Medical Imaging WG

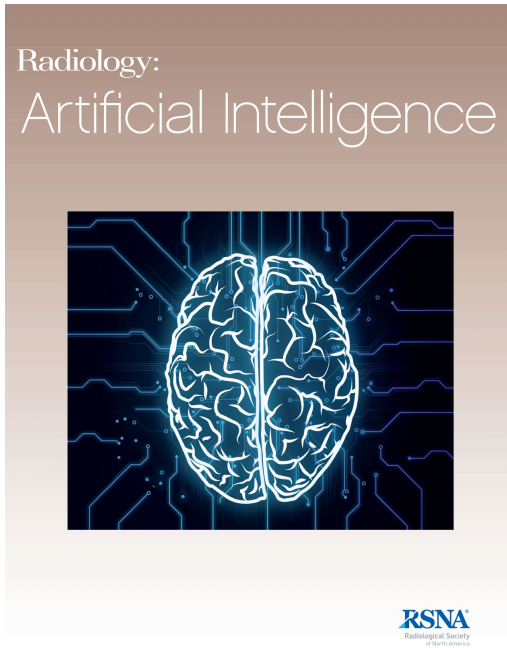
From pixels to Phenotypes

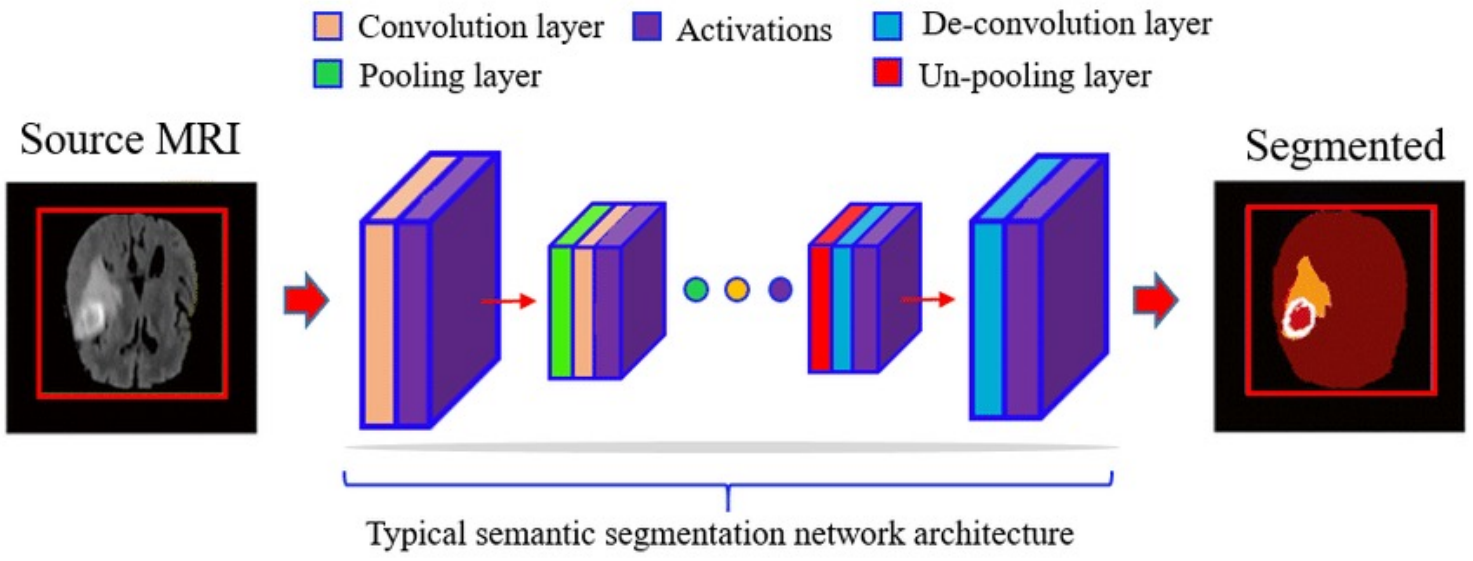
WG co-leads Seng Chan You and Paul Nagy

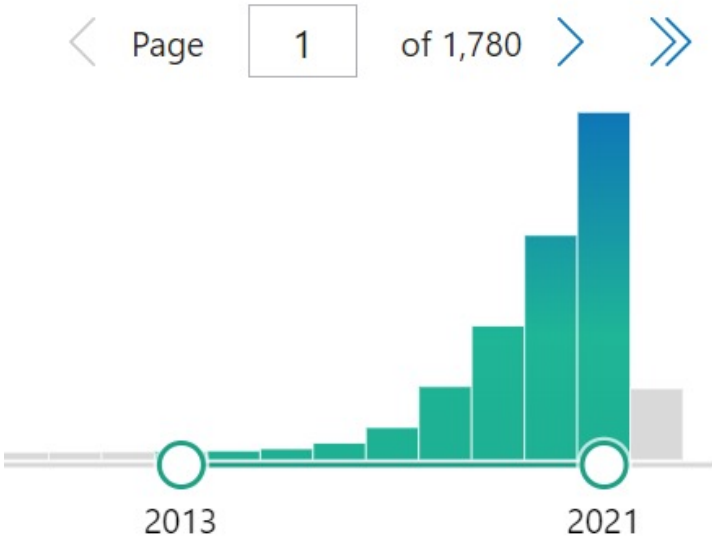
Wednesdays every 2 weeks at 7 AM / 7 PM

Deep Learning Imaging based Biomarkers

- 2012 ImageNet Challenge Deep Convolution Neural Networks
- Facial recognition
- Self Driving cars





