Using LOINC codes to build MIDRC cohorts

Paul Kinahan
Vice-Chair, Radiology Research
University of Washington

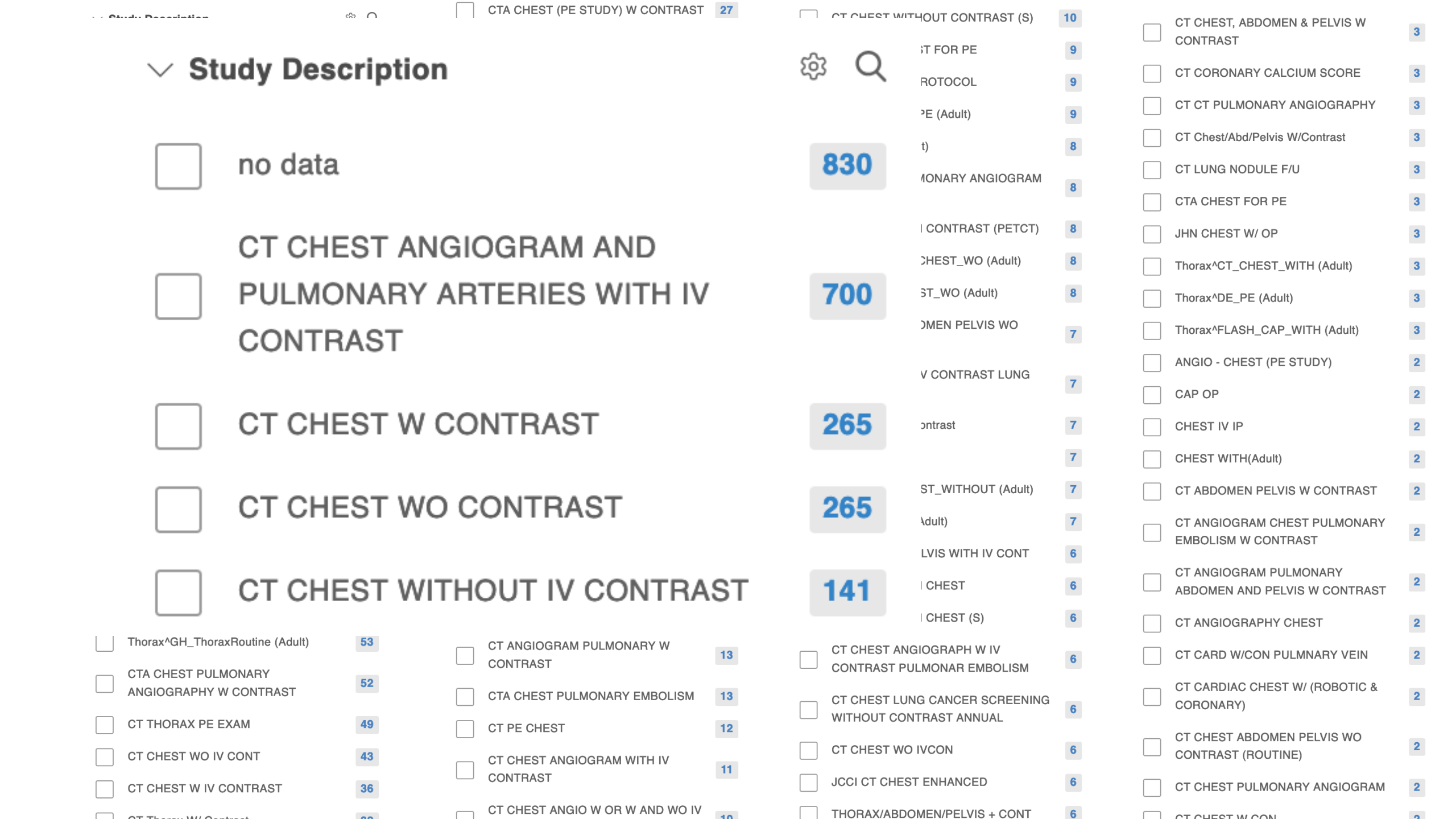
Funding from NIH-NIBIB Contract 75N92020D00021

Example use case

- You want a cohort of chest CT images, without contrast agent, to develop or test a model that detects, segments, and analyzes nodules to, say, classify a disease or make a prediction.
- You start with the MIDRC data explorer data.midrc.org/explorer
- Under the “Imaging studies / Study Properties” tab you select “CT” for Study Modality and “CHEST” for Body Part Examined in the Study Property filter
- You are (currently) left with 4,300 Imaging studies (aka “Exams”)
- Then you look under Study Description to rule out those with contrast and you get…

