

# Wat is Kunstmatige Intelligentie eigenlijk?

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UMC Utrecht

# Disclosure

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(potentiële) belangenverstrengeling	Geen / Zie hieronder
Voor bijeenkomst mogelijk relevante relaties met bedrijven	Bedrijfsnamen
<ul style="list-style-type: none"><li>• Sponsoring of onderzoeksgeld</li><li>• Honorarium of andere (financiële) vergoeding</li><li>• Aandeelhouder</li><li>• Andere relatie, namelijk ...</li></ul>	<ul style="list-style-type: none"><li>•</li><li>•</li><li>•</li><li>•</li></ul> <p>- geen -</p>

# Wat is kunstmatige intelligentie?

Van Dale:

**in·tel·li·gen·tie** (de; v)

- 1 verstandelijk vermogen: *kunstmatige intelligentie* het met behulp van een computer nabootsen van het menselijk denken

Wikipedia:

## Kunstmatige intelligentie

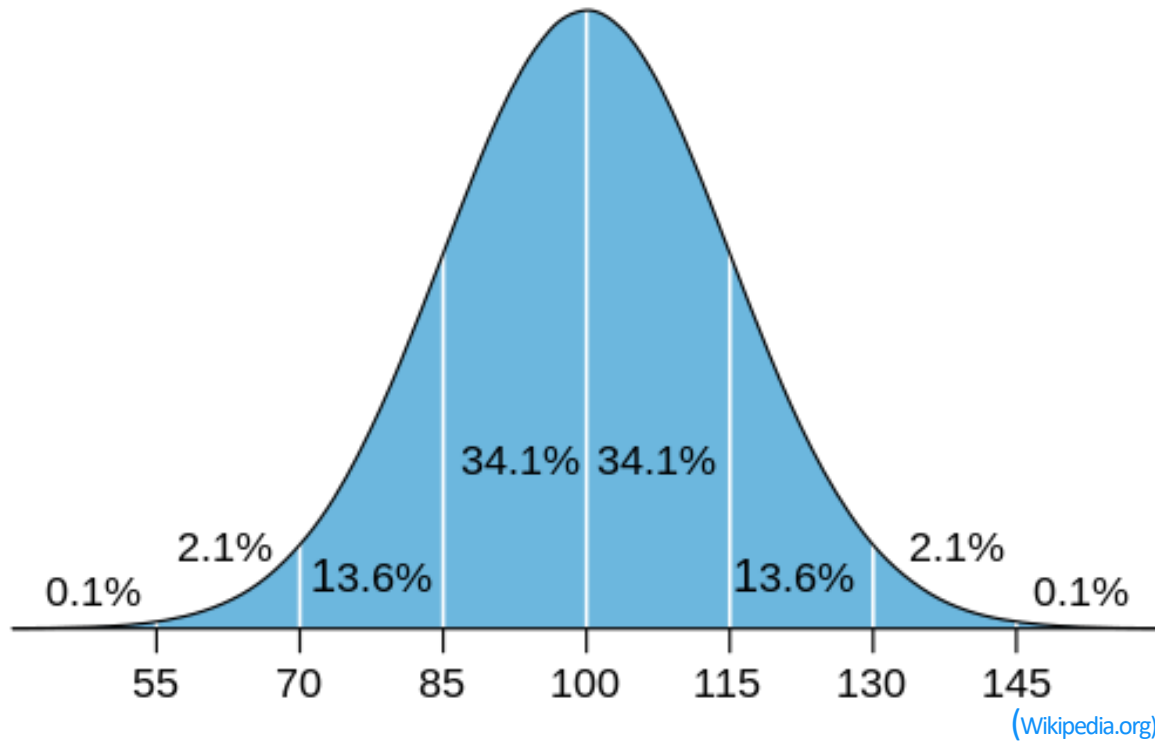
Kunstmatige intelligentie of artificiële intelligentie is de wetenschap die zich bezighoudt met het creëren van een artefact dat een vorm van intelligentie vertoont. [Wikipedia \(NL\)](#)



Automaton; Henri Maillardet (1745–1830)

# Hoe beoordelen we kunstmatige intelligentie?

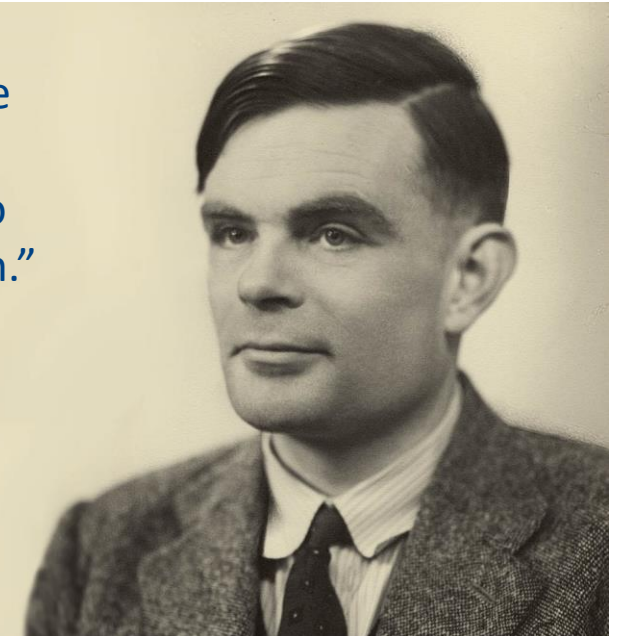
## IQ test (mens)



## Turing test (computer)

“A computer would deserve to be called intelligent if it could deceive a human into believing that it was human.”

(1950)



# De Turing test - 1950

VOL. LIX. NO. 236.] [October, 1950

**MIND**  
A QUARTERLY REVIEW  
OF  
PSYCHOLOGY AND PHILOSOPHY

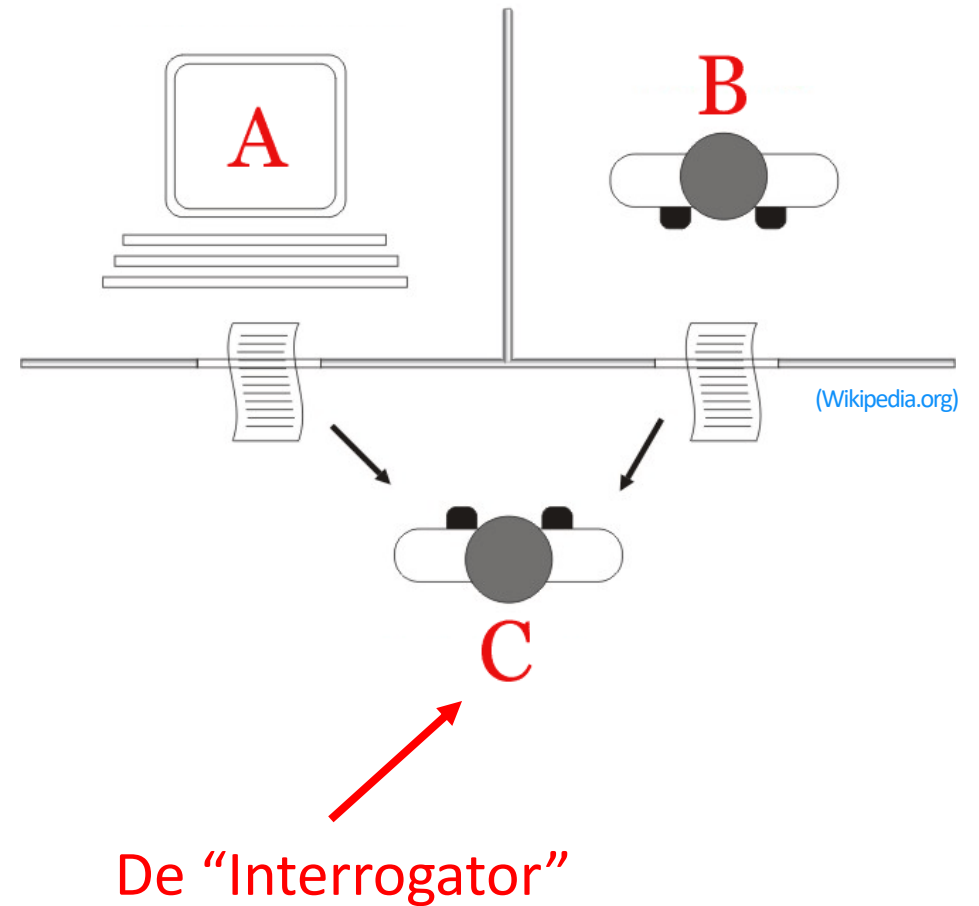
**I.—COMPUTING MACHINERY AND INTELLIGENCE**

BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup

Downloaded from <https://academic.oup.com/mind/article-abstract/LIX/236/4/33/986238>



# De Turing test - 2023

## HUMAN OR NOT?

A GAMIFIED APPROACH TO THE TURING TEST

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*"I believe that in 50 years' time it will be possible to make computers play the imitation game so well that an average interrogator will have no more than 70% chance of making the right identification after 5 minutes of questioning."*

– Alan Turing, 1950

### ABSTRACT

We present "*Human or Not?*"<sup>[1]</sup> an online game inspired by the Turing test, that measures the capability of AI chatbots to mimic humans in dialog, and of humans to tell bots from other humans. Over the course of a month, the game was played by over 1.5 million users who engaged in anonymous two-minute chat sessions with either another human or an AI language model which was prompted to behave like humans. The task of the players was to correctly guess whether they spoke to a person or to an AI. This largest scale Turing-style test conducted to date revealed some interesting facts. For example, overall users guessed the identity of their partners correctly in only 68% of the games. In the subset of the games in which users faced an AI bot, users had even lower correct guess rates of 60% (that is, not much higher than chance). This white paper details the development, deployment, and results of this unique experiment. While this experiment calls for many extensions and refinements, these findings already begin to shed light on the inevitable near future which will commingle humans and AI.

1.5 million participants had to guess whether they spoke to a person or to an AI.

"Overall, users guessed the identity of their partners correctly in only 68% of the games. In the subset of games in which users faced an AI bot, users had even lower correct guess rate of 60% (that is, not much higher than chance)."



