Artificial Intelligence in Healthcare

1. Introduction to Artificial Intelligence (AI)
2. AI applied in healthcare
3. AI applied in Critical Care units
4. Ethics and Regulations

Dima Siblani, MD.

Réanimation Médicale, Hôpital Emile Muller

No Conflict of Interest to Disclose

Introduction to Artificial Intelligence

“The science and engineering of making intelligent machines”

John McCarthy in 1955

Thinking Humanly

The cognitive modeling approach

Thinking Rationally

The law of thoughts approach

Acting Humanly

Acting Rationally

Philosophy

Mathematics

Economics

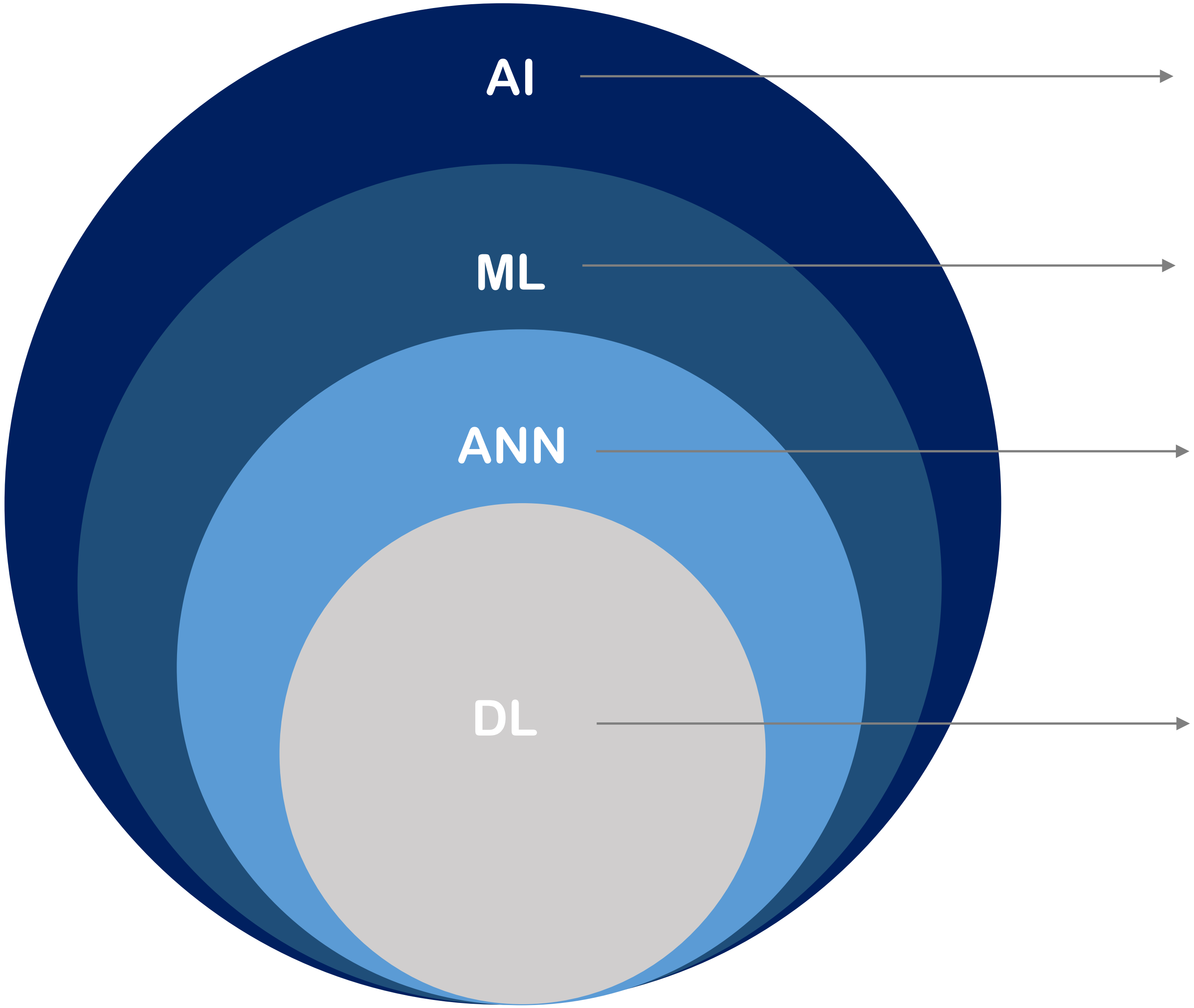
Neuroscience

Psychology

Computer engineering

Control theory & cybernetics

Linguistics



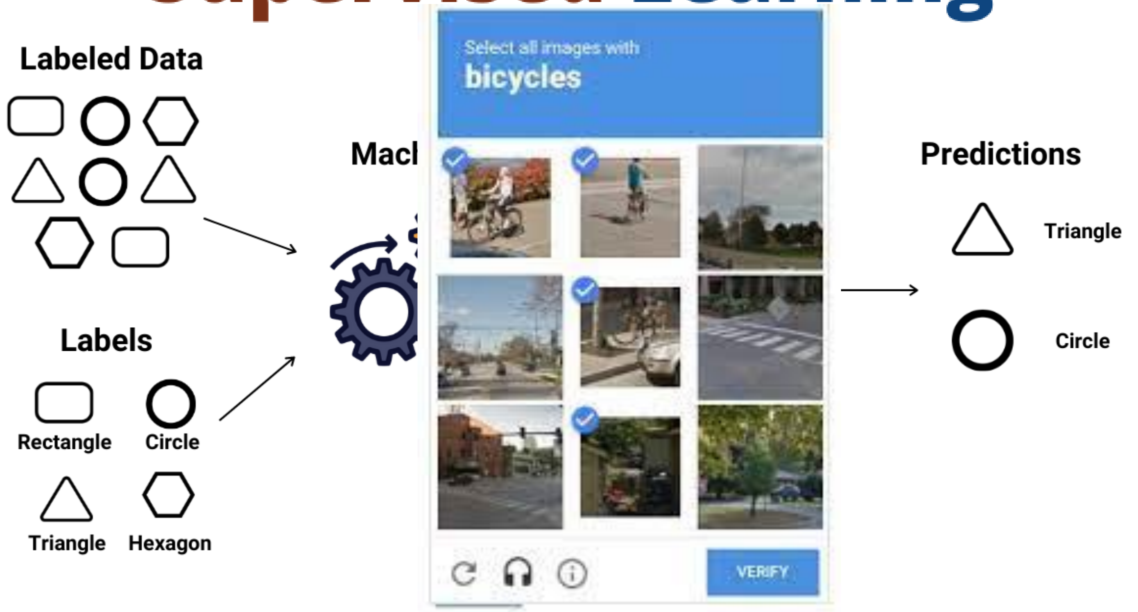
Artificial Intelligence (AI)
Techniques that enable machine to solve a task in a way like human do

Machine Learning(ML)
Algorithm that allow computers to learn without being explicitly programmed

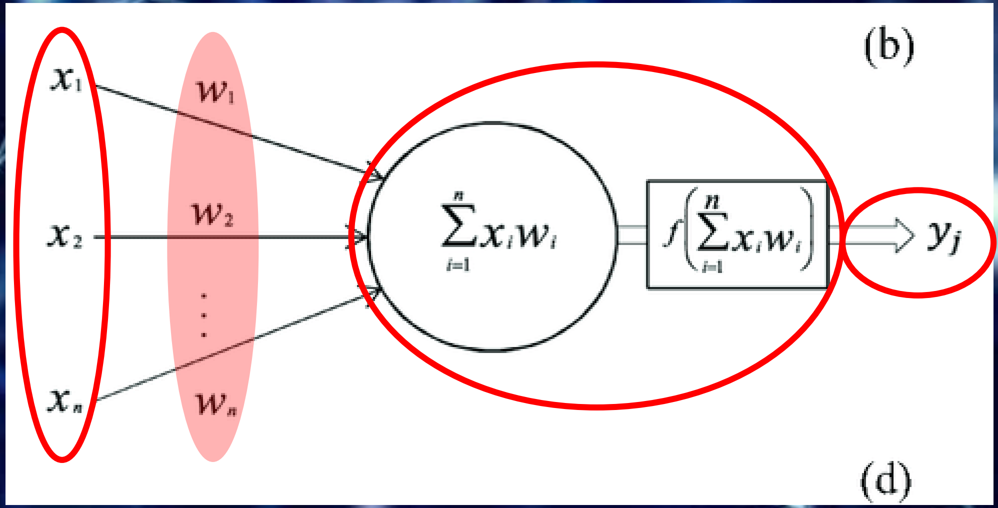
Artificial Neural Network(ANN)
Brain-inspired learning algorithm

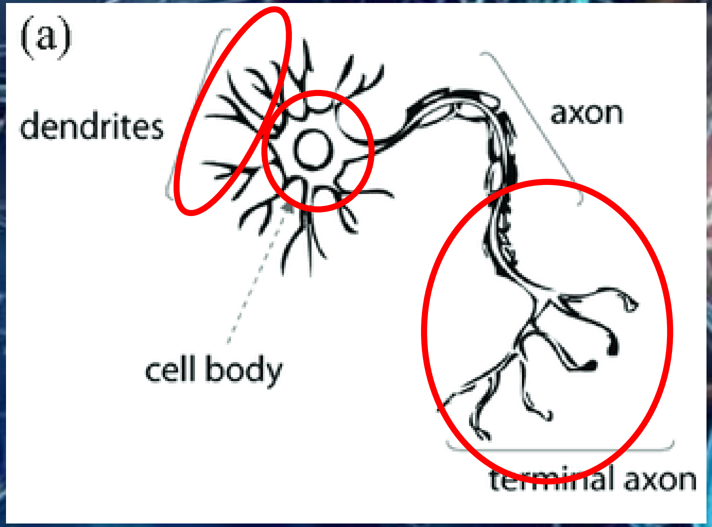
Deep Learning (DL)
A subset of machine learning using deep ANN

