Welcome to XNAT Workshop 2022

Dan Marcus
Chief Scientific Officer, Flywheel
Professor of Radiology, Washington University
Presenter: Dan Marcus, Flywheel & WashU

- Chief Scientific Officer (not meant to be ironic) @ Flywheel
- Professor of Radiology & Director of the Computational Imaging Research Center @ WashU
- Worked on XNAT since before it was XNAT
- Haven’t been back to England since 2017 sabbatical. I will be needing some Nando’s.
Workshops are an important part of the XNAT experience – thanks for coming
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Today’s Themes

- Continuity
- Evolution
- Sustainment
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The origin story: Birth

- It all begin ~2001 at the WUMC Alzheimer’s Disease Research Center
- CDs were awkward, QC was sporadic, and processing was inconsistent.
- DICOM was barely a thing.
- Randy Buckner asked me to write some scripts to better manage the data
The origin story: Infancy

- Instead, I wrote a web app. Randy liked it. We called it the CNDA.
- He committed HHMI resources to build it.
- Tim Olsen & Mohana Ramaratnam hired as the first XNAT developers. Kevin Archie joined soon after in 2002.
- First open source release followed soon after.
The origin story: Adolescence

- We joined the Biomedical Informatics Research Network (BIRN) in 2005
  - Freesurfer, 3D Slicer, ADNI, Human Connectome Project, XNAT, BIDS, Pipelines
- First XNAT R01 grant started in 2008 (24 letters)
The origin story: Coming of Age

- Growth of the XNAT team (40+ developers over the years)
- Expansion beyond neuroimaging
- Radiologics founded (2009)
- Human Connectome Project (2009)
- XNAT R01 renewal (2012: 53 letters)
The origin story: Adulthood

- Global adoption across many biomedical domains
- Links with many industry and academic initiatives
- Containerization introduced
- AI drives many use cases
- XNAT grant renewal (2016: 107 letters)
XNAT Today

- Broad DICOM support
- Modern open image viewer
- Containerized processing
- Comprehensive API
- Extensive administration interface
- Automations
- Integrated notebooks

**XNAT impact by the numbers**
- XNAT.org visitors: >100,000
- XNAT application downloads: >20,000
- XNAT plugin downloads: >7,500
- XNAT Forum members: >850

**Supported Research Areas**
- Neuroimaging 85%
- Cancer 33%
- Cardiovascular 13%
- Whole Body 32%
- General Imaging 22%

**Number of users (per XNAT)**
- 1-10: 33.8%
- 11-100: 47.3%
- 101-1000: 18.9%

**Number of years in service**
- >10 Years: 34.3%
- 4-6 Years: 20.9%
- 7-10 Years: 17.9%
- <1 Year: 14.9%
- 1-3 Years: 11.9%
XNAT Today

INGEST
- DICOM send from scanner
- DICOM retrieve from PACS
- Web-based upload
- Metadata anonymization
- Pixel anonymization
- Face scrubbing
- Support for all imaging modalities.
- Support for all file formats (DICOM, NIFTI, TIFF, etc.)

CURATE
- Automated image quality metrics
- Manual image review
- Pre-archive data staging area
- Scan type harmonization
- Group-level image statistics
- Linked clinical, genetic, and other non-imaging data
- Automated format conversion

ANNOTATE
- OHIF integration
- Manual annotation tools (ROI, angles, lines, etc.)
- AI-assisted annotation
- Templatized assessment forms
- Rapid reader module
- Blinded reader mode
- Radreport.org integration

COMPUTE
- Docker Container Service
- HPC Integration (Slurm, Torque, PBS, etc.)
- Batch processing dashboard
- Live Tensorboard and stdout/stderr monitoring
- Event-based container automation

ANALYZE
- Standalone Jupyter integration
- CLARA-based ML development
- Scriptable data sets for training, test, validation
- Scriptable analysis with Python and Groovy
- Integrations with common analysis tools (3D Slicer, MITK, CapTK, etc.)