Study Description

- [ ] no data 830
- [ ] CT CHEST ANGIOGRAM AND PULMONARY ARTERIES WITH IV CONTRAST 700
- [ ] CT CHEST W CONTRAST 265
- [ ] CT CHEST WO CONTRAST 265
- [ ] CT CHEST WITHOUT IV CONTRAST 141
- [ ] CTA PE CHEST W 111
- [ ] CT CHEST PULMONARY EMBOLISM W CONTRAST 99
- [ ] 01_PM_Thorax_Plain(Adult) 98
- [ ] Thorax^CT_PE (Adult) 74
- [ ] CT CHEST WITH CONTRAST 69
- [ ] CT CHEST WO 68
- [ ] CT CHEST WITH IV CONTRAST 63
- [ ] CT CHEST WITHOUT CONTRAST 59
- [ ] CT CHEST WO IV CONTRAST 59
- [ ] CT CHEST W/O CONTRAST 58
- [ ] CT CHEST PULMONARY EMBOLISM (CTPE) 55
- [ ] Thorax^GH_ThoraxRoutine (Adult) 53
- [ ] CTA CHEST PULMONARY ANGIOGRAPHY W CONTRAST 52
- [ ] CT THORAX PE EXAM 49
- [ ] CT CHEST WO IV CONT 43
- [ ] CT CHEST W IV CONTRAST 36
- [ ] CT Thorax W/ Contrast 28
- [ ] CTA CHEST (PE STUDY) W CONTRAST 27
- [ ] CTA CHEST PULMONARY EMBOLUS W/ IVCON 24
- [ ] CT Angio Pulmonary 23
- [ ] CT CHEST HIGH RESOLUTION 23
- [ ] CT CHEST ABDOMEN PELVIS W CONTRAST 22
- [ ] CT CHEST W 22
- [ ] CTA CORONARY 20
- [ ] JCCI CT CHEST 20
- [ ] CT CT-Thorax for Pulmonary Embolism W/Cont 19
- [ ] THORAX PE 19
- [ ] Thorax^CHEST_WO (Adult) 19
- [ ] CT CHEST W/O IV CON 18
- [ ] CT CHEST PULMONARY ANGIO WITH IV CON 17
- [ ] CT ANGIO CHEST WWO 16
- [ ] CT CHEST ABDOMEN PELVIS W 16
- [ ] CTA PULMONARY EMBOLUS 16
- [ ] Thorax^DE_CHEST_PE_Customized (Adult) 15
- [ ] CT ANGIOGRAM PULMONARY W CONTRAST 13
- [ ] CTA CHEST PULMONARY EMBOLISM 13
- [ ] CT PE CHEST 12
- [ ] CT CHEST ANGIOGRAM WITH IV CONTRAST 11
- [ ] CT CHEST ANGIO W OR W AND WO IV 10
- [ ] CT CHEST WITHOUT CONTRAST (S) 10
- [ ] CT ANGIO CHEST FOR PE 9
- [ ] CT CHEST PE PROTOCOL 9
- [ ] Thorax^FLASH_PE (Adult) 9
- [ ] CHEST WO(Adult) 8
- [ ] CT CHEST PULMONARY ANGIOGRAM (ACUTE) 8
- [ ] CT CHEST WITH CONTRAST (PETCT) 8
- [ ] Thorax^FLASH_CHEST_WO (Adult) 8
- [ ] Thorax^XL_CHEST_WO (Adult) 8
- [ ] CT CHEST ABDOMEN PELVIS WO CONTRAST 7
- [ ] CT CHEST WO IV CONTRAST LUNG PARENCHYMA 7
- [ ] CT Chest W/O Contrast 7
- [ ] CTA CHEST 7
- [ ] Thorax^CT_CHEST_WITHOUT (Adult) 7
- [ ] Thorax^XL_PE (Adult) 7
- [ ] CT ABD AND PELVIS WITH IV CONT 6
- [ ] CT ANGIOGRAM CHEST 6
- [ ] CT ANGIOGRAM CHEST (S) 6
- [ ] CT CHEST ANGIOGRAPH W IV CONTRAST PULMONAR EMBOLISM 6
- [ ] CT CHEST LUNG CANCER SCREENING WITHOUT CONTRAST ANNUAL 6
- [ ] CT CHEST WO IVCON 6
- [ ] JCCI CT CHEST ENHANCED 6
- [ ] THORAX/ABDOMEN/PELVIS + CONT 6
- [ ] CT CHEST, ABDOMEN & PELVIS W CONTRAST 3
- [ ] CT CORONARY CALCIUM SCORE 3
- [ ] CT CT PULMONARY ANGIOGRAPHY 3
- [ ] CT Chest/Abd/Pelvis W/Contrast 3
- [ ] CT LUNG NODULE F/U 3
- [ ] CTA CHEST FOR PE 3
- [ ] JHN CHEST W/ OP 3
- [ ] Thorax^CT_CHEST_WITH (Adult) 3
- [ ] Thorax^DE_PE (Adult) 3
- [ ] Thorax^FLASH_CAP_WITH (Adult) 3
- [ ] ANGIO - CHEST (PE STUDY) 2
- [ ] CAP OP 2
- [ ] CHEST IV IP 2
- [ ] CHEST WITH(Adult) 2
- [ ] CT ABDOMEN PELVIS W CONTRAST 2
- [ ] CT ANGIOGRAM CHEST PULMONARY EMBOLISM W CONTRAST 2
- [ ] CT ANGIOGRAM PULMONARY ABDOMEN AND PELVIS W CONTRAST 2
- [ ] CT ANGIOGRAPHY CHEST 2
- [ ] CT CARD W/CON PULMNARY VEIN 2
- [ ] CT CARDIAC CHEST W/ (ROBOTIC & CORONARY) 2
- [ ] CT CHEST ABDOMEN PELVIS WO CONTRAST (ROUTINE) 2
- [ ] CT CHEST PULMONARY ANGIOGRAM 2
- [ ] CT CHEST W CON 2



