

Data Science and AI for Medicine Training School

TRAINING: Application of Deep Learning in Medical Imaging (Radiology)

SPEAKERS: Leo Misera, Asier Rabasco

GEFÖRDERT VOM



Bundesministerium
für Forschung, Technologie
und Raumfahrt



SACHSEN Diese Maßnahme wird gefördert durch die Bundesregierung aufgrund eines Beschlusses des Deutschen Bundestages. Diese Maßnahme wird mitfinanziert durch Steuermittel auf der Grundlage des von den Abgeordneten des Sächsischen Landtags beschlossenen Haushaltes.



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Data Science and AI for Medicine Training School
Training: Application of Deep Learning in AI
(Radiology)

Slide 1

ScaDS.AI
DRESDEN LEIPZIG

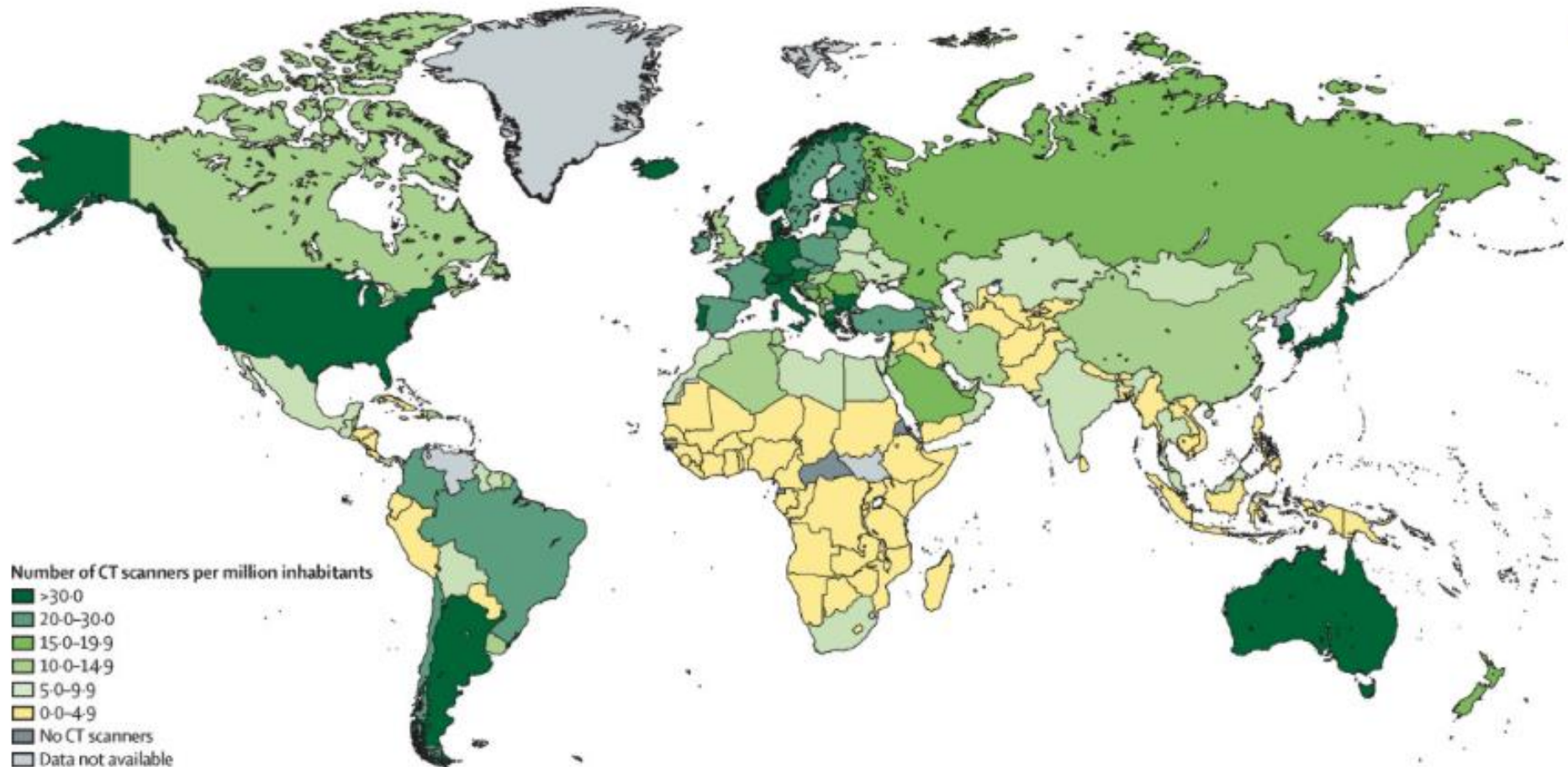


Deep Learning is
everywhere...



**And so is
Radiology!**

Radiology in Medicine: how every is everywhere?





```
graph LR; A[Radiology in Medicine] --> B[Imaging modalities]; B --> C[Applications of Radiology in AI]; C --> D[Hands-On Session];
```

**Radiology in
Medicine**

**Imaging
modalities**

**Applications
of Radiology
in AI**

**Hands-On
Session**



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(Radiology)

Slide 5

ScaDS.AI
DRESDEN LEIPZIG

Radiology in Medicine: history and definition

Radiology: leverage of human body imaging for treatment guidance and diagnosis



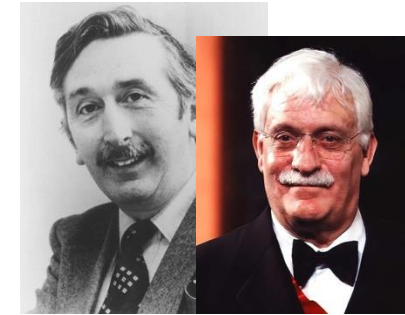
1895-1896
Discovery of X-rays
and
radioactivity¹



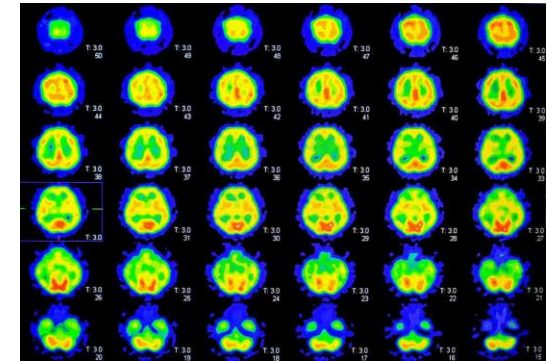
1914-1918
Film used for
radiology
Usage in WWI