PUBLISH
- Data sharing across projects
- Data sharing across instances
- Federated datasets across instances
- Automated export to public data repositories (TCIA, OpenNeuro, etc.)
- Automated export to public analysis platform (Imaging Data Commons, Brainlife.io, etc.)
XNAT Today
Evolution: Installation

Installation: Setup

• bin/setup.sh
  • Builds the project directory
    – Location for site specific customizations
    – Built from the skeleton in the plugin-resources
  • Builds the initial deployment directory
    – Staging area for deployment to Tomcat
    – Combines contents of projects/ and plugin-resources/
  • Reads schema and auto-generates data model
    – Builds SQL for Database creation
    – Builds Java classes, reports and edit pages
    – Builds Display documents for use with the search engine
Evolution: Installation

Installing
Start by cloning the xnat-docker-compose repository and checking out the features/dependency-mgmt branch:

```
$ git clone https://github.com/NrgXnat/xnat-docker-compose
$ cd xnat-docker-compose
$ git checkout features/dependency-mgmt
```

Launching
At this point, you can start XNAT with a basic configuration just by building and launching the docker-compose configuration:

```
$ ./gradlew composeBuild composeUp
```
Evolution: Viewer
Evolution: Viewer
Why REST?

- History
  - SOAP, ArcGet, ArcPut, StoreXAR, StoreXML
  - Cumbersome, Difficult in some languages
- URIs uniquely identify resources (meta & file)
- Uses basic HTTP model
- REST, REST-ful, REST-like
  - HTTP Sessioning
Evolution: Interfaces

XNAT REST API
The XNAT REST API (XAPI) functions provide access to XNAT internal functions for remote clients.

- Created by XNAT
- See more at [http://www.xnat.org](http://www.xnat.org)
- Contact the developer: Simplified 2-Course BSD

**anonymize-api**: XNAT DICOM Anonymization API

- GET /api/anonymize/default: Gets the default anonymization script.
- GET /api/anonymize/projects/[projectID]: Gets the project-specific anonymization script.
- GET /api/anonymize/projects/[projectID]/enabled: Indicates whether the project-specific anonymization script is enabled or disabled.
- GET /api/anonymize/site: Gets the site-wide anonymization script.
- GET /api/anonymize/site/enabled: Indicates whether the site-wide anonymization script is enabled or disabled.
- PUT /api/anonymize/[siteID]/enabled: Enables or disables the site-wide anonymization script.

**automation-api**: Automation Service API

- GET /api/anonymize/site: Gets the site-wide anonymization script.
- GET /api/anonymize/site/enabled: Indicates whether the site-wide anonymization script is enabled or disabled.

**catalog-api**: XNAT Archive and Resource Management API

- GET /api/anonymize/site: Gets the site-wide anonymization script.
- GET /api/anonymize/site/enabled: Indicates whether the site-wide anonymization script is enabled or disabled.

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XNAT WORKSHOP 2022
Evolution: Compute

Pipeline: Compute

- **name**: Compute
- **location**: Compute
- **description**: Compute

**Document**: Compute

- **resourceRequirements**: Compute
- **documentation**: Compute
- **outputFileNamePrefix**: Compute

**Steps**

1. Create NIFTI folder
2. Create folder for each series in NIFTI subfolder
3. Create RAW folder
4. InCopy Scan DICOM DATA into RAW folder
5. Convert each series file into 4d NIFTI file
6. Upload files to XNAT

**Generated with XMLSpy Schema Editor**

**XNAT WORKSHOP 2022**
Evolution: Compute
Evolution: Compute
Evolution: Customization
Evolution: Customization
Evolution: Customization
A bit about Flywheel

2011 Dr. Brian Wandell and Gunnar Schaefer work together at Stanford University's Center for Cognitive and Neurobiological Imaging to develop a medical imaging data management and collaboration platform.

2015 Wandell and Schaefer partner with Minnesota-based Invenshure to launch Flywheel.

2018 With a focus on the academic research community, Flywheel grows quickly, helping researchers focus on research and not IT.

