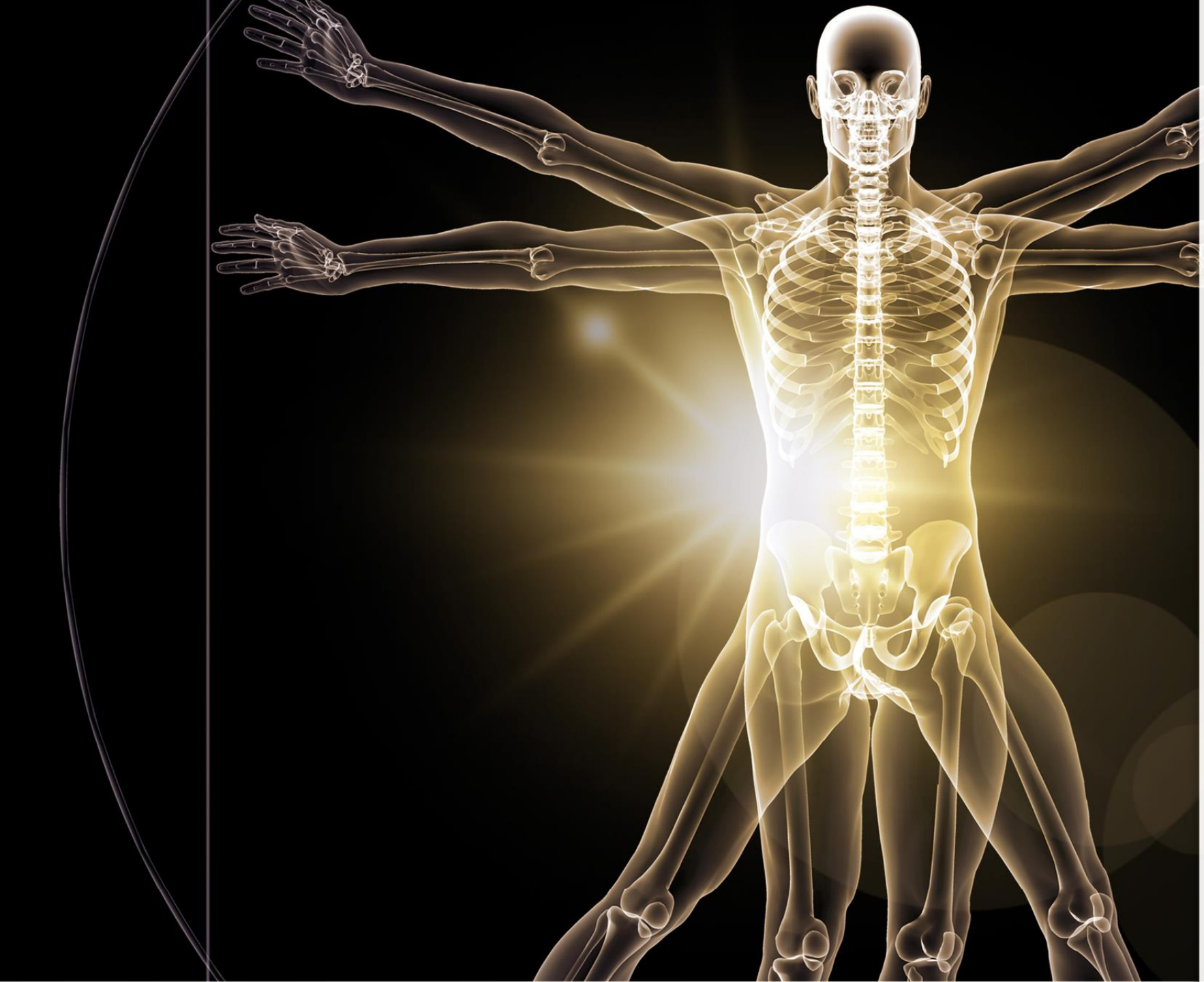


15th Biennial Symposium of the International Society for Strategic Studies in Radiology

IS3R 2023

Berlin/Germany
August 24–26, 2023

HOW CLOSE ARE COMPREHENSIVE AI SOLUTIONS?

Jacob Sosna, MD

Hadassah Hebrew University Medical Center

Jerusalem, Israel

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

DISCLOSURES

- FUNDER HIGH-RAD

AI will replace ALL physicians

#SARELGAURMD

PROF. GEOFFREY HINTON-2016

Geoffrey Hinton

"I think that if you work as a radiologist, you are like Wile E. Coyote in the cartoon. You're already over the edge of the cliff, but you haven't yet looked down. There's no ground underneath. People should stop training radiologists now. It's just completely obvious that in five years deep learning is going to do better than radiologists."

Nov 24, 2016

SURVEILLANCE TECHNOLOGY

waze

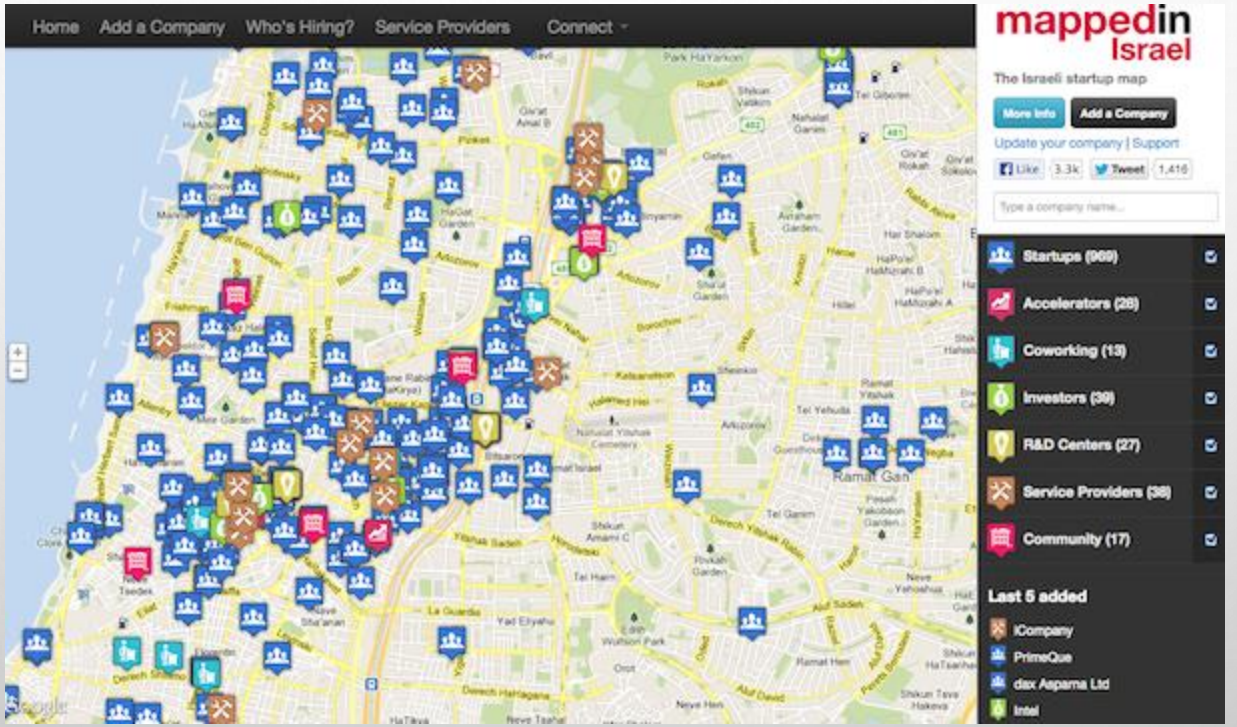
Windows NT, XP developed primarily in Israel

