

Rapidly Exploring Use Cases for Multimodal AI in Radiology

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Artificial intelligence can transform clinical practice

... identifying clinically relevant use cases is challenging.



How can we rapidly explore AI use cases to develop feasible and clinically relevant applications?



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Multimodal Healthcare AI: Identifying and Designing Clinically Relevant Vision- Language Applications for Radiology



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Exploring Vision-Language Model use cases for radiology

Prompt:

Write a radiology report as an expert radiologist for the following case:

Case:

A 32-year-old woman presented with a complaint of pain in her right wrist. The patient reported that she fell on her outstretched hand while playing basketball. An X-ray of the right wrist was performed.



GPT-4V:

Radiology Report:

Date: 01/01/2021

Exam: X-ray of the right wrist

Indication: Right wrist pain after falling on outstretched hand while playing basketball

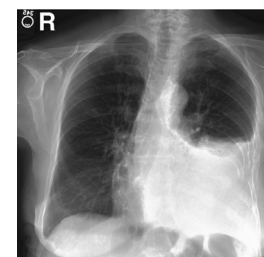
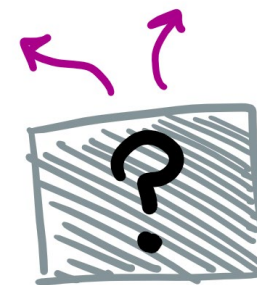
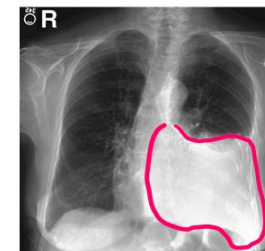
Findings: There is a transverse fracture of the distal radius with mild dorsal angulation. No other fractures or dislocations are seen. The carpal bones are in normal alignment. No significant soft tissue swelling is noted.

Impression: Transverse fracture of the distal radius with mild dorsal angulation. No other fractures or dislocations are seen.

Recommendation: Orthopedic consultation for management of the fracture.

GPT-4 Vision (Yang et al. 2023)

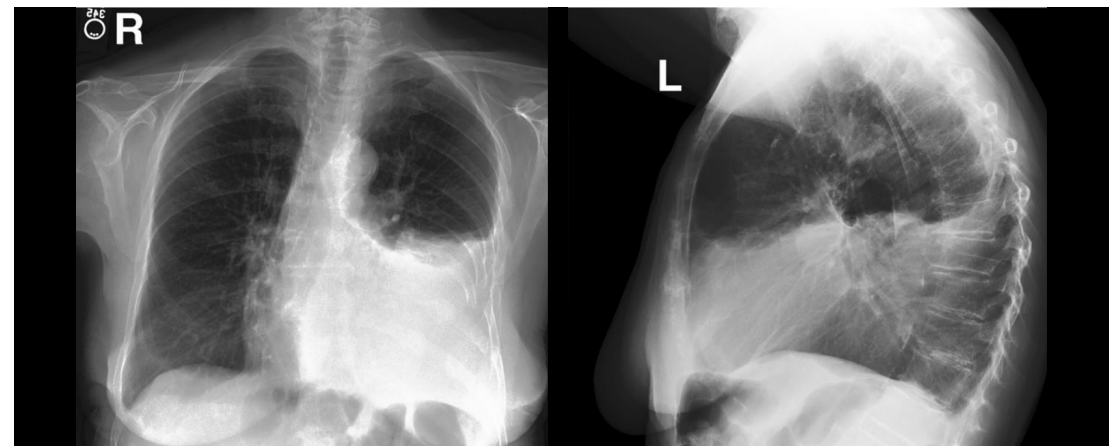
Left lung
base



"Where is the
pleural effusion?"

Overview of radiology workflow

1. Referring clinician asks for patient image
2. Radiologist examines the image, describes their findings and impression
3. Report goes back to referring clinician to inform care + treatment



EXAMINATION: CHEST (PA AND LAT)

INDICATION: ___ year old woman with ?pleural effusion // ?pleural effusion

TECHNIQUE: Chest PA and lateral

COMPARISON: ___

FINDINGS:

Cardiac size cannot be evaluated. Large left pleural effusion is new. Small right effusion is new. The upper lungs are clear. Right lower lobe opacities are better seen in prior CT. There is no pneumothorax. There are mild degenerative changes in the thoracic spine

IMPRESSION:

Large left pleural effusion

Research Questions

What are the clinically relevant use cases for vision-language model capabilities in radiology?

Whether, how, and in what form these use cases might provide value to radiologists & clinicians?

