AI in onderzoek:

Wat weten we al?

V&VN Congres: Focus op de Toekomst

7 November 2024

Henk Marquering

[m ɑ r- k w e- r ɪ ŋ]

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Dept of Radiology & Nuclear Medicine / Biomedical Engineering & Physics

Amsterdam UMC

Disclosures

Cofounder and shareholder of
- Nicolab
- TrianecT
- inSteps

Unrestricted research grants
- STW
- ITEA2 / ITEA3
- FNO
- H2020
- RVO
- Stichting TWIN
- NVIDIA
- CVON
- NutsOhra
- Horizon Europe
- NWO

None of the presented text has been generated by ChatGPT

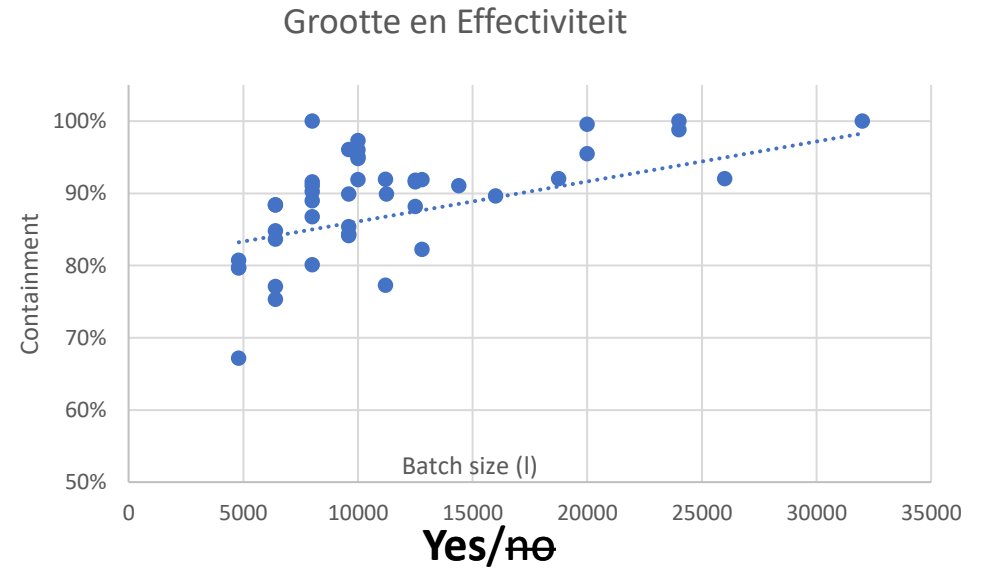# Eerste contact met AI

Eerste contact met AI

vs

Wat weten we al? Wat is AI?

Grootte en Effectiviteit

Yes/no

Don't forget: friday presentation for european society for

Paediatric Endocrinology

Yes/no

Yes/no

Wat weten we al? Hoe oud is AI?

Wat is het geboortejaar van AI?

- 1726
- 1955
- 1980
- 2015
- 2045

Wat weten we al? Hoe oud is AI?

- 1726: Gulliver's travels: first time mentioning a thinking machine
- **1955: Dartmouth workshop on Artificial Intelligence**
- 1980: 2nd AI summer
- 2015: 3rd (and current) AI summer
- 2045: Singularity

History of AI

Left: Marvin Minsky, Claude Shannon, Ray S[...]
Project on Artificial Intelligence (Photo: Marg[...]
Project [...]

Photographer: Joe Mehling

Figure 1. Trenchard More, John McCarthy, Marvin Minsky, Oliver Selfridge, and Ray Solomonoff.

Wat weten we al? Al zomers & winters
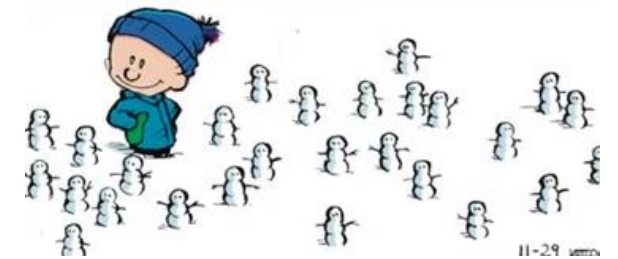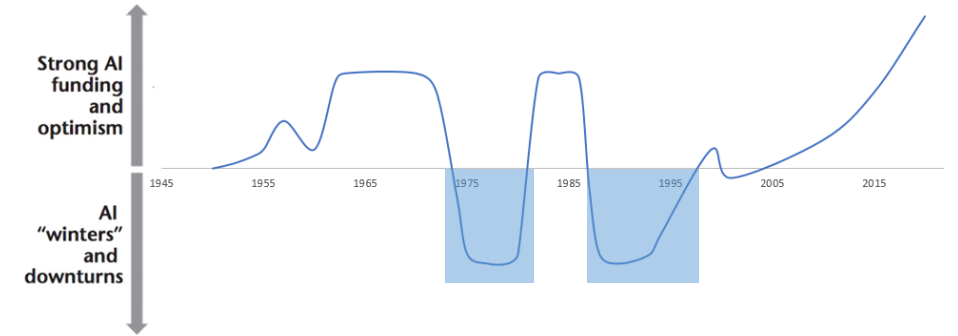
Wat weten we al? AI zomers & winters


AI Enthousiasm
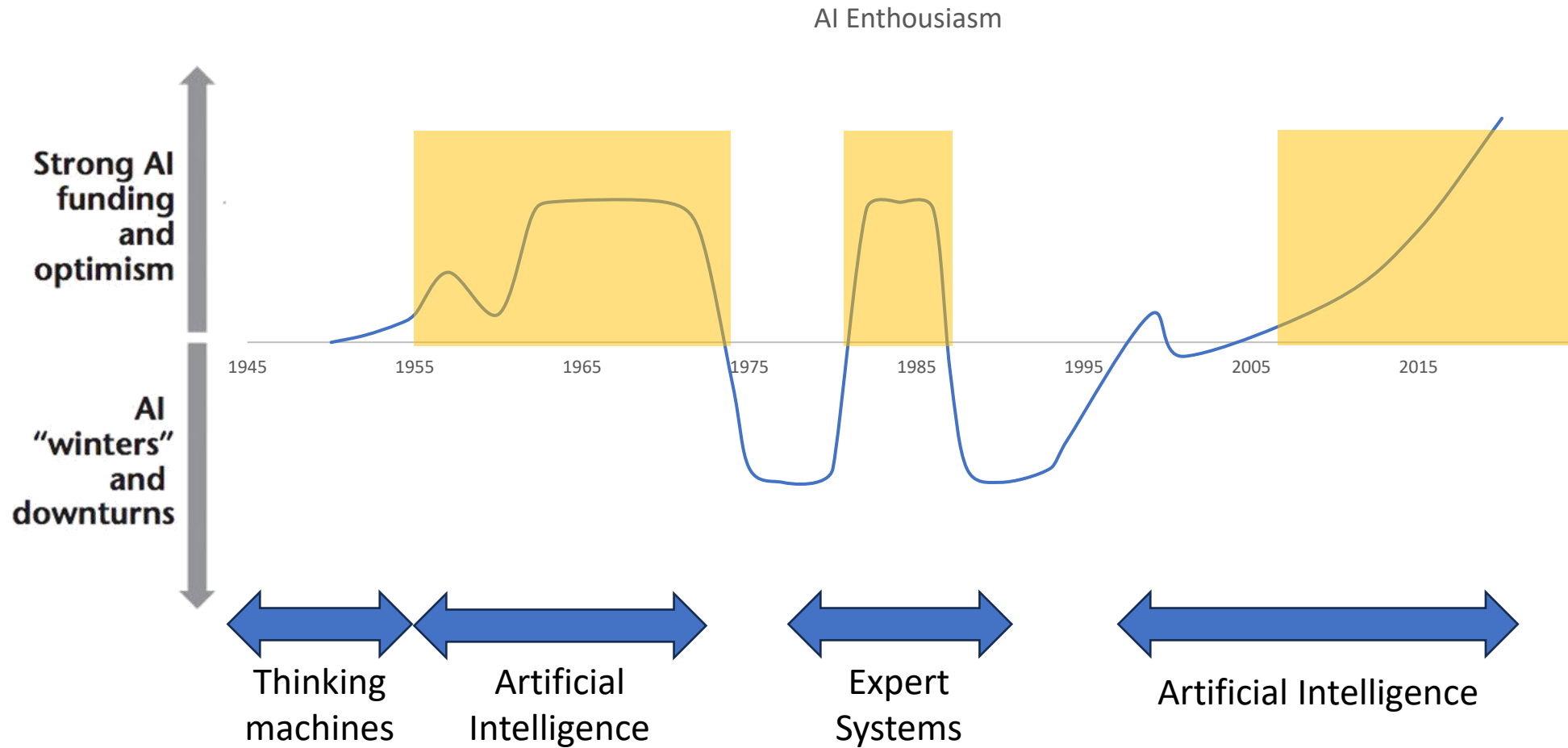
AI winters

- Periods of reduced interest and funding
- Many AI labs were closing
- 3,000 AI companies went bankrupt

Leren van fouten (het liefst fouten van anderen)

What went wrong?

- Extensive promotion in the media
- Overly ambitious and unrealistic promises
- Impossibly high expectations
- Expectations failed to materialize
- A chain reaction of pessimism in the AI community → in the press → cutbacks in funding → end of serious research

3rd AI Summer

AI Enthousiasm
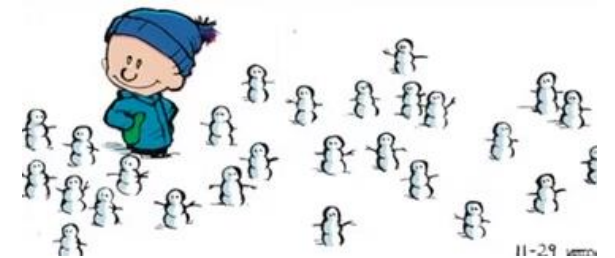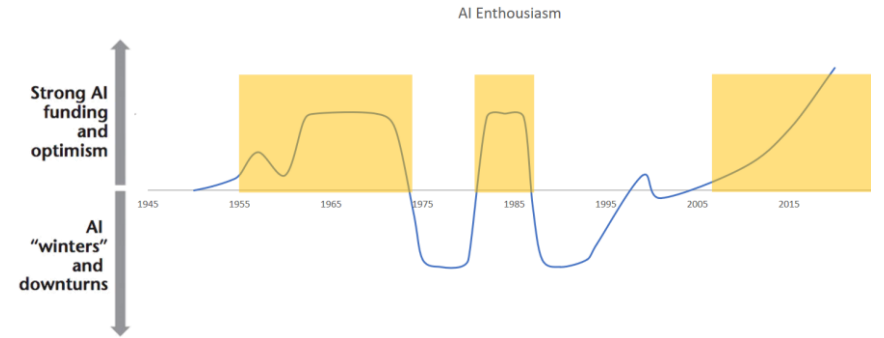
Differences with previous summers (climate is changing)

- More digital data available
- Cheaper computing facilities
- End-users familiar with digital tools
- **Strong focus on health**

3rd AI Summer: IBM's Watson

- Very (artificial) intelligent

3rd AI Summer: IBM's Watson

- 600,000 pieces of medical evidence
- 2,000,000 pages of medical literature
- Data of 1,500,000 patients

- 90% accurate vs 50% for an average MD in lung cancer diagnosis

DAILY●NEWS | NEWS

Crime   U.S.   World   Politics

IBM's Watson gives proper diagnosis after doctors were stumped

BY ALFRED NG

NEW YORK DAILY NEWS   Sunday, August 7, 2016, 2:47 PM

3rd AI Summer: IBM's Watson

- IBM invested $62M in Watson
- $5 billion of acquisitions alone

- In practice, less efficient doctors.
- Overpromise
- Expectations failed to materialize

- May 2018 (7 years later) pulled the plug
- 7,000 employees, 80% laid off

The New York Times

What Ever Happened to IBM's Watson?