CTA CHEST (PE STUDY) W CONTRAST 27

CT CHEST WITHOUT CONTRAST (S) 10

ST FOR PE 9

ROTOCOL 9

PE (Adult) 9

t) 8

MONARY ANGIOGRAM 8

CONTRAST (PETCT) 8

CHEST_WO (Adult) 8

ST_WO (Adult) 8

OMEN PELVIS WO 7

V CONTRAST LUNG 7

ontrast 7

7

ST_WITHOUT (Adult) 7

Adult) 7

LVIS WITH IV CONT 6

CHEST 6

CHEST (S) 6

CT CHEST, ABDOMEN & PELVIS W CONTRAST 3

CT CORONARY CALCIUM SCORE 3

CT CT PULMONARY ANGIOGRAPHY 3

CT Chest/Abd/Pelvis W/Contrast 3

CT LUNG NODULE F/U 3

CTA CHEST FOR PE 3

JHN CHEST W/ OP 3

Thorax^CT_CHEST_WITH (Adult) 3

Thorax^DE_PE (Adult) 3

Thorax^FLASH_CAP_WITH (Adult) 3

ANGIO - CHEST (PE STUDY) 2

CAP OP 2

CHEST IV IP 2

CHEST WITH(Adult) 2

CT ABDOMEN PELVIS W CONTRAST 2

CT ANGIOGRAM CHEST PULMONARY EMBOLISM W CONTRAST 2

CT ANGIOGRAM PULMONARY ABDOMEN AND PELVIS W CONTRAST 2

CT ANGIOGRAPHY CHEST 2

CT CARD W/CON PULMNARY VEIN 2

CT CARDIAC CHEST W/ (ROBOTIC & CORONARY) 2

CT CHEST ABDOMEN PELVIS WO CONTRAST (ROUTINE) 2

CT CHEST PULMONARY ANGIOGRAM 2

CT CHEST W CON 2

Thorax^GH_ThoraxRoutine (Adult) 53

CTA CHEST PULMONARY ANGIOGRAPHY W CONTRAST 52

CT THORAX PE EXAM 49

CT CHEST WO IV CONT 43

CT CHEST W IV CONTRAST 36

CT ANGIOGRAM PULMONARY W CONTRAST 13

CTA CHEST PULMONARY EMBOLISM 13

CT PE CHEST 12

CT CHEST ANGIOGRAM WITH IV CONTRAST 11

CT CHEST ANGIO W OR W AND WO IV 10

CT CHEST ANGIOGRAPH W IV CONTRAST PULMONAR EMBOLISM 6

CT CHEST LUNG CANCER SCREENING WITHOUT CONTRAST ANNUAL 6

CT CHEST WO IVCON 6

JCCI CT CHEST ENHANCED 6

THORAX/ABDOMEN/PELVIS + CONT 6

Study Description

- no data 830
- CT CHEST ANGIOGRAM AND PULMONARY ARTERIES WITH IV CONTRAST 700
- CT CHEST W CONTRAST 265
- CT CHEST WO CONTRAST 265
- CT CHEST WITHOUT IV CONTRAST 141
- CTA PE CHEST W 111
- CT CHEST PULMONARY EMBOLISM W CONTRAST 99
- 01_PM_Thorax_Plain(Adult) 98
- Thorax^CT_PE (Adult) 74
- CT CHEST WITH CONTRAST 69
- CT CHEST WO 68
- CT CHEST WITH IV CONTRAST 63
- CT CHEST WITHOUT CONTRAST 59
- CT CHEST WO IV CONTRAST 59
- CT CHEST W/O CONTRAST 58
- CT CHEST PULMONARY EMBOLISM (CTPE) 55
- Thorax^GH_ThoraxRoutine (Adult) 53
- CTA CHEST PULMONARY ANGIOGRAPHY W CONTRAST 52
- CT THORAX PE EXAM 49
- CT CHEST WO IV CONT 43
- CT CHEST W IV CONTRAST 36