Supervised Learning

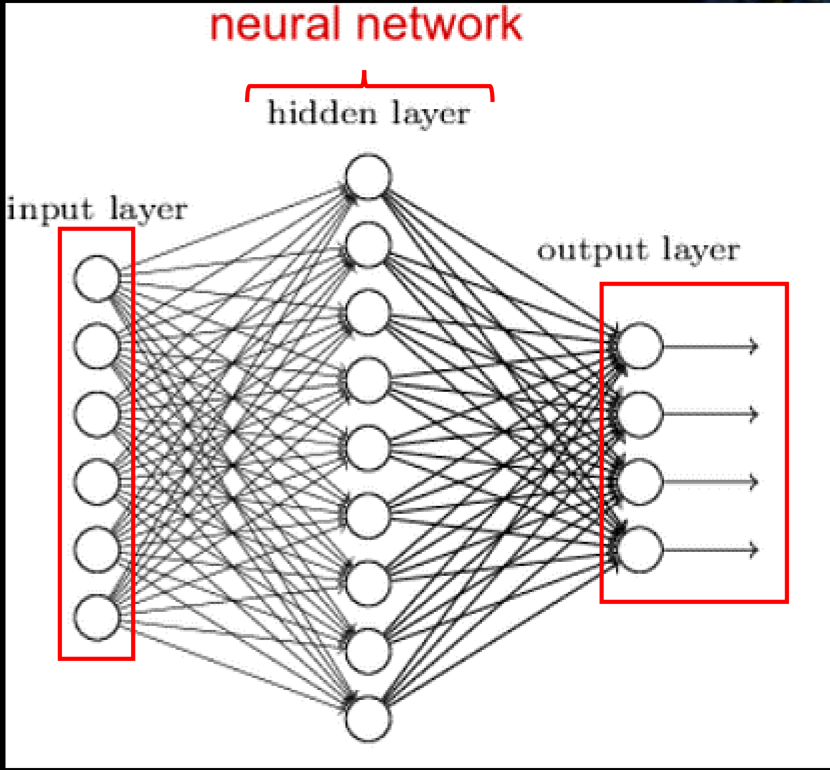


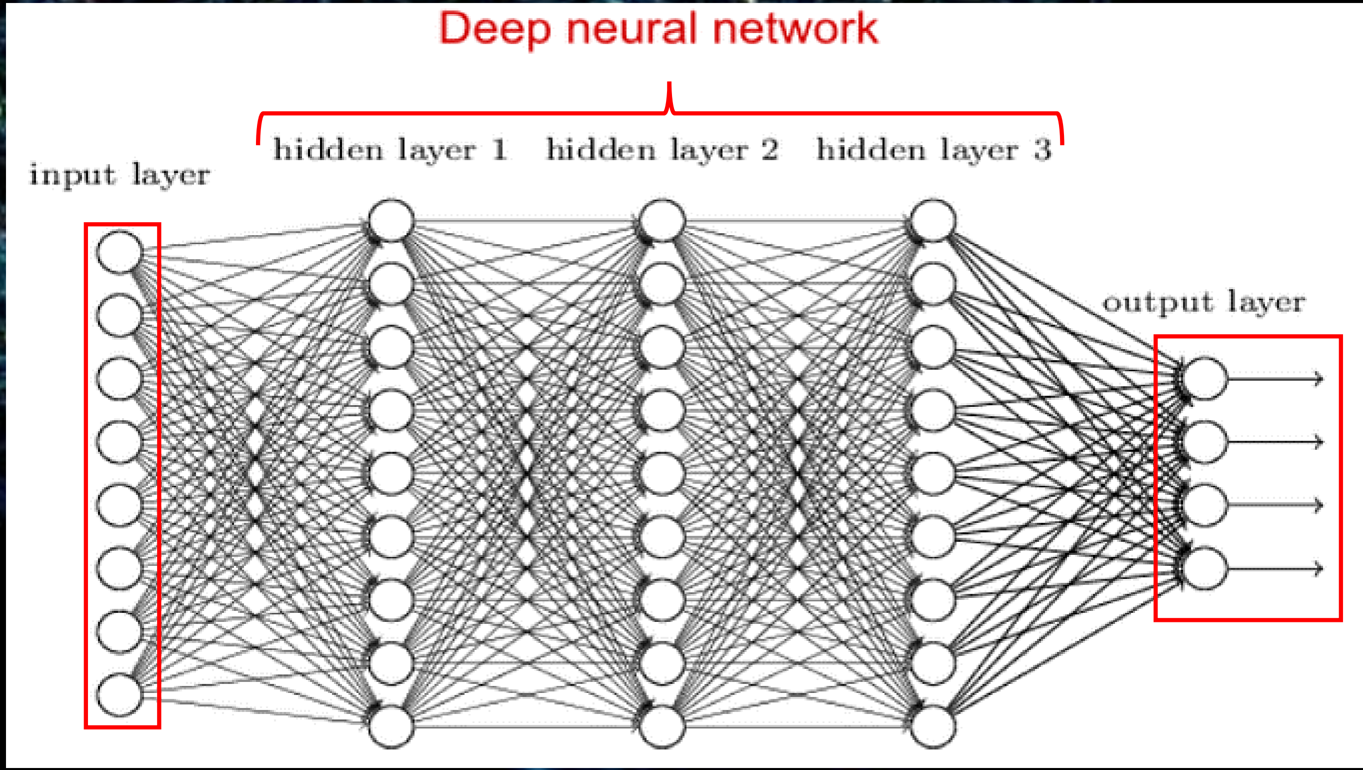
Artificial Neurone

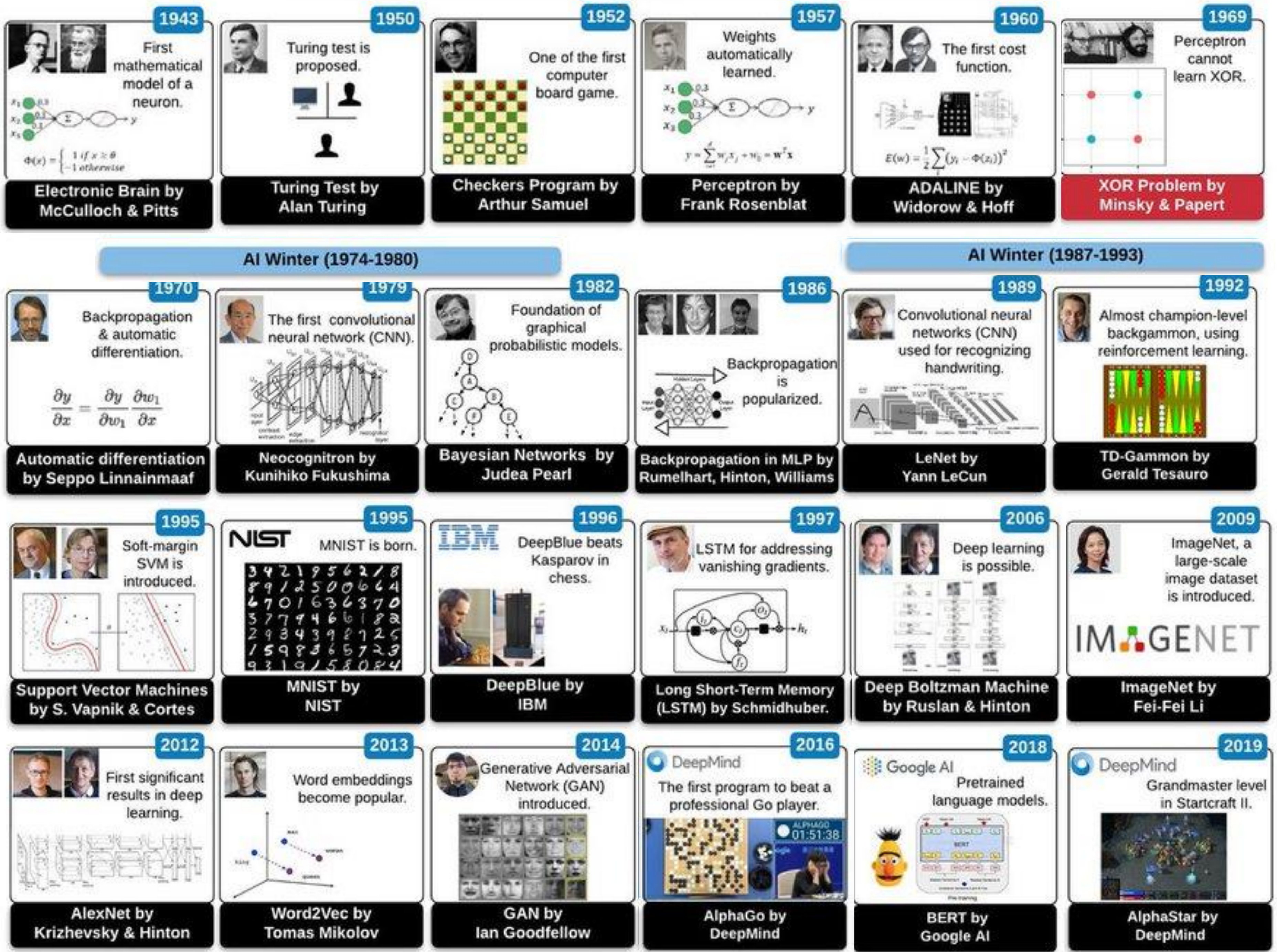




Neural Network

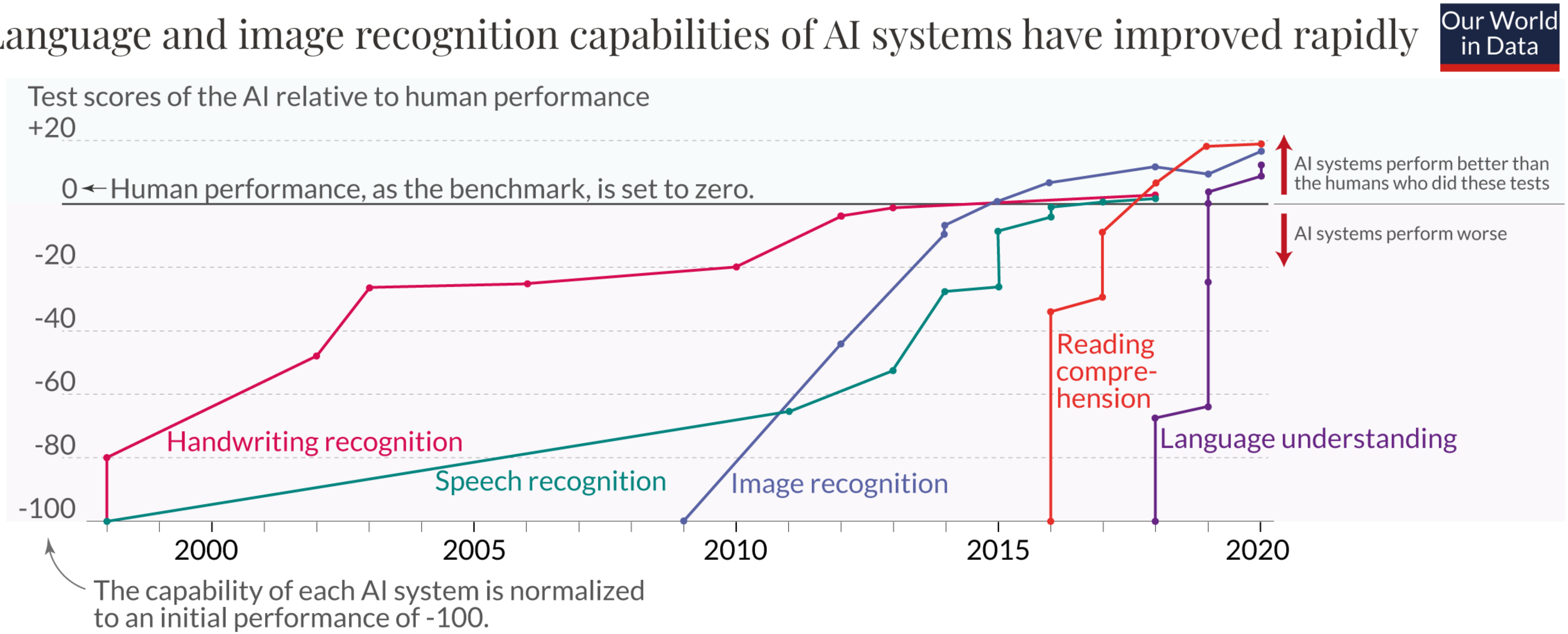






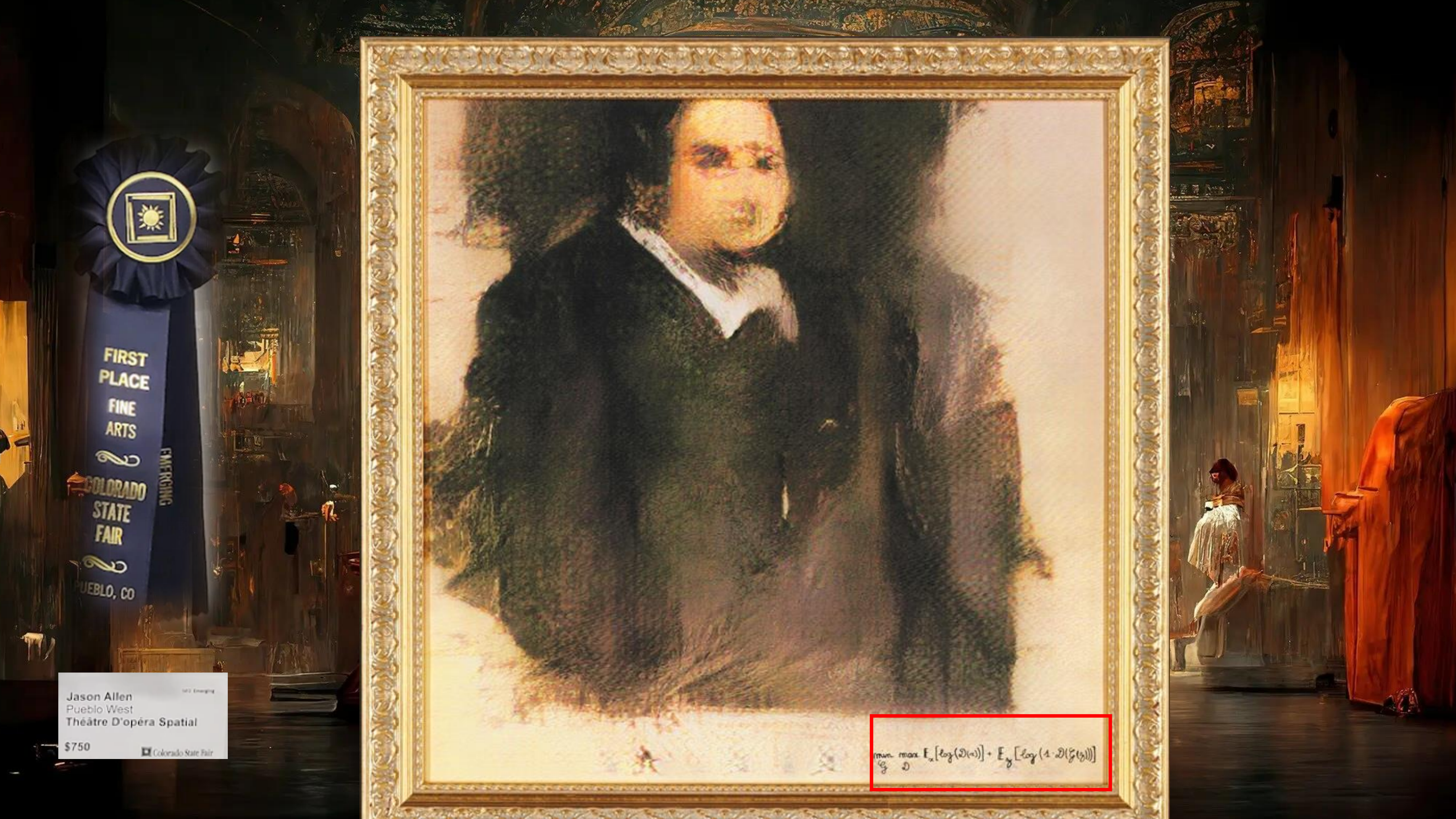
Parisa Rashidi, May 2020. CC BY 4.0

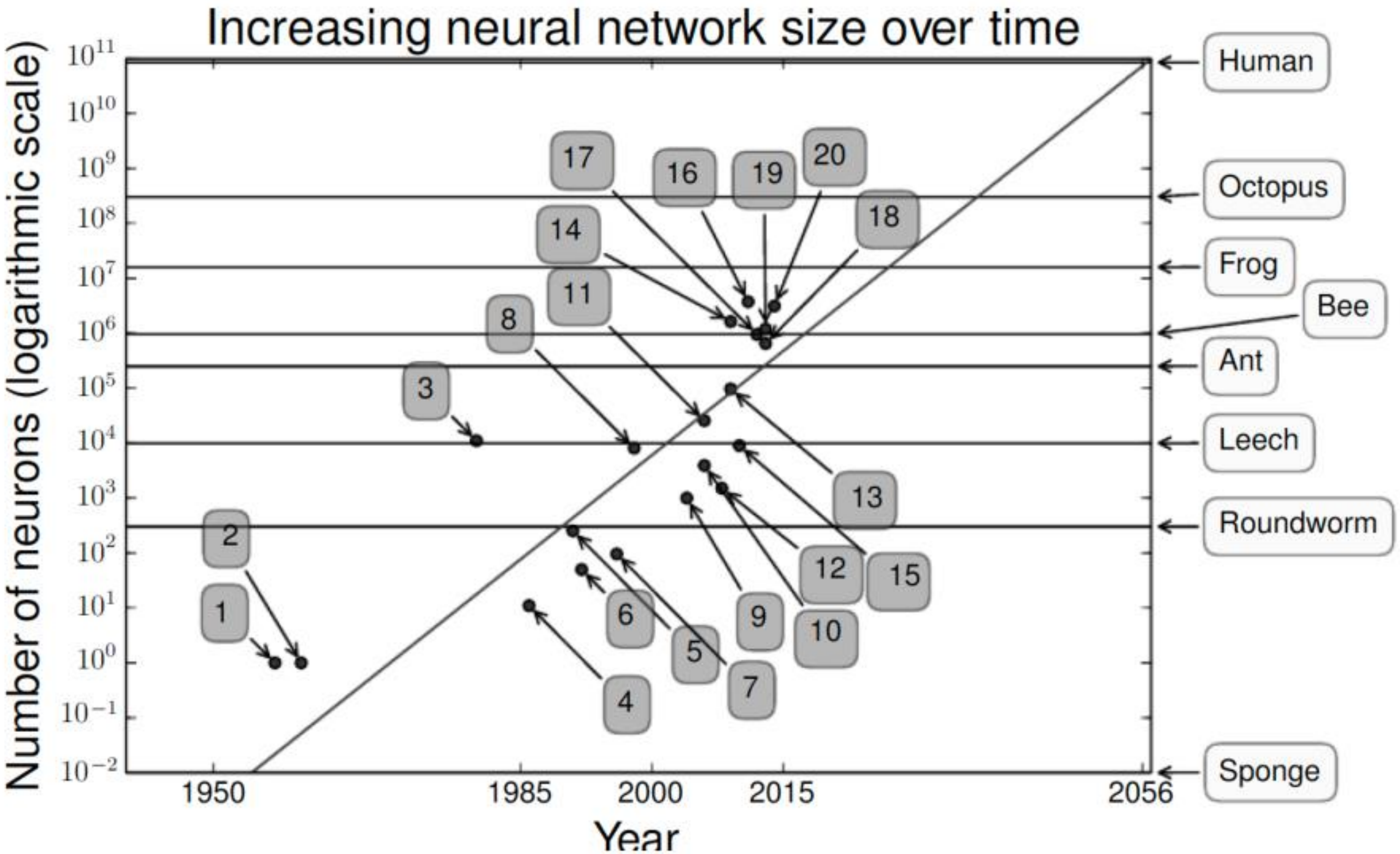
Language and image recognition capabilities of AI systems have improved rapidly



