

# La IA en imatge mèdica avui

VICOROB

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**PINT OF SCIENCE 23**  
22, 23 i 24 DE MAIG

#PINT23GIR  
#PINT23ES

# INTEL·LIGÈNCIA ARTIFICIAL I MEDICINA. ON SOM I CAP A ON ANEM?



**22 MAIG - 19:30H**  
**SBAR-JO CAFETERIA**  
**@SBAR\_JO**



## Girona

Robert Martí / Xavier Lladó

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## La rebel·lió de les màquines I: IA i medicina

Robert Martí Marly (Institut VICOROB, Universitat de Girona. )

 @rmartimarly

Pot la intel·ligència artificial (IA) substituir els metges? Un dels principals camps d'introducció de la IA en medicina és la radiologia, per les grans quantitats d'informació que cal processar i per la possibilitat d'automatitzar el diagnosi de malalties. En la primera part de la xerrada veurem què pot i què no pot fer la IA actualment en el camp de la radiologia, i repassarem el seu passat, present i més que probable brillant futur.



# Revolució de la IA

Pot la IA ajudar a diagnosticar?

Pot un ordinador diagnosticar una malaltia millor que un metge?

Confiaríeu amb el diagnòstic d'un ordinador?  
En cas d'error qui seria el responsable?

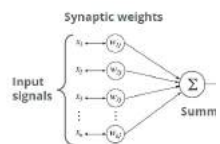
On estem? Què pot i què no pot fer la IA?

Obtenim el millor dels dos móns. Els reflexos **més ràpids** possibles avui en dia, memòria **assistida per ordinador** i tota una vida de l'**experiència** de policia al carrer programada. És un gran plaer presentar-vos...

# ROBOCOP

Podem tenir diagnòstics més ràpids, més  
acurats, tenir segones opinions, l'expertesa  
de 100 metges, totes les nostres dades  
mèdiques integrades en un mateix lloc,  
podem tenir...

# ROBORADIOLEG



**1943**  
Neurona Artificial



**1950**  
Invenció de la Màquina de Turing



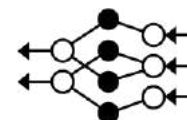
**1956**  
Concepte de Intel·ligència Artificial

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00 11 11 11 11 11 11
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**1960**  
Primer Xatbot ELIZA

**1970**  
Algoritme de backpropagation



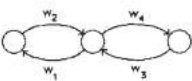
**1972**  
1r Robot WABOT



**1970-1980**  
1r AI Winter



**1986**  
Hinton NN article Nature



**1987-1993**  
2n AI Winter



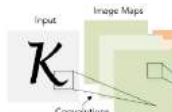
**1997**  
Ordinador guanya campió d'escacs



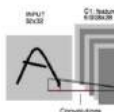
**2004-2015**  
AI Spring: GPUs CNNs, ImageNet



**1998**  
Lecun CNN reconeix documents



**1989**  
Lecun CNN reconeix caràcters



**ARA**  
AI Hype Tardor Hivern?



# Deep learning





# Deep learning in medical Imaging



*"We should **stop training radiologists** now. It's just completely obvious that within five years, deep **learning** is going to do better than **radiologists**."*

**Geoffrey Hinton  
2016**

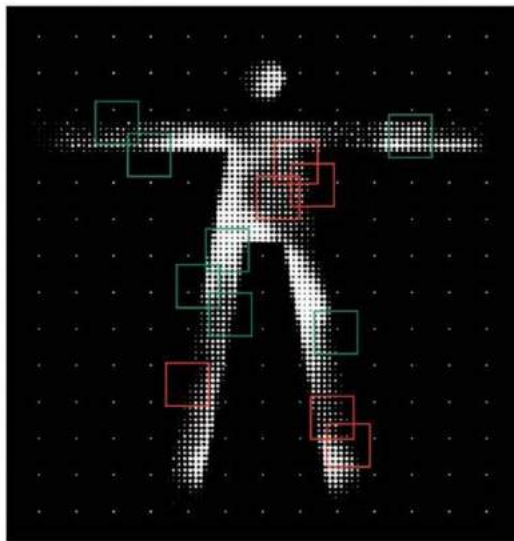
# Deep learning in medical Imaging

ANNALS OF MEDICINE

## THE ALGORITHM WILL SEE YOU NOW

*When it comes to diagnosis, will A.I. replace the M.D.?*

BY SIDDHARTHA MUKHERJEE



*In some trials, "deep learning" systems have outperformed human experts.*

ONE EVENING LAST November, a fifty-four-year-old woman from the Bronx arrived at the emergency room at Columbia University's medical center with a grinding headache. Her vision had become blurry, she told the E.R. doctors, and her left hand felt numb and weak. The doctors examined her and ordered a CT scan of her head.

A few months later, on a morning this January, a team of four radiologists-in-training huddled in front of a computer in a third-floor room of the hospital. The room was windowless and dark, aside from the light from the screen, which looked as if it had been filtered through

seawater. The residents filled a cubicle, and Angela Lignelli-Dipple, the chief of neuroradiology at Columbia, stood behind them with a pencil and pad. She was training them to read CT scans.

"It's easy to diagnose a stroke once the brain is dead and gray," she said. "The trick is to diagnose the stroke before too many nerve cells begin to die." Strokes are usually caused by blockages or bleeds, and a neuroradiologist has about a forty-five-minute window to make a diagnosis, so that doctors might be able to intervene—to dissolve a growing clot, say. "Imagine you are in the E.R.," Lignelli-Dipple continued, raising the ante. "Every

minute that passes, some part of the brain is dying. Time lost is brain lost."

She glanced at a clock on the wall, as the seconds ticked by. "So where's the problem?" she asked.

Strokes are typically asymmetrical. The blood supply to the brain branches left and right and then breaks into rivulets and tributaries on each side. A clot or a bleed usually affects only one of these branches, leading to a one-sided deficit in a part of the brain. As the nerve cells lose their blood supply and die, the tissue swells subtly. On a scan, the crisp borders between the anatomical structures can turn hazy. Eventually, the tissue shrinks, trailing a parched shadow. But that shadow usually appears on the scan several hours, or even days, after the stroke, when the window of intervention has long closed. "Before that," Lignelli-Dipple told me, "there's just a hint of something on a scan"—the premonition of a stroke.

The images on the Bronx woman's scan cut through the skull from its base to the apex in horizontal planes, like a melon sliced from bottom to top. The residents raced through the layers of images, as if thumbing through a flipbook, calling out the names of the anatomical structures: cerebellum, hippocampus, insular cortex, striatum, corpus callosum, ventricles. Then one of the residents, a man in his late twenties, stopped at a picture and motioned with the tip of a pencil at an area on the right edge of the brain. "There's something patchy here," he said. "The borders look hazy." To me, the whole image looked patchy and hazy—a blur of pixels—but he had obviously seen something unusual.

"Hazy?" Lignelli-Dipple prodded. "Can you describe it a little more?"

The resident fumbled for words. He paused, as if going through the anatomical structures in his mind, weighing the possibilities. "It's just not uniform." He shrugged. "I don't know. Just looks funny."

Lignelli-Dipple pulled up a second CT scan, taken twenty hours later. The area pinpointed by the resident, about the diameter of a grape, was dull and swollen. A series of further scans, taken days apart, told the rest of the story. A distinct wedge-shaped field of gray appeared. Soon after the woman got to the E.R., neurologists had tried to open the clogged artery with clot-busting

ILLUSTRATION BY DANIEL SAVAGE



Forbes

Apr 30, 2017, 12:10pm EDT

## AI In Medicine: Rise Of The Machines



Paul Hsieh Contributor

Health

*I cover health care and economics from a free-market perspective.*

This article is more than 4 years old.

Could a robot do my job as a radiologist?

If you asked me 10 years ago, I would have said, "No way!" But if you ask me today, my answer would be more hesitant, "Not yet — but perhaps someday soon."

In particular, new "deep learning" artificial intelligence (AI) algorithms are showing promise in performing medical work which until recently was thought only capable of being done by human physicians.

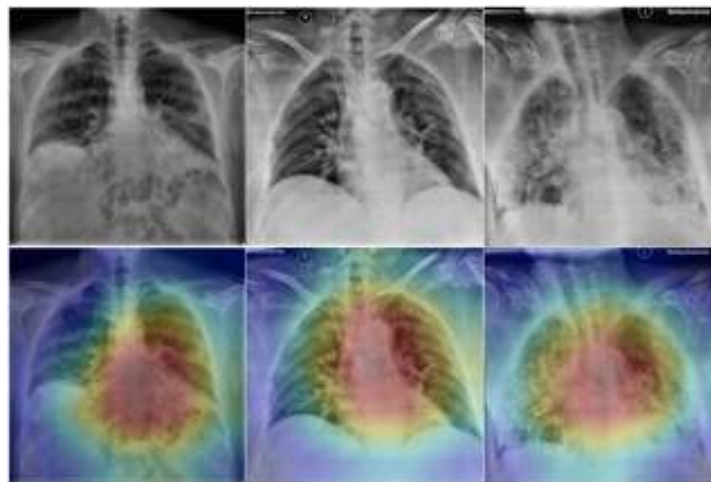
For example, deep learning algorithms have been able to [diagnose the presence or absence of tuberculosis \(TB\)](#) in chest x-ray images with astonishing accuracy. Researchers first "trained" the AIs with hundreds of x-ray images of patients without and with tuberculosis. Then, they tested the AIs with 150 new x-rays. The algorithms achieved an impressive 96% accuracy rate — better than many human radiologists — and the researchers believe they can improve upon this with more training cases and more advanced deep learning models. As the [study authors note](#), "Automated detection of pulmonary TB at chest radiography may facilitate screening and evaluation efforts in TB-prevalent areas with limited access to radiologists."

Similar deep learning algorithms have shown encouraging successes in other branches of medicine such as pathology, ophthalmology (eye diseases), and cardiology.

Researchers at Google were able to train an AI to detect spread of breast cancer into lymph node tissue on microscopic specimen images with [accuracy comparable to \(or greater than\) human pathologists](#). Looking for tiny deposits of cancer on a specimen slide can be challenging — like trying to find a single unusually shaped house in a stack of satellite photographs of an entire city. But whereas a human pathologist might suffer from fatigue or inattention, the AI can process gigapixel images without breaking a sweat.