- CTA CHEST (PE STUDY) W CONTRAST 27
- CTA CHEST PULMONARY EMBOLUS W/ IVCON 24
- CT Angio Pulmonary 23
- CT CHEST HIGH RESOLUTION 23
- CT CHEST ABDOMEN PELVIS W CONTRAST 22
- CT
- CT
- JC
- CT W/
- TH
- Tho
- CT
- CT IV
- CT
- CT
- CT
- Tho (Ad
- CT CO
- CT
- CT
- CT CHEST ANGIOGRAM WITH IV CONTRAST 11
- CT CHEST ANGIO W OR W AND WO IV

- CT CHEST WITHOUT CONTRAST (S) 10
- CT ANGIO CHEST FOR PE 9
- CT CHEST PE PROTOCOL 9
- Thorax^FLASH_PE (Adult) 9
- CHEST WO(Adult) 8
- CT CHEST PULMONARY ANGIOGRAM

- CT CHEST, ABDOMEN & PELVIS W CONTRAST 3
- CT CORONARY CALCIUM SCORE 3
- CT CT PULMONARY ANGIOGRAPHY 3
- CT Chest/Abd/Pelvis W/Contrast 3
- CT LUNG NODULE F/U 3

- 3
- 3
- /ITH (Adult) 3
- 3
- WITH (Adult) 3
- STUDY) 2
- 2
- 2
- 2
- S W CONTRAST 2
- ST PULMONARY AST 2
- MONARY IS W CONTRAST 2
- HEST 2
- MNARY VEIN 2
- W/ (ROBOTIC & 2