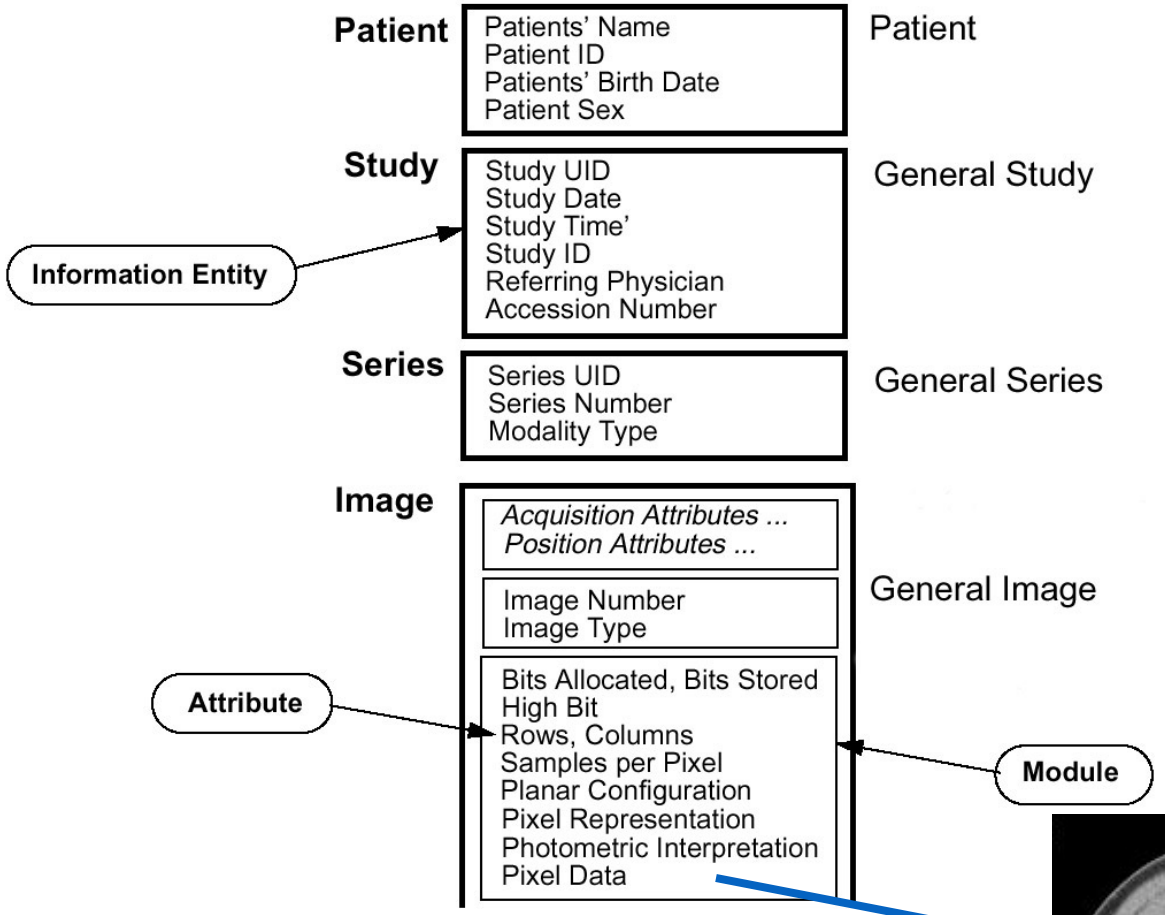


Pubmed deep learning imaging

Imaging WG Goals

1. Ability to perform cohort definitions in OHDSI for medical imaging research studies.

DICOM Information Object Definition



Every modality has its own IODs
CT
MR
DX
CR
PET
NM
US

Memo > Paragraph > Sentence > Word
Object > Entity > Module > Attribute

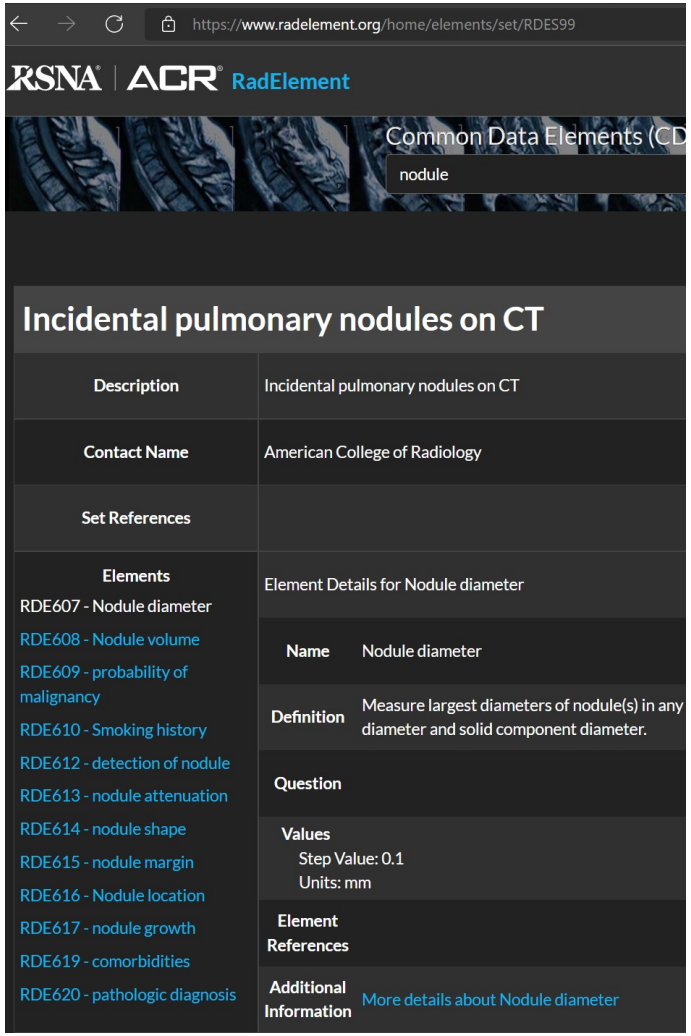