IBM's artificial intelligence was supposed to transform industries and generate riches for the company. Neither has panned out. Now, IBM has settled on a humbler vision for Watson.

SELF-DRIVING VEHICLE HITS BICYCLIST
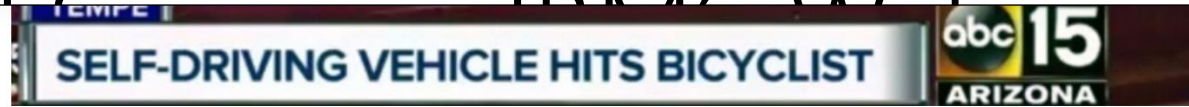
ABC 15 screenshot of deadly Uber accident.

IBM Watson comes up short in healthcare

"This product is a piece of shit" wrote a doctor at Florida's Jupiter Hospital regarding IBM's flagship AI program Watson, according to internal documents obtained by Stat. Originally a question-answering machine, IBM has been exploring Watson's AI capabilities across a broad range of applications and processes, including healthcare. In 2013 IBM developed Watson's first commercial application for cancer treatment recommendation, and the company has secured a number of key partnerships with hospitals and research centers over the past five years. But Watson AI Health has not impressed doctors. Some complained it gave wrong recommendations on cancer treatments that could cause severe and even fatal consequences.

Not just IBM…

- Google glass

- Google Health

- SAS

- Apple Health App and Apple Watch

- Amazon Web Services

- …
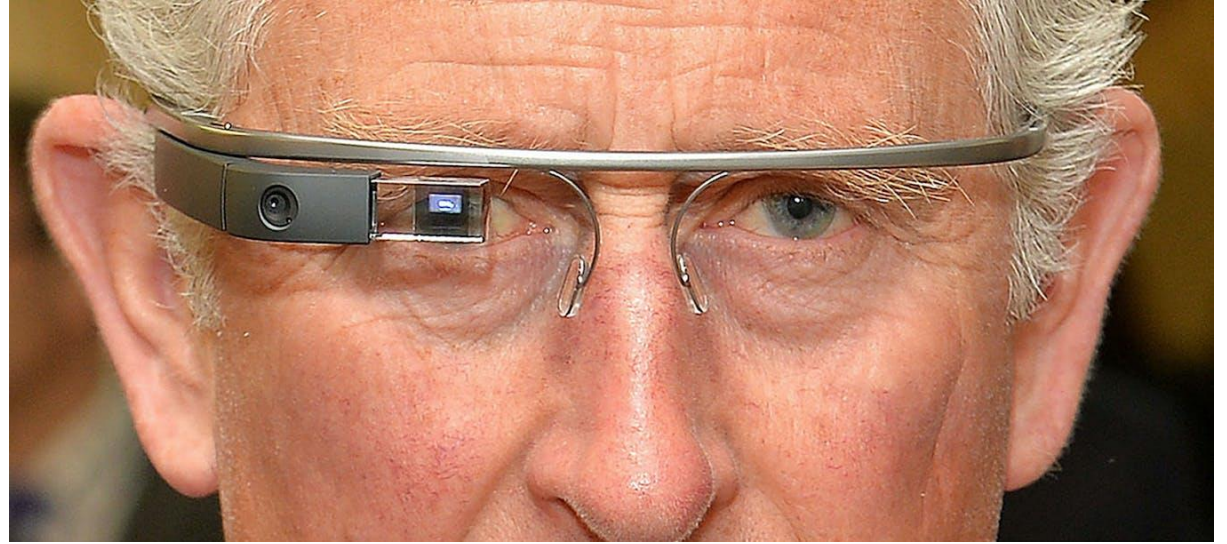
AI algorithms in clinical practice

2024: FDA has cleared > 500 AI algorithms

Popularity

What is the main application

- Large Language Models (ChatGPT)

- Medical education

- Cardiology

- Radiology

Health Exec: FDA has now cleared more than 500 healthcare AI algorithms (healthexec.com)
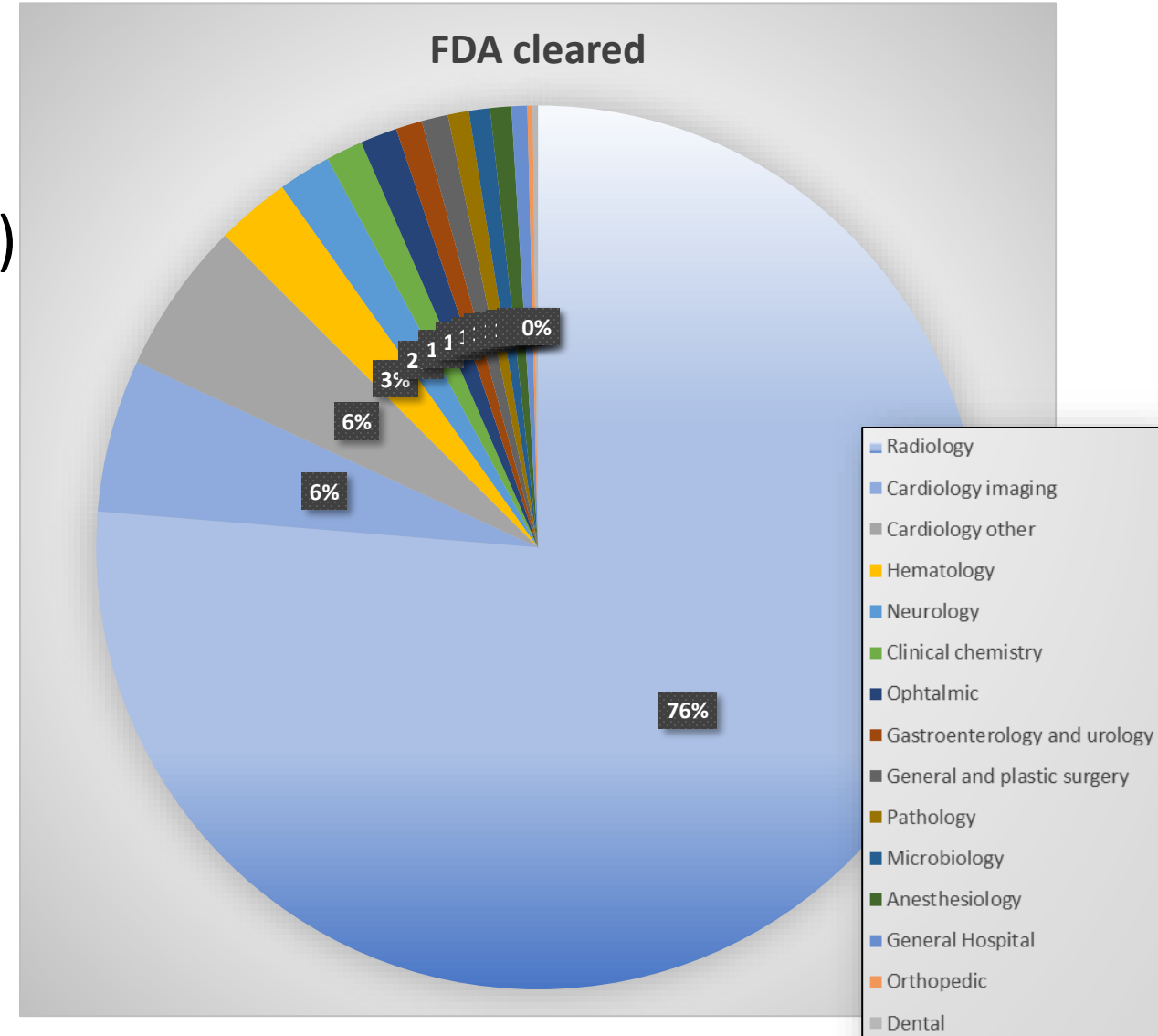
Radiology

- Early adapters
  - 1980's Computed tomography
  - 2000's digital radiology
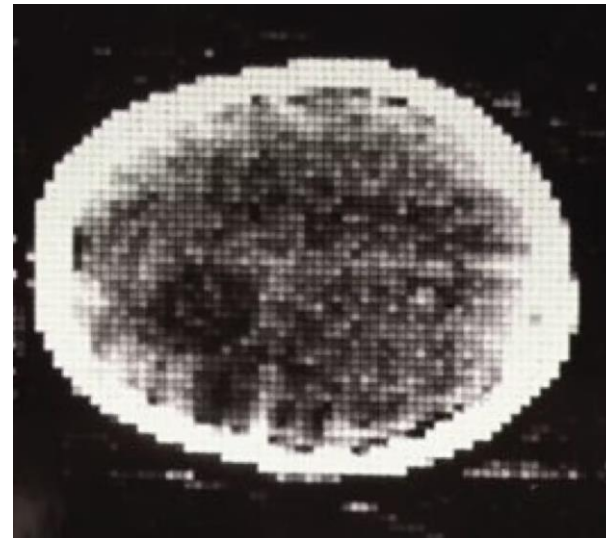
Radiology

- Early adapters

- Digital Images
  - Large (digital) databases
    - 4,000 – 5,000 TB / year.
    - 2nd largest image data base worldwide.
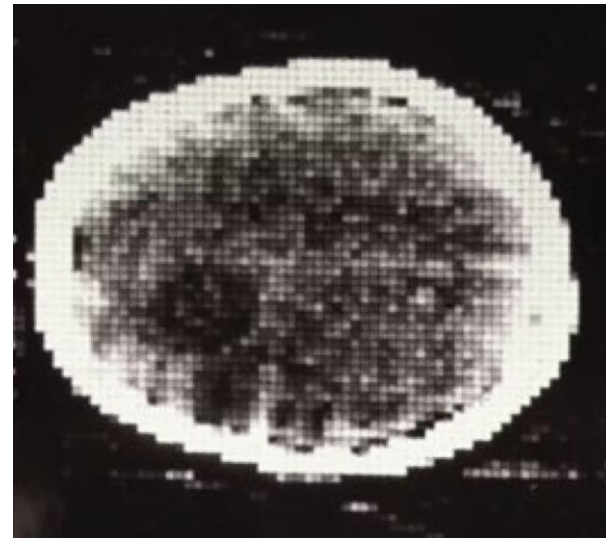
Radiology

What is the largest digital image database?

- **Satellite Imagery from the US/China defense**
- Radiology
- FLIM: images extracted from movies
- Social media
- …

Radiology

Radiology

AuntMinnie.com

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Do patient values guide your clinical decisions?
Start delivering true Patient-Centered Care. Carestream

NEW AI COMMUNITY
Artificial intelligence

Will AI soon put radiologists out of a job?
By Erik L. Ridley, AuntMinnie staff writer

July 11, 2016 -- Are radiologists really "wasted protoplasms" -- as described recently by a CEO of a medical imaging start-up com... easily replaced in the future with artificial intelligence (AI) tech... according to Dr. Eliot Siegel of the University of Maryland.

Despite a number of predictions that it won't be long before... need for radiologists, vast technical and even regulatory bar...

Perspective

COMMENTARY

Will Con...

Saurabh Jha, MBBS, M...