Method

1 Brainstorming

7 Interviews
4 Brainstorming sessions

2 Concept Design

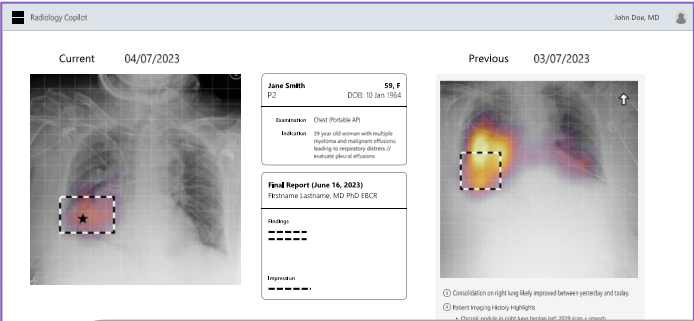
Identified four use cases
Prototyped to high fidelity

3 Evaluation

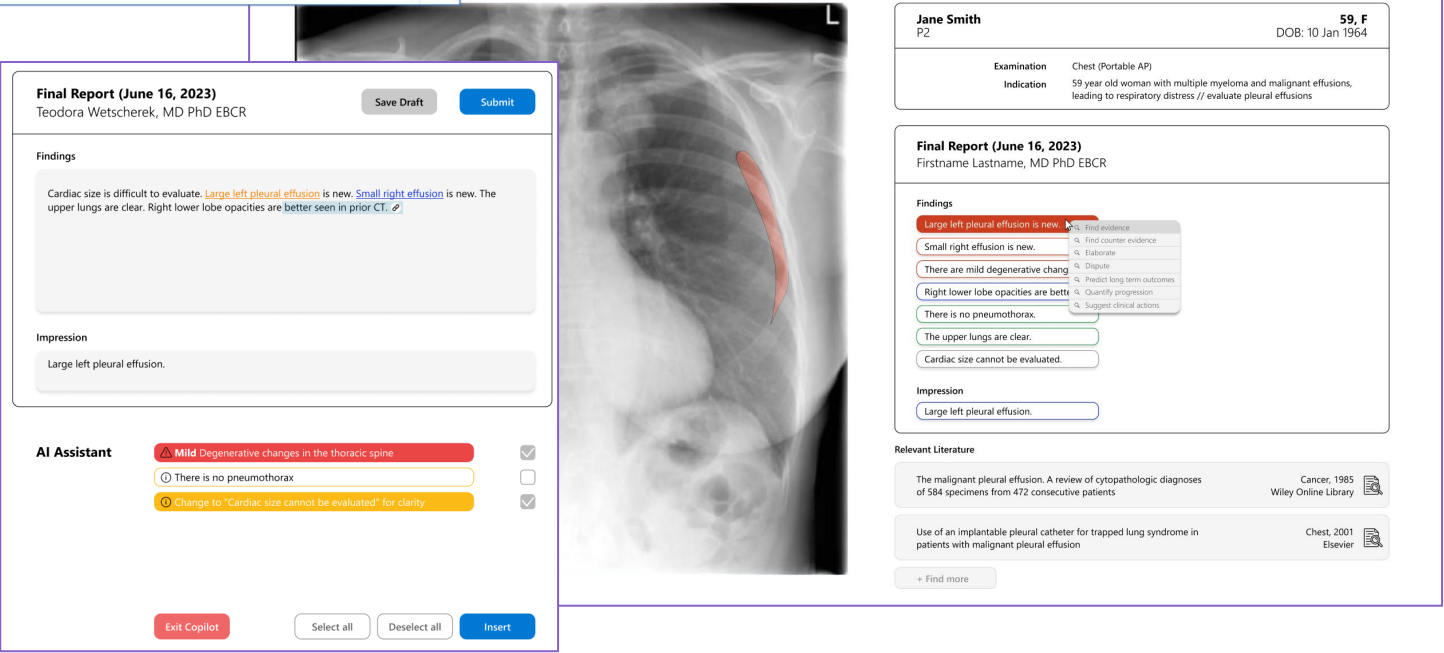
1-hour interviews
5 Radiologists
8 Clinicians

Brainstorming Use Cases

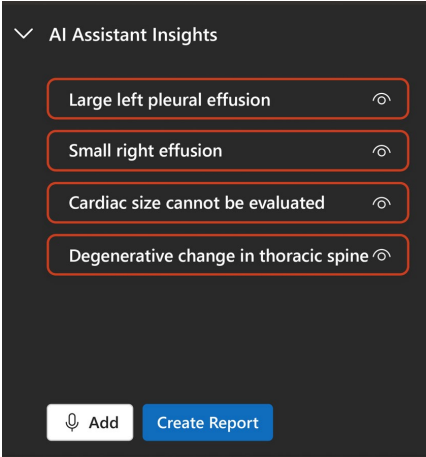
- Auto correction
- Text generation
- Visual question answering
- Summarization
- Visual measurements + quantification
- Image manipulation + counterfactuals
- Visually annotated reports
- AI assistant + chat
- ...



