

Semantic discovery of resources in cloud-based PACS/RIS systems

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PACS/RIS systems

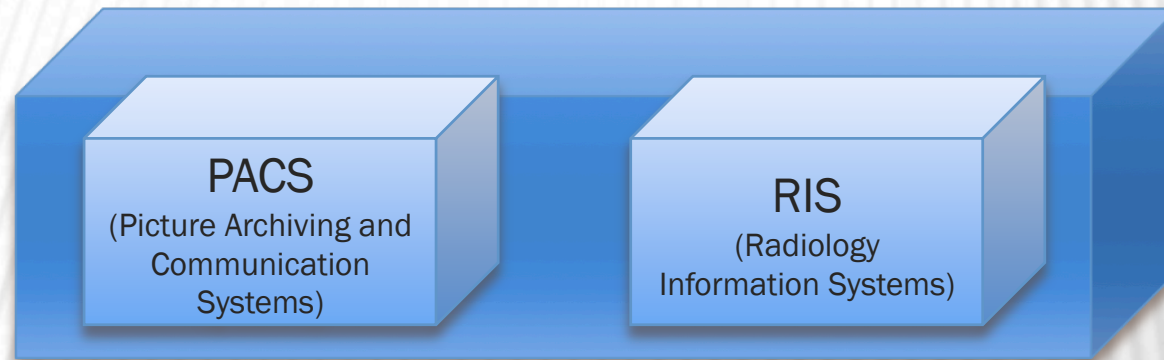
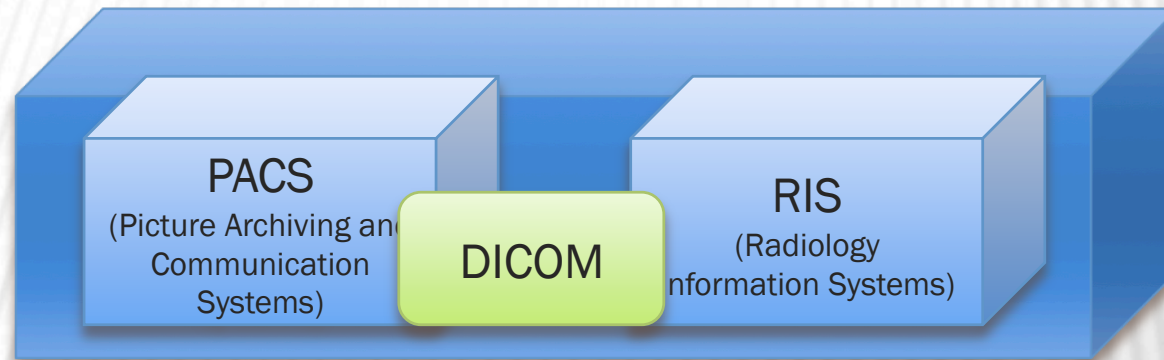