# De Turing test - 2023

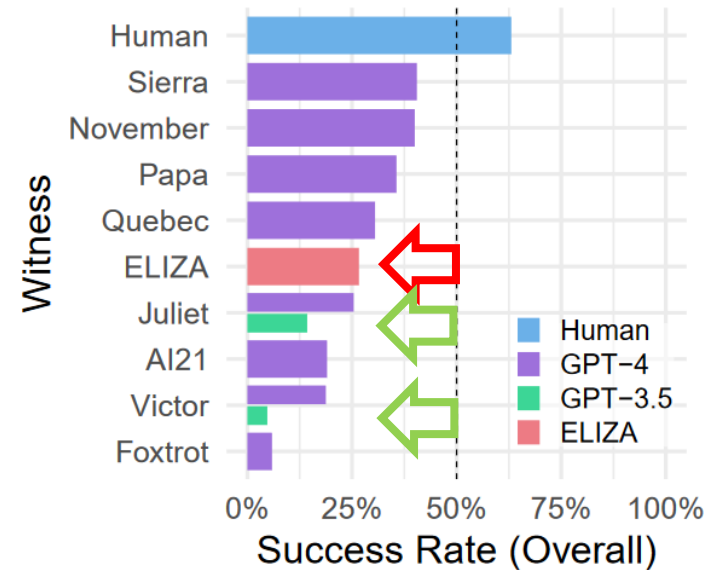
But we broke the Turing test!

```
Welcome to
          EEEEE  LL      IIII  ZZZZZZ  AAAAA
          EE      LL      II     ZZ     AA  AA
          EEEEE  LL      II     ZZZ    AAAAAA
          EE      LL      II     ZZ     AA  AA
          EEEEE  LLLLLL  IIII  ZZZZZZ  AA  AA

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```

A 60-year old chatbot (1966) beat OpenAI's ChatGPT-3.5 in a 2023 Turing test

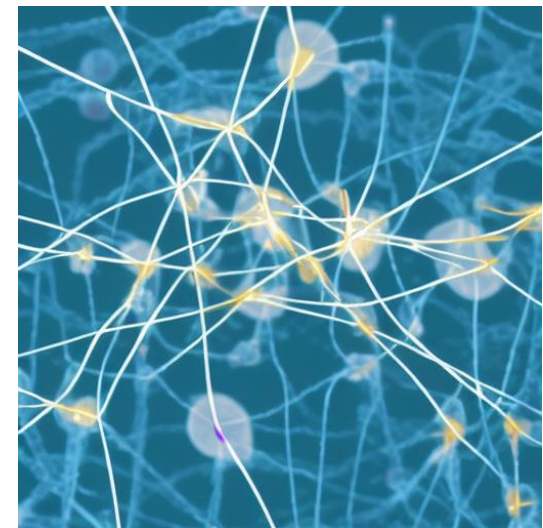
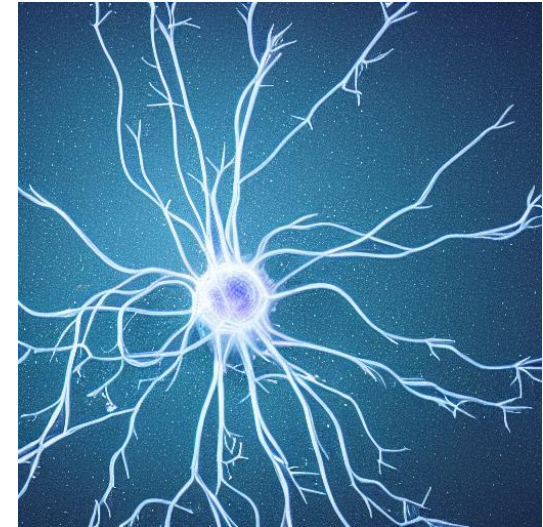


Jones and Bergen,  
<https://doi.org/10.48550/arXiv.2310.20216>, 2023

# Waarom komt AI intelligent over?

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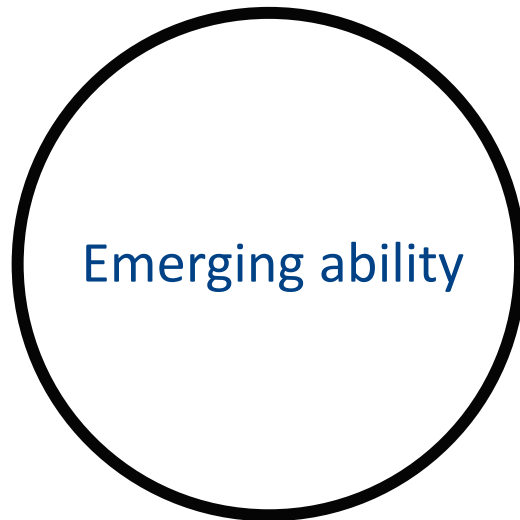
Emerging ability








# Waarom komt AI intelligent over?


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 **You**  
Complete the following sentence: The host asked, "Milk or..."

 **ChatGPT**  
The host asked, "Milk or sugar with your coffee?"

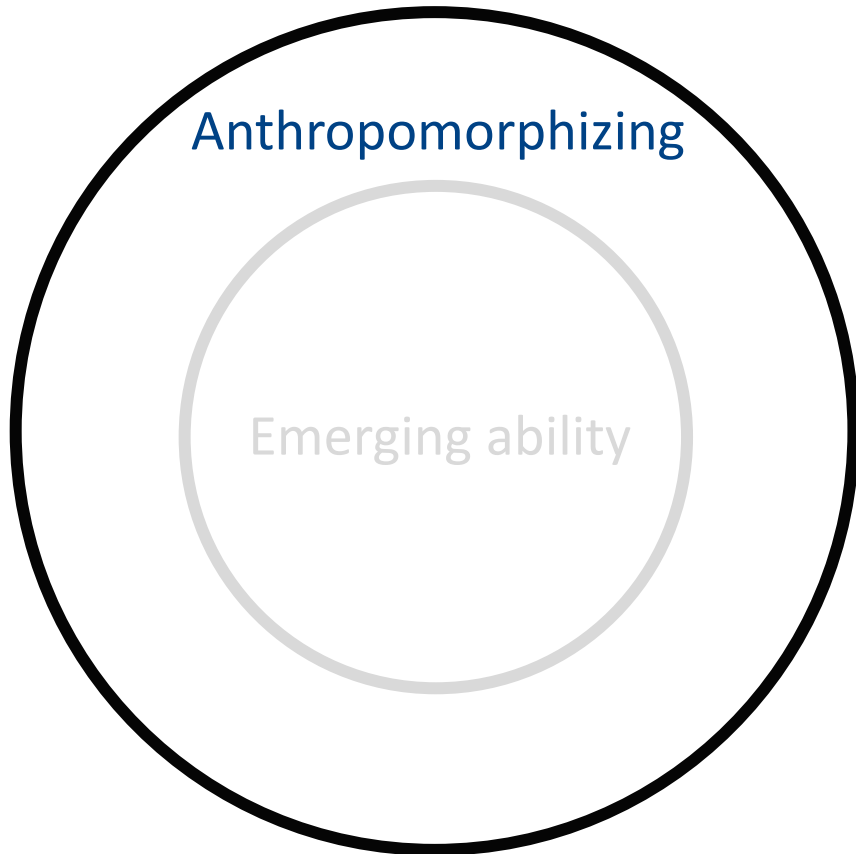
 **You**  
Complete the following sentence: The painter asked, "Milk or..."  