Data source: Kiela et al. (2021) – Dynabench: Rethinking Benchmarking in NLP
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Max Roser


FIRST PLACE
FINE ARTS
COLORADO STATE FAIR
EMERGING
PUEBLO, CO
Jason Allen
Pueblo West
Théâtre D'opéra Spatial
$750
Colorado State Fair
$\min_G \max_D E_x[\log(D(x))] + E_z[\log(1 - D(G(z)))]$



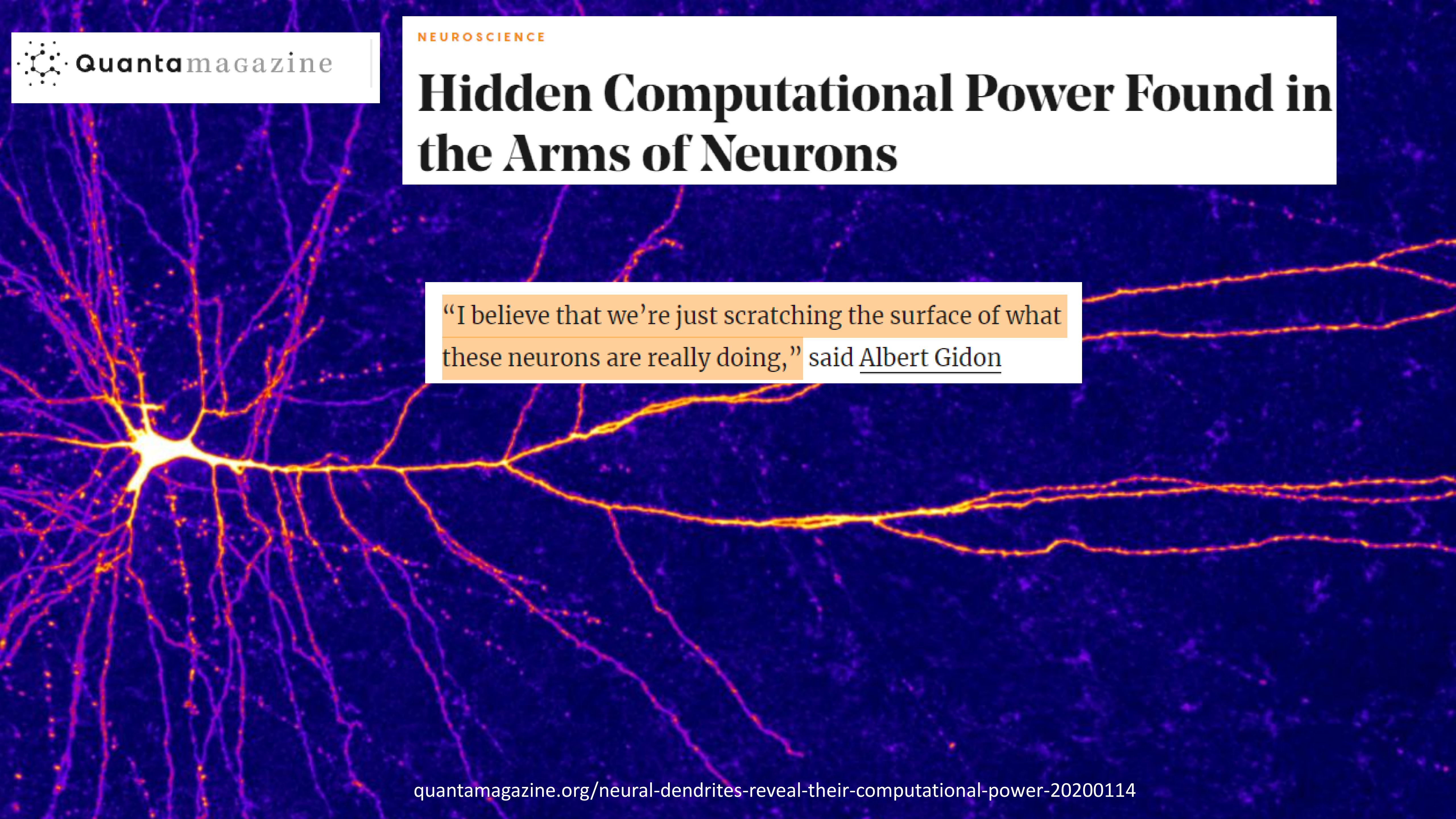
1. Perceptron (Rosenblatt, 1958, 1962)
2. Adaptive Linear Element (Widrow and Hoff, 1960)
3. Neocognitron (Fukushima, 1980)
4. Early backpropagation network (Rumelhart *et al.*, 1986b)
5. Recurrent neural network for speech recognition (Robinson and Fallside, 1991)
6. Multilayer perceptron for speech recognition (Bengio *et al.*, 1991)
7. Mean field sigmoid belief network (Saul *et al.*, 1996)
8. LeNet-5 (LeCun *et al.*, 1998b)
9. Echo state network (Jaeger and Haas, 2004)
10. Deep belief network (Hinton *et al.*, 2006)
11. GPU-accelerated convolutional network (Chellapilla *et al.*, 2006)
12. Deep Boltzmann machines (Salakhutdinov and Hinton, 2009a)
13. GPU-accelerated deep belief network (Raina *et al.*, 2009)
14. Unsupervised convolutional network (Jarrett *et al.*, 2009b)
15. GPU-accelerated multilayer perceptron (Ciresan *et al.*, 2010)
16. OMP-1 network (Coates and Ng, 2011)
17. Distributed autoencoder (Le *et al.*, 2012)
18. Multi-GPU convolutional network (Krizhevsky *et al.*, 2012a)
19. COTS HPC unsupervised convolutional network (Coates *et al.*, 2013)
20. GoogLeNet (Szegedy *et al.*, 2014a)

Quanta magazine

NEUROSCIENCE

Hidden Computational Power Found in the Arms of Neurons

"I believe that we're just scratching the surface of what these neurons are really doing," said Albert Gidon



quantamagazine.org/neural-dendrites-reveal-their-computational-power-20200114


AI in Healthcare

○ Face recognition:

FDNA was incorporated with a mission to give hope to children with rare diseases, and their families.

Deep Learning and Computer Vision

Deep learning algorithms build syndrome-specific

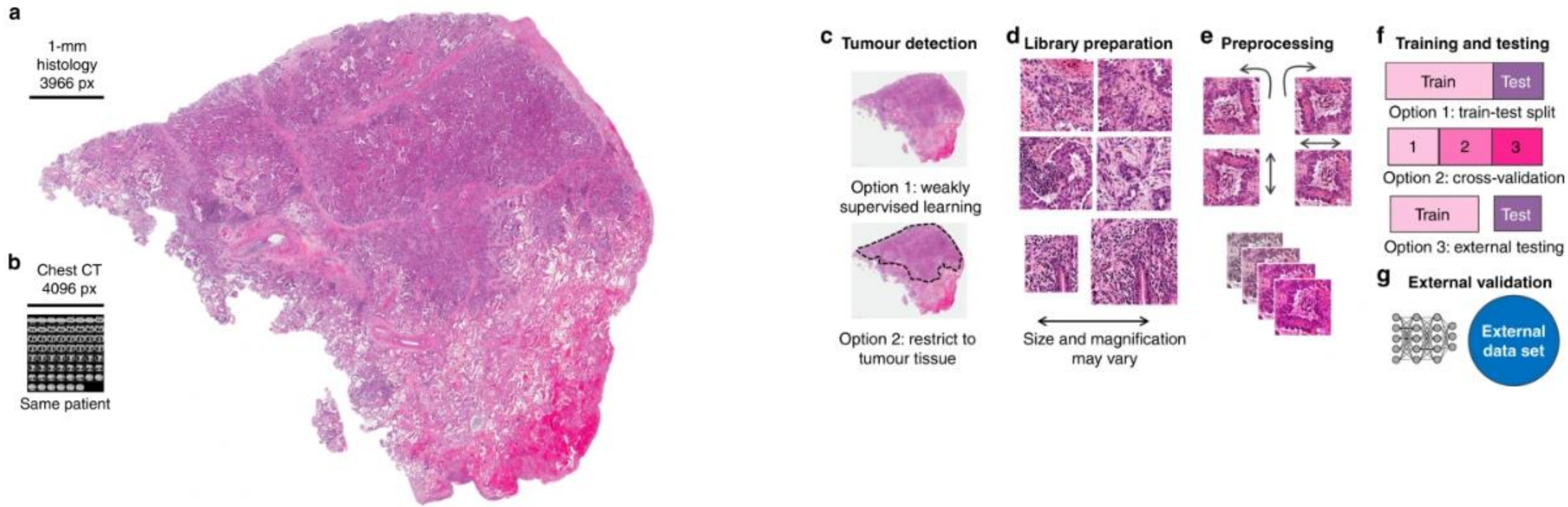
Image Processing

- Pathology

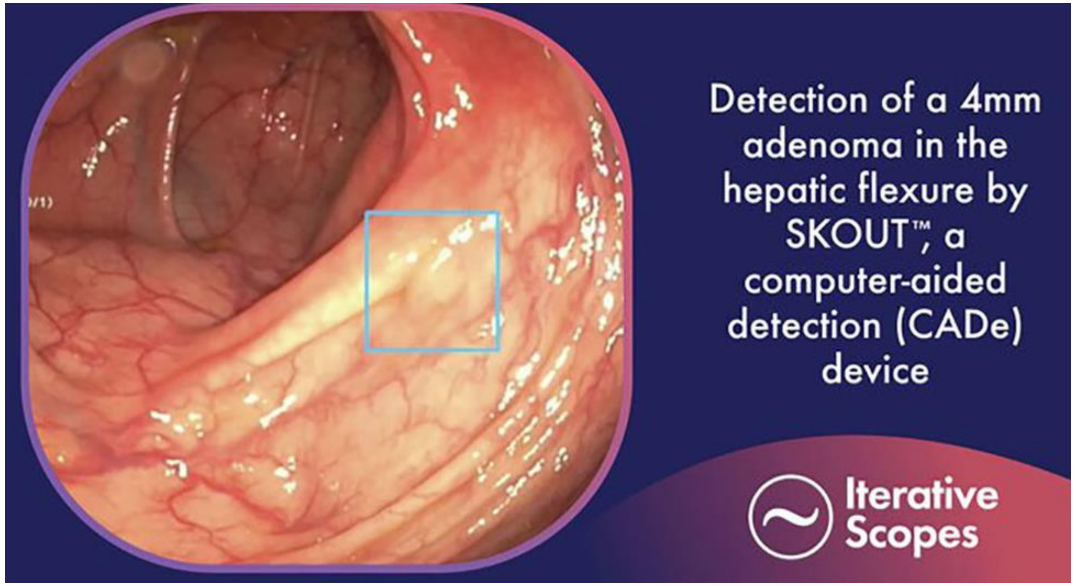
Review Article | Open Access | Published: 18 November 2020

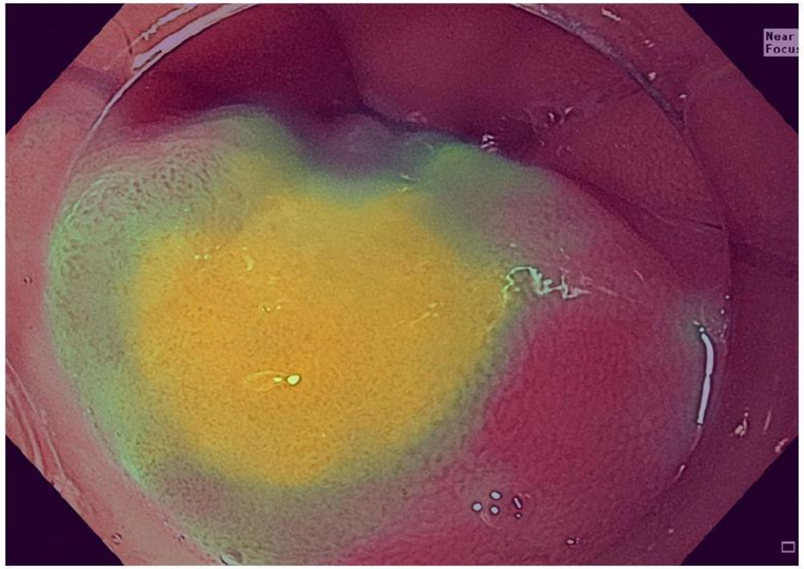
Deep learning in cancer pathology: a new generation of clinical biomarkers

Fig. 1: Consensus pipeline of deep learning in pathology.



○ GI Endoscopy





Artificial intelligence in gastroenterology: A state-of-the-art review. World journal gastroenterology

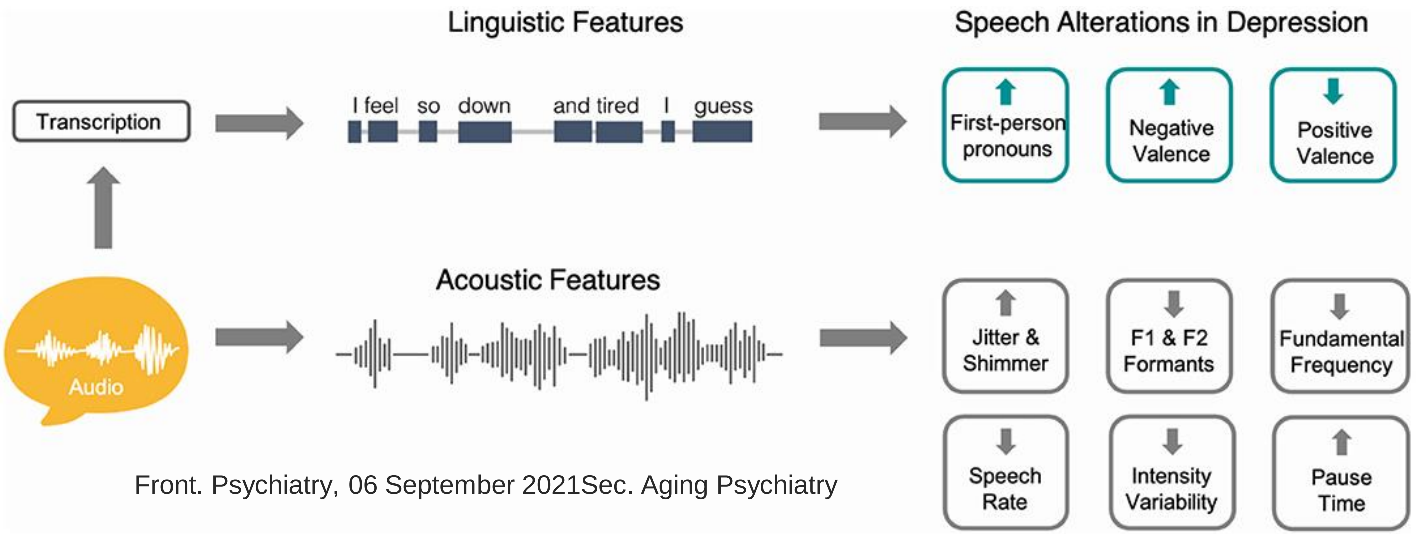
Ther Adv Gastrointest Endosc. 2021 Jan-Dec;

Image Processing

Language Processing

- **Chat-bot:** Primary care, Mental health, History of present illness, weight loss..