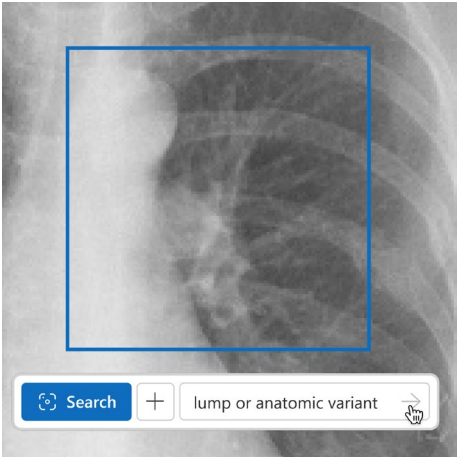
- ① Consolidation on right lung likely improved between yesterday and today.
- ① Patient Imaging History Highlights
 - Chronic nodule in right lung benign (ref: 2019 scan + report)
 - Had prior radiation for breast cancer treatment (ref: 2018 scan + report)



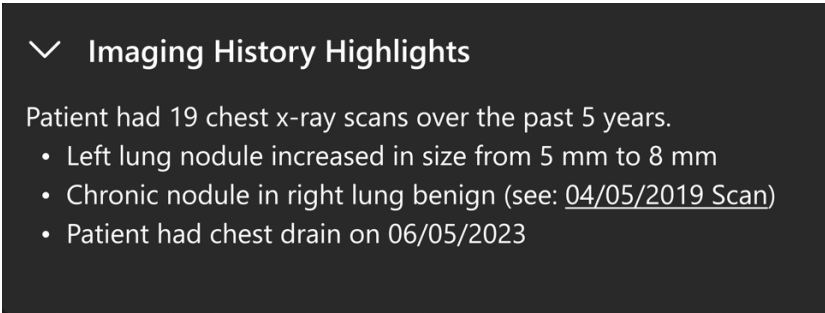
Use Case Concepts



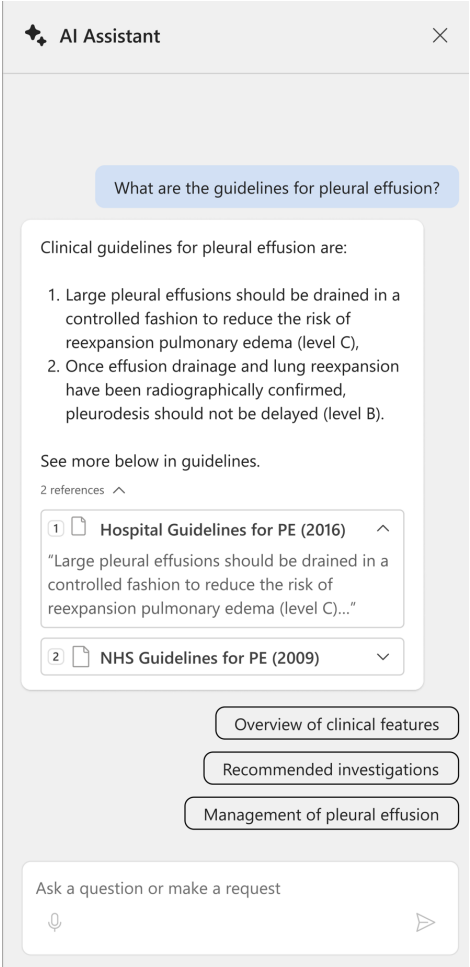
Draft Report Generation



Visual Search & Querying



Patient Imaging History Highlights



Augmented Report Review

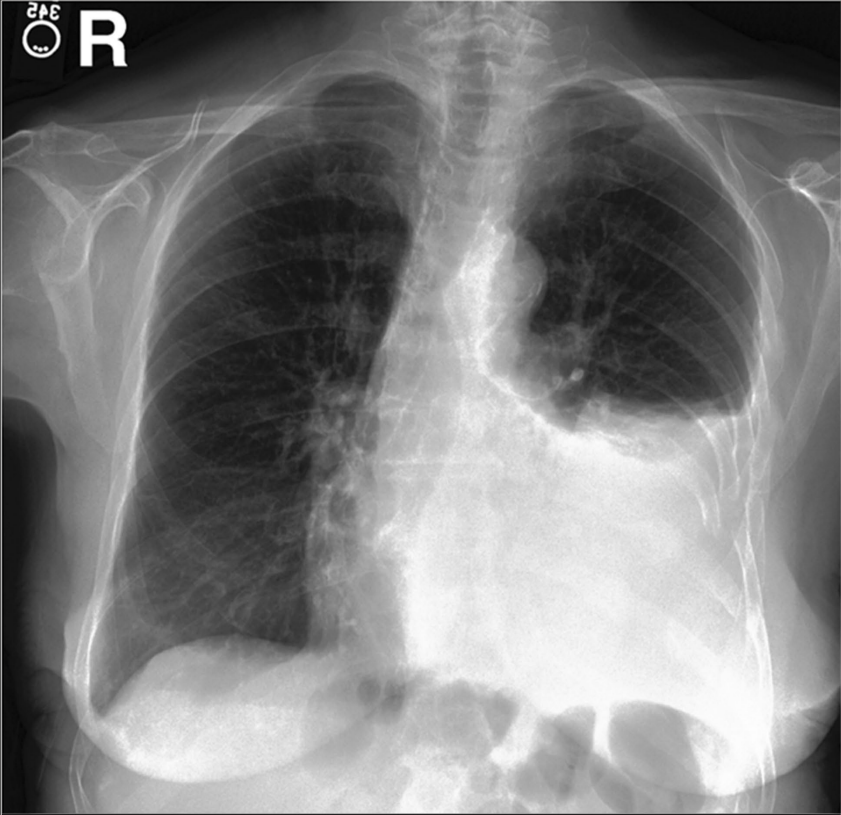
Draft Report Generation (Radiologists)

John Doe, MD

Patient NameJane Smith 59 F

Indication59 year old woman with ?pleural effusion // ?pleural effusion

233R



AI Assistant Insights

Large left pleural effusion

Small right effusion

Cardiac size cannot be evaluated

Degenerative change in thoracic spine

Add

Create Report

Report

Findings

Cardiac size cannot be evaluated. Large left pleural effusion is new. Small right effusion is new. The upper lungs are clear. Right lower lobe opacities are better seen in prior CT. There is no pneumothorax. There are mild degenerative changes in the thoracic spine.

Impression

Large left pleural effusion

Save Draft

Submit Report

Draft Report Generation

Perceived value: saving time and cognitive effort

Saving time for multi-slice images,
especially for outside specialty

I might be a seasoned reporter for lung or cardiac, but as every week it happens, we'll get a neck CT ... it's extremely difficult. You would love an AI which is at least giving you the salient findings.

– R5, cardiothoracic

Expectation of near-perfect AI performance

I'm willing to correct 1 out of 10 reports – R1, emergency care

I would expect to change 5 to 10 out of 100 – R5, cardiothoracic

Bullet points vs prose report

Preference for short, standardized reporting

The idea of a narrative report happened in 1898 and we've not moved on from it. [This is] what we should be moving away from rather than using the technology to reverse engineer the future into what we got.

– R3, uroradiology

Impression is the key interpretative work that radiologists want to remain in charge of

The main focus of communication between us and the team taking care of the patient is that impression part of the report. So it's really important to me to have that correctly crafted.

– R1, emergency care

Draft Report Generation

Draft reports can be used for triage

Radiologists seemed comfortable with making AI reports available to clinicians

The subtlety there is that a draft report sounds too final in the health culture. But a 'prelim' or a 'wet read', that's a very rough, not final thing. **The clinicians would take that information and use their judgement to call the radiologist or wait for the report.**

– R5, cardiothoracic

Augmented Report Review (Clinicians)