< 3 / 3 >

 **ChatGPT**  
The painter asked, "Milk or water to thin out the paint?"

# Waarom komt AI intelligent over?

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## Antropomorfiseren:

Het toekennen van menselijke eigenschappen, emoties of intenties aan niet-menselijke entiteiten

## Cognitieve bias:

Mensen antropomorfiseren om betekenis te geven aan gebeurtenissen en gedragingen die zij ervaren

# Waarom komt AI intelligent over?

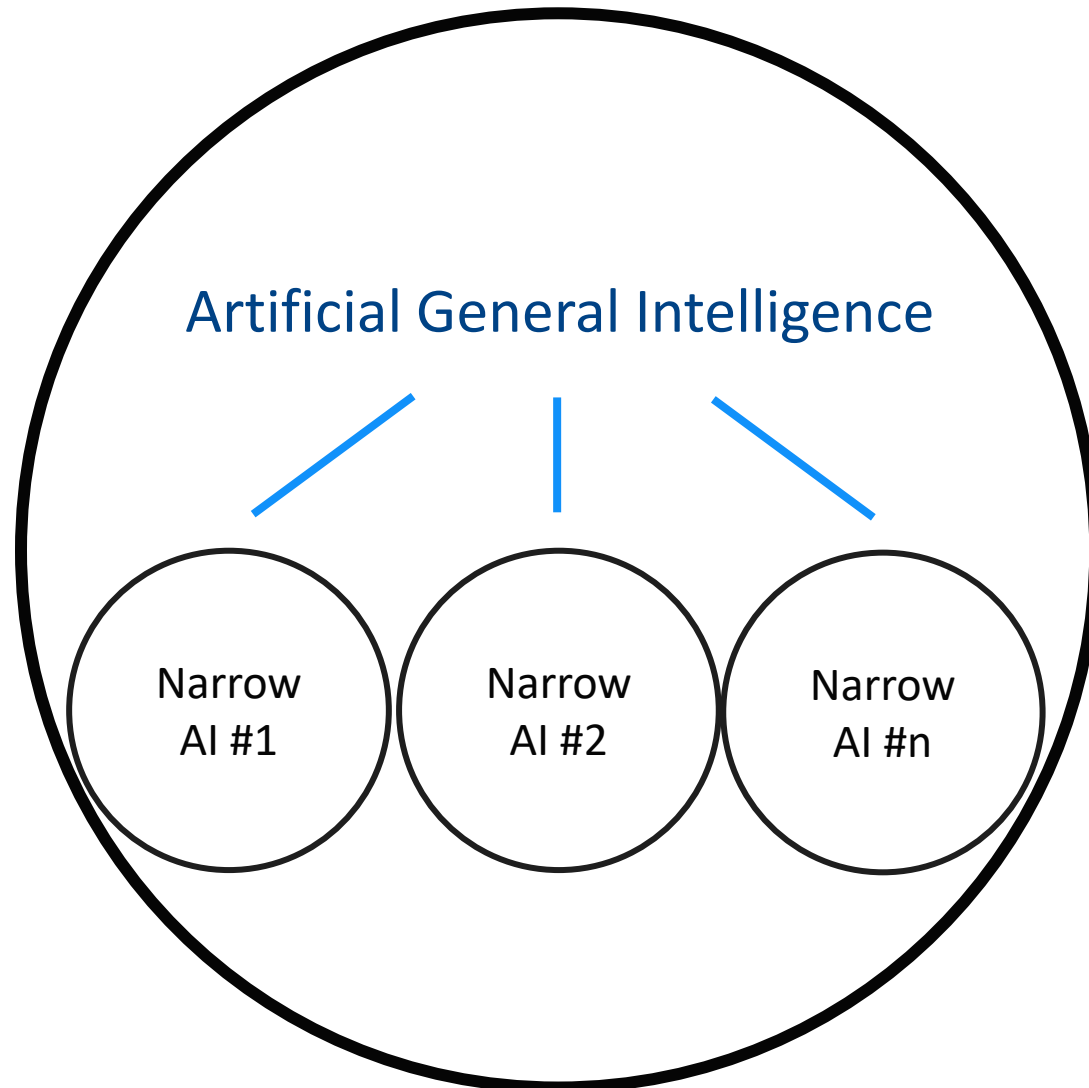
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“It could go quite wrong”

# Artificial General Intelligence (AGI)

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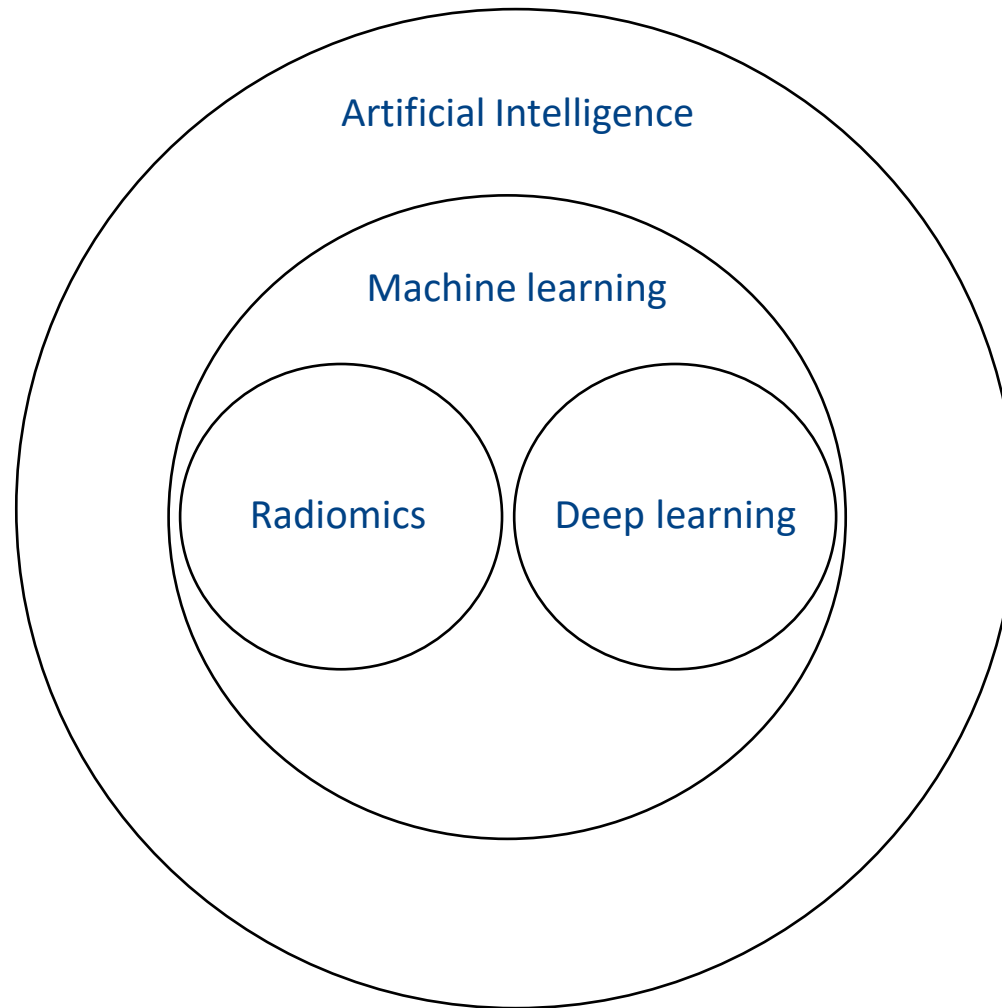


E.g.:

- 'Plugins'
- 'Mixture of Experts' (MOE)

# Narrow Artificial Intelligence (NAI)

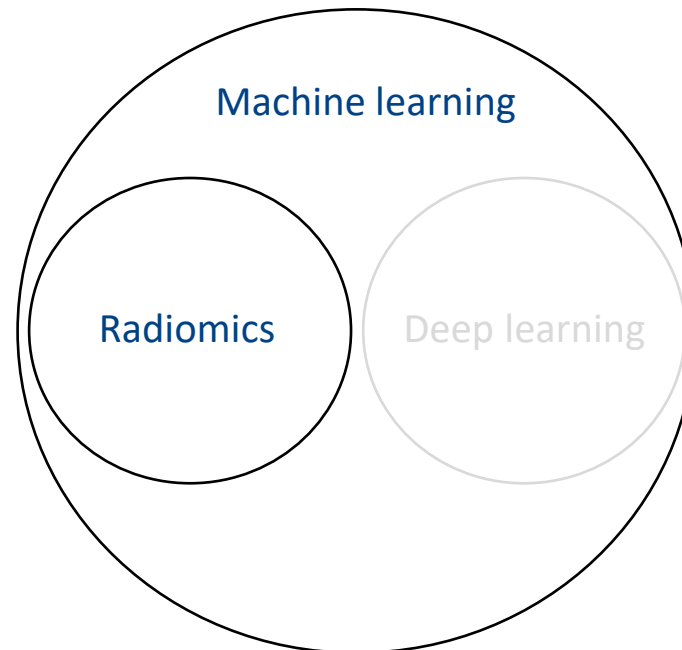
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# Narrow Artificial Intelligence (NAI)

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# Machine learning

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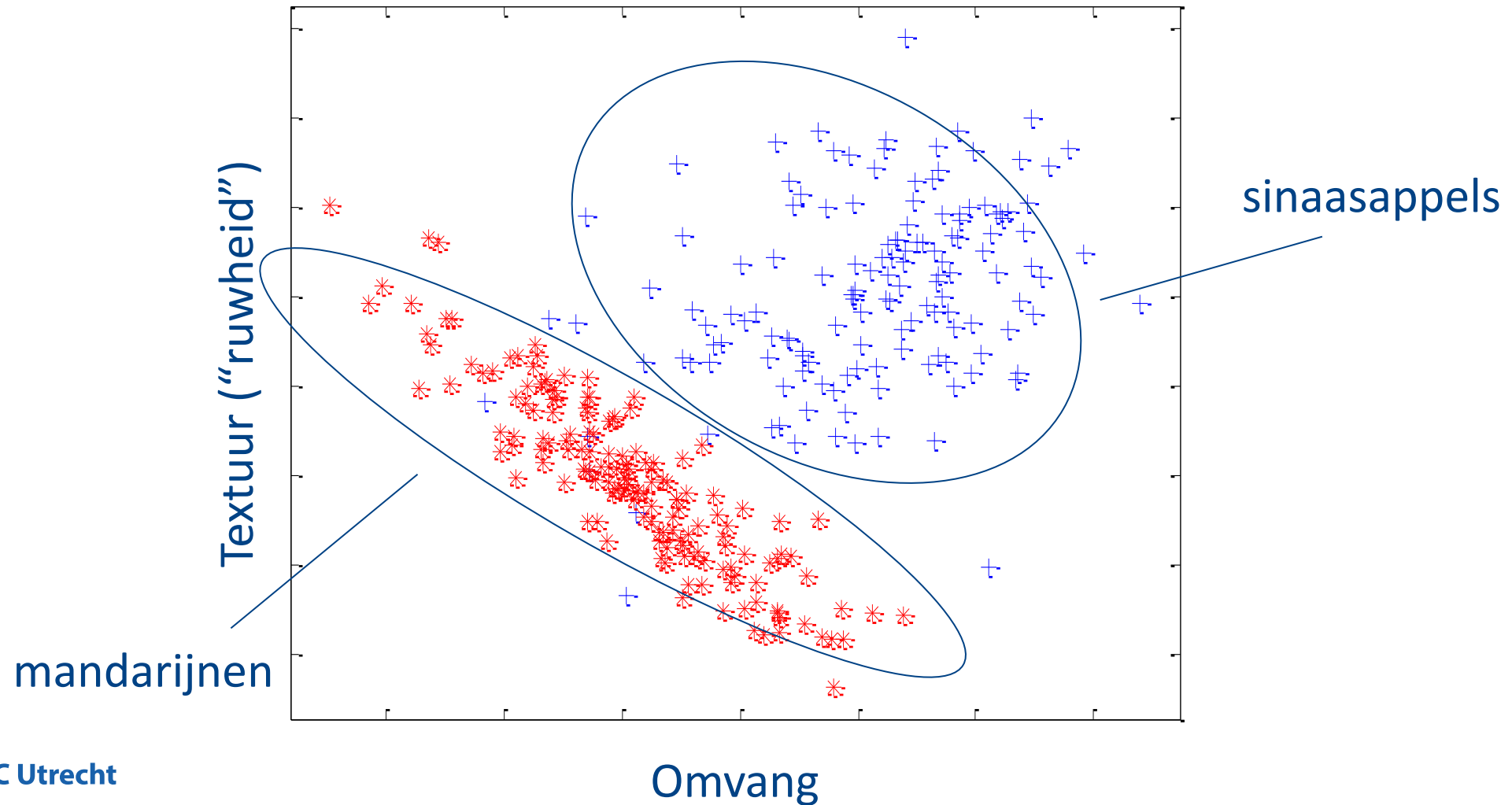
