6th July 2022

Bringing AI into Radiological Practice

Challenges & Opportunities

Women in Data Science

x

deepc

deepc

Welcome

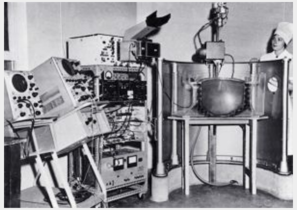
Julia Moosbauer, MSc Data Science
COO, Co-Founder

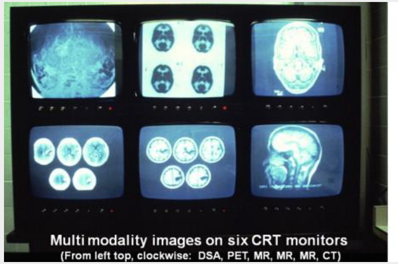
Rosenheimer Str. 143
81671 Munich, Germany

in/juliamoosbauer/

www.deepc.ai

julia.moosbauer@deepc.ai

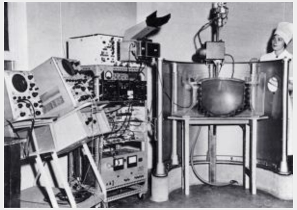




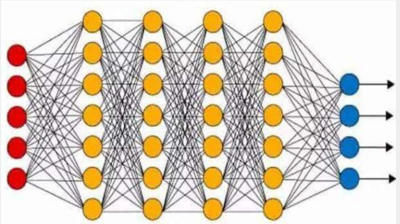
X-Ray Mammography Ultrasound MRI CT First PACS

1895 1913 1942 1971 1972

Source: Geo Magazin, Wikipedia.org, ASUM, Imaginis



Breakthrough of AI
with Deep Learning



X-Ray 1895

Mammography 1913

Ultrasound 1942

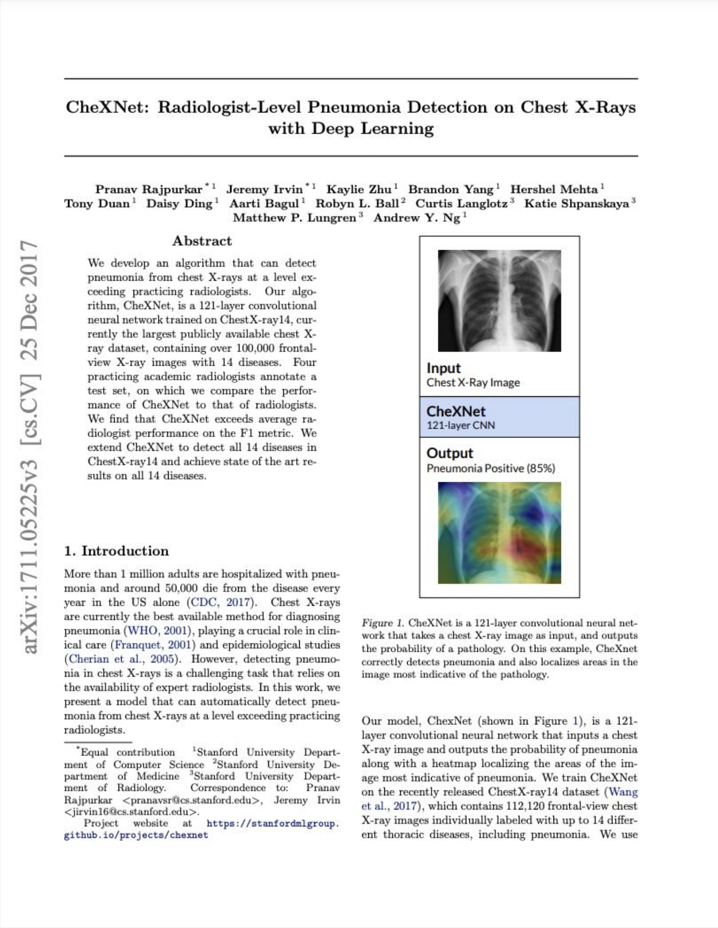
MRI 1971

CT 1972

First PACS

Breakthrough of AI with Deep Learning 2015

Source: Geo Magazin, Wikipedia.org, ASUM, Imaginis



arXiv:1711.05225v3 [cs.CV] 25 Dec 2017

CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning

Pranav Rajpurkar [*1] Jeremy Irvin [*1] Kaylie Zhu [1] Brandon Yang [1] Hershel Mehta [1]
Tony Duan [1] Daisy Ding [1] Aarti Bagul [1] Robyn L. Ball [2] Curtis Langlotz [3] Katie Shpanskaya [3]
Matthew P. Lungren [3] Andrew Y. Ng [1]

Abstract

We develop an algorithm that can detect pneumonia from chest X-rays at a level exceeding practicing radiologists. Our algorithm, CheXNet, is a 121-layer convolutional neural network trained on ChestX-ray14, currently the largest publicly available chest X-ray dataset, containing over 100,000 frontal-view X-ray images with 14 diseases. Four practicing academic radiologists annotate a test set, on which we compare the performance of CheXNet to that of radiologists. We find that CheXNet exceeds average radiologist performance on the F1 metric. We extend CheXNet to detect all 14 diseases in ChestX-ray14 and achieve state of the art results on all 14 diseases.

Figure 1. CheXNet is a 121-layer convolutional neural network that takes a chest X-ray image as input, and outputs the probability of a pathology. On this example, CheXnet correctly detects pneumonia and also localizes areas in the image most indicative of the pathology.

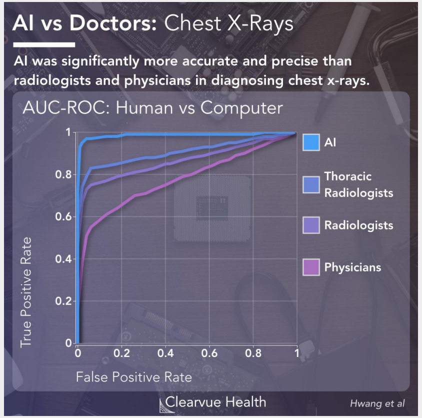
1. Introduction

More than 1 million adults are hospitalized with pneumonia and around 50,000 die from the disease every year in the US alone (CDC, 2017). Chest X-rays are currently the best available method for diagnosing pneumonia (WHO, 2001), playing a crucial role in clinical care (Franquet, 2001) and epidemiological studies (Cherian et al., 2005). However, detecting pneumonia in chest X-rays is a challenging task that relies on the availability of expert radiologists. In this work, we present a model that can automatically detect pneumonia from chest X-rays at a level exceeding practicing radiologists.

