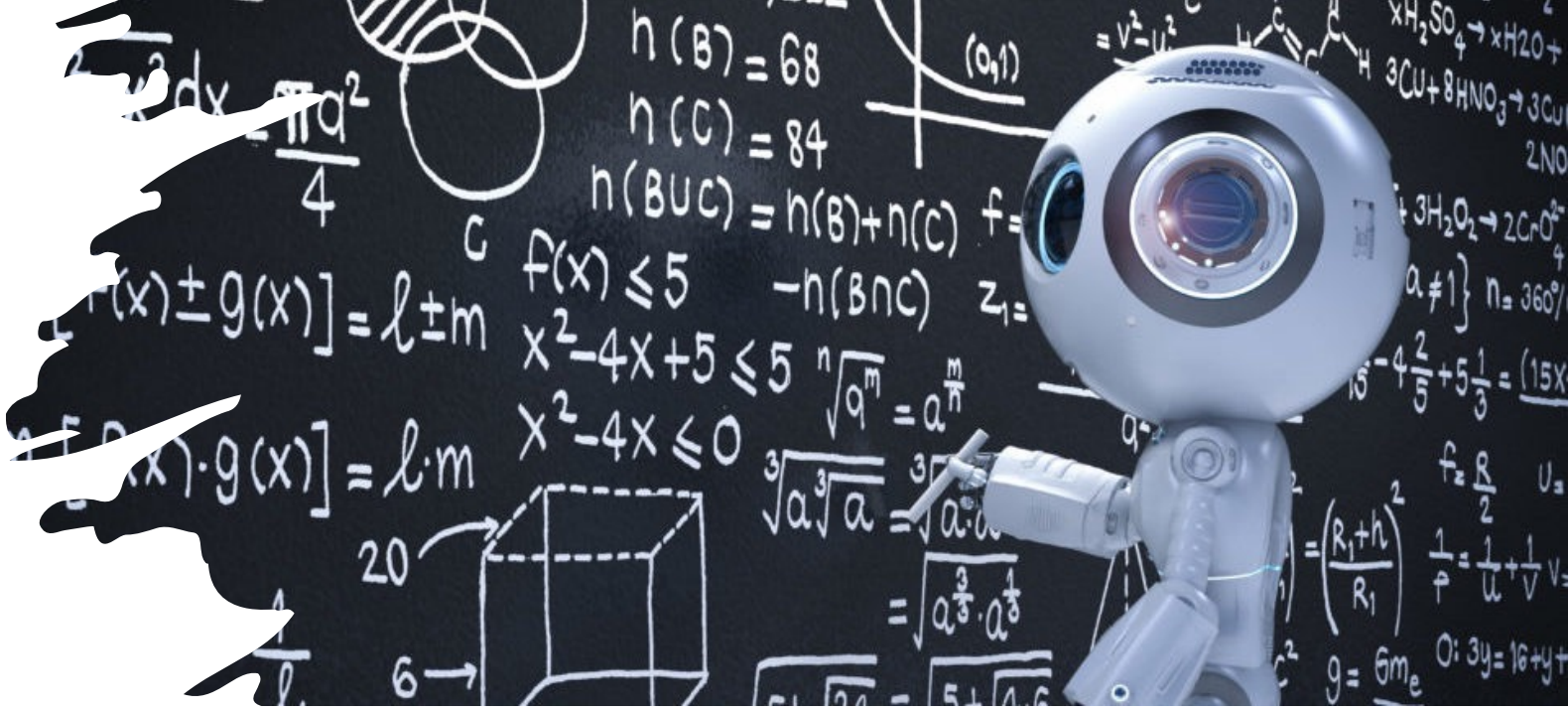
Data Science in Radiology and Imaging Informatics

Tessa S. Cook, MD PhD CIIP FSIIM

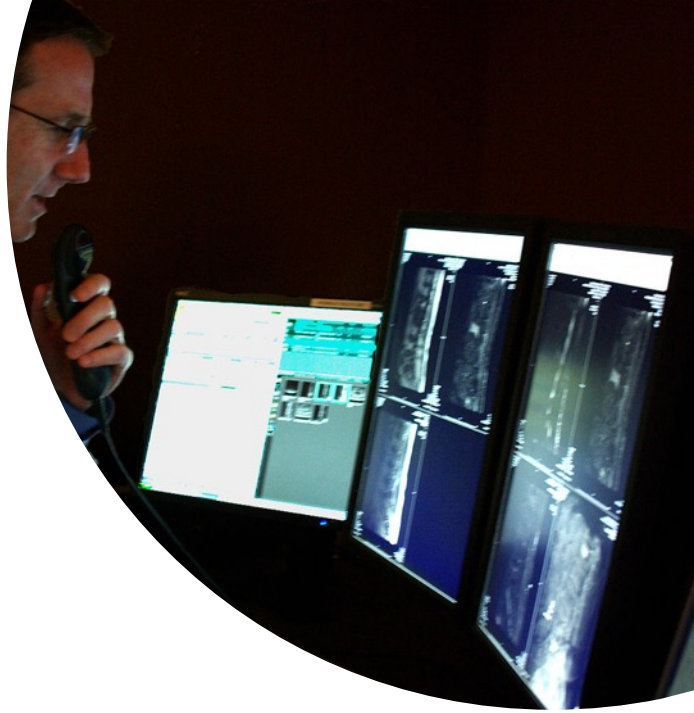
Penn Medicine

@asset25

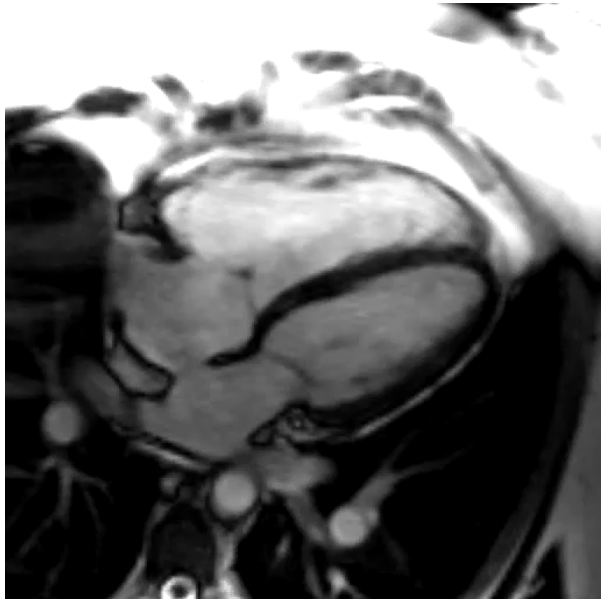


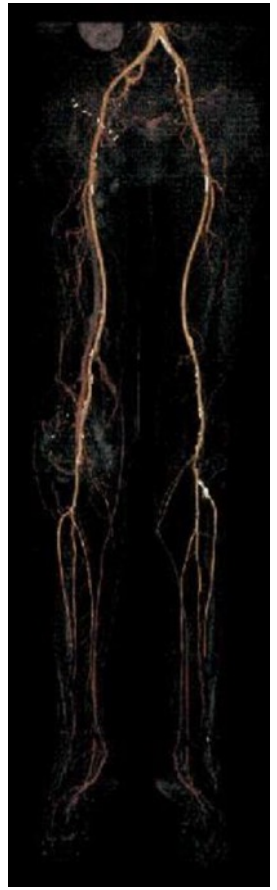
Disclosures

- Board Member (SIIM, AUR)
- Director, National Imaging Informatics Course
- Member, Program Committee (RSNA, AUR)
- Member, RSNA Research and Development Committee
- Member, ACR Informatics Commission
- Fellowship Director, Imaging Informatics, Penn Radiology
- Grant funding from RSNA, ACR, NIH
- Departmental AI vendor agreements



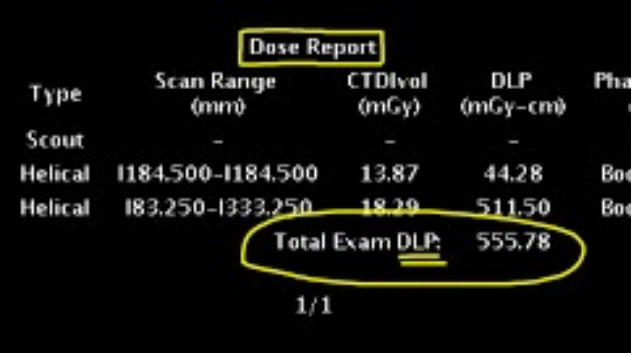
A Day in the Life of a Radiologist

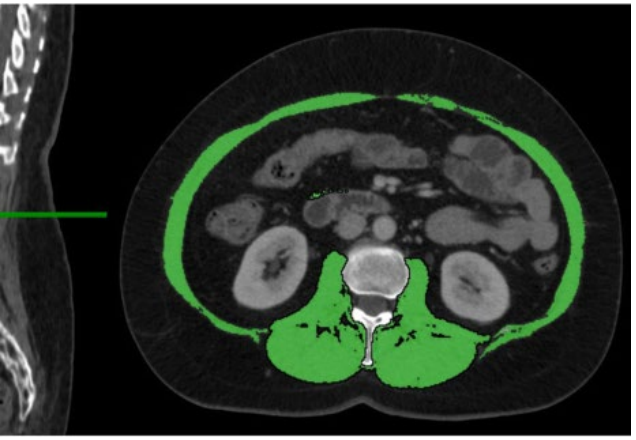


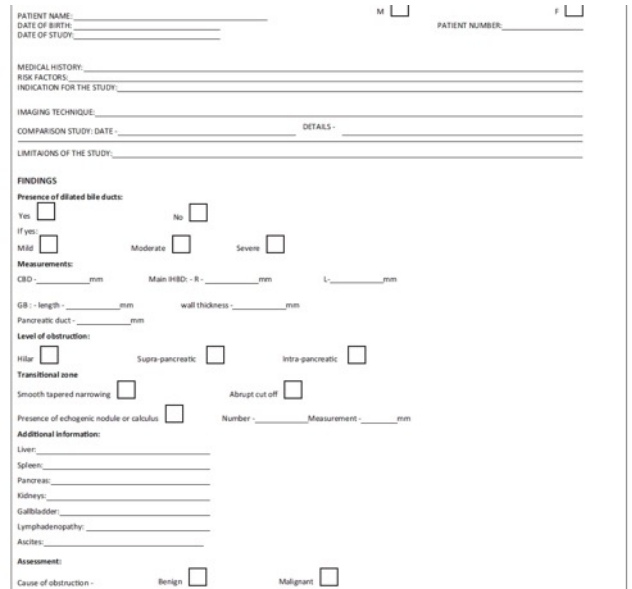


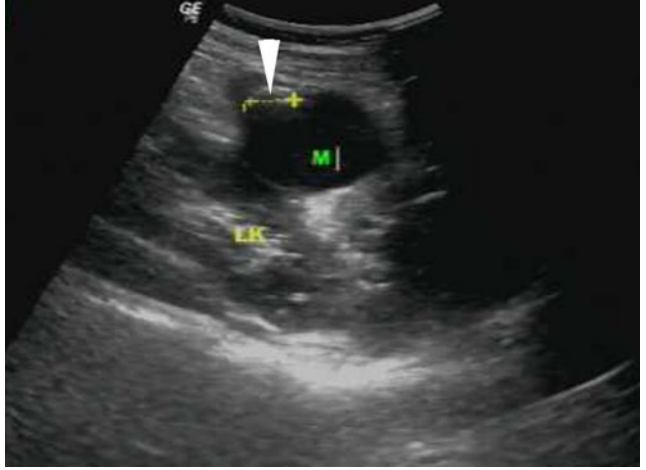
A Day in the Life of a Cardiovascular Radiologist