Mandarijn



Sinaasappel

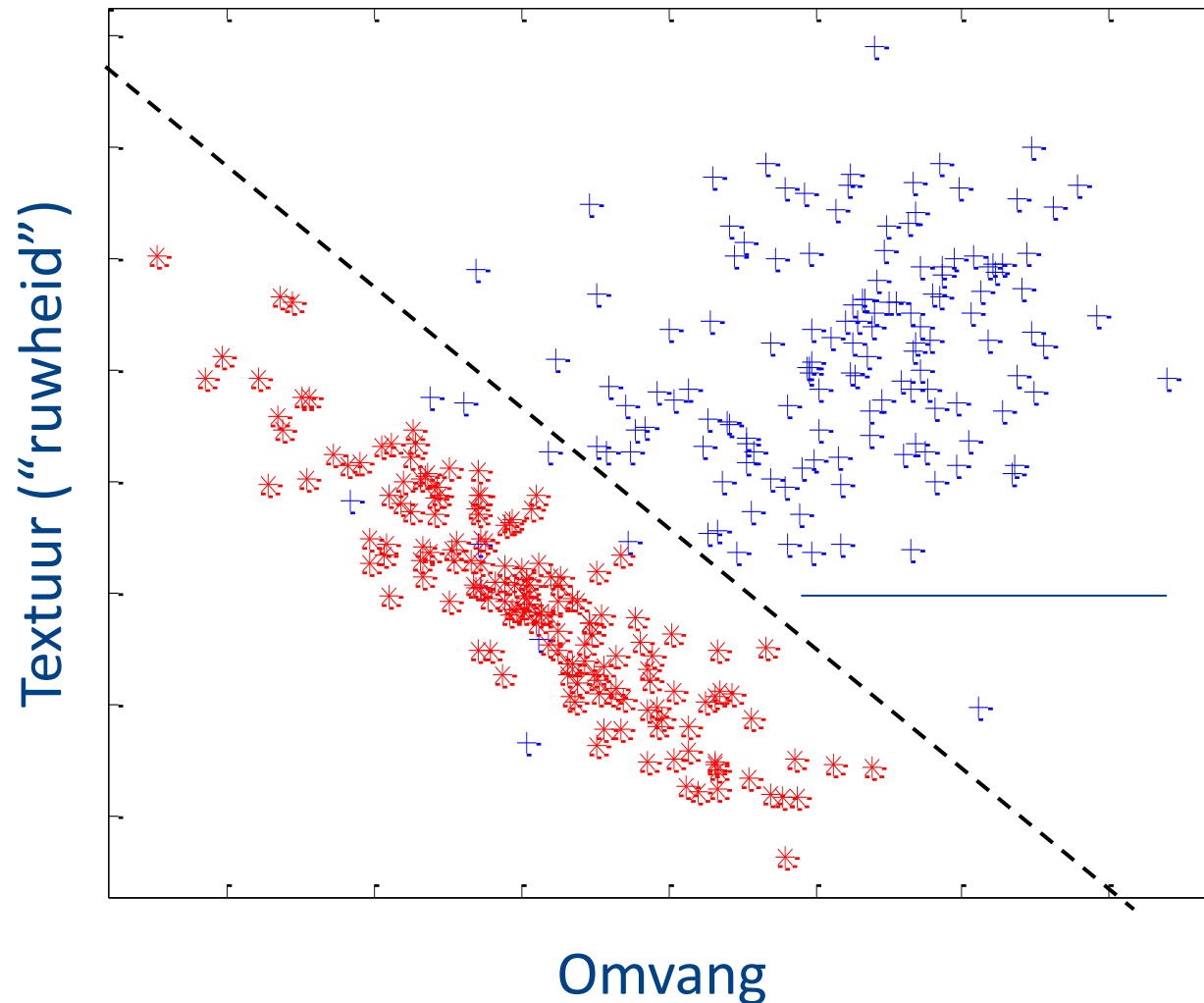
# Machine learning

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# Machine learning

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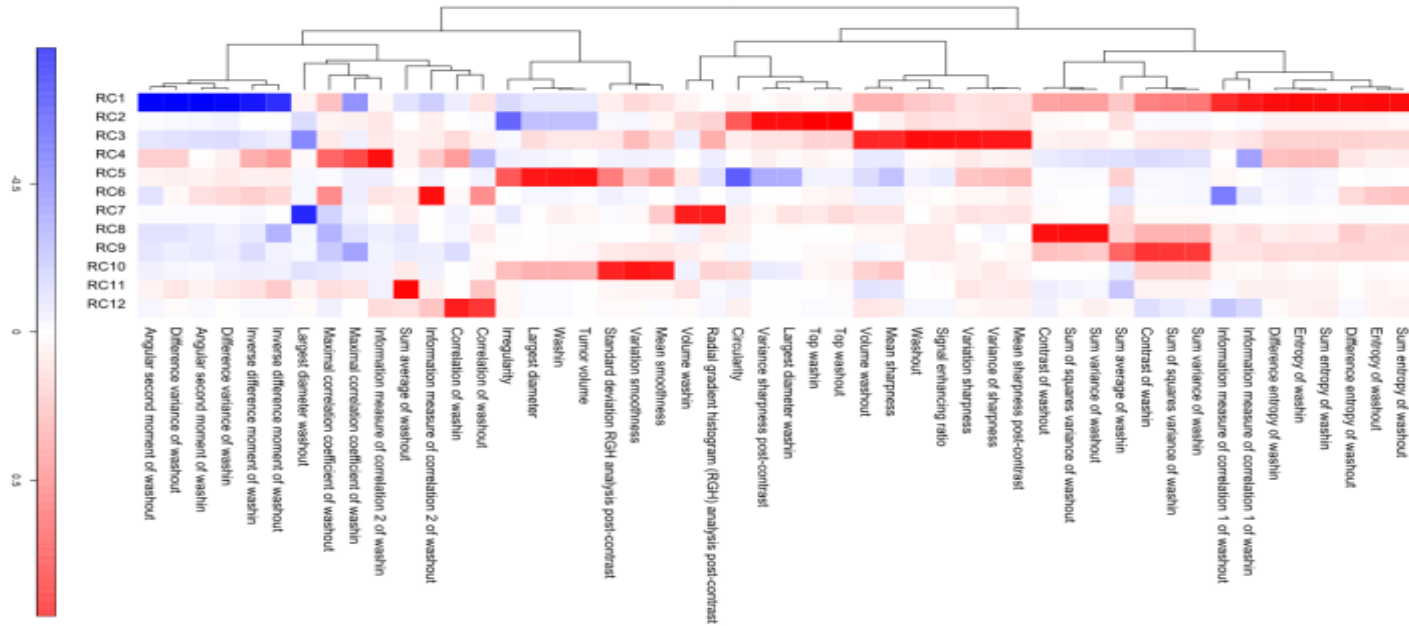
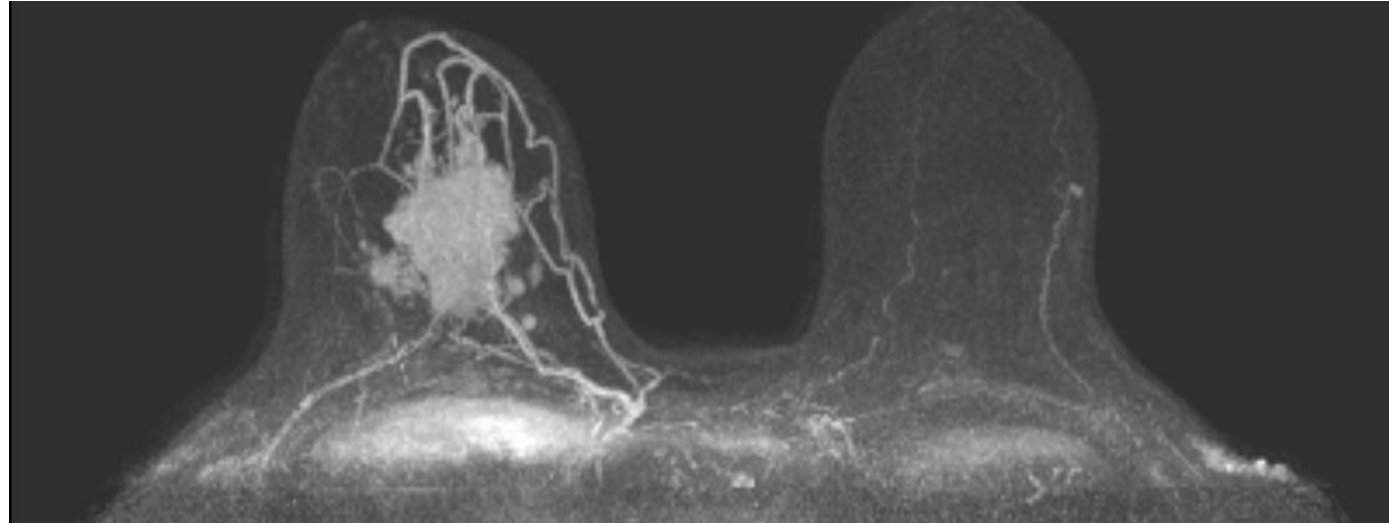
Classificatielijn:

$$\text{Textuur} - m \cdot \text{Omvang} - b = 0$$

als  $<0$ : mandarijn

als  $>0$ : sinaasappel

# Machine learning

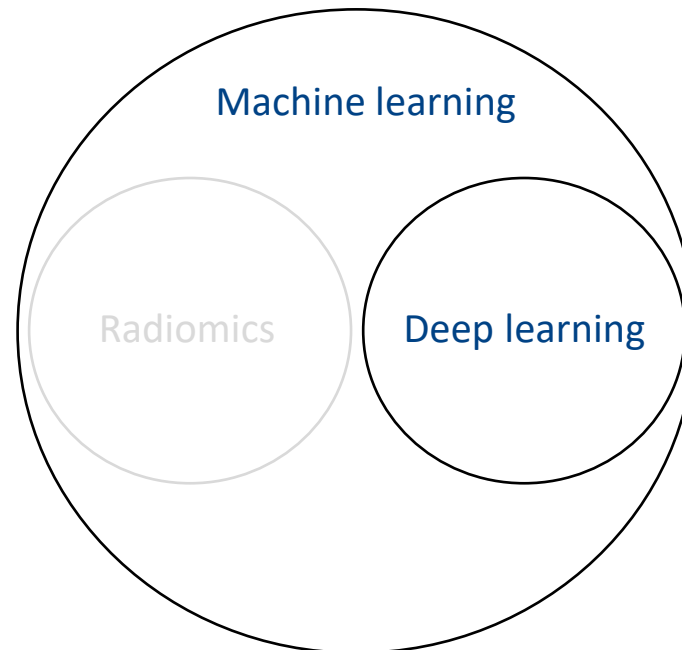


Machine learning met een groot aantal (50 – 1000) vooraf gekozen beeldkenmerken

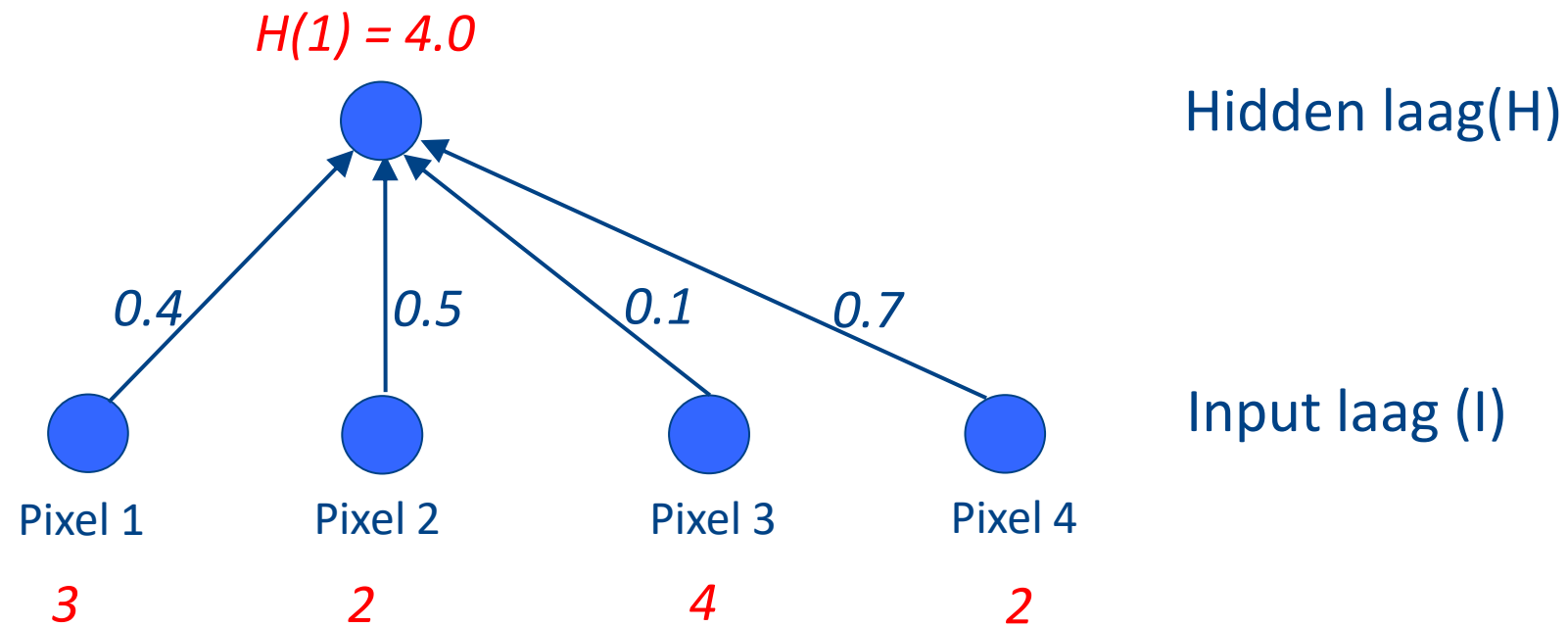


# Narrow Artificial Intelligence (NAI)

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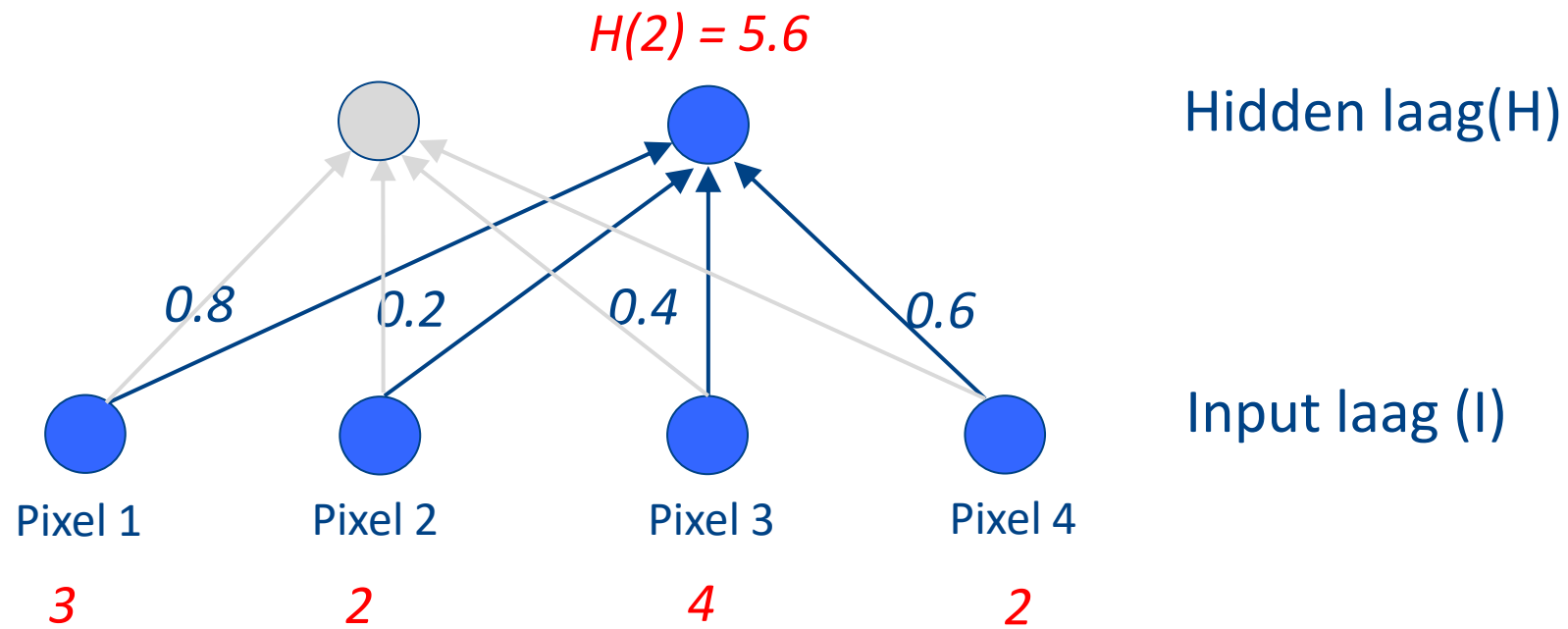


# Neuraal Netwerk



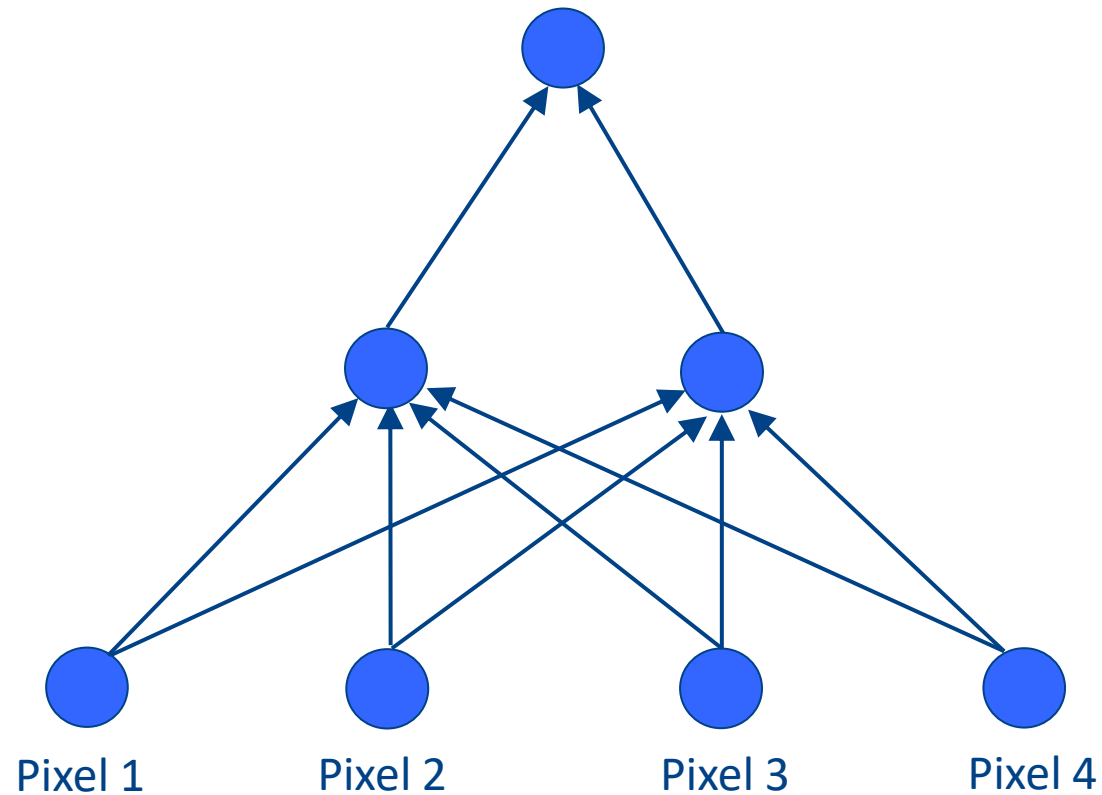
$$\text{want } H(1) = 3 \times 0.4 + 2 \times 0.5 + 4 \times 0.1 + 2 \times 0.7 = 4.0$$

# Neuraal Netwerk



# Neuraal Netwerk

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Output laag(O)

*als  $O = 0$  → mandarijn*

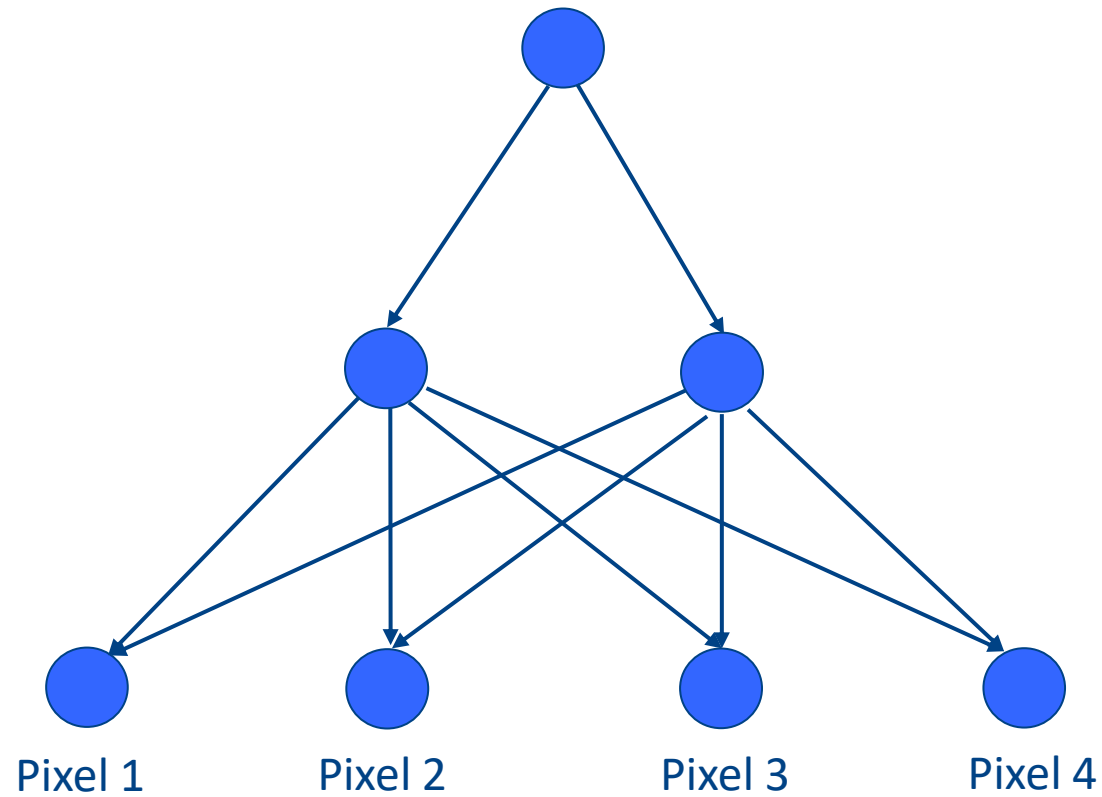
*als  $O = 1$  → sinaasappel*