Cookies on Forbes

# Hype or Hope?



## Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans

Michael Roberts<sup>1,2</sup>, Derek Driggs<sup>1</sup>, Matthew Thorpe<sup>3</sup>, Julian Gilbey<sup>1</sup>, Michael Yeung<sup>4</sup>, Stephan Ursprung<sup>4,5</sup>, Angelica I. Aviles-Rivero<sup>1</sup>, Christian Etmann<sup>1</sup>, Cathal McCague<sup>4,5</sup>, Lucian Beer<sup>4</sup>, Jonathan R. Weir-McCall<sup>4,6</sup>, Zhongzhao Teng<sup>4</sup>, Effrossyni Gkrania-Klotsas<sup>7</sup>, AIX-COVNET<sup>\*</sup>, James H. F. Rudd<sup>8,36</sup>, Evis Sala<sup>4,5,36</sup> and Carola-Bibiane Schönlieb<sup>1,36</sup>

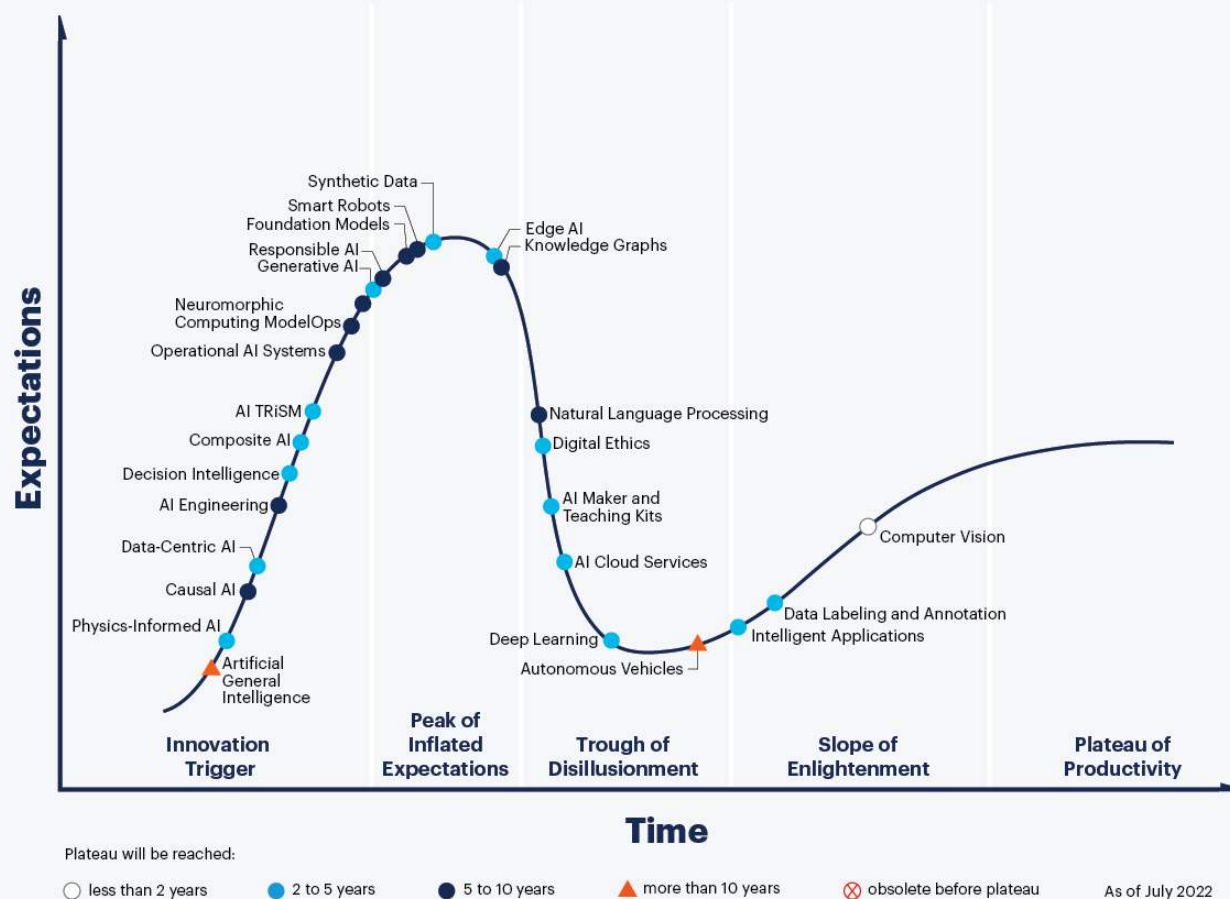
Machine learning methods offer great promise for fast and accurate detection and prognostication of coronavirus disease 2019 (COVID-19) from standard-of-care chest radiographs (CXR) and chest computed tomography (CT) images. Many articles have been published in 2020 describing new machine learning-based models for both of these tasks, but it is unclear which are of potential clinical utility. In this systematic review, we consider all published papers and preprints, for the period from 1 January 2020 to 3 October 2020, which describe new machine learning models for the diagnosis or prognosis of COVID-19 from CXR or CT images. All manuscripts uploaded to bioRxiv, medRxiv and arXiv along with all entries in EMBASE and MEDLINE in this timeframe are considered. Our search identified 2,212 studies, of which 415 were included after initial screening and, after quality screening, 62 studies were included in this systematic review. Our review finds that none of the models identified are of potential clinical use due to methodological flaws and/or underlying biases. This is a major weakness, given the urgency with which validated COVID-19 models are needed. To address this, we give many recommendations which, if followed, will solve these issues and lead to higher-quality model development and well-documented manuscripts.

<https://www.nature.com/articles/s42256-021-00307-0>



# Hype or Hope?

## Hype Cycle for Artificial Intelligence, 2022



[gartner.com](https://www.gartner.com)

Source: Gartner  
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**Gartner**