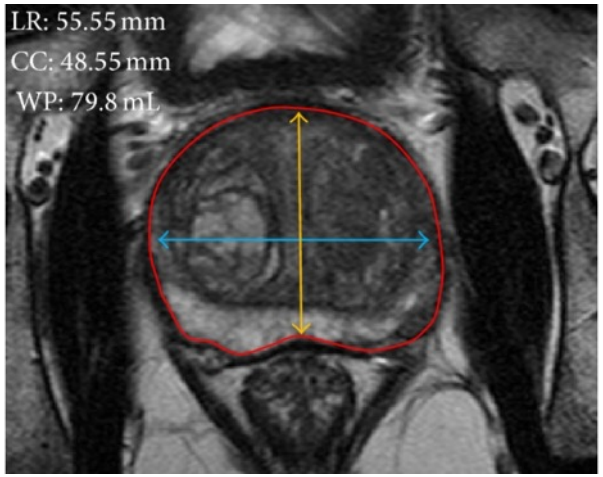
Why Radiology Needs Data Science

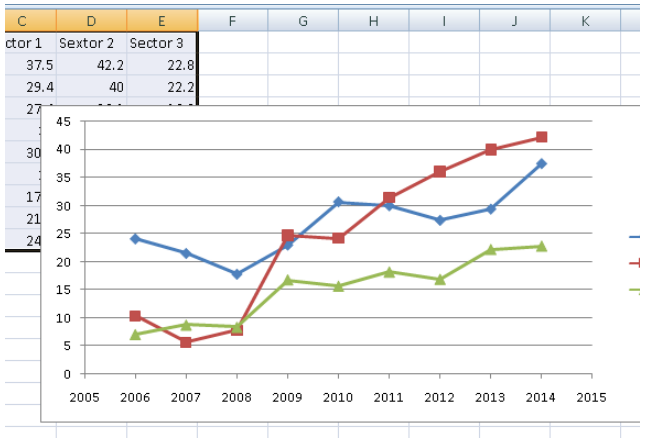








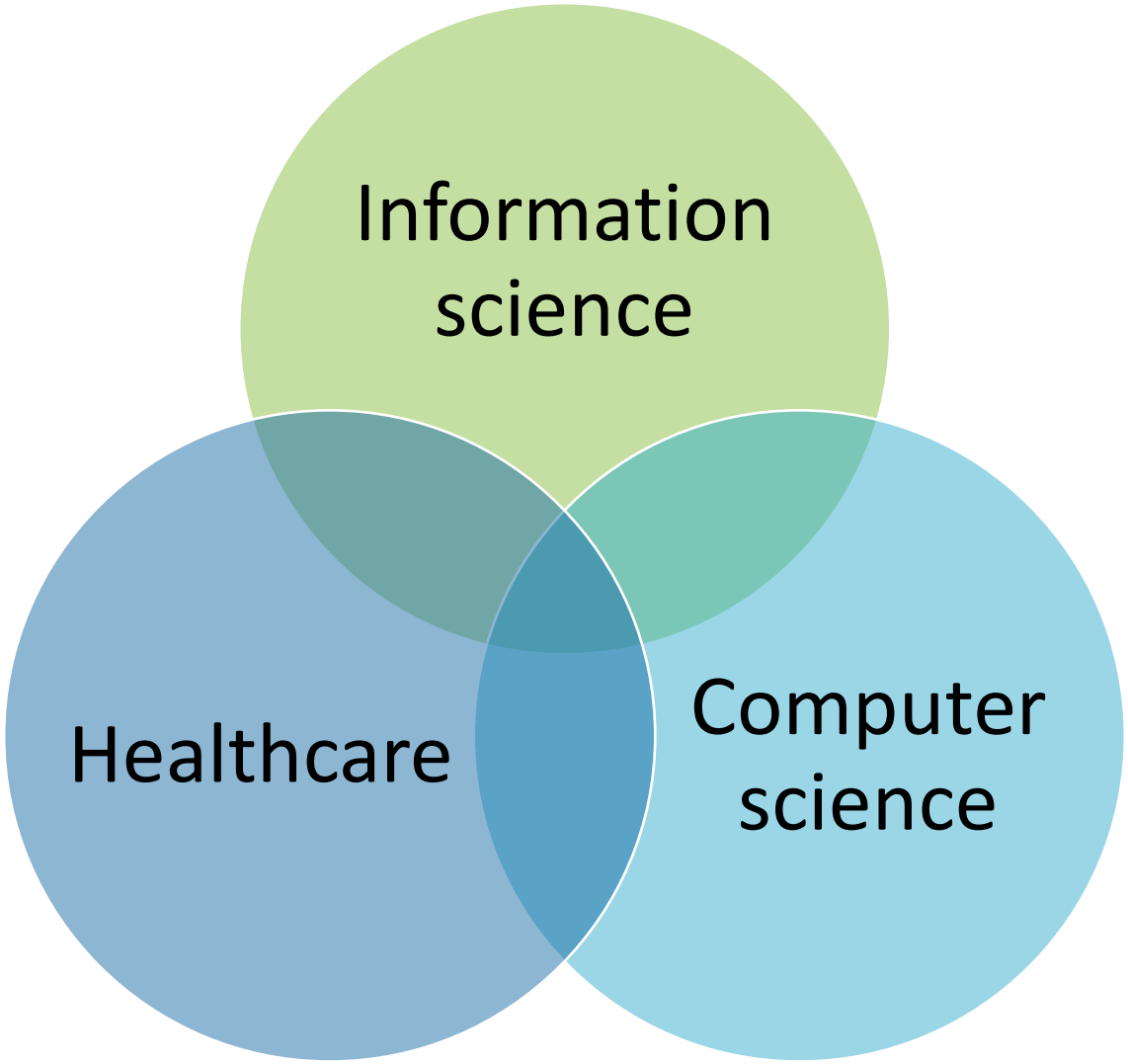




Why Radiology Needs Data Science

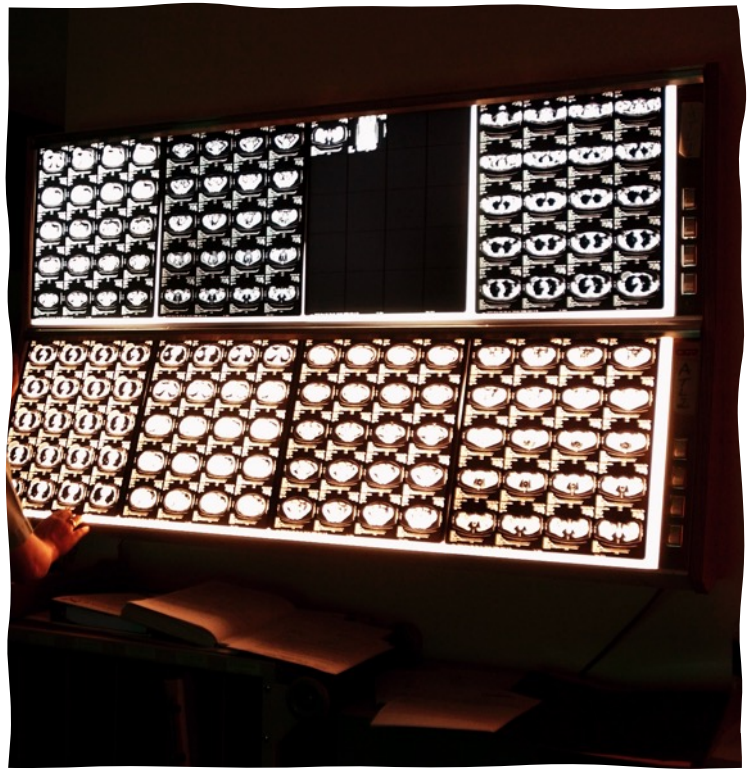
- Clinical practice → large amounts of data
- Types
  - Images
  - Reports
  - Measurements
  - Interval change
  - …more
- Where does the data go?

Imaging Informatics



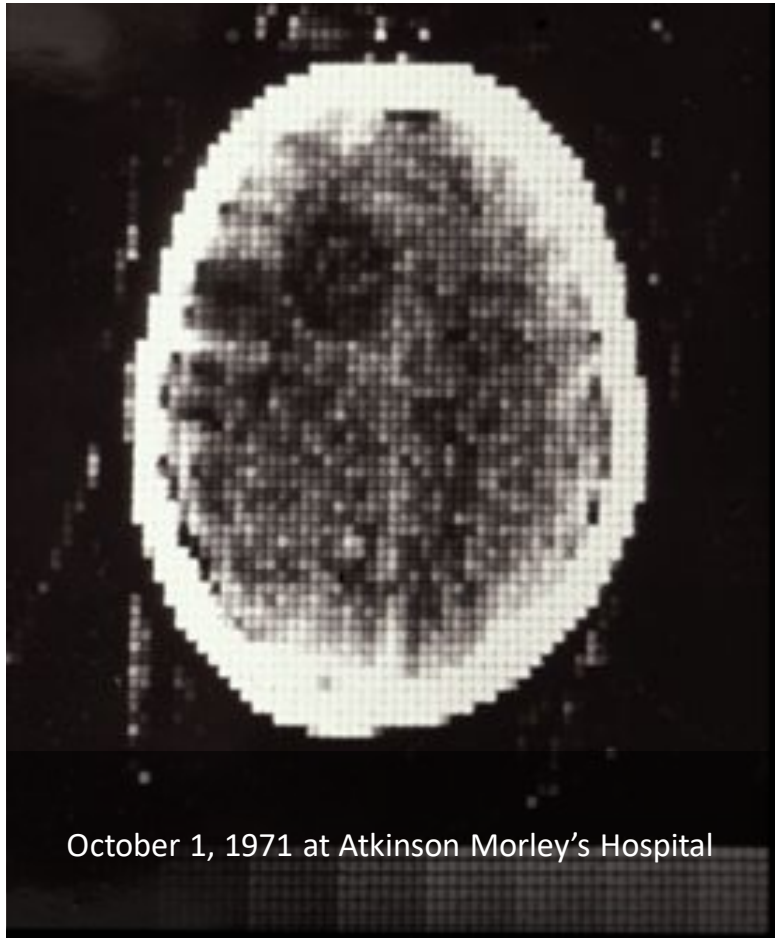
ABII American Board of Imaging Informatics