Ability to perform cohort definitions in OHDSI for medical imaging research studies.

Imaging_Study

- Imaging_study_id
- Procedure_occurrence_id
- DICOM URI
- Modality
- Body Part
- Protocol

<u>DICOM tags typically used for cohort discovery.</u>

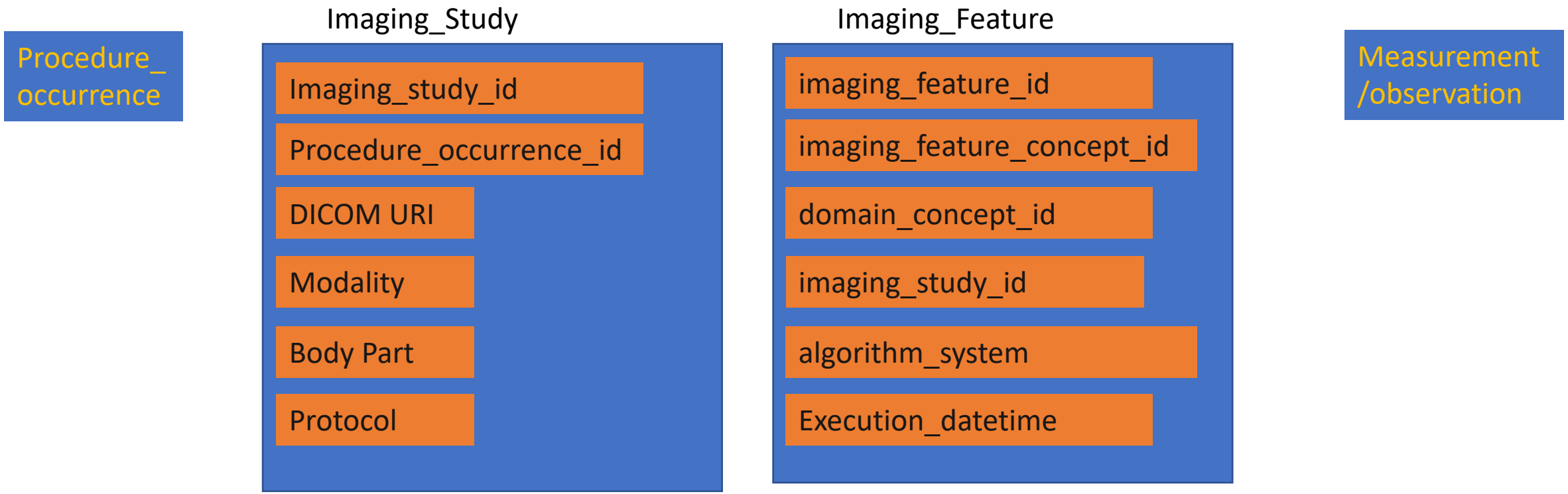
Modality
Laterality
Contrast
Technique
Image resolution
Slice thickness
Protocol



