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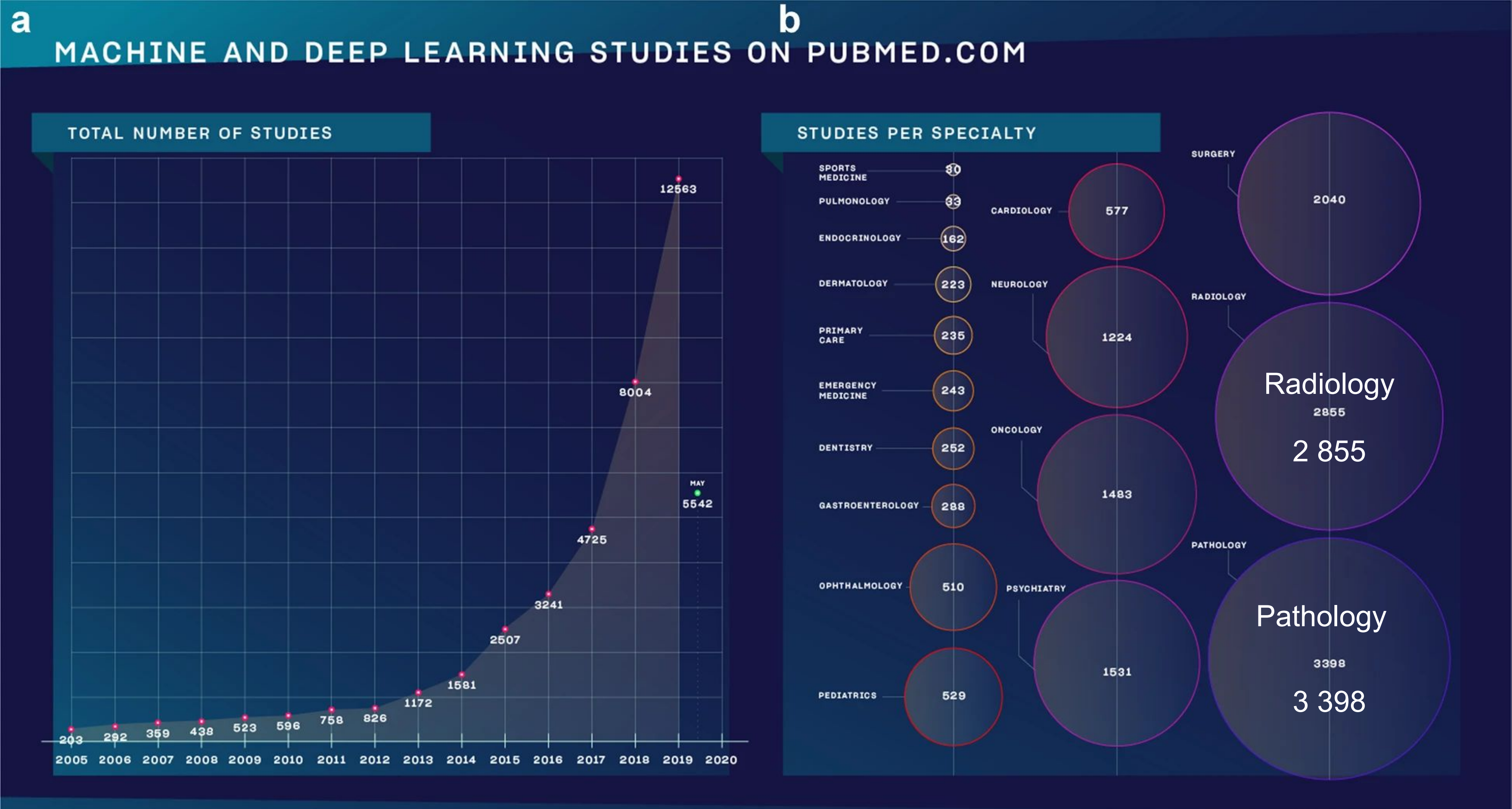
Part I
Artificial Intelligence for Medical Imaging: A Brief Review of Clinical Evidence

Sergio Uribe, DDS, MSc, PhD.
www.rsu.lv/**bioinformatika**

Aim

Brief introduction of the key terms of IA in medical imaging
Evidence of its clinical effectiveness
Limitations and future perspectives



Meskó, 2020. *Nature Digital Medicine* 3, 1–8.