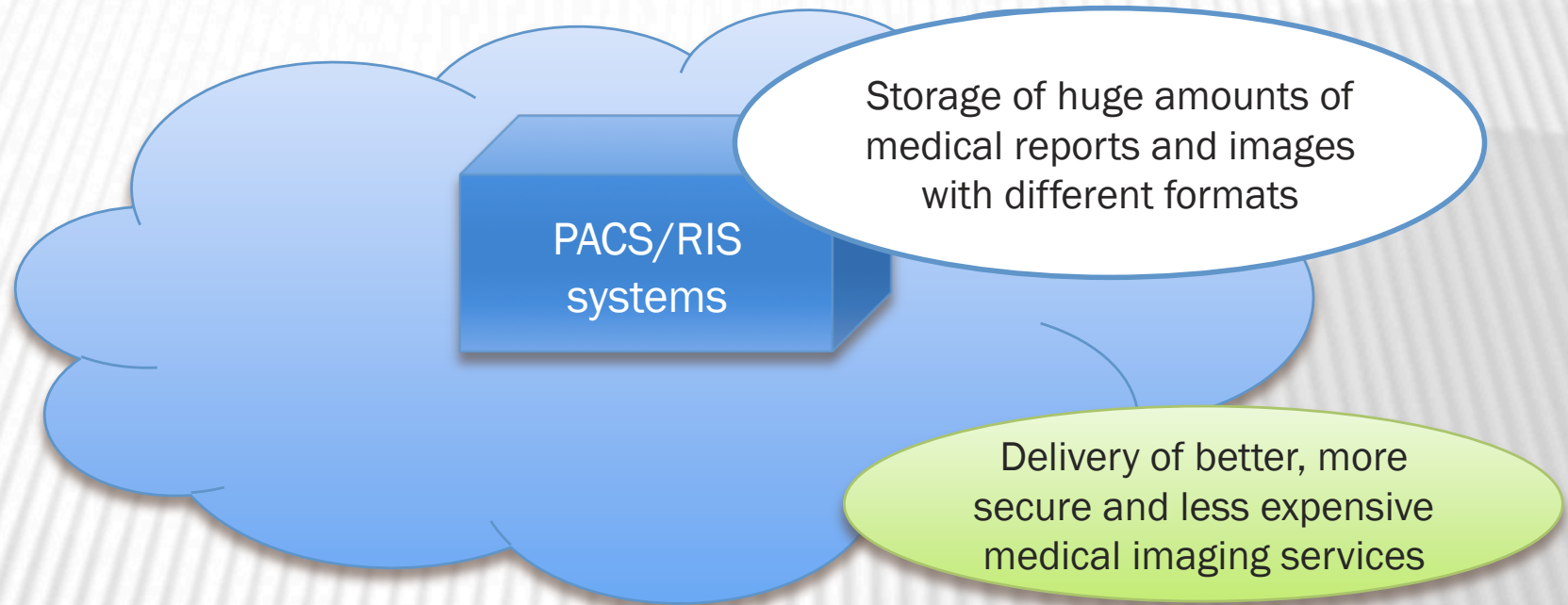
Image communications between individual components, such as archive systems, diagnostic workstations, ...

Radiology workflow such as creation of orders, scheduling, reading, reporting, medical coding, ...