The Origins of Imaging Informatics



Radiology, pre-1970

The First Head CT



October 1, 1971 at Atkinson Morley's Hospital

Godfrey Hounsfield, EMI Central Research Labs

The Origin of Imaging Informatics

APPLICATIONS OF PICTURE PROCESSING, IMAGE ANALYSIS AND COMPUTER GRAPHICS TECHNIQUES TO CRANIAL CT SCANS

H.U.Lemke, H.S.Stiehl, H.Scharnweber, D.Jackél

COMPACT Project Group, Institut für Technische Informatik,
Technische Universität Berlin

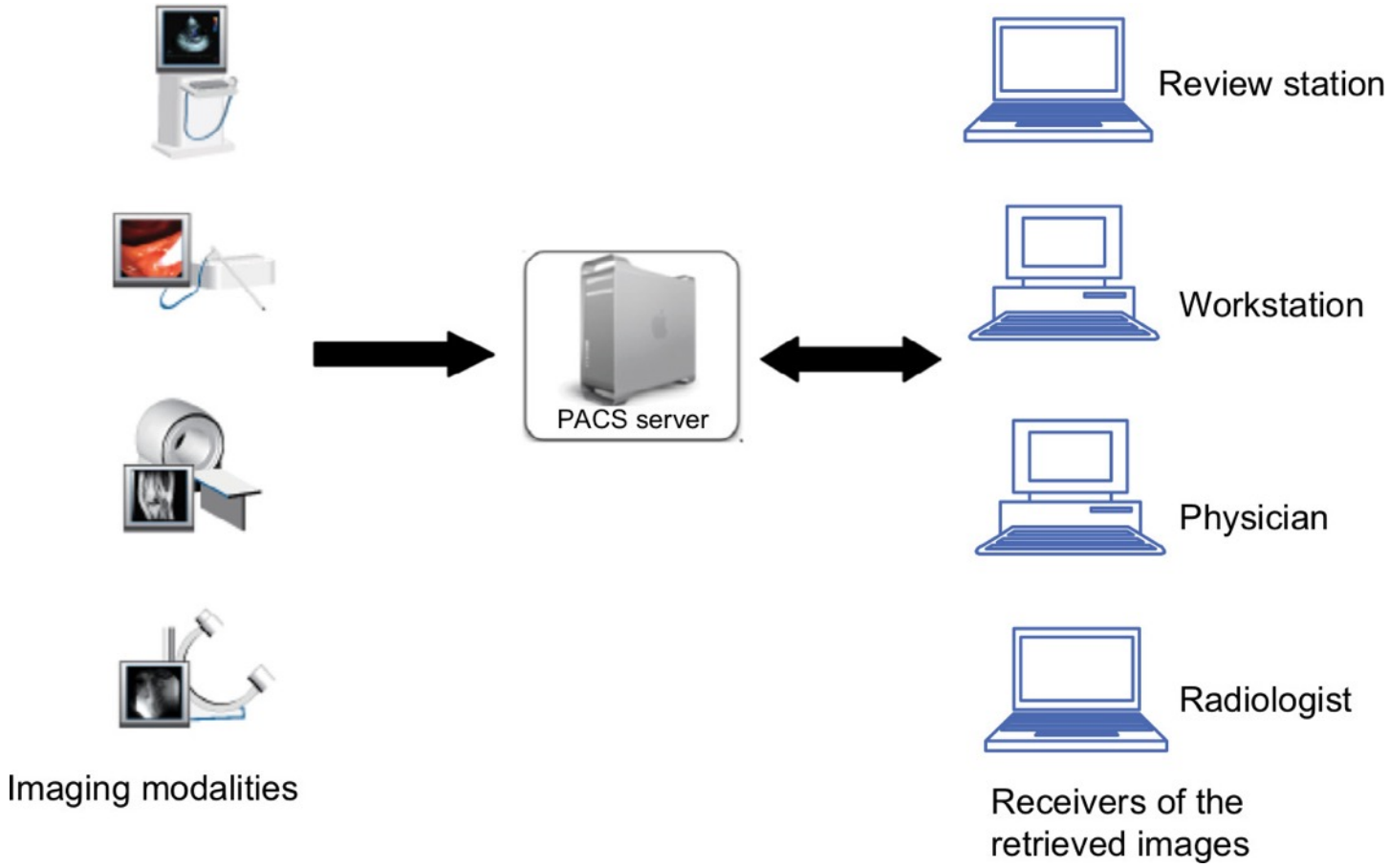
Further thought is also given to the framework in which CT processing may take place. To ensure clinical efficacy a concept of a Medical Work Station as part of a distributed computing network is discussed. Some consideration is then given to the physicians possible working modes within such a system.

all modes of communication
nd voice communication).

paper that each of the above
tion management and evalu-
atisfied by using medical
a distributed computing

system is currently being
tut für Technische Informa-
iversität Berlin. The prin-
ciple application of the MWS's is for the management of neurological disorders and includes a system for the COmputerized Management, Processing and Analysis of Computed Tomograms (COMPACT).

PACS: Picture Archiving and Communications System



Imaging Informatics—More than Just Images

Journal of Digital Imaging (2020) 33:547–553
https://doi.org/10.1007/s10278-019-00292-2

Check for updates

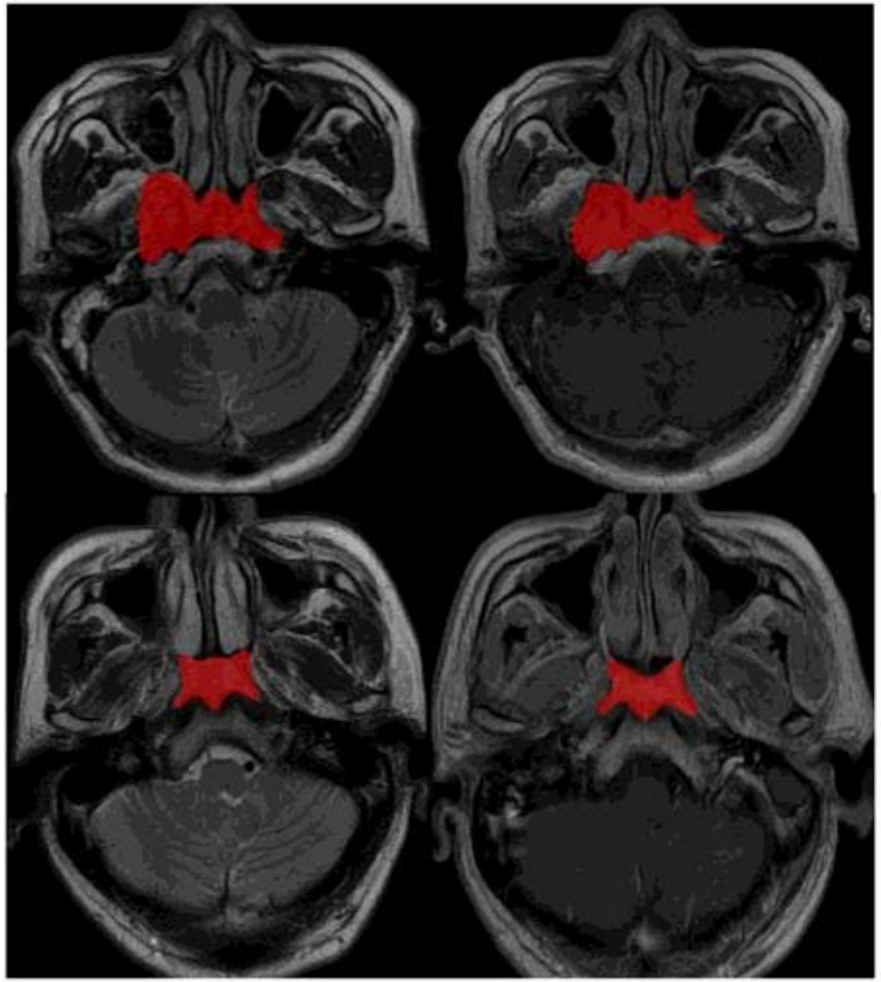
Imaging Informatics Fellowship Curriculum: a Survey to Identify Core Topics and Potential Inter-Program Areas of Collaboration

Valeria Makeeva[1] · B Vey[1] · TS Cook[2] · P Nagy[3,4] · RW Filice[5] · KC Wang[6] · P Balthazar[1] · P Harri[1] · NM Safdar[1]