Israeli lab reports successful transplant of lab-grown bones

Leading MS medication worldwide

GIVEN IMAGING

START-UP MAP OF TEL AVIV

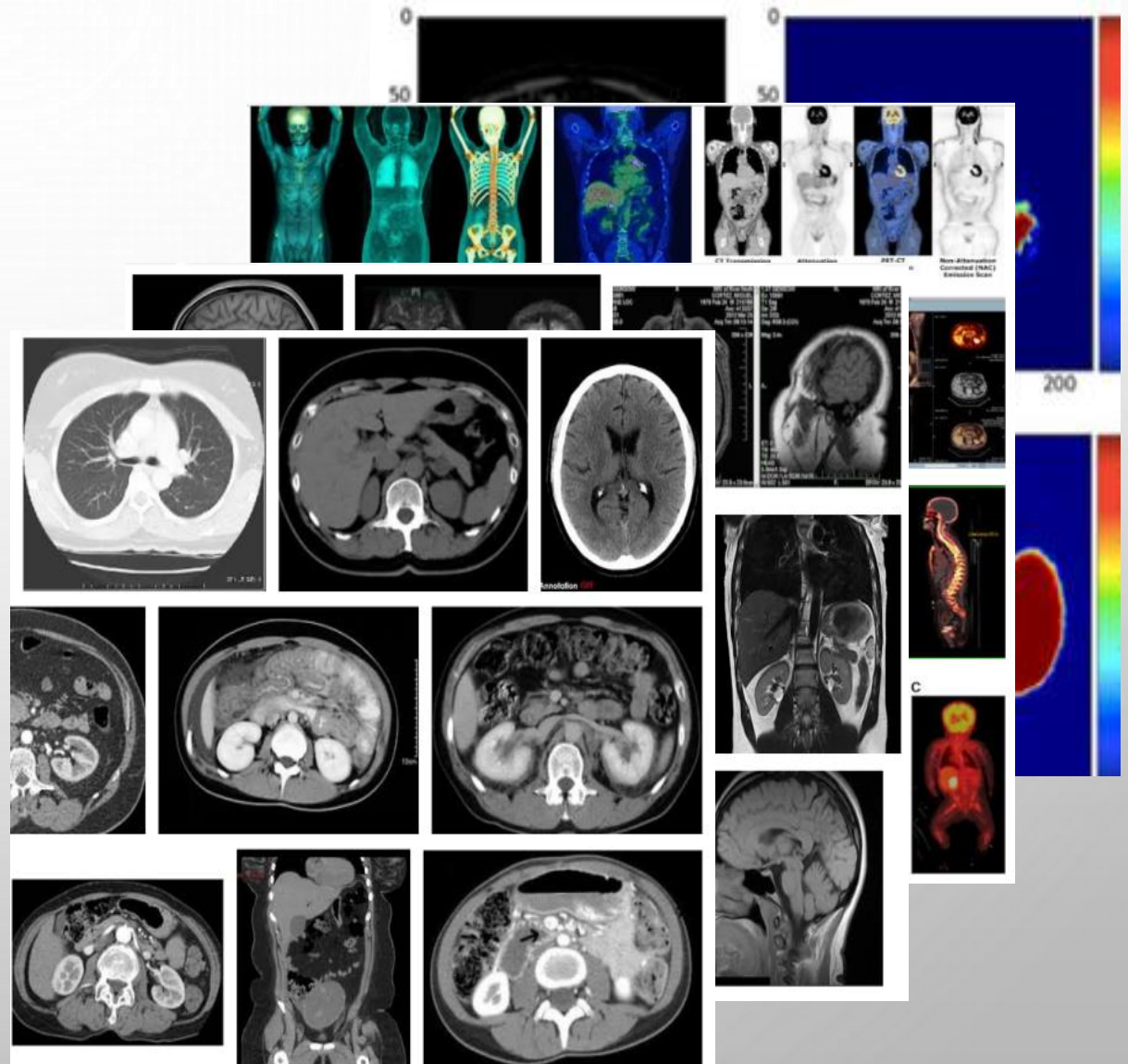


Israel AI


tupHub.ai
ISRAELI AI HEALTHCARE LANDSCAPE
Medical Imaging
DermaDetect
PerSimiO
DIA
IMAGING ANALYSIS
MAGENTIQ
SEE BEYOND THE VISIBLE
XPRINT XRAY
TECHSOMED
aidoc
iz.ai
maxQ
Artificial Intelligence
ORCA
DENTAL AI
Generic Imaging
MARPE
innoging
RADLogics
zebra
MEDICAL.VISION
MedHub-AI
BODY VISION
SEE BEYOND LIMITS
FDNA
Biopmedical
RADICAL AI
DeePathology.ai
IBEX
MobileODT
Mobile Optical Detection Technologies
Genomics
2bPrecise
igentify
KOL
GENOOX
GENE
NOVELLUSDX
PATH TO CANCER CARE
emedgene
Security
CyberMDX
Cynerio
CYBER
MDX
MEDIGATE
Analytics
OpisoftCare
HEALTHCARE INTELLIGENCE
CLEW
The Future of Clinical Intelligence
PINK OF VIEW
QUESTION OF LIFE
optimata
sweetch
Patient Data
nym
efficacy
BELONG
Beating Cancer Together
PROFILITY
MDClone
Wearable & Devices
tytocare
health is in your hands
somatix
Data with a purpose
6 degrees
Adherence
MEDORION
Medisafe
Vision Impairment
Renew Senses
ICI VISION
eyecontrol
ORCAM
Clinical Trials
TrialJectory
BEACONCURE
DocBoxMD
Other
AIVF
Lynx.MD
Healthcare. Connected.
MedinTec
Neurology
ElMindA
BrainTalk
Intendu.
COGAID
MyndYou
From Cognition to Action
neurosteer
ValeraHealth
BrainQ
BIO EYE
INSIGHT YOUR MIND
Mon4t
Your Personal Checkup
Selfit
Senior Care
VITALERTER
intuition robotics
kytera
Owlytics Healthcare
ECHO CARE Technologies
UNIPER
PERLIS
invisi.care
wisdom
Disease Management
MEDINT
Medical Intelligence Ltd.
Medivizor
VIM
OBERON SCIENCES
Next Generation Personalized Medicine
dreamed
DIABETES
LIFEGRAPH
brook
Data2Life
GlucoMe
Diabetes Care Made Simple.
Surgery
Deep Health
AUGmedics
SurgeonAI
Support
medCPU
MEDECIDE
Medial
EarlySign
Prescription Errors
IRODY
MedAware
mydimed
TALIAZ
Patient Engagement
Well-Beat
WellBē
helparound
Proactive Care
RMDY
Monitor
MEDASENSE
pain monitoring solutions
EarlySense
GLYCEMIACARE
VERIFIED PLANET™
EXPAIN
CU
CONTINUSE BIOMETRICS
Optometry
NOVASIGHT
6 over 6
DIABETES BLINDNESS ALERT
cameryes
Specta.AI
Electronic Health Records
Semantic Medical Simulations Ltd
Datos
Remote Patient Management
attentive.ai
carebox
MAVERICK
MEDICAL AI
ALEPHBOT
Diagnostics
diagnostics.ai
IMedis
BAT-CALL
Dqme
nucleai
Healthy.io
AcousticView
synesthesia
scopio
EchoSense
RetiSpec
sight
MDalgorithms
Voice
voiceitt
HEALTHYMIZE
NiNiSpeech
Knowledge
bioz
Infant
HERA MED
nanit
Drug Discovery
CytoReason
PEPTICOM
Nutrition
DAY TWO
fitto
Lumen

THE INFORMATION AGE

- USA:
  - X-RAY 250 M
  - CT 82 M
  - MRI 39 M



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Radiology and AI

Trends and needs

- Increase in the clinical load: more than 40% in the last 5 years
  - Worldwide ~100M comparative studies
- Continued growth in the number of patients
- Shortage of radiologists
- Unprecedented pressure to find automatic solutions to support the radiologists

→ ***Boost the need for AI solutions***

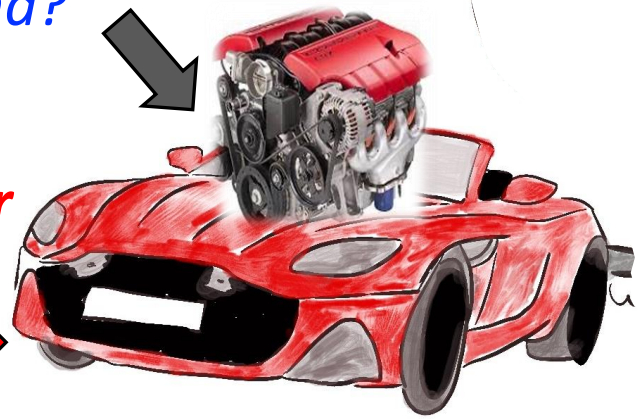
Deep learning and race cars

where's the catch?

③ *Method?*
Cost?

① *What is the Promised land?*

⑤ ***Deep network***

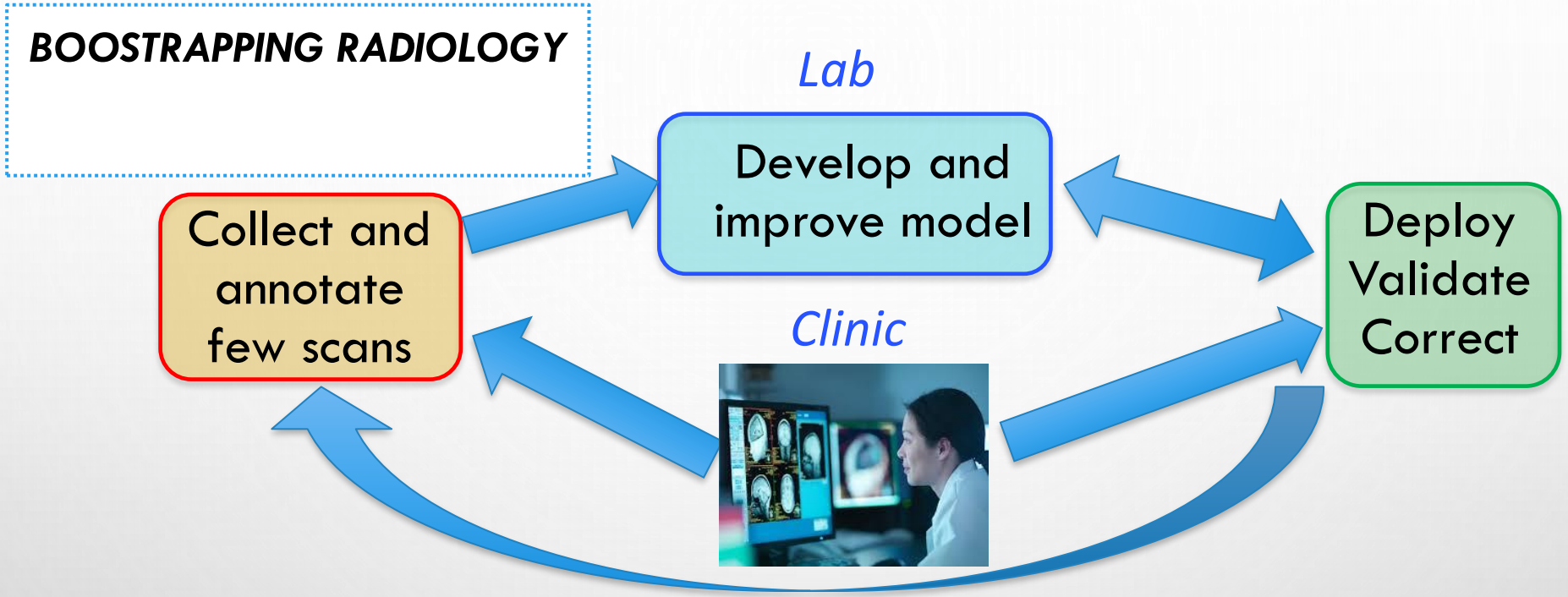


Race car

④ *Pipeline*

② *Quantity?*
Quality?
Distribution?

