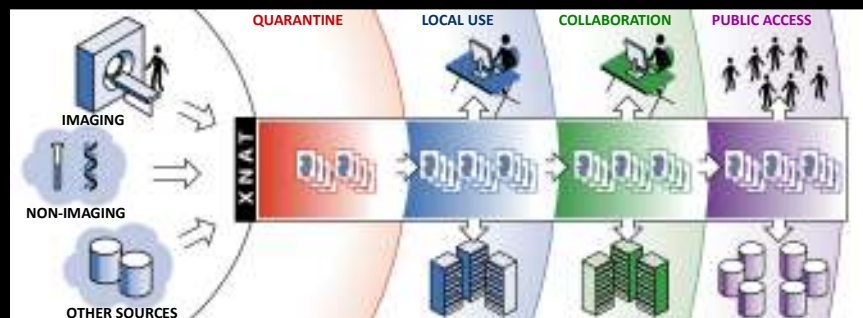
Daniel Marcus has financial interests to disclose. Potential conflicts of interest have been resolved.

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Consulting/employment:	None
Speakers Bureau:	None
Other:	None

XNAT is...

- A platform to manage, process, and share imaging and related data.
- Good at:
 - Clinical/translational research
 - Institutional repositories
 - Multi-center studies
- Developed by the Neuroinformatics Research Group at Washington University in St. Louis.
- Free, open source, and used by organizations around the world.

The XNAT workflow




- Data archiving
- Quality control
- Data access
- Security
- Visualization
- Automation
- Integration
- Data sharing

Data organization

- Project (NP179)


Data organization

- Project (NP179) 
 - ✓ *Navigation*
 - ✓ *Security*
 - ✓ *Configuration*



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 - ✓ *Navigation*
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 - ✓ *Configuration*
- Subject (001)



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 - Visit (“3 Month FU”)

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 - ✓ *New is XNAT 1.6!*
 - ✓ *Protocol compliance*
 - ✓ *Visualization*

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 - ✓ *Visualization*
 - Experiment
(001_3FU_MR1)

central neuroimaging data archive

Search

CNDA currently contains 697 Projects, 13435 Subjects, and 17201 Imaging Sessions.

Projects Subjects MR PET CT

ID Name Description

Keywords Investigator SELECT

Submit

Projects

DEAN Columbia University (CPMC) (0101)
 Project ID: DEAN_010 PE: Richard Mayeux
 The Columbia University site-data for the Dominantly Inherited Alzheimer Network.
 You are an **owner** for this project.

CONDR
 Project ID: CONDR PE: Daniel Marcus
 The Comprehensive Neuro-oncology Data Repository (CONDR).
 You are an **owner** for this project.

East Building Bay 3 fMRI Quality Control
 Project ID: Bay3_QC
 Quality control data obtained on a weekly basis using agar phantoms.
 You are an **owner** for this project.

Trin Atlas
 Project ID: TRIN_ATLAS PE: Daniel Marcus
 This project includes all of the sessions that constitute the adolescent and young adult atlas. This includes the non-distortion-corrected

Recent Data Activity

INTR_MR...	MR	1234
GNF1126...	US	2804_670_003_US...
GNF1126...	US	2804_670_001_US...
GNF1126...	US	2804_670_001_US...
ADNM2	MR	011-S-4222_P5antem
GNF1126...	ECT	5397_670_003_AC...
Bay3_QC	MR	110920_spartan
CONDR	MR	5006_MR_2010110...
ADEM	MR	MSA019_122002
ADEM	MR	MSA019_002906
CONDR	MR	5004_MR_1018062...
INTR_MR...	MR	IM1106T_019_V_B...
MPR84	MR	342
CONDR	MR	W022_MR_2011091...
CONDR	MR	W013_MR_2011091...
...

powered by XNAT

central neuroimaging data archive

CONDR

Details Access Manage Pipelines History

ID: CONDR Aka: 09-1625

Description: The Comprehensive Neuro-oncology Data Repository (CONDR).