- CT CHEST WO IVCON 6
- JCCI CT CHEST ENHANCED 6
- THORAX/ABDOMEN/PELVIS + CONT 6

- CT CHEST ABDOMEN PELVIS WO CONTRAST (ROUTINE) 2
- CT CHEST PULMONARY ANGIOGRAM 2
- CT CHEST W CON 2

Thorax^DE_PE (Adult) 3

Thorax^FLASH_CAP_WITH (Adult) 3

ANGIO - CHEST (PE STUDY) 2

CAP OP 2

CHEST IV IP 2

CHEST WITH(Adult) 2

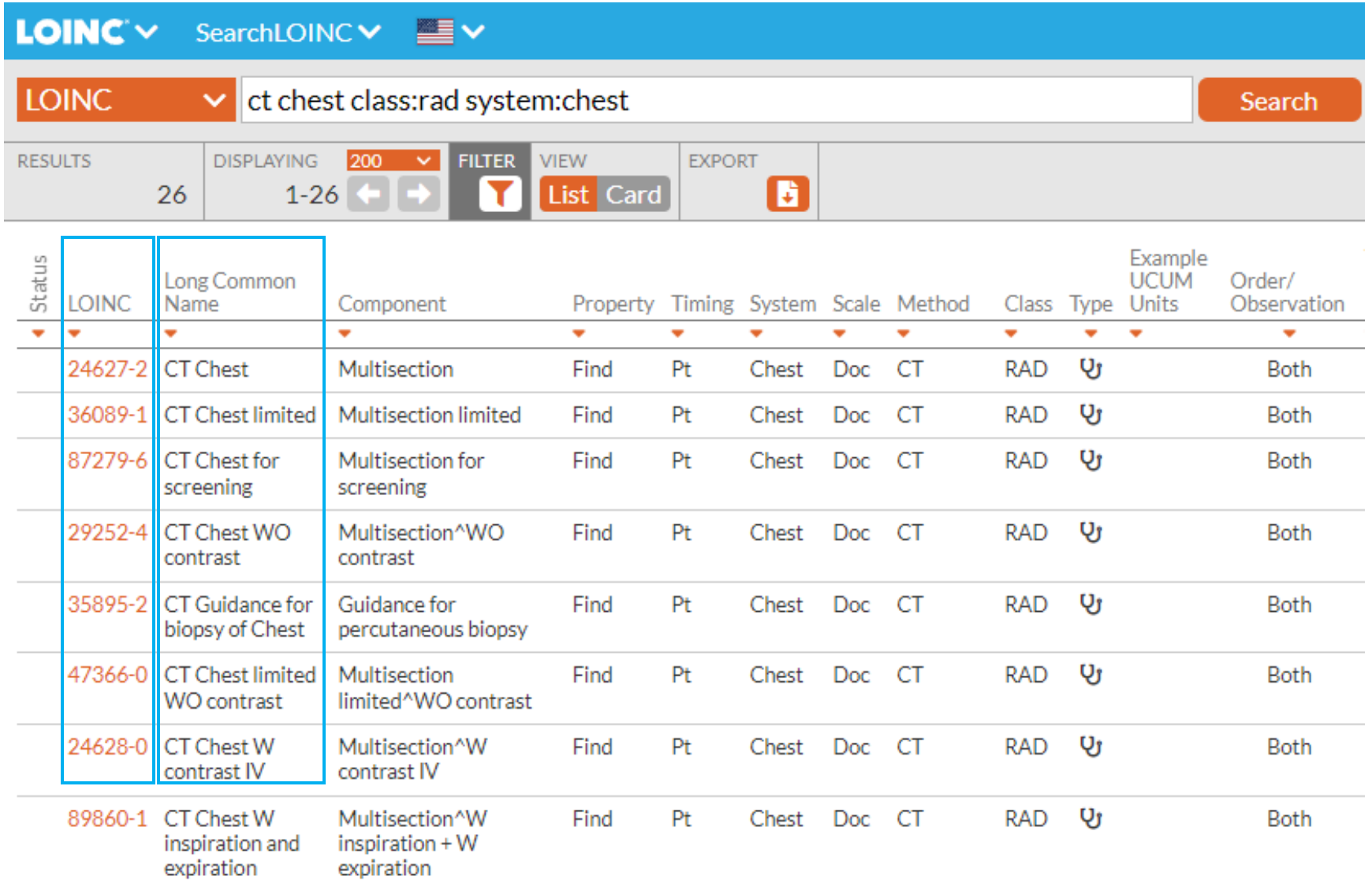
CT ABDOMEN PELVIS W CONTRAST 2

What is with all the study descriptions?

- There are (in this example) over 270 different study descriptions, some are obscure
- These arise as every hospital uses what it wants, and in general this works okay for local use, but not for external users of pooled data
- Is there a standard?
  - Not one that is widely used
  - However. LOINC (Logical Observation Identifiers Names and Codes) does provide a standard for laboratory test orders and results
  - MIDRC is using the Radlex Playbook / LOINC subset of codes
  - LOINC codes are unique with an algorithmically derived Long Common Name that is designed to look like a Study Description (for this subset)

LOINC Structure

- LOINC Code:
  - Unique numerical identifier
- Long Common Name:
  - Also unique, human readable
- Either field may be used



Status	LOINC	Long Common Name	Component	Property	Timing	System	Scale	Method	Class	Type	Example UCUM Units	Order/ Observation
	24627-2	CT Chest	Multisection	Find	Pt	Chest	Doc	CT	RAD			Both
	36089-1	CT Chest limited	Multisection limited	Find	Pt	Chest	Doc	CT	RAD			Both
	87279-6	CT Chest for screening	Multisection for screening	Find	Pt	Chest	Doc	CT	RAD			Both
	29252-4	CT Chest WO contrast	Multisection^WO contrast	Find	Pt	Chest	Doc	CT	RAD			Both
	35895-2	CT Guidance for biopsy of Chest	Guidance for percutaneous biopsy	Find	Pt	Chest	Doc	CT	RAD			Both
	47366-0	CT Chest limited WO contrast	Multisection limited^WO contrast	Find	Pt	Chest	Doc	CT	RAD			Both
	24628-0	CT Chest W contrast IV	Multisection^W contrast IV	Find	Pt	Chest	Doc	CT	RAD			Both
	89860-1	CT Chest W inspiration and expiration	Multisection^W inspiration + W expiration	Find	Pt	Chest	Doc	CT	RAD			Both

Harmonization of MIDRC Study Descriptions

Input study descriptions

Long-tail problem

Modality	Study Description	Count	Cumulative %
DX	XR CHEST 1 VIEW AP	15945	10.9%
DX	XR CHEST 1 VW, FRONTAL	14137	20.5%
CR	XR PORT CHEST 1V	11941	28.6%
DX	XR CHEST PORTABLE 1 VIEW	9978	35.4%
CR	CHEST PORT 1 VIEW (RAD)-CS	7326	40.4%
CR	XR CHEST 2 VIEWS	6212	44.6%
CR	XR CHEST 1 VW PORTABLE	5873	48.6%
CR	XR CHEST 1 VIEW AP	5335	52.2%
	•••		
CT	CT P CHEST WO	4	99%
	•••		
DX	THORACIC SPINE 3 VIEWS	1	100%

Row 444

Row 1385

Harmonized study descriptions

↓ 95%+

Reduction

LOINC Common Name	Count	Cumulative %
Portable XR Chest AP single view	41057	30.7%
XR Chest AP	21416	46.7%
XR Chest Single view	19990	61.6%
XR Chest 2 Views	9754	68.9%
XR Chest PA and Lateral	9173	75.7%
Portable XR Chest Views AP	6533	80.6%
XR Unspecified body region Views	6494	85.4%
CT Chest WO contrast	4148	88.5%
CT Abdomen W contrast IV	115	99%