RADIOLOGIST (HI) IN THE LOOP WORKFLOW



Goals

- Provide useful results as soon as possible
- Optimize radiologist time budget
- Improve deep learning model
- Handle rare and out-of-distribution cases

TYPES OF MACHINE LEARNING MODELS

Supervised Learning

Unsupervised Learning

Goal: identify patterns/groupings

Reinforcement Learning

Goal: optimize prediction by trial and error

AI in Radiology: overview and evidence

Primary Market

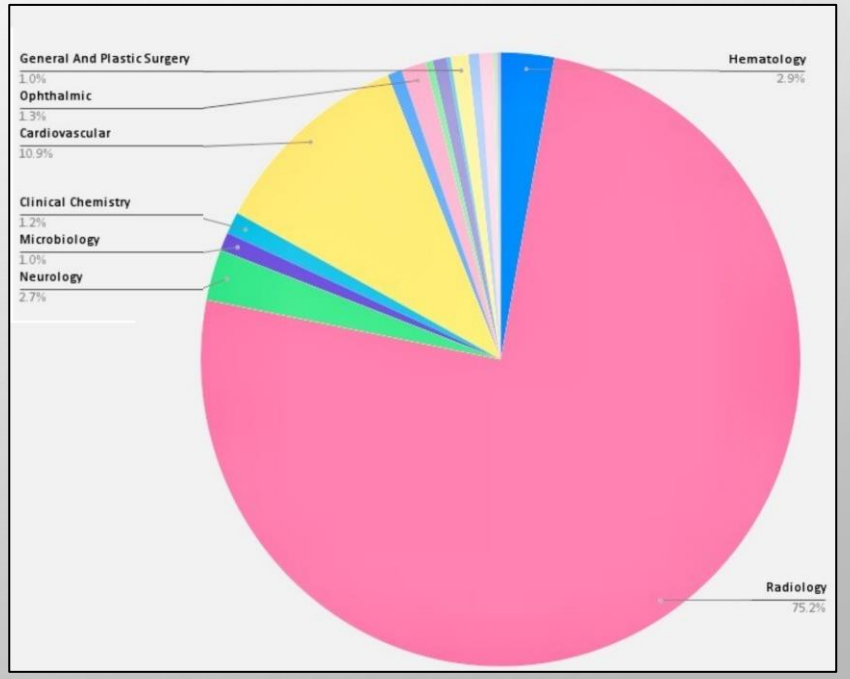
- **211 AI-based companies with 591 FDA-cleared applications;** most of the products are a single-point solution for a single finding.
- 448 of the approved devices are within radiology and cardiology

➢ 75% are in **radiology/oncology**: 391 devices

➢ 11% are in **cardiology**: 57 devices

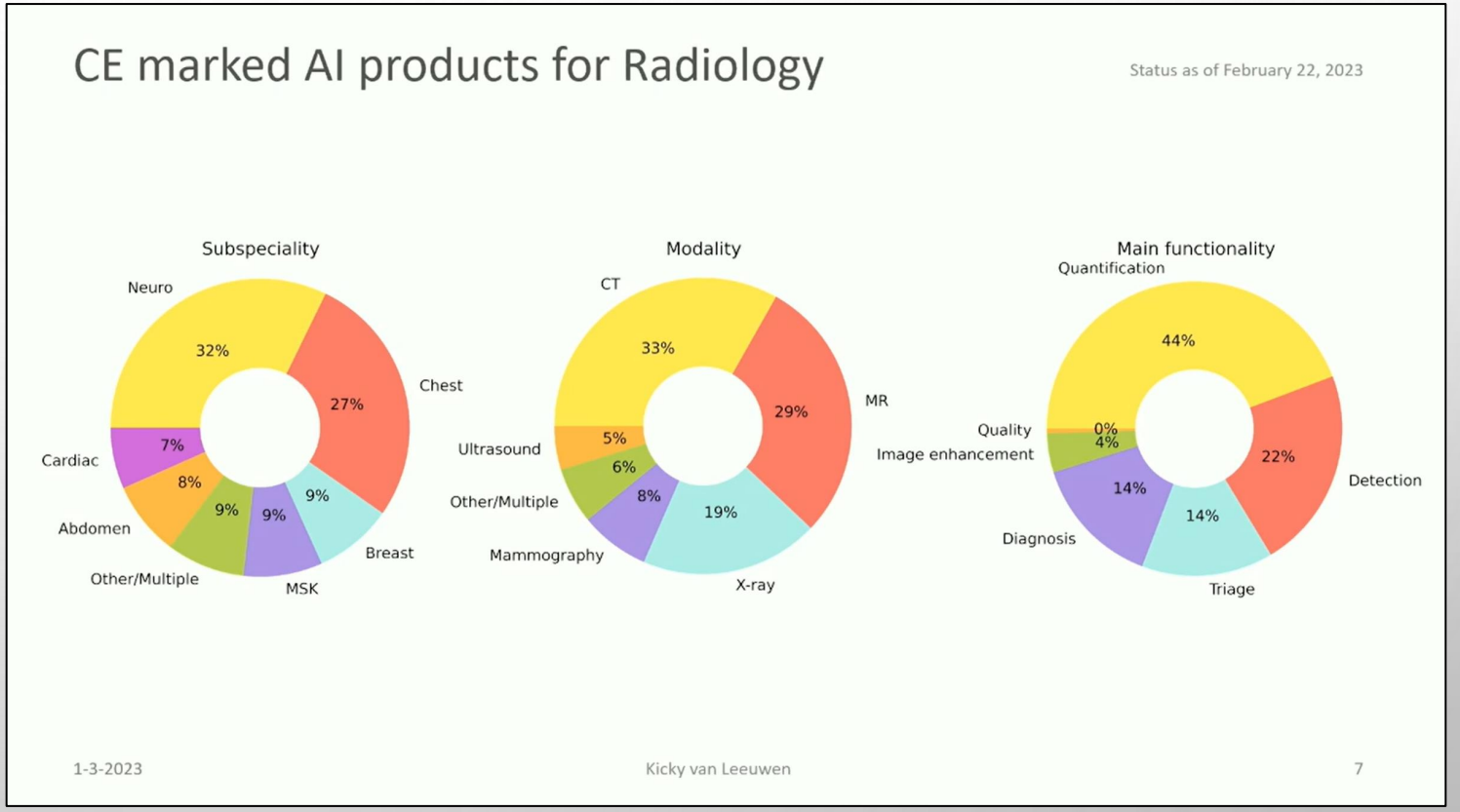
➢ 3% are in **hematology**: 15 devices

➢ 3% are in **neurology**: 14 devices



AI for Radiology: overview and evidence

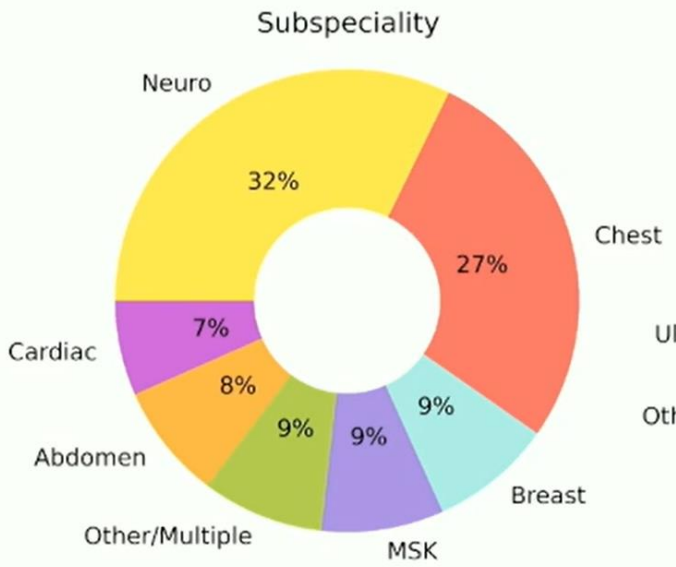
- Subspecialty: 32% in Neuroradiology, 27% are in Chest, 9% in breast, 9% in MSK (bone), 9% in multiple, 8% in Abdoman, and 7% in cardiac
- Modality: 33% in CT, 29% in MR, 19% in X-ray, 8% in mammography, 5% in Ultrasound and 6% in others
- Main Functionality: 44% quantitative, 22% detection, 14% in Triage, 14% in Diagnostic and 4% in others