PACS/RIS systems

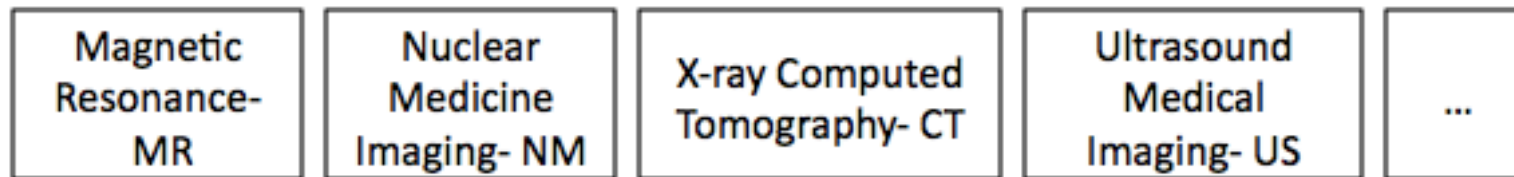


Cloud-based PACS/RIS systems

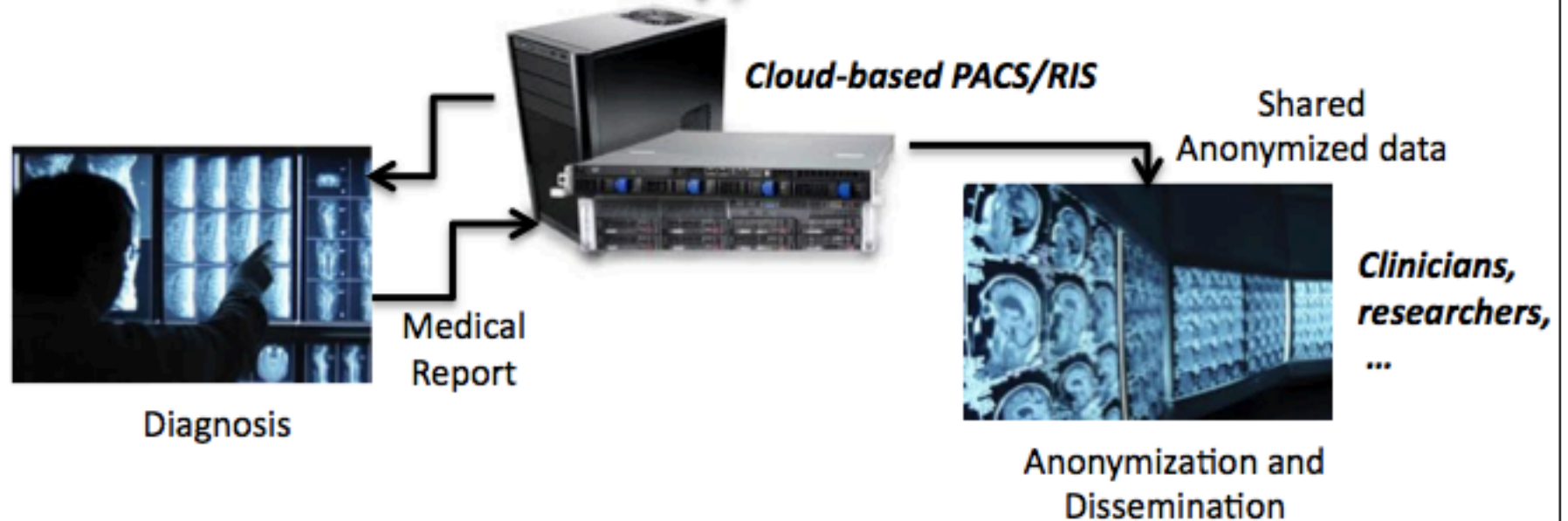