Our model, ChexNet (shown in Figure 1), is a 121-layer convolutional neural network that inputs a chest X-ray image and outputs the probability of pneumonia along with a heatmap localizing the areas of the image most indicative of pneumonia. We train CheXNet on the recently released ChestX-ray14 dataset (Wang et al., 2017), which contains 112,120 frontal-view chest X-ray images individually labeled with up to 14 different thoracic diseases, including pneumonia. We use

*Equal contribution [1]Stanford University Department of Computer Science [2]Stanford University Department of Medicine [3]Stanford University Department of Radiology. Correspondence to: Pranav Rajpurkar <pranavsr@cs.stanford.edu>, Jeremy Irvin <jirvin16@cs.stanford.edu>.
Project website at https://stanfordmlgroup.github.io/projects/chexnet

	F1 Score (95% CI)
Radiologist 1	0.383 (0.309, 0.453)
Radiologist 2	0.356 (0.282, 0.428)
Radiologist 3	0.365 (0.291, 0.435)
Radiologist 4	0.442 (0.390, 0.492)
Radiologist Avg.	0.387 (0.330, 0.442)
CheXNet	0.435 (0.387, 0.481)



Chinese AI beats 15 doctors in tumor diagnosis competition

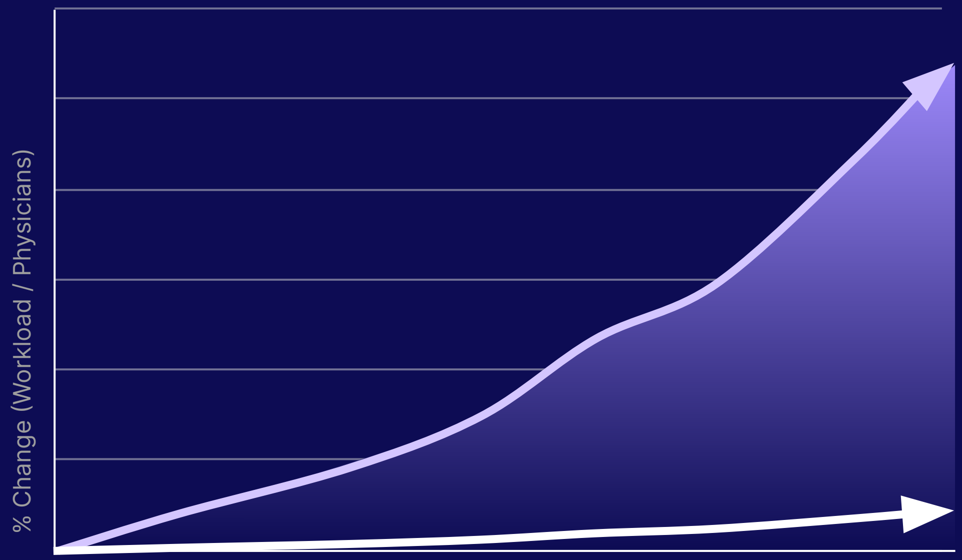
„We should stop training radiologists now!“

- Geoffrey Hinton, 2016

https://www.youtube.com/watch?v=2HMPRXstSvQ

Current Demand-Supply-Gap Challenge

Radiology under Pressure



Source: RSNA Radiology Workforce 2019, DESTATIS 2020

Workload increase of

2.5x

In the last 10 years

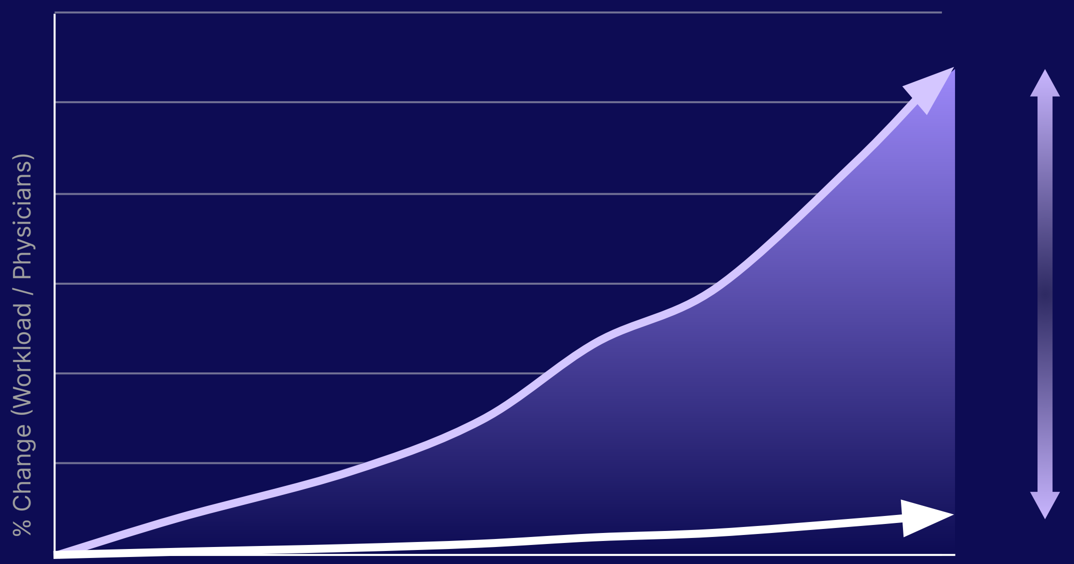
On Average only

1.1x

In number of Radiologists

Current Demand-Supply-Gap Challenge

Radiology under Pressure



Source: RSNA Radiology Workforce 2019, DESTATIS 2020

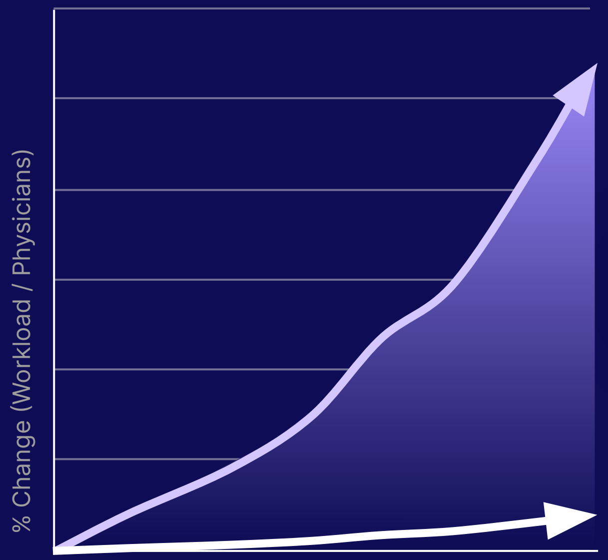
55%
Physician burnout

67%
Senior positions unfilled

>2x
Increase in Error Rates

AI can fill the demand-supply gap

by making radiologists ...



Source: RSNA Radiology Workforce 2019, DESTATIS 2020

AI

... More **Efficient**

... More **Accurate**

... **Faster** in decisions

AI for routine tasks
e.g. high volume use cases

AI enhancing doctors
e.g. head CT diagnosis

AI augmenting doctors
e.g. MS quantification

AI as safety net
e.g. emergency care

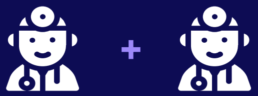
AI for routine tasks

Example

Mammography screening

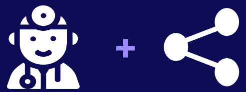
A. Current process:

Each mammogram read by two radiologists



B. Process with AI:

Mammogram read by only one radiologist plus AI



[1] Mattie Salim et al., External Evaluation of 3 Commercial Artificial Intelligence Algorithms for Independent Assessment of Screening Mammograms. JAMA Oncol. (2020).
[2] McKinney et al. International evaluation of an AI system for breast cancer screening. Nature (2020).