Imaging WG Goals

1. Ability to perform cohort definitions in OHDSI for medical imaging research studies.
2. The ability to bring features derived from medical images into the OMOP data model while maintaining provenance.

Develop Imaging extension to bring features derived from medical images into the OMOP data model while maintaining provenance.



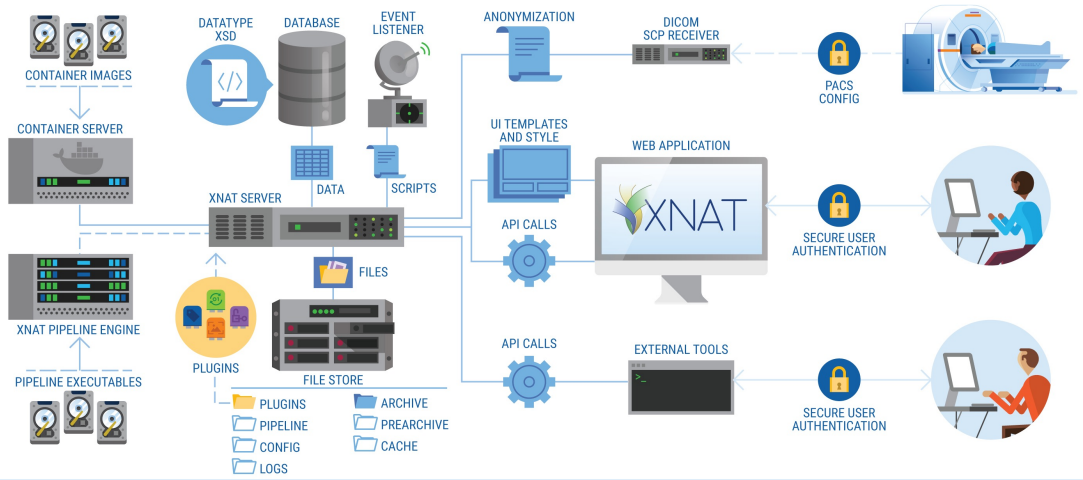
Imaging WG Goals

1. Extension to perform cohort definitions in OHDSI for medical imaging research studies.
2. Extension to bring features derived from medical images into the OMOP data model while maintaining provenance.
3. Create refence implementations of infrastructure for reproducible research on medical images.

Understanding the Components of XNAT

XNAT ACADEMY

FILED UNDER: GETTING STARTED



CONTAINER SERVICE
Run processing in containers where each container image controls its own environment. Enabled via plugin.

XNAT PIPELINE ENGINE
Run processing on XNAT data and return outputs to XNAT.

PLUGIN FRAMEWORK
Add data types, API, UI & features.

XNAT SERVER
Java-based web application on an Apache Tomcat server.

XNAT DATABASE
PostgreSQL used to store indexed project data according to defined XSD Schemas.

FILE STORE
All file resources are stored. Only the Archive should be backed up.

EVENT SERVICE & AUTOMATION
Script automated responses to user or system events.

ANONYMIZATION
DicomEdit scripts can be applied site-wide or on a per-project basis to remove PHI from DICOM headers.

FRONT END
UI is built in Velocity templates and delivered as HTML / CSS for use in a web browser.

API
Core data functions and commands can be accessed by external tools or scripts with proper authentication.

DICOM SCP RECEIVER
Allows your XNAT to be set up as a destination for PACS to send image sessions to. Requires PACS to be set up separately.

USER AUTHENTICATION
Spring Security used by default. LDAP / OpenID can be enabled by plugins.