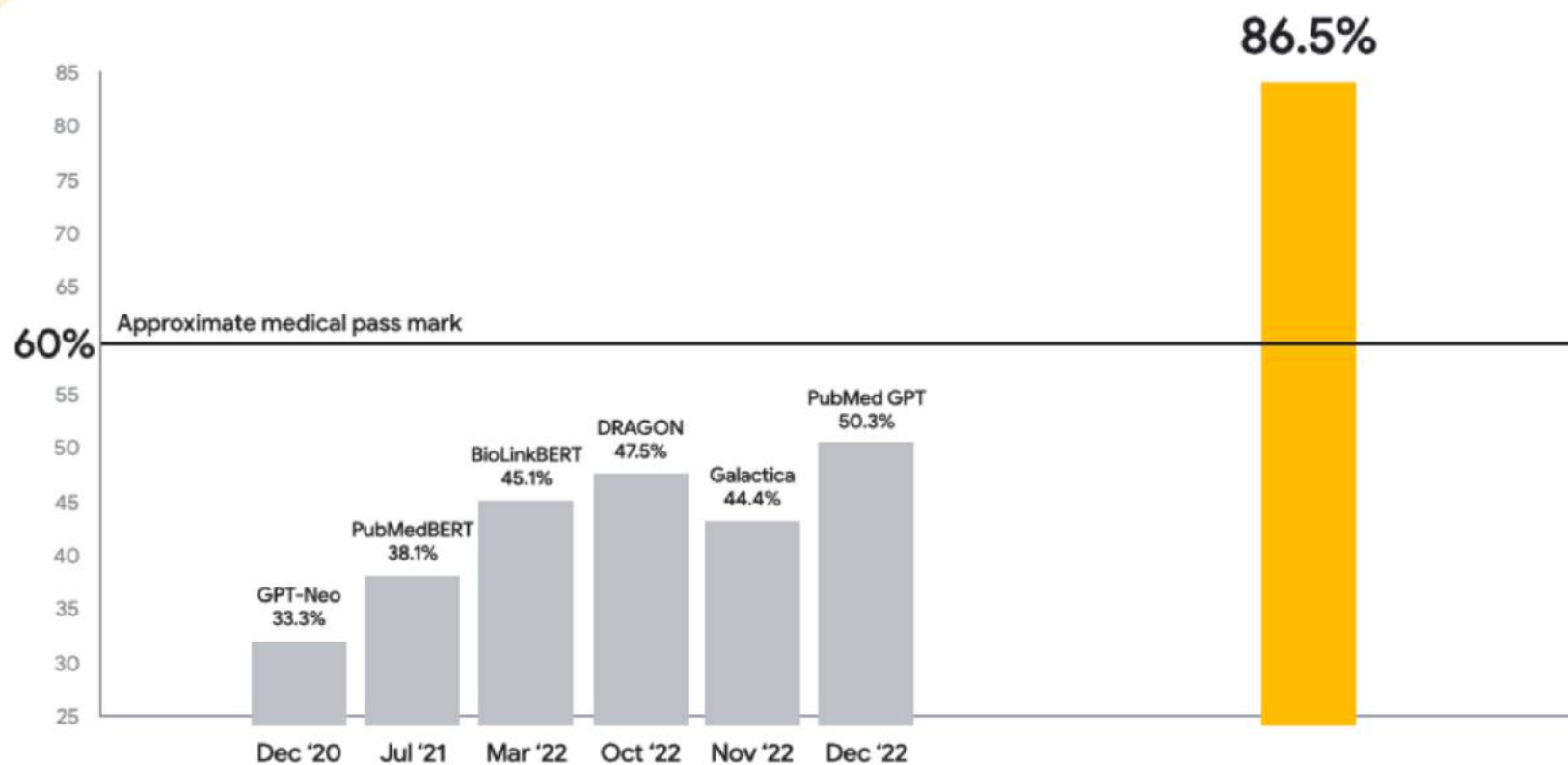




# IA or not IA?



## Med-PaLM 2



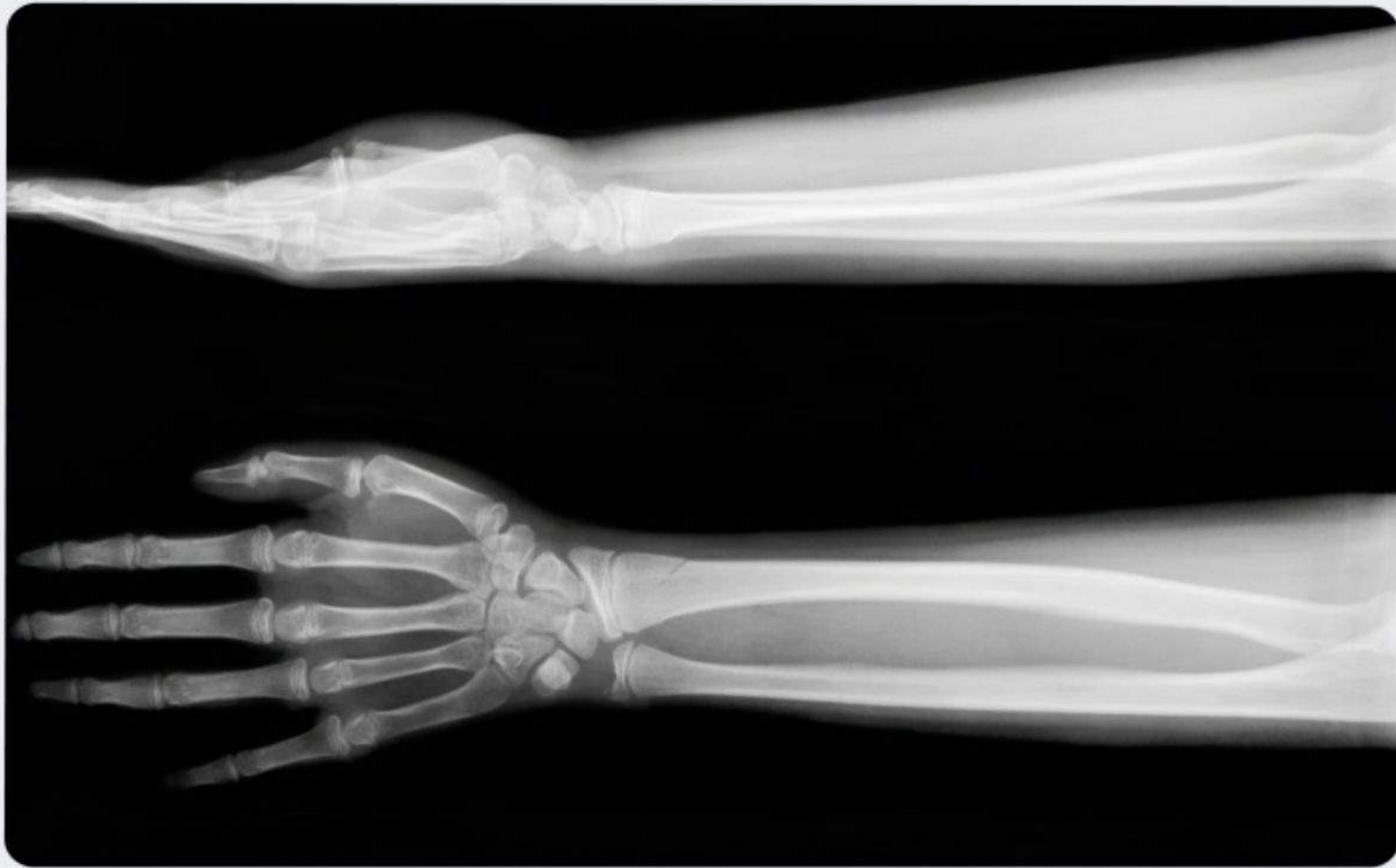
Med-PaLM 2 reached **86.5% accuracy** on the MedQA medical exam benchmark in research

<https://sites.research.google/med-palm/>

Prompt



What does this film show?





## FOREARM (2 VIEWS)

### Findings:

- Minimally displaced acute oblique fracture through distal radial metaphysis (Salter-Harris II).
- Possible minimally displaced vertical fracture through distal ulnar epiphysis with ulnar styloid avulsion fracture vs. unfused ossification center.
- No dislocation.

### Impression:

Acute distal radius fracture. Indeterminate assessment of distal ulna; clinical correlation recommended.



# Exemple en càncer de mama

- Com pot ajudar la IA en el càncer de mama?
  - Detecció i diagnosi de lesions
  - Quantificació de les lesions, anàlisi temporal
  - Predicció del tractament
  - Predicció del risc
- Ajudar al radiòleg a...
  - Ser més **objectiu**: reduir errors i variabilitat
  - Millorar **expertesa**
  - Disminuir **el temps** de lectura de casos
  - Millorar **protocols**
  - Millorar la **detecció precoç**

# AI challenges radiologists at detecting breast cancer

March 06, 2019 | [Matt O'Connor](#) | [Artificial Intelligence](#)



Additionally, the AI system achieved a higher sensitivity than 55 of 95 radiologists, but its performance was “way lower” than that of the best radiologist, the authors noted.



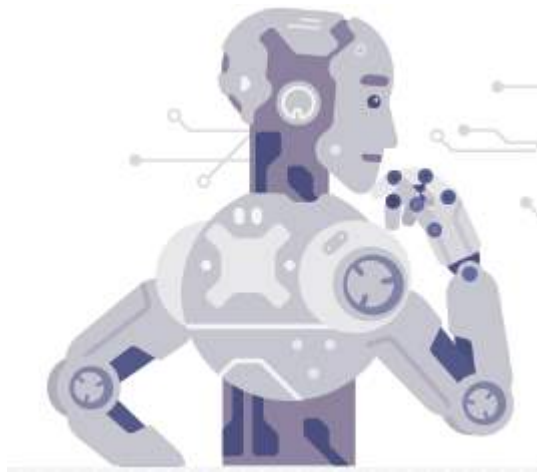
An AI approach developed by Dutch researchers performed similarly to radiologists at detecting breast cancer, according to a multi-center, multi-dataset [study](#) published March 5 in the *Journal of the National Cancer Institute*.

The researchers looked at 29,000 readings broken down into nine datasets, each containing digital mammography (DM) exams read by a total of 101 radiologists. The AI—trained, validated and tested on more than 9,000 mammograms with cancer and 180,000 without abnormalities—performed better than radiologists.

Specifically, it gained a 0.840 area under the ROC score compared to the 0.814 achieved by the radiologists—a higher mark than 61 percent of the 101 interpreters, wrote Alejandro Rodriguez-Ruiz, MSc, of Radboud University Medical Center in the Netherlands, and colleagues.

# Ètica

- Com poden treballar els humans i la IA?
- Què fem en el cas on la IA i l'humà no coincideixen?
- Els algoritmes poden discriminar?
- Aspectes importants:
  - Robustesa tècnica
  - Privacitat i seguretat
  - Transparència
  - IA justa (fair AI) i inclusiva (biaix).
  - Rendició de comptes (accountability).
  - Impacte ambiental



## La rebel·lió de les màquines II: IA a VICOROB

Xavier Lladó Bardera (Institut VICOROB, Universitat de Girona. )

En la segona part de la xerrada veurem exemples reals d'aplicació de la IA actuals, i especialment casos made in Girona en el grup de recerca VICOROB de la Universitat de Girona, en el camp de càncer de mama i malalties neurològiques.

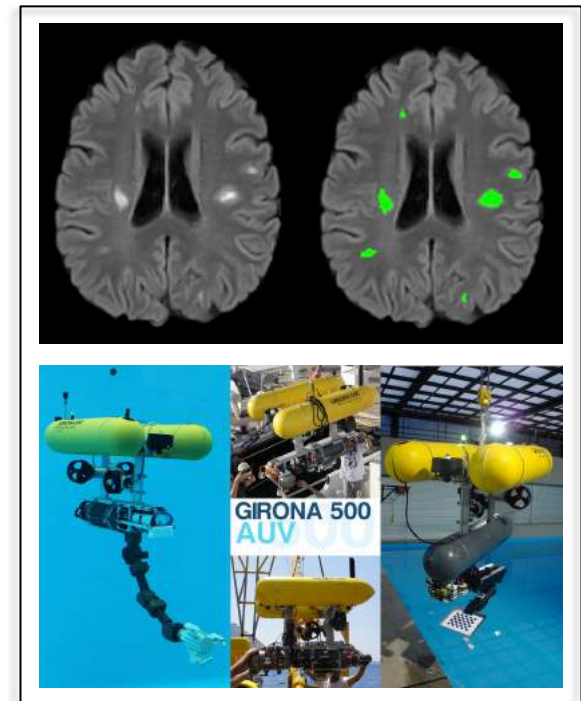
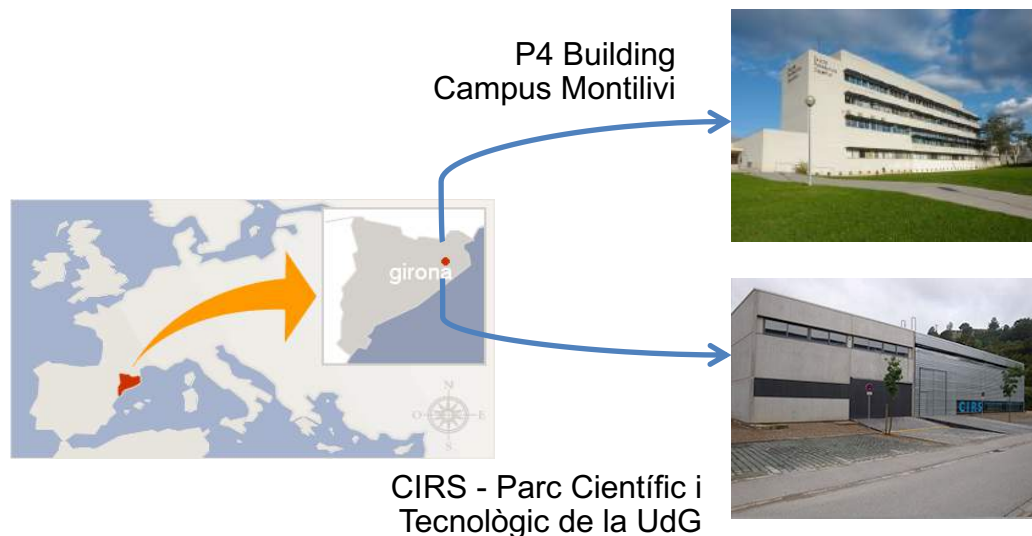