Keywords: rDLD neuro-oncology

PE: Marcus, Daniel

Investigators: Benzinger, Tamara ; Lee, Sarah ; Rich, Keith ; Chicoise, Michael

MR details Delete Message Custom Variables

Subjects MR Sessions Surgical Encounters SELECT

1 2 3 next > last >> 20 1 of 3 Pgs (37 Rows) refresh Options

Subject	M/F	DOB	Medical Hst	Medication Lists	MR Sessions	Clinical Enc
S001	F	1953	1	1	20	10
S002	F	1970	1	1	5	4
S003	F	1955	1	1	14	8
S004	M	1946	1	1	8	7
S005	M	1974	1	1	15	8
S006	F	1956	1	1	3	5
S007	M	1939	1	1	3	7
S008	F	1952	1	1	15	7
S009	M	1944	1	1	8	7
S010	M	1962	1	1	10	8

Actions

- Add
- Upload Images
- View Prearchive
- Add to Favorites
- Download XML
- Download Images

Subject Details: S001

Details | Projects

Accession #: ONDA_S03023
Date Added: 2010-04-29 13:19:36.0 (browse)
Birth year: 1953
Gender: Female
Handedness: Left
Race(s): White
Ethnicity: Not Hispanic
Height: 64.0 in
Weight: 113.0 lb

Actions

- Edit
- View XML
- Add Experiment
- Download XML
- Email
- Manage Files
- Delete

Experiments

Date	Experiment	Project	Label
2009-12-12	MR Session	CONDOR	S001_MR_20091212_Prep
2011-02-10	+ RAD Read	CONDOR	S001_MR_091212_0347_Prep_RAD_1297374670354
2009-12-14	CONDOR: Surgical Encounter	CONDOR	S001_SURG_20091214
2009-12-15	MR Session	CONDOR	S001_MR_20091215_Postop
2011-02-10	+ RAD Read	CONDOR	S001_MR_091212_0023_Postop_RAD_1297374706097
2010-03-16	MR Session	CONDOR	S001_MR_20100316_Followup
2011-02-10	+ RAD Read	CONDOR	S001_MR100316_1033_Followup_RAD_1297375548540
2010-03-16	CONDOR: Clinical Encounter	CONDOR	S001_CLIN_110725
2010-05-11	CONDOR: Clinical Encounter	CONDOR	S001_CLIN_100511
2010-05-11	MR Session	CONDOR	S001_MR_20100511_Followup
2011-02-11	+ RAD Read	CONDOR	S001_100511_Followup_RAD_1297434652079
2010-06-08	MR Session	CONDOR	S001_MR_20100608_Followup
2011-02-22	+ RAD Read	CONDOR	109408.S001_Followup_MR_RAD_1296410559645
2010-06-09	CONDOR: Clinical Encounter	CONDOR	S001_CLIN_100609

MR Session: S001_MR_20091212_Prep

Details | Projects

Accession #: ONDA_EI00110
Date Added: 2010-05-12 09:46:22.0 (browse)
Date: 2009-12-12
Time: 19:47:47
Operator: REL
Scanner: GEHOSHCP-FLESCDBURN
Acquisition Site: SWEDISH ST MR750
Session Type: CONDOR
Subject: S001
Gender: Female
Handedness: Left
Age: 56.00

Actions

- Edit
- View
- Upload
- Download
- Email
- Download DICOMDIR
- Build
- Add Manual QC
- Manage Files
- Delete

Notes:

Scans

Scan	Type	Usability	Files	Note
3	FLAIR	usable	DICOM (19 files, 9.76 Mb)	
4	DTI	usable	DICOM (650 files, 90.12 Mb)	
5	AX T2 FRFSEXL 2MM	usable	DICOM (85 files, 11.78 Mb)	
6	FLAIR	usable	DICOM (57 files, 7.99 Mb)	
7	AX T1 FSPGR 3D	usable	DICOM (136 files, 18.88 Mb)	
8	AX EPI DWI	usable	DICOM (52 files, 7.21 Mb)	
9	AX EPI PERFUSION	usable	DICOM (1248 files, 56.03 Mb)	
10	COR T2 FSE-XL FS POST	usable	DICOM (47 files, 24.15 Mb)	
11	AX EPI PERFUSION #2	usable	DICOM (1248 files, 56.04 Mb)	
12	FLAIR	usable	DICOM (26 files, 13.36 Mb)	
13	AX T1 FSPGR 3D POST	usable	DICOM (136 files, 18.88 Mb)	
99	SCREENSAVE	usable	secondary (11 files, 5.52 Mb)	
400-MR1	SCREENSAVE	usable	secondary (13 files, 9.79 Mb)	
400-MR2	Average DC	usable	DICOM (25 files, 4.79 Mb)	
401	Functional Atlas	usable	DICOM (35 files, 5.54 Mb)	