2019 Flywheel lands its first commercial customer, Roche and Genentech, providing a global platform to enable the ingestion and automated curation of massive amounts of data for their digital transformation initiative.

2021 Flywheel adds to its expertise and talent base with the acquisition of Radiologics creating the only global network for biomedical research and collaboration.
A bit about Flywheel

- Project-based data management
- OHIF Viewer
- Containerized apps (Gears)
- DICOM de-ID
- Provenance & audit trails
- Roles & managed access
A bit about Flywheel
A bit about Flywheel

Index and archive every DICOM file in the imaging archive
Create dynamic search and analytics dashboards for cohort identification and retrieval
Enable data provisioning in an automated, streamlined workflow
Incorporate cohorts into Flywheel Enterprise for research and machine learning
A bit about Flywheel

Data Exchange
- Data Discovery
- Shared Projects
- Public Data Sets
- Commercial Data Sets

Gear Exchange
- Algorithm Discovery
- Curated library of 125+ Gears
- Community Contributed Gears

Federated Projects
- Learning/Training
- Analysis/Validation
- Secure Data Sharing

Communities
- Forums
- Technology Communities
- Research Domain Communities

Flywheel Sites
- Life Sciences
- Academic Medical Centers

XNAT Sites
- Academic Medical Centers
- Open Data Initiatives

Commercial Data Partners
- Hospitals / Health Systems
- Radiology Practices
A bit about Flywheel

The XNAT network
## A bit about Flywheel

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|必須列了關於Flywheel的詳細內容，包括治療領域、項目查找和添加功能。
# A bit about Flywheel

## Federated Mammography

**Cohort:** Processing

- Houston Methodist Mammography
- MD Anderson Mammography
- University of Pennsylvania Mammography
- Washington University Mammography

**Data:**
- 512 Subjects
- 1,200 Sessions
- 1,200 Acquisitions

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<td>Male</td>
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**Age & Sex**

- 502 Subjects

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<tr>
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**Race & Ethnicity**

- 502 Subjects

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**BI-RADS**

- 1,242 mammograms

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<td>6</td>
<td>15</td>
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**BI-RADS & Race**

- 502 subjects

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<th>2</th>
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<tr>
<td>Asian</td>
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<tr>
<td>Native Hawaiian</td>
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<tr>
<td>White</td>
<td>82</td>
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</table>
A bit about Flywheel
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2-year $2m NCI contract will build the breast cancer network!

**NCI Contract Objectives**

1. **Data**: Geographically, demographically representative patient network
2. **Platform**: Federated data discovery and AI development & validation
3. **Governance**: Secure data management w/ differential privacy, provenance, and auditability.

**Clinical Data Partners**

- 10+ AMCs
- + OneMedNet
- + America’s Essential Hospitals
**XNAT in the context of Flywheel**

- Ongoing development and support of XNAT has moved from WashU to Flywheel
  - NIH R01 grant officially renewed at Flywheel (Sept 1, 2022 – Aug 30, 2026)
  - XNAT core development team (mostly) moved to Flywheel.
  - Dan lives half-time at Flywheel
- Unified XNAT development w/ coherent commercial open source strategy.
- XNAT site engagement in Flywheel initiatives (e.g. Exchange).
- Path to ongoing sustainment beyond NIH funding.
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XNAT in the context of Flywheel

- XNAT R01 (NIBIB) is renewed at Flywheel through 2026.
- XNAT U24 (NCI: I3CR) was renewed through 2025.
- XNAT U24 (NCI: PIXI) was funded in 2025.
- Foundation grant (TWCF: Lab notebooks) funded through 2023.
- SBIR (NCI: Intelligent Anonymization) funded through 2023.
- SBIR (NCI: Breast Cancer Federation) funded through 2024.
XNAT sustainment is a community endeavor
XNAT sustainment is a community endeavor

THANKS TO THESE GUYS!!!