“There is no function the computer cannot do in radiology”

Gwilym S. Lodwick, MD

VOL. 81 NO. 2 **Radiology** AUGUST 1963

a monthly journal devoted to clinical radiology and allied sciences

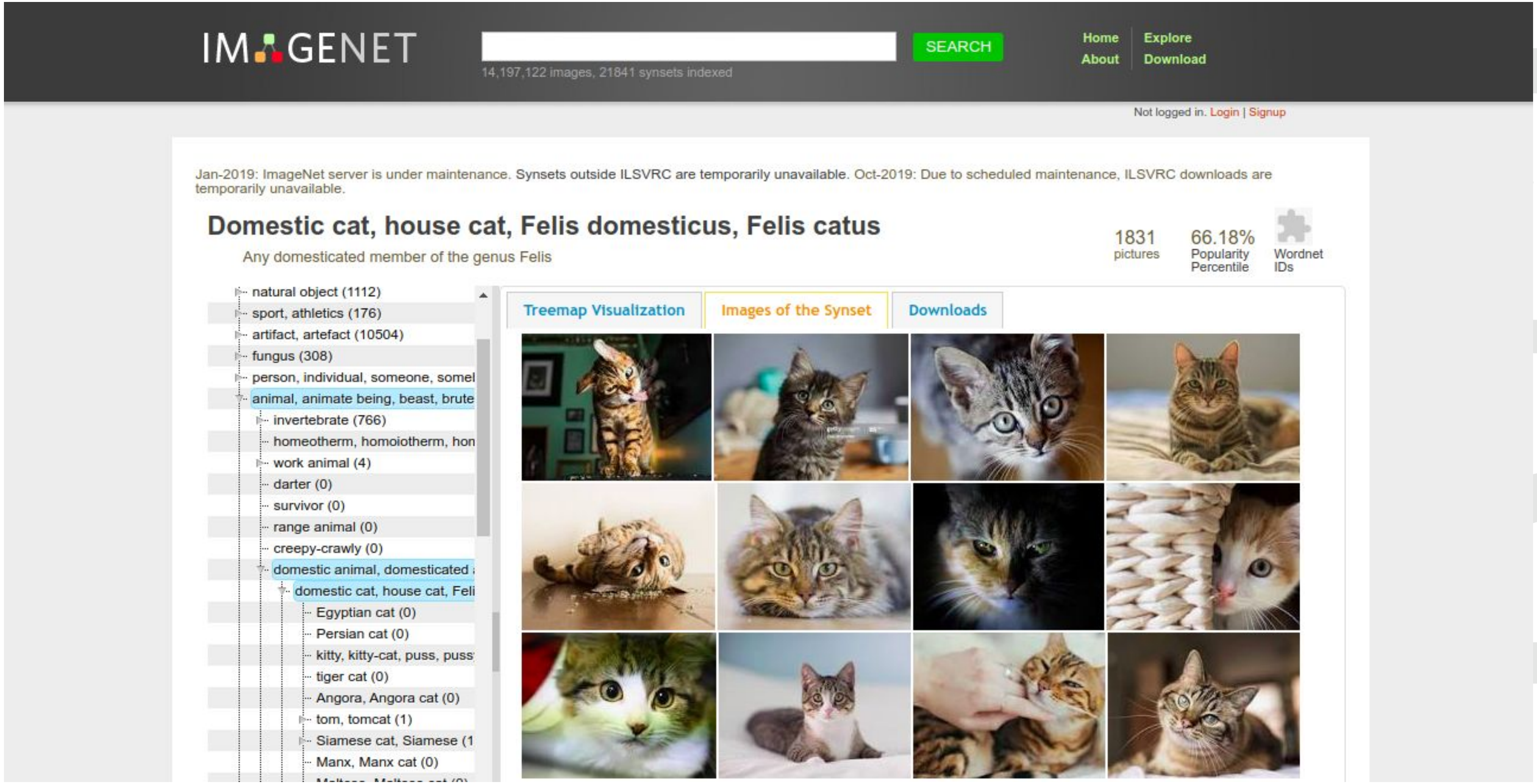
PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA, INC.

The Coding of Roentgen Images for Computer Analysis as Applied to Lung Cancer[1]

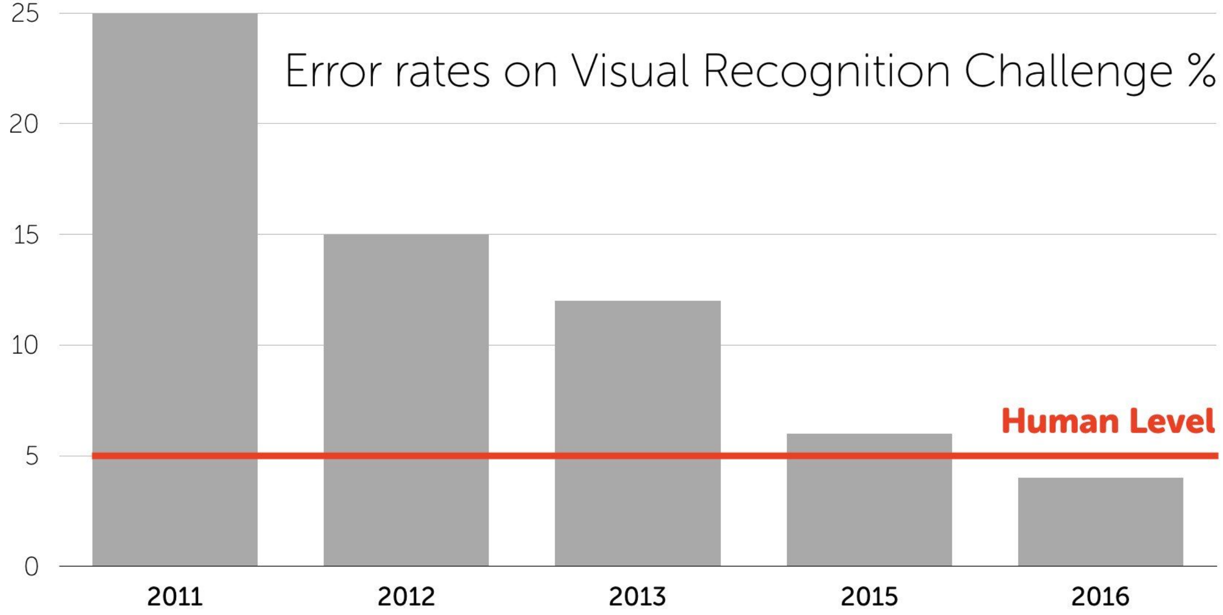
GWILYM S. LODWICK, M.D., THEODORE E. KEATS, M.D., and JOHN P. DORST, M.D.