AI for routine tasks

Example

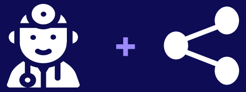
Mammography screening

A. Current process:

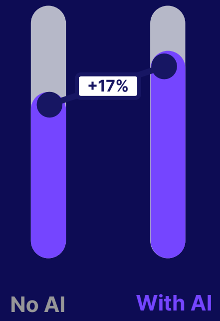
Each mammogram read by two radiologists

B. Process with AI:

Mammogram read by only one radiologist plus AI



Cancer Detection Rate [1]



[1] Mattie Salim et al., External Evaluation of 3 Commercial Artificial Intelligence Algorithms for Independent Assessment of Screening Mammograms. JAMA Oncol. (2020).
[2] McKinney et al. International evaluation of an AI system for breast cancer screening. Nature (2020).

AI for routine tasks

Example

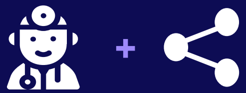
Mammography screening

A. Current process:

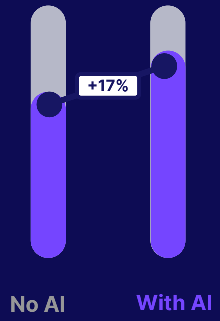
Each mammogram read by two radiologists

B. Process with AI:

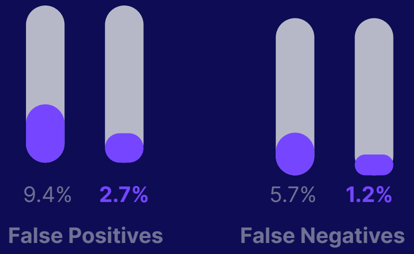
Mammogram read by only one radiologist plus AI



Cancer Detection Rate [1]



Doctor vs. AI Performance [2]



[1] Mattie Salim et al., External Evaluation of 3 Commercial Artificial Intelligence Algorithms for Independent Assessment of Screening Mammograms. JAMA Oncol. (2020).
[2] McKinney et al. International evaluation of an AI system for breast cancer screening. Nature (2020).

AI enhancing doctors

Example

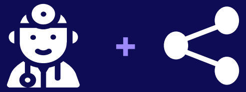
Diagnosis of CT Brain scans

A. Current process:

Each cCT read by one radiologists

B. Process with AI:

cCT read by one radiologist plus AI

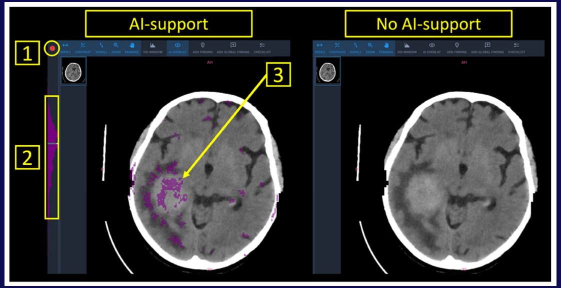


[3] Faster and Better: How Anomaly Detection Can Accelerate and Improve Reporting of Head Computed Tomography. Diagnostics 2022

AI enhancing doctors

Example

Diagnosis of CT Brain scans



A. Current process:

Each cCT read by one radiologists

B. Process with AI:

cCT read by one radiologist plus AI

+

[3] Faster and Better: How Anomaly Detection Can Accelerate and Improve Reporting of Head Computed Tomography. Diagnostics 2022

AI enhancing doctors

Example

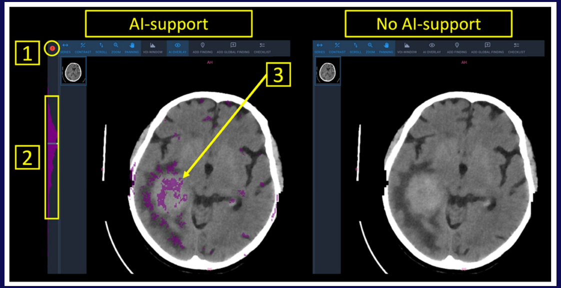
Diagnosis of CT Brain scans

A. Current process:

Each cCT read by one radiologists

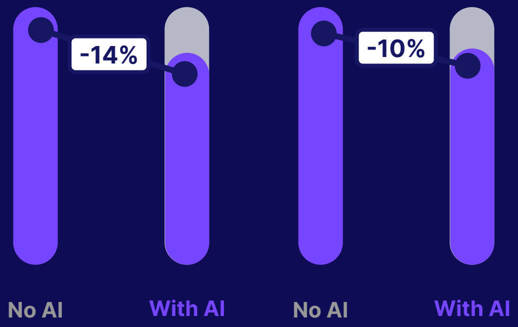
B. Process with AI:

cCT read by one radiologist plus AI



Reading Time
(Inexperienced)

Reading Time
(Experienced)



[3] Faster and Better: How Anomaly Detection Can Accelerate and Improve Reporting of Head Computed Tomography. Diagnostics 2022

AI enhancing doctors

Example

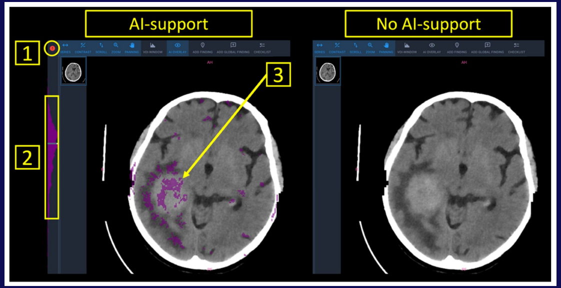
Diagnosis of CT Brain scans

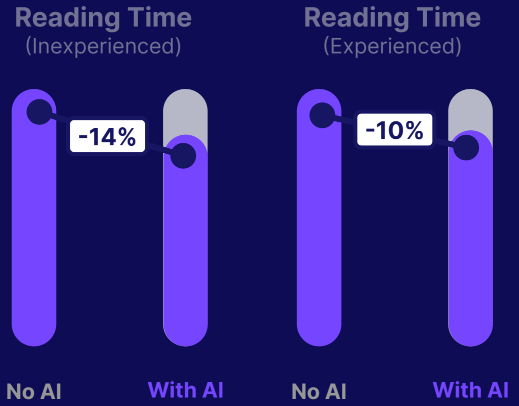
A. Current process:

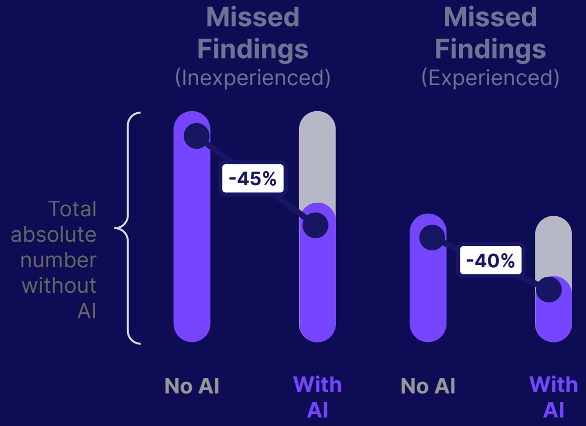
Each cCT read by one radiologists

B. Process with AI:

cCT read by one radiologist plus AI







[3] Faster and Better: How Anomaly Detection Can Accelerate and Improve Reporting of Head Computed Tomography. Diagnostics 2022

AI as safety net

Example

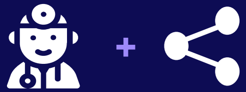
Prioritisation based on cCTs

A. Current process:

Radiologist is working through chronologically

B. Process with AI:

Worklist prioritised based on AI



[4] Arbabshirani et al. Advanced machine learning in action: identification of intracranial hemorrhage on computed tomography scans of the head with clinical workflow integration. Nature Digital Medicine (2018).