DISCLOSURES | May 12

What happens when aut... highly paid doctors

by Matt McFarland @mattmcfarland

July 14, 2017: 11:04 AM ET

CNN Money

re IT News

TO...

e learning will replace
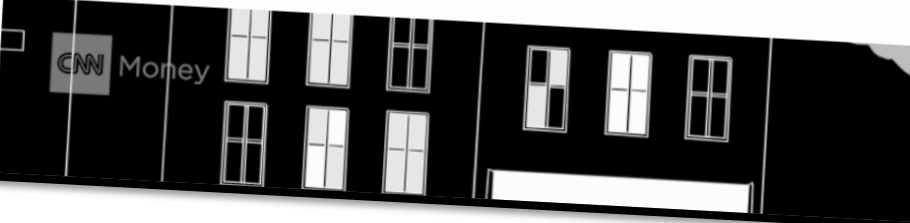
Viewpoint | Innovations in Health Care Delivery

December 13, 2016

Adapting to Artificial Intelligence
Radiologists and Pathologists as Information Specialists

Saurabh Jha, MBBS, MRCS, MS[1]; Eric J. Topol, MD[2]

» Author Affiliations

What caused the 3rd AI summer?

What initiated the 3rd AI summer?

2006

- Let's not think about the algorithms

- Let's pay attention to the data: ImageNet

- July 2008: 0 images
- December 2008: 3,000,000 / 6,000 categories
- 2010: 11,000,000 images / 15,000 categories
- 2024: 14,000,000 images / 22,000 categories
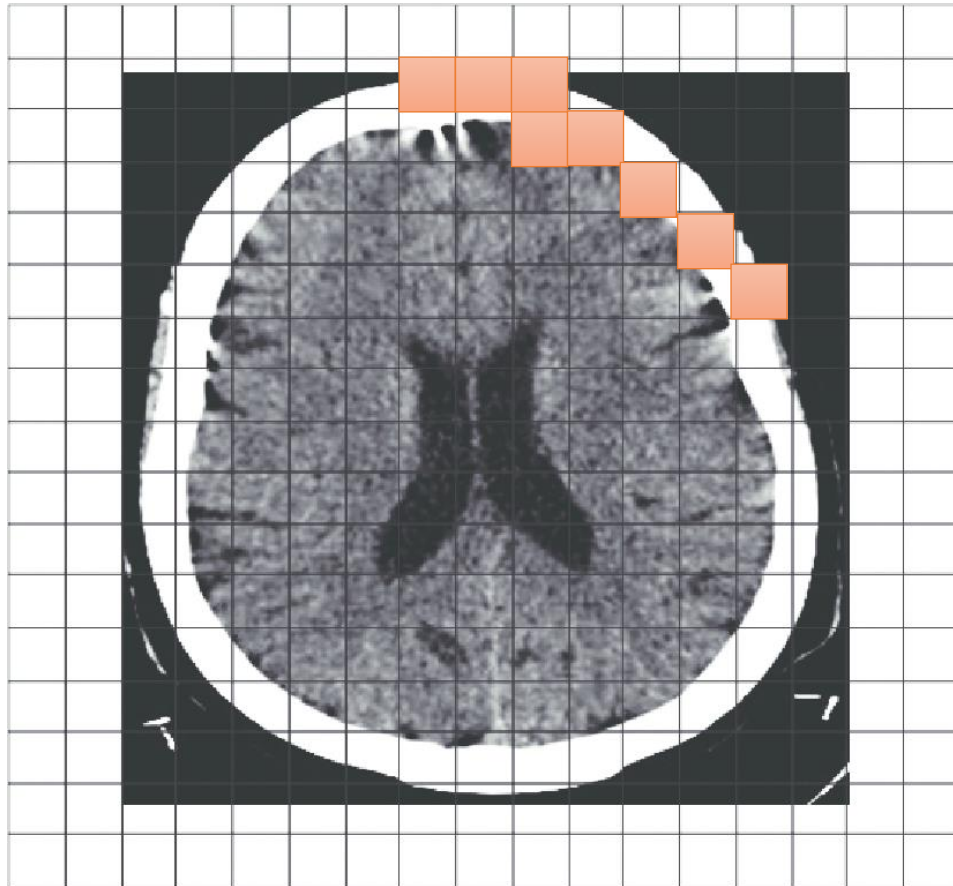
2012: AlexNET

Deep neural networks
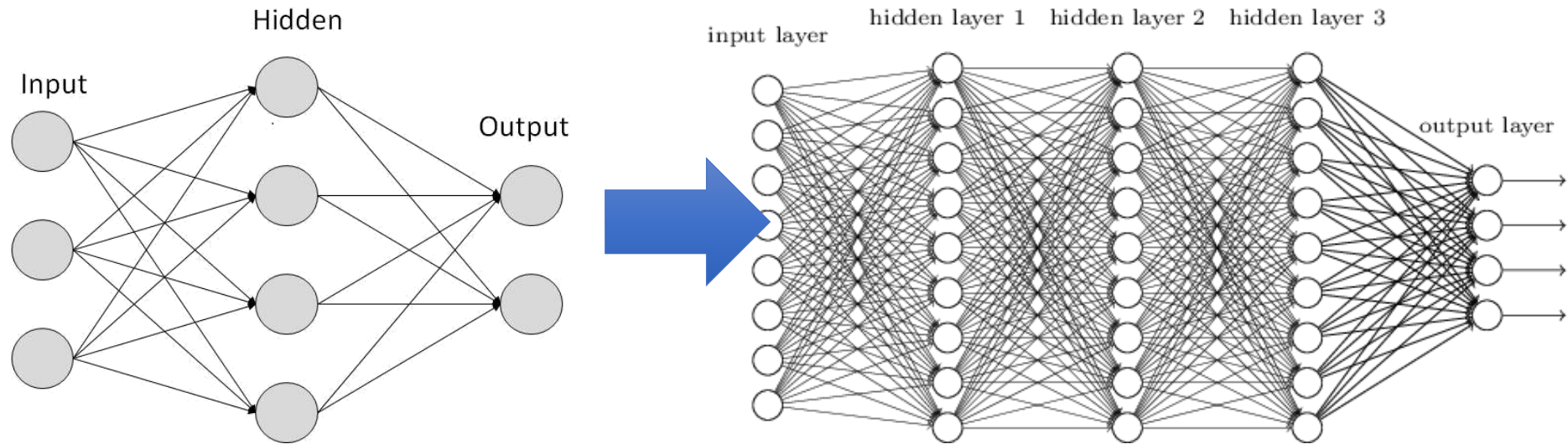
What changed?

(in preclinical medical image processing: an illustration)

Let's get personal

Image processing

Rule based


```
If pixel > Threshold1 {
    for (x = -Width ; x <= Width ; x++) {
        if pixel_Neighbor > Threshold2 {
            listOfPixels ++ pixelNeighbor
        } else {
            listOfUnconnectedPixels++
        }
    }
} else {
    listOfPotentialConnectedPixels++
}
```

Let's get personal

Stroke

Stroke

Stroke

A Multicenter Randomized CLinical trial of Endovascular treatment for Acute ischemic stroke in the Netherlands
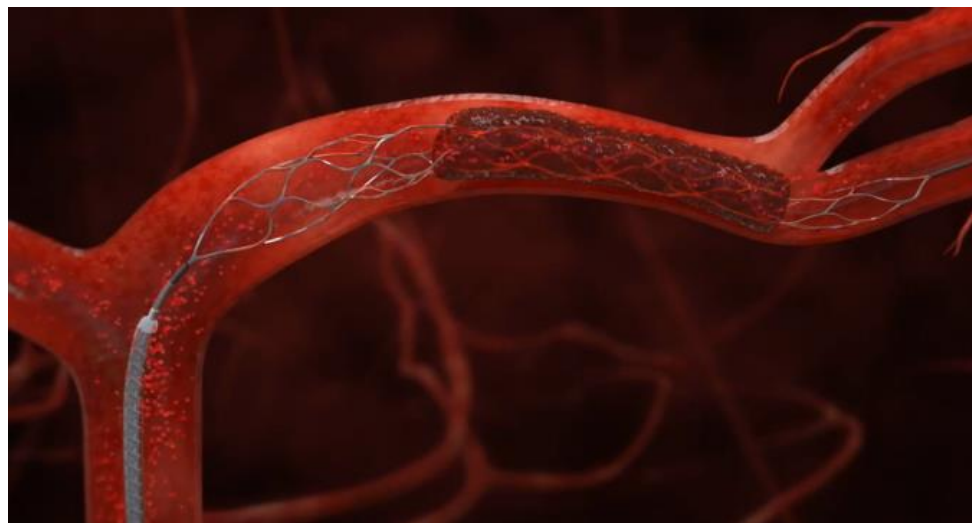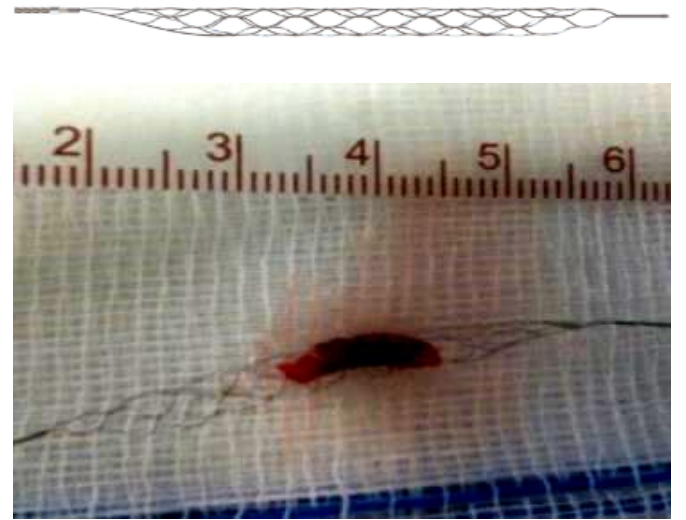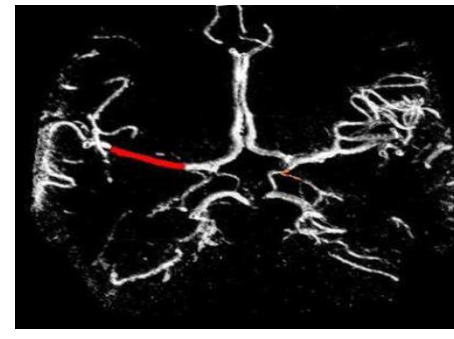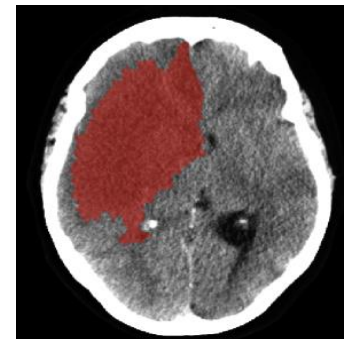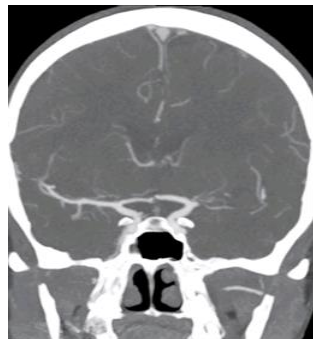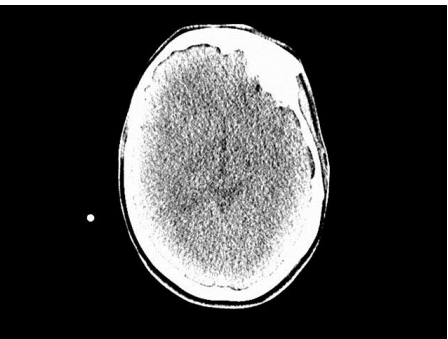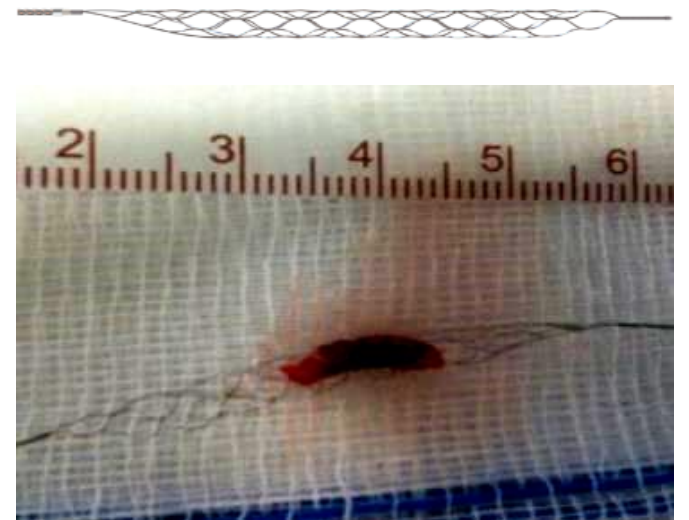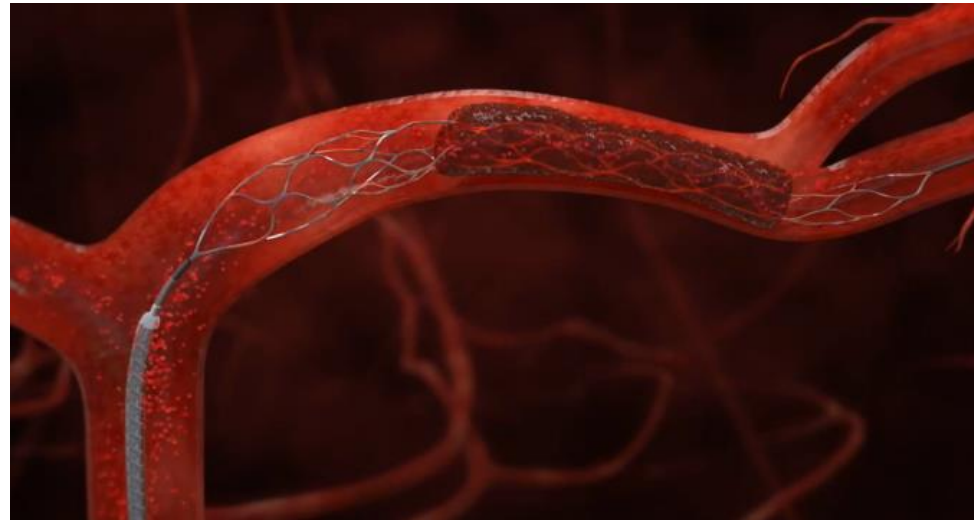
MR CLEAN: Results