USER ACCESS
Data access in XNAT is segregated by project. Each project determines who has access to its data. User access can be enabled or disabled by site administrators as needed.

MONAI+

Medical Open Network for Artificial Intelligence

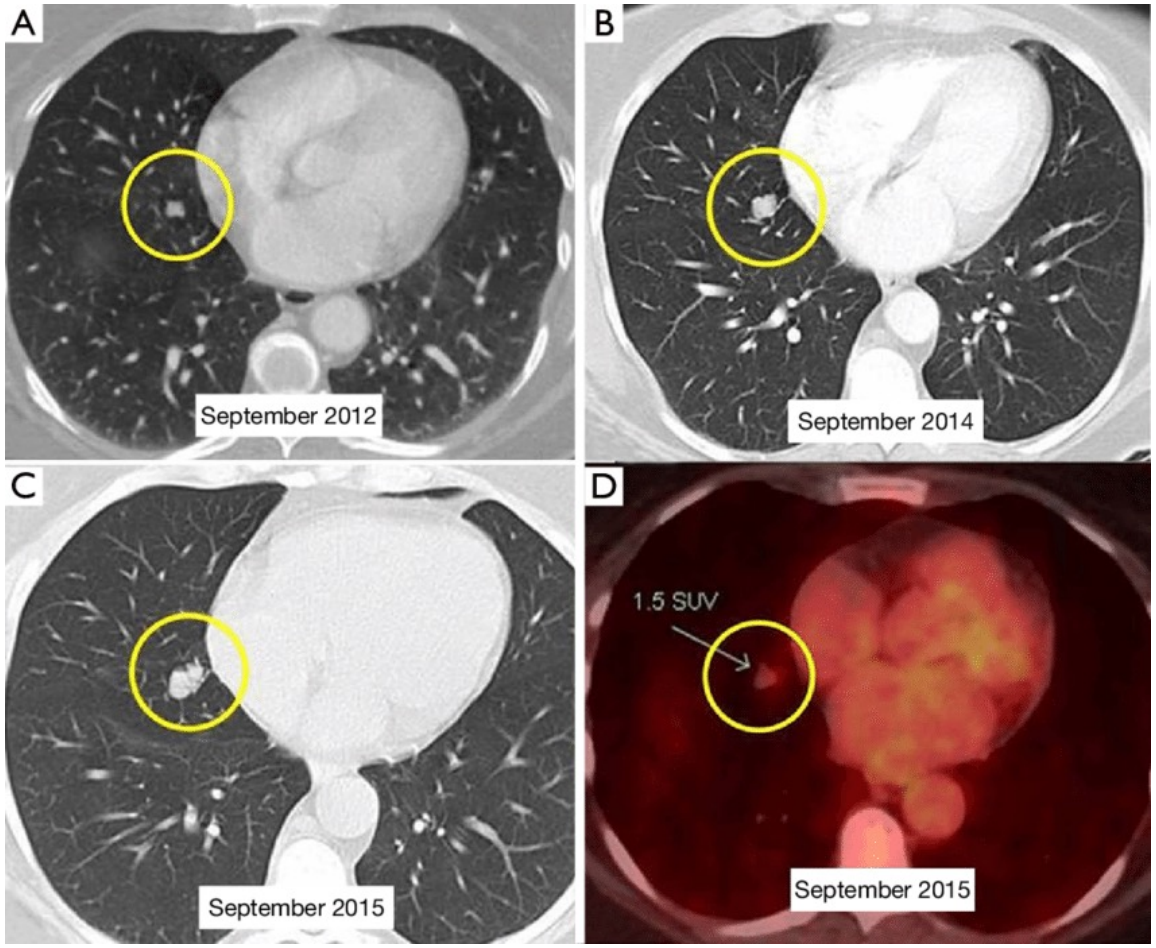
New Releases:

2022 OKR’s

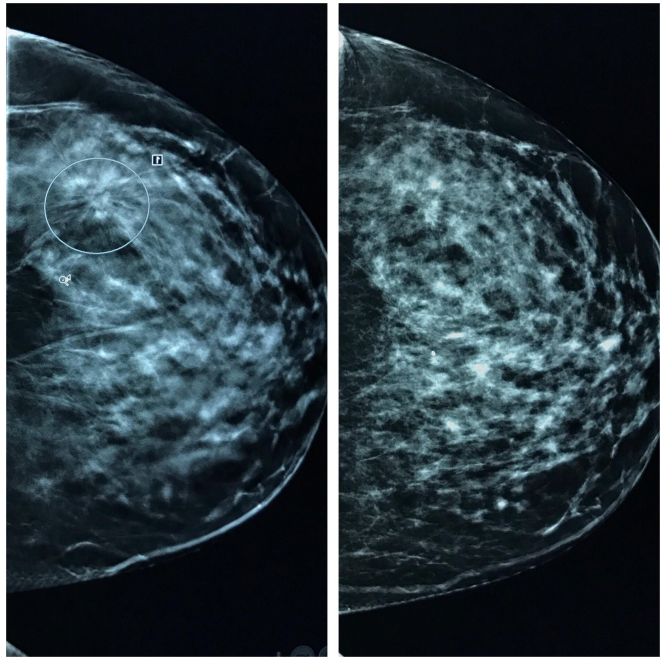
- Have the OMOP CDM WG incorporate our data model and write a white paper
  - Identify data elements are necessary to accomplish the goals
  - Identify vocabulary (DICOM, LOINC, Radlex, AIM)
  - Develop Schema
  - Harmonize with noteNLP, Genomics (oncology), and Telemetry
- Have a reference implementation and write a paper.
  - Build some infrastructure
  - Identifying some of the building blocks
  - Potential pilots with xnat, monai
  - MICAI, NCI curation and build an open architecture

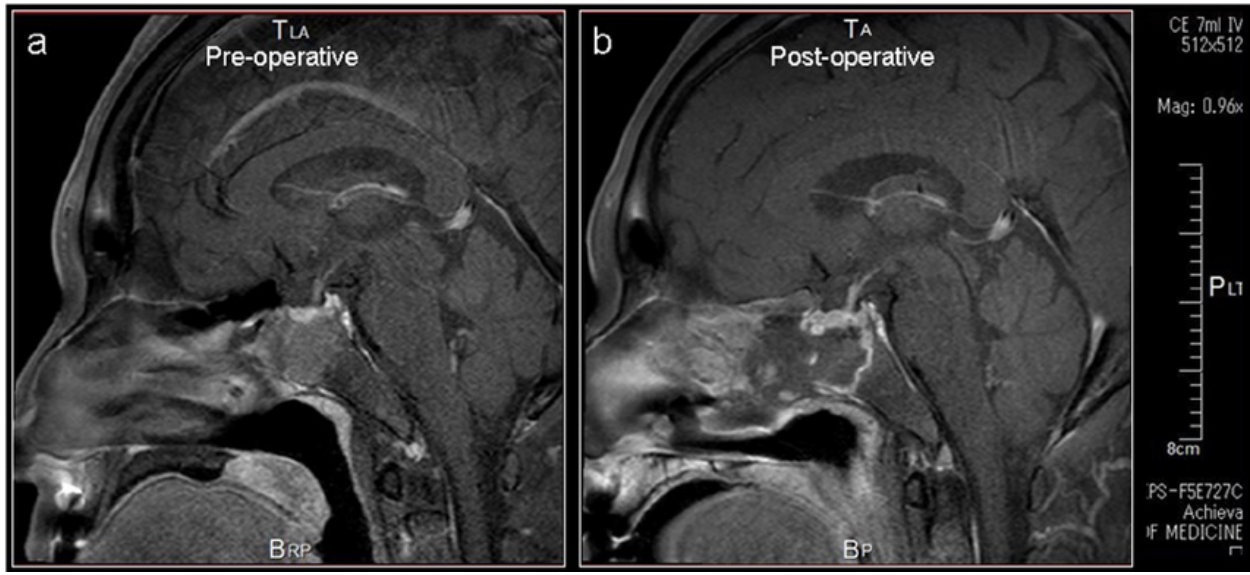
Use Cases

- **Lung Cancer**. Tracking pulmonary nodules in CT. Looking at the doubling rate of nodules volume is a key predictor of malignancy. For patients having serial Chest CT imaging Studies(CPT). Where the analysis looks at the morphology of nodules and their locations and tracks to see how they change over time. Outcomes defined by pathology biopsy and lung cancer DX. OMOP model has the diagnosis and the biopsy results. The goal is to bring automated measurements of the morphology of nodules into OMOP with direct provenance to the algorithm and the original images that created that feature. We can then validate algorithms as well as use these measurements to study progression of disease.



- **Breast Cancer**. Retrospective analysis looking at Cancer DX identified for cohort discovery. Using supervised training techniques to evaluate prediction models based on pixel data. Mammogram analysis extracting new phenotypes on breast density, calcifications into the OMOP database and see how they are predictive of disease for patients.
- **Pre and post operative imaging analysis**. Neuro fixed body registration between pre and post surgery to look at change in tumor size. This requires identification of both imaging studies as well as an able to fix the reference orientation between.