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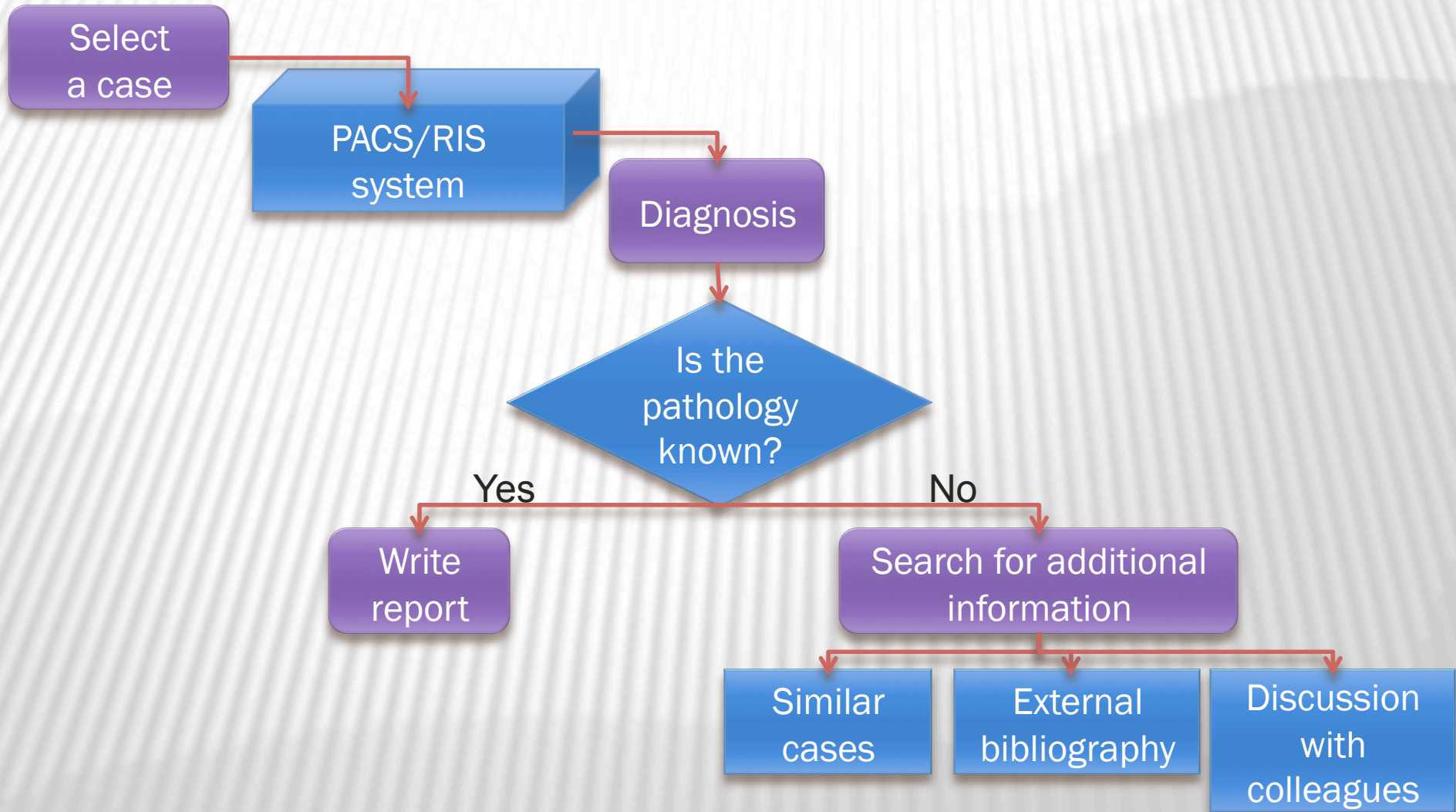
Radiologist