- **Voice recognition:**



Front. Psychiatry, 06 September 2021Sec. Aging Psychiatry

- **Data Retrieval:**

Western Pacific THE LANCET *Regional Health*

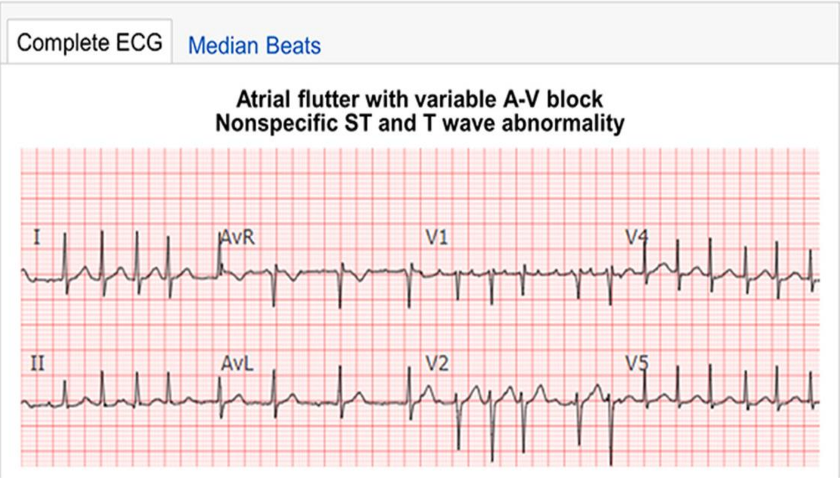
Applying natural language processing to electronic medical records for estimating healthy life expectancy

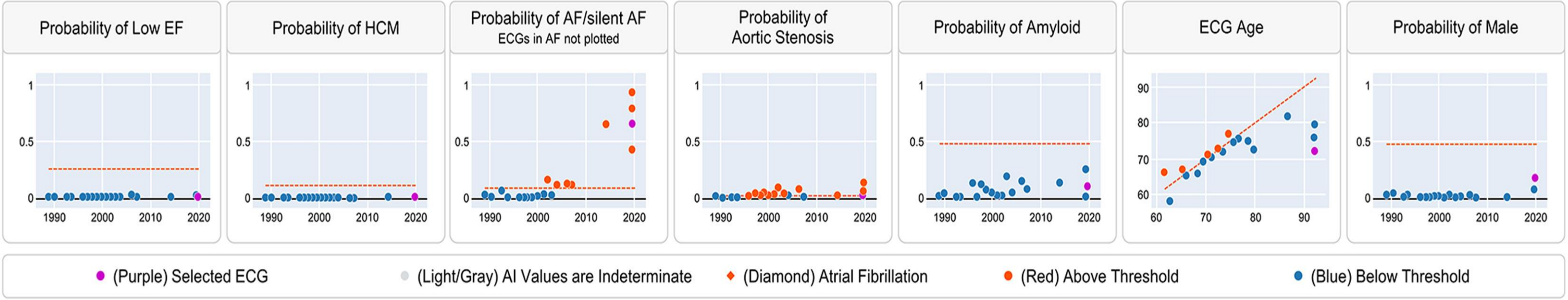
VOLUME 9, 100132, APRIL 01, 2021

Image Processing | Language Processing | **Signal Processing**

○ Feature Extraction: ECG

(1) Performing human-like tasks
(2) Extending human capability to "sees beyond" human eyes capability





Emerging role of artificial intelligence in cardiac electrophysiology. Cardiovascular digital health journal. December 2022

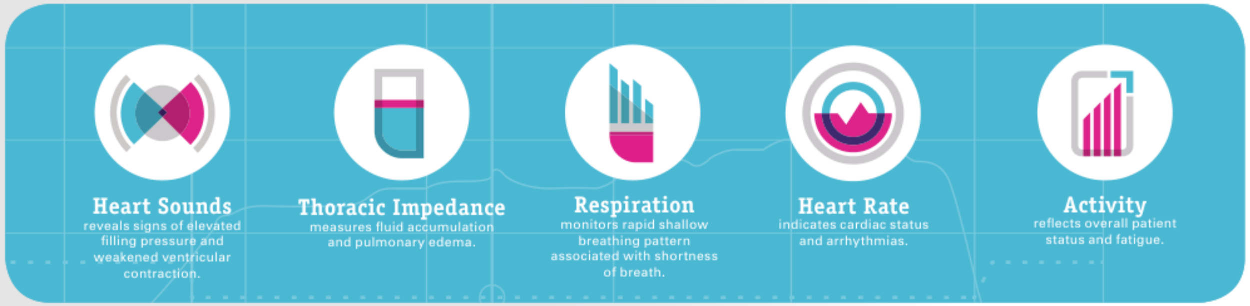
Image Processing | Language Processing | Signal Processing | **Monitoring/IOT**

○ Cardiac Monitoring

Boston Scientific
Advancing science for life™

HeartLogic™ Heart Failure Diagnostic

Multisensor Chronic Evaluation in Ambulatory Heart Failure Patients (MultiSENSE Study) Demonstrated High Sensitivity, Low Alert Burden and Weeks of Advance Notice of a Heart Failure Event



The study assessed **more than 900 patients** who had enhanced sensor data collection enabled in their cardiac resynchronization therapy defibrillator (CRT-D) systems. The data validated the alert to have:

an observed sensitivity of **70%**

The ability to provide weeks of advance notice – a median of **34-days** ahead of an impending HF event – and low burden for detecting indications of worsening HF.[4]

34 days

The following were observed in the MultiSENSE Study:

THE HEARTLOGIC DIAGNOSTIC PERFORMANCE*

- Observed sensitivity to detect a hospitalization or unplanned intravenous therapy primarily for heart failure of **70%**
- Low burden of **less than two total alerts per patient per year**
- Success in alerting clinicians of an associated HF event with weeks of advance notice
  - **34 day median alert window**
  - **89%** of events had alert occur **at least 2 weeks before event**

HF EVENT RATE DURING AN ALERT*

- **10 times higher HF event rate** when in vs. out of alert (0.80 vs. 0.08 events per patient per year)
- **5.9 times higher HF event rate** when in vs. out of alert after adjusted for baseline characteristics: N-terminal pro b-type natriuretic peptide (NT-proBNP), history of atrial fibrillation, renal disease, New York Heart Association (NYHA) functional classification, diabetes, left ventricular ejection fraction, plasma total protein and sodium
- **83%** of patient-days out of alert

SLEEP INCLINE TREND

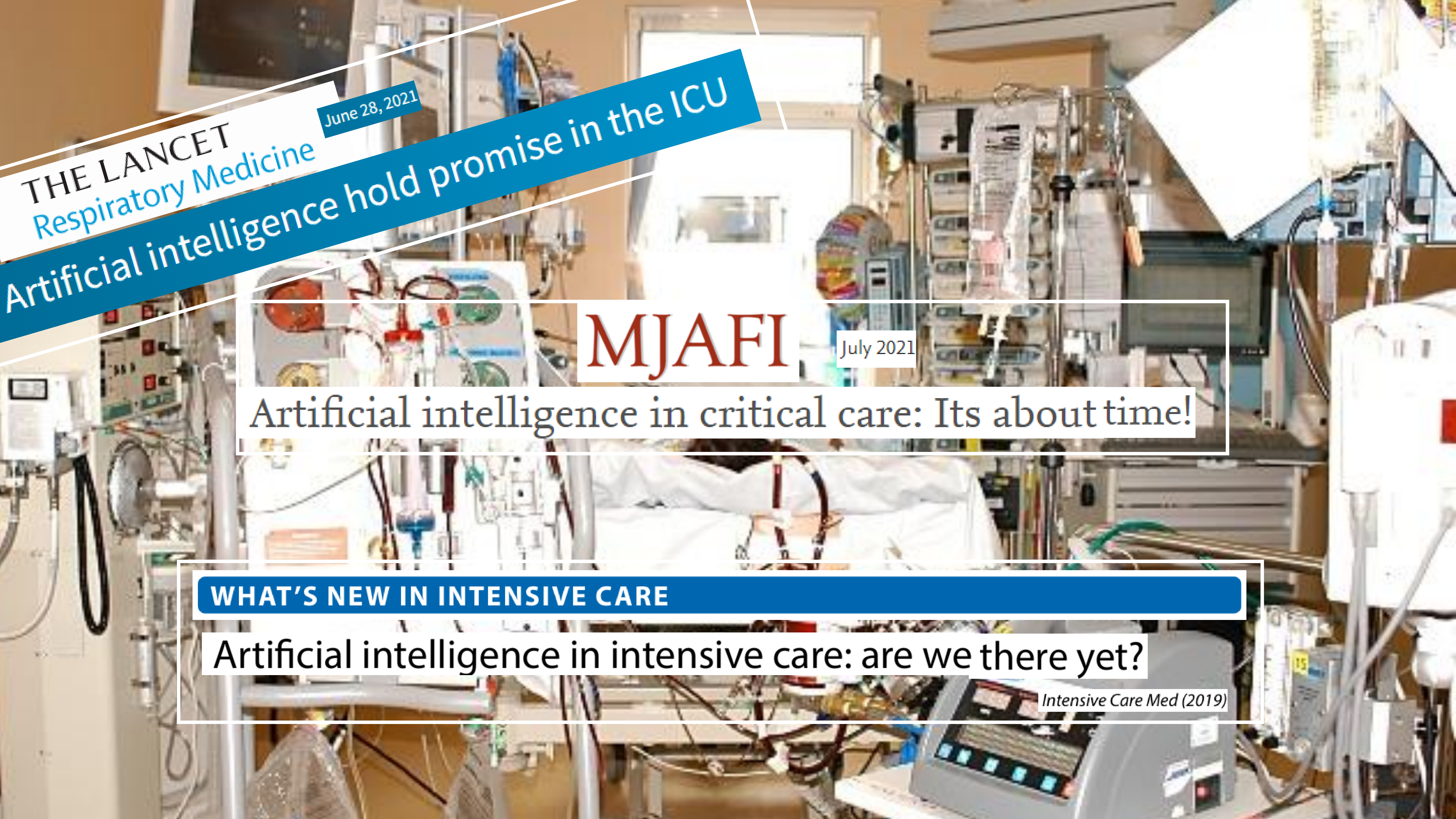
- Available only in the Boston Scientific Resonate™ family of implantable cardioverter defibrillator (ICD) and CRT-D devices in addition to the HeartLogic Diagnostic
- **Elevated sleep incline angle** was indicative of Orthopnea or Paroxysmal nocturnal dyspnea[5,6]

The HeartLogic Heart Failure Diagnostic and sleep incline trend have CE Mark and U.S. Food and Drug Administration approval within the Resonate™ family of ICD and CRT-D systems.

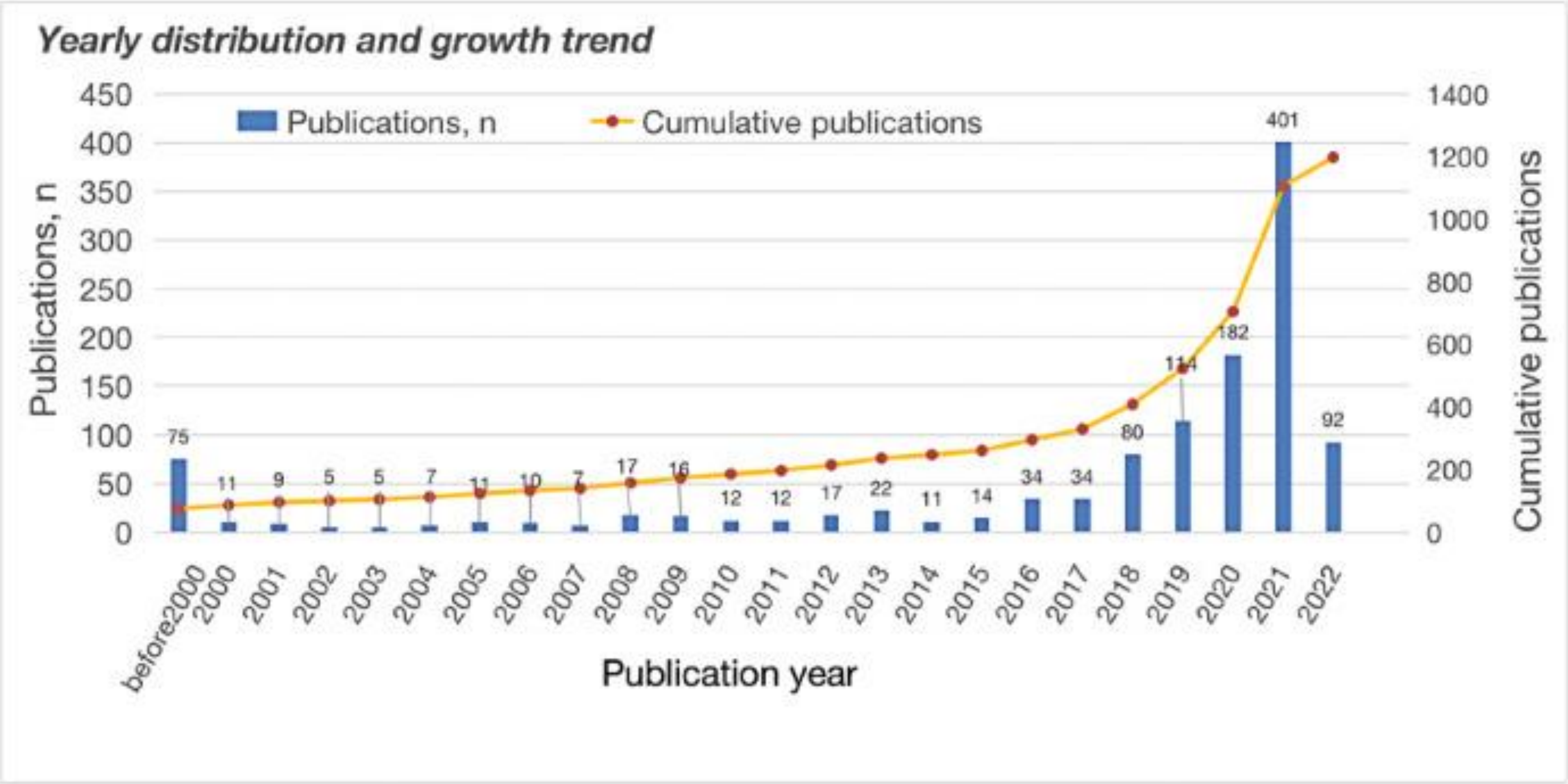
Image Processing | Language Processing | Signal Processing | Monitoring/IOT | **Other**