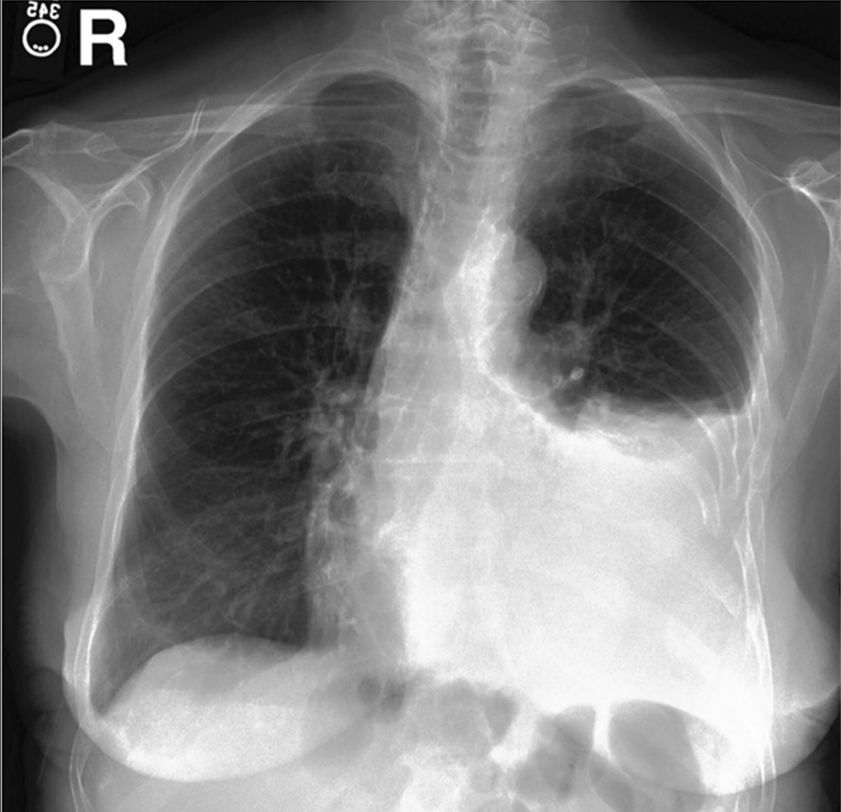
John Doe, MD

Patient Name

Jane Smith 59 F

Indication

59 year old woman with ?pleural effusion // ?pleural effusion



2AP 342 R

🔍

🔍

🔄

🔄

Report Overview

Large left pleural effusion

Small right effusion

Cardiac size cannot be evaluated

Full Report

Findings

Cardiac size cannot be evaluated. Large left pleural effusion is new. Small right effusion is new. The upper lungs are clear. Right lower lobe opacities are better seen in prior CT. There is no pneumothorax. There are mild degenerative changes in the thoracic spine.

Impression

Large left pleural effusion

Ask AI Assistant

What are guidelines for pleural effusion?

Clinical guidelines for pleural effusion are:

1. Large pleural effusions should be drained in a controlled fashion to reduce the risk of reexpansion pulmonary edema (level C),

2. Once effusion drainage and lung reexpansion have been radiographically confirmed, pleurodesis should not be delayed (level B).

See more below in guidelines.

2 references

1 Hospital Guidelines for PE (2016)

"Large pleural effusions should be drained in a controlled fashion to reduce the risk of reexpansion pulmonary edema (level C)..."

2 NHS Guidelines for PE (2009)

Overview of clinical features

Suggested investigations

How to manage pleural effusion?

Clinicians prefer tool-based interactions over chat

Clinicians are extremely busy, they don't have time to chat with a computer

I don't need a chatbot function where I'm talking and stuff.
I haven't got the time for it. – C5, internal medicine

Need for patient-specific, contextual information

There is only so much you can tell from images,
combining image + EHR + other tools

I don't need it to remind me the ten common causes of pleural effusion. What will be really helpful is for it to know that actually in this context, hypothyroidism becomes not the 29th thing, but actually upping [that to] your top five you should be considering ... because this patient's got some other clues or signs.

– C3, intensive care

Is that a radiology assistant or a clinical assistant?

Expectation of workflow-specific assistance
over generalist healthcare AI

If I've got a radiologist at my fingertips, I'd restrict to asking it the kind of questions I might be asking the radiologist. Therefore it belongs in this screen, whereas **some of the other things like, how should I treat this patient? I think that belongs in the main body of EHR.**

– C4, public health

Patient Imaging History Highlights (Clinicians & Radiologists)

Patient Name

Jane Smith 59 F

Indication

59 year old woman with ?pleural effusion // ?pleural effusion

Report

Imaging History

John Doe, MD

PAE

R



Imaging History Highlights

Patient had 19 chest x-ray scans over the past 5 years.

- Left lung nodule increased in size from 5 mm to 8 mm
- Chronic nodule in right lung benign (see: [04/05/2019 Scan](#))
- Patient had chest drain on 06/05/2023

[Patient Scan]

[Patient Scan]

[Patient Scan]

[Patient Scan]

Imaging History Highlights

Patient had 19 chest x-ray scans over the past 5 years.

- Left lung nodule increased in size from 5 mm to 8 mm
- Chronic nodule in right lung benign (see: [04/05/2019 Scan](#))
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Perceived value: enormous time savings

Imperfect AI can be useful, having a summary is better than nothing

Half of my life is spent chasing pre-existing conditions. A sentence or two, just about the radiology would save me a lot of time.

