Data Science in Radiology and Imaging Informatics

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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

- Information science
- Computer science
- Healthcare
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. Jackel

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.
PACS: Picture Archiving and Communications System
Imaging Informatics—More than Just Images

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
Early Radiology Workflow

https://wiki.ihe.net/index.php/Scheduled_Workflow
Standards
Standards in Radiology

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. Yeah!

Soon:

Situation:
There are 15 competing standards.

https://xkcd.com/927/
Interoperability of Healthcare Systems

**Radiology**

IHE Radiology was formed in 1998 to address issues of interoperability and information sharing that impact the quality of care in medical imaging. It has developed and documented standards-based solutions to these problems and organized testing and education to foster their adoption. IHE solutions are now available in hundreds of commercial radiology-related information systems and are implemented in care sites around the world.

IHE Radiology is sponsored by the Radiological Society of North America.

**Radiology Profiles**

IHE Radiology integration profiles are specified in detail in the IHE Radiology Technical Framework. These profiles include:

- **Profiles for Workflow**
  - [SWF] *Scheduled Workflow* integrates ordering, scheduling, imaging acquisition, storage and viewing for Radiology exams.
  - [PiR] *Patient Information Reconciliation* coordinates reconciliation of the patient record when images are acquired for unidentified (e.g. trauma), or misidentified patients.
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
Structured Reporting

https://radreport.org/
Common Data Elements

<table>
<thead>
<tr>
<th>Description</th>
<th>Incidental pulmonary nodules on CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Name</td>
<td>Jordan Meyer</td>
</tr>
<tr>
<td>Elements</td>
<td>RDE607 - Nodule diameter</td>
</tr>
<tr>
<td></td>
<td>RDE608 - Nodule volume</td>
</tr>
<tr>
<td></td>
<td>RDE609 - Probability of malignancy</td>
</tr>
<tr>
<td></td>
<td>RDE610 - Smoking history</td>
</tr>
<tr>
<td></td>
<td>RDE611 - Age</td>
</tr>
<tr>
<td></td>
<td>RDE612 - Detection of nodule</td>
</tr>
<tr>
<td></td>
<td>RDE613 - Nodule attenuation</td>
</tr>
<tr>
<td></td>
<td>RDE614 - Nodule shape</td>
</tr>
<tr>
<td></td>
<td>RDE615 - Nodule margin</td>
</tr>
<tr>
<td></td>
<td>RDE616 - Nodule location</td>
</tr>
<tr>
<td></td>
<td>RDE617 - Nodule growth</td>
</tr>
<tr>
<td></td>
<td>RDE618 - Sex at birth</td>
</tr>
<tr>
<td></td>
<td>RDE619 - Comorbidities</td>
</tr>
<tr>
<td></td>
<td>RDE620 - Pathologic diagnosis</td>
</tr>
</tbody>
</table>

Element Details

- **Name**: Nodule diameter
- **Definition**: Measure largest diameters of nodule(s) in any plane, including 3D. Optional. For part solid nodule, return both the overall diameter and solid component diameter.
- **Question**: Nodule diameter
- **Values**: Step Value: 0.1 Units: mm

https://radelement.org/
AIs: New Robot Radiologists?
No.
AI & Radiology: Better Together

Better patient care
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

[Link to the article] 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

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

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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
In Conclusion
Questions?
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