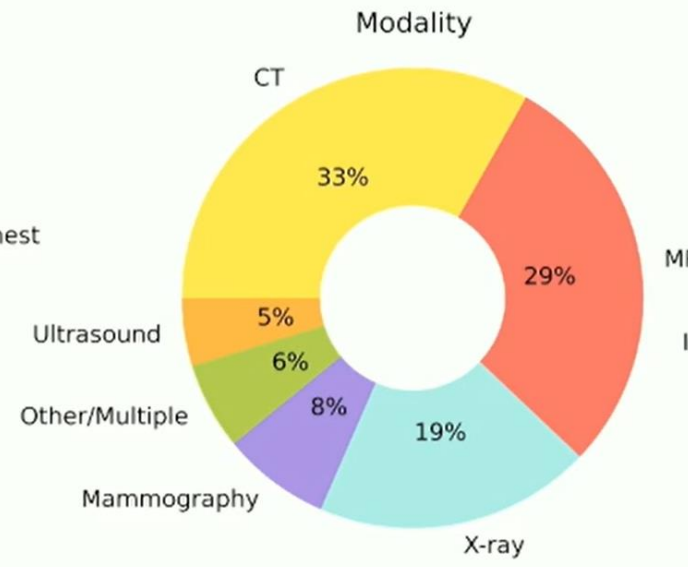


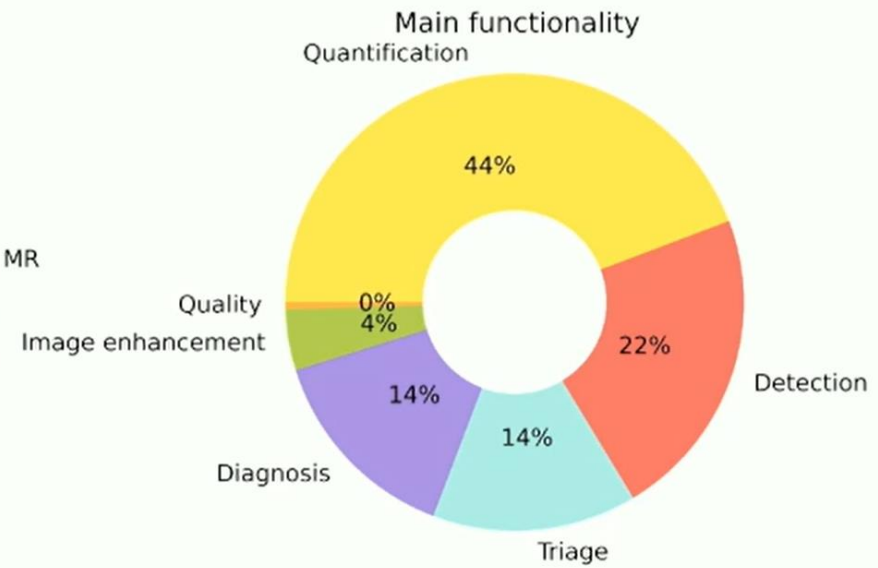
Shifting from single-point solutions to multiple-point solutions

CE marked AI products for Radiology

Status as of February 22, 2023







Value Proposition of Food and Drug Administration (FDA)-Approved Artificial Intelligence (AI) Algorithms for Neuroimaging

JACR, August 11th, 2023
August 11,2023DOI: https://doi.org/10.1016/j.jacr.2023.06.03

- A total of 59 AI neuroimaging algorithms were cleared by the FDA between May 2008 and August 2022
- Most of these algorithms (24/59) were compatible with noncontrast CT, 21 with MRI, nine with CT perfusion, eight with CT angiography, three with MR perfusion, and two with PET
- Six algorithms were compatible with multiple imaging techniques.
- The following are the advertised value proposition for these algorithms:
  - Improved quality of care (38/55, 69.1%)
  - Saving user time (24/55, 43.6%)
  - Decreased costs (9/55, 15.7%)
  - Increased revenue (6/55, 10.9%)

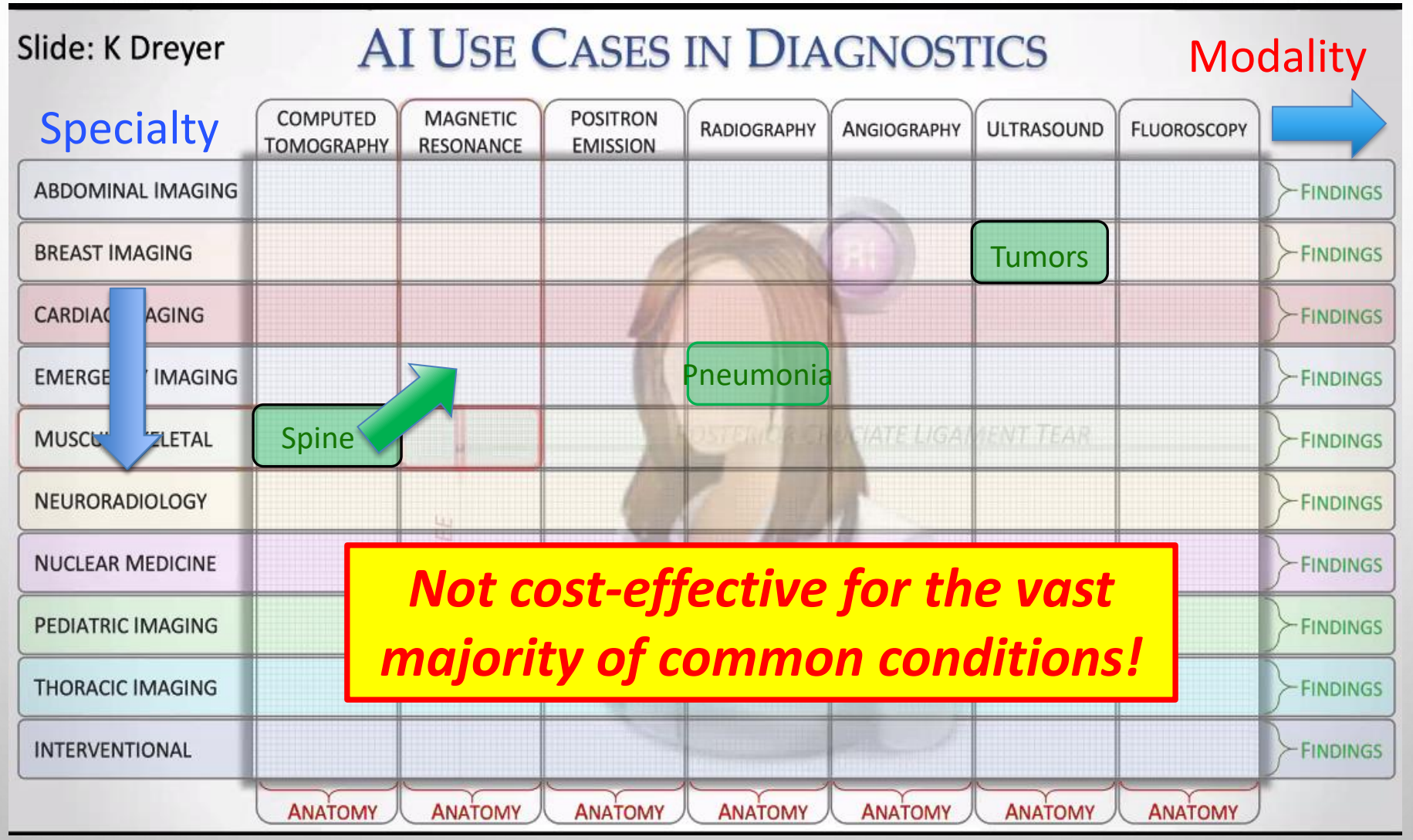
Value Proposition of Food and Drug Administration (FDA)-Approved Artificial Intelligence (AI) Algorithms for Neuroimaging

JACR, August 11th, 2023
August 11,2023DOI: https://doi.org/10.1016/j.jacr.2023.06.03

Take-Home Points:

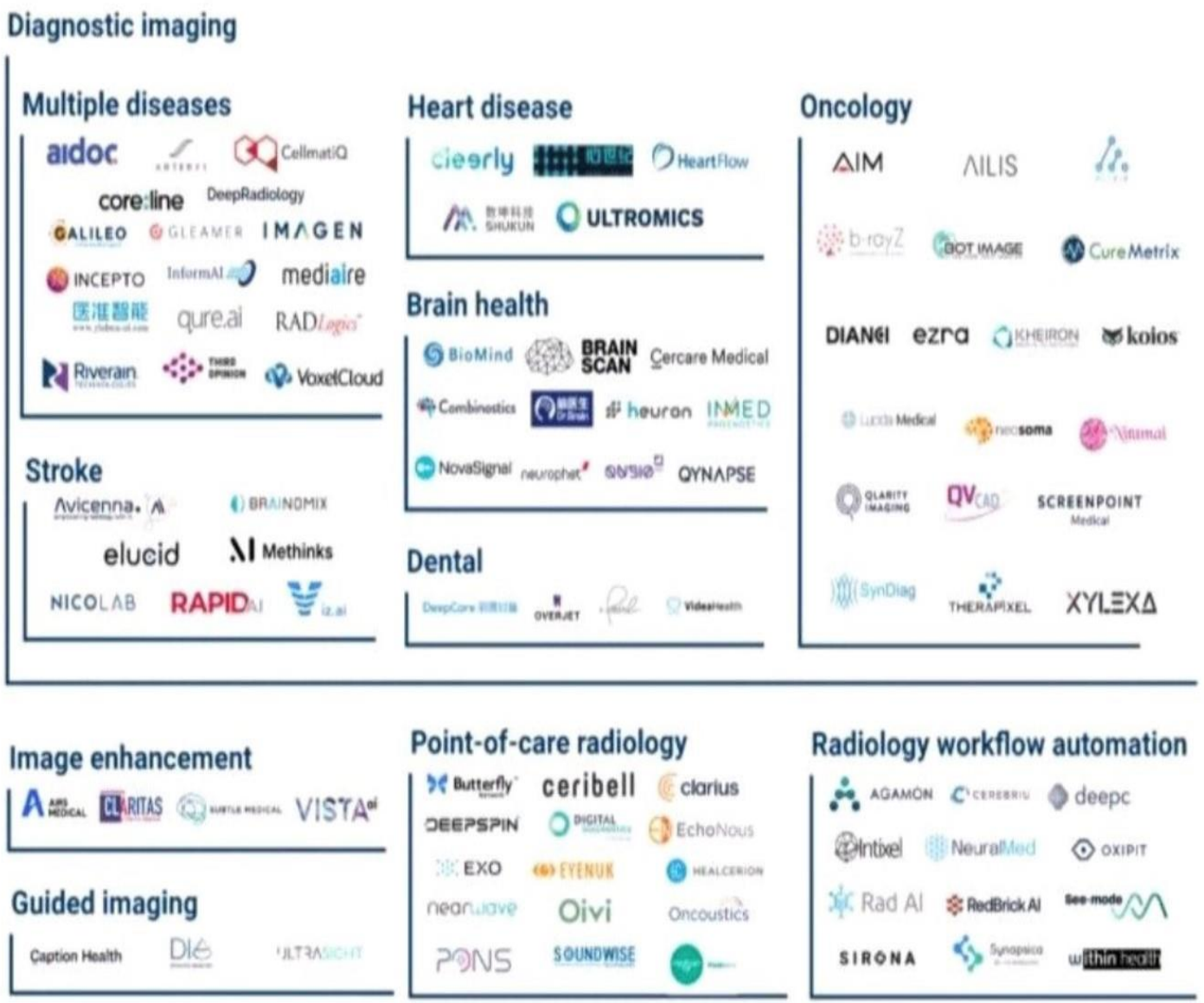
1. A majority of the FDA- cleared AI algorithms approved for neuroimaging are related to the detection or quantification of stroke.
2. Most of the algorithms in this study focus on a single clinical problem with binary outcome.
3. The most widely advertised value proposition was improved quality of care.