Data Science and Imaging Informatics in Practice

A

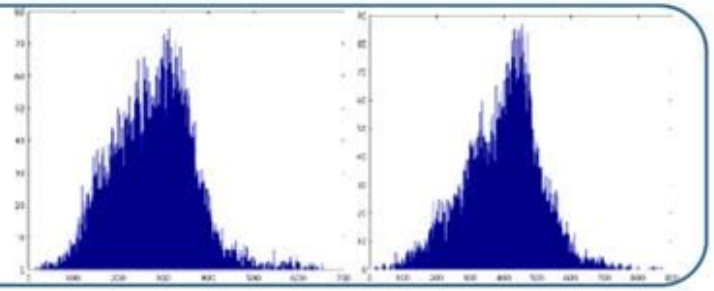
MRI images



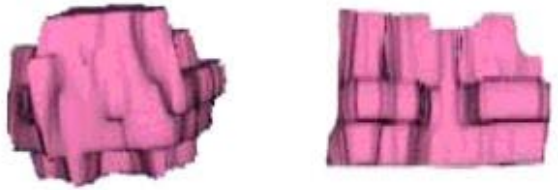
B

Feature extraction

Tumor intensity

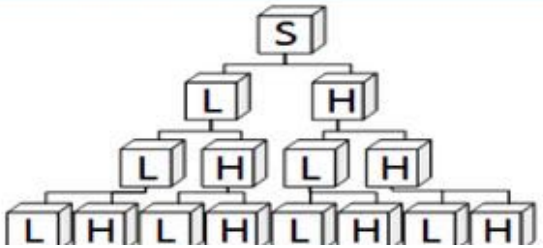


Tumor shape



Tumor texture

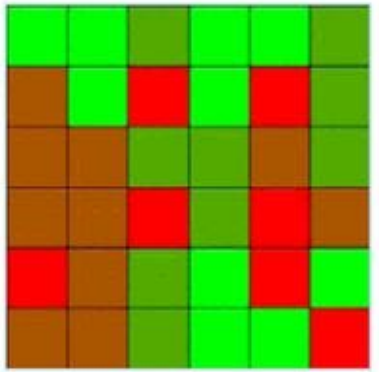
Wavelet filter

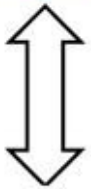


C

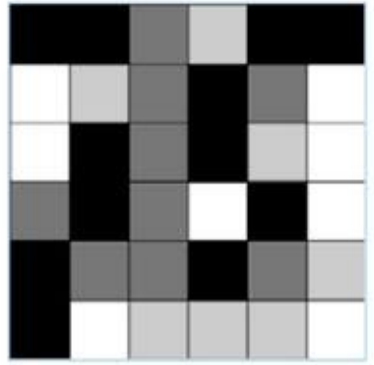
Analysis

Radiomic features





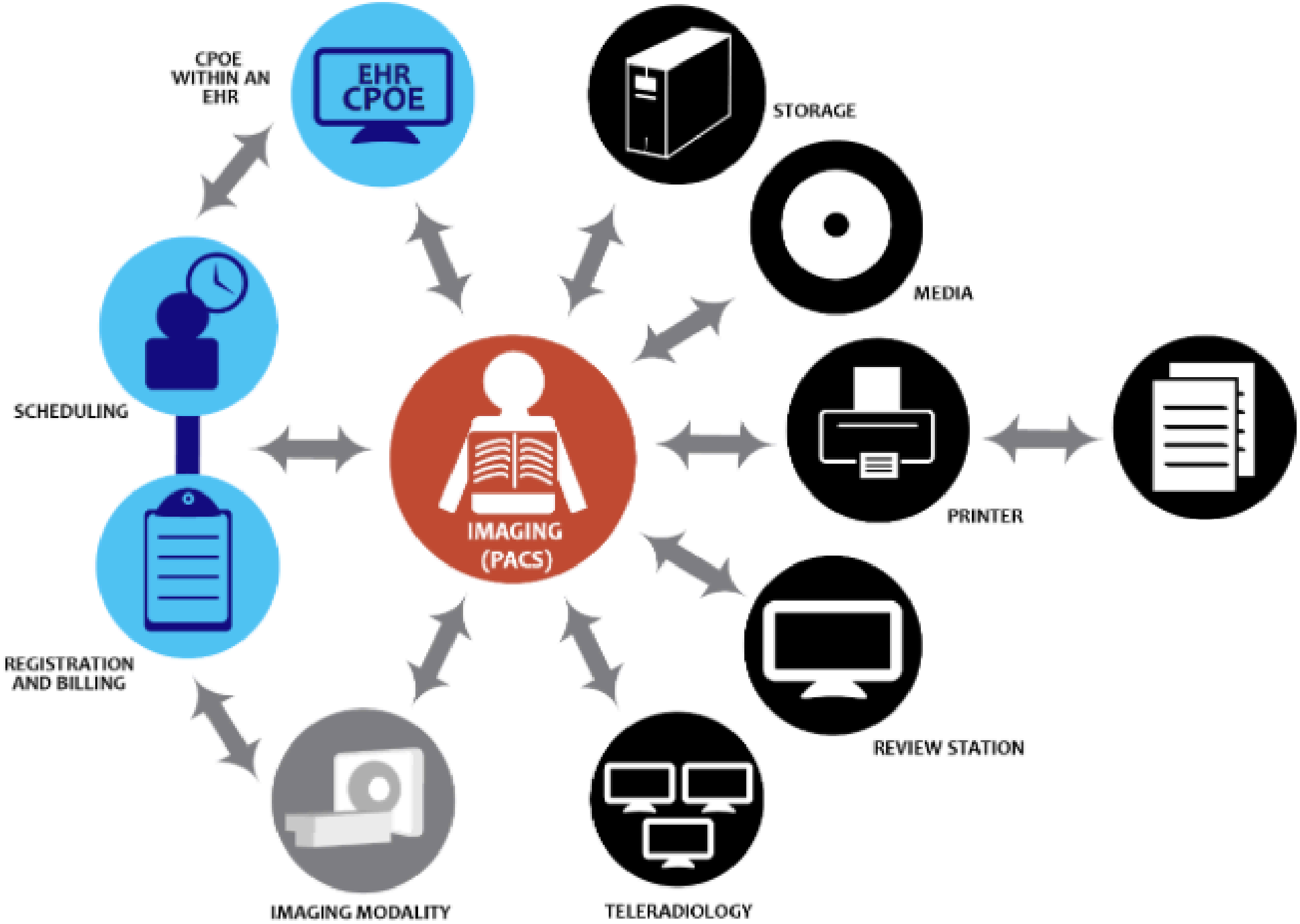
Clinical data

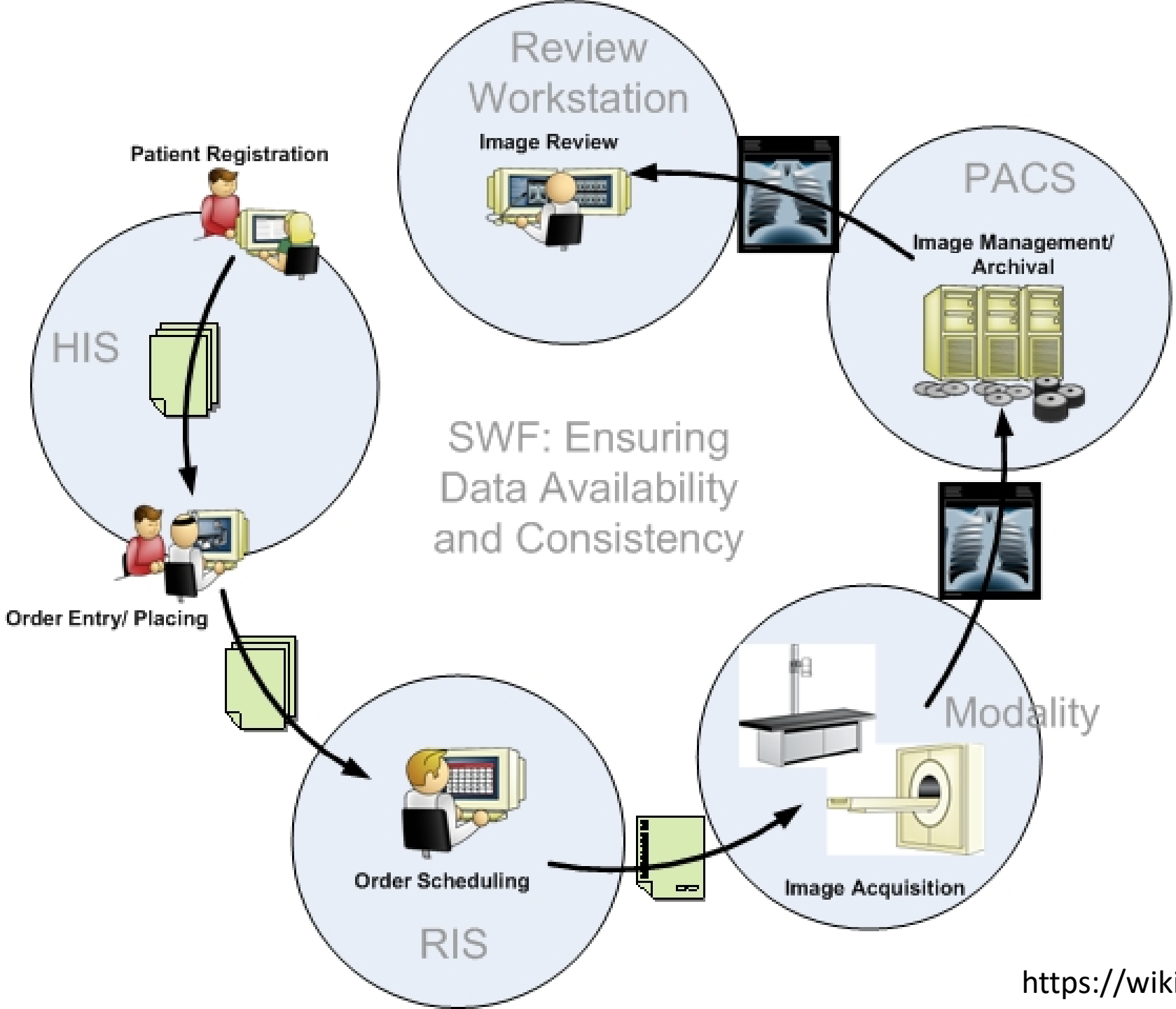


Bin Zhang et al. Clin Cancer Res 2017;23:4259-4269

Clinical Cancer Research

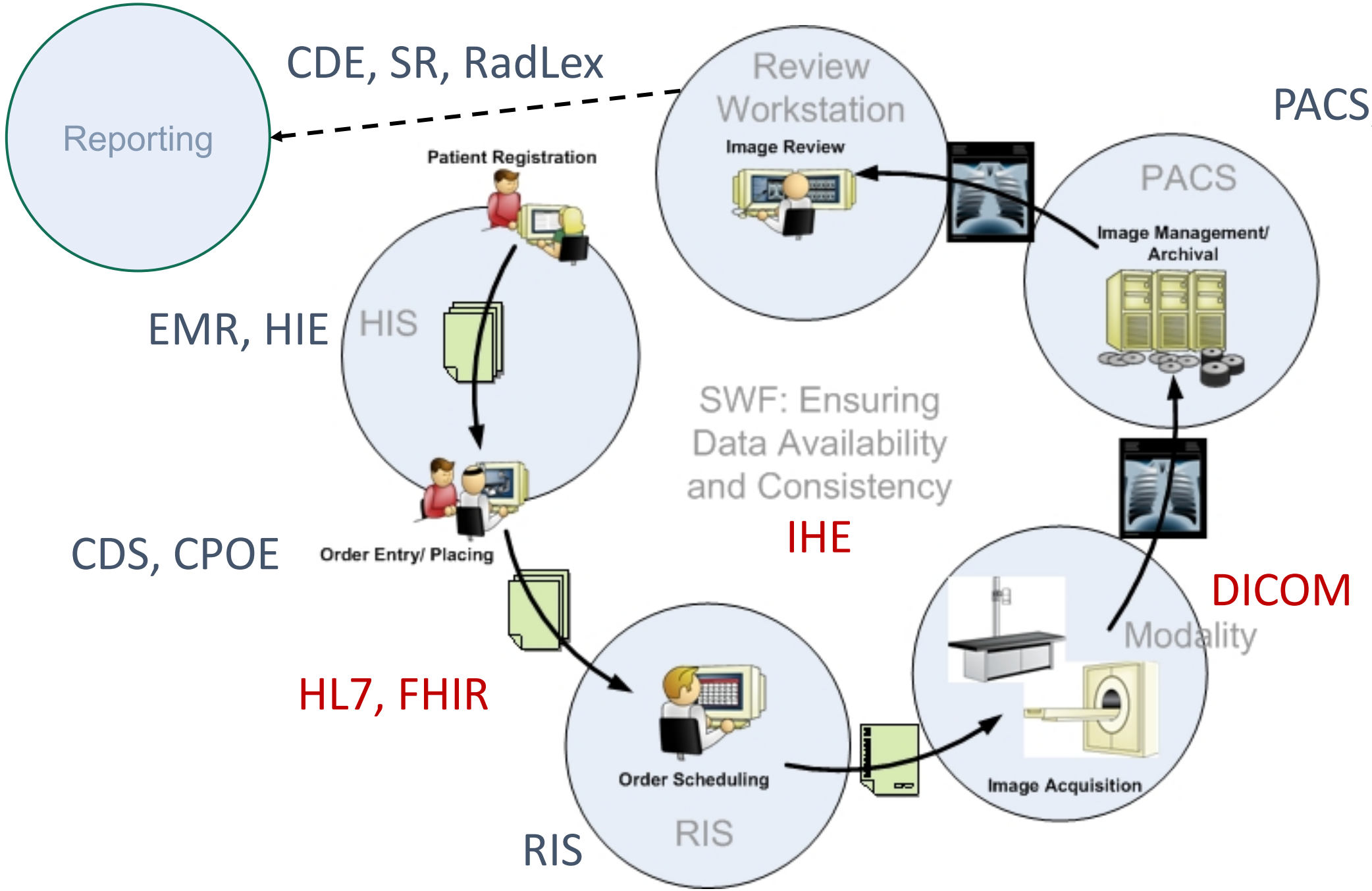
AACR American Association for Cancer Research