Hidden laag(H)

Input laag (I)

# Neuraal Netwerk

“Trainen” van een neuraal netwerk: veel beelden nodig

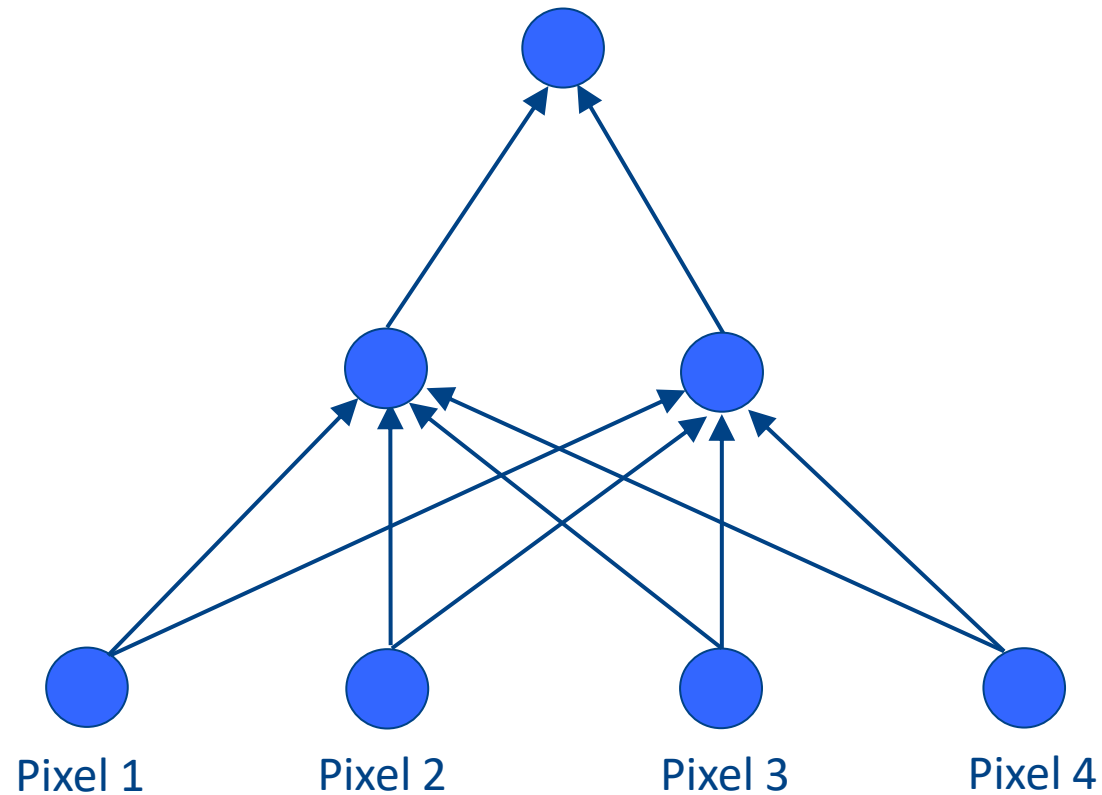


*Beeld 1*



# Neuraal Netwerk

“Trainen” van een neuraal netwerk: veel beelden nodig!

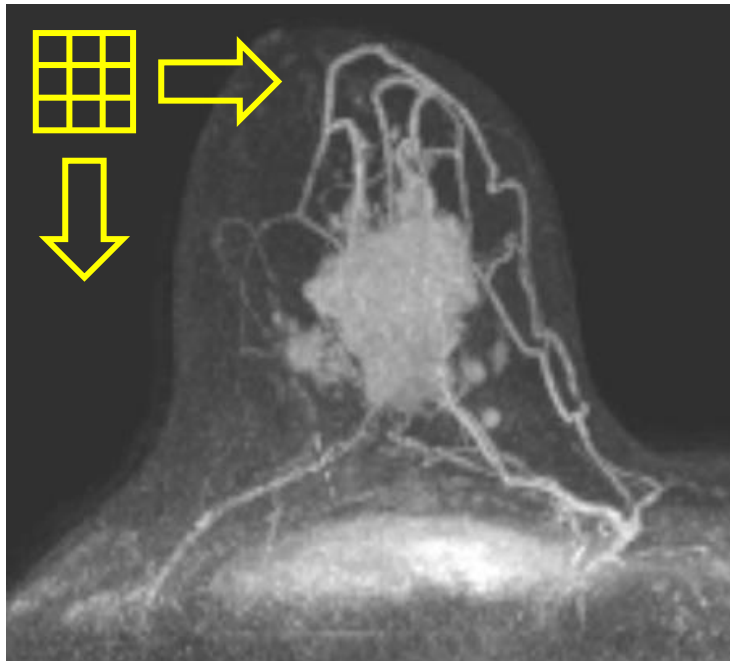


*Beeld 1*

*Beeld 2*

...

# Convolutional Neural Network (CNN)



3	10	4
4	6	8
5	6	5

*Beeldwaarden onder filter (voorbeeld)*

x

0	-1	0
-1	5	-1
0	-1	0

*Waarden in filter (voorbeeld)*

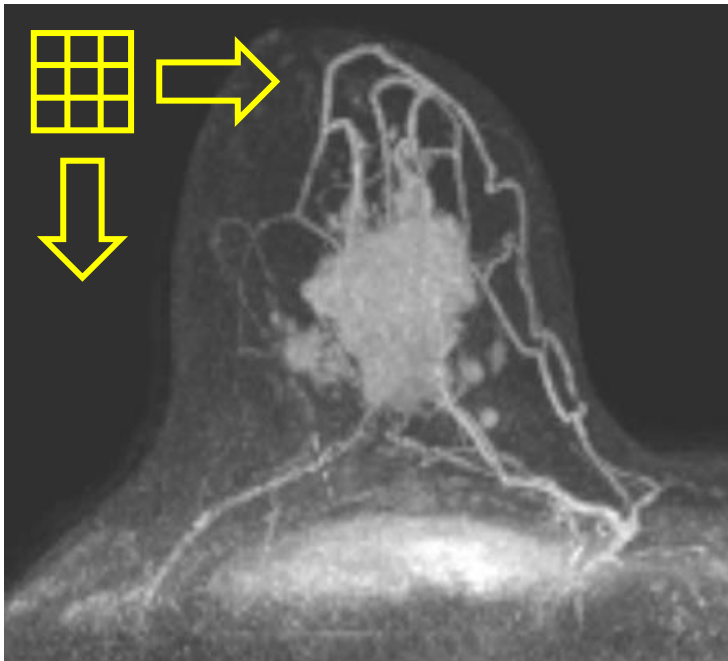
*Convolutie:  $-1 \times 10 - 1 \times 4 + 5 \times 6 - 1 \times 8 - 1 \times 6 = 2$*

	2	

*Nieuwe beeldwaarde*



# Convolutional Neural Network (CNN)



3	10	4
4	6	8
5	6	5

*Beeldwaarden onder filter (voorbeeld)*

x

0	-1	0
-1	5	-1
0	-1	0

*Waarden in filter (voorbeeld)*

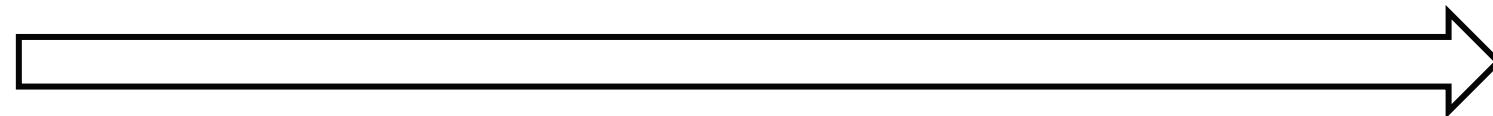
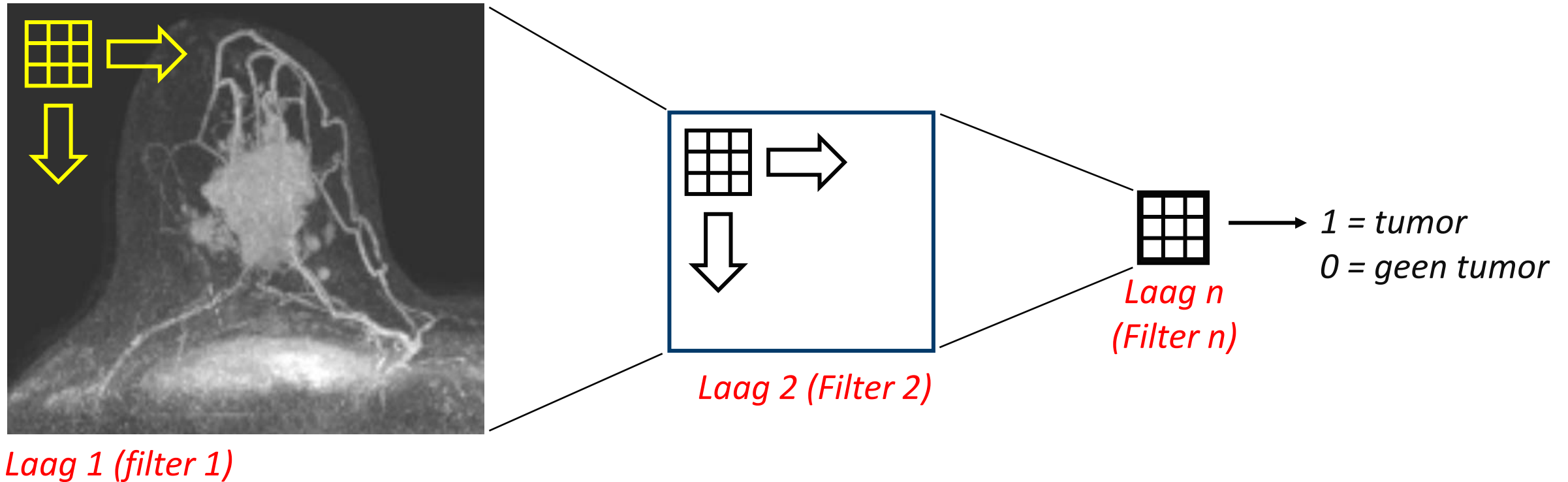
*Convolutie:  $-1 \times 10 - 1 \times 4 + 5 \times 6 - 1 \times 8 - 1 \times 6 = 2$*

0	12	1
3	2	19
5	1	4

*Nieuwe beeldwaarden*

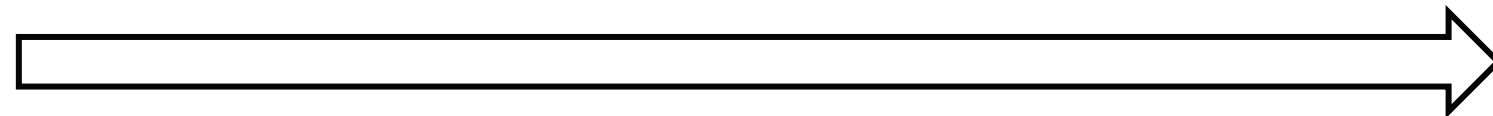
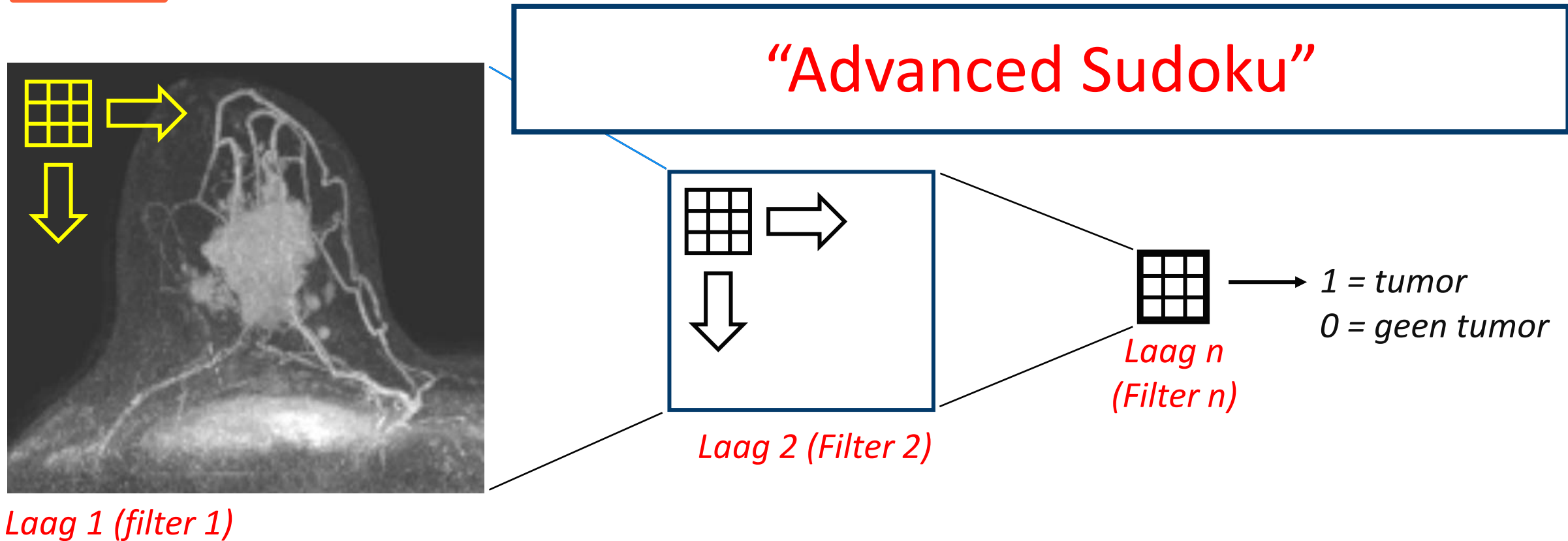