– C1, intensive care

Key Takeaways

Opportunity to reimagine future radiology reporting

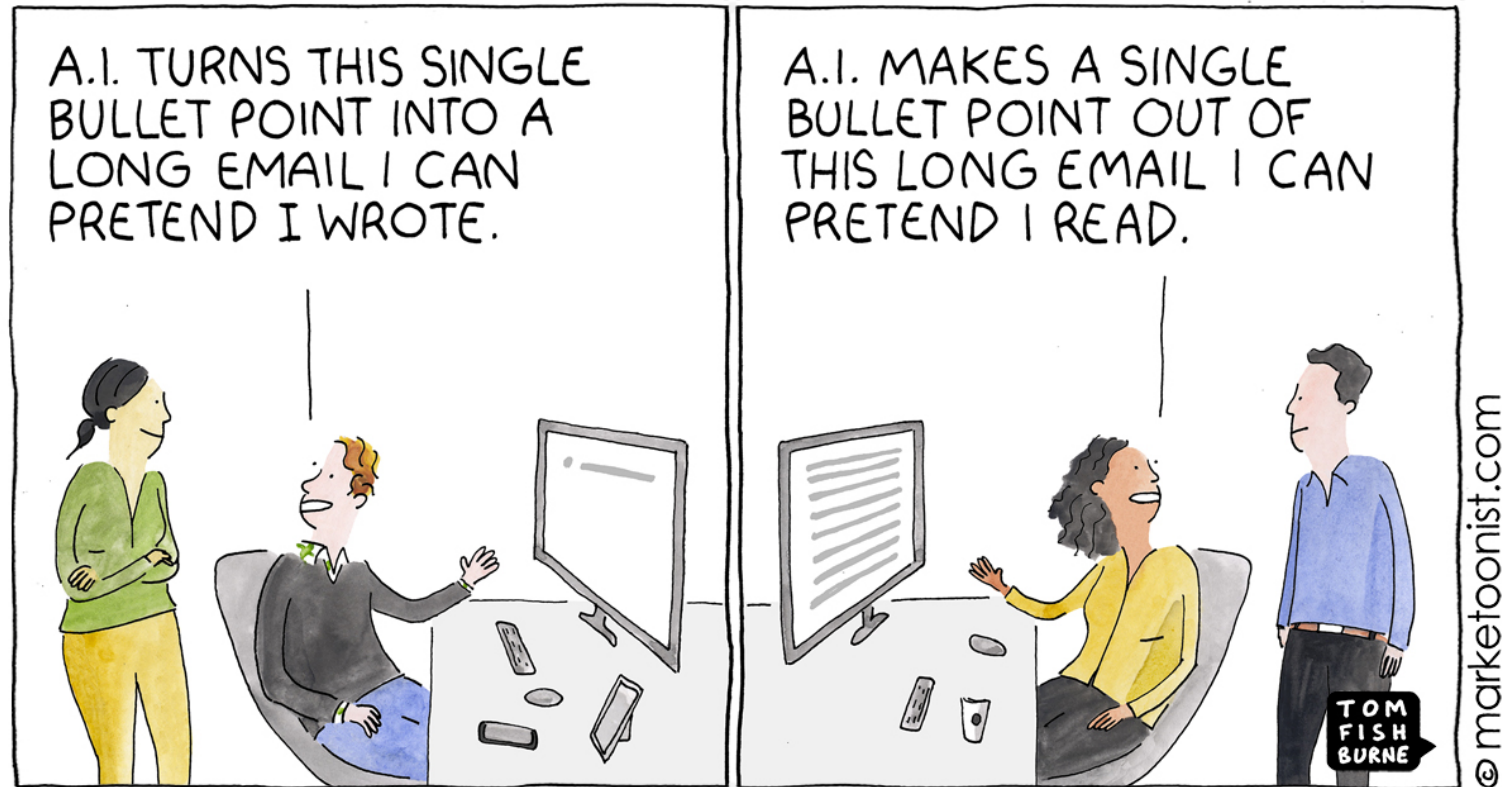
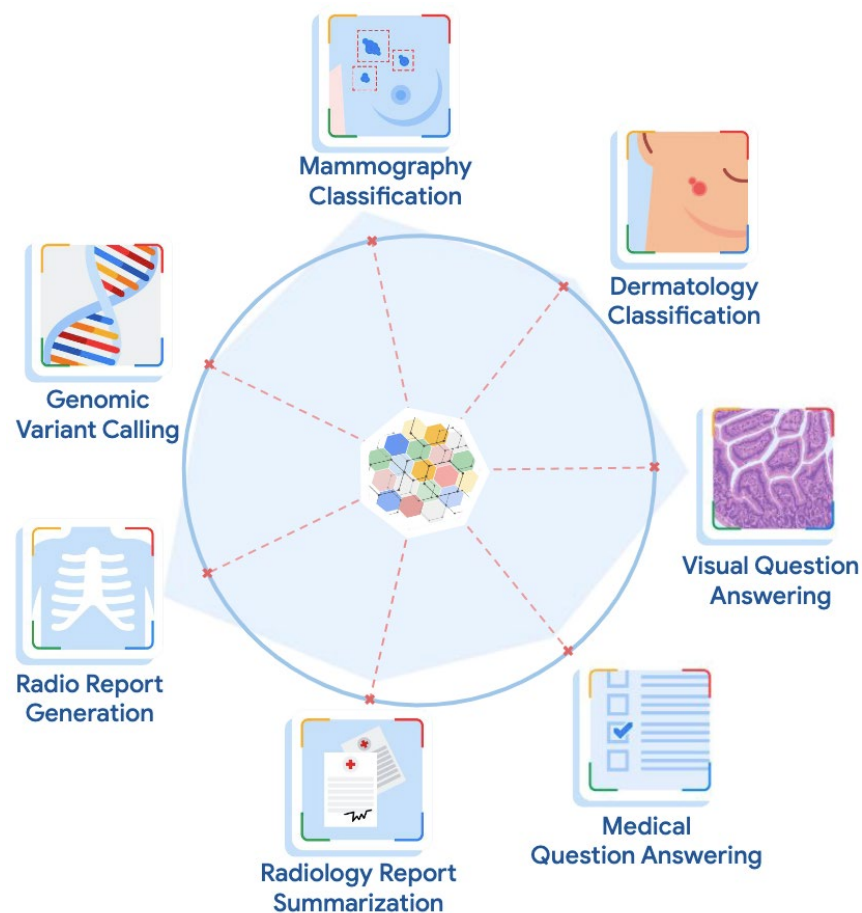