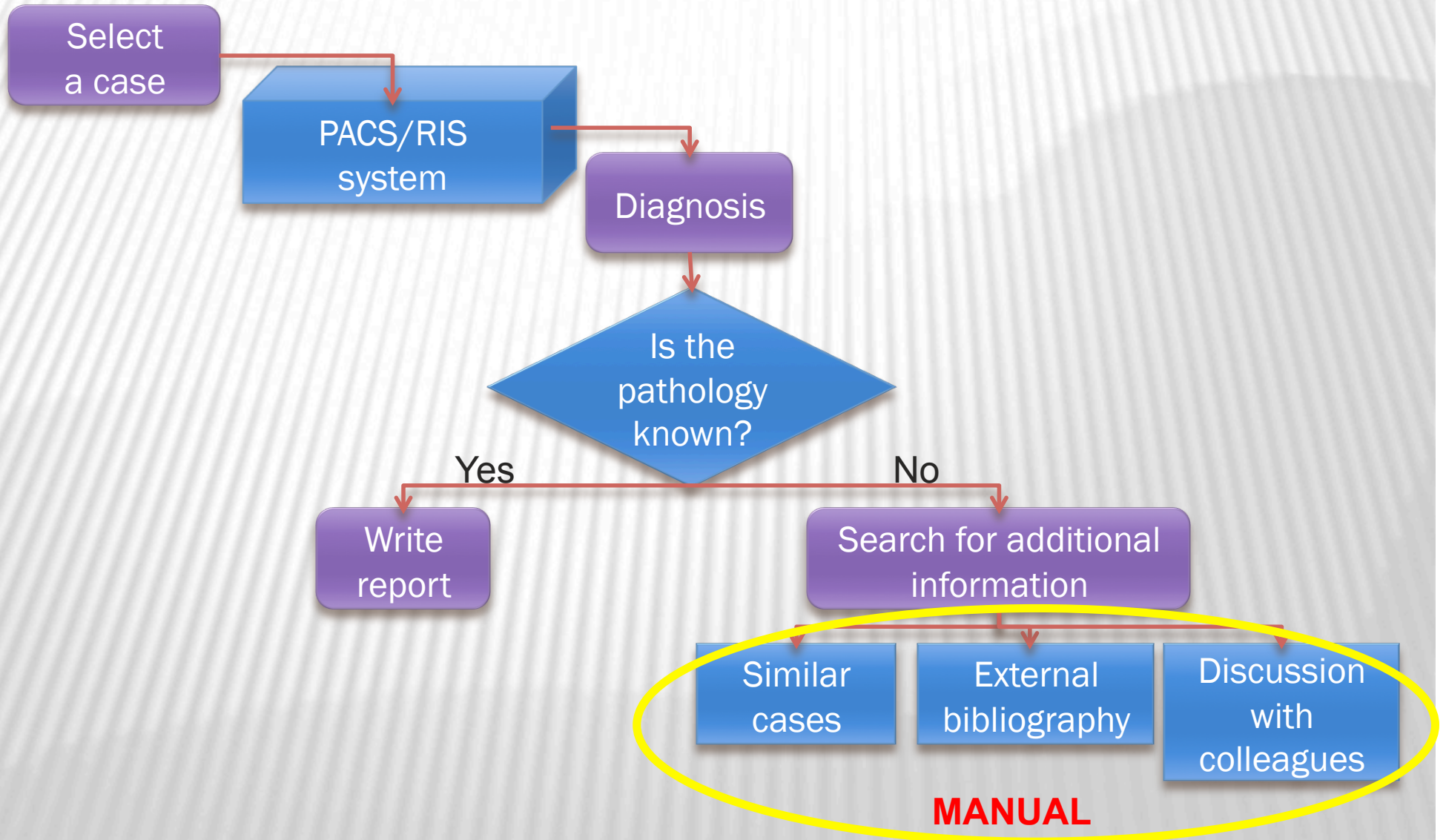
Clinicians



Retrieval in current PACS/RIS systems



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Clinicians' Requirements

- More precise user's requirements specification

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- Automatic classification of cases