AI as safety net

Example

Prioritisation based on cCTs

A. Current process:
Radiologist is working through chronologically

B. Process with AI:
Worklist prioritised based on AI

+

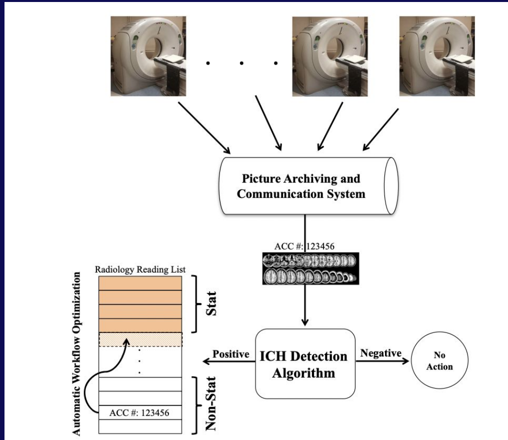


Fig. 4 Clinical implementation of the ICH detection algorithm as a radiology workflow optimization tool

[4] Arbabshirani et al. Advanced machine learning in action: identification of intracranial hemorrhage on computed tomography scans of the head with clinical workflow integration. Nature Digital Medicine (2018).

AI as safety net

Example

Prioritisation based on cCTs

A. Current process:

Radiologist is working through chronologically

B. Process with AI:

Worklist prioritised based on AI

+

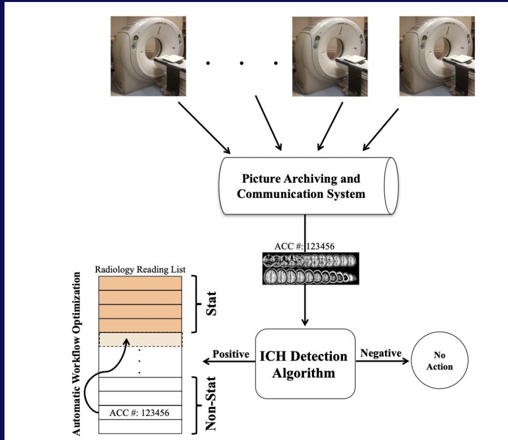
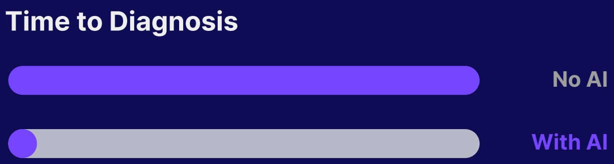


Fig. 4 Clinical implementation of the ICH detection algorithm as a radiology workflow optimization tool



Decreased time to diagnosis by up to 96%

[4] Arbabshirani et al. Advanced machine learning in action: identification of intracranial hemorrhage on computed tomography scans of the head with clinical workflow integration. Nature Digital Medicine (2018).

AI augmenting doctors

Example

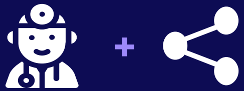
Brain MRI scans

A. Current process:

Radiologist is diagnosing as usual

B. Process with AI:

Radiologist receives additional quantification through AI



[5] J Albers et al. Real-life evaluation of the AI-based Neuroradiology Suite mdbrain. Accepted for ECR2022; n=285
[6] J Rudolph et al. Artificial intelligence substantially improves dementia diagnosis – Added diagnostic value of rapid brain volumetry. RSNA 2021 NR02-A6

AI augmenting doctors

Example

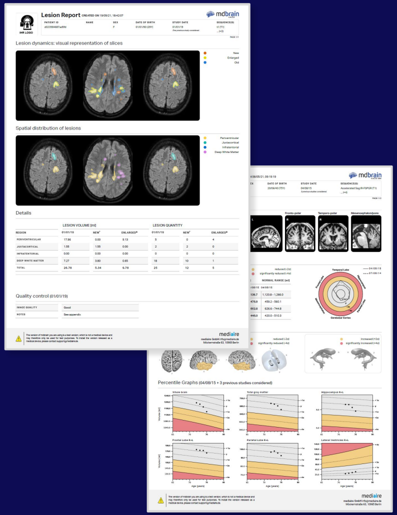
Brain MRI scans

A. Current process:

Radiologist is diagnosing as usual

B. Process with AI:

Radiologist receives additional quantification through AI



[5] J Albers et al. Real-life evaluation of the AI-based Neuroradiology Suite mdbrain. Accepted for ECR2022; n=285

[6] J Rudolph et al. Artificial intelligence substantially improves dementia diagnosis – Added diagnostic value of rapid brain volumetry. RSNA 2021 NR02-A6

AI augmenting doctors

Example

Brain MRI scans

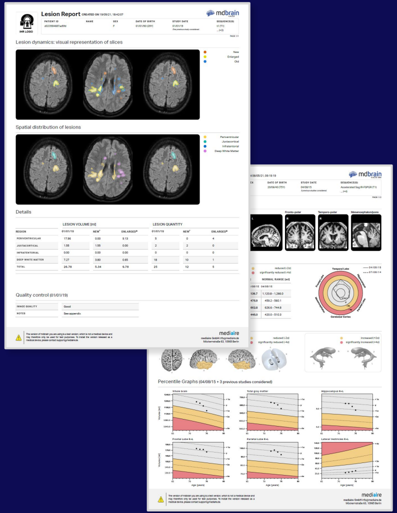
A. Current process:

Radiologist is diagnosing as usual

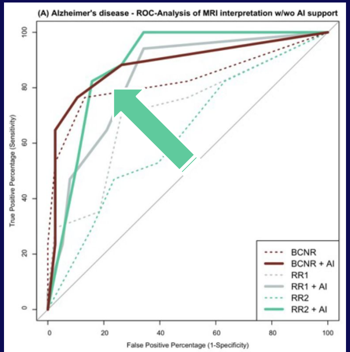
B. Process with AI:

Radiologist receives additional quantification through AI

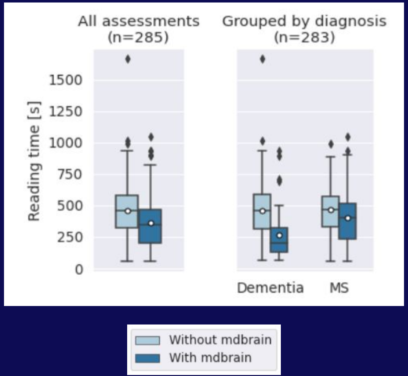
+



Increased **diagnostic accuracy**



Reading time reduced
by ~25%
Effect size largest in brain volumetry (-57%)



[5] J Albers et al. Real-life evaluation of the AI-based Neuroradiology Suite mdbrain. Accepted for ECR2022; n=285
[6] J Rudolph et al. Artificial intelligence substantially improves dementia diagnosis – Added diagnostic value of rapid brain volumetry. RSNA 2021 NR02-A6