- VICOROB: qui som, on som i què fem?
- Aplicacions de la IA al càncer de mama
- Aplicacions de la IA a les malalties neurodegeneratives



# VICOROB

- ViCOROB és el grup de recerca en **Visió per Computador i Robòtica** de la UdG
- És un dels grups de recerca més gran, tant en termes d'equip, com d'ingressos per R+D+i (1,2M€ anuals) i compta **amb 3 grups SGR consolidats**
- La seva recerca és aplicada en els àmbits de **la imatge mèdica**, percepció 3D per a la inspecció industrial, robòtica i visió subaquàtica i la robòtica educativa

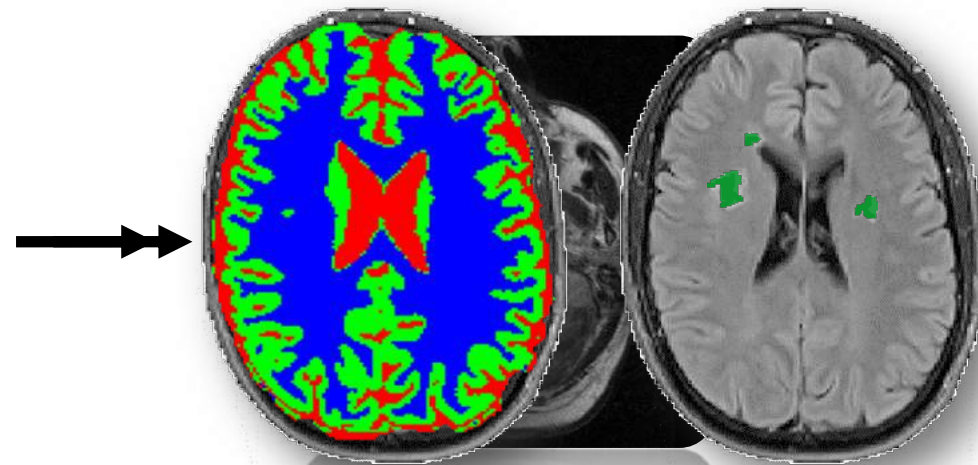


# VICOROB: què fem?

- **Processos i tècniques d'anàlisi d'imatges:** segmentació, detecció i reconeixement d'objectes, classificació d'imatges, registre d'imatges
- **Tècniques d'intel·ligència artificial** aplicades a l'anàlisi d'imatges mèdiques: *Machine Learning, Deep Learning i Big Data*
- **Desenvolupament de sistemes CAD** (eines d'ajut al diagnòstic). Aplicacions: càncer de mama, malalties neurodegeneratives (ex: esclerosi múltiple), càncer de pròstata, de pell, etc



Scanner



Tissue WM, GM, CSF

Lesions

## La rebel·lió de les màquines II: IA a VICOROB

Xavier Lladó Bardera (Institut VICOROB, Universitat de Girona. )

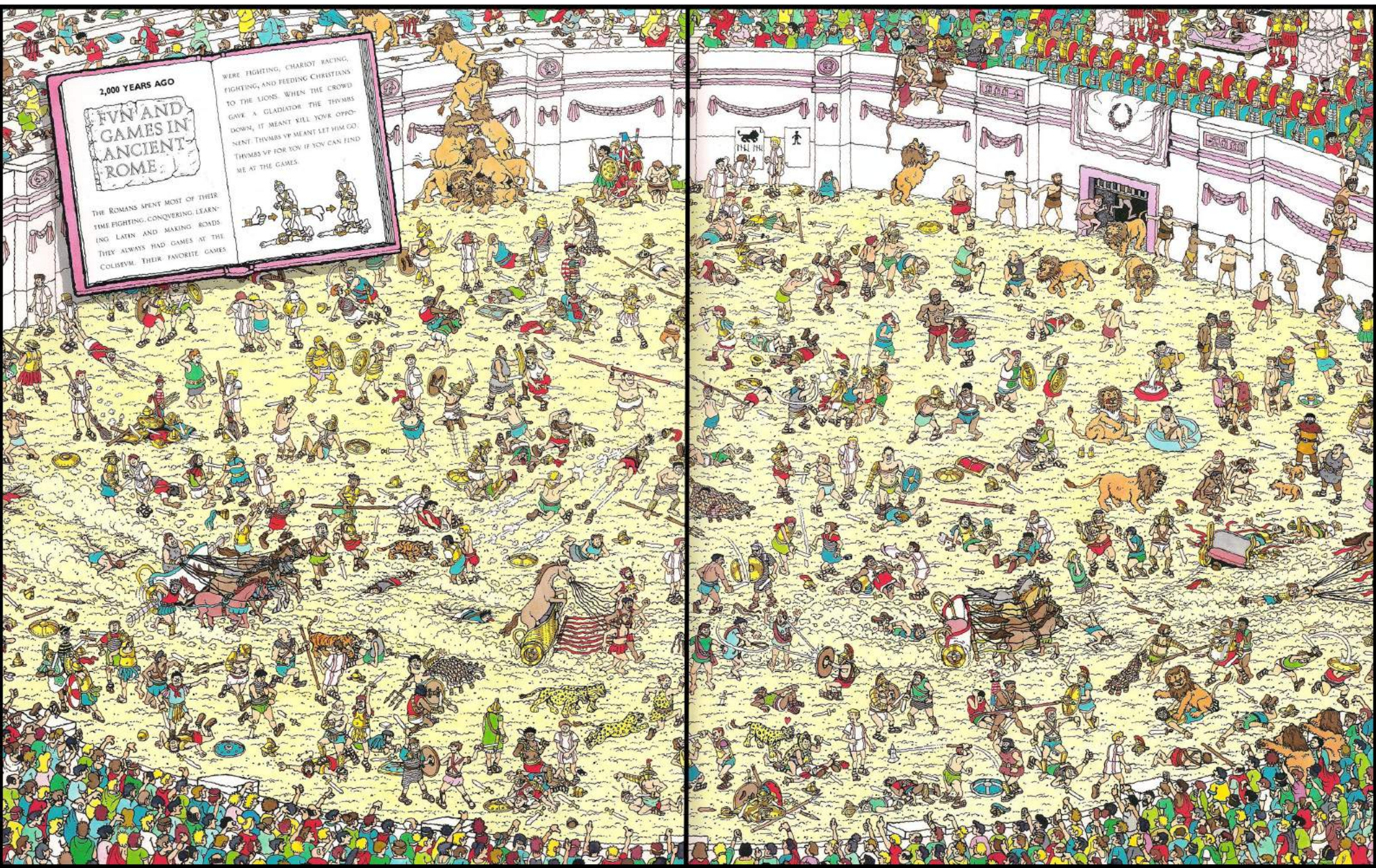
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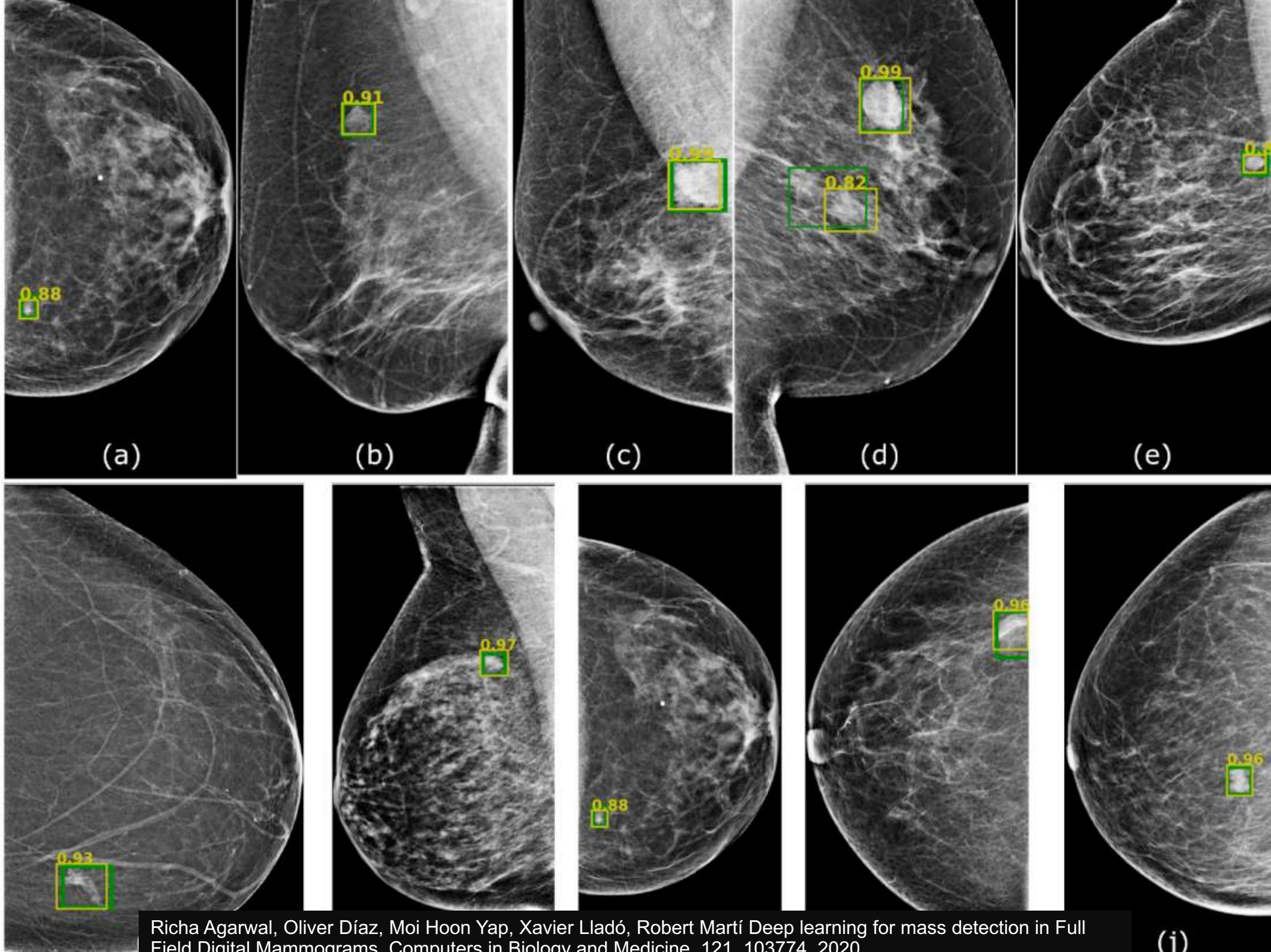
- VICOROB: qui som, on som i què fem?
- **Aplicacions de la IA al càncer de mama**
- Aplicacions de la IA a les malalties neurodegeneratives