1946-1958
Discovery of NMR
Usage of ultrasound in
gynecology

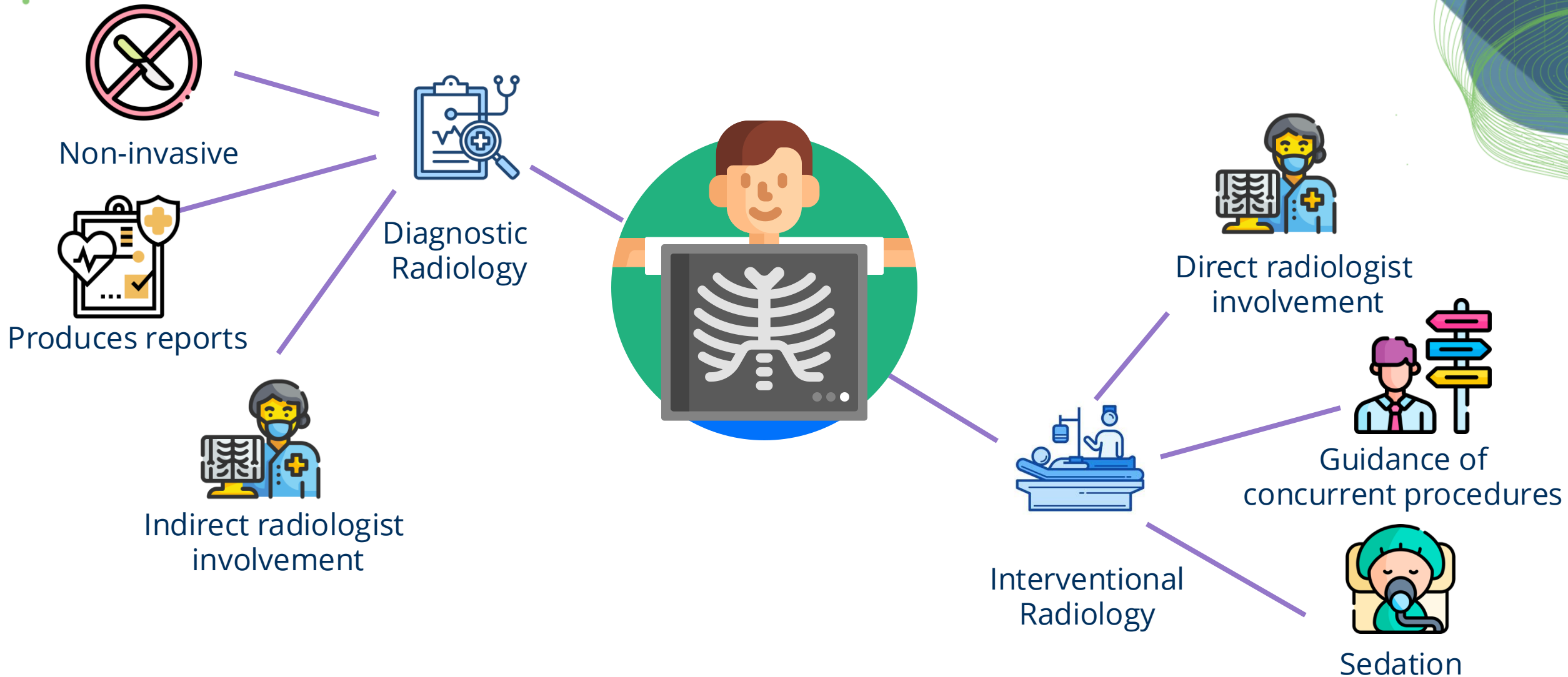


1970s-1980s
First CT and MRI
images



1990s+
Refinement of
radiological
technologies²

Radiology in Medicine: subtypes





**Radiology in
Medicine**

**Imaging
modalities**

**Applications
of Radiology
in AI**

**Hands-On
Session**



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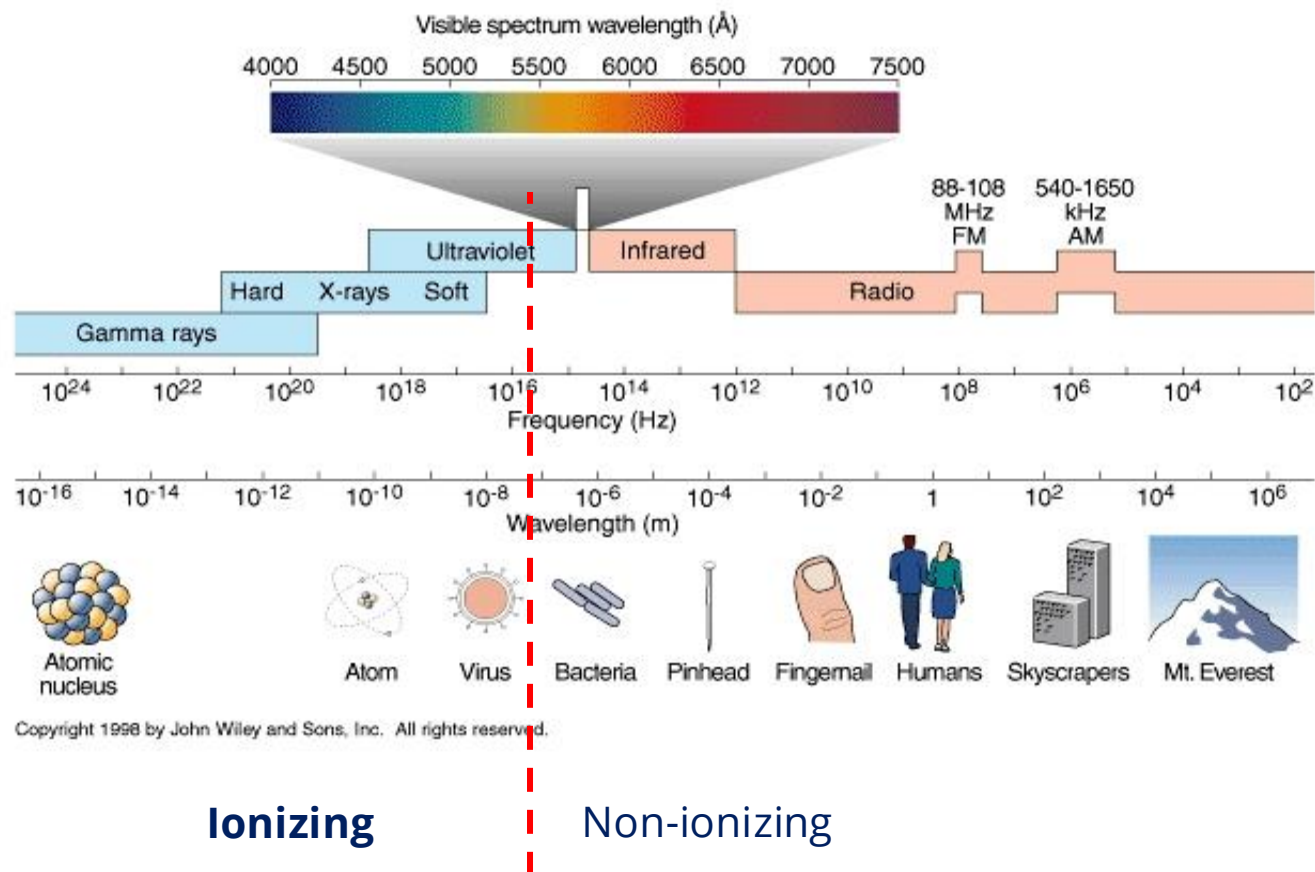
Data Science and AI for Medicine Training School
Training: Application of Deep Learning in AI
(Radiology)

Slide 8

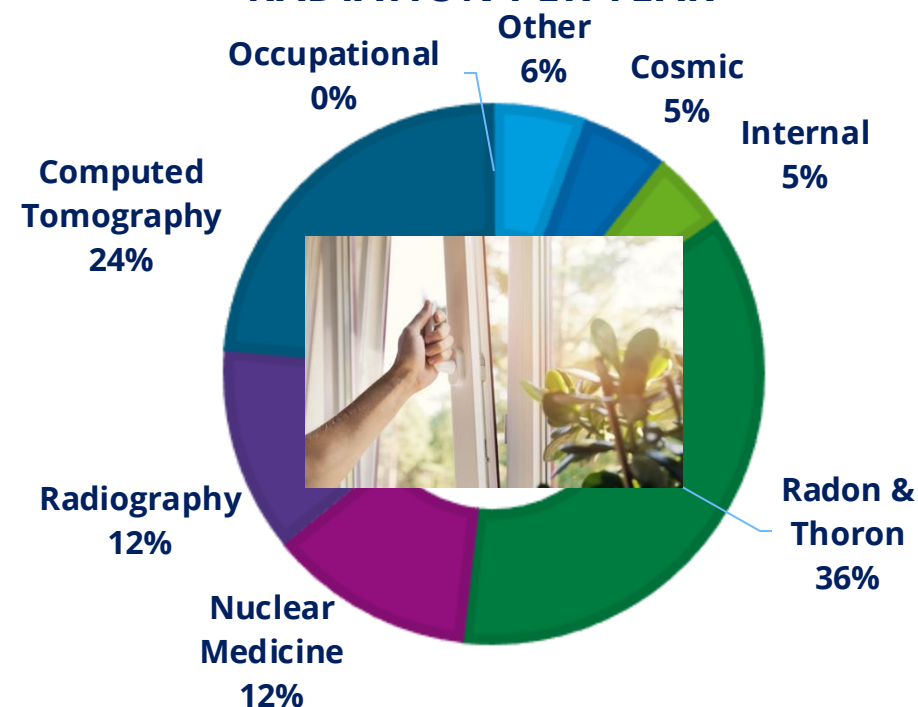
ScaDS.AI
DRESDEN LEIPZIG

Imaging modalities: brief summary of radiation

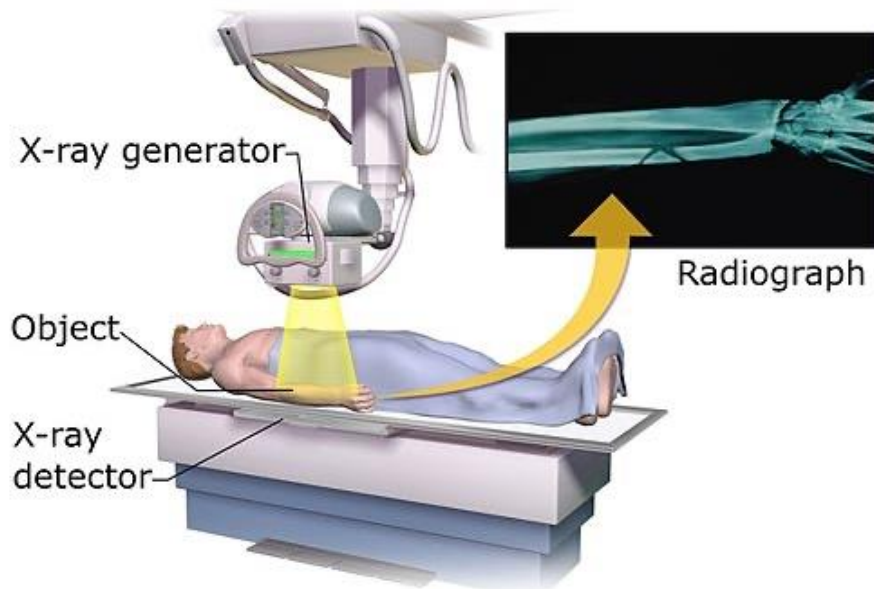
Radiation: emission/transmission of energy through space via waves or particles