AI for stroke?

48 hours vs 1 year (8,760 hours!) learning and implementing

A tsunami of deep networks

10 Years in the 3rd AI summer

AI Enthousiasm

Strong AI funding and optimism

AI "winters" and downturns

1945 1955 1965 1975 1985 1995 2005 2015

AI in Healthcare in practice: 2024

- Imbalance in interest and purchase

- Lack of reimbursement

- Liability

- No proof of value

- No proof of the ability to integrate

AI in Healthcare in Practice: an example

- 20,000 scans / 11 radiologists

- Average 14.8 → 13.3 seconds

- Complicated cases 18.4 → 18.6 s

Gain of 11 minutes/radiologist/month

npj | digital medicine   www.nature.com/npjdigitalmed

ARTICLE   **OPEN**

The impact of artificial intelligence on the reading times of radiologists for chest radiographs

Hyun Joo Shin [1,2], Kyunghwa Han[3], Leeha Ryu[4] and Eun-Kyung Kim [1,2]

Whether the utilization of artificial intelligence (AI) during the interpretation of chest radiographs (CXRs) would affect the radiologists' workload is of particular interest. Therefore, this prospective observational study aimed to observe how AI affected the reading times of radiologists in the daily interpretation of CXRs. Radiologists who agreed to have the reading times of their CXR interpretations collected from September to December 2021 were recruited. Reading time was defined as the duration in seconds from opening CXRs to transcribing the image by the same radiologist. As commercial AI software was integrated for all CXRs, the radiologists could refer to AI results for 2 months (AI-aided period). During the other 2 months, the radiologists were automatically blinded to the AI results (AI-unaided period). A total of 11 radiologists participated, and 18,680 CXRs were included. Total reading times were significantly shortened [...] detected by AI, reading times were [...] by AI, reading times did not differ [...] scores increased, and a more sign[...] reading times of CXRs among radi[...] radiologists referred to AI; howev[...]

npj Digital Medicine (2023)6:82; htt[...]

AI in Hea... ...e

- 20,000 scan...
- Average 14...
- Complicate...

Gain of 11 r...

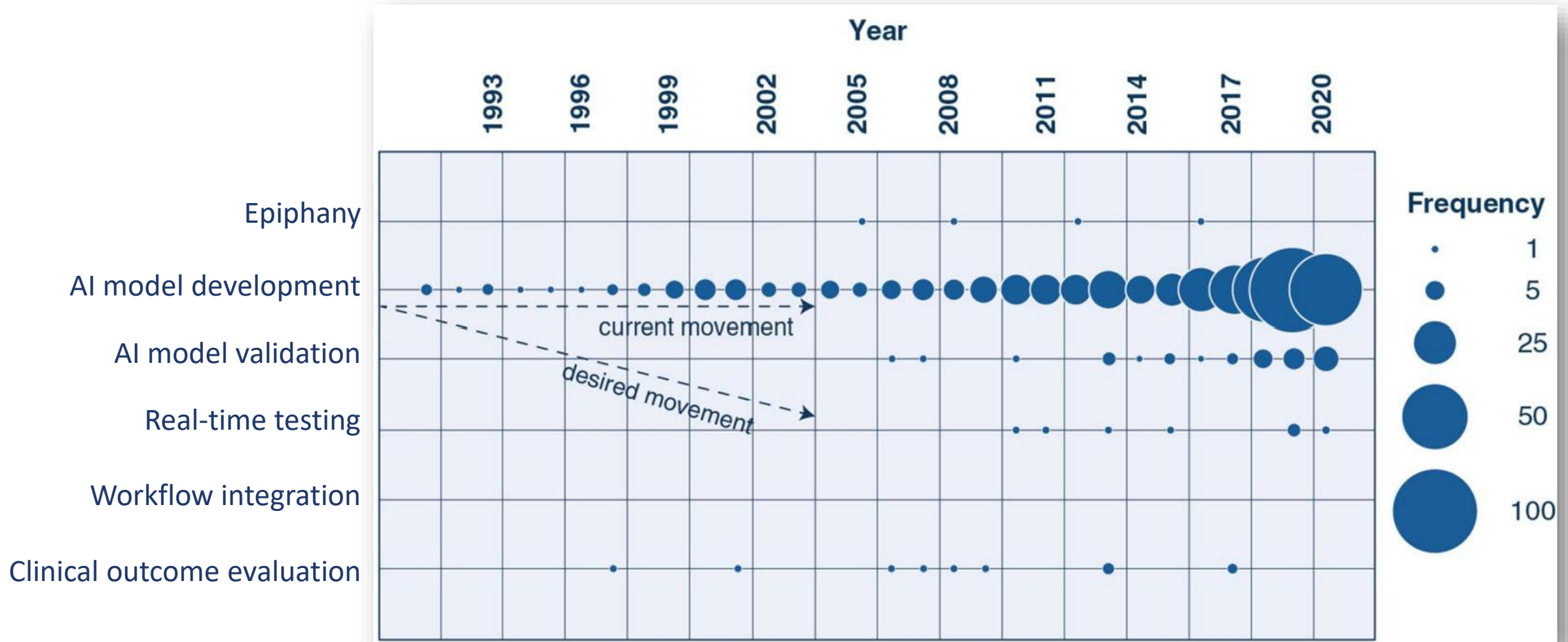...ce on the reading times of
...s

...pretation of chest radiographs (CXRs) would affect the
...ctive observational study aimed to observe how AI affected the
...adiologists who agreed to have the reading times of their CXR
...recruited. Reading time was defined as the duration in seconds
...gist. As commercial AI software was integrated for all CXRs, the
...During the other 2 months, the radiologists were automatically
...ists participated, and 18,680 CXRs were included. Total reading

Woensdag 16 oktober, 23:37

Agema ziet 'revolutionaire' rol voor AI in zorg, praktijk tempert verwachting

'Een revolutie in de zorg', zo noemt zorgminister Fleur Agema (PVV) de mogelijkheden van Artificial Intelligence (AI) voor de zorgsector. Haar doel is dat, onder andere met behulp van AI, de administratietijd in de zorg in 2030 is gehalveerd. Ook professionals in de zorg zijn hoopvol over de mogelijkheden van AI om de administratiedruk te verlagen, maar zij plaatsen ook kanttekeningen.

Volgens het ministerie van Volksgezondheid is er in 2033 een personeelstekort in de zorg van 200.000 mensen. In Nieuwsuur noemt Agema het haar "heilige plicht" om de zorg niet "in elkaar te laten klappen". Om dit te voorkomen legt de minister een belangrijke rol weg voor AI. Daarnaast kijkt ze bijvoorbeeld naar het aanpassen van wetten die...
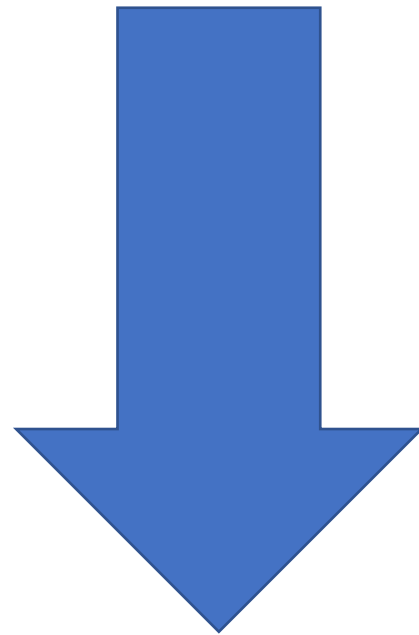
Elements of AI translation

From Idea

Epiphany

AI model development

AI model validation

Real-time testing

Workflow integration

Clinical outcome evaluation

To Value

Elements of AI translation

Elements of AI translation

Epiphany

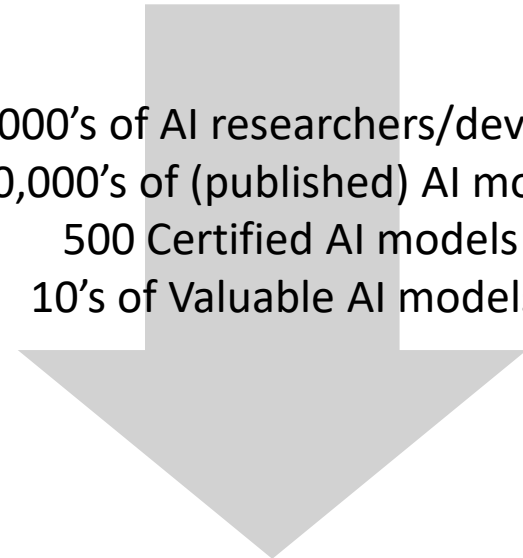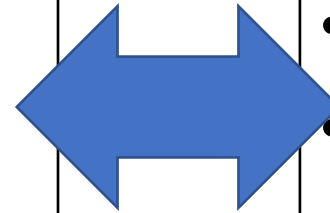AI model development

AI model validation

Real-time testing

Workflow integration

Clinical outcome evaluation

From Idea

To Value

100,000's of AI researchers/developers
10,000's of (published) AI models
500 Certified AI models
10's of Valuable AI models

A success story

Stroke treatment
- Speed
- Early patient/treatment selection
- All patients treated?