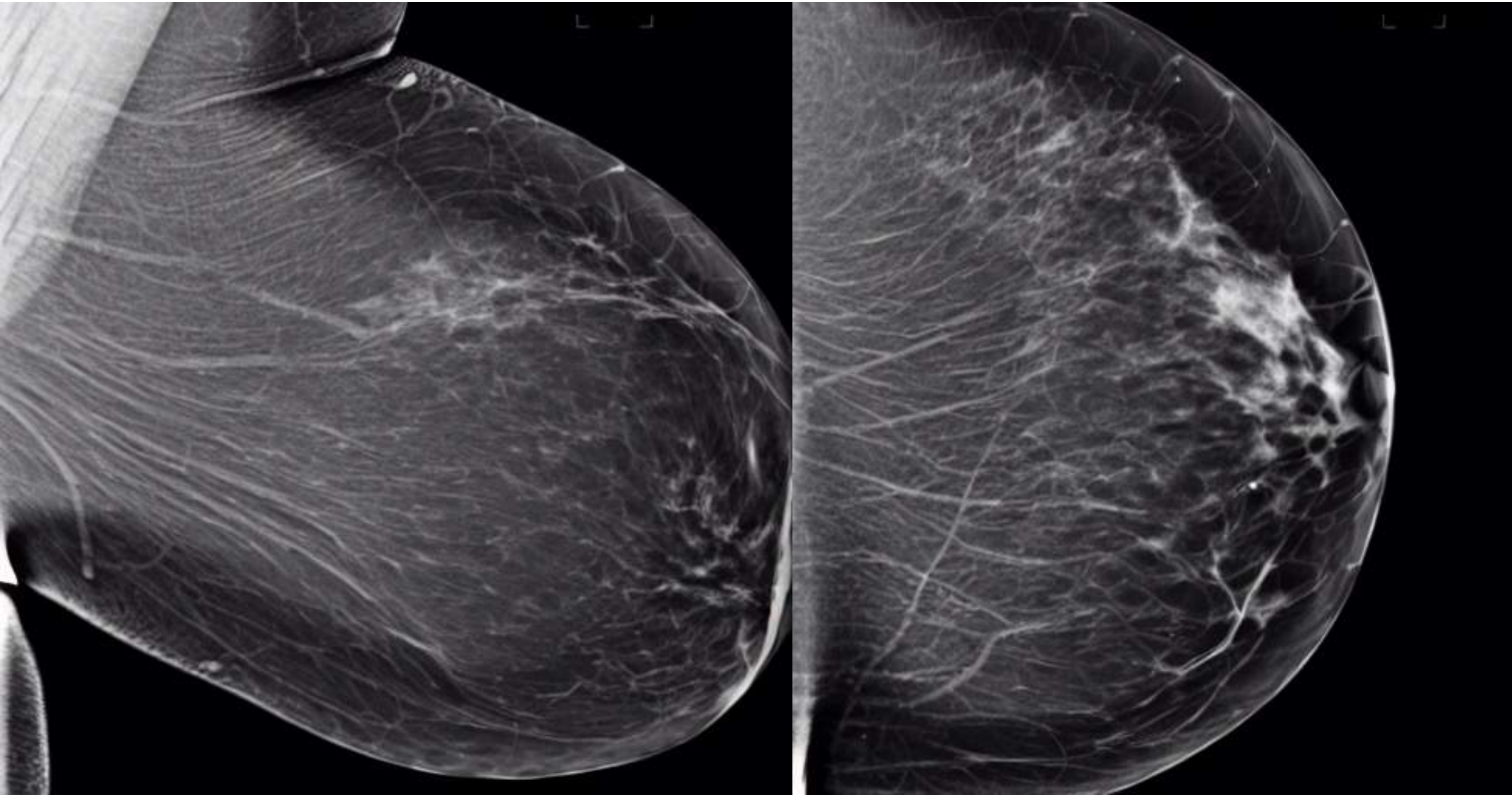
# Exemple en càncer de mama







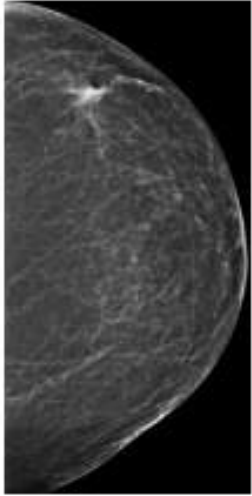
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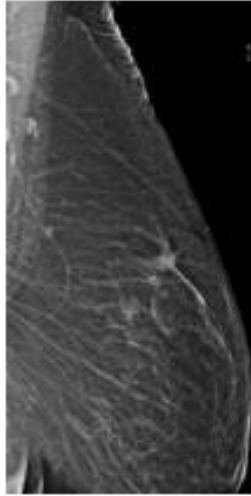


# Explicabilitat

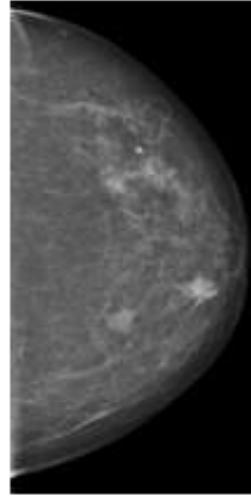
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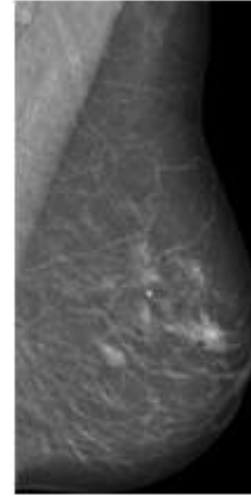
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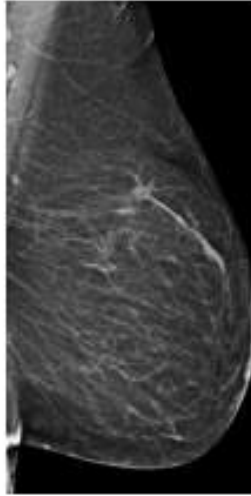
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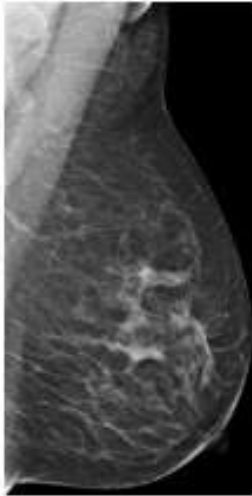
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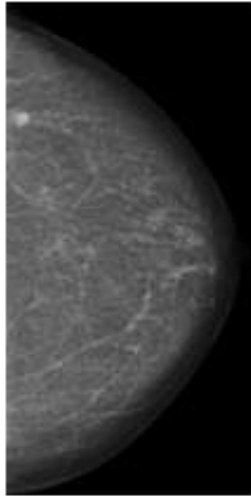
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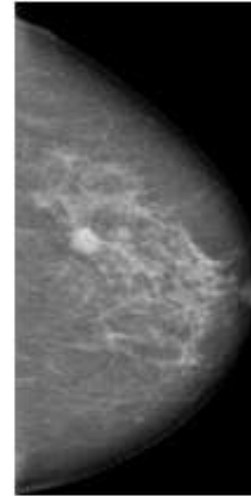
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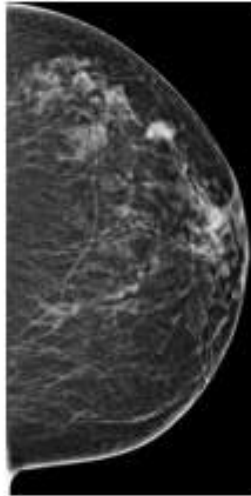
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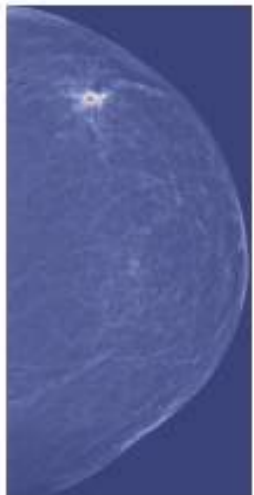


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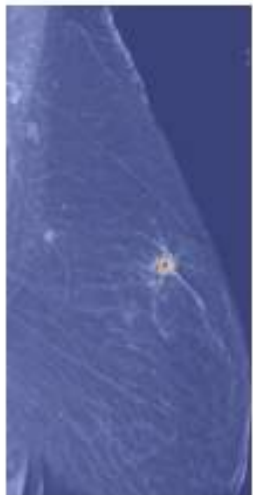