Row 22

MIDRC-LOINC Mapping Table

DICOM → LOINC

Modality	Study Description	LOINC code	LOINC Long Common Name
CT	CT CHEST WITHOUT CONTRAST	29252-4	CT Chest WO contrast
CT	CHEST WITHOUT IV CONTRAST	29252-4	CT Chest WO contrast
CT	CT CHEST WO	29252-4	CT Chest WO contrast
CT	CT CHEST WO CONTRAST	29252-4	CT Chest WO contrast
CT	CT CHEST WO IV CONT	29252-4	CT Chest WO contrast
CT	CT CHEST WO IV CONTRAST	29252-4	CT Chest WO contrast
CT	Thorax^CHEST_WITHOUT (Adult)	29252-4	CT Chest WO contrast
CT	Thorax^CHEST_WO (Adult)	29252-4	CT Chest WO contrast
CT	Thorax^CT_CHEST_WITHOUT (Adult)	29252-4	CT Chest WO contrast
CT	Thorax^CHEST_WO_GR (Adult)	29252-4	CT Chest WO contrast
CT	Thorax^ROUTINE_CHEST_WO (Adult)	29252-4	CT Chest WO contrast

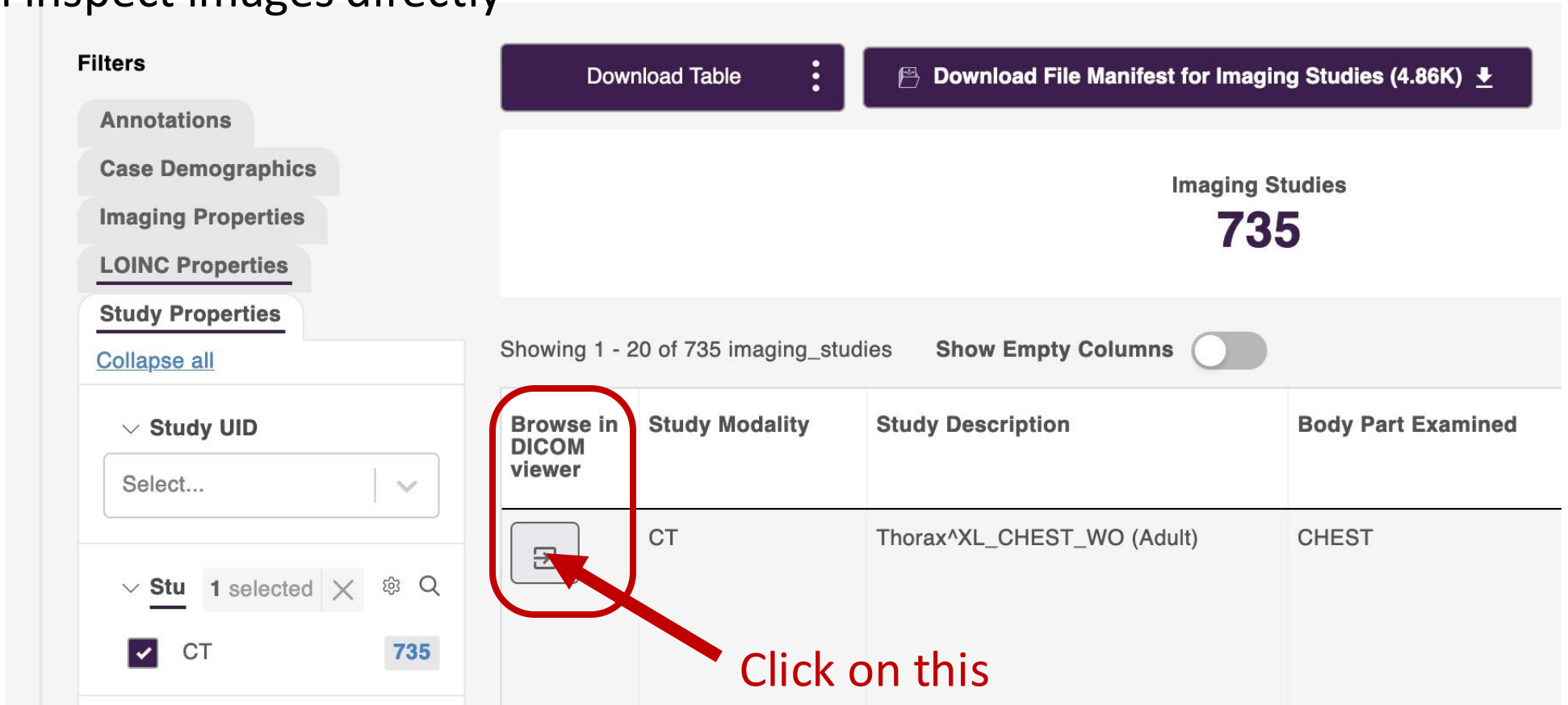
The MIDRC-LOINC Mapping Table is open source on Github