AVERAGE DOSE OF IONIZING RADIATION PER YEAR³



Imaging modalities: projectional radiography



X-rays are ionising sources of radiation.
Small doses used to produce 2D images of body structures



Contrast can be limited due to overlapping of structures in one single view

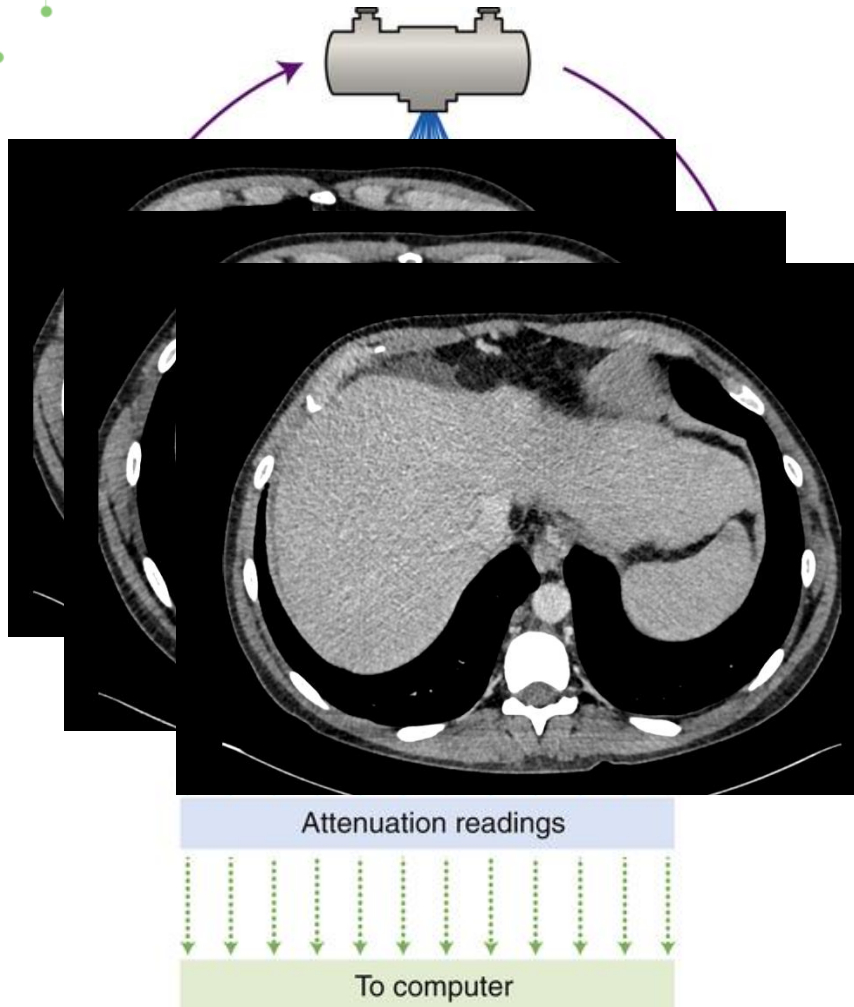


Radiography is used to diagnose broken bones, foreign objects in soft tissue or screen for infections



Oldest and most used form of medical imaging

Imaging modalities: computerised tomography



More radiation than X-rays, but allows for 3D scanning of the body/area of interest



Contrast is used intravenously to highlight different parts of the anatomy in real time

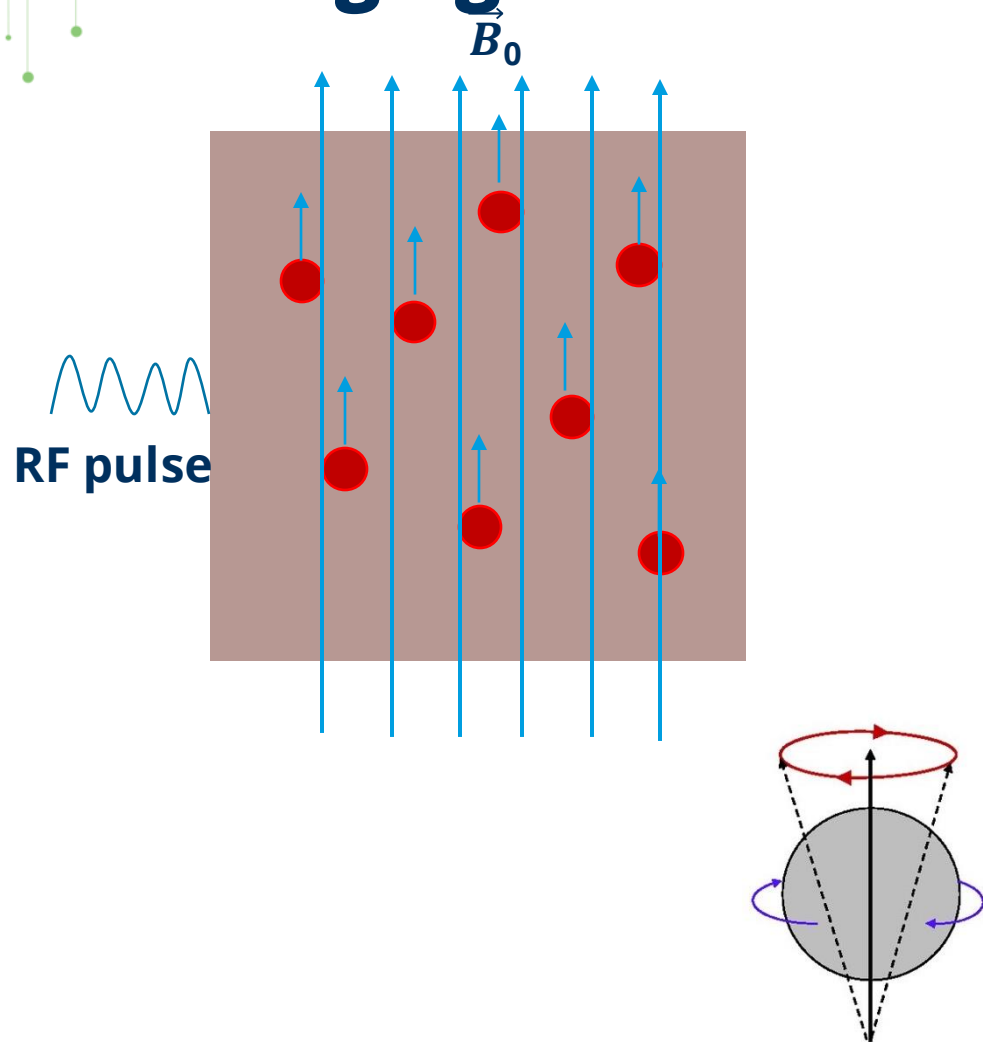


Allows for locating lesions within the body, assess sizes and make first impressions on a diagnosis



CT units have physical meaning, related to the attenuation of water.

Imaging modalities: magnetic resonance imaging



MRI does not produce ionizing radiation, it is based on nuclear magnetic resonance from hydrogen nuclei (protons)



MRI is very very diverse. Sequences use different resonance aspects, highlighting different phenomena

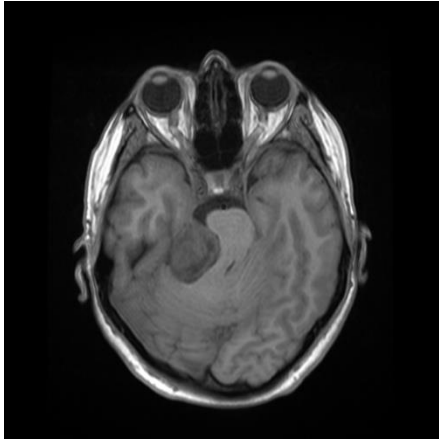


MRIs are better at contrast resolution than CTs but lower at spatial resolution

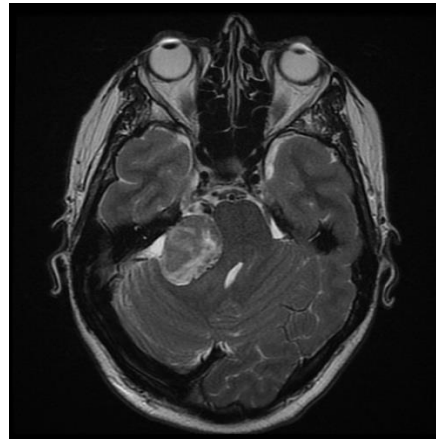


MRI units are dimensionless and can vary from person to person for the same exam.