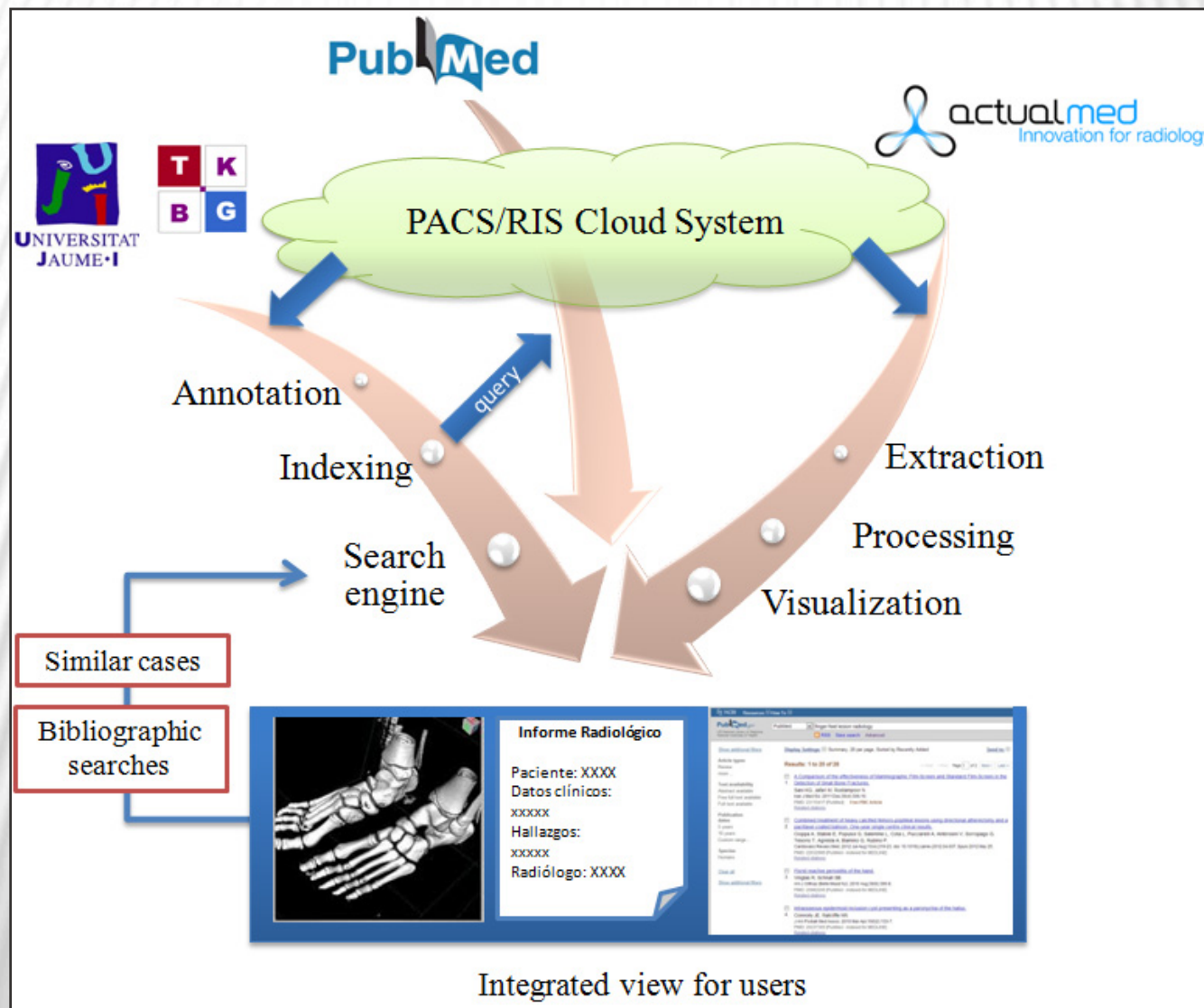
Clinicians' Requirements

- More precise user's requirements specification
- Multilingual and multimodal retrieval
- Semantic retrieval
- Automatic classification of cases
- External queries

Our Proposal

Semantic annotation allows the system to summarize the knowledge stored in clinical reports as well as images in terms of a reference ontology

Our Proposal



Data Processing

- DICOM metadata: technical information of the image and information about the patient
- Clinical reports: Low structured information expressed in free-text

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Semantic annotation to process and integrate all the data
stored in a cloud-based PACS/RIS system

Automatic Semantic Annotation

A semantic annotation is a mapping between a text chunk identified in a text and concepts described in a knowledge resource (KR)

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Biomedical knowledge resources: UMLS, MeSH, RadLex...

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- Easy to parameterize
- High recall
- Simultaneous use of several KRs
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“Conclusión: Discreto <_{C125396} derrame articular> y <_{C2609134} focos de edema óseo>

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Semantic annotation of all the data suitable for querying:
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Vocabulary heterogeneity

Multi-linguality

Characterization of resources

Navigation through the concepts relationships

Integration of different types of resources

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Semantic Index

Semantic Retrieval

Retrieval: Similarity between the semantic representations of the query and the resources

$$\mathit{sim}(r_1, r_2) \propto \mathit{sim}(r_1^{KR}, r_2^{KR})$$

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$$2 \quad \text{sim}(r_1^{KR}, r_2^{KR}) = \prod_{c_i \in r_1^{KR}} \sum_{t_k \in T} p(c_i | t_k) \cdot p(t_k | r_2^{KR})$$

Preliminary Results

Subset of the reports and images stored in *ActualMed PACS* (>50,000 resources April 2013)

Experiments subset:

- 8088 reports associated with medical images
 - 730 Doppler images, 4320 ecographies and 4145 MRN
- Metadata of 5893 DICOM images

Preliminary Results

<i>DICOM field</i>	<i>Frequency</i>
StudyDescription	4458
AnatomicStructure	0
AnatomicRegion	0
BodyPartExamined	1092
TherapyType	0
TherapyDescription	0
InterventionDescription	0
Type of Patient	0
PatientGroupLength	0
Allergies	0
PatientBirthDate	5893
PatientSex	5893
PatientWeight	1852
Total DICOM files	5893

Semantic Annotation- Preliminary Results

Knowledge resource: UMLS (version 2012AB). English and Spanish for a subset of entries

<i>Report set</i>	<i>Annot.</i>	<i>Annotations Avg. Size</i>	<i>Ambiguity</i>
Doppler	14991	1.7	0.9%
Ecographies	60598	1.5	18.6%
MRN	65358	1.6	10.0%
All	140947	1.6	12.9%

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All	140947	1.6	12.9%	8087	8083	8043	3186

