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Ontology-based classification of radiological procedures for consistent sharing in Clinical Data Warehouses

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Context, Goals

- Improving our Clinical Data Warehouse « eHop » to handle imaging data
- Considering artificial intelligence or data mining study cases
 - We chose to align our imaging data with an ontology of medical imaging procedures

Context : RadLex ontology

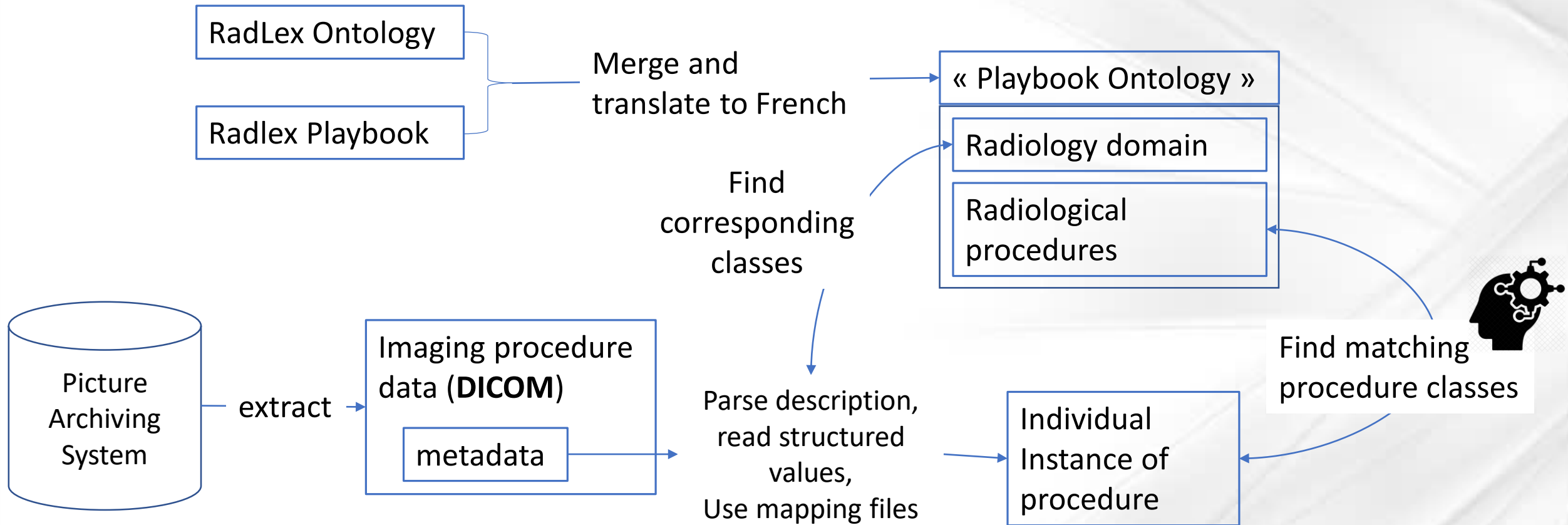
- Produced by the Radiological Society of North America (RSNA)
- Started in 2005, Including more than 30,000 terms covering the whole domain of radiology
- Every class has a RID (Radlex ID)
- Is available in OWL format

Context : The RadLex Playbook

- A CSV file defining more than 4400 procedures identified by a unique RadLex Playbook ID (RPID)
- Text fields manually and automatically filled in

RPID	SHORT_NAME	AUTOMATED_SHORT_NAME	MODALITY	BODY_REGION	MODALITY_MODIFIER	ANATOMIC_FOCUS	RIDS
RPID2599		XRAY LE 1-2VWS ANKLE BILAT	XR	LOWER EXTREMITY	1 - 2 VIEWS	ANKLE	RID10345 RID13060 0 RID2638 0 0 0
RPID2600	XR Ankle 1-2V	XRAY LE 1-2VWS ANKLE	XR	LOWER EXTREMITY	1 - 2 VIEWS	ANKLE	RID10345 RID13060 0 RID2638 0 0 0
RPID2601		XRAY GUIDE MAJ JNT ASP	XR		GUIDANCE	MAJOR JOINT	RID10345 RID13060 0 0 0 0 0 0 RID