Using LOINC Codes for Cohort Building

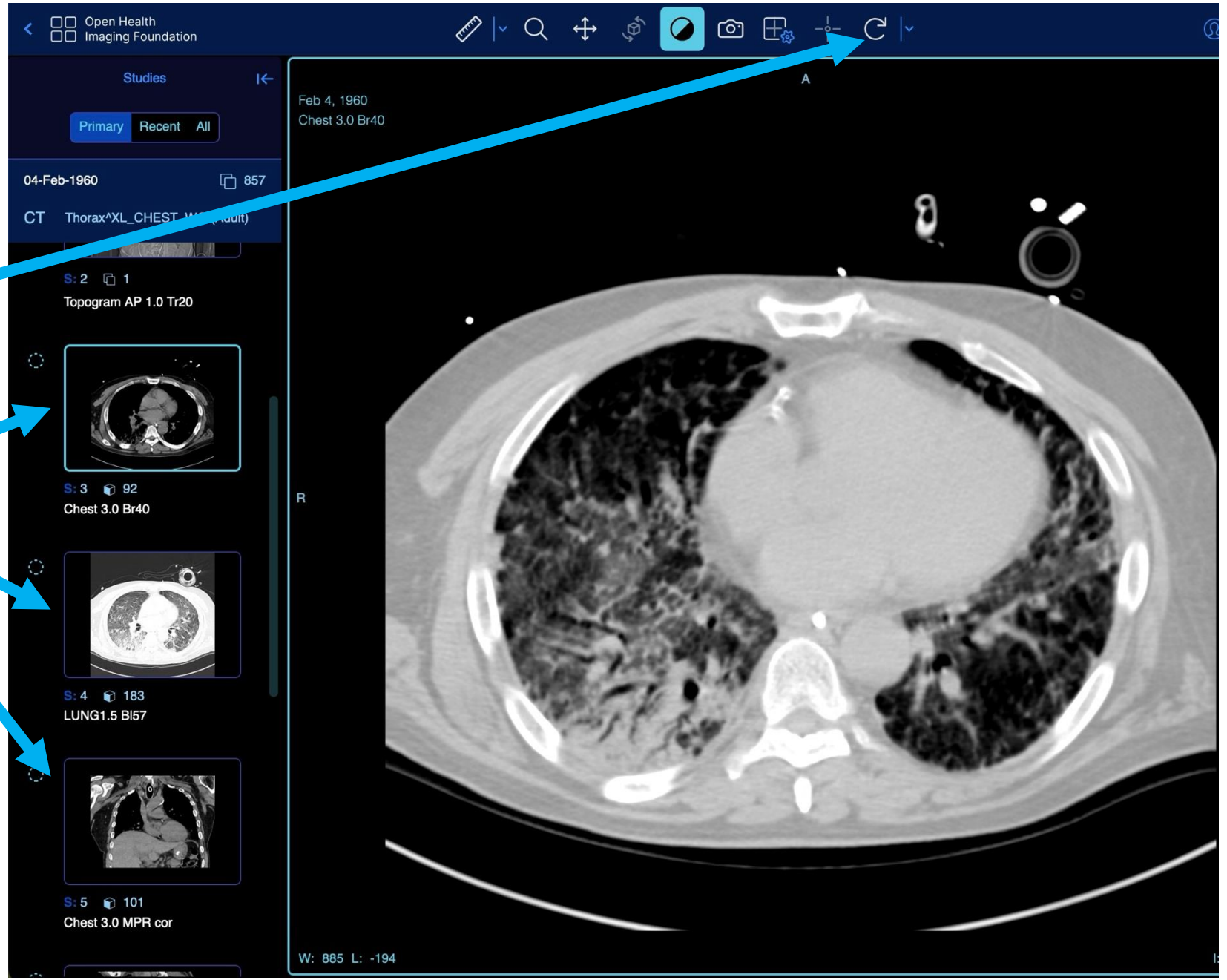
- Say you find a Study Description “Thorax^CHEST_WO (Adult)” that looks good
- In the MIDRC Data Explorer table, the LOINC Long Common Name is “CT Chest WO contrast”
- Selecting the Long Common Name filter tab, search for “CT Chest WO contrast”
- This brings up over 700 studies, with about 20 different Study Descriptions like:
  - Thorax^XL_CHEST_WO (Adult)
  - CT CHEST WO
  - CT CHEST WO CONTRAST
  - CT CHEST WO IV CONT
  - CT CHEST HIGH RESOLUTION
  - CT CHEST WITHOUT IV CONTRAST

Inspecting Studies

- We are not necessarily done yet
  - Some studies may be mis-labelled by a submitting site
  - Some useful studies may not be in the selected cohort
  - We can inspect images directly