THIS PAPER WILL DESCRIBE a concept of converting the visual images on roentgenograms into numerical sequences that can be manipulated and evaluated by the digital computer and will report the results of employing this system to cause, against a background of air density, the intimate details of the relationship between tumor and host may be faithfully reproduced roentgenographically. Parenthetically, it may be stated that similar density ranges exist in the relationships

Computers for image classification



Computers for image classification



The Economist, ImageNet Stanford Vision Lab

Why AI for radiology?

Diagnostic errors play a role in up to 10% of patients deaths
Reporting error rate up to 20-30% more complex studies such as computed tomography (CT) and magnetic resonance imaging (MRI)
> 101 050 radiology reports contain clinically significant errors
~

Committee on Diagnostic Error in Health Care. 2016 National Academies Press (US), Washington (DC).
Insights Imaging. 2017 Feb; 8(1): 171–182.

Why AI for radiology?

Popular Latest **The Atlantic** My Account

HEALTH

Most of the World Doesn't Have Access to X-Rays

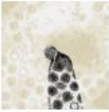
One hospital in Boston has 126 radiologists. Liberia has two.

JASON SILVERSTEIN SEPTEMBER 27, 2016

MORE STORIES

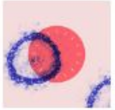
Trump's Pathology Is Now Clear

JAMES HAMBLIN

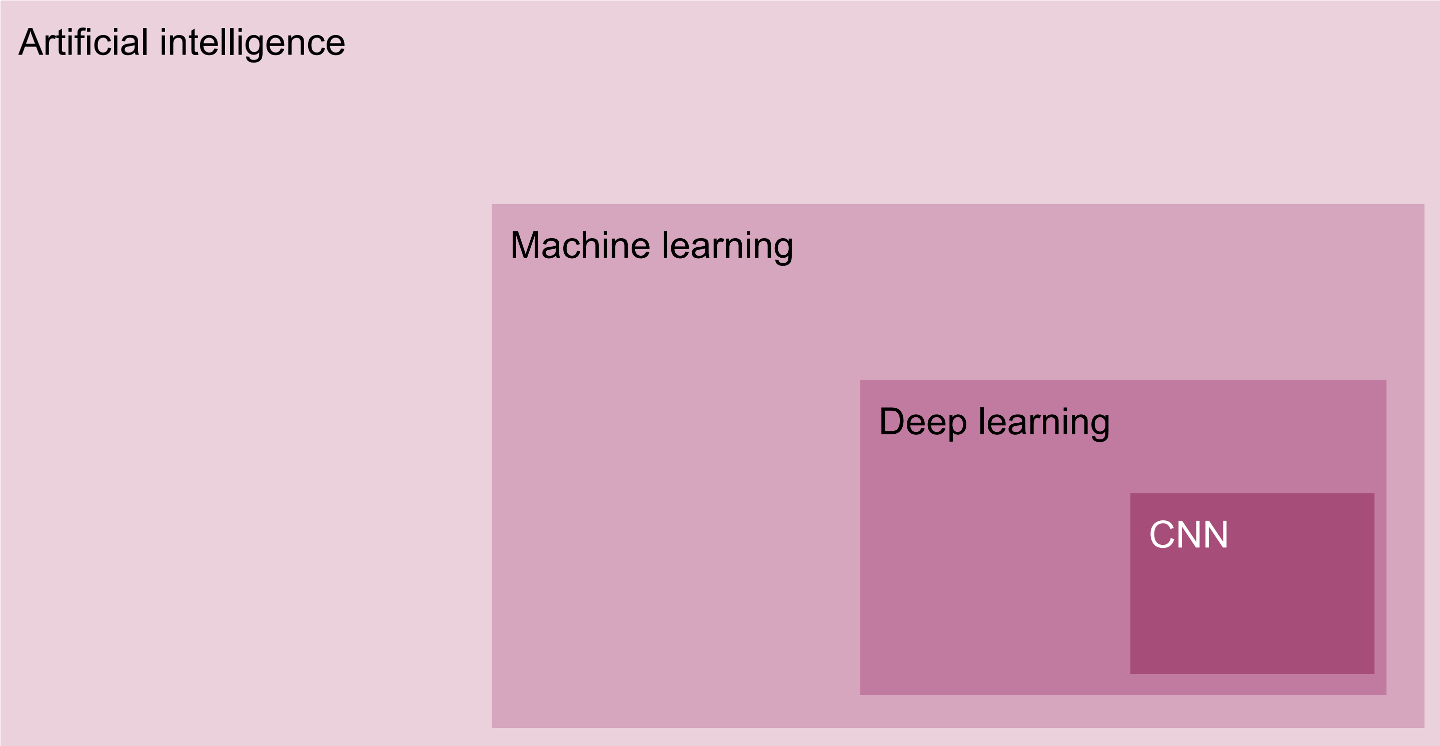


The Simple Rule That Could Keep COVID-19 Deaths Down

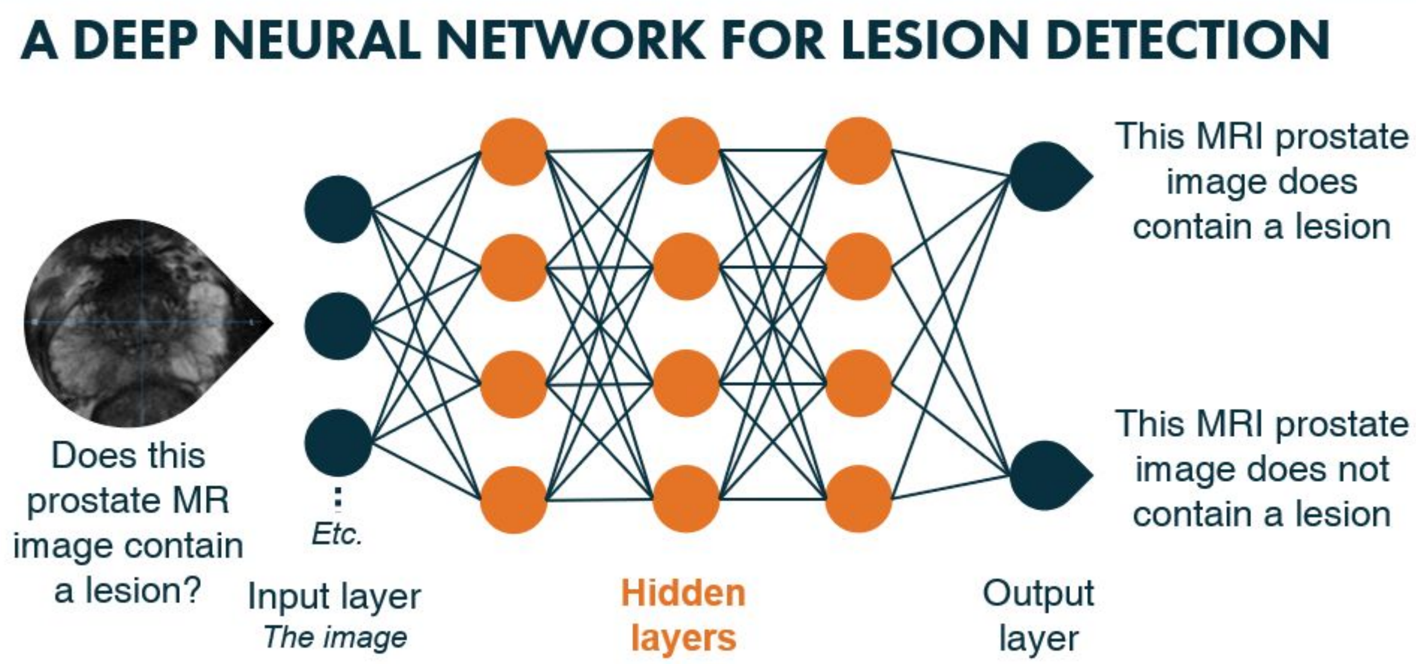
SARAH ZHANG



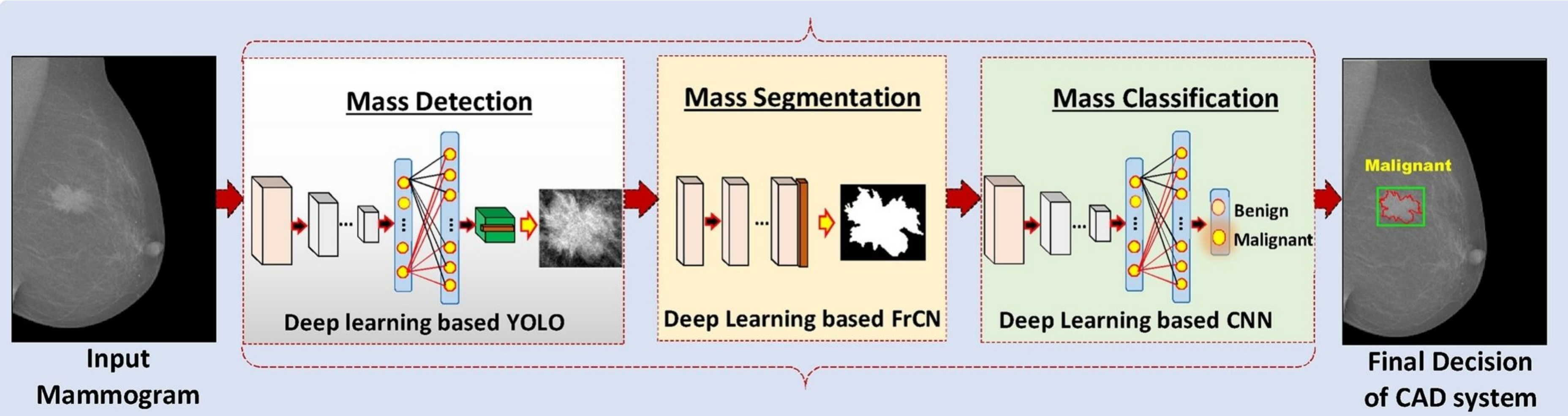
Some definitions



Convolutional Neural Networks (CNN)



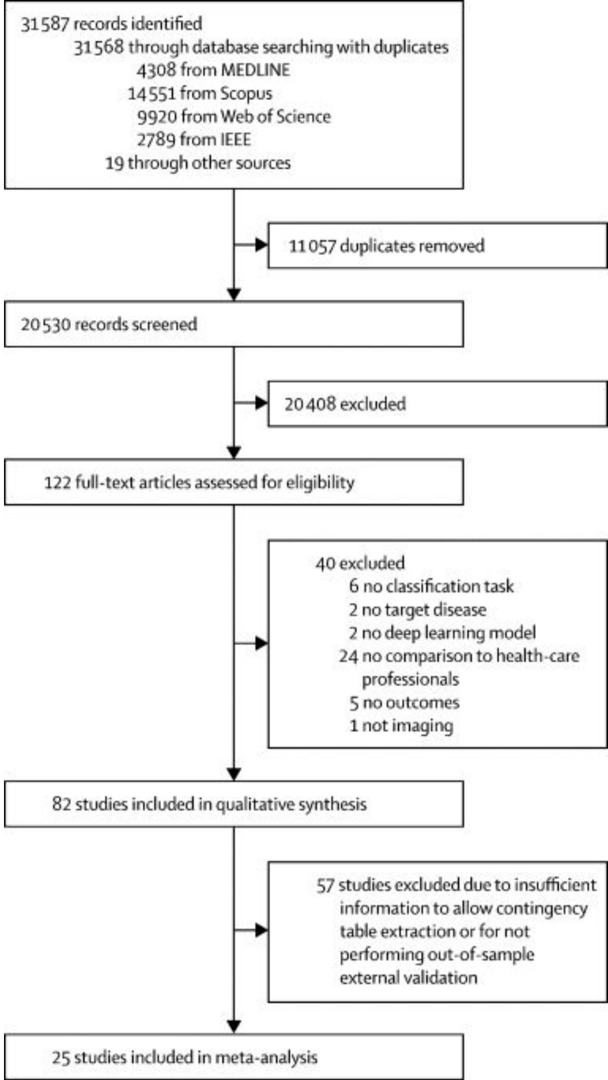
Example



Al-Antari et al.. *Int. J. Med. Inform*. 2018: 117, 44–54.

Diagnostic performance of AI vs health care professionals

Liu et al. 2019. A comparison of deep learning performance against health-care professionals in detecting diseases from medical imaging: a systematic review and meta-analysis. *The Lancet Digital Health* 1, e271–e297.