AI
- Fast analysis
- Non-linear relations
- Quantitative analysis
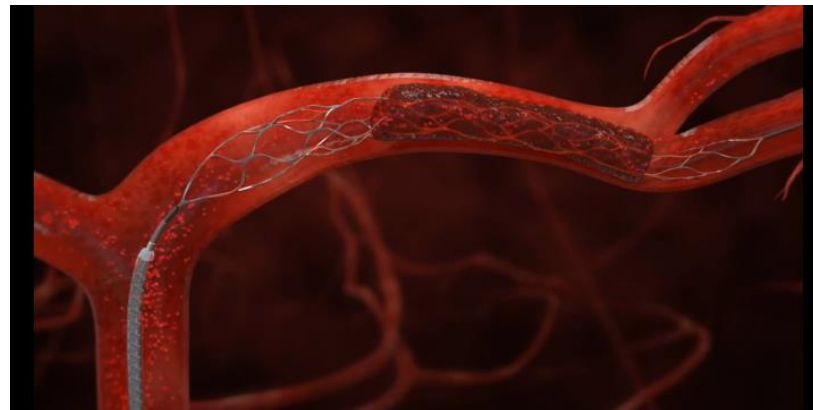
Find the Thrombus

- Challenge:
  - No contrast agent at the site of the thrombus
  - Thrombus characterized by the absence of high intensities

Find the thrombus

NCCT

CTA
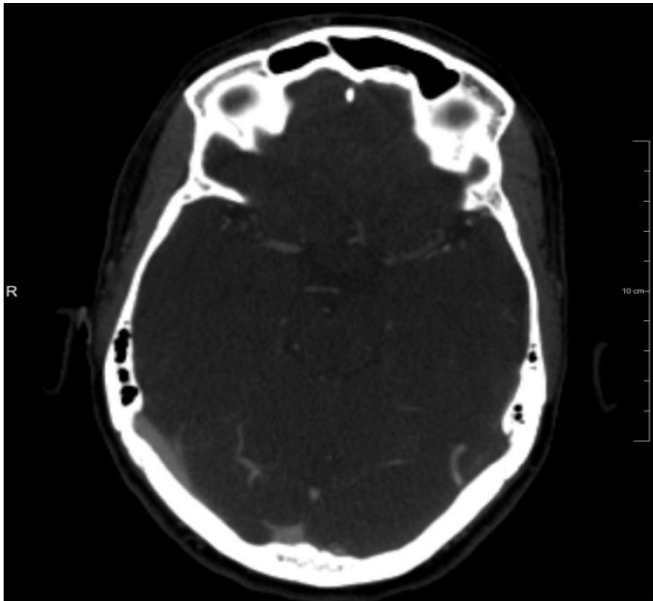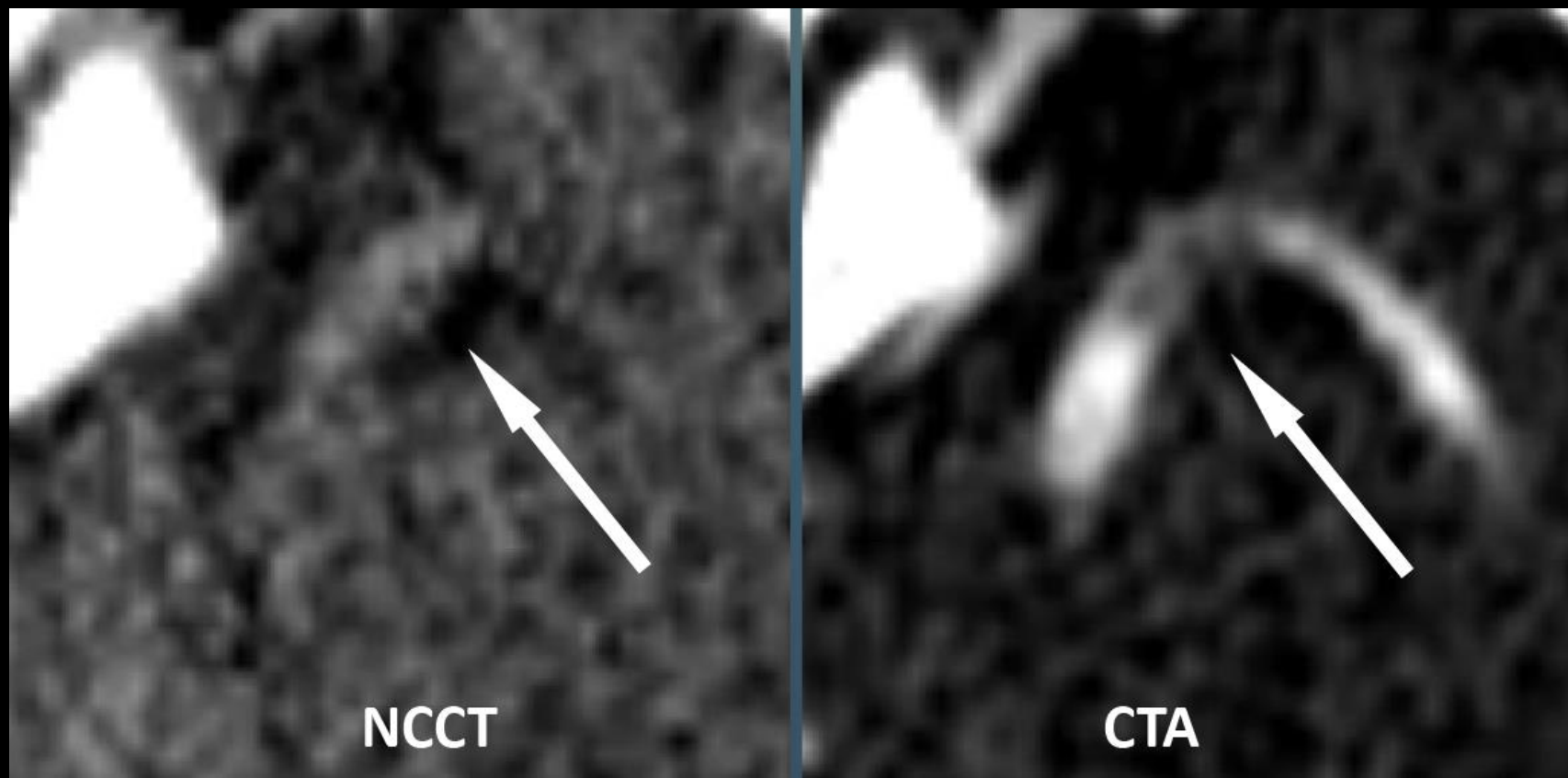
Thrombus detection and segmentation
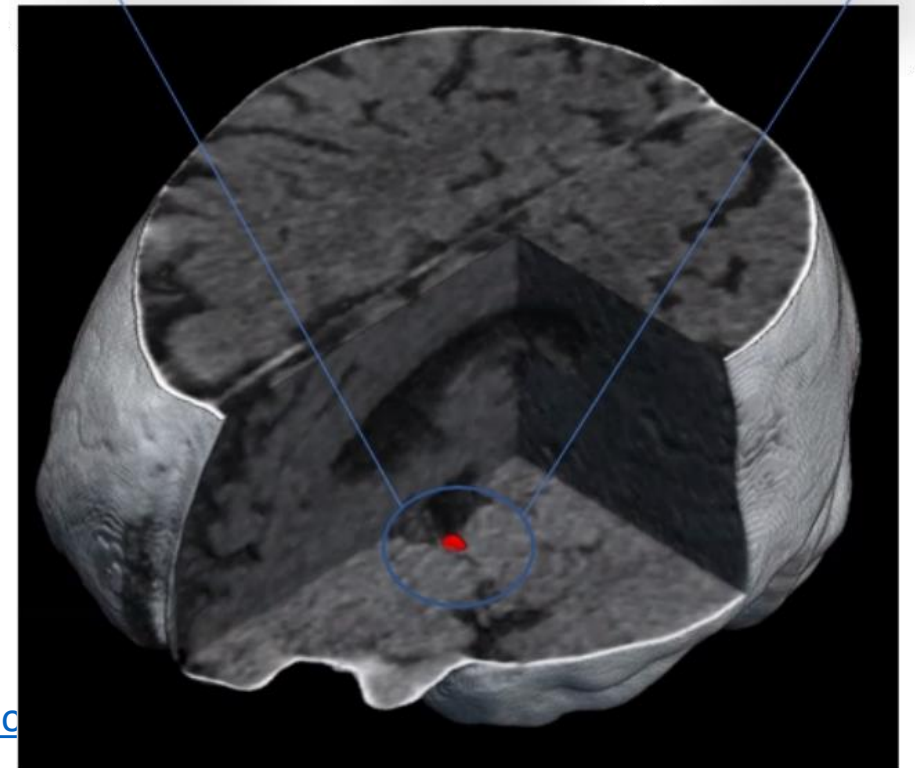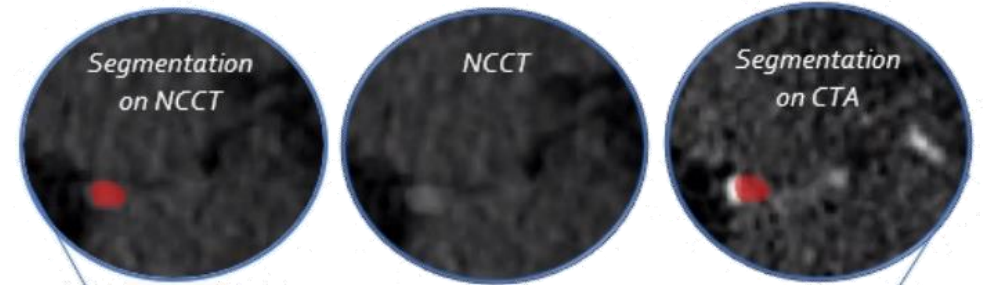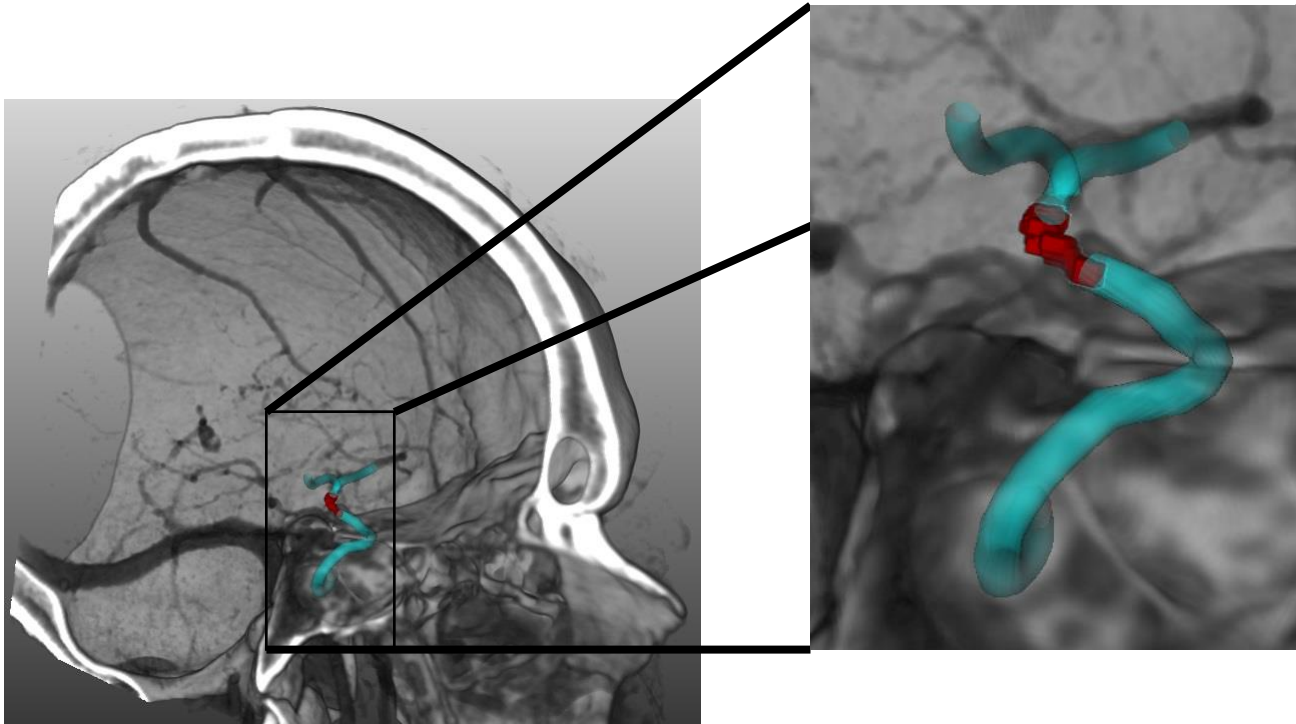
Success stories
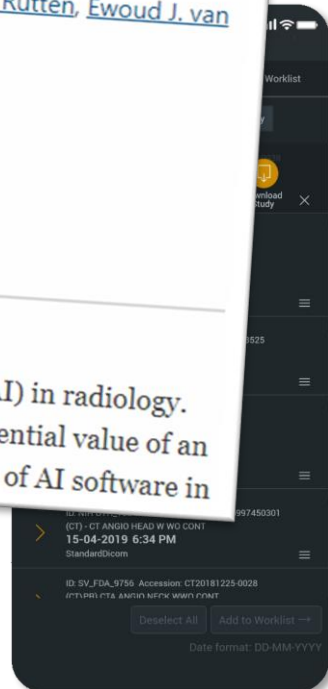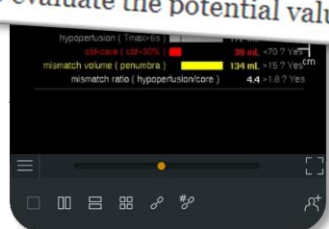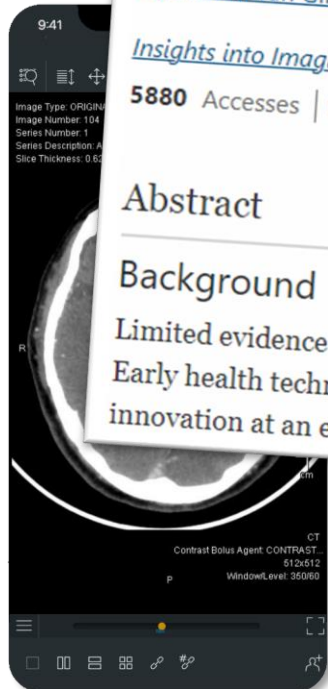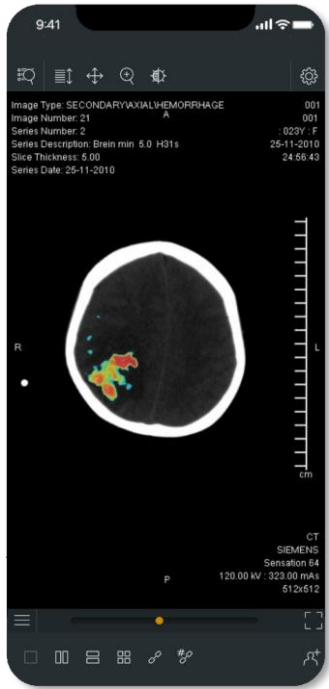
Cost-effectiveness of artificial intelligence aided vessel occlusion detection in acute stroke: an early health technology assessment