3 Key Challenges of AI in Radiology

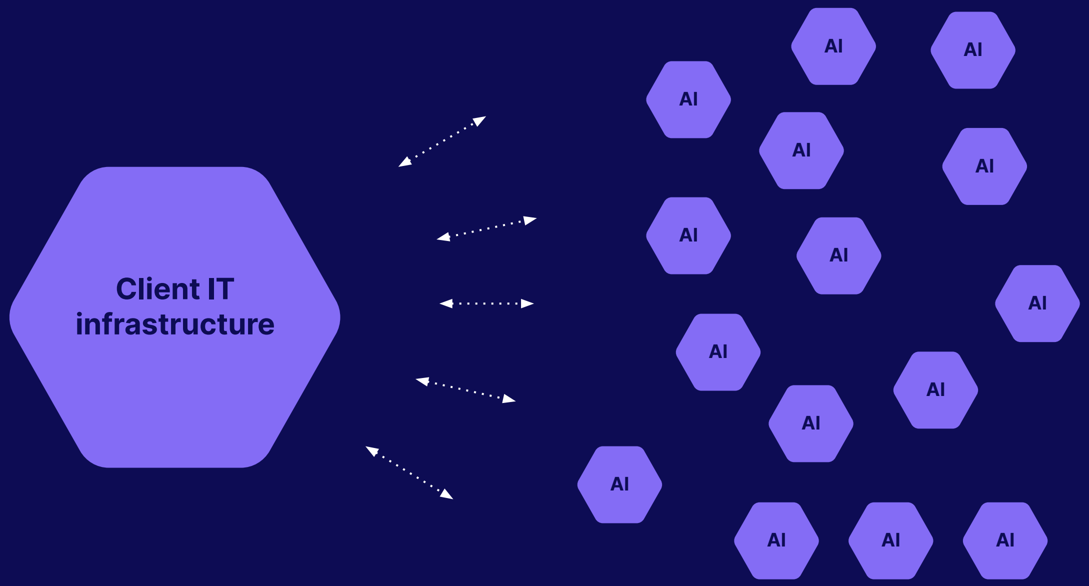
3 Key Challenges of AI in Radiology

1

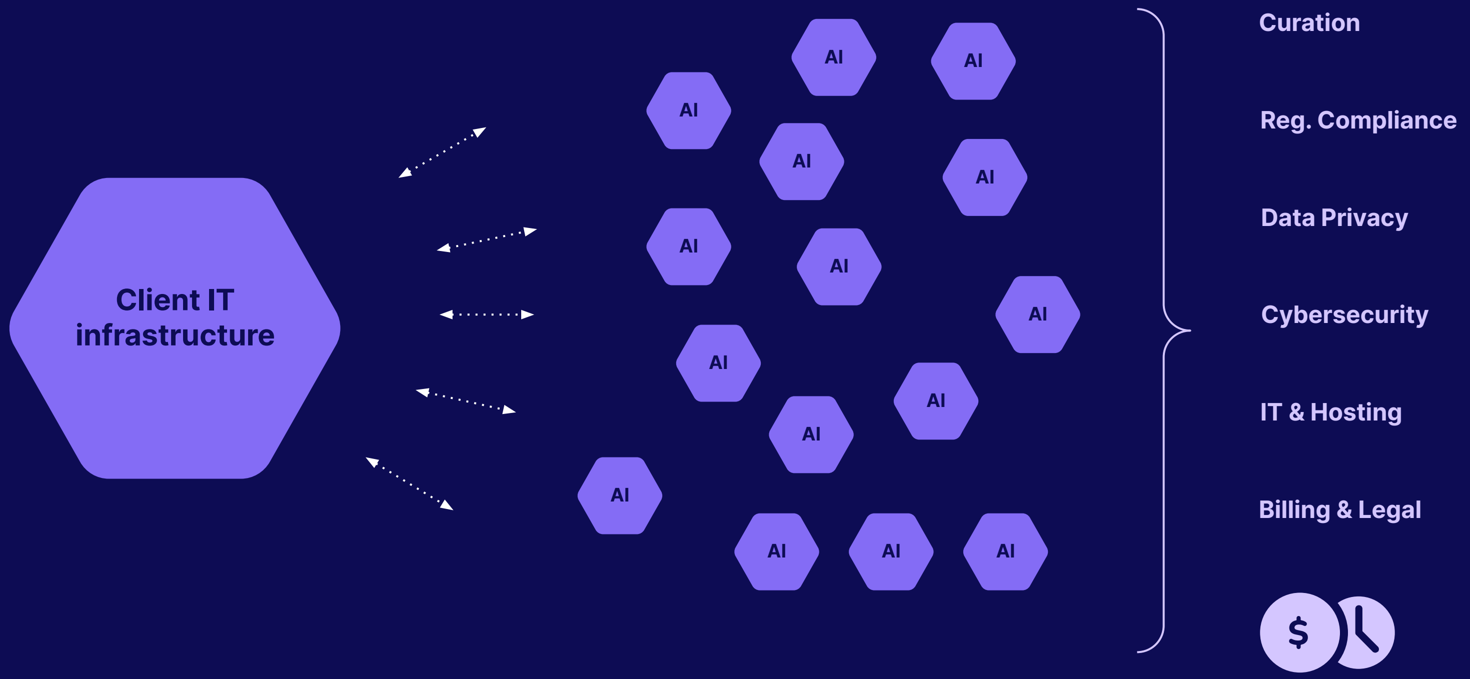
Choosing the right AI tool(s)

Any choice comes at a high cost

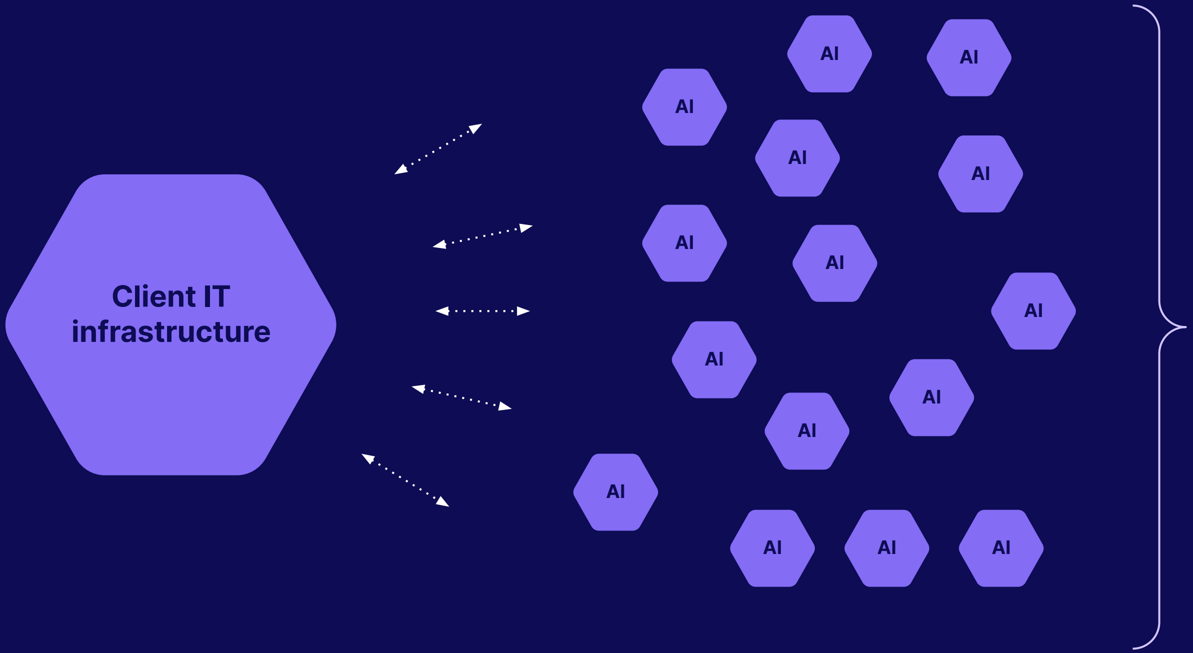
Choosing the right AI tool(s)