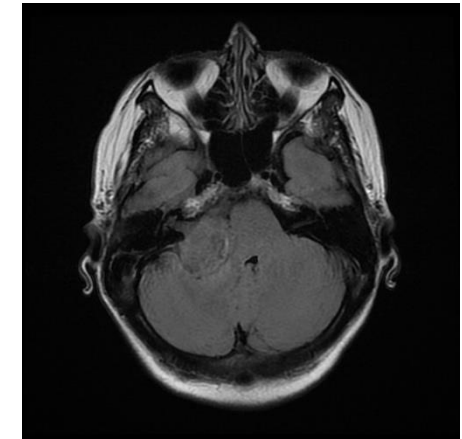
Imaging modalities: magnetic resonance imaging



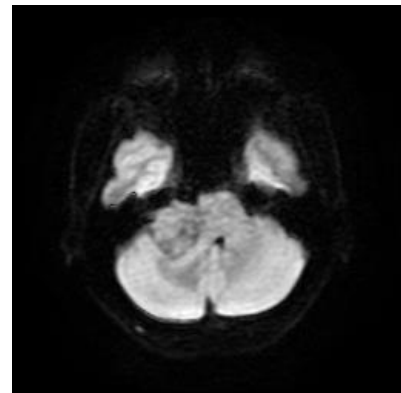
T1-weighted



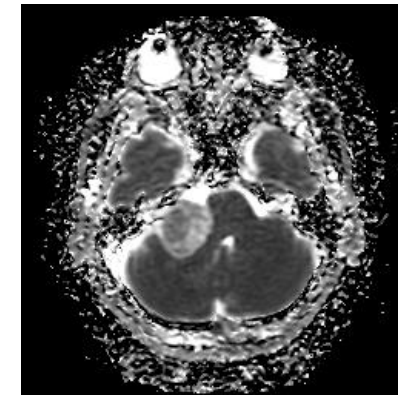
T2-weighted



FLAIR



Diffusion-weighted



Apparent diffusion
weighted



**Radiology in
Medicine**

**Imaging
modalities**

**Applications
of Radiology
in AI**

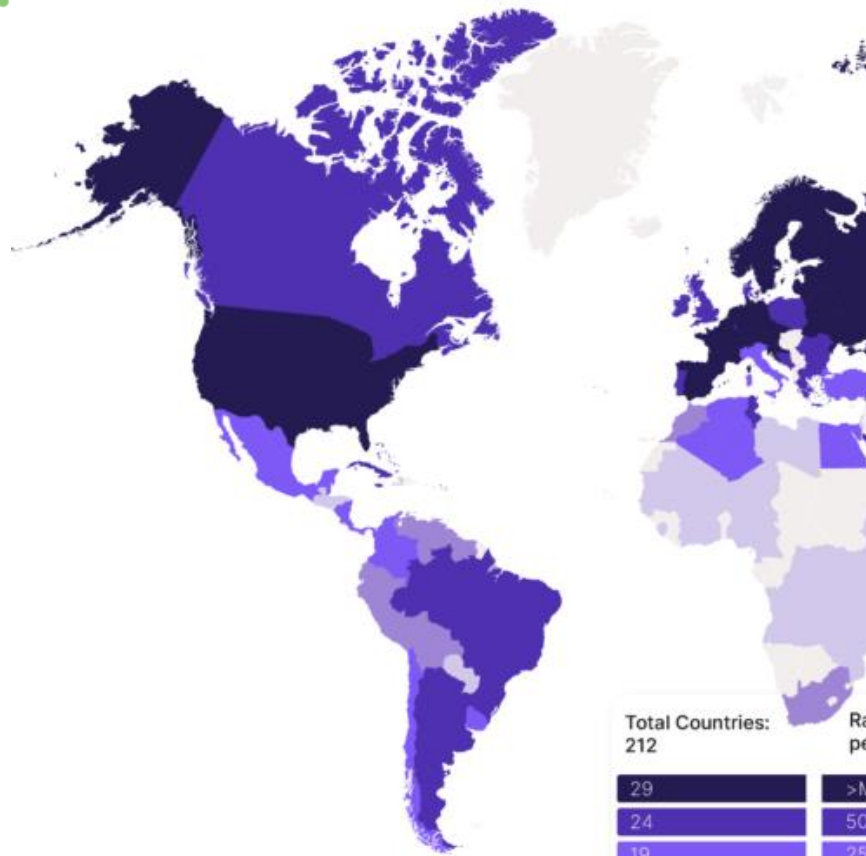
**Hands-On
Session**

Applications of Radiology in AI



“Radiologists will be obsolete in 5 years”
George Hinton, 2016, Godfather of AI and Nobel prize in Physics.
Not a radiologist

Applications of Radiology in AI: the need for AI



Prevalence of burnout amongst German radiologists: A call to action

Burnout is prevalent among medical professionals, including radiologists

Distributed burnout focused questionnaires to members of the German Society of Radiology and Interventional Radiology

A burnout-rate of 76.7% was observed in 172 participants

Further observations included:



ESR[®] EUROPEAN SOCIETY OF RADIOLOGY

Applications of Radiology in AI: synergistic fields

npj | digital medicine

Article

Published in partnership with Seoul National University Bundang Hospital

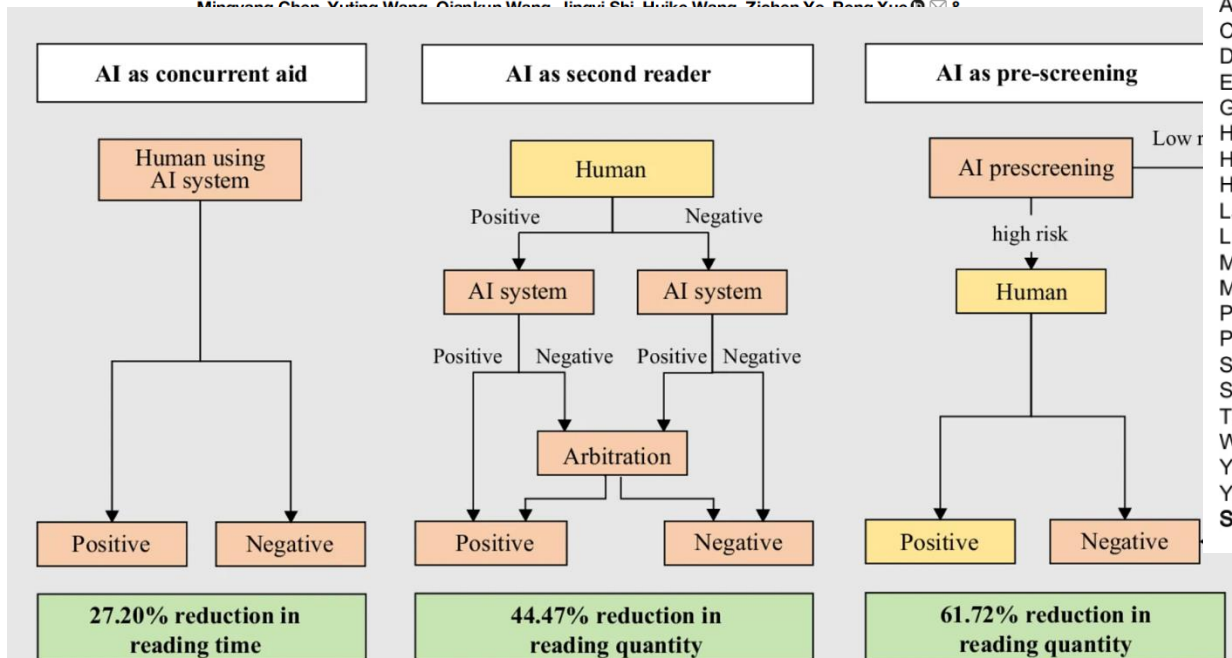


<https://doi.org/10.1038/s41746-024-01328-w>

Impact of human and artificial intelligence collaboration on workload reduction in medical image interpretation

Check for updates

Mingming Chen, Yuting Wang, Qiankun Wang, Jieqi Shi, Huika Wang, Zichen Ye, Peng Yue

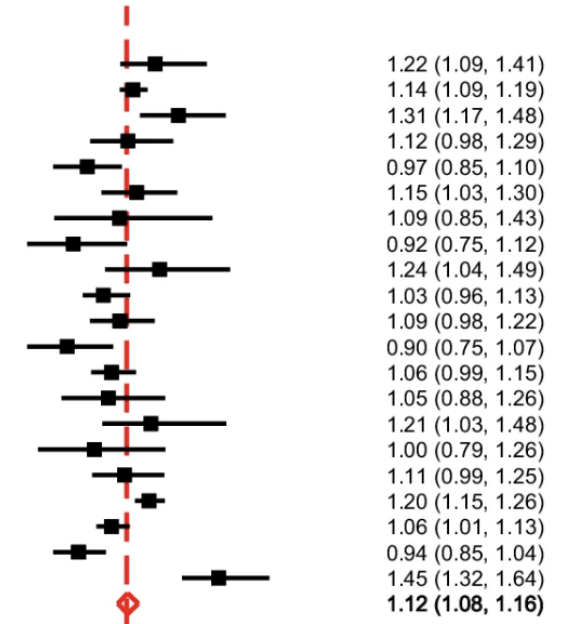


Study

Workload = time

Ahn 2022
Ajmera 2023
Canoni-Meynet 2022
Duron 2021
Eloy 2023
Guermazi 2022
Hempel 2022
Hendrix 2023
Hsu 2021
Lai 2022
Lin 2023
Meng 2023
Mu 2021
Pacile 2020
Pei 2023
Sun 2021
Sung 2021
Tan 2023
Wei 2022
Yang 2023
Yao 2023
Subgroup