CPOE WITHIN AN EHR
EHR CPOE
STORAGE
MEDIA
SCHEDULING
IMAGING (PACS)
PRINTER
REGISTRATION AND BILLING
REVIEW STATION
IMAGING MODALITY
TELERADIOLOGY



Early Radiology Workflow

https://wiki.ihe.net/index.php/Scheduled_Workflow



https://wiki.ihe.net/index.php/Scheduled_Workflow

Standards

Standards in Radiology

https://www.ihe.net

https://www.dicomstandard.org

http://hl7.org/

http://hl7.org/fhir

HOW STANDARDS PROLIFERATE:

(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)

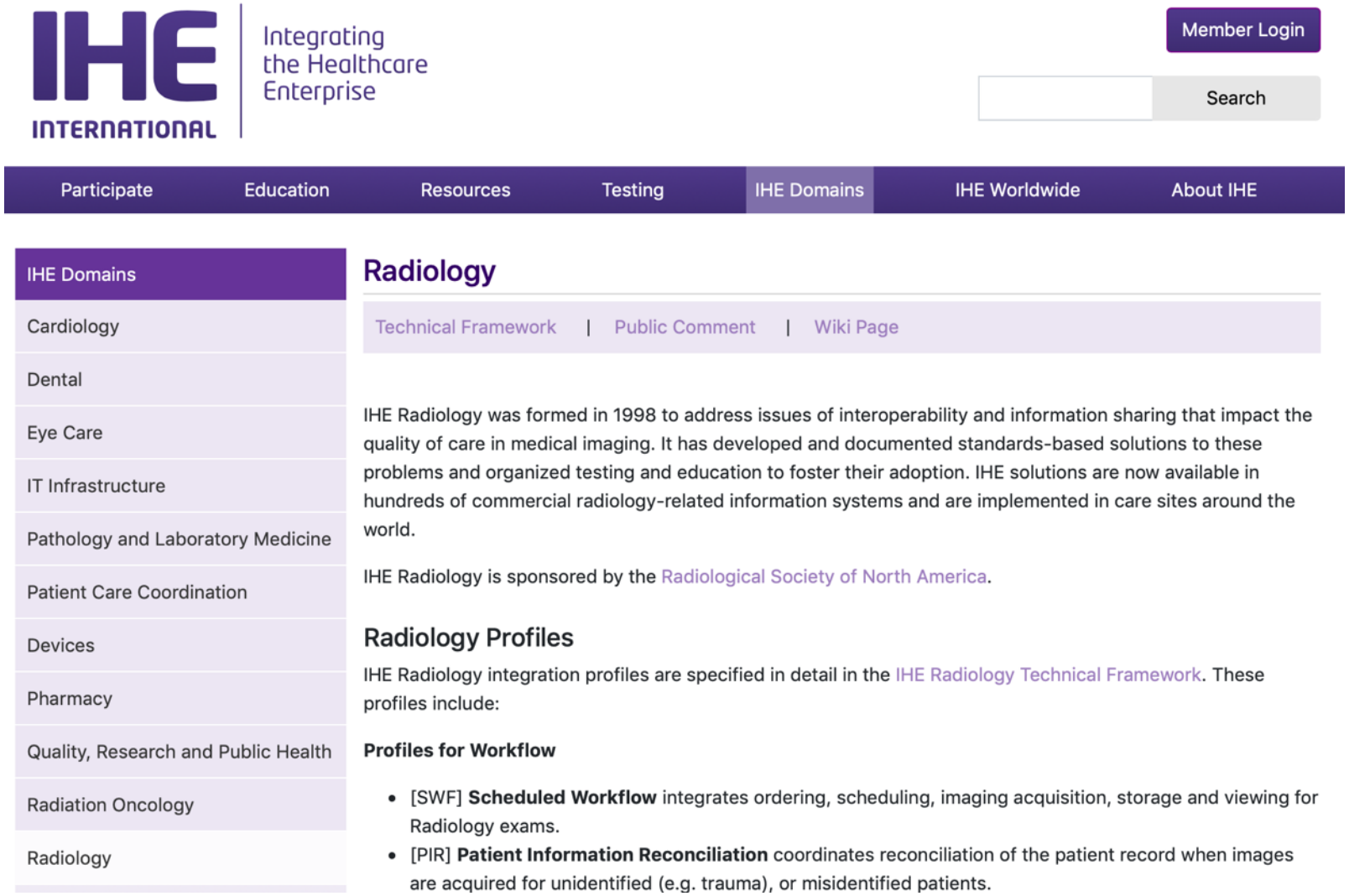
SITUATION:
THERE ARE
14 COMPETING
STANDARDS.

14?! RIDICULOUS!
WE NEED TO DEVELOP
ONE UNIVERSAL STANDARD
THAT COVERS EVERYONE'S
USE CASES.

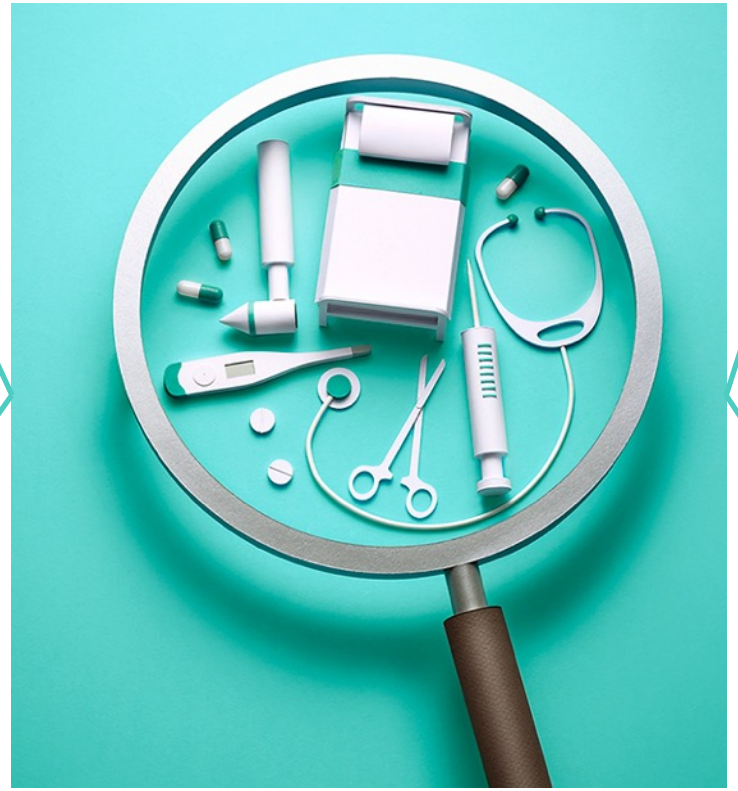
SOON:

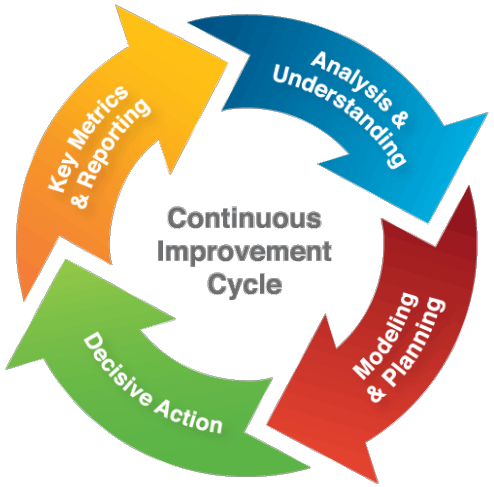
SITUATION:
THERE ARE
15 COMPETING
STANDARDS.