Choosing the right AI tool(s)



Choosing the right AI tool(s)



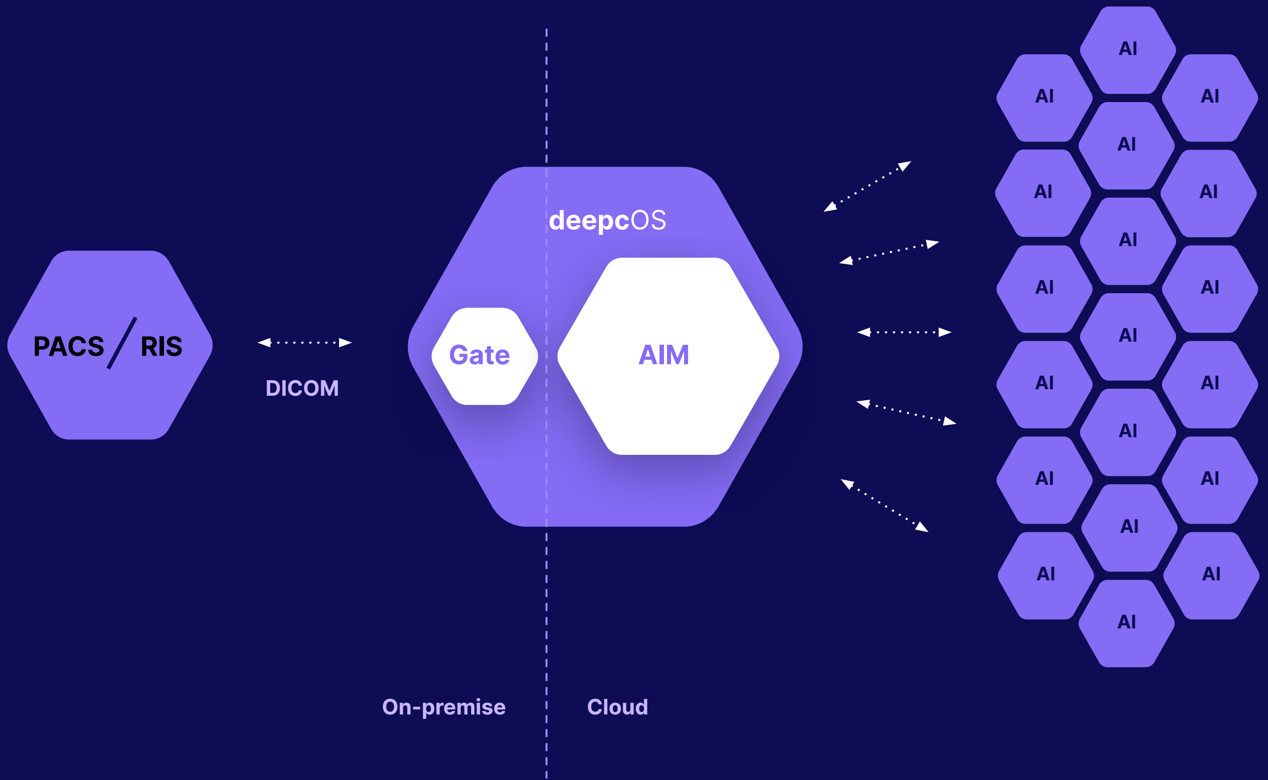
- Curation
- Reg. Compliance
- Data Privacy
- Cybersecurity
- IT & Hosting
- Billing & Legal

Institutions need **3 to 20** AI products

Solution

deepcOS AIM

Provides a single-installation solution to easily integrate AI into clinical workflows



3 Key Challenges of AI in Radiology

1

Choosing the right AI tool(s)
Any choice comes at a high cost

2

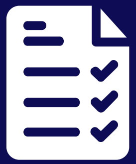
Integrating AI into the workflow
Radiologists will not buy in into changing their existing workflow