NARROW AI – LONG TIME AND HIGH COSTS!



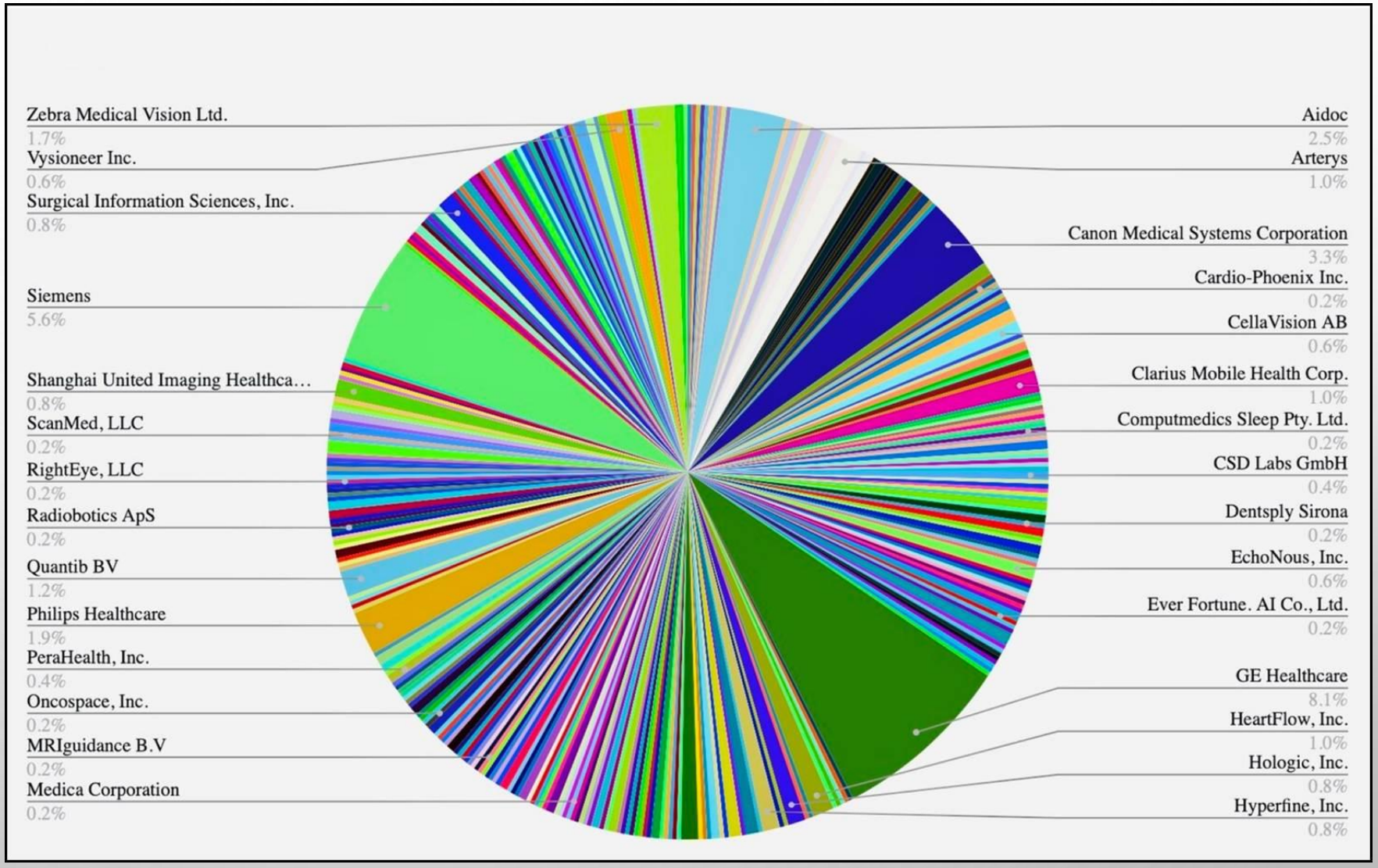
* *Transfer learning, one-shot image classification, GANs to date have shown limited effectiveness for medical image classification tasks*

96 AI companies building the next generation of radiology tech



The AI market

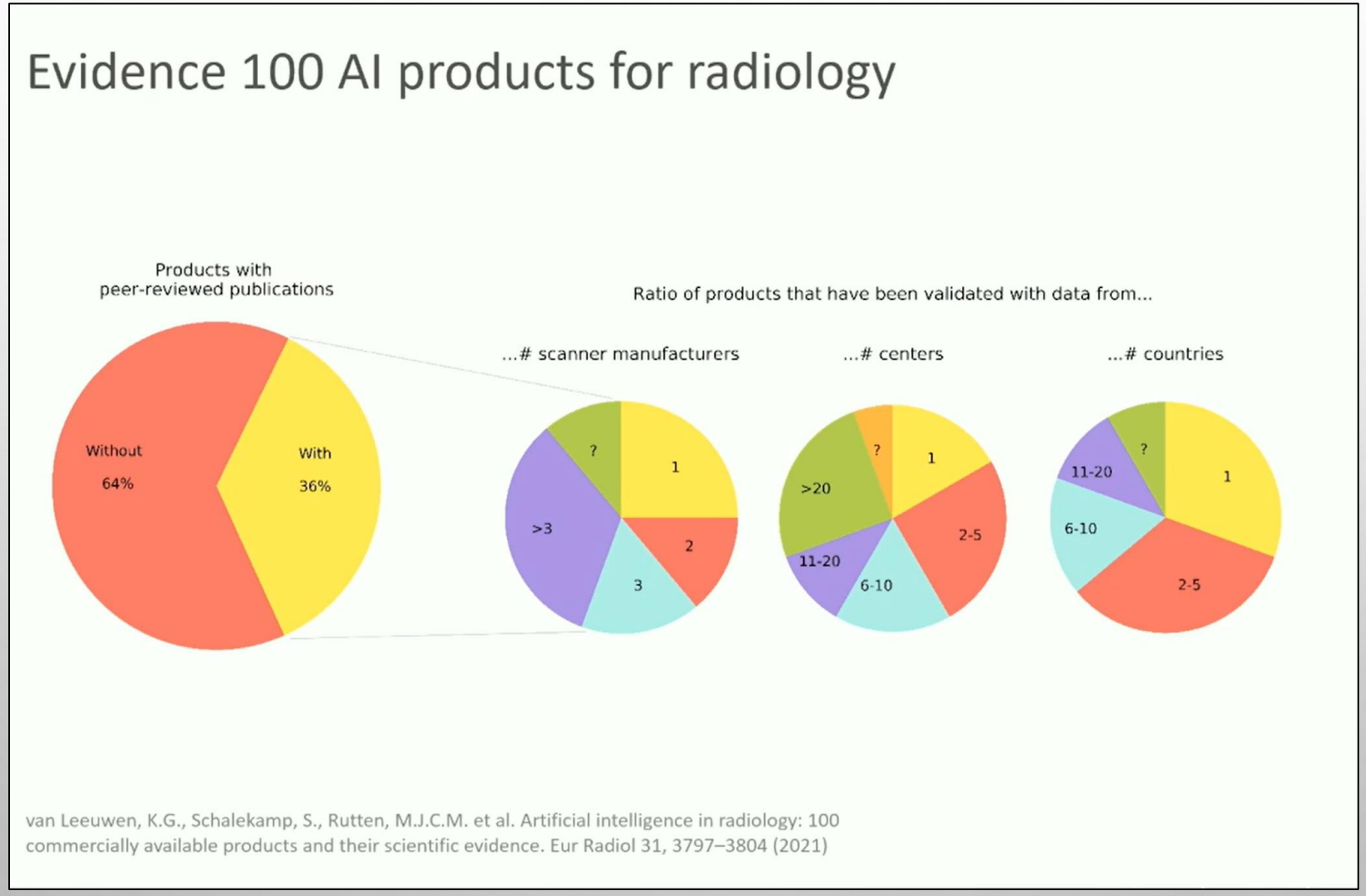
- The map of the current landscape of commercially available AI companies by market share



The AI platforms hold the most significant market share

Supportive clinical publications

- 64% of the companies don't have supportive clinical publications.



Restraints and Challenges

- The **FDA regulations** concerning AI products are **constantly changing**, i.e., "Moving Target."
- The European Regulation for **CE & MDR** demands more **substantial clinical evidence** and focuses on real-world performance

AI consolidator platforms

- Is consolidation of products a comprehensive solution?