Context : Our approach



Method : Creating our Playbook Ontology

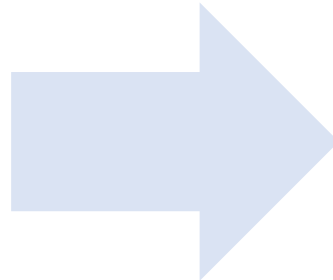
- Merge the playbook in the Radlex Ontology

The screenshot displays a web-based ontology editor interface. The left pane, titled 'Class hierarchy: 'CT 3D IMAGE RECON'', shows a tree structure starting from 'owl:Thing'. Under 'Radlex ontology entity', there are several sub-entities, including 'procedure'. The 'CT 3D IMAGE RECON' class is highlighted in blue. The right pane, titled 'Annotations: 'CT 3D IMAGE RECON'', shows a list of annotations for this class, including 'AUTOMATED_LONG_DESCRIPTION', 'AUTOMATED_SHORT_NAME', 'Preferred_name', and 'RPID'. Below the annotations, there is a 'Description: 'CT 3D IMAGE RECON'' section, followed by 'Equivalent To' and 'SubClass Of' sections. The 'Equivalent To' section shows a logical expression: `procedure and (has_MODALITY some 'computed tomography') and (has_MODALITY_MODIFIER some reconstruction) and (has_MODALITY_MODIFIER some '3D image processing')`. The 'SubClass Of' section lists several classes, including 'has_MODALITY some 'computed tomography'', 'has_MODALITY_MODIFIER some '3D image processing'', 'has_MODALITY_MODIFIER some reconstruction', and 'playbook_procedure'. The bottom of the interface shows 'General class axioms'.

Method : Creating our Playbook Ontology

- Translate the properties into French

Annotations +
rdfs:label [language: en] RID10312
Acronym [language: en] MRI
Definition Non-invasive method of demonstrating internal anatomy based on the principle into computerized images. The concept includes proton spin tomographic techn
Preferred_name [language: en] magnetic resonance imaging
Preferred_name_German [language: de] Magnetresonanztomographie
Source Playbook
Synonym [language: en] MR imaging
Synonym [language: en] MR
UMLS_ID C0024485
UMLS_Term MRI



Annotations +
Acronym [language: en] MRI
Definition Non-invasive method of demonstrating internal anatomy based on the into computerized images. The concept includes proton spin tomograp
Preferred_name [language: en] magnetic resonance imaging
Preferred_name_German [language: de] Magnetresonanztomographie
Source Playbook
Synonym [language: en] MR
Synonym_French imagerie par rmn
Synonym_French imagerie par résonance magnétique nucléaire
Synonym_French imagerie par résonance magnétique
Synonym_French irm (imagerie par résonance magnétique)
Synonym_French irm

Method : Extraction & Classification

- Create instance of 'procedure' from imaging data

The screenshot displays a web-based ontology editor interface. On the left, a class hierarchy is shown under 'owl:Thing', with 'procedure' selected. The main area is divided into several panels:

- Annotations:** Shows 'Annotations: 1.2.250.174.20200317103500.1000088950271'.
- Description:** Shows 'Description: 1.2.250.174.20200317103500.1000088950271'.
- Types:** Shows 'proc...' as a type.
- Object property assertions:** Lists several assertions for 'has_BODY_REGION' and 'has_MODALITY' with their respective URIs.
- Data property assertions:** Shows 'Data property assertions +'.
- Negative object property assertions:** Shows 'Negative object property assertions +'.
- Negative data property assertions:** Shows 'Negative data property assertions +'.