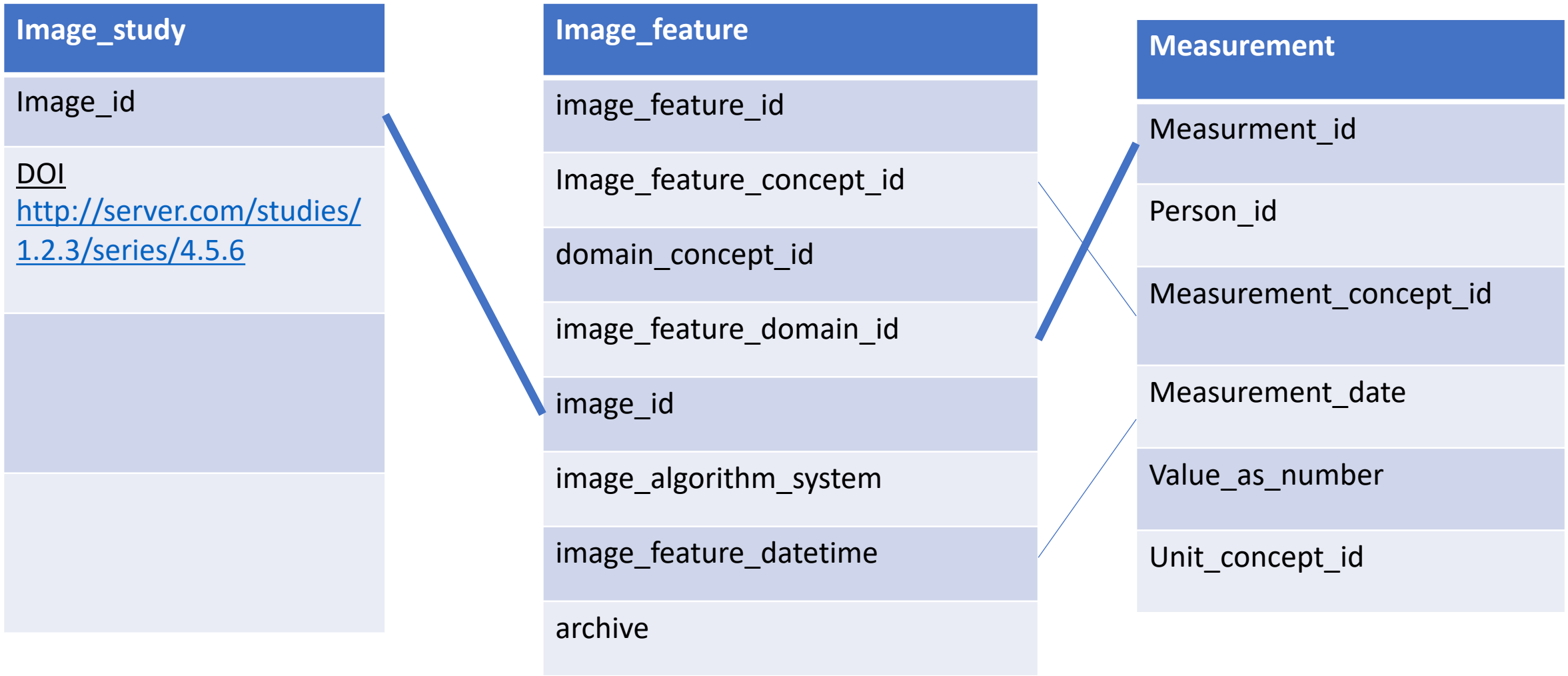


- A.7.2 Target DICOM SR "Measurement Report" (TID 1500) (nema.org)

A.7.2 Target DICOM SR "Measurement Report" (TID 1500)