# Convolutional Neural Netwerk (CNN)



*Verklein resolutie in volgende laag (max-pooling) en doe nieuw filter*

# Convolutional Neural Netwerk (CNN)



*Verklein resolutie in volgende laag (max-pooling) en doe nieuw filter*

# Explainable Artificial Intelligence (xAI)

## Radiology

ORIGINAL RESEARCH • BREAST IMAGING

### Deep Learning for Automated Triaging of 4581 Breast MRI Examinations from the DENSE Trial

Erik Verburg, MSc • Carla H. van Gils, PhD • Bas H. M. van der Velden, PhD • Marije F. Bakker, PhD • Ruud M. Pijnappel, MD, PhD • Wouter B. Veldhuis, MD, PhD • Kenneth G. A. Gilhuijs, PhD

From the Image Sciences Institute (E.V., B.H.M.v.d.V., K.G.A.G.), Julius Center for Health Sciences and Primary Care (C.H.v.G., M.F.B.), and Department of Radiology (R.M.P., W.B.V.), University Medical Center Utrecht, Utrecht University, Utrecht 3584 CX, the Netherlands. Received October 9, 2020; revision requested November 17; revision received July 18, 2021; accepted July 28. Address correspondence to K.G.A.G. (e-mail: [K.G.A.Gilhuijs@umcutrecht.nl](mailto:K.G.A.Gilhuijs@umcutrecht.nl)).

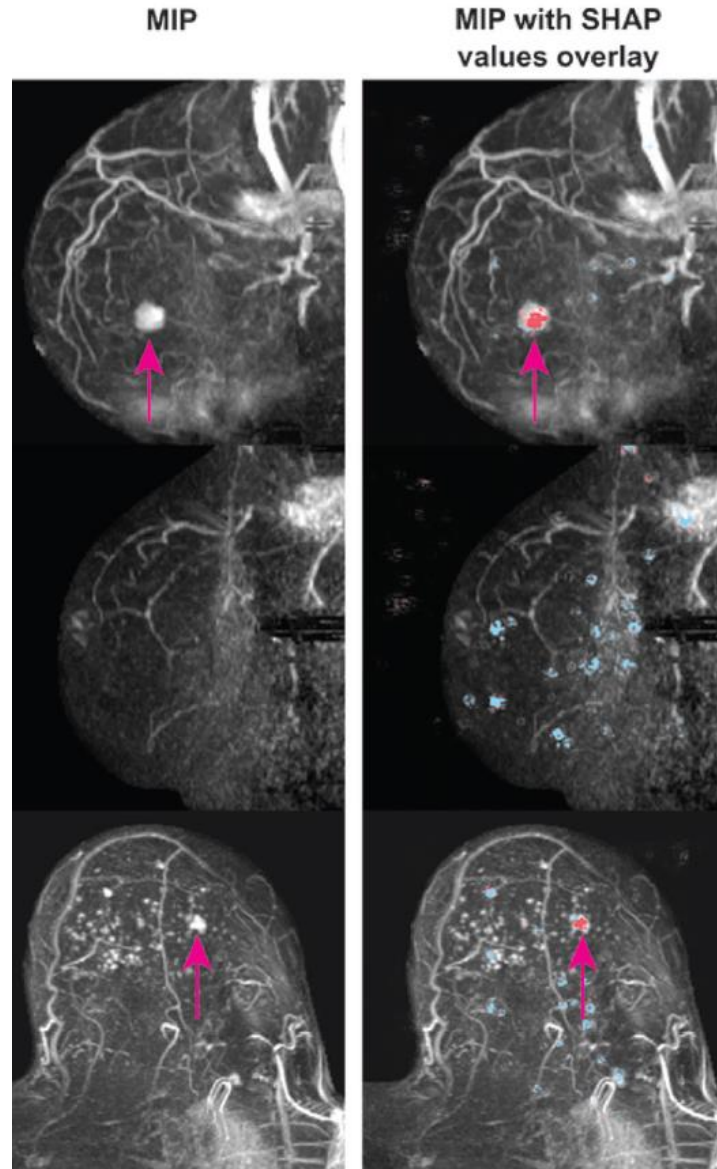