AI consolidator platforms

- Companies have been doing so by opening their AI platform to other companies and/or developing multiple applications, i.e., **offering a multi-finding solution**
- **27 AI consolidator platforms for AI:** Nuance, Blackford, SH, Incepto, Medica:, Sectra, Fufifilm, TCM, Philips, Siemens, AstraZeneca, CTS, DeepPC, etc.
- Companies also pushed to get **multiple FDA Clearances** to extend their offering. For example, GE has 42 devices cleared, Siemens 29, Canon 17, Aidoc 13, Philips 10, Zebra (acquired by Nanox Vision) 9, Quantib 7 and Viz.ai 6

AI consolidator platforms (n=27)

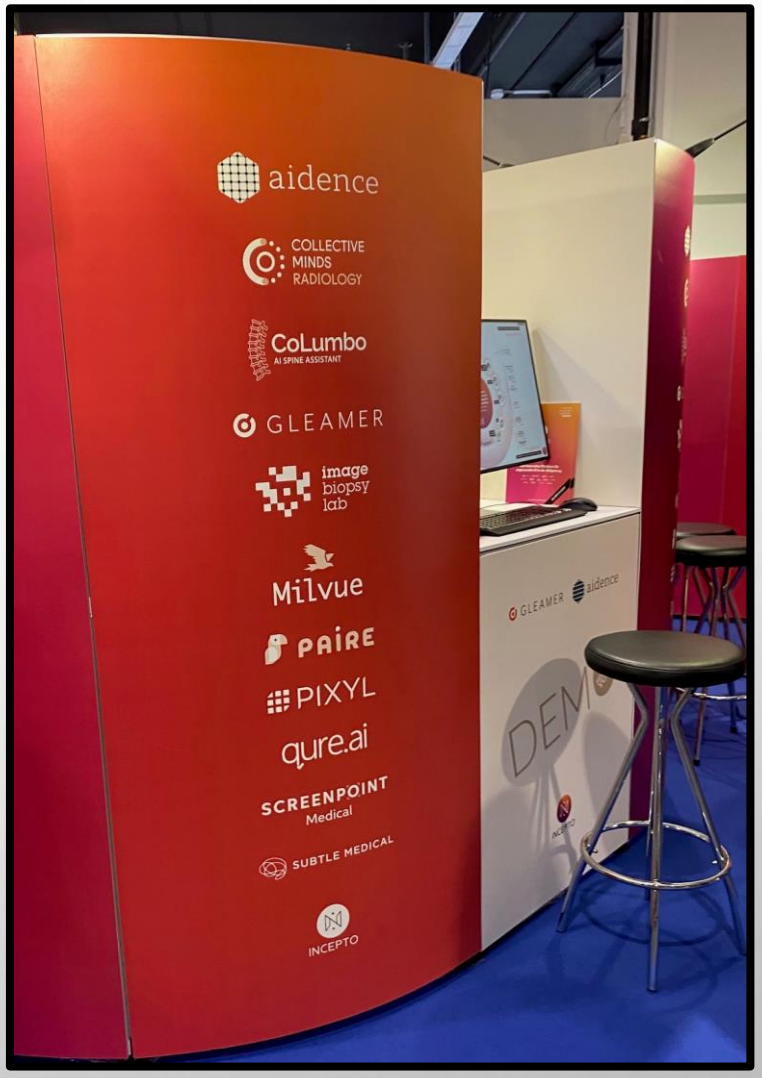
AI Platform	PACS/RIS vendor	OEM	AI vendor	Other
Blackford Platform (Blackford Analysis [Bayer])	**AI Connect** (Wellbeing Software)	**Automation Platform** (Canon Medical Systems)	**Aidoc aiOS** (Aidoc)	**Change Healthcare Marketplace** (Change Healthcare)
CARPL (CARPL.AI)	**Intelerad AI Hub and Odyssey** (Intelerad)	**Digital marketplace, syngo.via** (Siemens Healthineers)	**Arterys** (Arterys [Tempus])	**Imaging AI Orchestrator/Marketplace** (IBM)
deepcOS (deepc)	**Medimsight AI marketplace** (Medimsight)	**Fujifilm REiLI** (Fujifilm)		**Softway Medical** (Softway Medical)
FOLIO platform (Incepto)	**RUBEE for AI** (Agfa Healthcare)	**GE Edison** (GE Healthcare)	**Postprocessing platform**	**Precision Imaging Network** (Nuance)
Myrian (Intrasense)	**Sectra Amplifier Store** (Sectra)	**Philips AI Manager** (Philips Healthcare)	**Alma Health Platform** (Alma Health Platform)	**Calantic Digital Solutions** (Bayer Pharmaceuticals)
Private AI Hub (Ferrum Health)	**Telepaxx** (TELEPAXX)		**Eureka Clinical AI** (TeraRecon)	
	Visage AI Accelerator (Visage Imaging)			

AI consolidator platforms (n=27)

- **Blackford (Bayer) - 80 apps** across **30 partner vendors**
- **Arterys - 19 apps** for radiology from **11 vendors**
- **Incepto - 22 apps** for radiology; offered by modality, department and organ
- **DeepPC- 35 apps** from over **20 partners**

- **Medica:;**
- **Sectra;**
- **Fufifilm;**
- **TCM;**
- **Philips;**
- **Siemens;**
- **AstraZeneca;**
- **CTS;**
- **SH;**
- **Nuance;**

AI consolidator platform at the ECR 2023



The AI platforms offer a variety of apps without a common ground or focus

AI consolidator platforms

- Is consolidation of products a comprehensive solution?
- NO

Merging and Acquisition

- Is M&A a comprehensive solution?

M&A activity


Acquisitions
RadNet
Quantib
aidence
human sense in artificial intelligence
Aidence and Quantib acquired by RadNet
American diagnostic imaging services company RadNet acquired the Dutch AI vendors Aidence (lung CT) and Quantib (prostate, neuro). This should build upon RadNet's AI division which already includes breast AI after an earlier acquisition of DeepHealth. So far it seems like not much is going to change for current customers. This acquisition is not the first in the medical imaging AI field, and probably won't be the last.
Blackford announces our acquisition by Bayer
NEWS | August 11, 2021
Nanox to acquire Zebra Medical Vision for $200m
Nanox will leverage the team, innovative AI technology and Cloud expertise of Zebra-Med to develop a med-tech firm.
ARTERYS
is now a part of
TEMPUS

Changing market segments

Shift of focus

MaxQ discontinues Accipio AI software as firm switches gears

By Erik L. Ridley, AuntMinnie.com staff writer

January 13, 2022 -- Artificial intelligence (AI) software developer MaxQ is switching gears, discontinuing its Accipio line of software for detection and triage of intracranial hemorrhage (ICH) and ending its involvement in the development of image analysis-based AI applications.

Founded in 2014, Enlitic continues to innovate the way artificial intelligence is utilized in healthcare, shifting focus from diagnostics to workflow. Partnerships with the Department of Defense, Konica Minolta, TMC (a Unilabs company), as well as some of the largest diagnostic reading groups in the world give momentum continuing into 2022 with the debut of Curie™, an enterprise platform that utilizes human, artificial, and real-world intelligence to create an evidence-based solution for healthcare information.

"This is the first time Lunit's AI has been officially integrated into an insurance underwriting process, and this proves that our solutions can also bring value to workflows outside of hospital settings," said Brandon Suh, CEO of Lunit. "We are excited to expand the reach of our AI-powered software and become the driving force of digital innovation in the global insurance market."

Shifting to Pharmaceutical

Shift of focus

- **contextflow partners with clinical data company Medexprim:** The partnership is specifically aimed at indicating treatment effectiveness and predict disease progression in non-small cell lung cancer. This collaboration highlights the growing trend of AI vendors, in this case contextflow, expanding their reach into the pharmaceutical and clinical research industries, broadening their customer base.

- **VIDA moving to pharma:** VIDA announced a partnership with RAYUS Radiology, an American provider of advanced diagnostic and interventional radiology, to onboard more than 150 locations as clinical trial imaging sites. VIDA originally focused on patient care with their lung AI VIDA Insights. But with the launch of the VIDA Lung Intelligence services last May, their focus seems to have completely shifted to biomarker analysis for pharma. Together with Thirona and Quibim forming another type of AI-vendors.

Merging and Acquisition

- Is M&A a comprehensive solution?
- NO

THE GENERAL PARADIGM OF MACHINE LEARNING

Input Data **Training of Model (e.g. decision tree/neural network)** **Application**

Variables

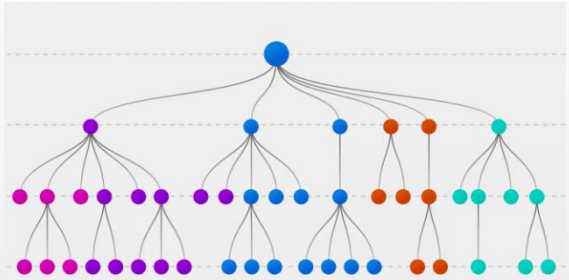
Images

Text

Videos

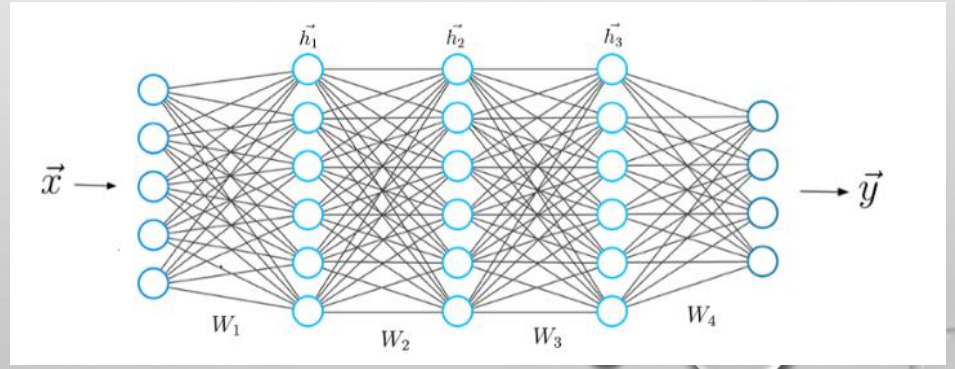
Others

Machine Learning

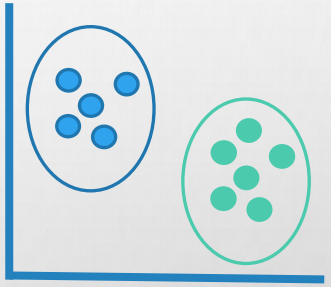


or

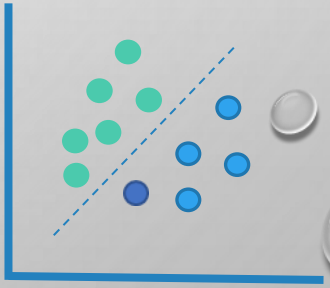
Deep Learning



Classification



Regression



What is a comprehensive solution?