- Clinical Trial
- Genetics
- Pharmacology and Drug Industry

Trends in Pharmacological Sciences, August 2019

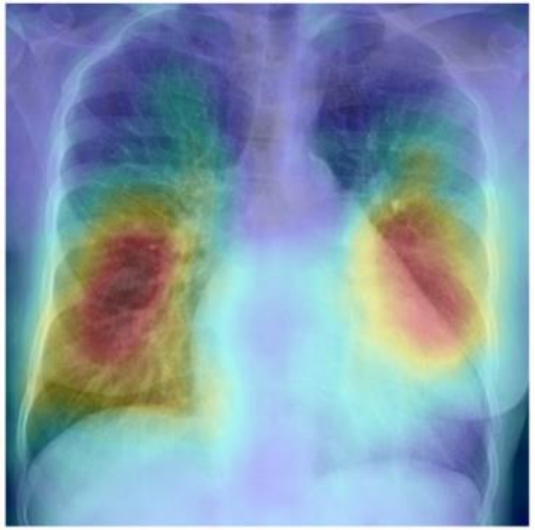

THE LANCET
Respiratory Medicine
June 28, 2021
Artificial intelligence hold promise in the ICU
MJAFI
July 2021
Artificial intelligence in critical care: Its about time!
WHAT'S NEW IN INTENSIVE CARE
Artificial intelligence in intensive care: are we there yet?
Intensive Care Med (2019)

The annual and cumulative numbers of research articles on artificial intelligence in intensive care in Scopus from 1986 to 2022

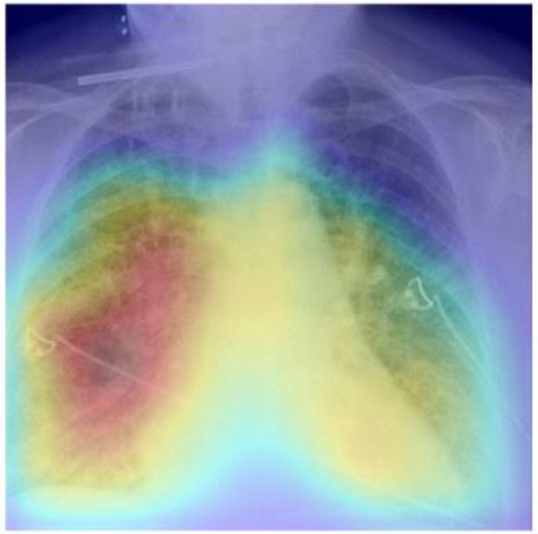


J Med Internet Res. 2022 Nov; 24(11): e42185.. Published online November 2022

Disease Identification



Vascular Congestion



Pulmonary Edema

Deep learning to quantify pulmonary edema in chest radiographs. Radiol Artif Intell. 2021

Radiology

Using Artificial Intelligence to Detect COVID-19 and Community-acquired Pneumonia Based on Pulmonary CT: Evaluation of the Diagnostic Accuracy

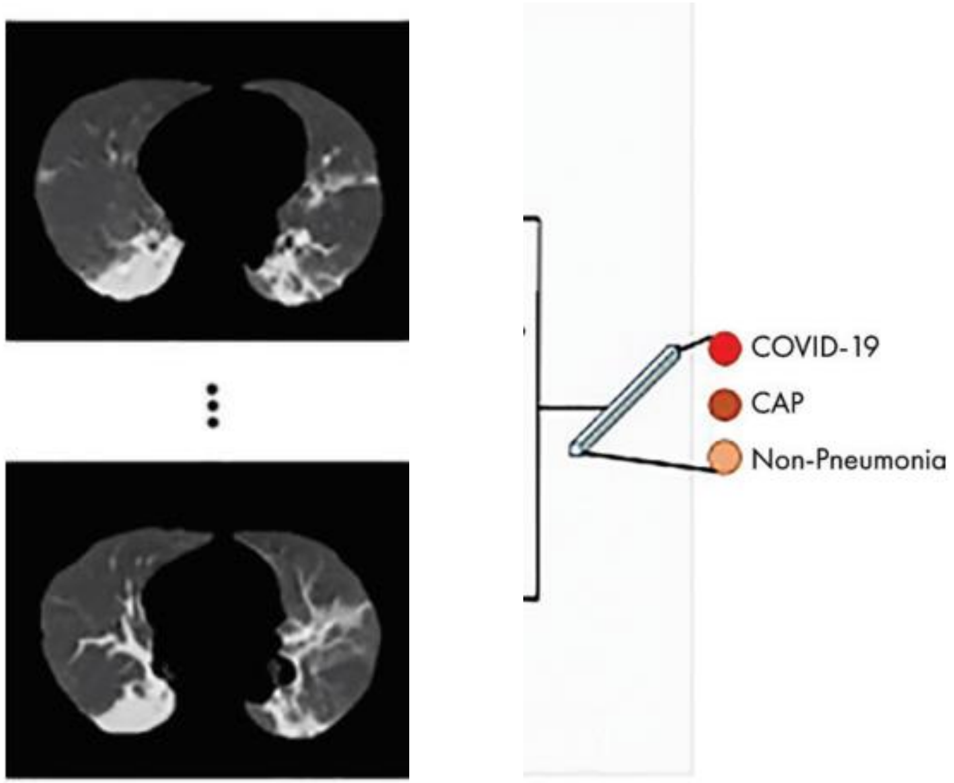


Table 3: Performance of Deep Learning Framework COVNet on the Independent Testing Set

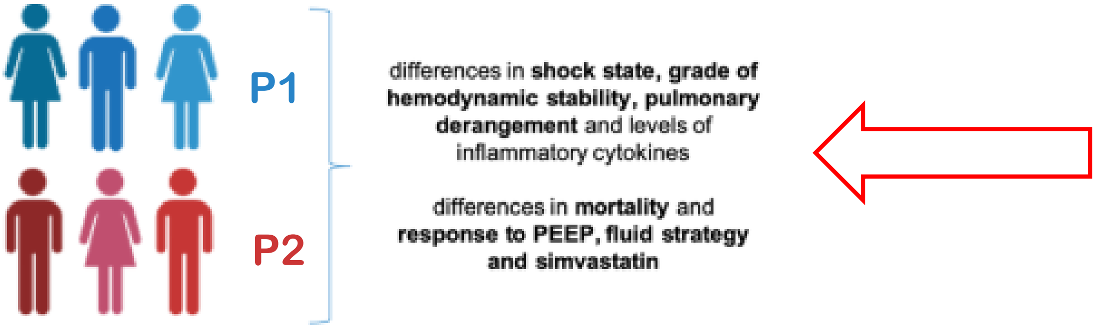
Group	Sensitivity (%)	Specificity (%)	AUC	*P* Value
COVID-19	90 (114 of 127) [83, 94]	96 (294 of 307) [93, 98]	0.96 [0.94, 0.99]	<.001
CAP	87 (152 of 175) [81, 91]	92 (239 of 259) [88, 95]	0.95 [0.93, 0.97]	<.001
Non-pneumonia	94 (124 of 132) [88, 97]	96 (291 of 302) [94, 98]	0.98 [0.97, 0.99]	<.001

Disease

Phenotyping

Machine Learning Classifier Models Can Identify Acute Respiratory Distress Syndrome Phenotypes Using Readily Available Clinical Data

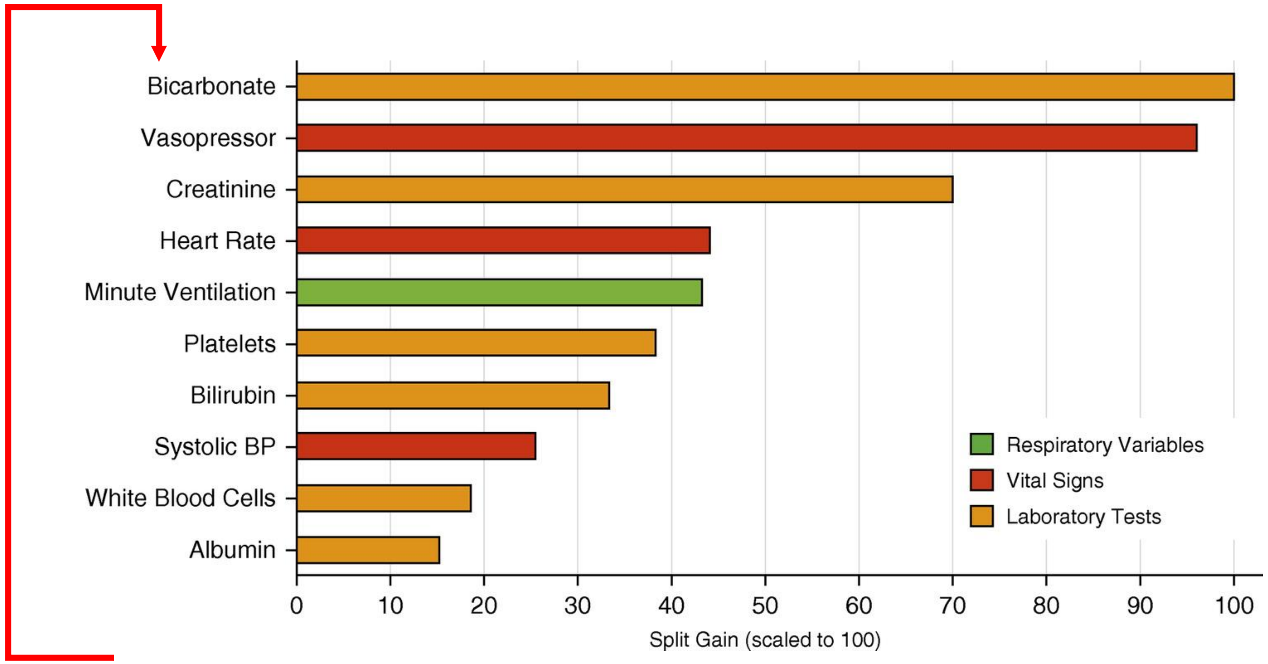
Pratik Sinha [1,2], **Matthew M. Churpek** [3], and **Carolyn S. Calfee** [1,2]

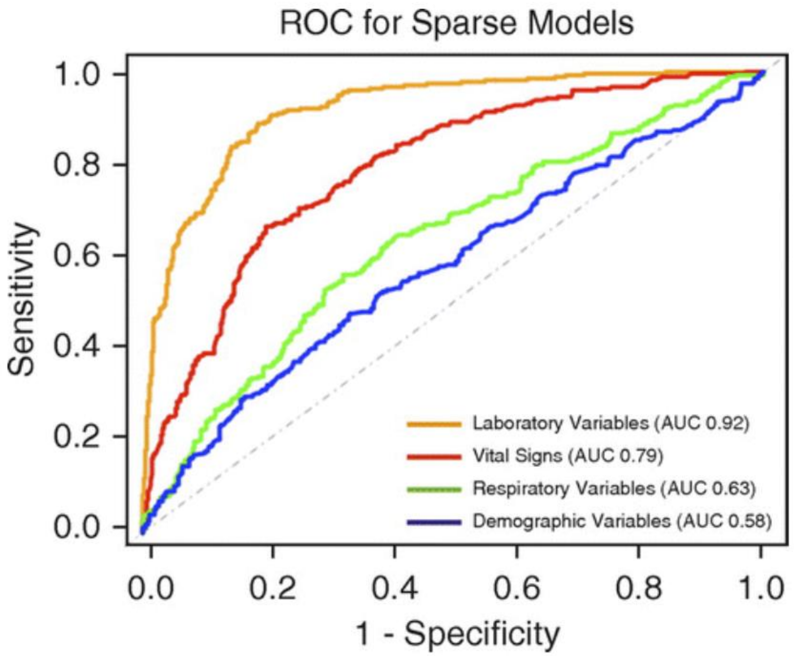


Clinical variables	Blood parameters
Circulatory: heart rate, BPm, vasoactive use Respiratory: minute ventilation, Pplat, PEEP	Inflammation: IL-6, IL-8, sTNFR-1, CRP, WCC Coagulation: PAI-1, protein C, platelets Endothelial: Ang-2, ICAM-1, vWF Others: bilirubin, bicarbonate, $PaCO_2$, albumin, glucose
None	Inflammation: IL-6, IL-8, IL-10, IFN-y Enothelial: Ang-1, Ang-2 Coagulation: PAI-1, antithrombin
Circulatory: heart rate, BPs, vasoactive use Respiratory: minute ventilation, airway pressure, PEEP	Inflammation: IL-6, IL-8, TNFR-1, IFN-y Coagulation: PAI-1, protein C, platelets Endothelial: Ang-2, vWF Lung epithelial: RAGE Others: bilirubin, bicarbonate, creatinine, $PaCO_2$, albumin, glucose, glucose
Circulatory: heart rate, BPs, vasoactive use Respiratory: minute ventilation, respiratory rate, pulmonary risk factors others: urinary output	Inflammation: IL-6, IL-8, sTNFR-1, WCC Coagulation: protein C, platelets, PAI-1, platelets Endothelial: ICAM-1 others: bilirubin, bicarbonate, creatinine, $PaCO_2$, albumin, glucose
Circulatory: vasoactive use Pulmonary: PF ratio	Inflammation: IL-6, sTNFR-1 Coagulation: platelets Others: creatinine, bilirubin
Circulatory: BPs, heart rate Pulmonary: PEEP, Pplat, PF ratio, respiratory rate, PF ratio Others: temperature	Inflammation: IL-6, IL-8, IL-10, TNFR-1, WCC, PCT Coagulation: protein C, platelets Endothelial: ICAM-1, Ang-2 Lung epithelial: RAGE Others: creatinine, $PaCO_2$, ST-2; fractalkine, pentraxin3, pH art

Machine Learning Classifier Models Can Identify Acute Respiratory Distress Syndrome Phenotypes Using Readily Available Clinical Data