Data archiving

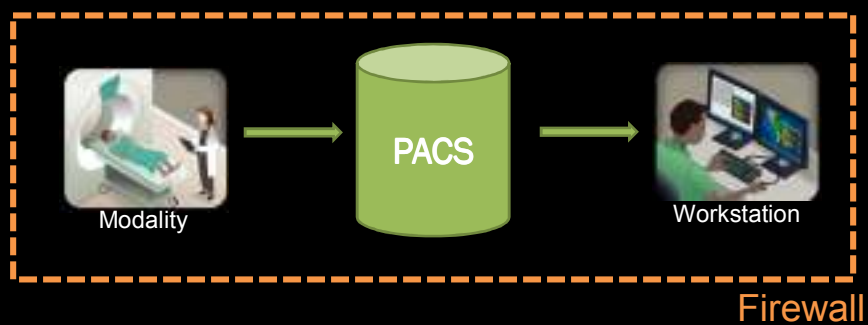
- DICOM C-Store for all modalities.
- Archiving from local and remote devices.
- Automatic mapping of metadata into XNAT structures
- Flexible DICOM anonymization.
- Automated protocol validation.



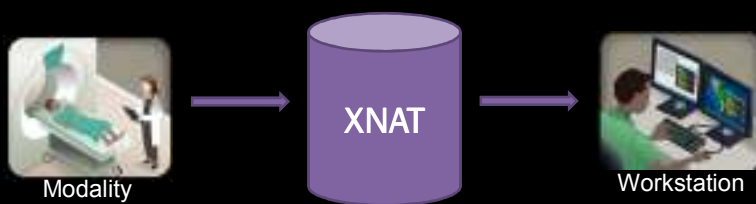
Data archiving: Secure workflow



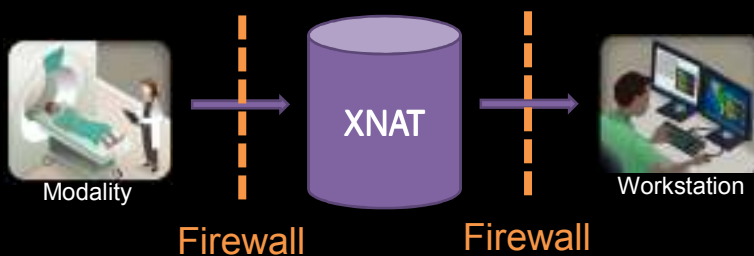
Data archiving: Secure workflow



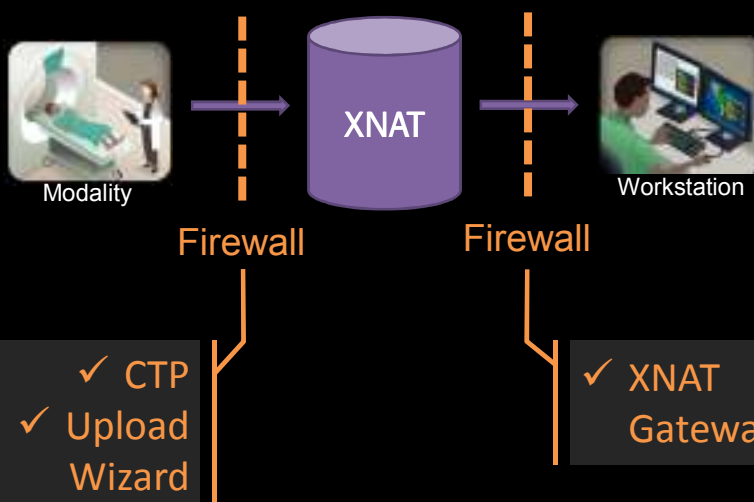
Data archiving: Secure workflow



Data archiving: Secure workflow



Data archiving: Secure workflow



Data archiving: anonymization

```
(0010,0010) := "Subject_346"
-(0010,0030)! // Patient's Birth Date
(0008,0080) = "CCIR 3T" : (0008,0080) := "WUSM CCIR"
(0020,000d) := new UID
(0010,0020) := replace[(0010,0020), " ", "_"]

(0008,1030) := "{0} ({1})" (0020,0010), (0008,1030)

(0020,0010) ~ "\d" : (0008,1030) := "One digit!"
(0020,0010) ~ "\d\d" : (0008,1030) := "Two digits!"
```

Data archiving: protocol validation

```
<?xml version="1.0" encoding="iso-8859-1"?>
<iso:title>Protocol Validator</iso:title>
<iso:pattern id="Acquisition">
  <iso:rule context="scans">
    <iso:assert
      test="count(scan[@type='localizer']) >= 1">
      <nrgxsl:acquisition> MRSession must have at
        least 1 localizer scan.
      <iso:value-of
        select="count(scan[@type='localizer'])"/>
      </nrgxsl:acquisition>
    </iso:assert>
  </iso:rule>
</iso:pattern>
(etc...)
```