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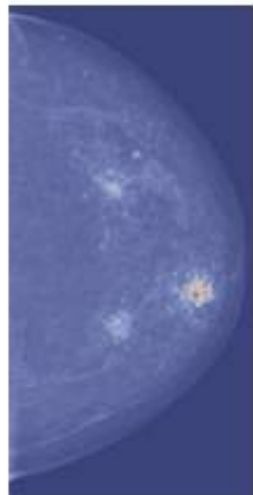
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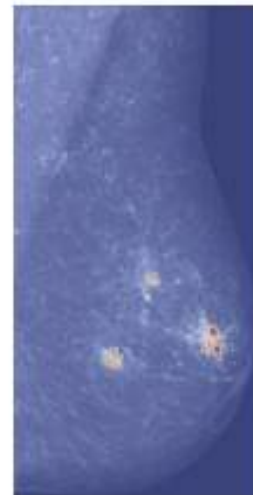
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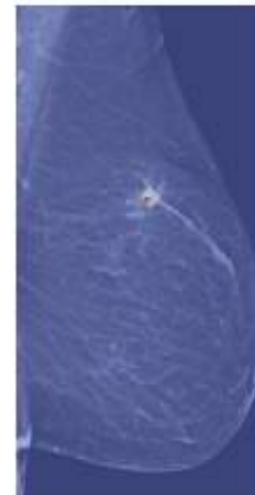
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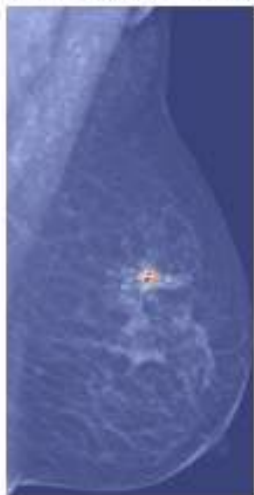
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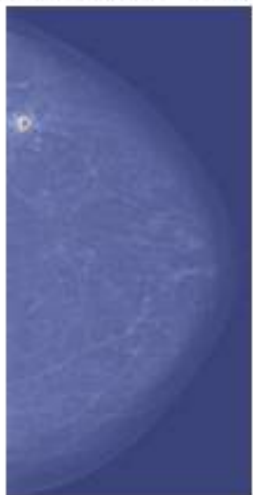
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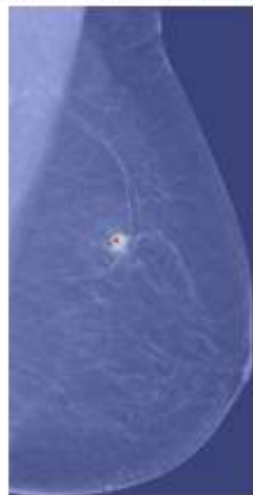
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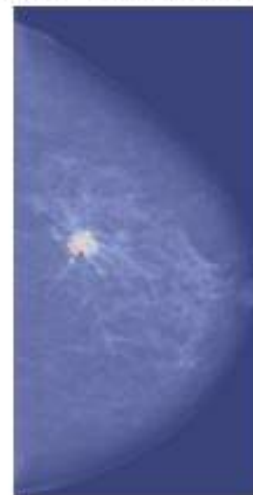
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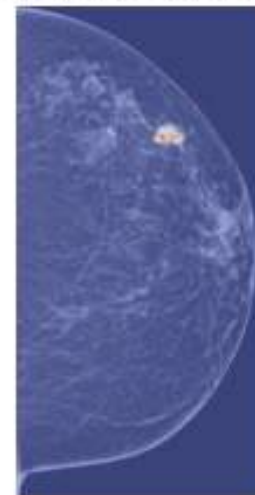
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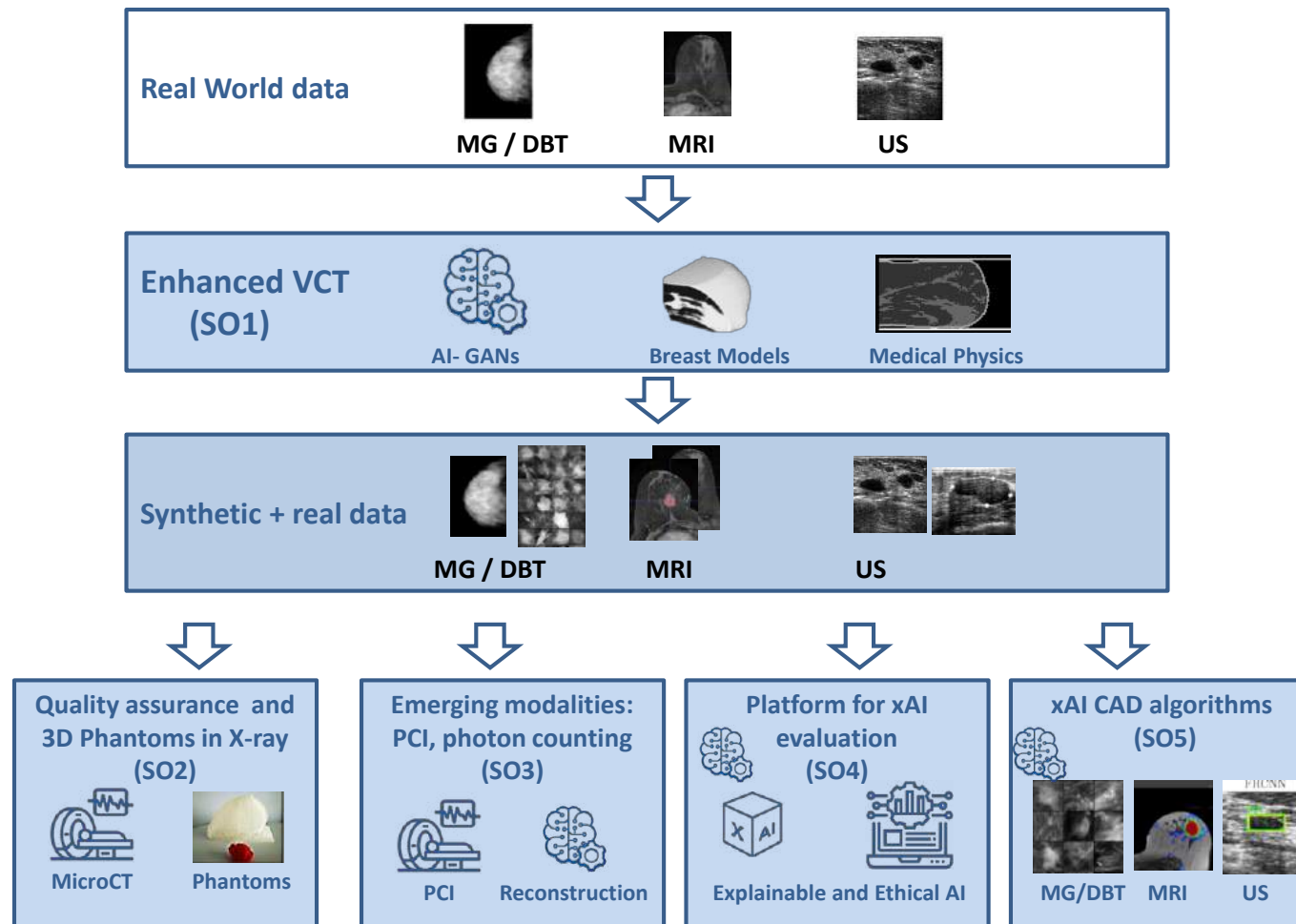
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# VICTORIA

## Virtual Clinical Trials and pre-clinical experiments for optimising new Imaging and AI algorithms in Breast Cancer



Universitat  
de Girona



1/9/2022 – 31/8/2025





transpara™

By ScreenPoint Medical

In Practice

Radiologists

Healthcare Providers

Women

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# Smart AI for early breast cancer detection and diagnosis

We focus on improving breast cancer survival rates by detecting cancers earlier and making treatment more effective and less invasive.

CE marked and FDA cleared

Transpara – the world's first dedicated breast AI decision support solution for 2D and 3D mammography.

- Commercially available right now. It is CE marked and FDA cleared
- Multiple independent peer reviewed publications demonstrating improvement in accuracy and consistency <sup>1</sup>
- Proven multivendor compatibility <sup>1</sup>

NOT ALL AI IS THE SAME – FIND OUT MORE ABOUT HOW TRANSPARA CAN HELP YOU



<sup>1</sup>. Published data held on file

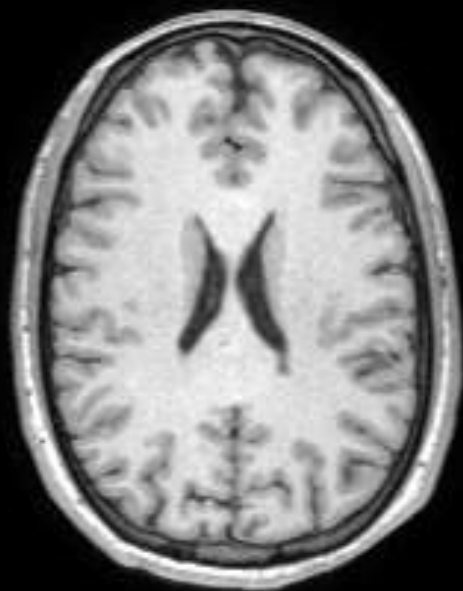
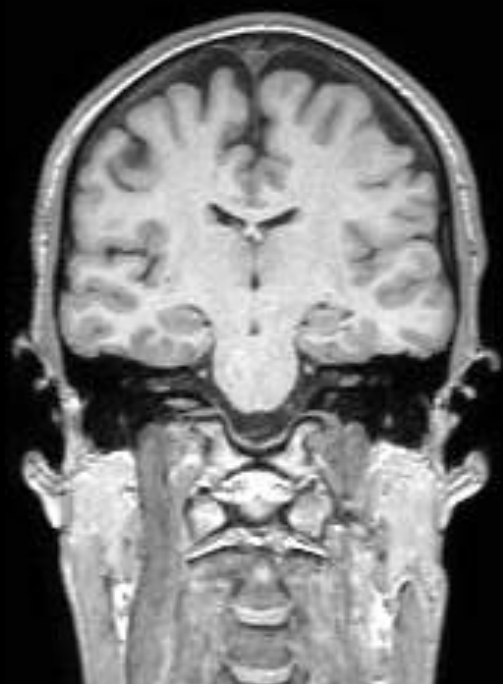
## La rebel·lió de les màquines II: IA a VICOROB

Xavier Lladó Bardera (Institut VICOROB, Universitat de Girona. )

En la segona part de la xerrada veurem exemples reals d'aplicació de la IA actuals, i especialment casos made in Girona en el grup de recerca VICOROB de la Universitat de Girona, en el camp de càncer de mama i malalties neurològiques.