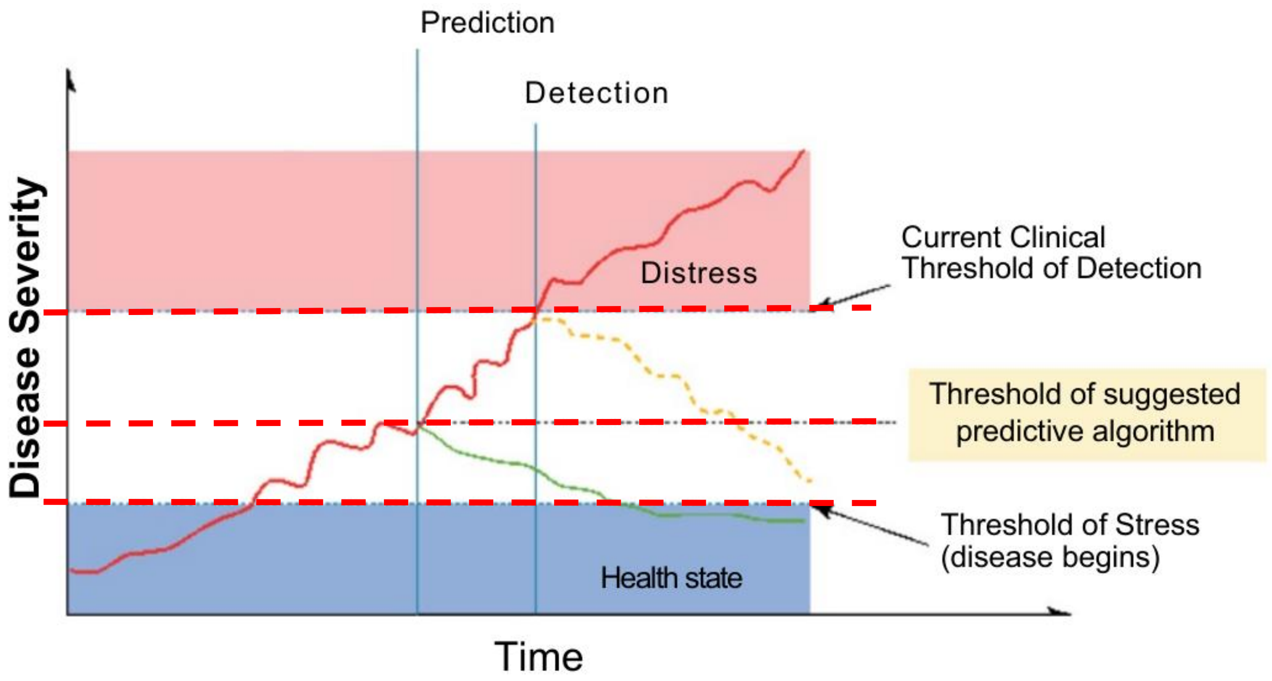
Pratik Sinha [1,2], **Matthew M. Churpek** [3], and **Carolyn S. Calfee** [1,2]





American Journal of Respiratory and Critical Care Medicine

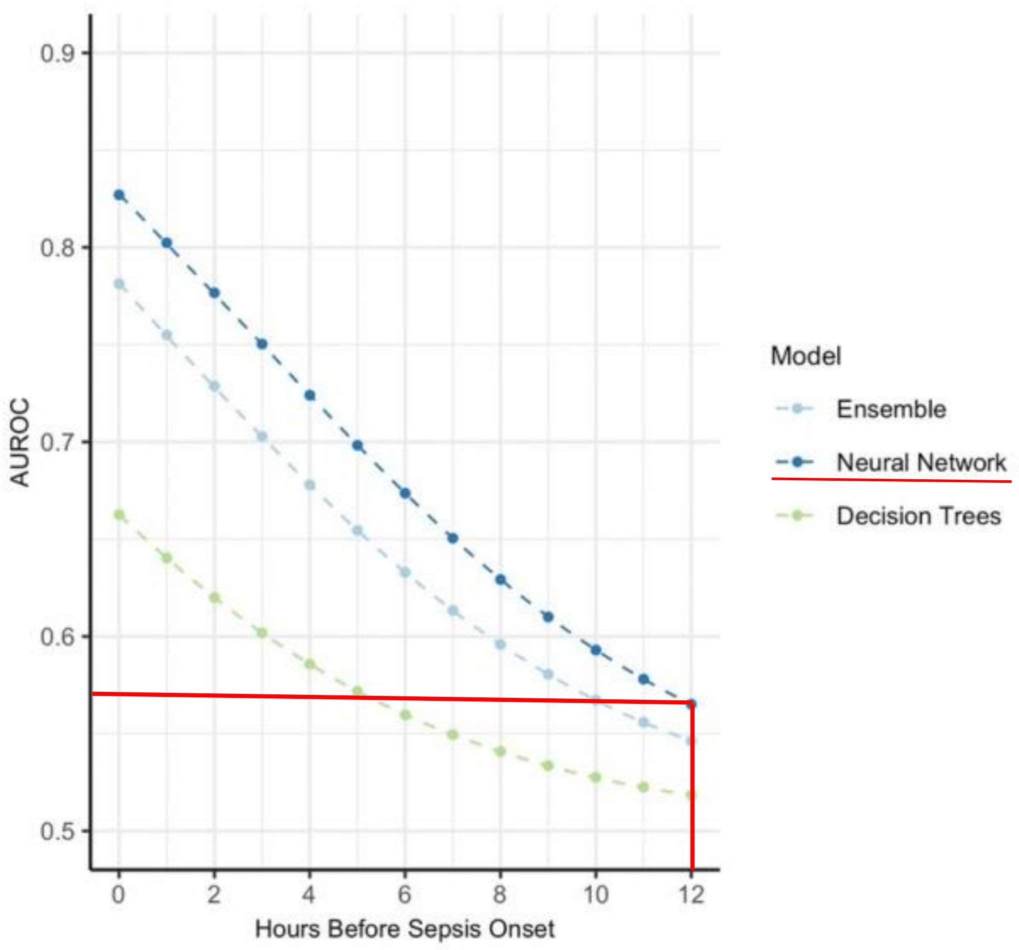
Early Detection
&
Evolution Prediction

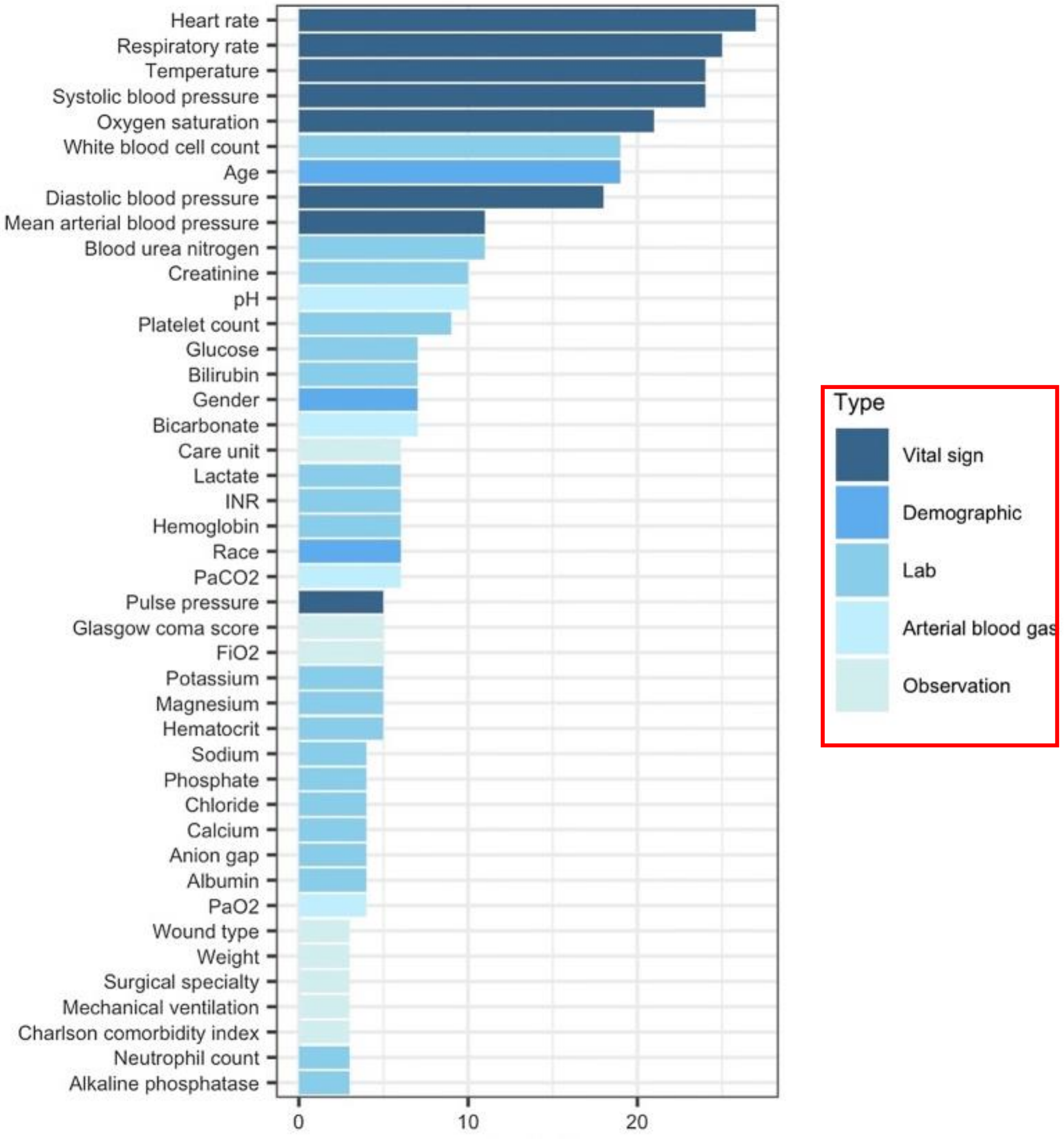


Artificial Intelligence in Critical Care Medicine, Critical Care, March 2022

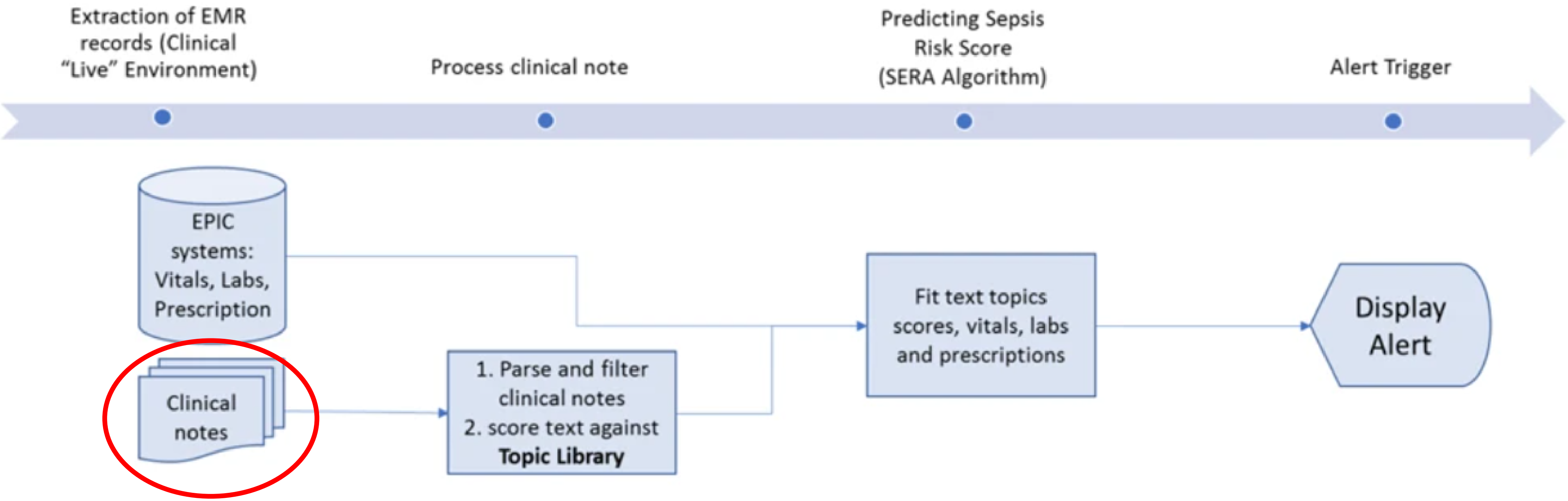
Machine learning for the prediction of sepsis: a systematic review and meta-analysis of diagnostic test accuracy

Review > Intensive Care Med. 2020 Mar





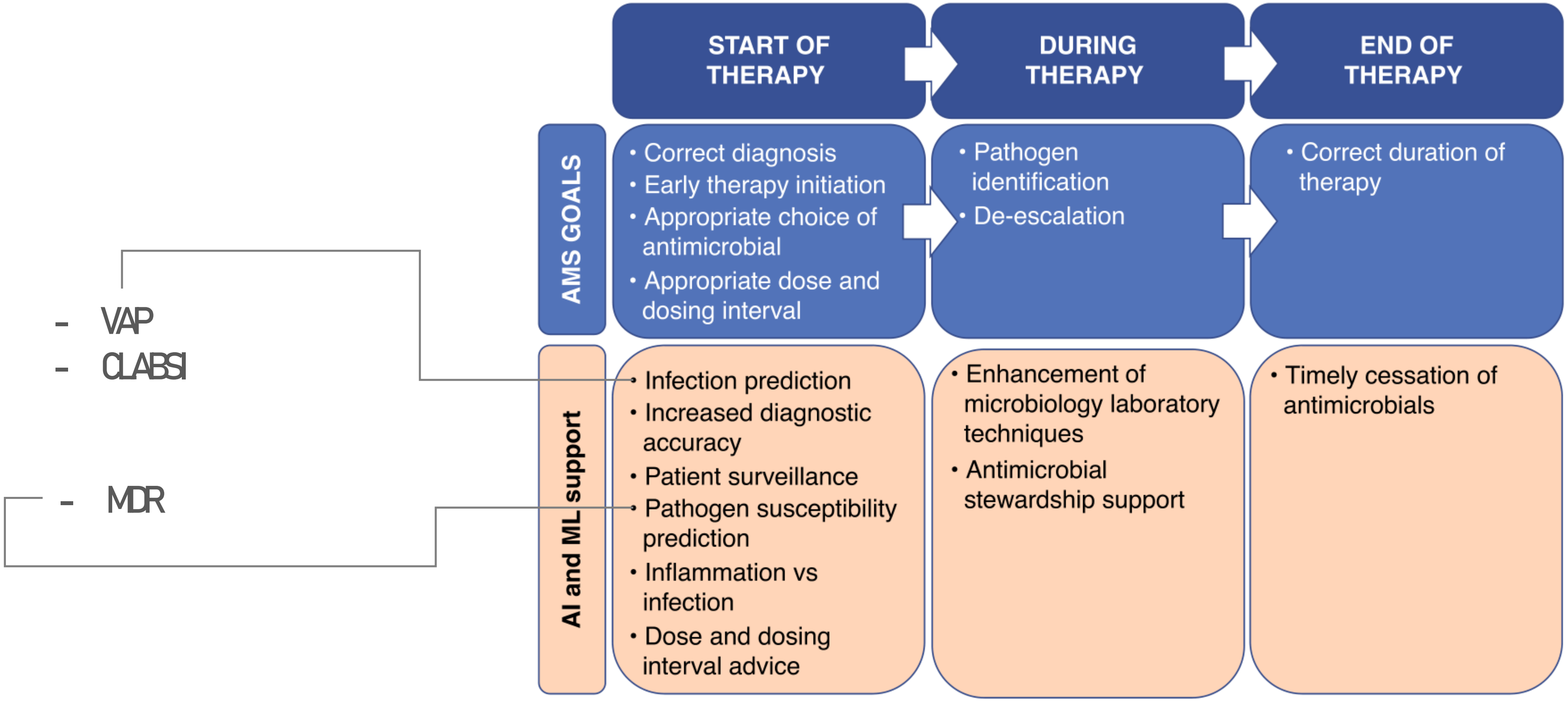
Sepsis early risk assessment (SERA) algorithm



- ➔ 21–32% more patients identified at risk of sepsis vs. usual care settings
- ➔ 4 to 48 hours before the onset of sepsis
- ➔ AUC 0.87 (48 hrs predictions), up to 0.94 (12 hrs prediction)