Kicky G. van Leeuwen ✉, Frederick J. A. Meijer, Steven Schalekamp, Matthieu J. C. M. Rutten, Ewoud J. van Dijk, Bram van Ginneken, Tim M. Govers & Maarten de Rooij

Insights into Imaging **12**, Article number: 133 (2021) | Cite this article

5880 Accesses | **9** Citations | **7** Altmetric | Metrics

Abstract

Background

Limited evidence is available on the clinical impact of artificial intelligence (AI) in radiology. Early health technology assessment (HTA) is a methodology to assess the potential value of an innovation at an early stage. We use early HTA to evaluate the potential value of AI software in
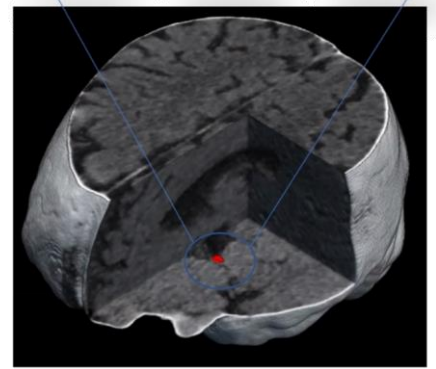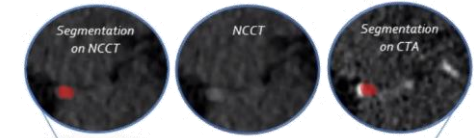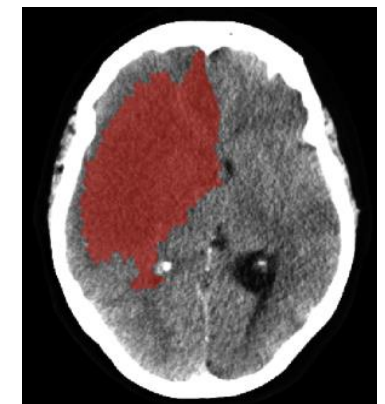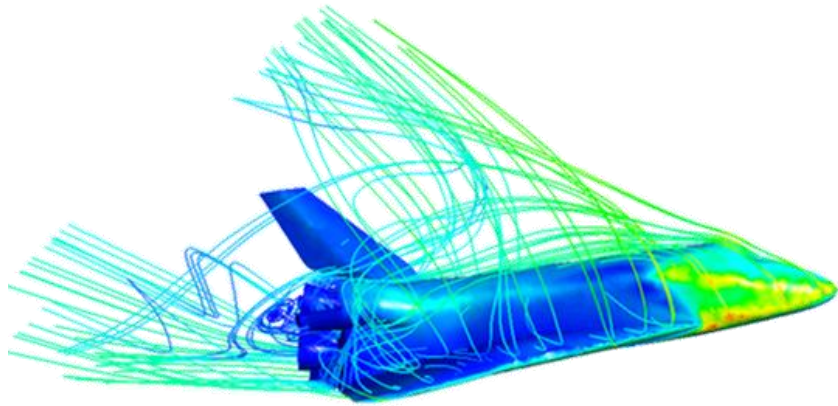
AI voor Klinisch Onderzoek: in-silico trials

Successful trials?

- Many trials in stroke turned out to be futile

- Trials are $$$

- Animal models translate poorly to human

- Explainability of failures is low

- It takes a long time to get a treatment from bench to bed site / clinical practice
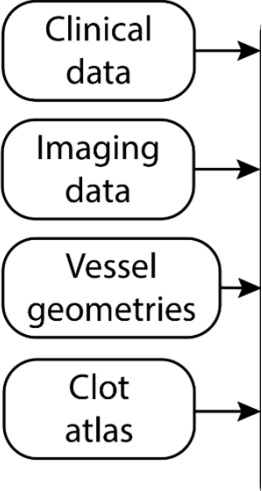 - Endovascular treatment: … years
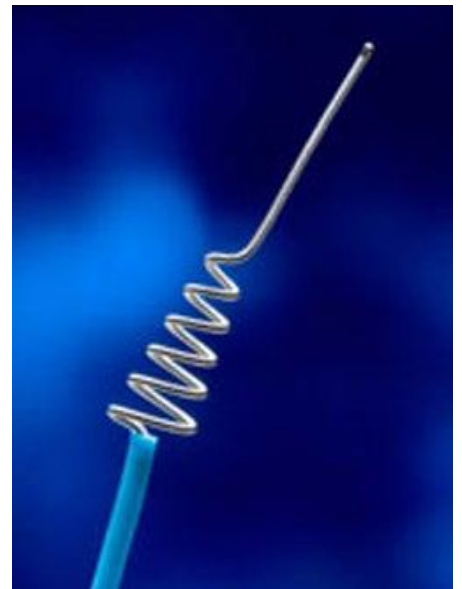
Can we learn from other disciplines?
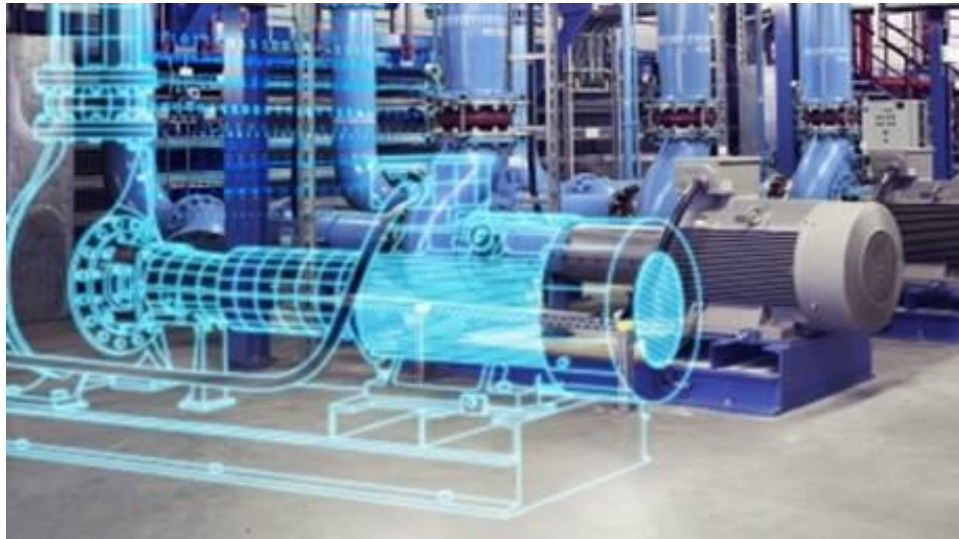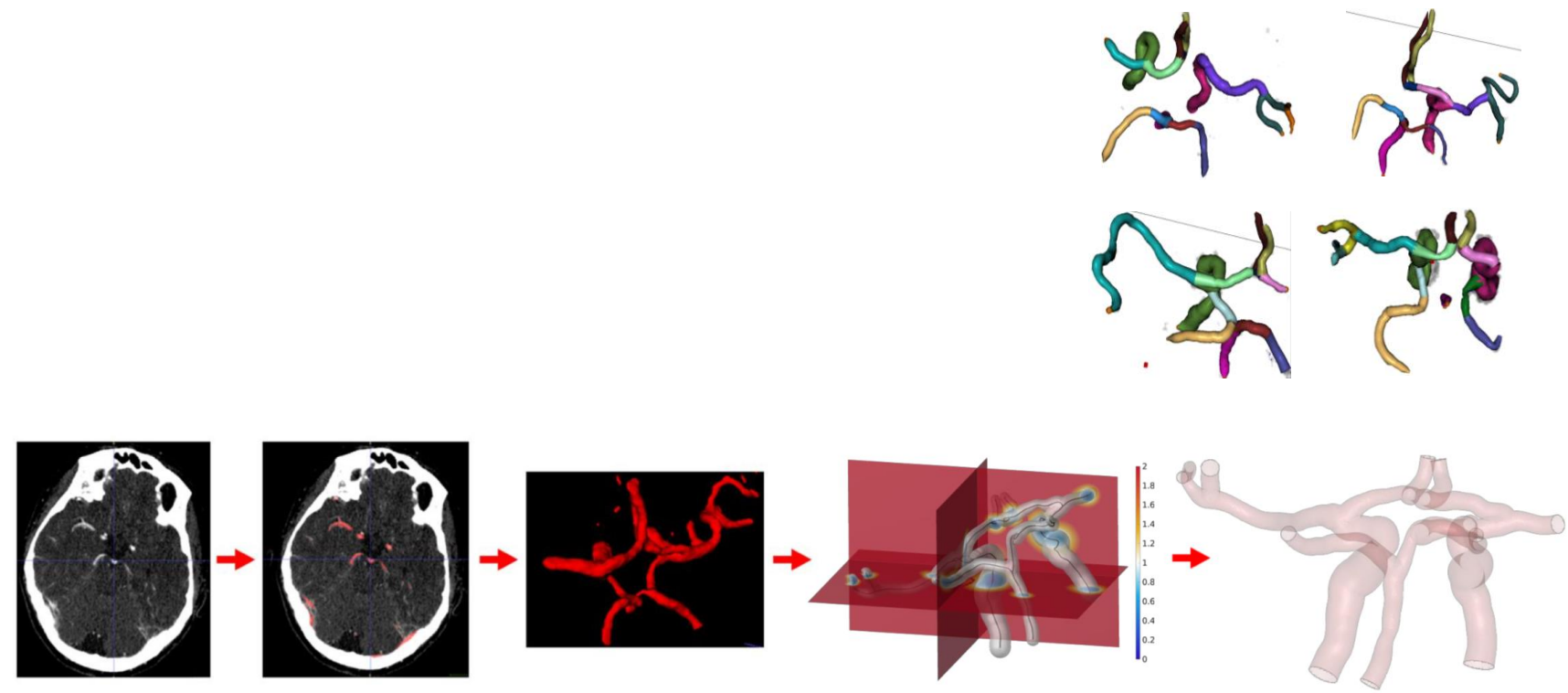