Semantic Annotation-Preliminary Results

Top-ranked concepts for semantic facets

<i>Anatomy</i>	<i>Disorders</i>	<i>Physical Features</i>
Body 6791	Injuries 3906	Sex 1348
Lien 1877	Malign neoplasm T1 2027	Bone densities 1348
Spleen 1877	Effusion into joint 1746	Projection 726
Bone 1784	Rupture 1618	Fluid pressure 655
Kidney 1721	Abnormal degeneration 1518	Liver size 335
Biliary tract 1686	Abnormal dilation 1244	Age 317
Liver 1569	Normal size breast 1148	Kidney feature 311
Collum femoris 1442	Changes nail 1012	Kidney size 151
Tendon 1398	Degenerated intervertebral disc 829	Body height 48
Abdominal aorta 1365	Bulging 816	Normal muscle function 46
Lumbar vertebra 1250	Hernia nucleus pulposus 774	Acoustic shadowing 26
Lumbar spine 1248	Calculoses 657	Appearance of anterior chamber 15
Conus medullaries 1160	Abnormal narrowing 647	Edema grade 10
Total=1442	Total=1256	Total=95

Semantic Annotation-Preliminary Results

Most frequent clusters in left knee MRN

<i>Anatomy</i>	<i>Disorders</i>	<i>Number of Reports</i>
Anterior horn	Abnormal degeneration	65
Entire medial meniscus	Abnormal degeneration	60
Entire lateral meniscus	Rupture	35
Anterior horn	Laceration	31
Anterior horn	Rupture	26
Region of bone	Effusion into joint	26
Bursa	Augmentation of size	21
Bursa	Benign cystic mucinous tumor	20
Entire medial meniscus	Cartilage tear in knee	20
Soft tissues	Dropsy	19
Anterior horn	Cartilage tear in knee	19
Bursa	Effusion into joint	16
Entire lateral meniscus	Abnormal degeneration	16
Articular	Effusion	13

Preliminary Results

Automatic semantic annotation can produce good enough results to perform classification and retrieval tasks over the resulting semantic vectors