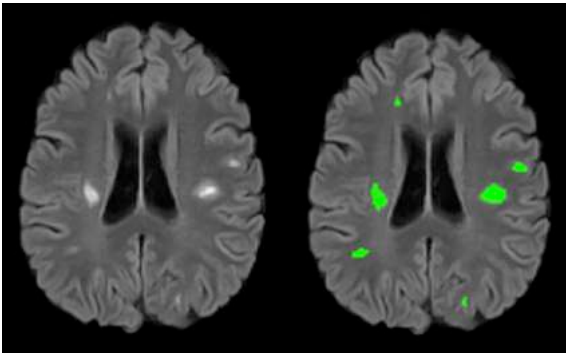
- VICOROB: qui som, on som i què fem?
- Aplicacions de la IA al càncer de mama
- **Aplicacions de la IA a les malalties neurodegeneratives**





# Esclerosi Múltiple: IA a VICOROB

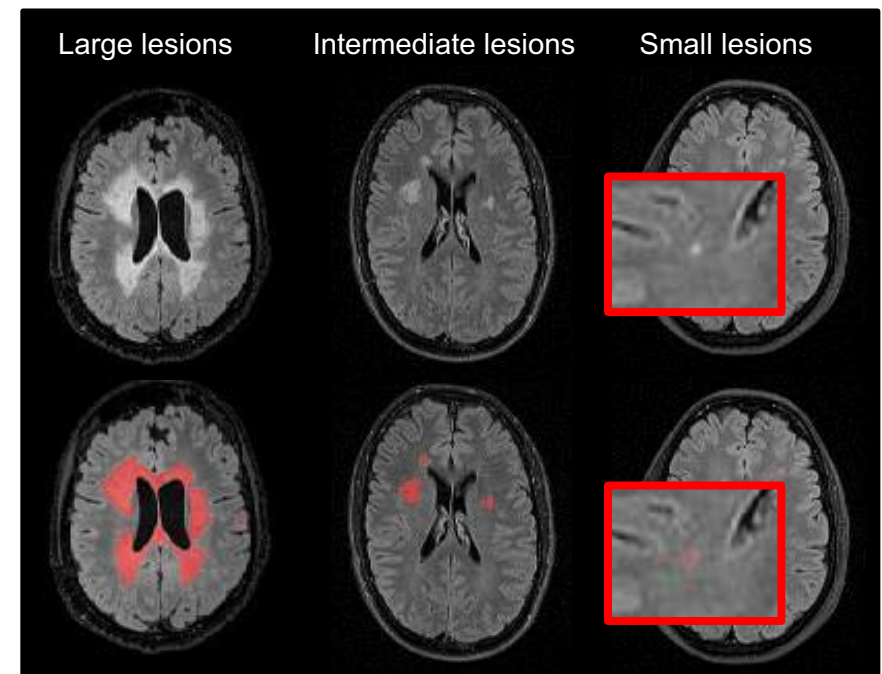
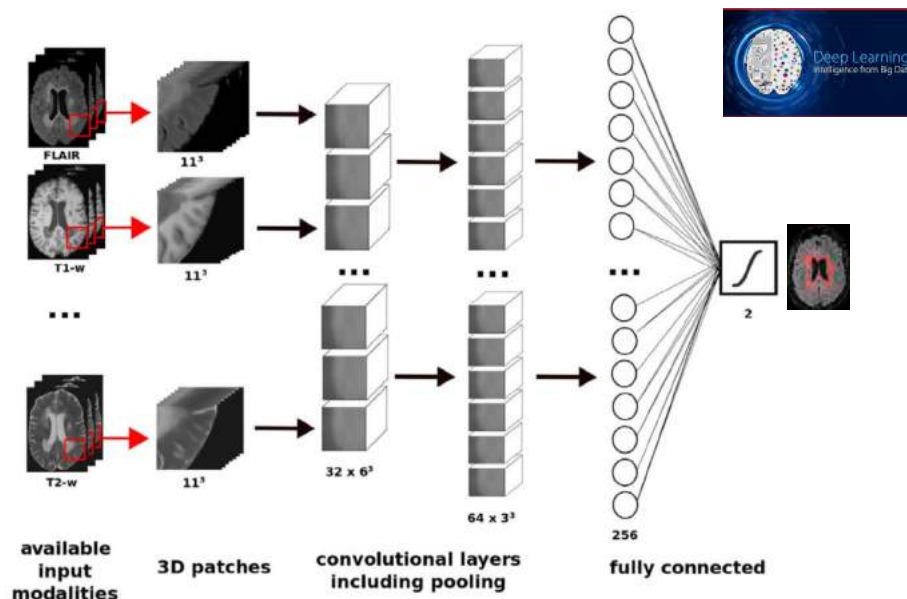
Extracció automàtica de marcadors de lesions amb tècniques deep learning



Valencia, et al. [Evaluating the use of synthetic T1-w images in new T2 lesion detection in multiple sclerosis](#). Frontiers in Neuroscience 2022

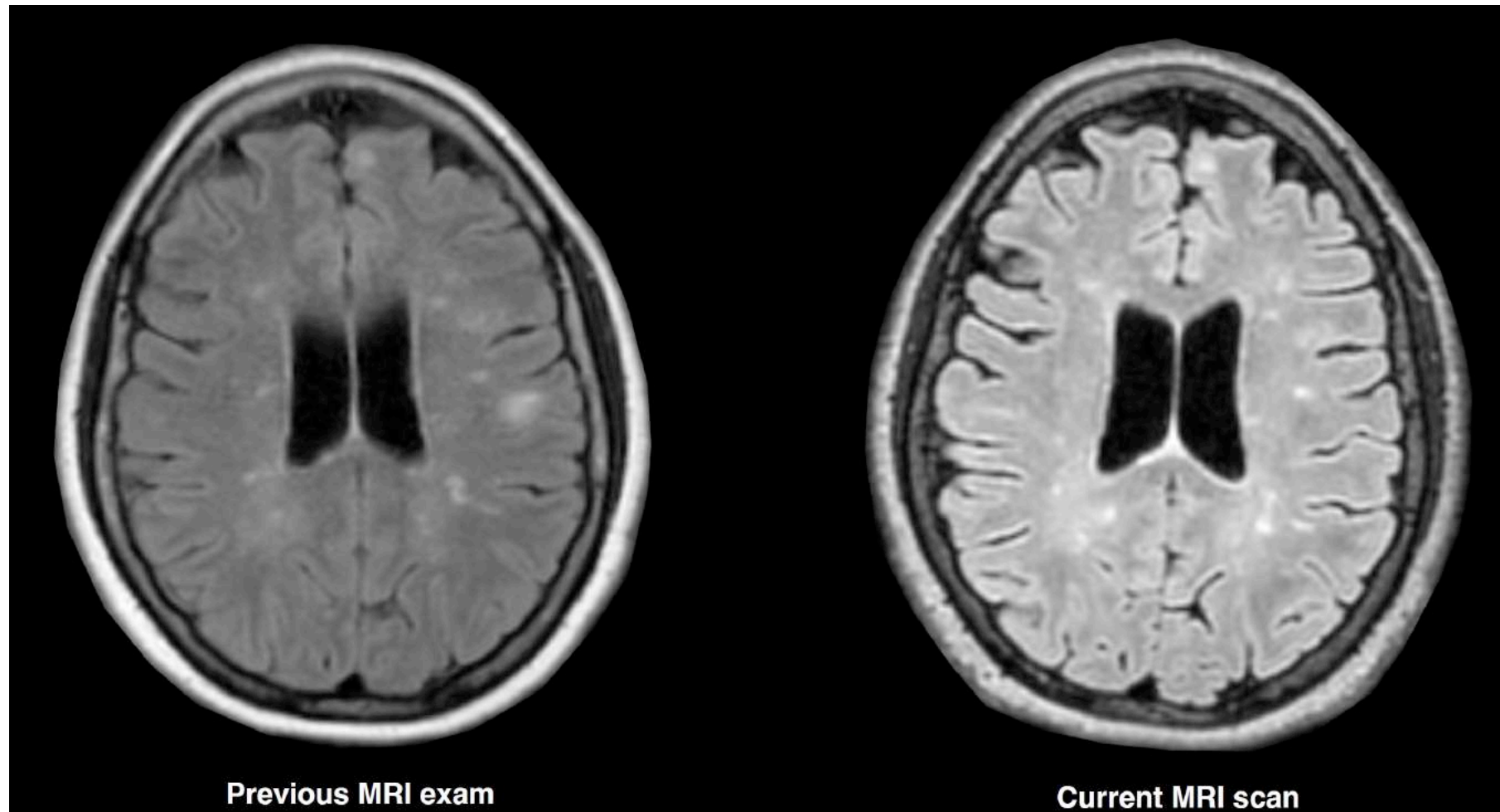
Valverde, et al. [One-shot domain adaptation in multiple sclerosis lesion segmentation using convolutional neural networks](#). Neurolmage: Clinical, 2019

Valverde, et al. [Improving automatic multiple sclerosis lesion segmentation with a cascaded 3D convolutional neural network approach](#). Neuroimage, 2017