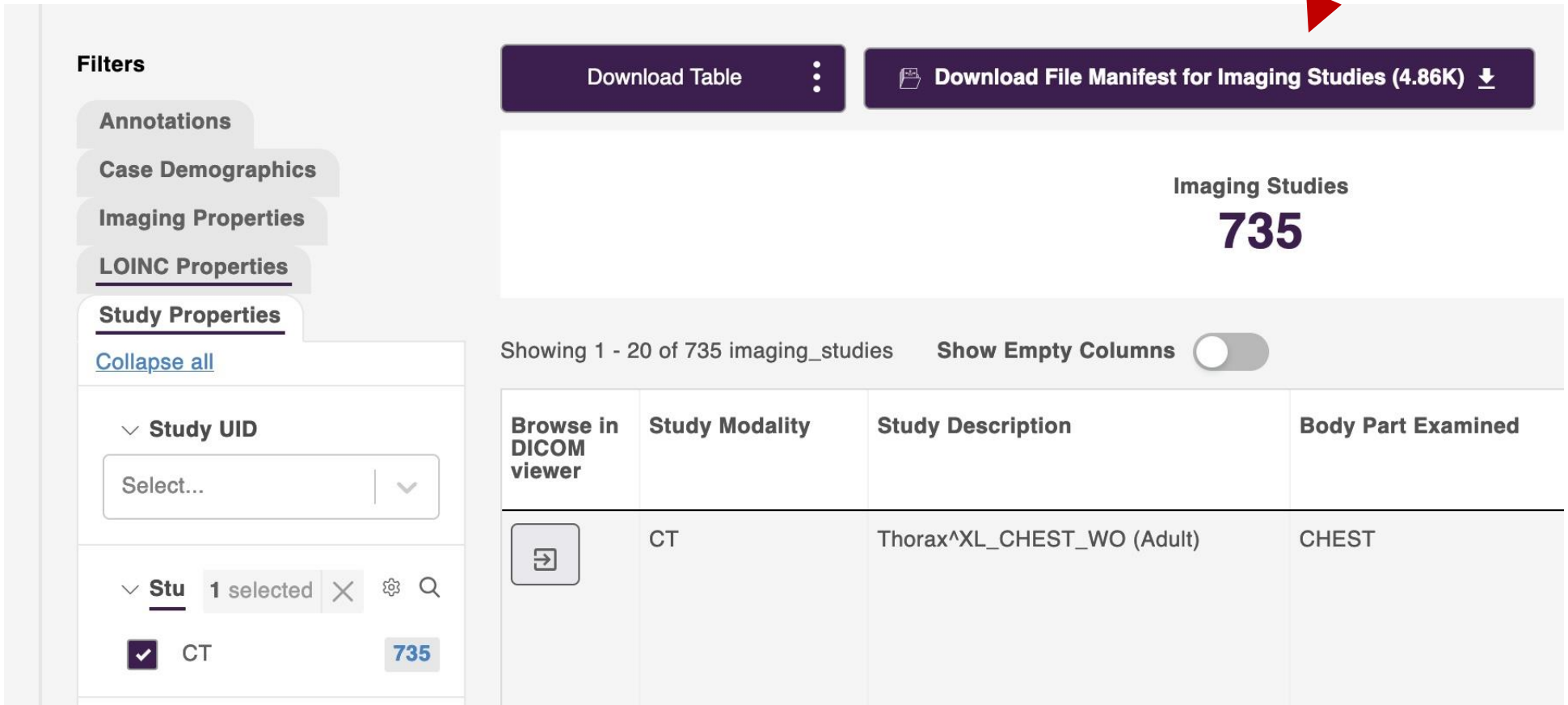
- This launches the OHIF viewer
- Many useful tools, including a DICOM meta-data viewer
- All the series are listed and can be viewed



Downloading Studies

- Whatever filters are applied selects the cohort manifest that will be downloaded
- The gen3-client application uses the manifest to pull the images locally

Click on this



Summary

- LOINC Long Common Names can provide a more meaningful and systematic set of study descriptions
- MIDRC uses a subset (currently < 200) of LOINC codes to simplify searching
- Some details may be lost, as there are almost 2k study descriptions in MIDRC, and over 7k radiologic LOINC codes
- This is due to the level of detail sometimes needed in local clinical use of a study description, versus what is desired to build a cohort from pooled data
- Even with the use of the MIDRC-LOINC descriptions, some data wrangling may be required
- You can use the MIDRC-LOINC descriptions that are built into the MIDRC data explorer, or access directly from Github
- Other LOINC filters: Contrast, Method (i.e. modality), and System (i.e. body region)

Links

- MIDRC data explorer data.midrc.org/explorer
- MIDRC-LOINC mapping table for study descriptions on Github
- Radlex Playbook / LOINC codes loinc.org (use “class:rad” in LOINC search)