Artificial intelligence in sepsis early prediction and diagnosis using unstructured data in healthcare, Nature, Jan 2021

Artificial Intelligence in Infection Management in the ICU

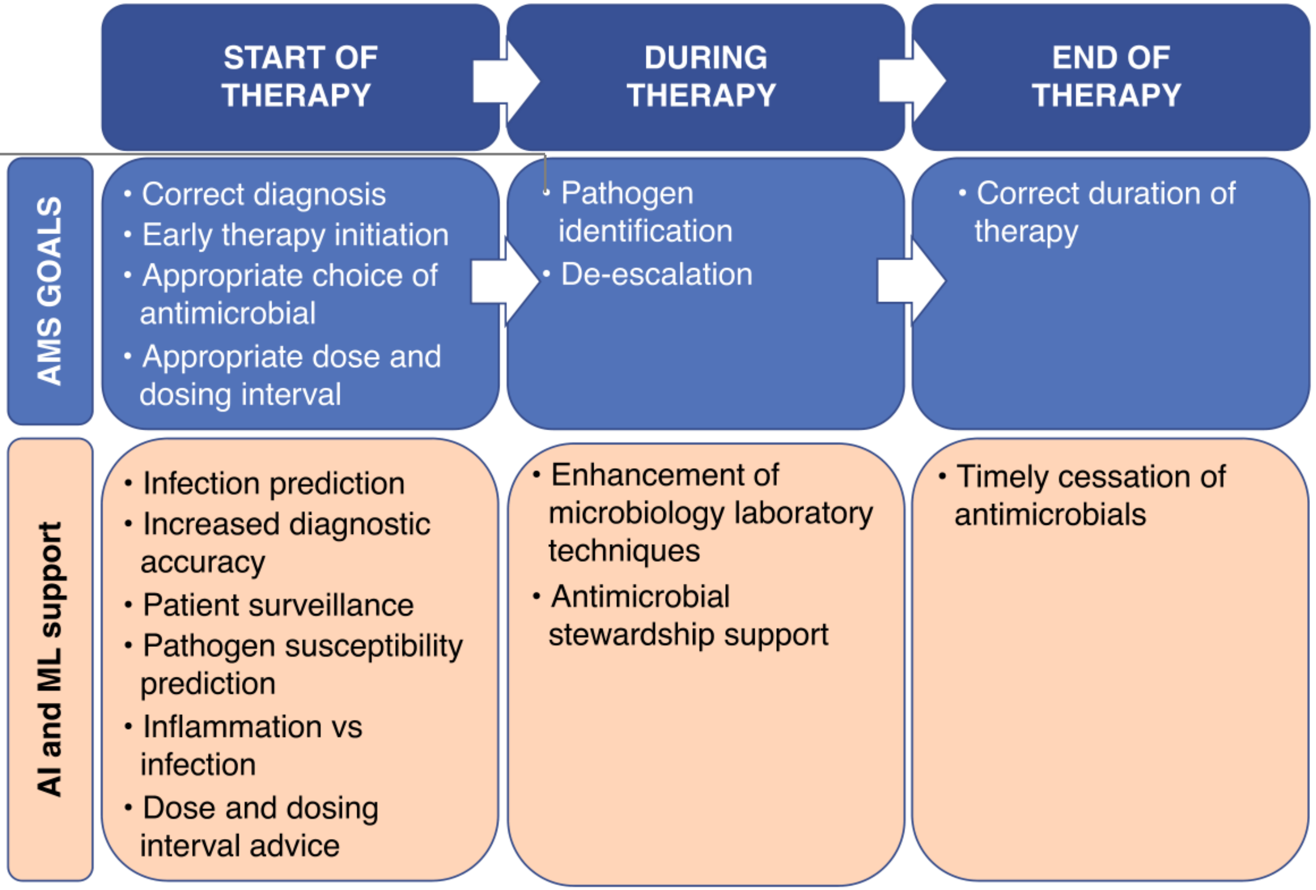


The antimicrobial stewardship (AMS) cycle. *AI* artificial intelligence, *ML* machine learning

Artificial Intelligence in Infection Management in the ICU

Analyze proteomics data from liquid chromatography with tandem mass Spectrometry

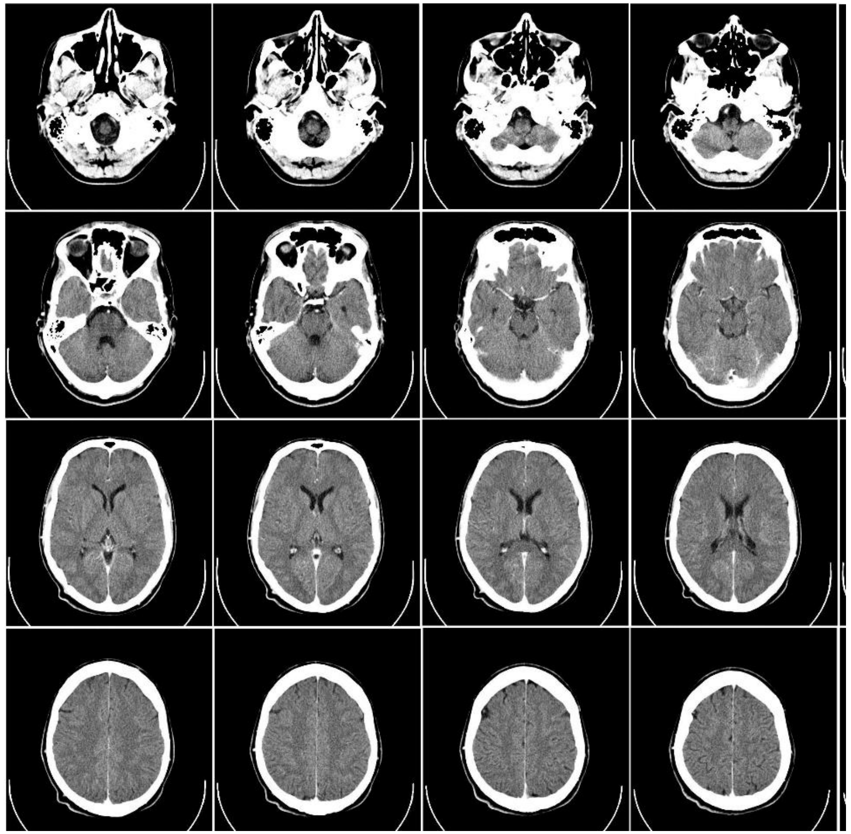
(Identify the presence of one of 15 prevalent bacterial species in UTI)



The antimicrobial stewardship (AMS) cycle. *AI* artificial intelligence, *ML* machine learning

Prognostication

Coma post Cardiac arrest



Brain CT

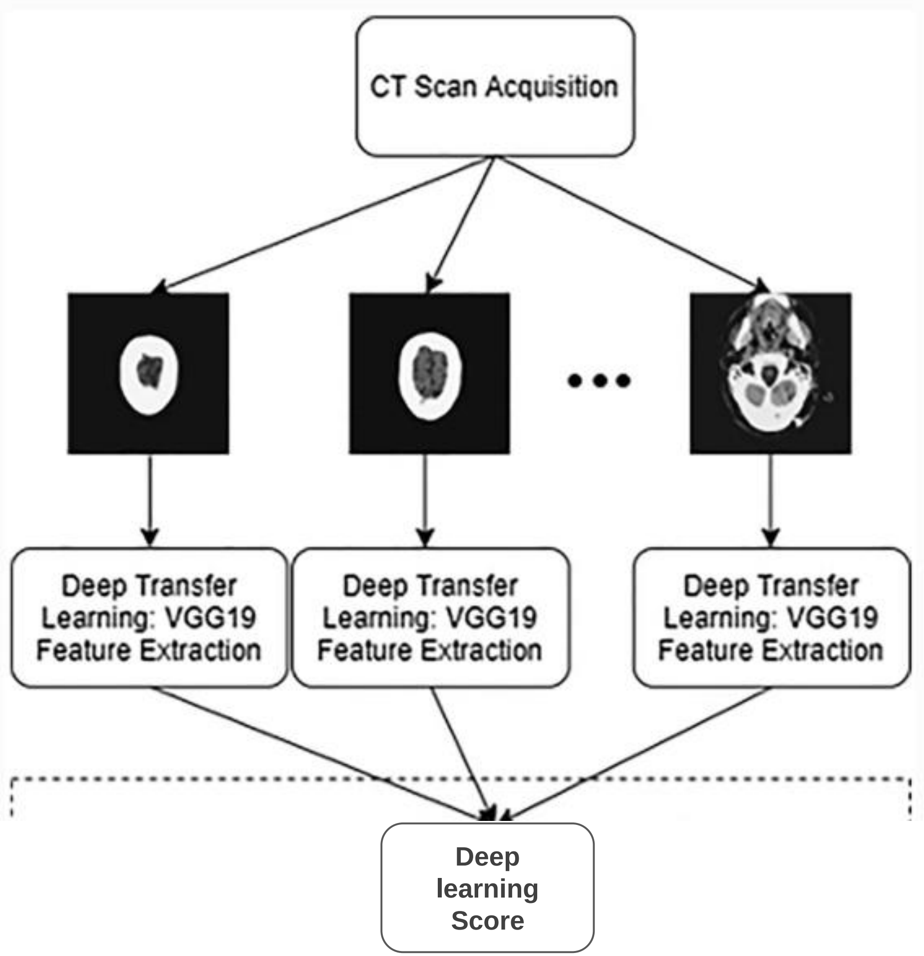
- On Day 1: Normal
- On Day 7 ?

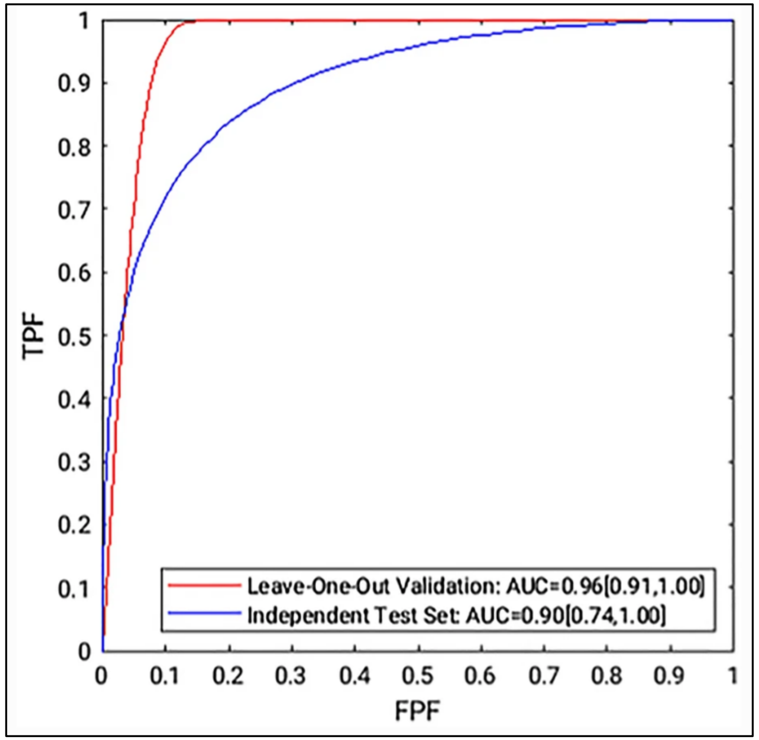
NEUROCRITICAL CARE SOCIETY
Original work | Published: 06 December 2021

Machine Learning for Early Detection of Hypoxic Ischemic Brain Injury After Cardiac Arrest

Hypothesis:

Use of Deep Learning (DLS deep learning score) on normal-appearing head CT performed after ROSC would allow to identify early evidence of HIBI.

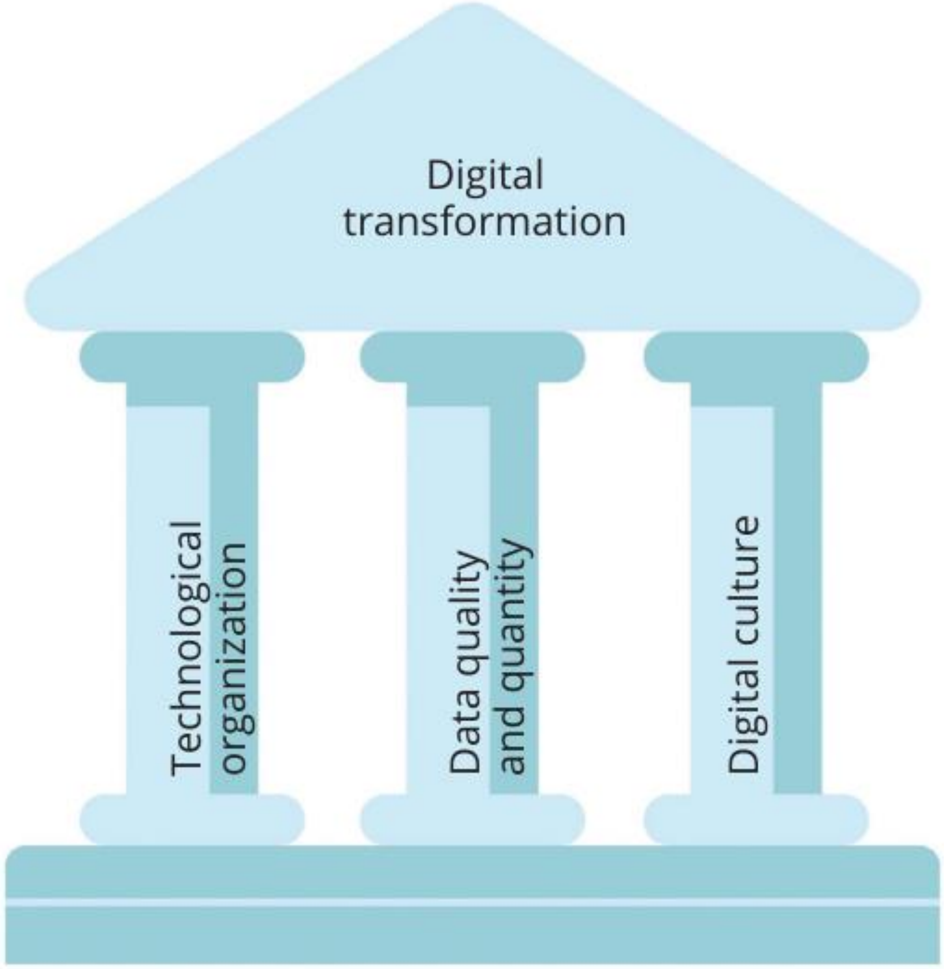




doi.org/10.1007/s12028-021-01405-y

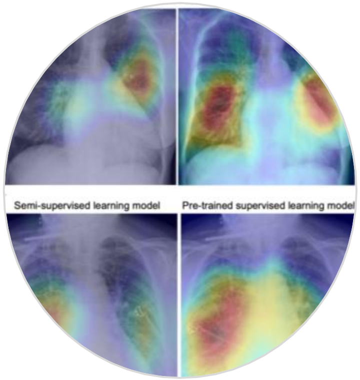
EHR Structuring
&
Data Mining

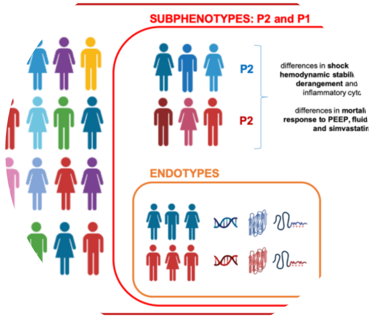
AI Implementation in ICU

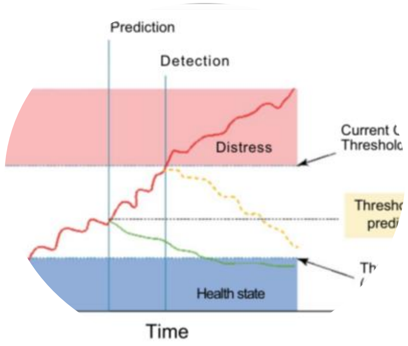


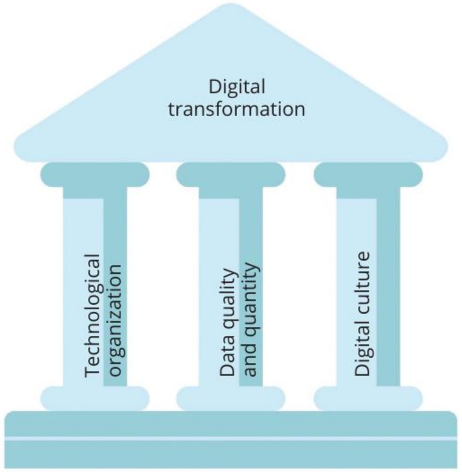
—The three pillars of the digital transformation.