A compact representation of the semantic content of the transformed DICOM SR tree is shown here:

```
1: : CONTAINER: (126000,DCM,"Imaging Measurement Report")  [SEPARATE] (DCMR,1500)
        >1.1: HAS CONCEPT MOD: CODE: (121049,DCM,"Language of Content Item and Descendants")  = (eng,RFC5646,"English")
                >>1.1.1: HAS CONCEPT MOD: CODE: (121046,DCM,"Country of Language")  = (US,ISO3166_1,"United States")
        >1.2: HAS OBS CONTEXT: PNAME: (121008,DCM,"Person Observer Name")  = "Doe^Jane"
        >1.3: HAS OBS CONTEXT: TEXT: (128774,DCM,"Person Observer's Login Name")  = "jdoe"
        >1.4: HAS CONCEPT MOD: CODE: (121058,DCM,"Procedure reported")  = (44136-0,LN,"PET unspecified body region")
        >1.5: CONTAINS: CONTAINER: (111028,DCM,"Image Library")  [SEPARATE]
                >>1.5.1: CONTAINS: CONTAINER: (126200,DCM,"Image Library Group")  [SEPARATE] (,2.25.239108061065263370785162033783811931375)
                        >>>1.5.1.1: CONTAINS: IMAGE:  = (1.2.840.10008.5.1.4.1.1.128,2.25.319214308104243787945491694789635628411)
                                >>>>1.5.1.1.1: HAS ACQ CONTEXT: CODE: (121139,DCM,"Modality")  = (PT,DCM,"Positron emission tomography")
                                >>>>1.5.1.1.2: HAS ACQ CONTEXT: TEXT: (121022,DCM,"Accession Number")  = "AN1234IMG"
                                >>>>1.5.1.1.3: HAS ACQ CONTEXT: DATE: (111060,DCM,"Study Date")  = "20170113"
                                >>>>1.5.1.1.4: HAS ACQ CONTEXT: TIME: (111061,DCM,"Study Time")  = "070844"
        >1.6: CONTAINS: CONTAINER: (126010,DCM,"Imaging Measurements")  [SEPARATE]
                >>1.6.1: CONTAINS: CONTAINER: (125007,DCM,"Measurement Group")  [SEPARATE] (20170201180043,2.25.560024661286274988869350799031729380 41)
                        >>>1.6.1.1: HAS OBS CONTEXT: TEXT: (112039,DCM,"Tracking Identifier")  = "Lesion1"
                        >>>1.6.1.2: HAS OBS CONTEXT: UIDREF: (112040,DCM,"Tracking Unique Identifier")  = "2.25.165294254063588909770717555738008800301"
                        >>>1.6.1.3: CONTAINS: CODE: (121071,DCM,"Finding")  = (52988006,SCT,"Lesion")
                        >>>1.6.1.4: CONTAINS: IMAGE: (121191,DCM,"Referenced Segment")  = (1.2.840.10008.5.1.4.1.1.66.4,2.25.134884066033959077306435705240550195701) [S
                        >>>1.6.1.5: CONTAINS: IMAGE: (121233,DCM,"Source image for segmentation")  = (1.2.840.10008.5.1.4.1.1.128,2.25.319214308104243787945491694789635
                        >>>1.6.1.6: CONTAINS: NUM: (126401,DCM,"SUVbw")  = 1.98024 (g/ml{SUVbw},UCUM,"g/ml{SUVbw}") (,2.25.514209682575309812438246589438719731 98)
                                >>>>1.6.1.6.1: HAS CONCEPT MOD: CODE: (121401,DCM,"Derivation")  = (255605001,SCT,"Minimum")
                        >>>1.6.1.7: CONTAINS: NUM: (126401,DCM,"SUVbw")  = 5.68816 (g/ml{SUVbw},UCUM,"g/ml{SUVbw}") (,2.25.205292243885258032428819330909580896146)
                                >>>>1.6.1.7.1: HAS CONCEPT MOD: CODE: (121401,DCM,"Derivation")  = (56851009,SCT,"Maximum")
                        >>>1.6.1.8: CONTAINS: NUM: (126401,DCM,"SUVbw")  = 2.329186593407 (g/ml{SUVbw},UCUM,"g/ml{SUVbw}") (,2.25.701602520802345771678475099483688932 76
                                >>>>1.6.1.8.1: HAS CONCEPT MOD: CODE: (121401,DCM,"Derivation")  = (373098007,SCT,"Mean")
                        >>>1.6.1.9: CONTAINS: NUM: (126401,DCM,"SUVbw")  = 1.8828952323684 (g/ml{SUVbw},UCUM,"g/ml{SUVbw}") (,2.25.140657026119469861895824082767088344 9
                                >>>>1.6.1.9.1: HAS CONCEPT MOD: CODE: (121401,DCM,"Derivation")  = (386136009,SCT,"Standard Deviation")
                        >>>1.6.1.10: CONTAINS: TEXT: (121106,DCM,"Comment")  = "PT / WB NAC P600 / 0"
```


Image_study
Image_id
DOI
http://server.com/studies/1.2.3/series/4.5.6
Image_feature
image_feature_id
Image_feature_concept_id
domain_concept_id
image_feature_domain_id
image_id
image_algorithm_system
image_feature_datetime
archive
Measurement
Measurment_id
Person_id
Measurement_concept_id
Measurement_date
Value_as_number
Unit_concept_id