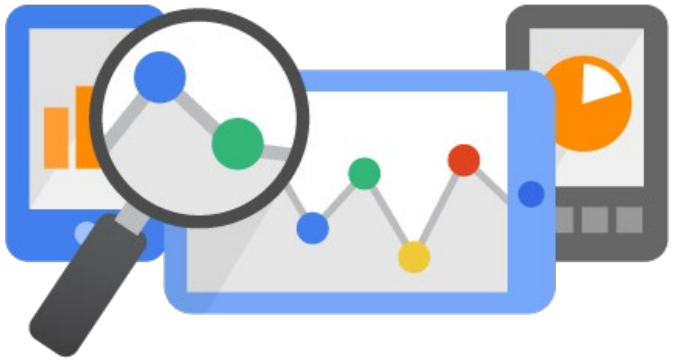
https://xkcd.com/927/



Interoperability of Healthcare Systems

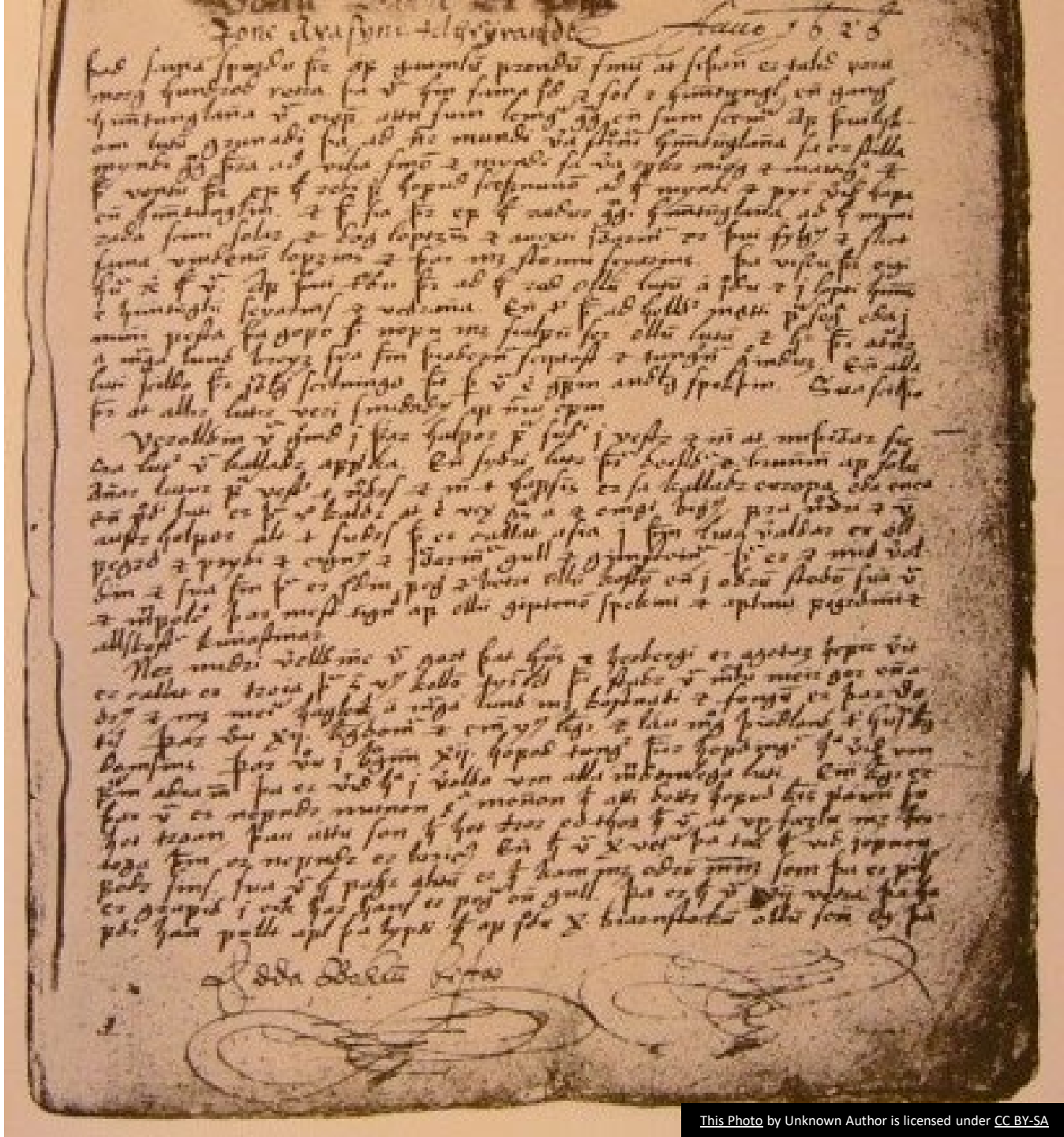



Continuous Improvement Cycle
Analysis & Understanding
Modeling & Planning
Decisive Action
Key Metrics & Reporting



Data Mining Challenges

- Different data sources
- Systems not communicating
- Obscure schema
- Structured vs. unstructured data



Adding Structure

RadLex radiology lexicon

We recognize the benefits that come from radiologists using common language to communicate diagnostic results. For this reason, RSNA produced RadLex®, a comprehensive set of radiology terms for use in radiology reporting, decision support, data mining, data registries, education and research.

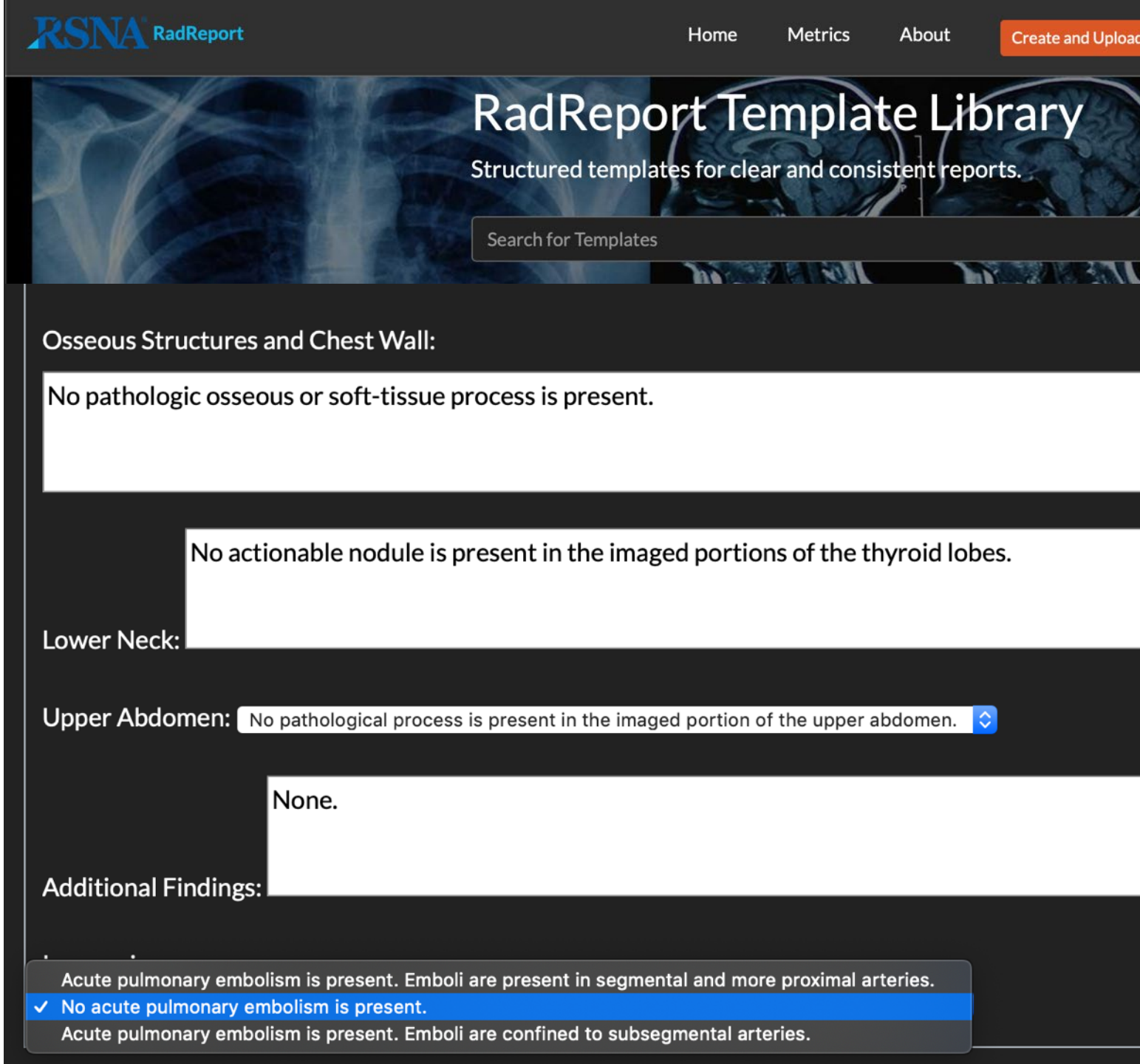
RadLex provides the foundation for vital data resources used in radiology:

- The LOINC/RSNA Radiology Playbook
- RadElement Common Data Elements
- RadReport Radiology Reporting Templates