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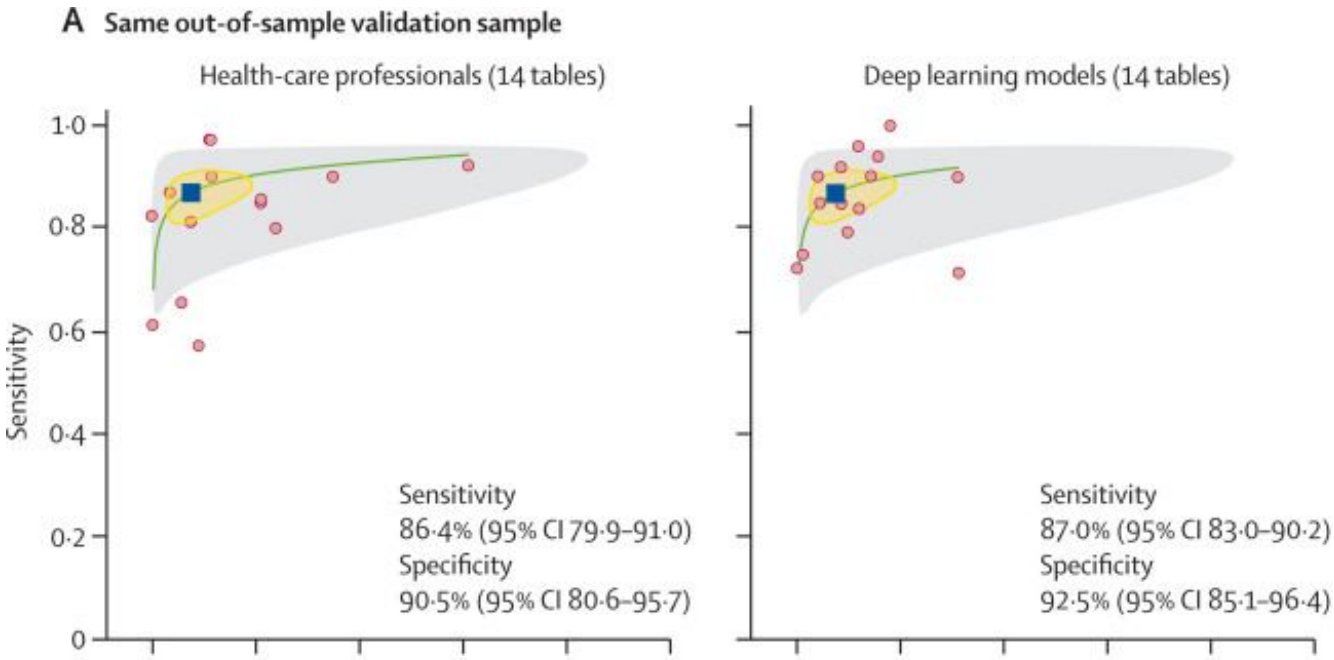
Diagnostic performance of AI vs health care professionals



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The Lancet Digital Health 2019: 1, e271–e297.

Major challenges ahead

1. Explainability
2. Augmented intelligence
3. Quality and quantity of data
4. Privacy issues
5. Legal issues and liability
6. Biased A.I.

Learn more

Liu et al. 2019. A comparison of deep learning performance against health-care professionals in detecting diseases from medical imaging: a systematic review and meta-analysis. *The Lancet Digital Health* 1, e271–e297.

Haibe-Kains et al. Transparency and reproducibility in artificial intelligence. *Nature* 586, E14–E16.

Meskó, B., Görög, M., 2020. A short guide for medical professionals in the era of artificial intelligence. *npj Digital Medicine* 3, 1–8.

European Society of Radiology (ESR), 2019. What the radiologist should know about artificial intelligence - an ESR white paper. *Insights Imaging* 10, 44.

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Part II AI Workflow for Medical Imaging Diagnosis: Critical steps from acquisition to prediction

Sergio Uribe, PhD, MSc, DDS
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Aim

To identify key stages from image acquisition and imaging protocols that allow the processing, annotation and use of images for the use of artificial intelligence algorithms

Critical steps

Aim: Proof of concept? Diagnostic accuracy? Patient outcomes?
Prospective or retrospective
Data de-identification
Data collection and curation

Resources

Shared Datasets

- CheXpert: Chest Xray's
- EchoNet-Dynamic Cardiac Ultrasound
- LERA- Lower Extremity RAdiographs
- MURA: MSK Xrays
- MRNet: Knee MRI's
- RSNA: Bone Age
- RSNA: CT Brain
- RSNA: Chest Xray's

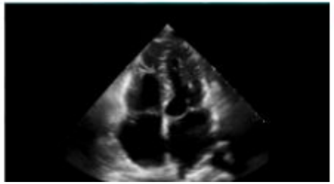
Software Tools

COVID-19

Shared Datasets

CheXpert: Chest X-rays

CheXpert is a dataset consisting of 224,316 chest radiographs of 65,240 patients who underwent a radiographic examination from Stanford University Medical Center between October 2002 and July 2017, in both inpatient and outpatient centers. Included are their associated radiology reports.



EchoNet-Dynamic Cardiac Ultrasound

EchoNet-Dynamic is a dataset of over 10k echocardiogram, or cardiac ultrasound, videos from unique patients at Stanford University Medical Center. Each apical-4-chamber video is accompanied by an estimated ejection fraction, end-systolic volume, end-diastolic volume, and dataverse.rsu.lv/dataverse/rsu/

Dataverse

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Dataverse (RSU)