Relative
Sensitivity (95% CI)

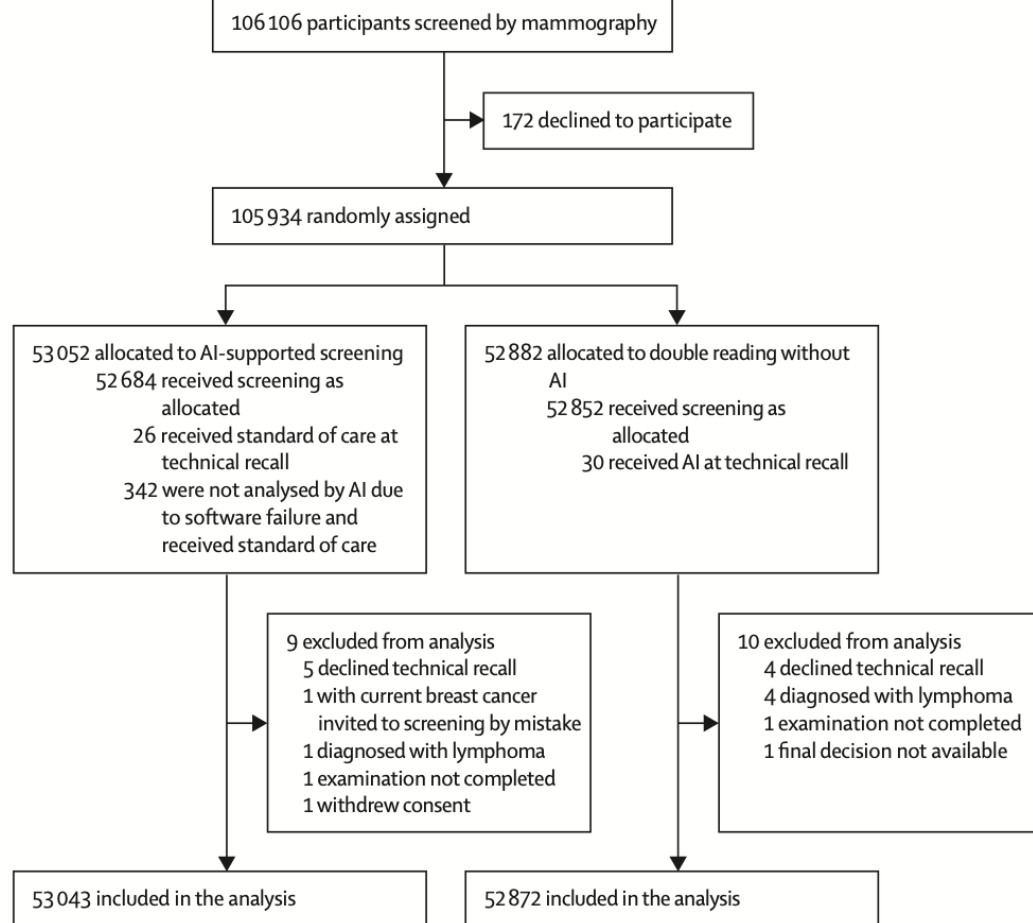


Applications of Radiology in AI: the MASAI trial

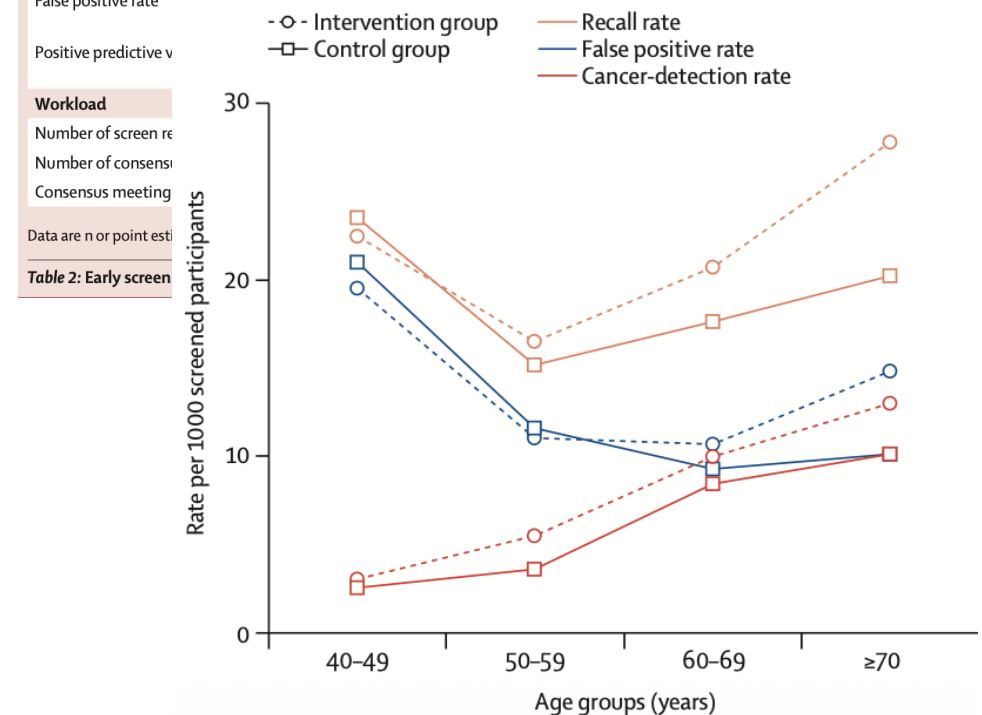
Screening performance and characteristics of breast cancer detected in the Mammography Screening with Artificial

parallel-
racy

1, Aldana Rosso,

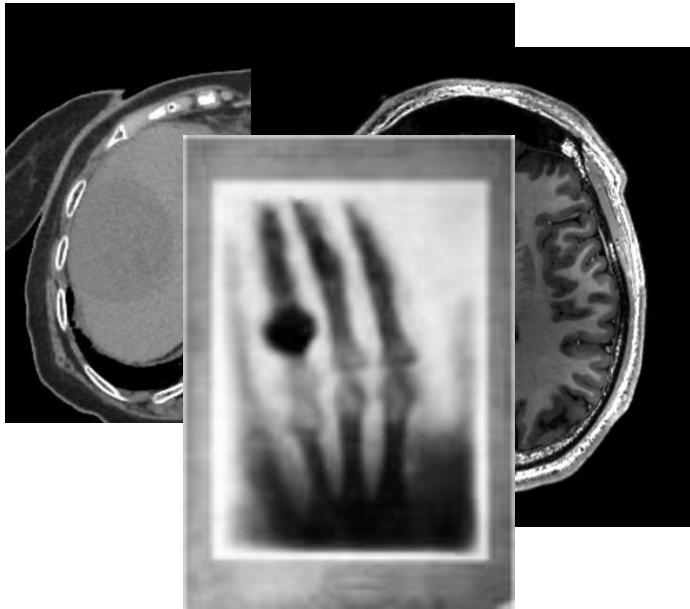


	Intervention group (n=53 043)	Control group (n=52 872)	Proportion ratio	p value
Early screening performance				
Number of recalls	1110	1027
Recall rate	2.1% (2.0-2.2)	1.9% (1.8-2.1)	1.08% (0.99-1.17)	0.084
Number of detected cancers	338	262
Cancer-detection rate, per 1000	6.4 (5.7-7.1)	5.0 (4.4-5.6)	1.29 (1.09-1.51)	0.0021
Number of false positives	772	765
False positive rate				
Positive predictive v				

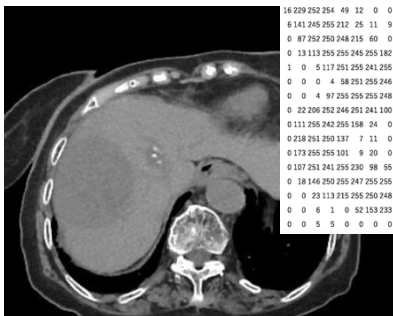


Workload
 Number of screen re
 Number of consensi
 Consensus meeting
 Data are n or point esti
Table 2: Early screen

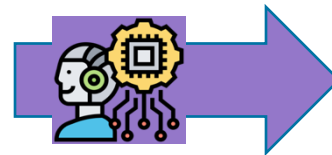
Applications of Radiology in AI: from data to insights