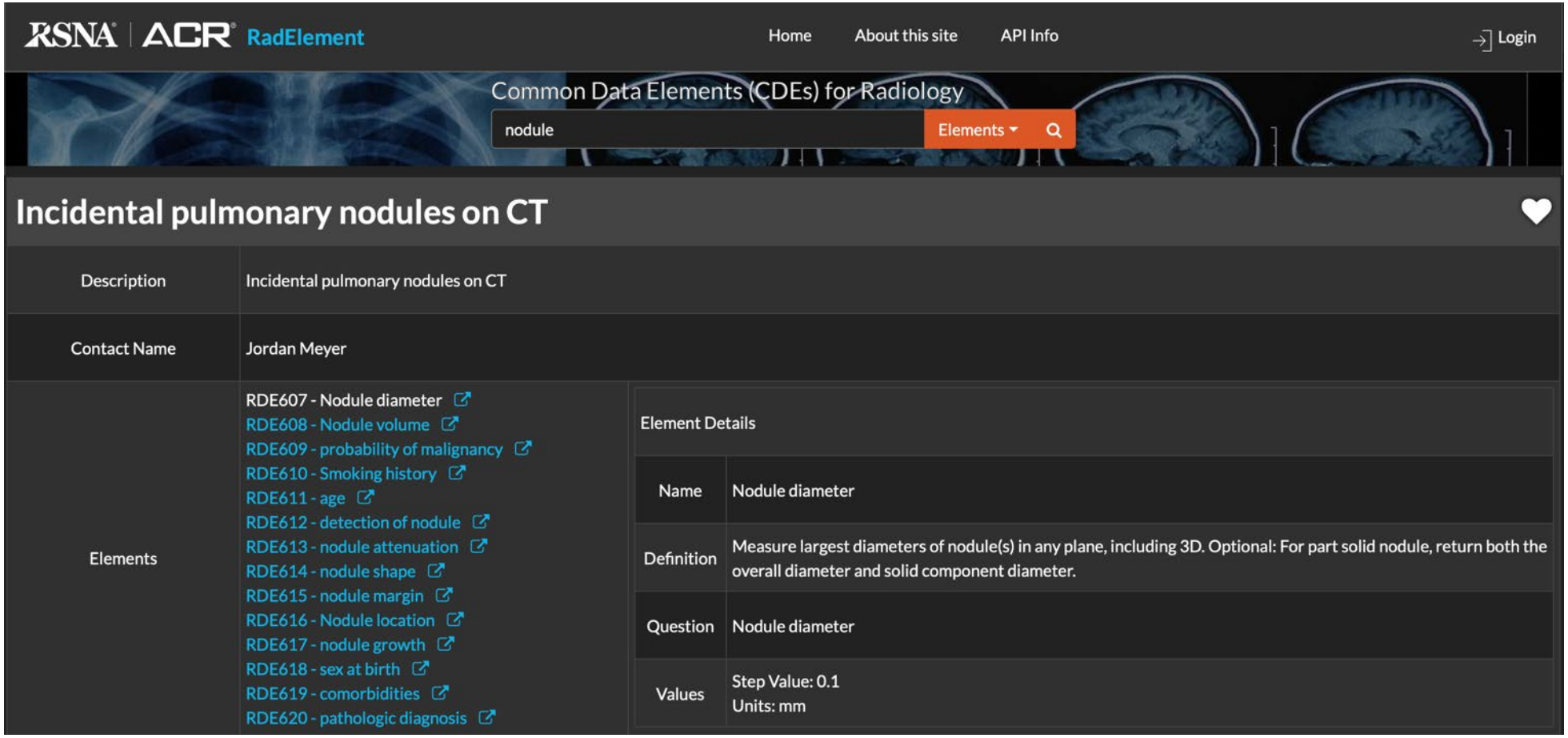
http://radlex.org

Structured Reporting

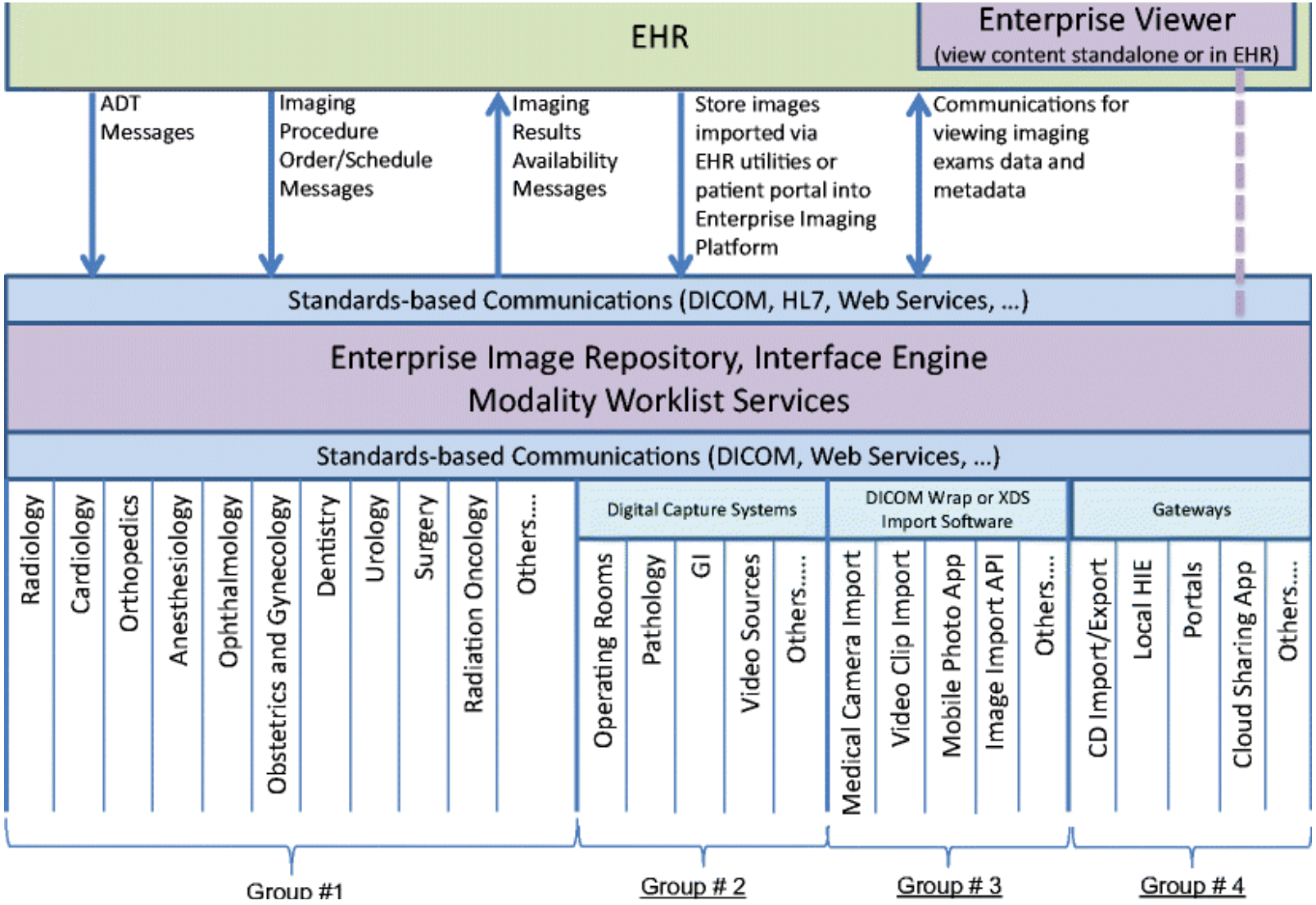
https://radreport.org/



Common Data Elements



https://radelement.org/

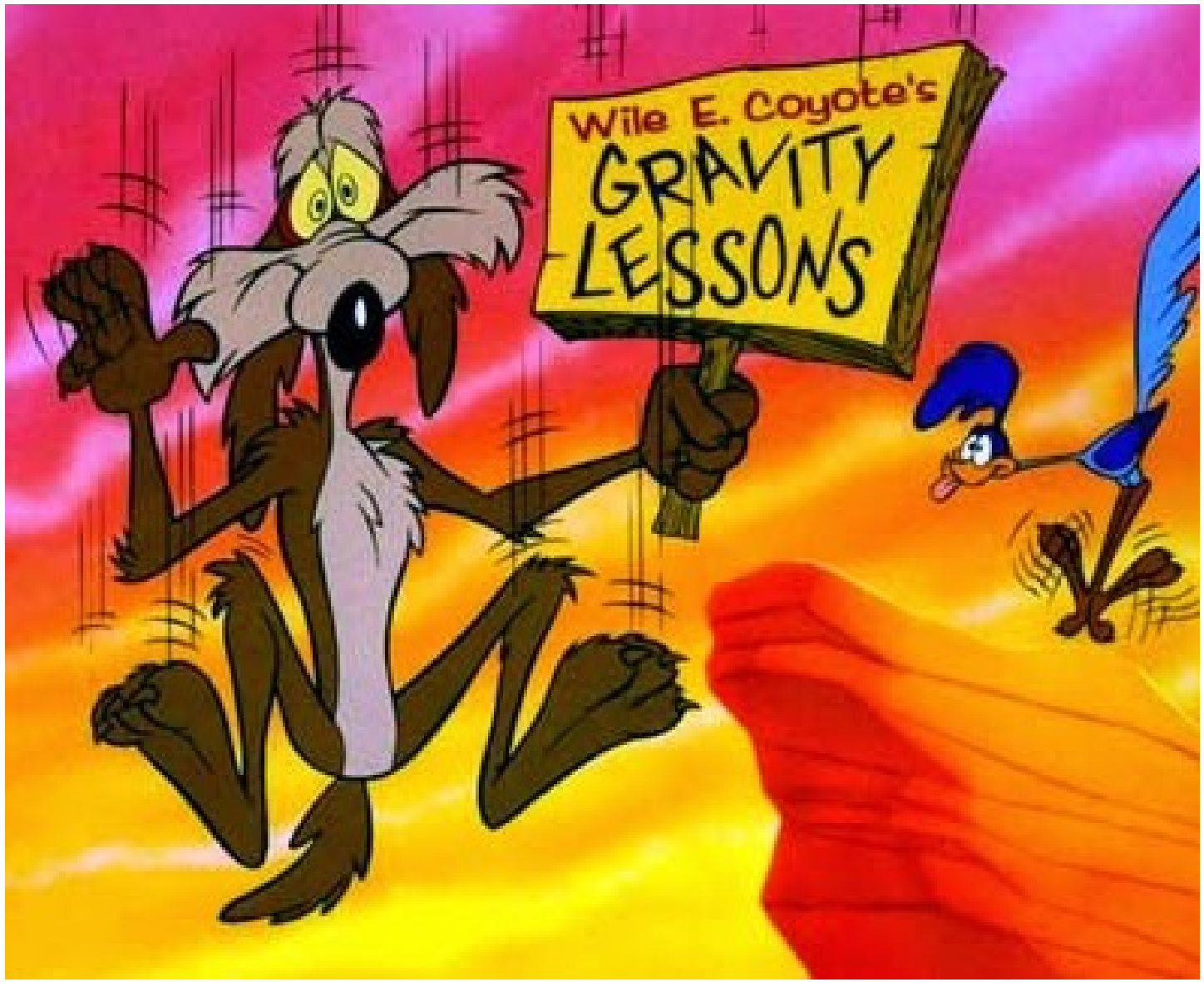


Enterprise Imaging

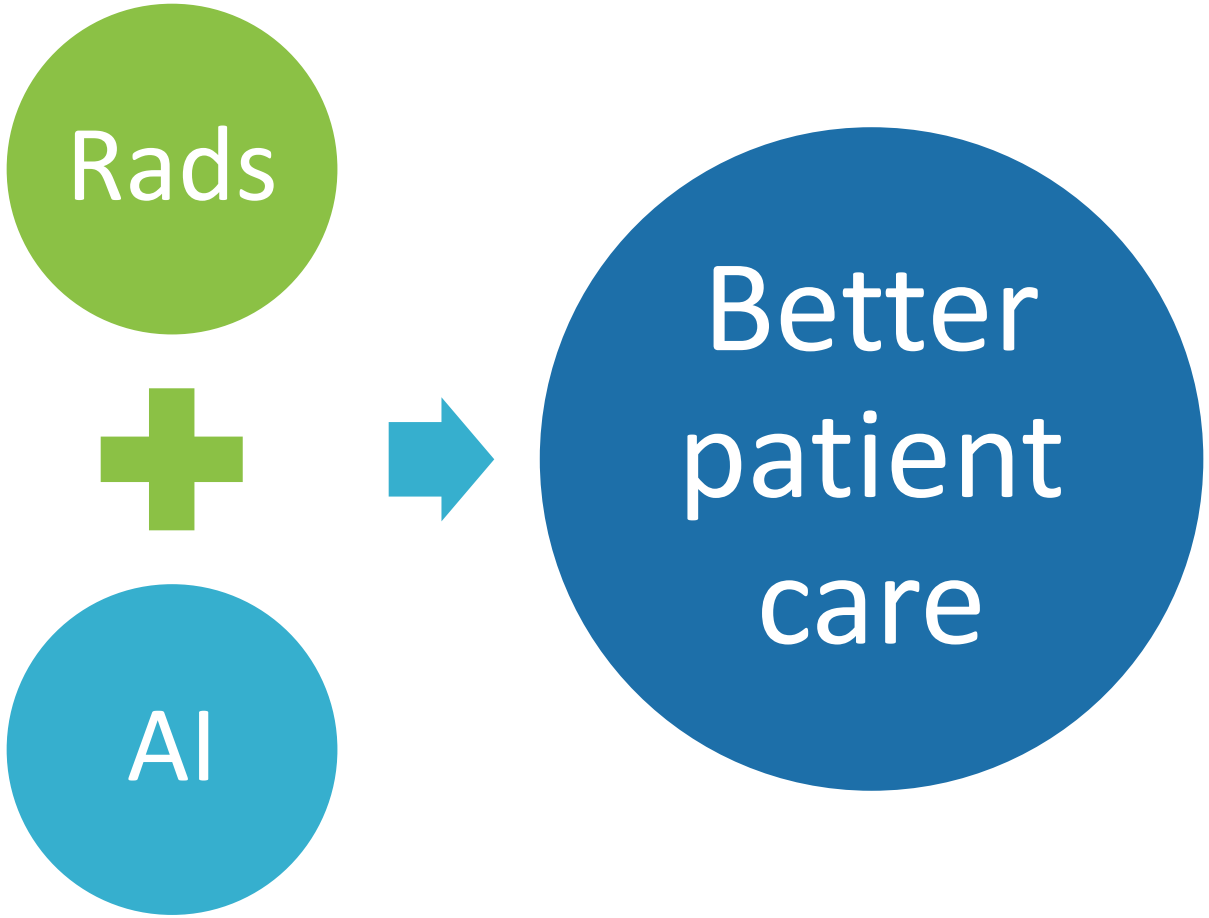
Roth, C.J., Lannum, L.M. & Persons, K.R. A Foundation for Enterprise Imaging: HIMSS-SIIM Collaborative White Paper. *J Digit Imaging* **29,** 530–538 (2016).