a

EXAMINATION: CHEST (PA AND LAT)

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

TECHNIQUE: Chest PA and lateral

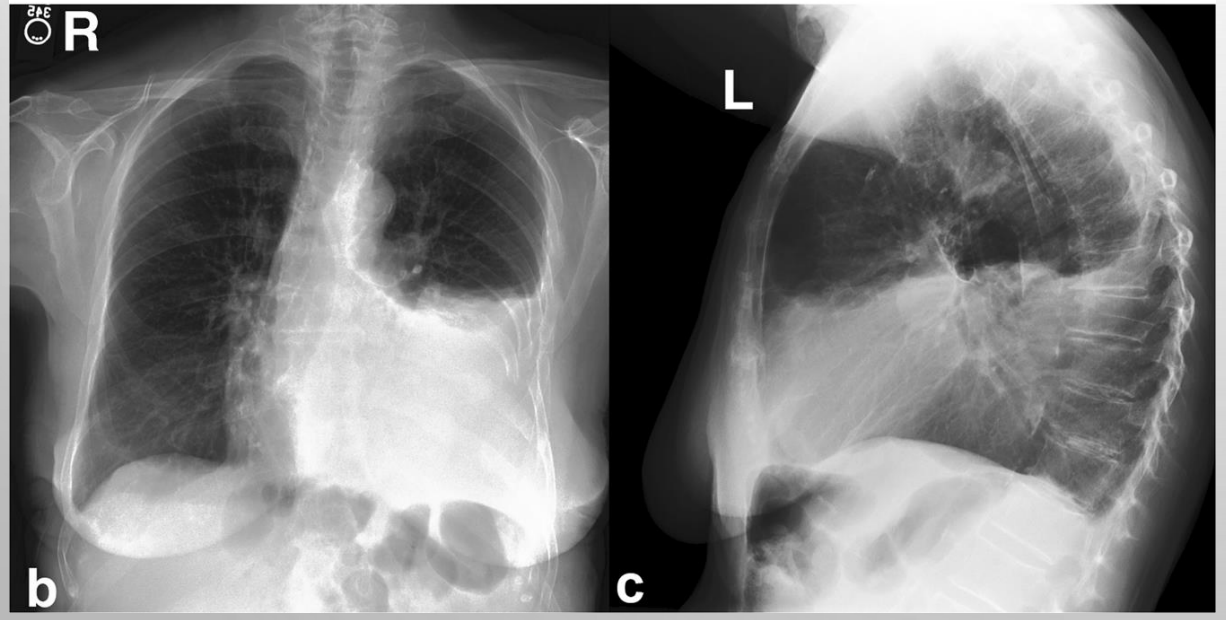
COMPARISON: ___

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



- Clinical information
- Comparison
- PA+Lat
- Most of these do not exist in current products

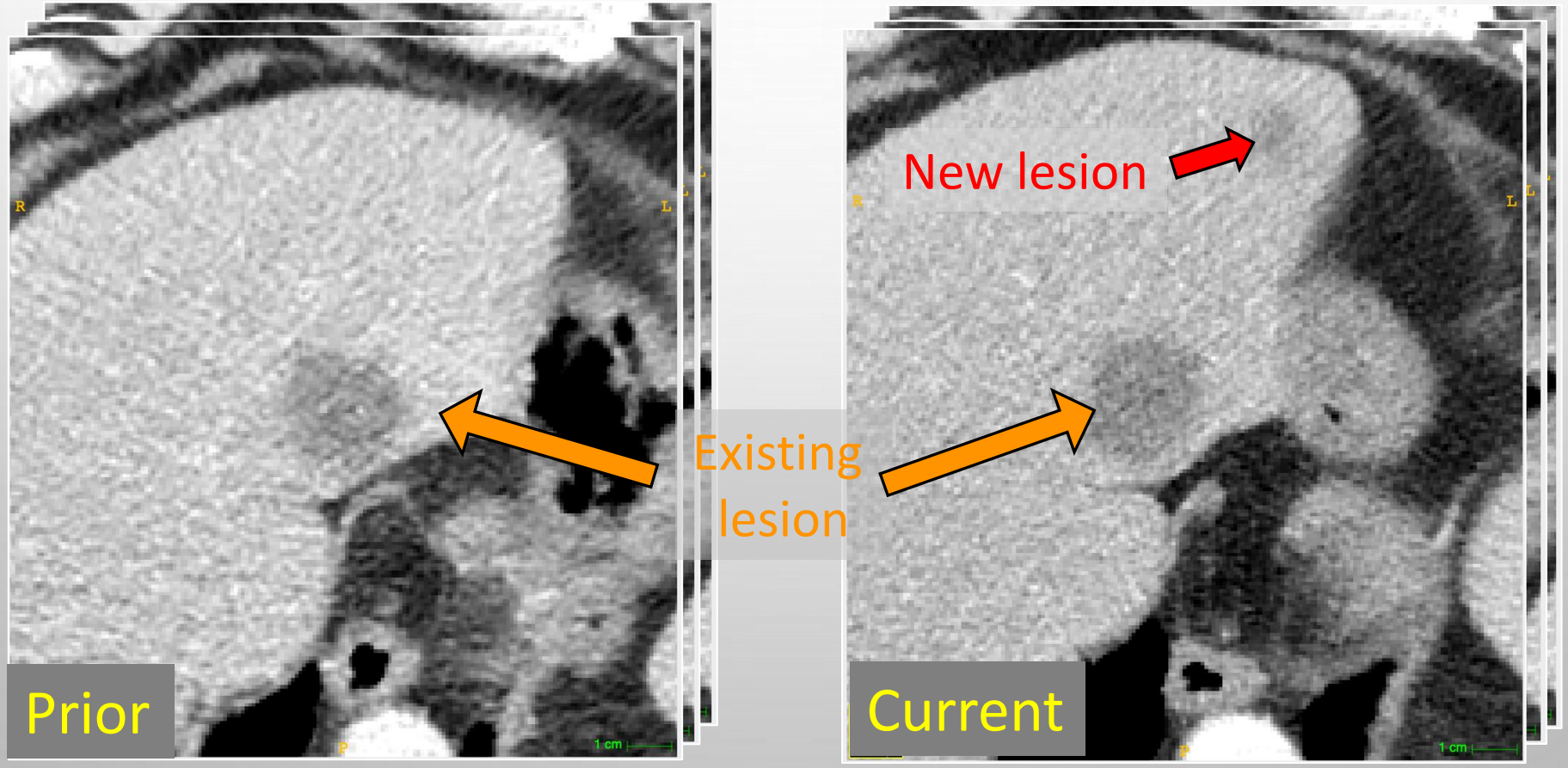
Johnson, A.E.W., Pollard, T.J., Berkowitz, S.J. *et al.* MIMIC-CXR, a de-identified publicly available database of chest radiographs with free-text reports. *Sci Data* **6**, 317 (2019).

Comprehensive Solutions

- **Replicating radiologists knowledge process**
  - **Clinical data for understanding significance of findings**
  - **Multiple modalities**
  - **Multiple time points**
  - **Incorporating other studies (echocardiography, bronchoscopy)**
  - **Pathological and genetic data**
  - ***AI for image reconstruction***