Image: Tom Fishburne

Implications

Task specific functionality rather than generalist AI



Implications

Need better forms of interaction than chat

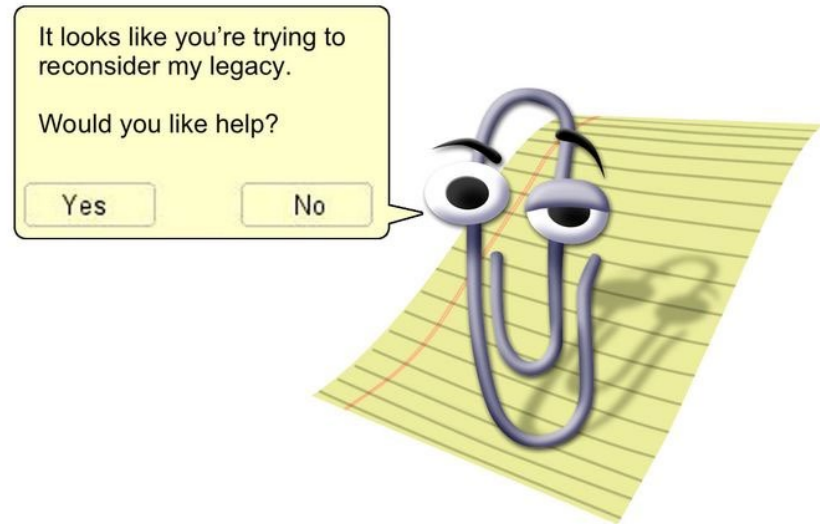
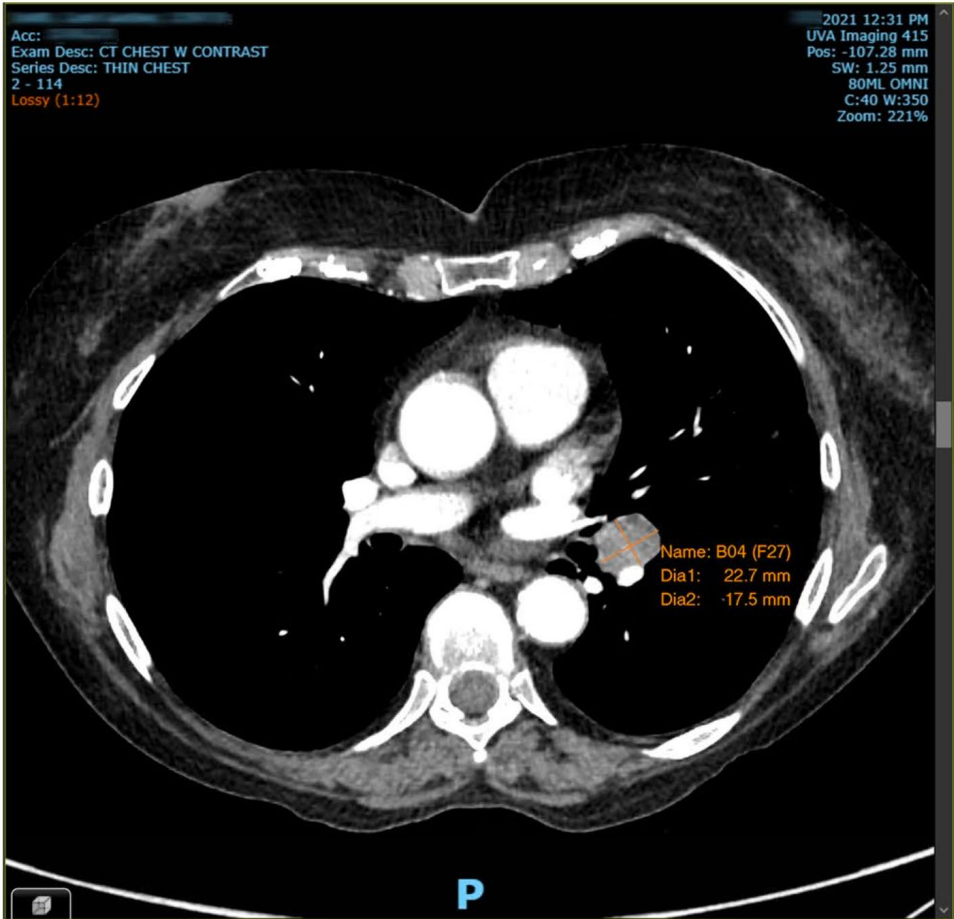