At the bottom left, a list of instances for 'procedure' is shown, with the first instance selected:

- 1.2.250.174.20200317103500.1000088950271
- 1.2.250.174.20200401111500.1000089013874
- 1.2.250.174.20200406141500.1000089333143
- 1.2.250.174.20200407151500.1000088823295
- 1.2.250.174.20200407163000.1000089161203
- 1.2.250.174.20200407170000.1000089298595
- 1.2.250.174.20200407170000.1000089598030
- 1.2.250.174.20200408082000.1000089468770

Method : Extraction & Classification

- Eventually, we run the reasoner to classify our instances

The screenshot displays a web-based ontology viewer interface. The left pane shows a class hierarchy for 'procedure', including subclasses like 'anatomical entity', 'clinical finding', and 'imaging modality'. The right pane shows the 'Annotations' and 'Usage' tabs, with the 'Annotations' tab selected. The 'Annotations' section shows the URI '1.2.250.1.74.20200317103500.1000088950271'. The 'Description' section shows the URI '1.2.250.1.74.20200317103500.1000088950271'. The 'Types' section shows the class 'procedure' and its instance 'CT NECK CHST'. The 'Property assertions' section shows several assertions, including 'has_BODY_REGION' and 'has_MODALITY_MODIFIER'.

Class hierarchy: procedure

Annotations Usage

Annotations: 1.2.250.1.74.20200317103500.1000088950271

Annotations +

Description: 1.2.250.1.74.20200317103500.1000088950271

Property assertions: 1.2.250.1.74.20200317103500.1000088950271

Object property assertions +

- has_BODY_REGION neckf382454e-9f13-4f30-b3ce-6c95e4ed2854
- has_BODY_REGION thoraxae663a8e-84bb-41d6-965b-bd8dbbf6cadd
- has_MODALITY_MODIFIER computed_tomography01961a0b-9b7f-4b6f-81b0-c8cb83303851
- has_MODALITY computed_tomography9b541c22-1838-4c71-b531-d23b17cc48d1
- has_MODALITY PET-CT07839547-6128-47da-8791-33e1578760be

Data property assertions +

Negative object property assertions +

Negative data property assertions +

Instances: 1.2.250.1.74.20200317103500.1000088950271

For: procedure

- 1.2.250.1.74.20200317103500.1000088950271
- 1.2.250.1.74.20200401111500.1000089013874
- 1.2.250.1.74.20200406141500.1000089333143
- 1.2.250.1.74.20200407151500.1000088823295
- 1.2.250.1.74.20200407163000.1000089161203
- 1.2.250.1.74.20200407170000.1000089298595

Results : Classification

- We tested our solution on radiological procedures from 2 different institutions on 1 day
 - On the first one : 122 instances; on average these instances are described by more than 2 object properties. 26 were not classified.
 - On the other one : we retrieved 75 instances, described by 5 object properties on average. All instances were classified.

Results : Classification

our Object Property	Institution 1		Institution 2	
	number of individuals using this object Property	number of different Radlex classes targeted by this object Property	number of individuals using this object Property	number of different Radlex classes targeted by this object Property
has_MODALITY	122	4	75	5
has_MODALITY_MODIFIER	58	2	63	2
has_BODY_REGION	41	6	57	9
has_ANATOMIC_FOCUS	29	11	41	5
has_REASON_FOR_EXAM	4	3	8	5
has_POPULATION	4	1	2	1
has_TECHNIQUE	0	0	26	1

Discussion

- The weak points of RadLex
 - Description of anatomy
 - No alignment onto foundational ontologies
 - Different modalities are covered differently in the Playbook
- The use of the DICOM standard depends on the institution
- Further validation of this work will be required and could allow for other uses

Thank you

Our ontology is available at :

https://github.com/pierrelemordantUR1/ICBO_2020/blob/master/playbook_ontology_v7_fr.owl