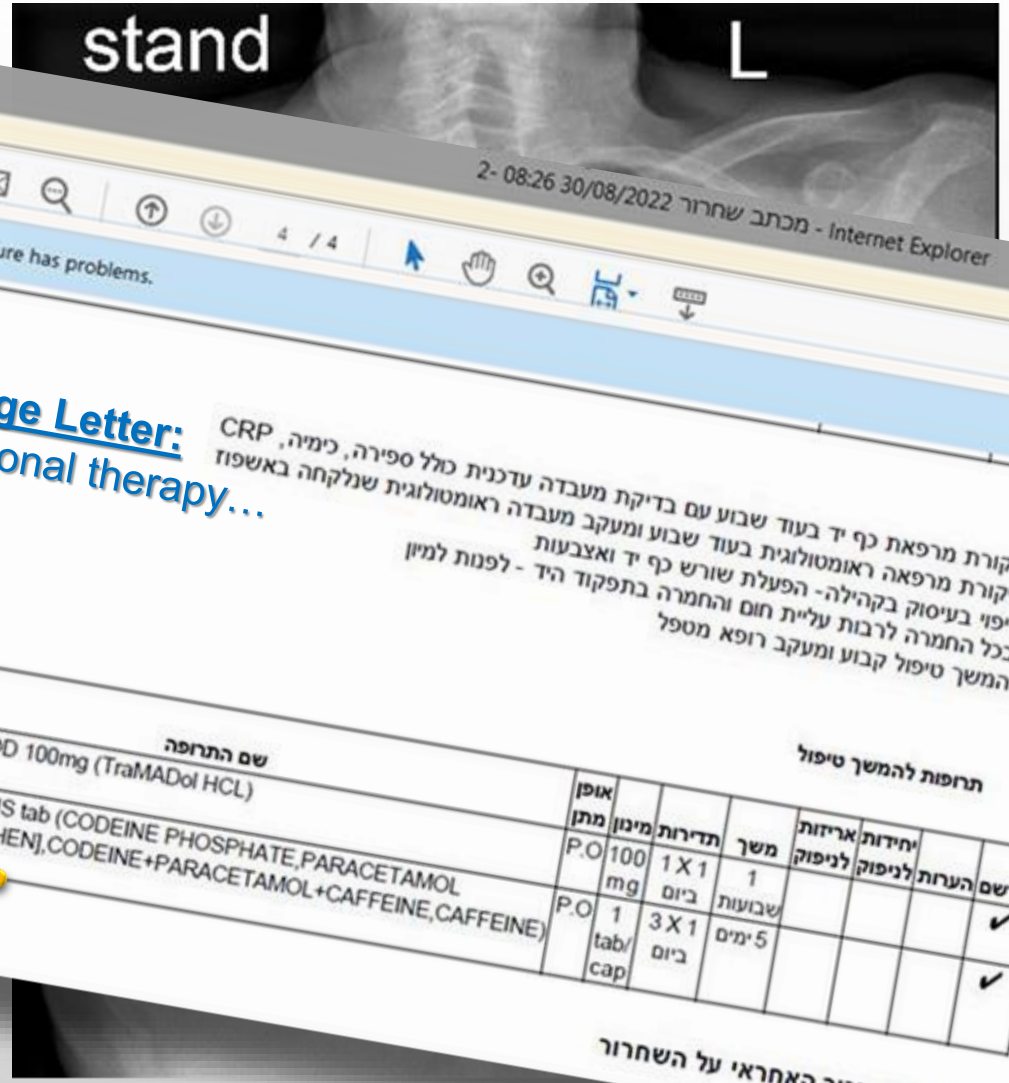
RADIOLOGICAL LESIONS FOLLOW-UP

- Measure **lesion changes over time**
- **Relative change** between consecutive scans is what matters
- **Lesion change type**: existing, new, disappeared



WORKFLOW INTEGRATION

- COURTESY PROF. ELI KONEN



2- 08:26 30/08/2022 מכתב שחרור - Internet Explorer

at least one signature has problems.

4 / 4

Signature Pa

Discharge Letter:
Occupational therapy…

CRP ,כימיה, כלל ספירה, עדכנית מעבדה בדיקת עם שבוע בעוד יד כף מרפאת ביקורת :המלצה
שנלקחה באשפוז ראומטולוגית מעבדה ומעקב שבוע בעוד ראומטולוגית מרפאה ביקורת
ואצבעות יד כף שורש הפעלת - בקהילה ריפוי בעיסוק
היד - לפנות למיון והחמרה בתפקוד עליית חום והחמרה לרבות בכל
רופא מטפל קבוע ומעקב טיפול המשך

המלצות

תרופות להמשך טיפול

שם התרופה	אופן מתן	מינון	תדירות	משך	אריזות לניפוק	יחידות לניפוק	הערות	מרשם
TRAMADEX OD 100mg (TraMADol HCL)	P.O	100 mg	1 X 1 ביום	1 שבועות				✔
ROKACET PLUS tab (CODEINE PHOSPHATE,PARACETAMOL [ACETAMINOPHEN],CODEINE+PARACETAMOL+CAFFEINE,CAFFEINE)	P.O	1 tab/ cap	3 X 1 ביום	5 ימים				✔

שם הרופא הבכיר האחראי על השחרור

A disturbing lesson:
Our referring physicians don't check the PACS or RIS…

8.2022 , Orthopedic Surgery of the hand…

IMPLEMENTATION OF AI FOR CHEST XR IN ISRAEL

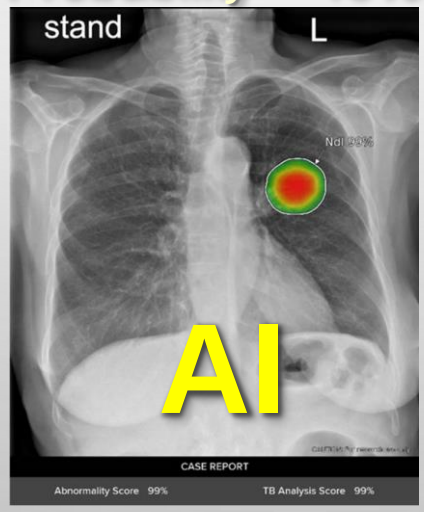
- Our main concern is the undetected nodules…
- Asked for excel of all detected "nodules" ☞ **list of 17,000 accession numbers…**
- Help for IT ☞ Exclusion criteria:

- Oncological Pts.
  - Active in recent year

(Oncology Pts. are marked in the EMR)

+

- Probability < 45%



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- PET CT /Chest CT - in recent year
- >2 chest x-rays - in recent week (ICU)

(to exclude ICU Pts.)

IMPLEMENTATION OF AI FOR CHEST XR IN ISRAEL

- Workflow integration!
- Real-time integration of AI with patient data from other hospital systems

- Oncological Pts.
  - Active in recent year
- Probability < 45%
- PET CT /Chest CT - in recent year
- >2 chest x-rays - in recent week (ICU)

☞ 5-10 “new” / unknown suspected nodule / day

Current state

- *The market is fragmented and with multiple low hanging fruit solutions*
- AI platforms offer a variety of apps without a common ground or focus
- *The AI market is currently shifting from point solutions to multi-findings solution*
- *Real comprehensive solutions are lacking*
- The demand for quantitative imaging biomarkers information is on the rise

AI will replace ALL physicians

#SARELGAURMD

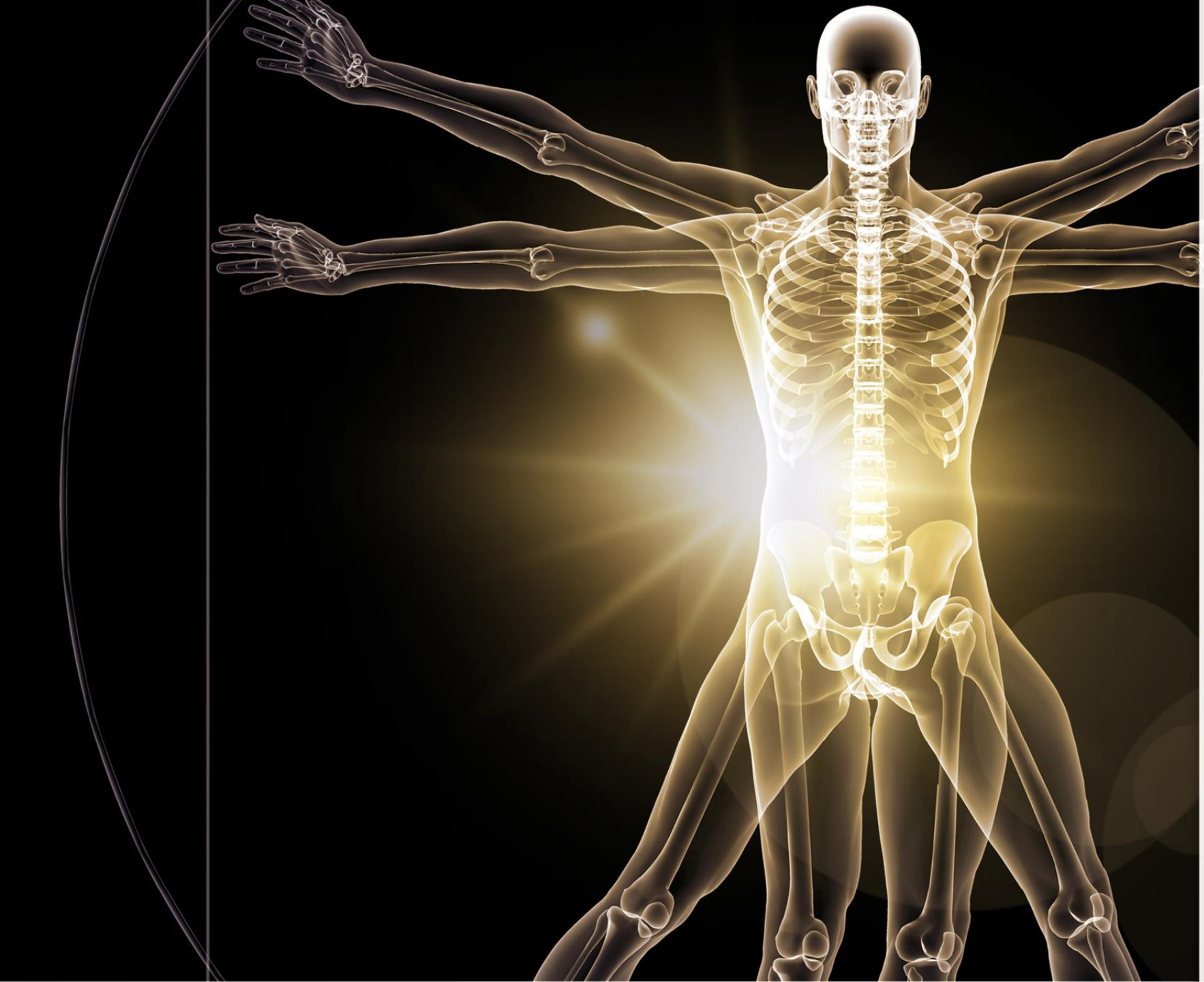
NEAR FUTURE

RADIOLOGISTS USING AI WILL REPLACE RADIOLOGISTS NOT USING IT

HOPEFULLY WITHIN 10 YEARS

RADIOLOGISTS USING COMPREHENSIVE AI SOULTIONS WILL REPLACE RADIOLOGISTS NOT USING IT

Thank you



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IS3R 2023

Berlin/Germany
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