Definition 'in silico clinical trials':
"The use of individualized computer simulation in the development or regulatory evaluation of a medicinal product, medical device, or medical intervention."

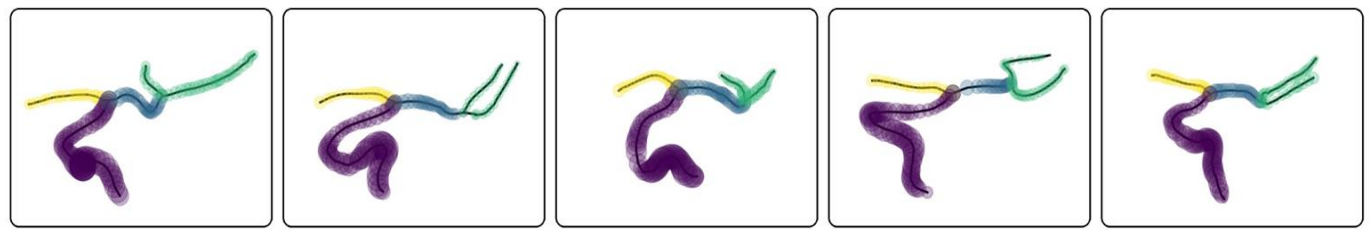# In silico trial platform
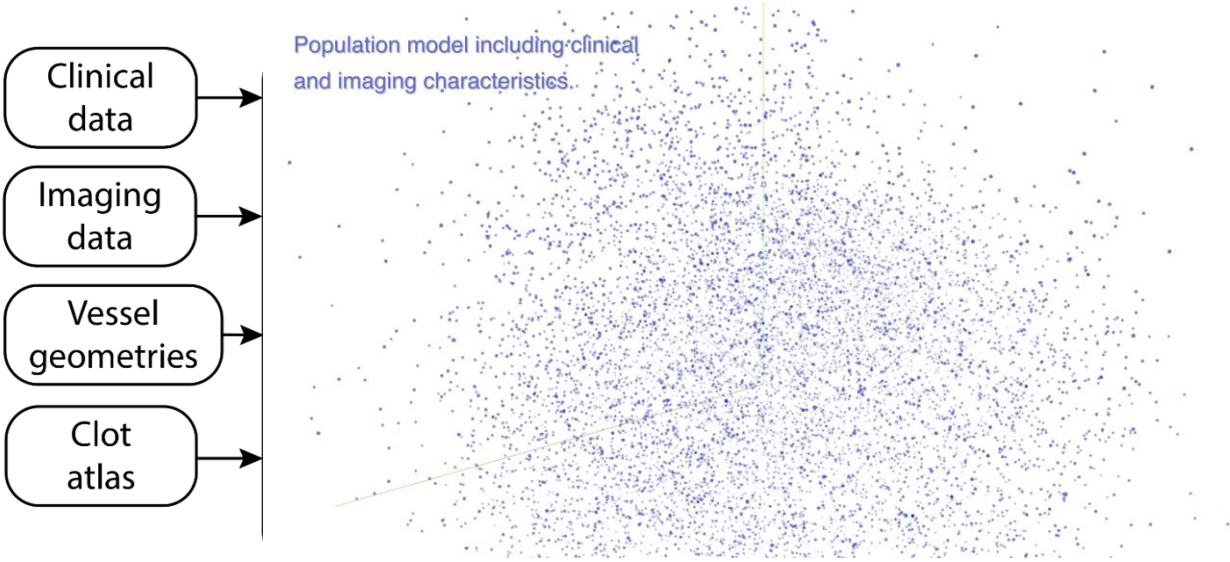
In silico trial platform
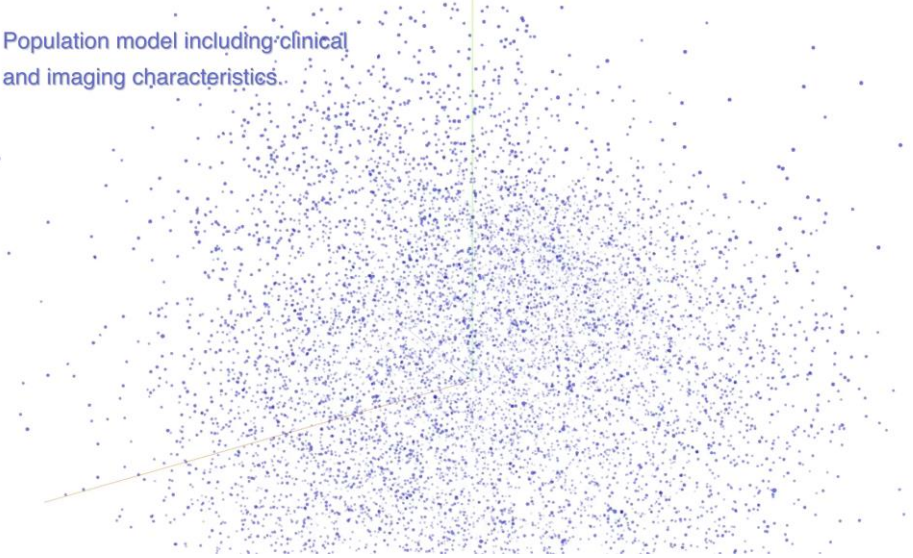
In silico trial platform
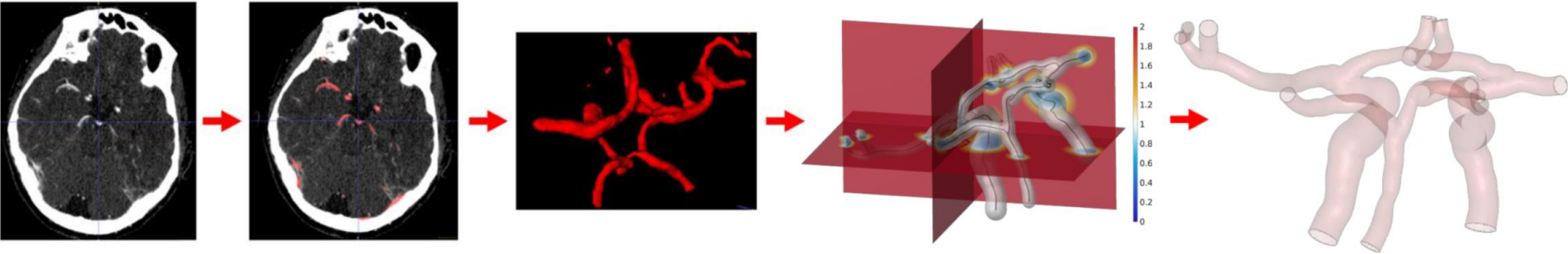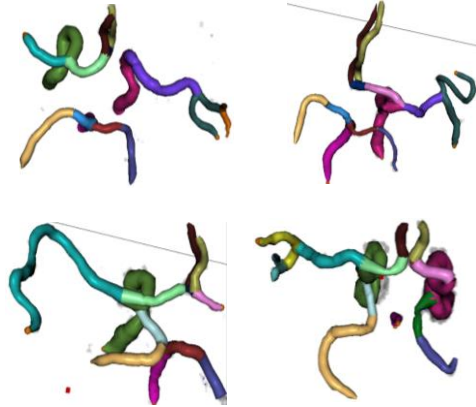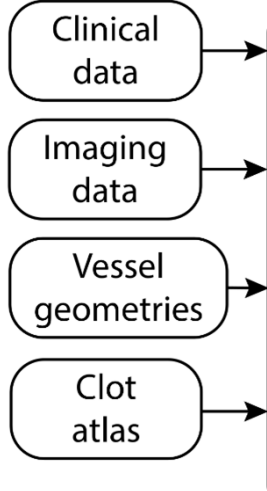
In silico trial platform: the virtual patient
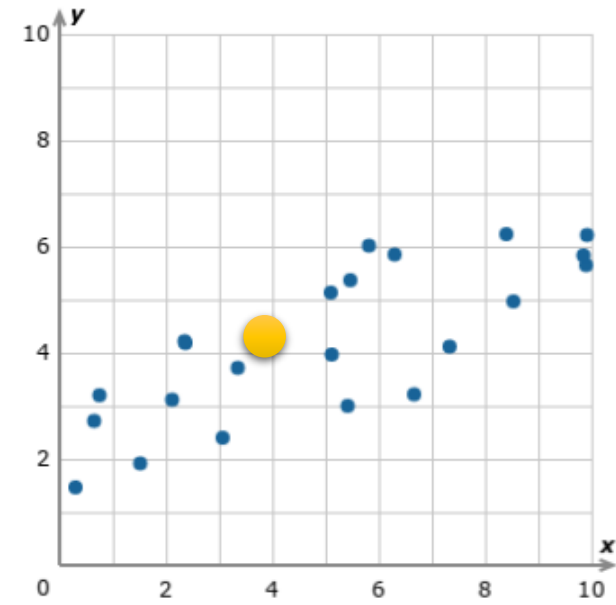
In silico trial platform

Clinical data

Imaging data

Vessel geometries

Clot atlas

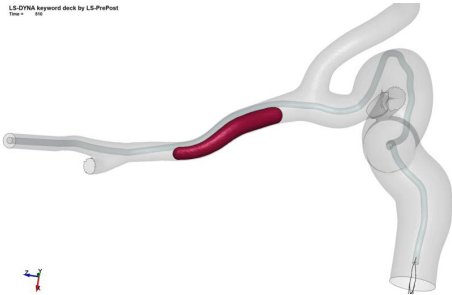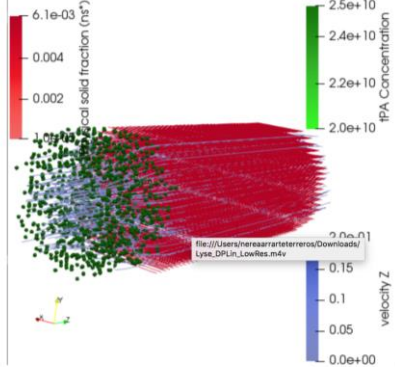Population model including clinical and imaging characteristics.