Data integration

- ADI-R
- ADOS Module 2
- ADOS Module 3
- ADOS Module 4
- Adult Behavior CL
- Child Behavior CL
- Task
- Categorization
- Computation Span
- CVOE
- Pair Binding
- Reading Span
- Simon
- Visual Spatial Test 1
- Visual Spatial Test 2
- Neurological Exam
- Physical Exam
- UA for Pregnancy
- Vital Signs
- Info
- News
- SCID
- Pitts. Side Effect
- UPDRS
- YBOCS
- YGTSS
- ASF
- CLIN
- CSF
- Diagnoses
- DTI
- Levels
- Manual Volumetry
- Mod Scheltens
- PET Timecourse
- PSYCH
- RAD Read
- Fast Seg
- TIC Video
- Vitals
- Hollingshead
- APARC
- ASEG
- Auto Seg
- Participant Exercise
- IPIP - Collateral Source
- IPIP - Participant
- IQ Assessment
- Clinical Encounter
- Medical History
- Age at Onset Eval
- Adverse Events
- Blood Collection
- CDR Supplemental Data
- Clinician Review
- Continuing Eligibility
- CSF Collection
- CS Interview
- Data Center Approval
- Eligibility Screening
- Participant Family Hist. Update
- FDG Metadata Form
- Clinical Asmt. Feedback
- CSF Result
- Lumbar Puncture FU
- Missed Visit
- Monitor Review
- MRI Metadata Form
- PIB Metadata Form
- Post Clinical Genetic Call
- Psych Battery Summary
- Registry
- Collateral Source Annual FU
- Participant Annual FU
- Upload Form
- Visit Frequency Calculation
- Study Params
- VAS
- LS Demo
- LS Health
- LS Neuropsych
- Encounter Log
- Enrollment
- SRS
- Chemotherapy
- Radiation
- Medication List
- UDS A1: Sub Demo
- UDS A2: Informant Demos
- UDS A3: Sub Family Hist.
- UDS A4: Sub Meds
- UDS A5: Sub Hist.
- UDS B2: HIS and CVD
- UDS B3: UPDRS
- UDS B4: CDR
- UDS B5: NPI-Q
- UDS B6: GDS
- UDS B6 Supplement
- UDS B7: FAQ
- UDS B8: Phys. Neuro Findings
- UDS B9: Clin. Judgements
- UDS B9 Supplement
- UDS D1: Clinician Diagnosis

Data processing

The screenshot displays the CNDA Beta web application interface. The main content area shows details for a project titled "DIAN Pre-phasic MRI Sequence Testing". Below the project title, there is a table with columns for "Add", "Details", "MR Sequence", "MR Param", "MR Param", "MR Param", and "MR Param". The table contains several rows of data, including "MR_PRANTER_PBS" and "MR_PRANTER_PBS". Below the table, there is a "Subjects" section with a table showing columns for "MR ID", "DOB", "Sex", "Age", and "Sequence". The table contains several rows of data, including "DIANPrePhasic_MRI_seq" and "MR_PRANTER_PBS".

Add	Details	MR Sequence	MR Param	MR Param	MR Param	MR Param
ADD	Details	MR Sequence	MR Param	MR Param	MR Param	MR Param
ADD	Details	MR Sequence	MR Param	MR Param	MR Param	MR Param
ADD	Details	MR Sequence	MR Param	MR Param	MR Param	MR Param

MR ID	DOB	Sex	Age	Sequence
DIANPrePhasic_MRI_seq	2008-11-09	MRI_M		CCP000-PR004
MR_PRANTER_PBS	2008-11-11	MRI_PRANTER		CCP000-PR004
MR_M1_PBS	2008-11-11	MRI_M1		CCP000-PR004
MR_M2_PBS	2008-11-11	MRI_M2		CCP000-PR004
MR_M3_PBS	2008-11-11	MRI_M3		CCP000-PR004
MR_M4_PBS	2008-11-11	MRI_M4		CCP000-PR004

Data processing

MR Session: 070806_TC25132

Type: ACDC CAP II **DATE:** 10/17/11
Date: 10/07/11 08:54 **MAP #:** 012532
Operator: 1100: D0766 **Head Lab (DW):** 01104401
Coort: **Coort:** 101116
Room: Bay 2 Two XT **Handedness:** LR
Hardware: GE SIGNA EXCELIS **Age:** 64.05
Modality: mra

Actions:

- View FIF
- View XPS
- View Images
- Build
- Export XPS
- Print
- Print
- Export all Images
- Optimal XPS

Scan Summary

Item	Type	Frames	Note
1-3	LOCALIZER	2 Files, 6.120s	
1-2	AMSCANT	290 Files, 4.769s	
1-3	LOCALIZER	3 Files, 9.120s	
1-4	MPRAGE	174 Files, 12.894s	used0
1-5	MPRAGE	174 Files, 12.894s	used0
1-6	T2E	174 Files, 11.379s	
1-7	AMSCANT	290 Files, 4.849s	
1-8	T2E	16 Files, 2.824s	
1-9	BOLD	9 Files, 6.740s	rest build
1-10	BOLD	184 Files, 12.038s	resting build
1-11	BOLD	184 Files, 12.038s	resting build
1-12	TE STIR MP2R_P2E	28 Files, 1.289s	
1-13	MP_1MP2R_P2E	72 Files, 2.209s	
1-14	ENC_MPRAGE	92 Files, 4.884s	

Quality Control Images

Data processing

Current Pipeline Step

The pipeline has been completed in the past. Rebuilding the pipeline may result in loss of data. Are you sure you want to proceed?

Session: 070806_TC25132 **Project:** ADRC CAP II

Atlas Representative Target: /MNI/mni1/brain/atlases/CAP10

Apply Distortion correction:

Include Freesurfer cortical segmentation:

Build MPRAGE

Check scans to include in build:

- 4 (MPRAGE Quality: usable)
- 5 (MPRAGE Quality: usable)

Build T2 Coronal Slices

Check scans to include in build:

- 8 (T2E Quality: usable)

Build EPI

Check scans to include in build:

- 9 (BOLD Quality: usable) Is a resting state scan
- 10 (BOLD Quality: usable) Is a resting state scan
- 11 (BOLD Quality: usable) Is a resting state scan

Parameters for EPI Build

Volume TR (in sec):

No. of pre-functional frames to skip:

Data processing



Programmable interface

This:

http://central.xnat.org/data/projects/CENTRAL_OASIS_CS/subjects/OAS1_0020



Programmable interface

This:

http://central.xnat.org/data/projects/CENTRAL_OASIS_CS/subjects/OAS1_0020



Gets this :

```
<Subject ID="OAS1_0020">
<demographics>
<age>48</age>
<gender>F</gender>
<handedness>right</handedness>
<ses>2</ses>
<educationDesc>5</educationDesc>
</demographics>
<experiments>
<experiment ID="OAS1_0020_CLIN_1"
xsi:type="cnda:clinicalAssessmentData">
(etc...)
```

Programmable interface

This:

http://central.xnat.org/data/projects/CENTRAL_OASIS_CS/subjects/OAS1_0020



Or this:



Programmable interface

- Various XNAT tools (command line, Matlab, Java)
- Roll your own (curl, shell)
- Connectome WB
- PyXNAT/Nipype
- LONI Pipeline
- Connectome Viewer
- 3D Slicer



Central (Neuro)imaging Data Archive

- Wash U's primary image repository in operation since 2005
 - 600+ users
 - 300+ local protocols, 10+ multi-center studies
 - 12,000+ subjects, 17,000+ sessions
 - 30 TB of raw and processed images

Central (Neuro)imaging Data Archive

- Operations
 - 5 FTEs (Helpdesk, programmers, project manager)
 - Direct DICOM connectivity with research scanners
 - Hardware infrastructure
 - Network attached storage (BlueArc)
 - Redundant web and database services
 - Dedicated compute cluster
 - High performance computing access

Central (Neuro)imaging Data Archive

- Funding
 - Per protocol fee (\$250)
 - Informatics cores (\$25K - \$250K)
 - P30 Center Core (NINDS 2 P30 NS048056) (\$200K)

Other XNATs

- CTSAs
 - Wash U, Harvard, Iowa, Mayo,...
- Institutional operations
 - NIMH, Johns Hopkins, KU, Duke, Cornell, Northwestern, Rottman, Wake Forest, Vanderbilt, MGH,...
- Multi-site studies
 - CVRG, IMAGEN, DIAN, BNRG, JHS, INTRUST
- Data sharing
 - OASIS, Brainscape, NITRC, XNAT Central, ADCS
- Big science
 - Human Connectome Project, Ontario Brain Institute
- Informatics infrastructure
 - BIRN, I2B2, NA-MIC, caBIG

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NRG

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- Harvard
University
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- BIRN
- NAMIC
- I2B2
- Many
contributors