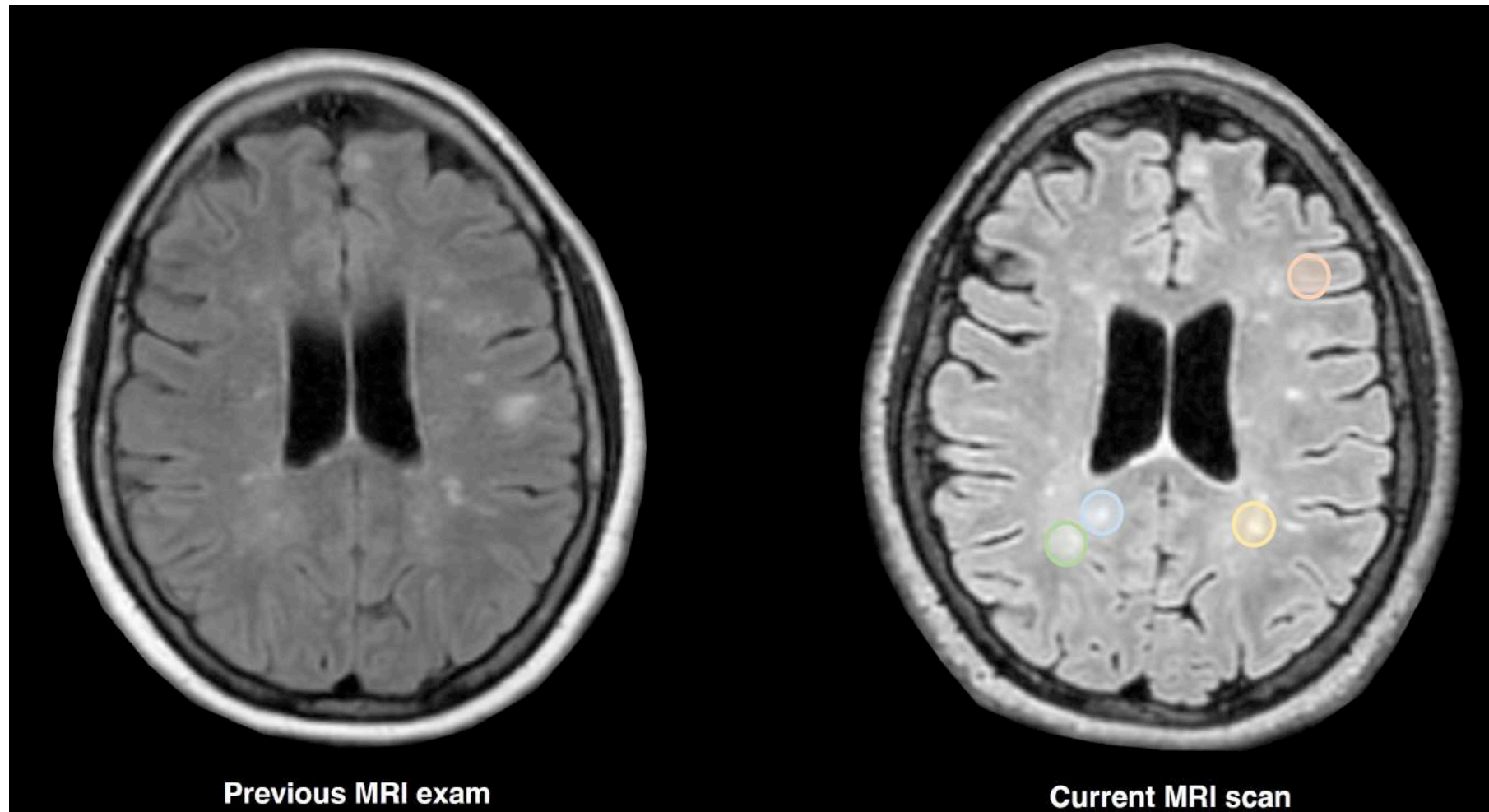
# Esclerosi Múltiple: IA a VICOROB

Podem trobar nova activitat de lesions al llarg del temps? → **marcador clínic clau** per decidir canvi de tractament en els pacients



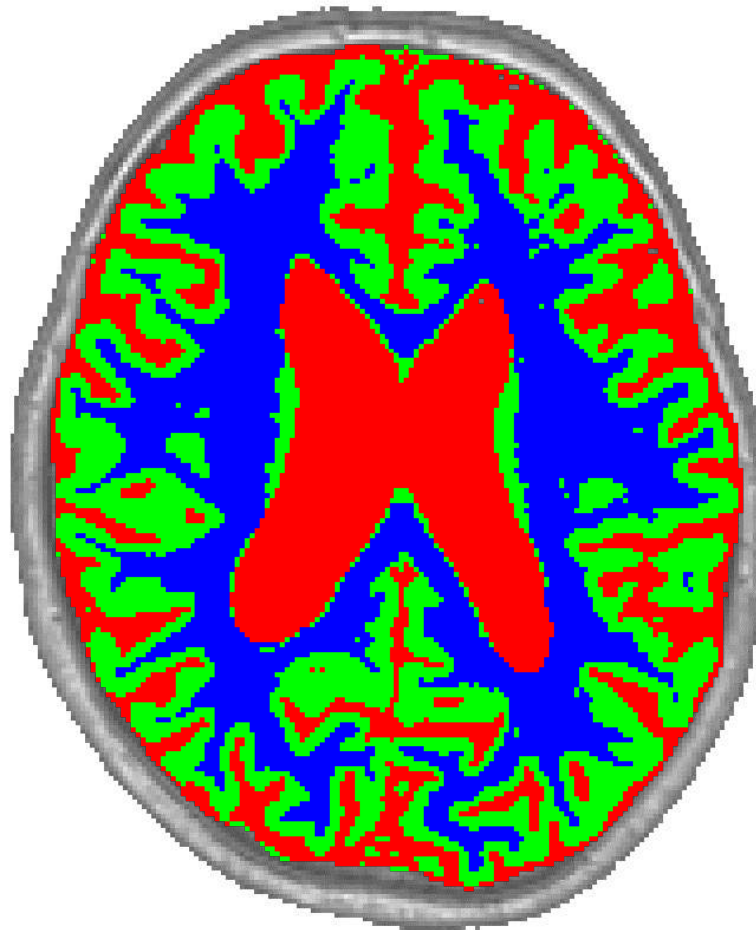
# Esclerosi Múltiple: IA a VICOROB

Podem trobar nova activitat de lesions al llarg del temps? → **marcador clínic clau** per decidir canvi de tractament en els pacients



# Esclerosi Múltiple: IA a VICOROB

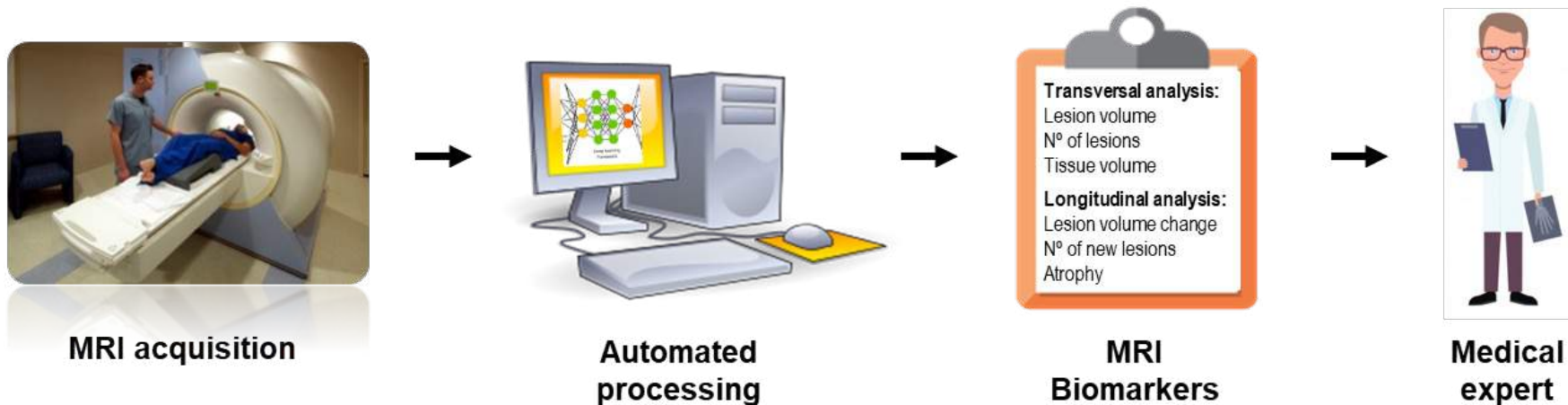
Podem mesurar de forma precisa l'atrofia (pèrdua de matèria blanca i grisa) del cervell al llarg del temps? **marcador clínic clau** per diagnosticar i monitoritzar la progressió de malalties neurodegeneratives





# IA a VICOROB

Desenvolupament d'eines basades en IA per a l'obtenció de marcadors d'imatges mèdiques que ajudin al diagnòstic i seguiment de diferents malalties



**Nicole** (2015-2018)  
**Evolution** (2018-2021)  
**Modelling** (2021-2024)



# Tensormedical: Spin-off de la UdG

tensormedical

Project Team Careers Contact

At **tensormedical**, we work to help clinical experts to improve care for patients suffering Multiple Sclerosis. We develop unique and automated machine intelligence tools that reduce the error associated with visual reading of magnetic resonance images of patients, offering unprecedented sensitivity and specificity detecting new appearing lesions.

We dream to improve patients' health and quality of life by developing novel tools to obtain the most robust and precise imaging biomarkers that will allow to predict the future stages of the disease and optimize the treatment decisions for each patient.

We are humans, we build tools for humans.



Sergi Valverde,  
PhD, MBA  
CEO and co-founder



Roger Bramon,  
PhD  
CTO and co-founder



Prof. Xavier Lladó,  
PhD  
CSO and co-founder



Prof. Àlex Rovira,  
MD  
CMO and co-founder



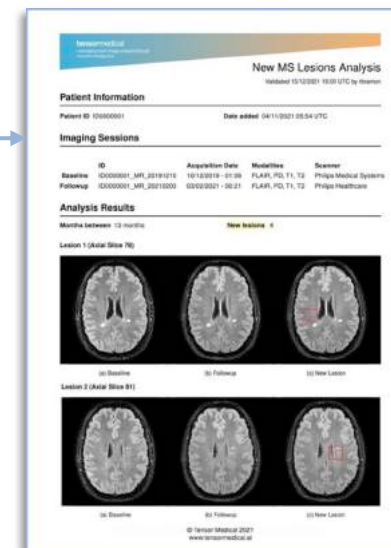
Prof. Xavier  
Montalbán, PhD,  
MD  
Chairman of the  
advisory board



Arnau Oliver, PhD  
Technology advisor  
and co-founder



Prof. Lluís Ramió-  
Torrentà, PhD, MD  
Clinical advisor



# Cap on anem?

*"We should **stop training radiologists** now. It's just completely obvious that within five years, deep **learning** is going to do better than **radiologists**."*

**Geoffrey Hinton  
2016**



# Cap on anem?

*"We should **stop training radiologists** now. It's just completely obvious that within five years, deep **learning** is going to do better than **radiologists**."*

**Geoffrey Hinton**  
**2016**

*"Will **AI replace radiologists**?" is the wrong question. The right answer is: **Radiologists who use AI** will replace radiologists who don't".*

**Curtis P. Langlotz.**  
**Radiology: Artificial Intelligence,**  
**2019**

# Gràcies!!!

VICOROB

Institut de Visió per Computador y Robòtica  
Universitat de Girona