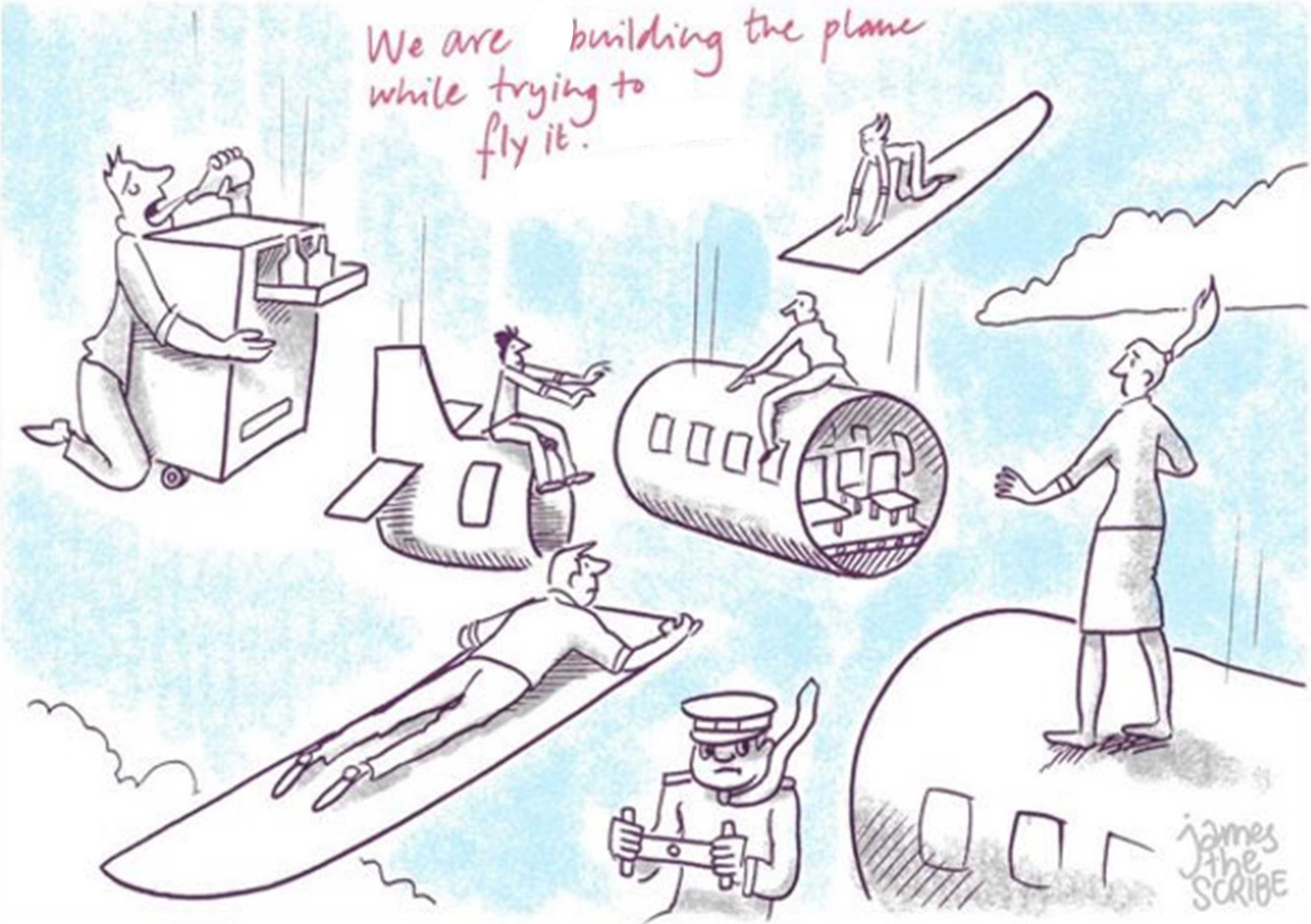
Physician’s Decision Assistance



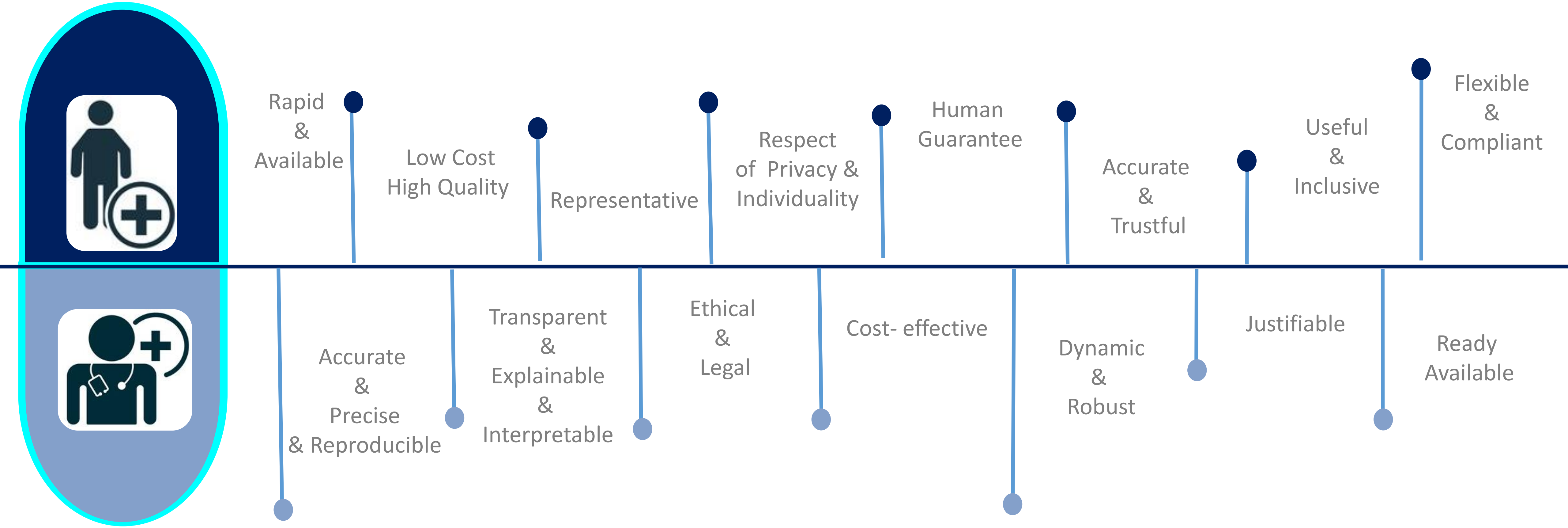







We are building the plane while trying to fly it.
james the SCRIBE

What do we expect from AI in Health?



CNIL.

To protect personal data, support innovation, preserve individual liberties

AI: ensuring GDPR compliance

21 September 2022

Safeguarding against the risks involved with AI models

Avoiding algorithmic discrimination

Minimising dat

Assessing the system

Establishing a legal base

Compiling a database

Defining a retention period

Supervising continuous improvement

Implementing the exercise of rights

Supervising automated decisions

Providing information and explicability

4. Lorsqu'une intelligence artificielle est mise en œuvre, le maximum a été fait p
discriminatoire

MINISTÈRE DE LA SANTÉ ET DE LA PRÉVENTION

Liberté Égalité Fraternité

FRANCE22

FRENCH PRESIDENCY OF THE COUNCIL OF THE EUROPEAN UNION

Digital Health actions and initiatives under the French Presidency of the Council

of 2022

Press kit

25 August 2022

ORDRE NATIONAL DES MEDECINS
Conseil National de l'Ordre

January 2018

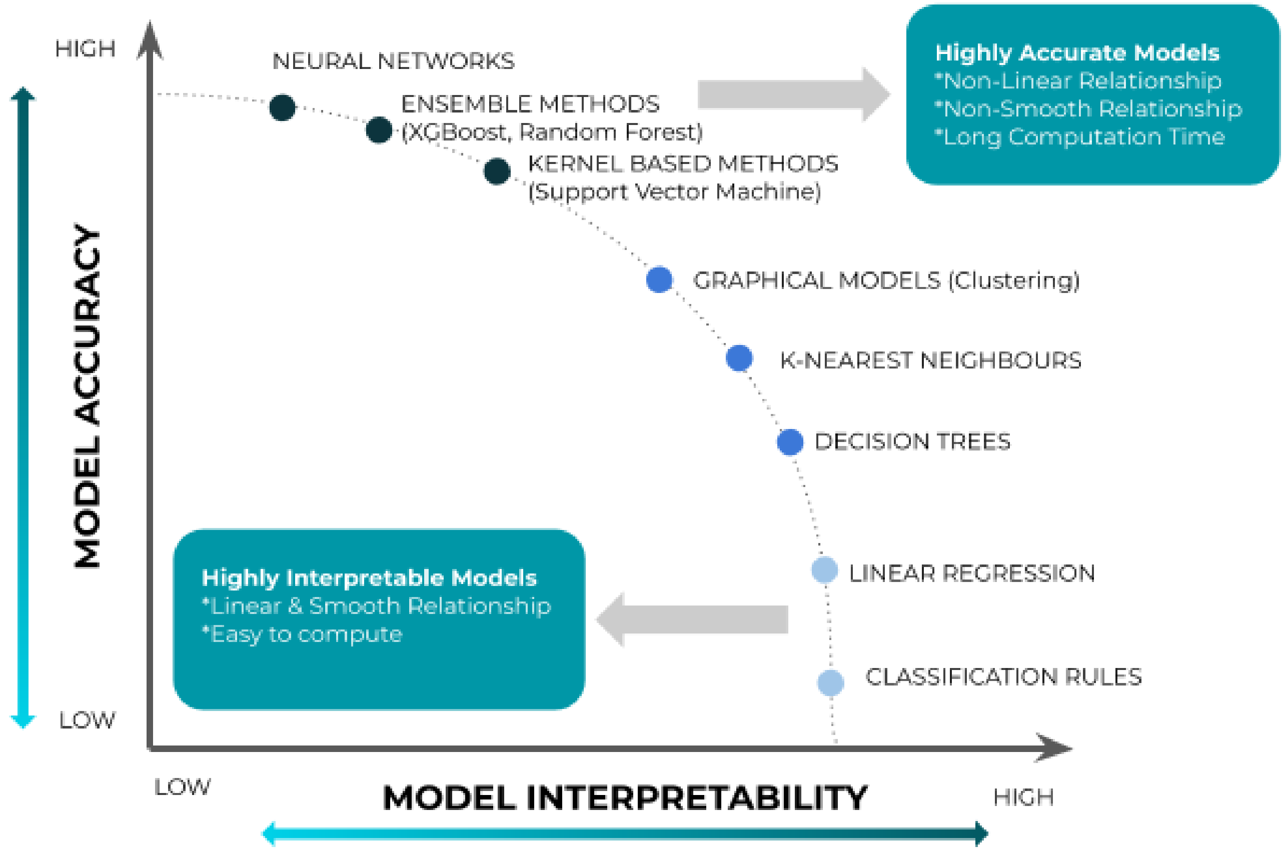
DOCTORS AND PATIENTS IN THE WORLD OF DATA, ALGORITHMS AND ARTIFICIAL INTELLIGENCE

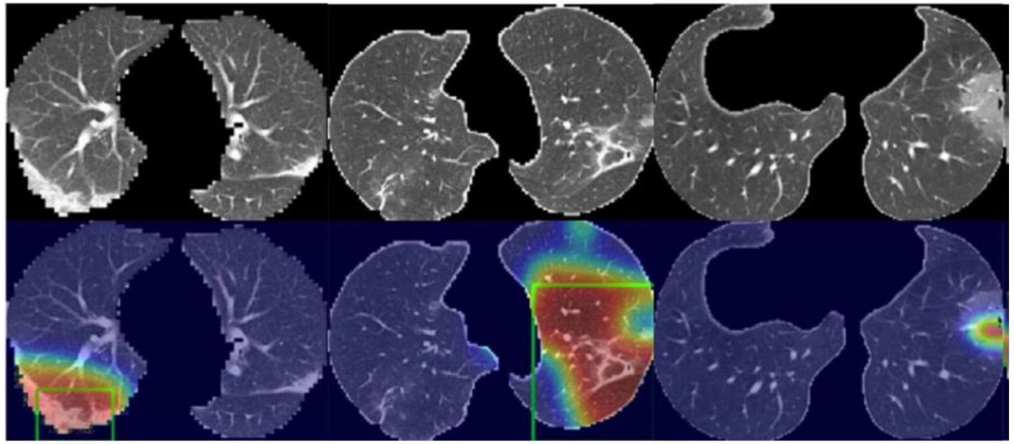
Analyses and recommendations of the Cnom

9

Participation in the design and execution of smart objects and systems to meet their requirements, rather than allowing the laws of the market to be imposed upon them.

Explainable AI (XAI)





Use of XAI to explain the classification of Pulmonary lesions on Chest CT

Take Home Message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Take Home Message

- AI is in its infancy but has already invaded the healthcare industry.
- As healthcare professionals, we must understand and embrace this technology.
- Our goal should be to use AI to improve patient outcomes and advance the healthcare industry.
- Let's make AI our new armamentarium and work together to harness its power ethically and effectively

Thank you for your attention

Artificial Intelligence in Healthcare

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