AIs: New Robot Radiologists?

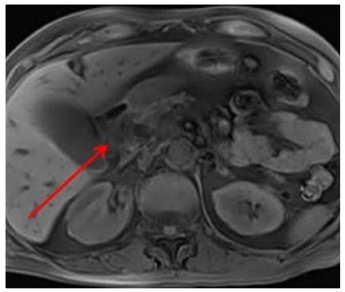
No.



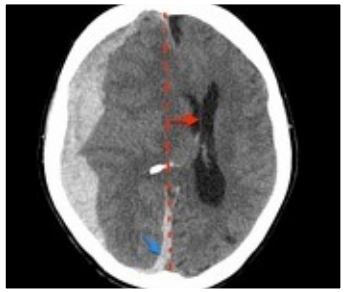
AI & Radiology: Better Together



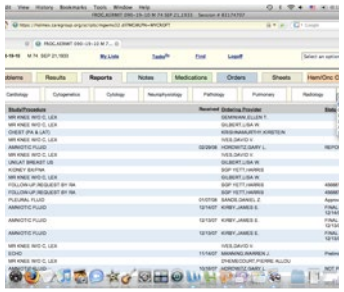
Use Cases for Imaging AI



Findings detection

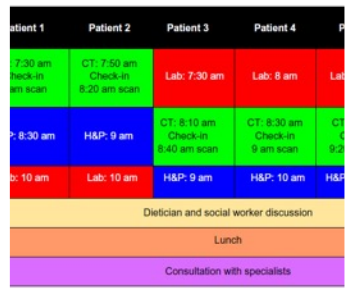


Case triage



EMR search

Reporting QI & QC

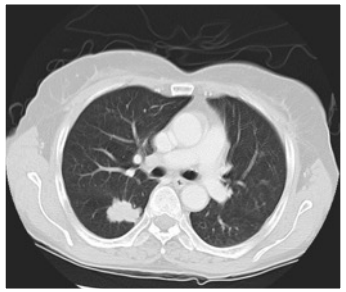


Schedule optimization

Protocoling

Billing & RVUs

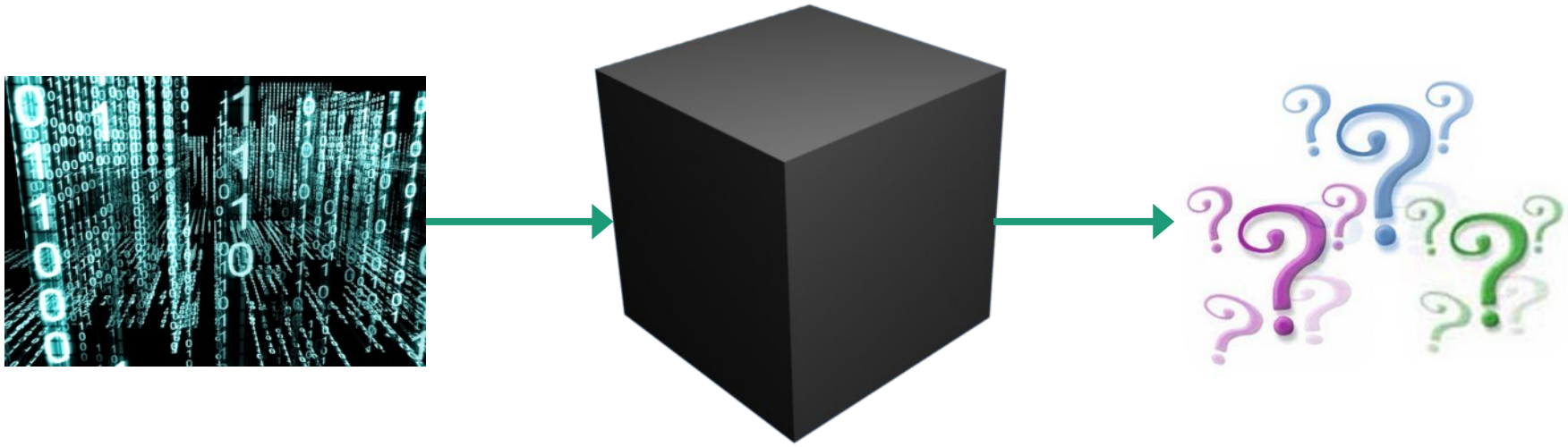
Results & follow-up



Screening & prediction

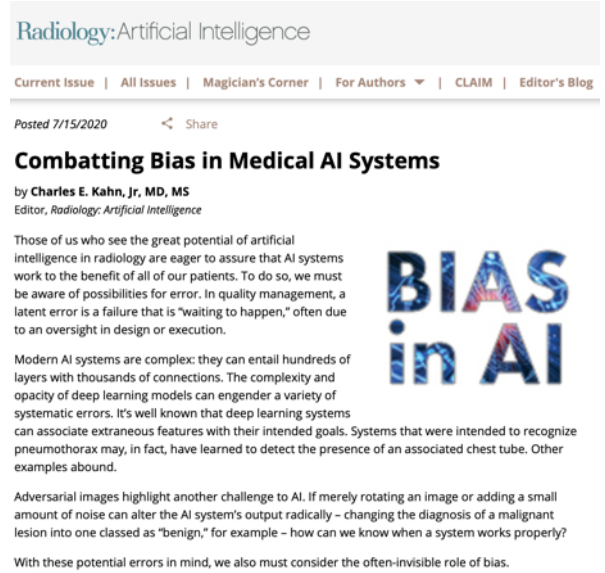
AI “Black Box”

- “transparency, interpretability, and explainability are necessary to build patient and provider trust” - *Ethics of AI in Radiology: European and North American Multisociety Statement, 2020*



The Devil is in the Details Data

- Data selection
- Expert labeling
- Quality vs. quantity
- Bias



Radiology: Artificial Intelligence

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Posted 7/15/2020 Share

Combatting Bias in Medical AI Systems

by **Charles E. Kahn, Jr, MD, MS**
Editor, *Radiology: Artificial Intelligence*

Those of us who see the great potential of artificial intelligence in radiology are eager to assure that AI systems work to the benefit of all of our patients. To do so, we must be aware of possibilities for error. In quality management, a latent error is a failure that is "waiting to happen," often due to an oversight in design or execution.

BIAS in AI

Modern AI systems are complex: they can entail hundreds of layers with thousands of connections. The complexity and opacity of deep learning models can engender a variety of systematic errors. It's well known that deep learning systems can associate extraneous features with their intended goals. Systems that were intended to recognize pneumothorax may, in fact, have learned to detect the presence of an associated chest tube. Other examples abound.

Adversarial images highlight another challenge to AI. If merely rotating an image or adding a small amount of noise can alter the AI system's output radically – changing the diagnosis of a malignant lesion into one classed as "benign," for example – how can we know when a system works properly?

With these potential errors in mind, we also must consider the often-invisible role of bias.

https://pubs.rsna.org/page/ai/blog/2020/7/ryai_editorsblog0715

Integrating AI into the Radiology Workflow

Artificial Intelligence May Cause a ~~Significant Disruption~~ to the Radiology Workforce

Maciej A. Mazurowski, PhD

Disruptive Innovation

Abstract

The increasingly realistic prospect of artificial intelligence (AI) playing an important role in radiology has been welcomed with a mixture of enthusiasm and anxiousness. A consensus has arisen that AI will support radiologists in the interpretation of less challenging cases, which will give the radiologists more time to focus on the challenging tasks as well as interactions with patients and other clinicians. The possibility of AI replacing a large number of radiologists is generally dismissed by the radiology community. The common arguments include the following: (1) AI will never be able to match radiologists' performance; (2) radiologists do more than interpret images; (3) even if AI takes over a large portion of the reading tasks, the radiologists' effort will be shifted toward interactions with patients and other physicians; (4) the FDA would never agree to let machines do the work of radiologist; (5) the issues of legal liability would be insurmountable; and (6) patients would never put complete trust in computer algorithms. In this article, I analyze these arguments in detail. I find a certain level of validity to some of them. However, I conclude that none of the arguments provide sufficient support for the claim that AI will not create a significant disruption in the radiology workforce. Such disruption is a real possibility. Although the radiology specialty has shown an astonishing ability to adapt to the changing technology, the future is uncertain, and an honest, in-depth discussion is needed to guide development of the field.

Key Words: Artificial intelligence, future of radiology, machine learning, opinion

J Am Coll Radiol 2019;16:1077-1082.

Radiology AI: Goals

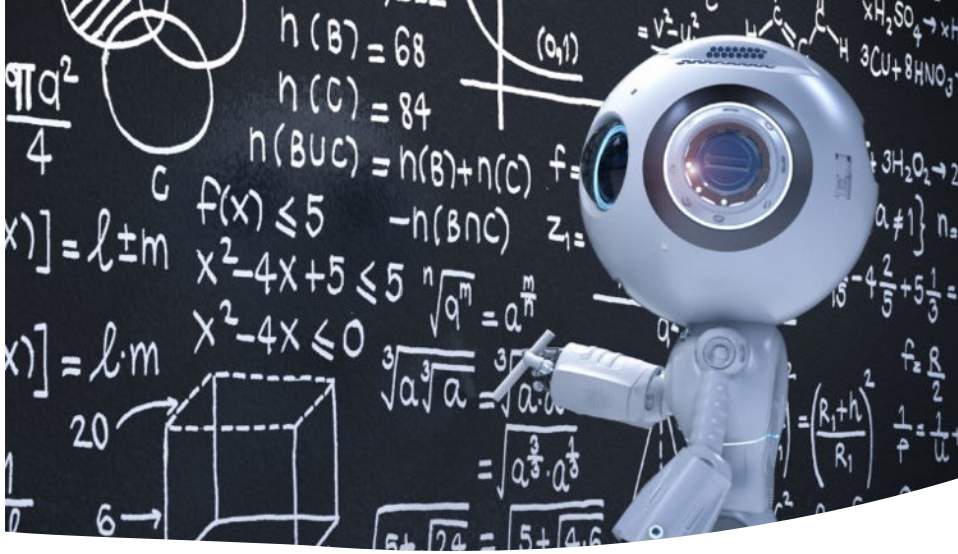
- Decrease image acquisition time
- Increase measurement accuracy
- Decrease repetitive tasks
- Facilitate reporting
- Augment expert physician reader

The Future of AI in Radiology

http://media.bemyapp.com/ai-fintech-will-bigger-impact-finance/
https://medium.com/@EvolvTechnology/3-ways-artificial-intelligence-will-impact-the-airport-2f921aaaeeb1

In Conclusion

Questions?



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