In silico trial platform

Clinical data

Imaging data

Vessel geometries

Clot atlas

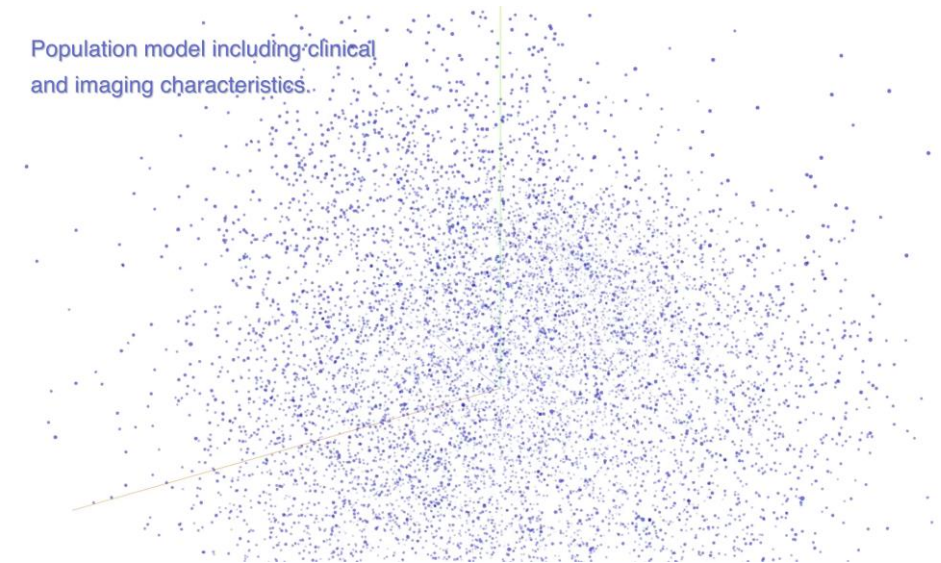Population model including clinical and imaging characteristics.
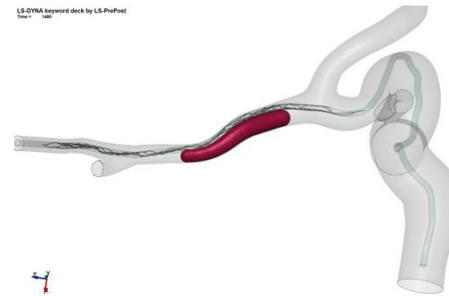
Thrombolysis

Thrombectomy

In silico trial platform

Clinical data

Imaging data

Vessel geometries

Clot atlas

Population model including clinical and imaging characteristics.

Thrombolysis

Thrombectomy
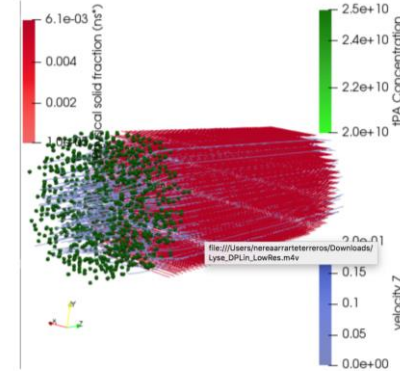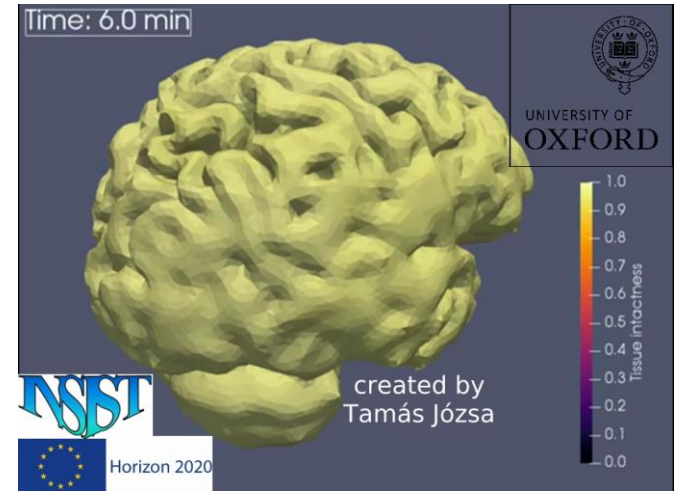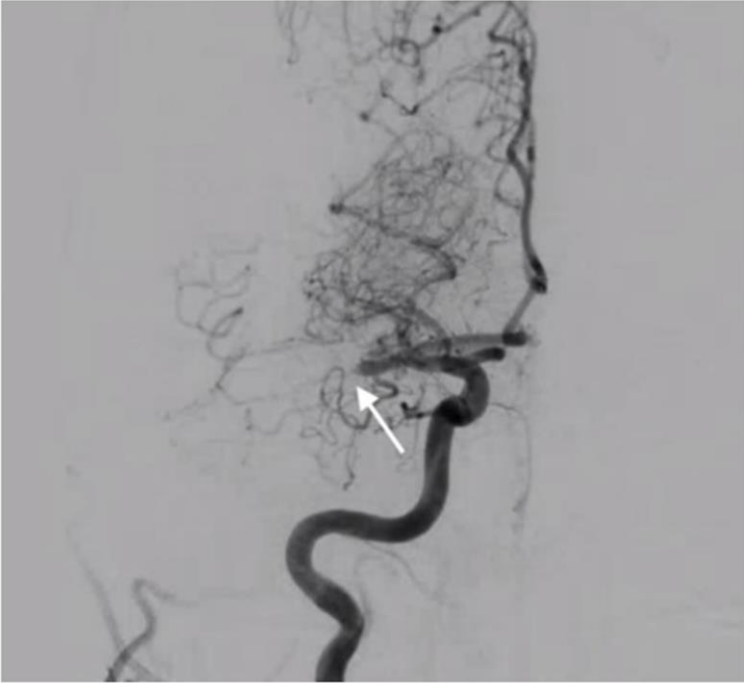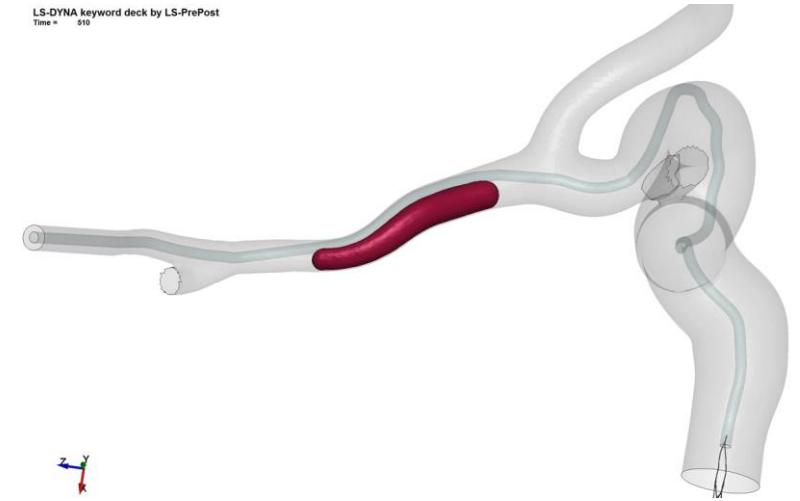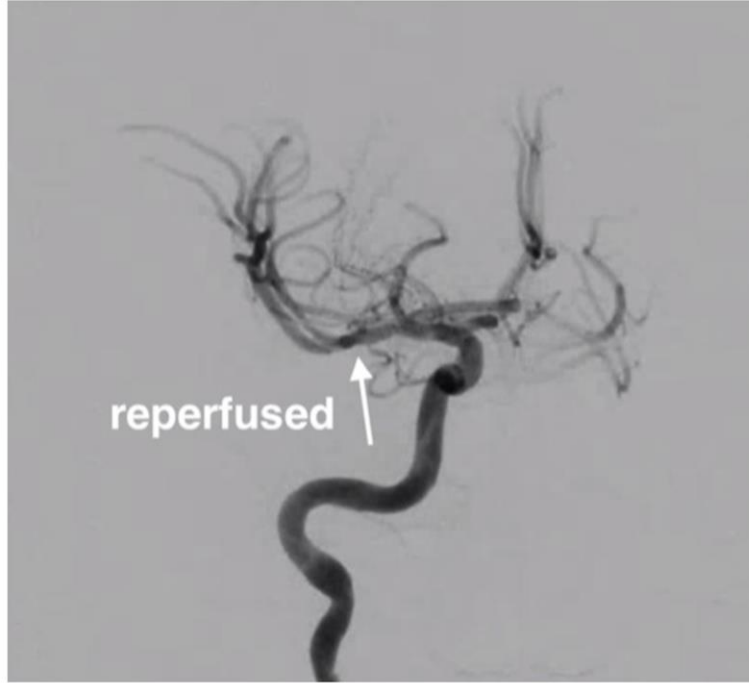
Time: 6.0 min

UNIVERSITY OF OXFORD

created by Tamás Józsa

Horizon 2020

In silico thrombectomy simulation

Clinical data

In-silico model

Luraghi G et al. *J Biomech (2021)* (

In silico trial platform for clinical trials

Characteristic	MR CLEAN (M1 thrombi)	*In silico* trial
Clinical		
Age (yr)	68 (56-76)	71 (61–80)
Male sex—no./%	36/50%	276/55%
NIHSS	16 (14-20)	15 (11–19)
Systolic blood pressure (mmHg)	145 (130-161)	145 (131–159)

Trial	Patients	Recanalization rate
MR CLEAN	72	82%
In-silico trial	500	85 ± 1.4%

Miller C, Konduri P, Bridio S, et al. *Comput Methods Programs Biomed* (2022)

Wat weten we al?

- AI ontwikkelingen gaan snel (al 75 jaar)

- AI in de Klinische praktijk gaat tergend langzaam

- Nieuwe toepassingen?
  - In-silico trials?
  - Digital twins?