Image: Brian Feldman, New York Magazine

Human-centered innovation can de-risk AI applications

- Engaging clinical stakeholders throughout the process
- When, where, and in what form AI output presented?
- What action will be taken, by whom?
- Low hanging fruit where some AI is better than nothing

Exploring UVA's Hyperlinked Image-Report Dataset



Patient Reports

1/1 Report date: 2021 (Report matches exam selected in Patient History pane)

FINDINGS:

Lungs/Pleura: Right upper lobe anterior segment pleural mass (2.0 cm x 1.4 cm) (series 2, image 79) measures similar by my measurement from 2021 but slightly increased since 2020 (1.9cm X 10mm). Another unchanged pleural nodule in the right upper hemithorax (series 2, image 48).

Left upper lobe perifissural nodule seems similar from and measures (1.1 cm)(series 2, image 106). Unchanged pleural nodule at the lateral aspect of the left upper lobe (0.8 cm x 0.3 cm)(series 2, image 98).

The other bilateral pulmonary nodules, including cluster in the right lower lobe lateral basal segment and left upper lobe posterior segment do not show appreciable change. No development of pleural effusion. No acute airspace disease. Patent airways.

Mediastinum: Right lower paratracheal lymph node measuring (1.7 cm)(series 2, image 92) does not show appreciable change since 2021. Right upper paratracheal lymph node (1.5 cm x 1.3 cm)(series 2, image 53) appears stable since 2021. Subcentimeter right retrotracheal lymph node (0.8 cm)(series 2, image 46) is stable. Left hilar lymph node mass (2.3 cm x 1.8 cm)(series 2, image 114) is similar compared with prior measurement (2.5 x 2.1 cm). No pericardial effusion. Stable heart size.

Axilla/Soft Tissue: No axillary lymph node enlargement.

Upper Abdomen: Bilateral renal cysts are similar to prior exam. Spleen is normal in size. Surgically absent adrenal glands.

Bones: Unchanged soft tissue lesion along the anterior surface of the right 3rd rib measuring (0.9 cm x 0.5 cm)(series 2, image 75). Unchanged multiple osteoblastic lesions along the thoracic spine, the dominant one measuring (1.8 cm)(series 2) at the T11. Please refer to separate dictation of same day thoracolumbar spine MR.

IMPRESSION:

Overall unchanged metastatic burden in the lung, pleura and mediastinal and hilar lymphadenopathy as detailed above.

_____. M.D.
Fellow Physician, Cardiovascular and Thoracic Imaging

_____. M.D.
Body Imaging, Attending Physician

Radiology Resident/Fellow: _____ M.D., Fellow Physician, Radiology

Radiology Attending: _____ M.D., Body Imaging, Attending Physician

Interactive multimedia reporting technical considerations: HIMSS-SIIM collaborative white paper
Berkowitz et al. 2022. Journal of Digital Imaging



Christopher Gaskin



Chirag Agarwal

Thank you!

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