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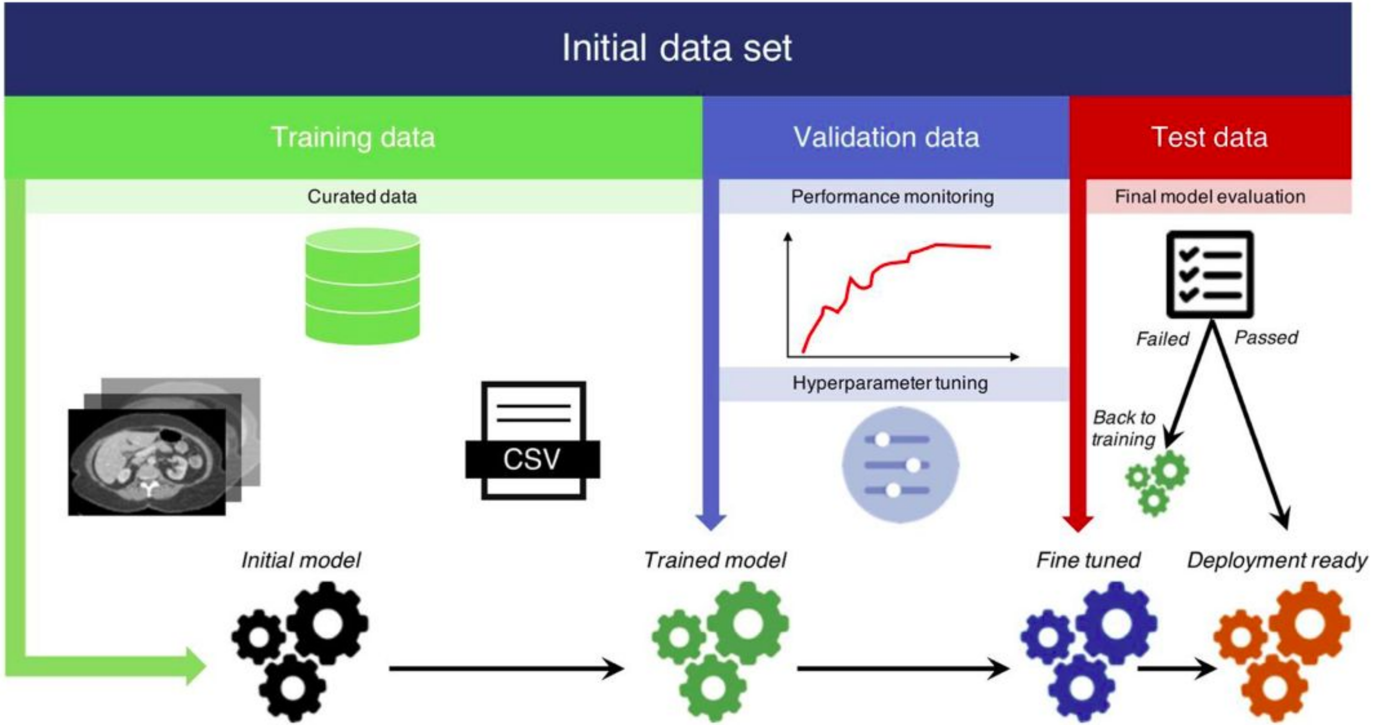
Critical steps

Aim: Proof of concept? Diagnostic accuracy? Patient outcomes?
Prospective or retrospective
Data de-identification
Data collection and curation
Reference standard
Dataset sampling strategies

Types of datasets



Critical steps

Aim: Proof of concept? Diagnostic accuracy? Patient outcomes?
Prospective or retrospective
Data de-identification
Data collection and curation
Reference standard
Dataset sampling strategies
Deep learning libraries and architectures