Issues and Challenges

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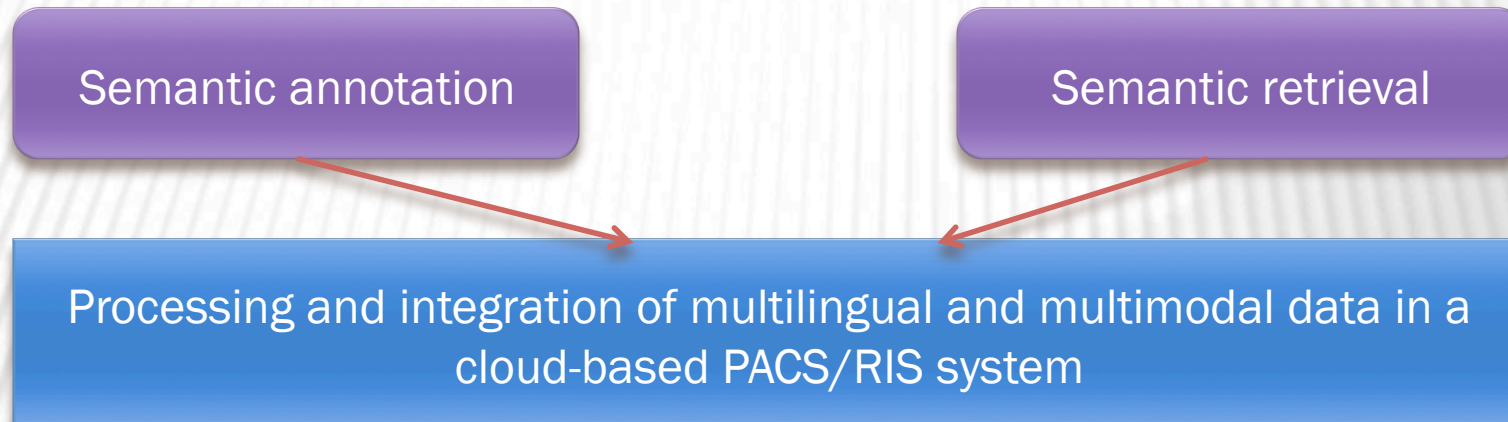
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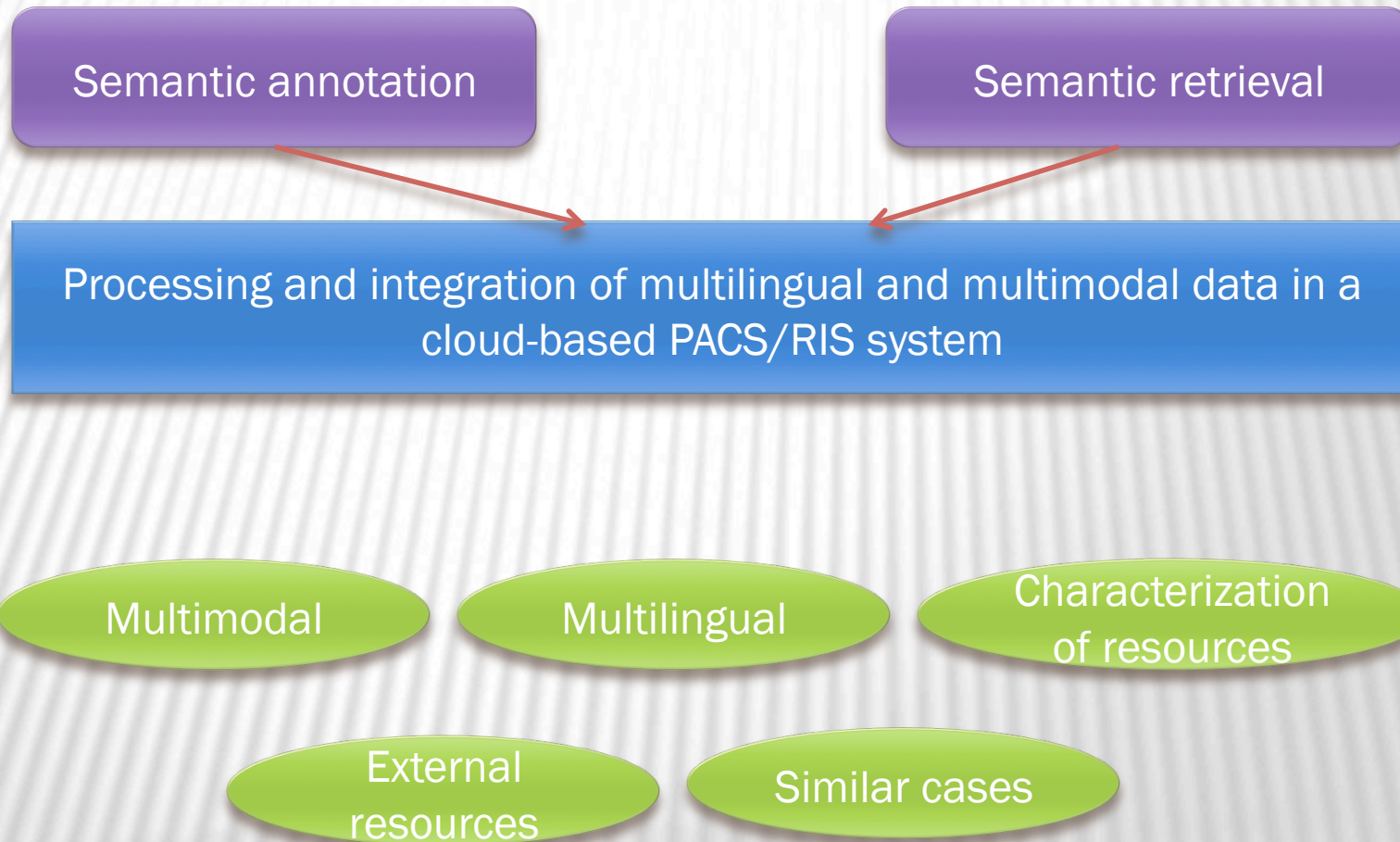
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“retrieve images related to injuries in the tendon”

Conclusions



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- Validate our techniques using the datasets provided by ImageClef and others, and compare the results with other proposals.

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 - Bibliographic search related with a radiology resource
 - Integration and visualization of all the resources

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Thank you!