0	2	15	0	0	11	10	0	0	0	0	9	9	0	0	0
0	0	0	4	60	157	236	255	255	177	95	61	32	0	0	29
0	10	16	119	238	255	244	245	243	250	249	255	222	103	10	0
0	14	170	255	255	244	254	255	253	245	255	249	253	251	124	1
2	98	255	228	255	251	254	211	141	116	122	215	251	238	255	49
13	217	243	255	155	33	226	52	2	0	10	13	232	255	255	36
16	229	252	254	49	12	0	0	7	7	0	70	237	252	235	62
6	141	245	255	212	25	11	9	3	0	115	236	243	255	137	0
0	87	252	250	248	215	60	0	1	121	252	255	248	144	6	0
0	13	113	255	255	245	255	182	181	248	252	242	208	36	0	19
1	0	5	117	251	255	241	255	247	255	241	162	17	0	7	0
0	0	0	4	58	251	255	246	254	253	255	120	11	0	1	0
0	0	4	97	255	255	255	248	252	255	244	255	182	10	0	4
0	22	206	252	246	251	241	100	24	113	255	245	255	194	9	0
0	111	255	242	255	158	24	0	0	6	39	255	232	230	56	0
0	218	251	250	137	7	11	0	0	2	62	255	250	125	3	0
0	173	255	255	101	9	20	0	13	3	13	182	251	245	61	0
0	107	251	241	255	230	98	55	19	118	217	248	253	255	52	4
0	18	146	250	255	247	255	255	255	249	255	240	255	129	0	5
0	0	23	113	215	255	250	248	255	255	248	248	118	14	12	0
0	0	6	1	0	52	153	233	255	252	147	37	0	0	4	1
0	0	5	5	0	0	0	0	0	14	1	0	6	6	0	0



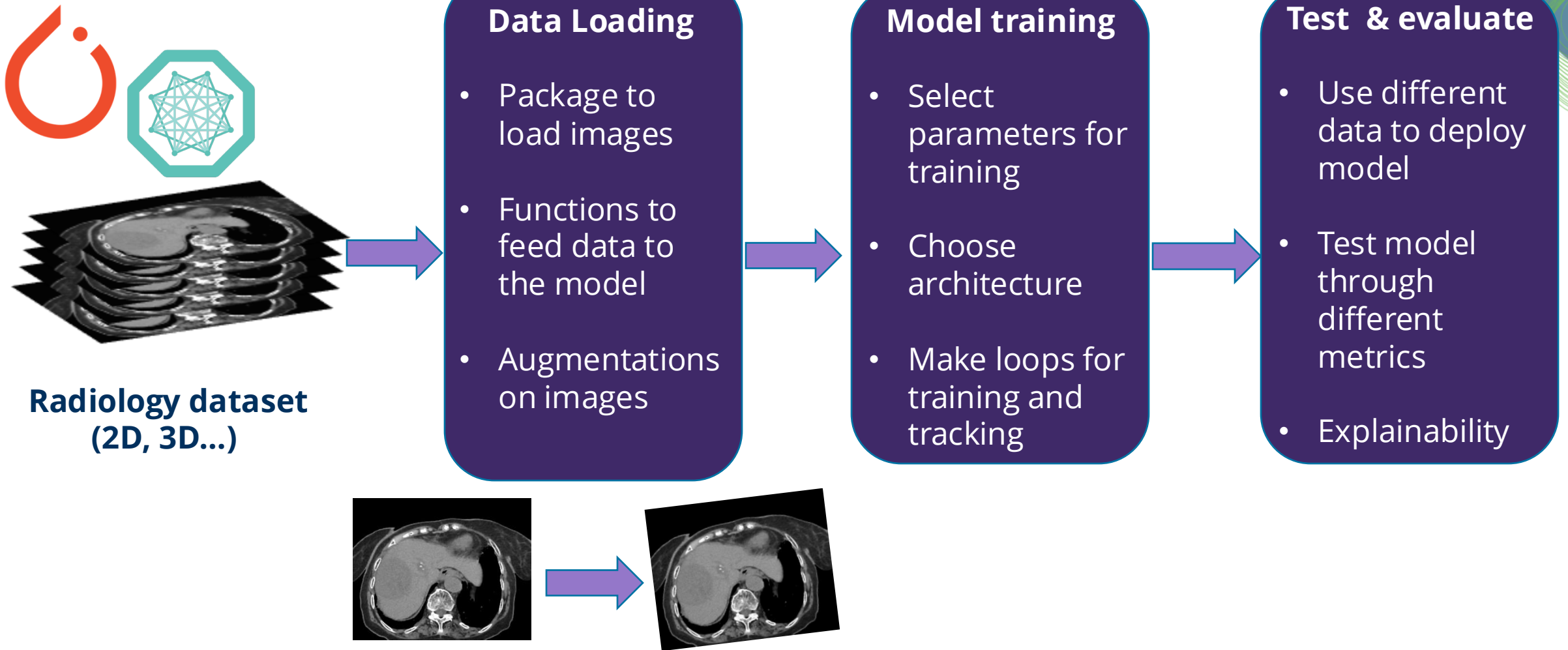
0	2	15	0	0	11	10	0	0	0	0	9	9	0	0	0
0	0	0	4	60	157	236	255	255	177	95	61	32	0	0	29
0	10	16	119	238	255	244	245	243	250	249	255	222	103	10	0
0	14	170	255	255	244	254	255	253	245	255	249	253	251	124	1
2	98	255	228	255	251	254	211	141	116	122	215	251	238	255	49
13	217	243	255	155	33	226	52	2	0	10	13	232	255	255	36
16	229	252	254	49	12	0	0	7	7	0	70	237	252	235	62
6	141	245	255	212	25	11	9	3	0	115	236	243	255	137	0
0	87	252	250	248	215	60	0	1	121	252	255	248	144	6	0
0	13	113	255	255	245	255	182	181	248	252	242	208	36	0	19
1	0	5	117	251	255	241	255	247	255	241	162	17	0	7	0
0	0	0	4	58	251	255	246	254	253	255	120	11	0	1	0
0	0	4	97	255	255	255	248	252	255	244	255	182	10	0	4
0	22	206	252	246	251	241	100	24	113	255	245	255	194	9	0
0	111	255	242	255	158	24	0	0	6	39	255	232	230	56	0
0	218	251	250	137	7	11	0	0	2	62	255	250	125	3	0
0	173	255	255	101	9	20	0	13	3	13	182	251	245	61	0
0	107	251	241	255	230	98	55	19	118	217	248	253	255	52	4
0	18	146	250	255	247	255	255	255	249	255	240	255	129	0	5
0	0	23	113	215	255	250	248	255	255	248	248	118	14	12	0
0	0	6	1	0	52	153	233	255	252	147	37	0	0	4	1
0	0	5	5	0	0	0	0	0	14	1	0	6	6	0	0



OpenCV
RADIOMICS

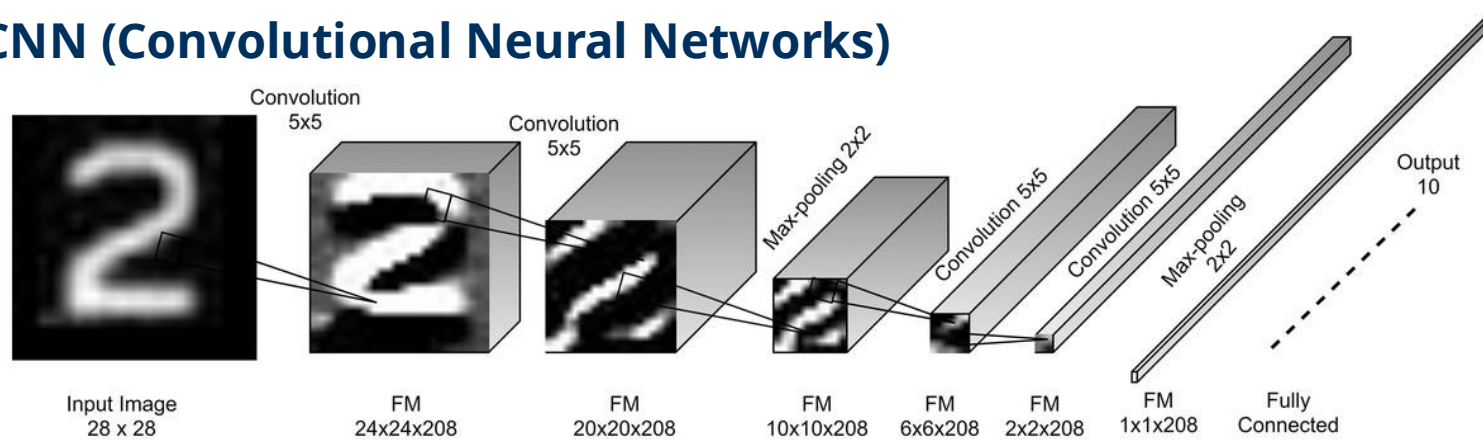


Applications of Radiology in AI: how is data used?