Integrating it into the workflow

Example

You want to use AI to prioritize stroke and bleeding cases in your workflow

Display 1:
Worklist



Display 2:
Image Study

Display 3:
Report writing

In addition:
Ringing phone

Integrating it into the workflow

Example

You want to use AI to prioritize stroke and bleeding cases in your workflow

Display 1:
Worklist

Display 2:
Image Study

Display 3:
Report writing

Stroke

Bleeding

In addition:
Ringing phone

Integrating it into the workflow

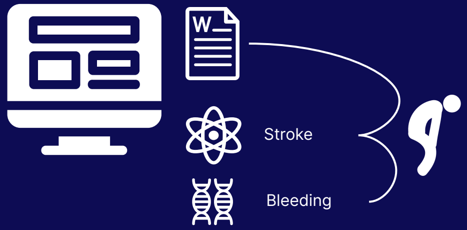
Example

You want to use AI to prioritize stroke and bleeding cases in your workflow

Display 1:
Worklist

Display 2:
Image Study

Display 3:
Report writing



In addition:
Ringing phone

Integrating it into the workflow

Example

You want to use AI to prioritize stroke and bleeding cases in your workflow

Display 1:
Worklist

Display 2:
Image Study

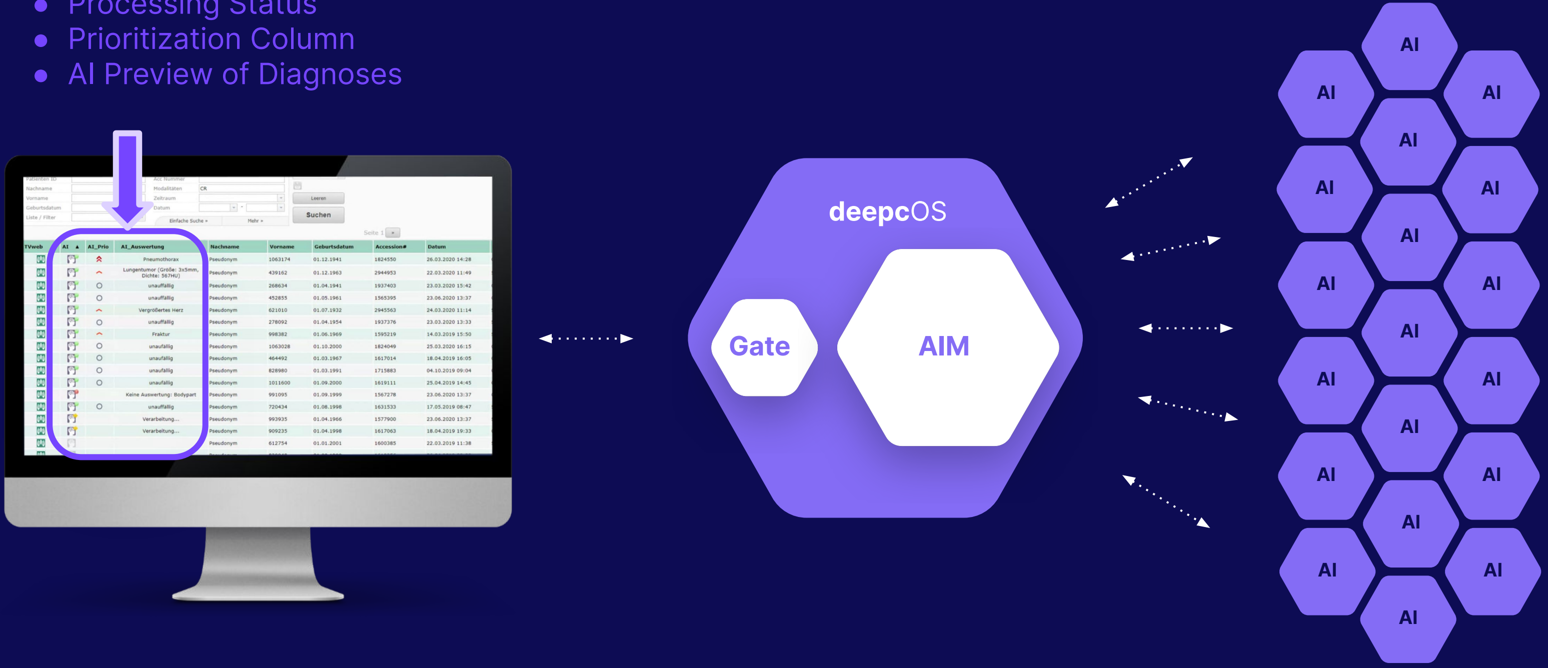
Display 3:
Report writing

In addition:
Ringing phone

Deeply integrating with existing workflows

Display of

- Processing Status
- Prioritization Column
- AI Preview of Diagnoses



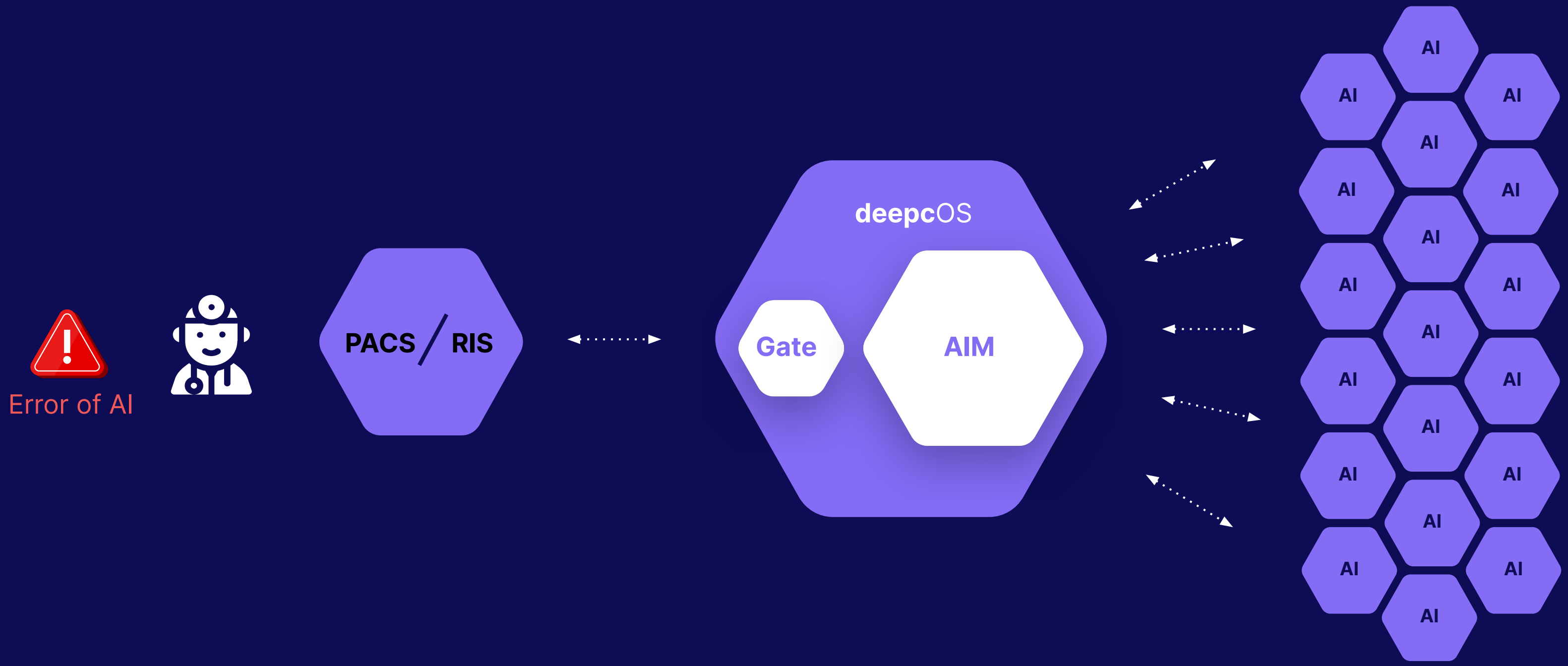
3 Key Challenges of AI in Radiology

1. **Choosing the right AI tool(s)**
   Any choice comes with a buy-in

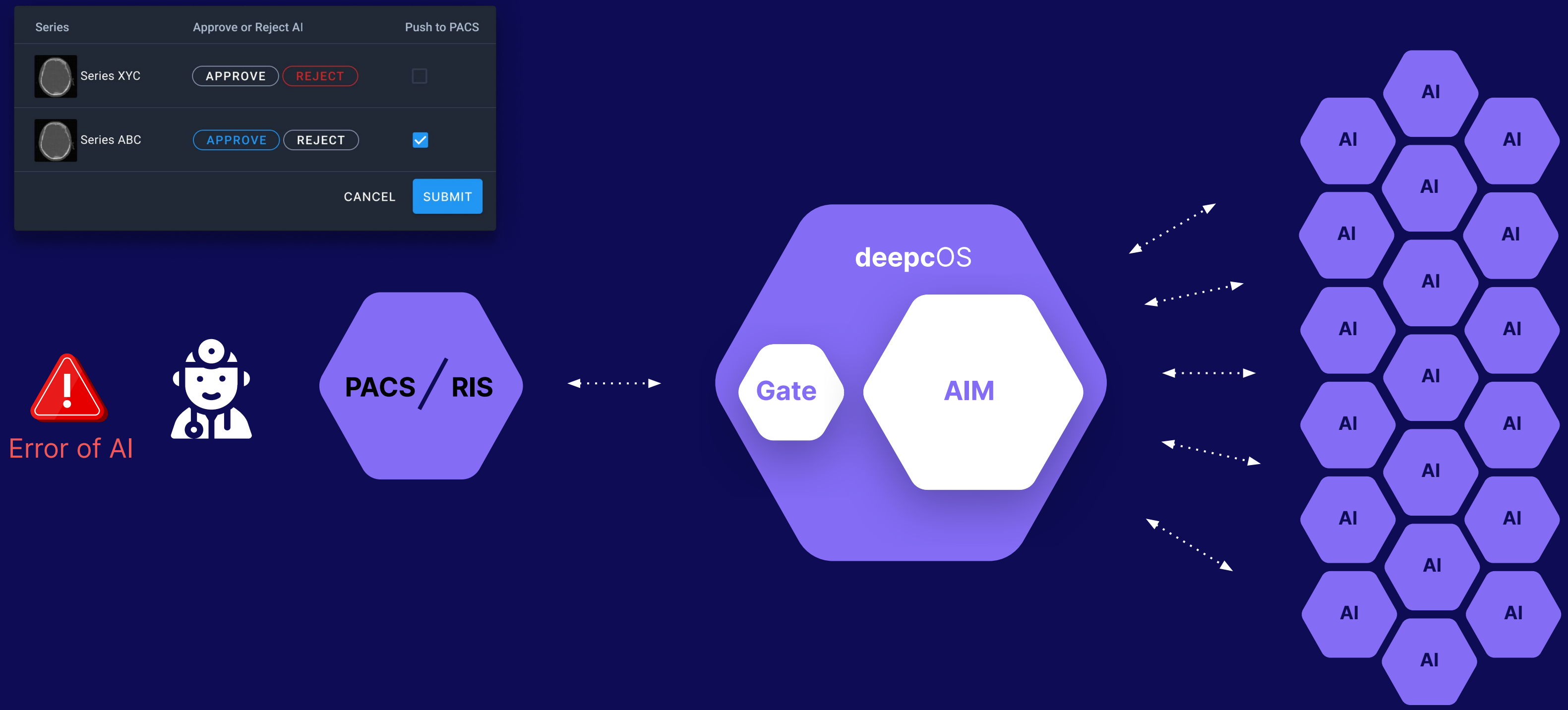
2. **Integrating AI into the workflow**
   Radiologists will not buy in into changing their existing workflow