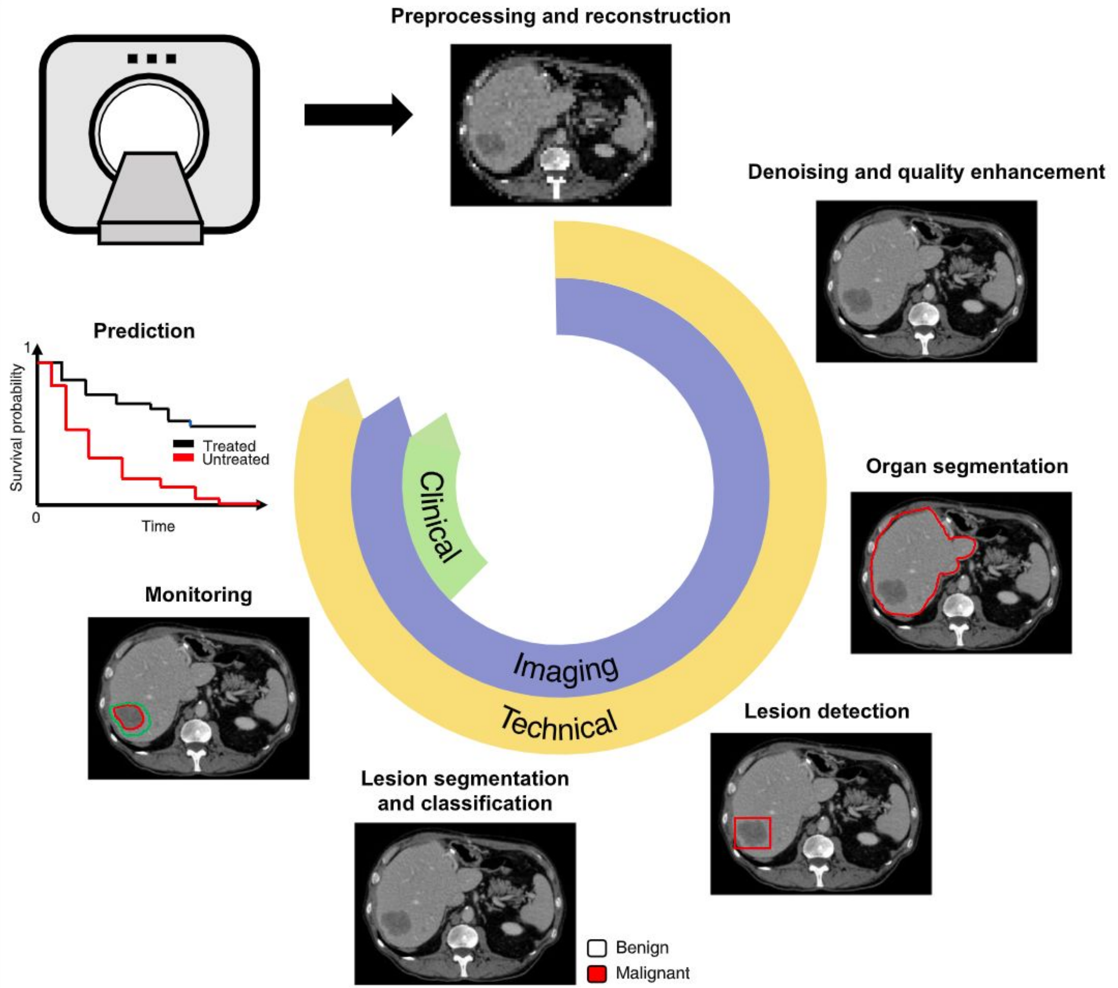


Fig. 1 Potential clinical uses of deep learning techniques. Tasks such as monitoring of treatment response or prediction of survival, can be derived from lesion detection, classification, and longitudinal follow-up

Metrics

	Detection	Segmentation	Classification	Prediction
Features	-Bounding boxes -Masks	-Lesion patch -Full image at max diameter -Radiomics features -Masks	-Lesion patch -Radiomic features	-Lesion patch -Time to recurrence -Survival time -TRG
Model architectures	-CNN	-U-Net	-Fully connected	-CNN
Performance metrics	-Intersection over union (IOU) -Mean average precision (mAP)	-Dice score -IOU	-Receiver operating characteristic (ROC) -Accuracy	-ROC curve -Accuracy -R^2

Project Manager

Clinical

Physicians and surgeons

Problem formulation

Task definition and specifications

Eligibility criteria

Retrospective vs. prospective cohorting

Reference standard

Imaging

Radiologists and technologists

Imaging examinations

Collection

Selection

Anonymization vs. de-identification

Lesions

Detection

Annotations and markups

Segmentation

Technical

Data scientists and computer scientists

Dataset

Visualization

Cleaning

Sampling: training, test and validation

Models

Framework, models and metrics

Training and fine tuning

Validation

Deployment

Report

nature medicine
CONSENSUS STATEMENT
https://doi.org/10.1038/s41591-020-1037-7
Check for updates

OPEN

Guidelines for clinical trial protocols for interventions involving artificial intelligence: the SPIRIT-AI extension

Samantha Cruz Rivera[1,2,3], Xiaoxuan Li
Melanie J. Calvert[1,2,3,6,10,11,12], The SPI
CONSORT-AI Steering Group and SPI

CONSENSUS STATEMENT
https://doi.org/10.1038/s41591-020-1034-x
nature medicine
Check for updates

OPEN

Reporting guidelines for clinical trial reports for interventions involving artificial intelligence: the CONSORT-AI extension

Xiaoxuan Liu[1,2,3,4,5], Samantha Cruz Rivera[5,6,7], David Moher[8,9], Melanie J. Calvert[4,5,6,7,10,11,12], Alastair K. Denniston[2,3,4,5,6,13] ✉ and The SPIRIT-AI and CONSORT-AI Working Group*

Learn more

Lambin P, Rios-Velazquez E, Leijenaar R et al (2012) Radiomics: extractin gmore information from medical images using advanced feature analysis. *Eur J Cancer* 48:441–446

Gebru T, Morgenstern J, Vecchione B et al (2018) Datasheets for datasets. Available via https://arxiv.org/abs/1803.09010. Accessed 3 Sept 2020

SPIRIT-AI and CONSORT-AI Consensus Group, 2020. Guidelines for clinical trial protocols for interventions involving artificial intelligence: the SPIRIT-AI extension. *Nat. Med.* 26, 1351–1363.

SPIRIT-AI and CONSORT-AI Working Group, 2020. Reporting guidelines for clinical trial reports for interventions involving artificial intelligence: the CONSORT-AI extension. *Nat. Med.* 26, 1364–1374.

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