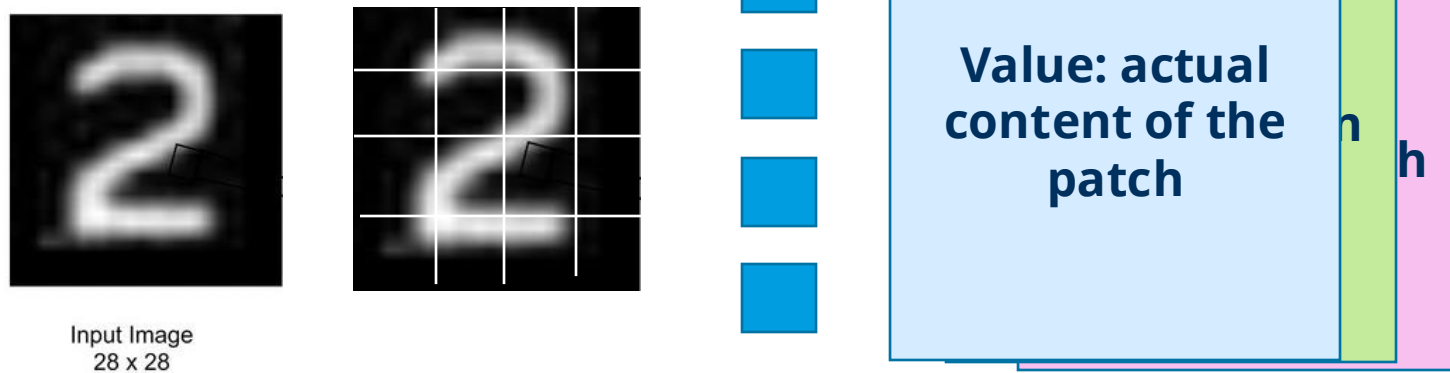
Applications of Radiology in AI: architectures

CNN (Convolutional Neural Networks)



Features based on relationships of **neighbouring** pixels through convolution

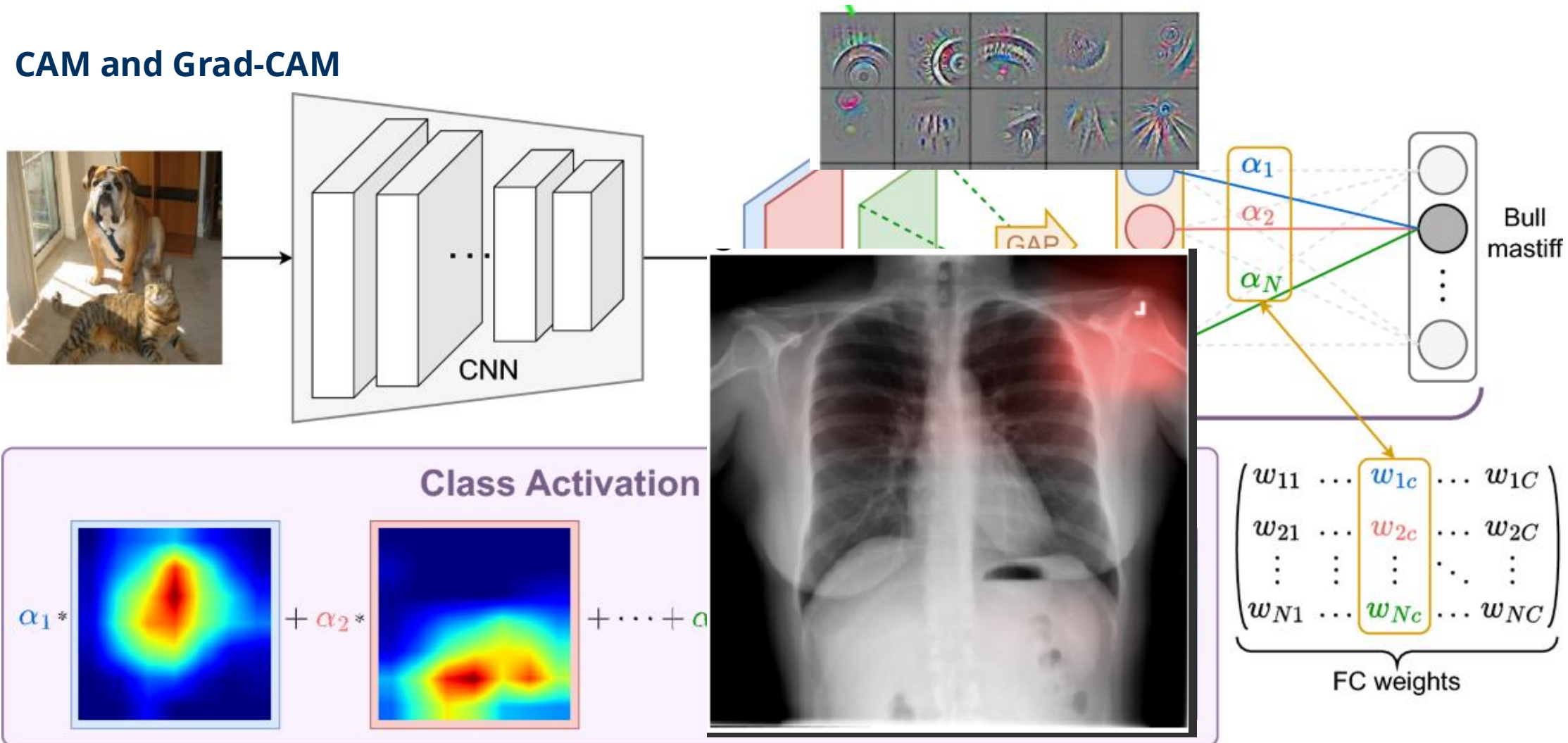
(Vision) Transformers



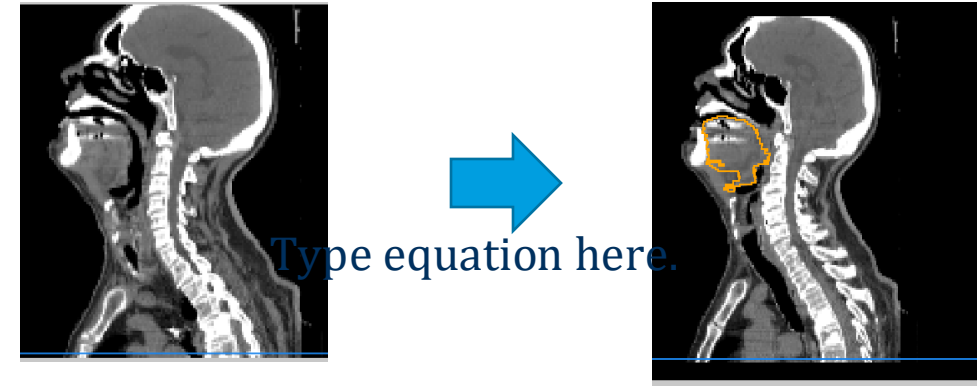
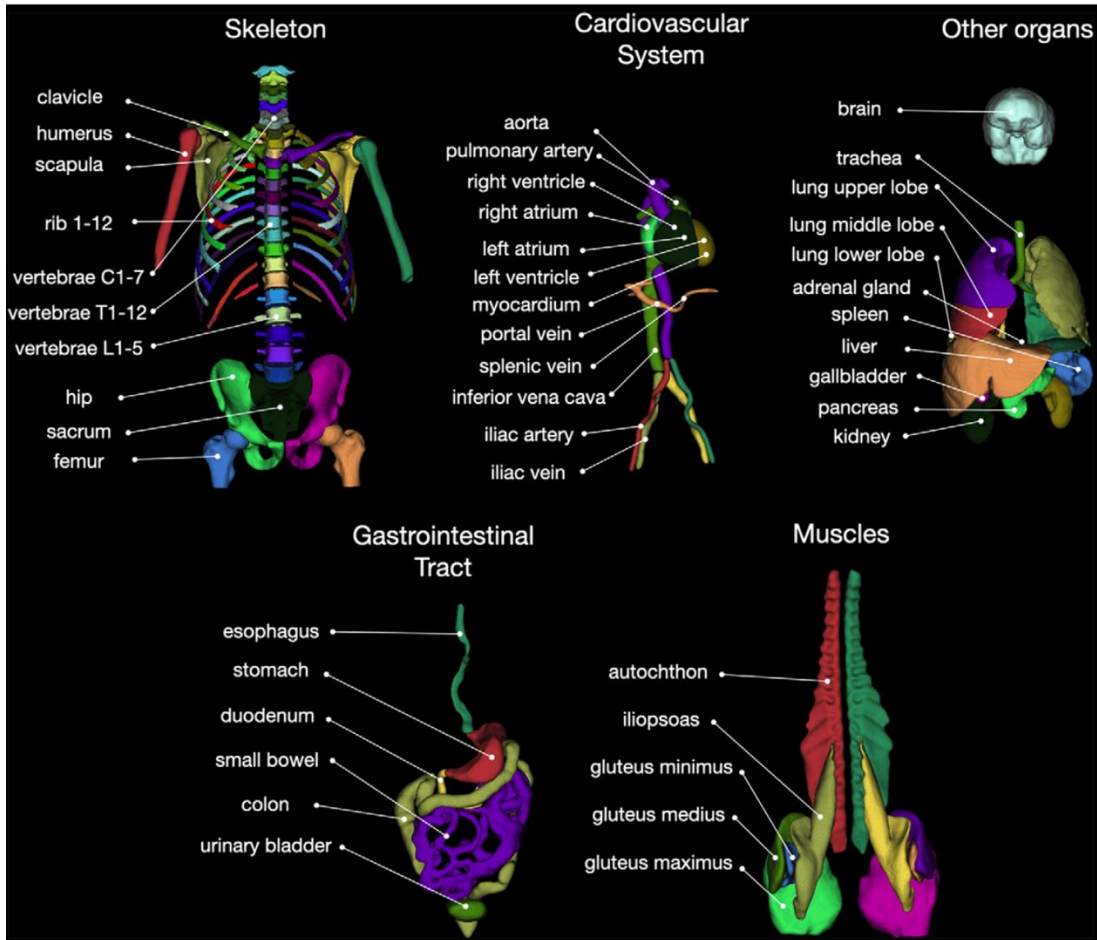
Features based on learned relationships between tokens, **very weak inductive bias**