3. **The need for giving feedback**
   It should be built into the system

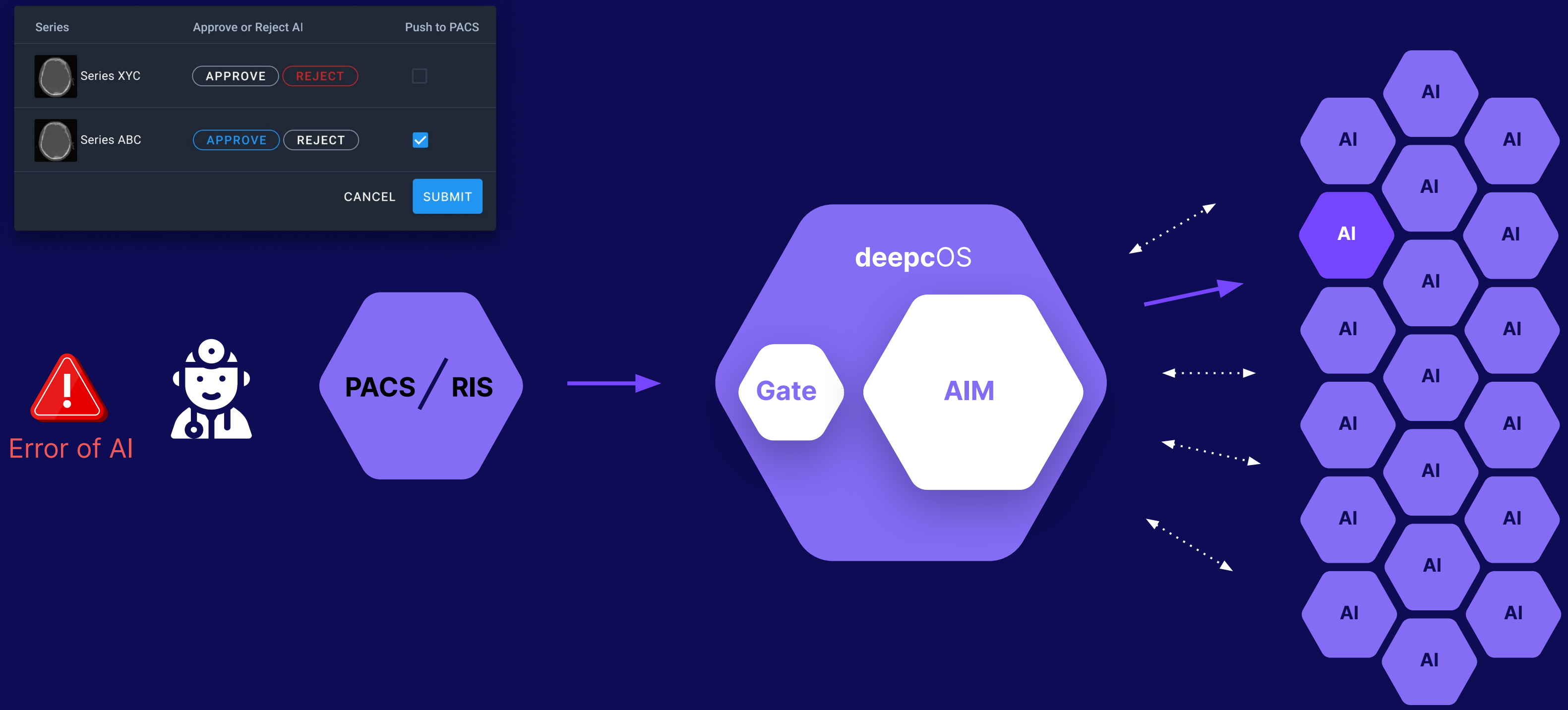
Establish a feedback loop



Establish a feedback loop



Establish a feedback loop



3 Key Challenges of AI in Radiology

1

Choosing the right AI tool(s)
Any choice comes with a buy-in

2

Integrating AI into the workflow
Radiologists will not buy in into changing their existing workflow

3

The need for giving feedback
It should be built into the system

deepc

Thank You

Julia Moosbauer, MSc Data Science

COO, Co-Founder

Rosenheimer Str. 143
81671 Munich, Germany

in/juliamoosbauer/

www.deepc.ai

julia.moosbauer@deepc.ai

Our Partners

Lunit
Cercare Medical
CEREBRIU
IBEX
qure.ai
GLEAMER
DIGITHURST eHealth made for you
image biopsy lab
Lucida Medical
nexus | chili imaging & radiology solutions
aidence
Avicenna. empowering radiology with AI
QUBIO tech
AI4MedImaging
RadioReport
Xvision
Radiobotics Augmented Radiology
Motilent
vuno
mediaire

& many more...

deepcOS is available for use in the EU. deepcOS will be registered as MDDS in the US and is currently not available for use in the US. All medical devices available on deepcOS are regulatory cleared for use in the EU under MDR / MDD. Only selected medical devices available on deepcOS are regulatory cleared for use in the US under FDA. Please contact support for further information.