Applications of Radiology in AI: explainability

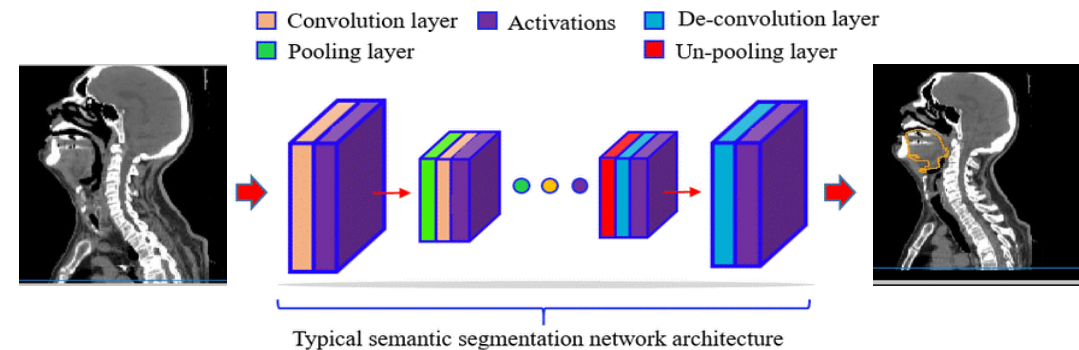
CAM and Grad-CAM



Applications of Radiology in AI: segmentation



Type equation here.



Segmentation Loss (Dice)

$$L_{dice} = 1 - \frac{2 \sum_{n=1}^N t_n y_n}{\sum_{n=1}^N (t_n + y_n)}$$

Segmentation tool and image of body:

Wasserthal, J. et al. *Radiology AI* (2023). 5(5)

H&N images: Welch, M et al. (2023).

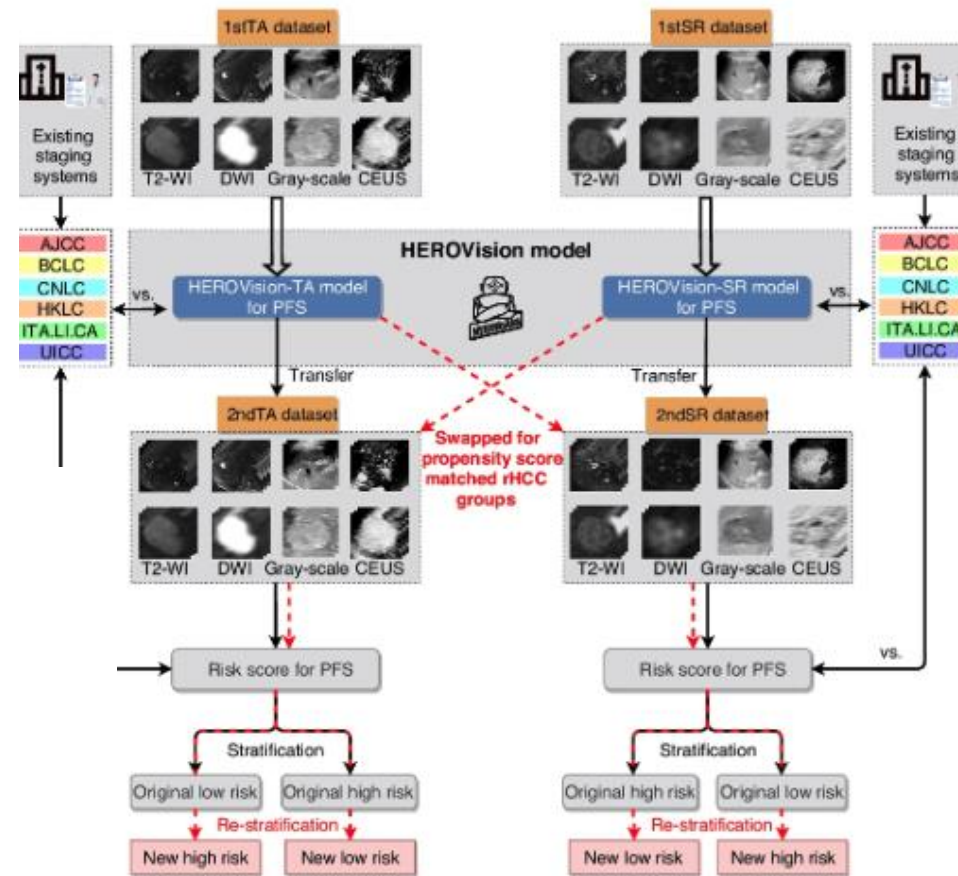
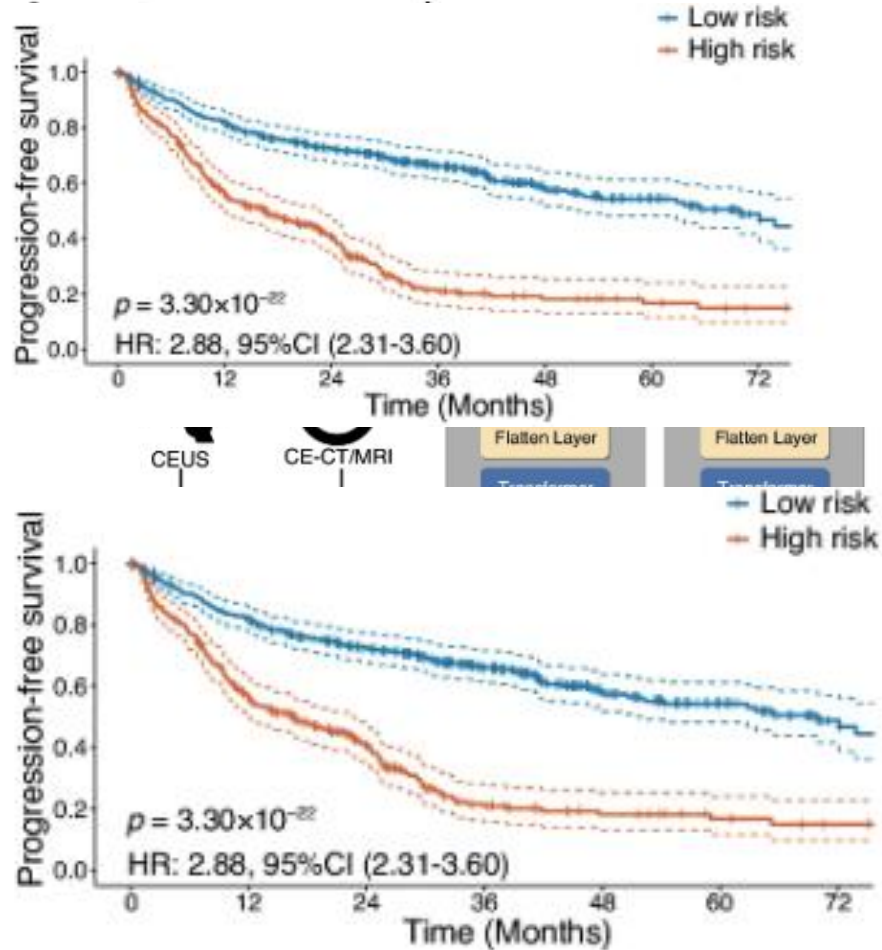
Computed Tomography Images from Large Head and Neck Cohort (RADCUR) (Version 4) The Cancer Imaging Archive. <https://doi.org/10.7937/J47W-NM11>

Slide 23

Applications of Radiology in AI: prognosis

Article | [Open access](#) | Published: 01 May 2025

Vision transformer-based model can optimize curative-



Conclusions

- **Radiology is a long-lived field with an early adoption of electronic technology**
- **Radiological images are varied and diverse, making Radiology a complex field.**
- **The complexity, number and link of radiological images with diseases makes them a rich source of informative data for modeling**
- **Radiology can benefit from AI, reducing workloads and enhancing radiologist readings**
- **AI in Radiology is an ongoing field of research. There is evolution in architectures, training styles and applications**

Now on to the hands-on session!