This study is financially supported by the Dutch Cancer Society (KWF Kankerbestrijding), grant number UU-2014-7151, and used data acquired during the DENSE trial. The DENSE trial was supported by the regional screening organizations, Volpara Solutions, the Dutch Expert Centre for Screening, and the National Institute for Public Health and the Environment. The DENSE trial is financially supported by the University Medical Center Utrecht (project number: UMCU DENSE), the Netherlands Organization for Health Research and Development (ZonMw, project numbers ZONMW-200320002-UMCU and ZonMW Preventie 50-53125-98-014), the Dutch Cancer Society (KWF Kankerbestrijding, project numbers c), the Dutch Pink Ribbon/A Sister's Hope (project number: Pink Ribbon-10074), Bayer AG Pharmaceuticals, Radiology (project number BSP-DENSE), and Stichting Kankerpreventie Midden-West.

Conflicts of interest are listed at the end of this article.

See also the editorial by Joe in this issue.

Radiology 2021; 000:1–7 • <https://doi.org/10.1148/radiol.2021203960> • Content codes: **BR** **MR**

**Background:** Supplemental screening with MRI has proved beneficial in women with extremely dense breasts. Most MRI examina-



# Trainen van Machine Learning

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Hoe leert een AI?

# Trainen van Machine Learning

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Supervised  
Learning

Unsupervised  
Learning

Reinforcement  
Learning



# Trainen van Machine Learning

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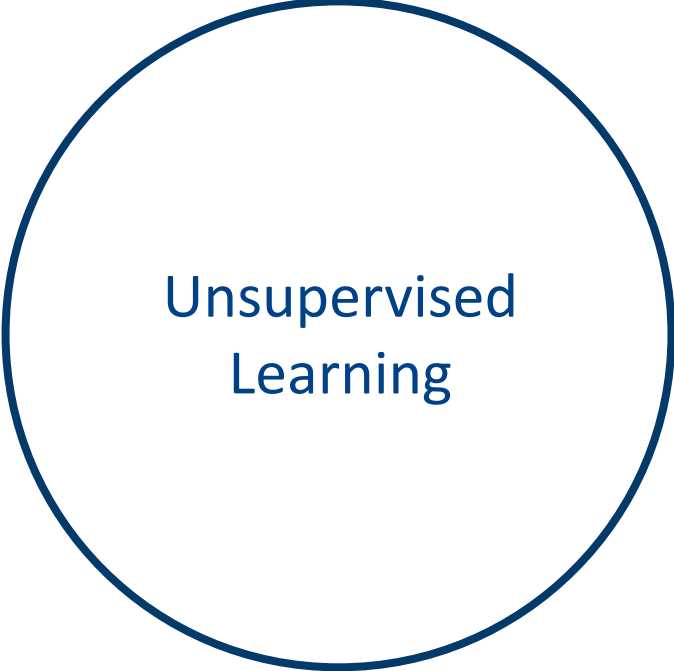


Supervised  
Learning

- De machine leert van gelabelde data
- Externe sturing nodig (supervisie)
- Koppelt input-labels aan gewenste output-labels
- Technieken: Regressie, classificatie

# Trainen van Machine Learning

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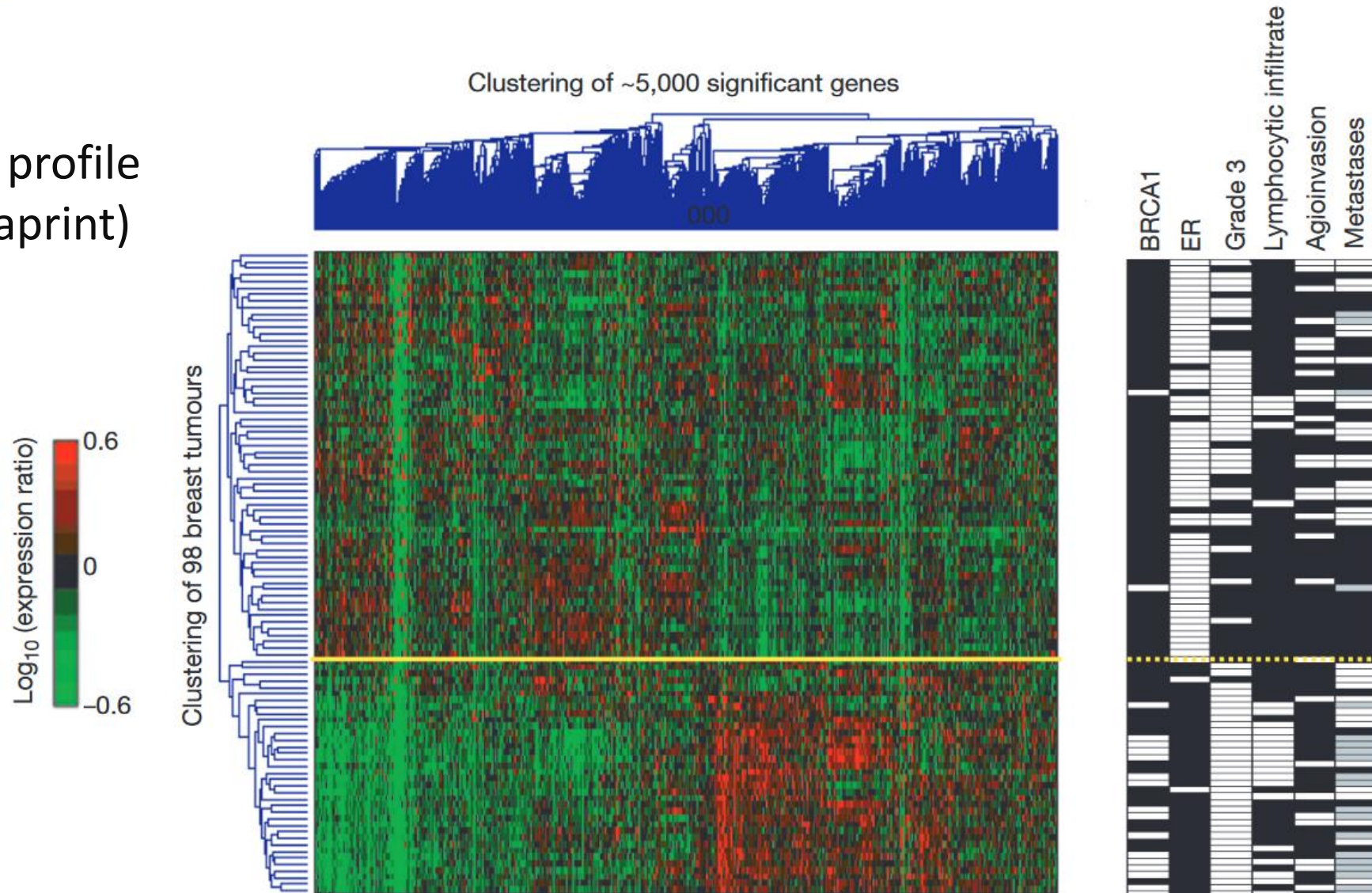


Unsupervised  
Learning

- De machine leert van ongelabelde data
- Geen externe sturing nodig (unsupervised)
- Zoekt patronen, output vooraf niet bekend
- Technieken: Principal component analyse, Clustering

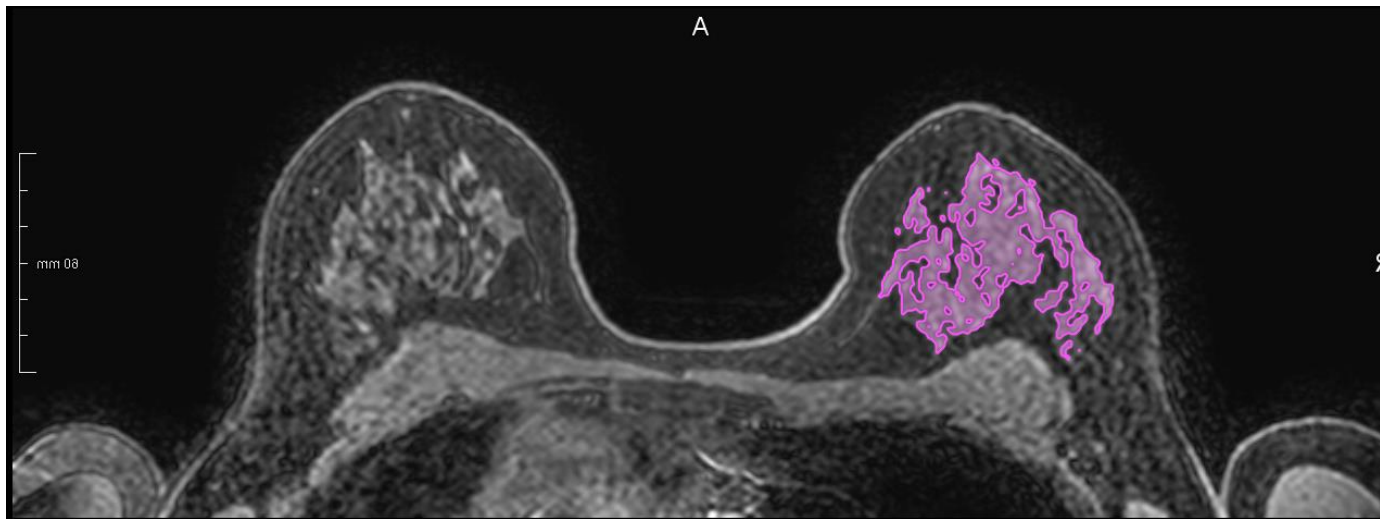
# Unsupervised Learning

70-gene profile  
(Mammaprint)



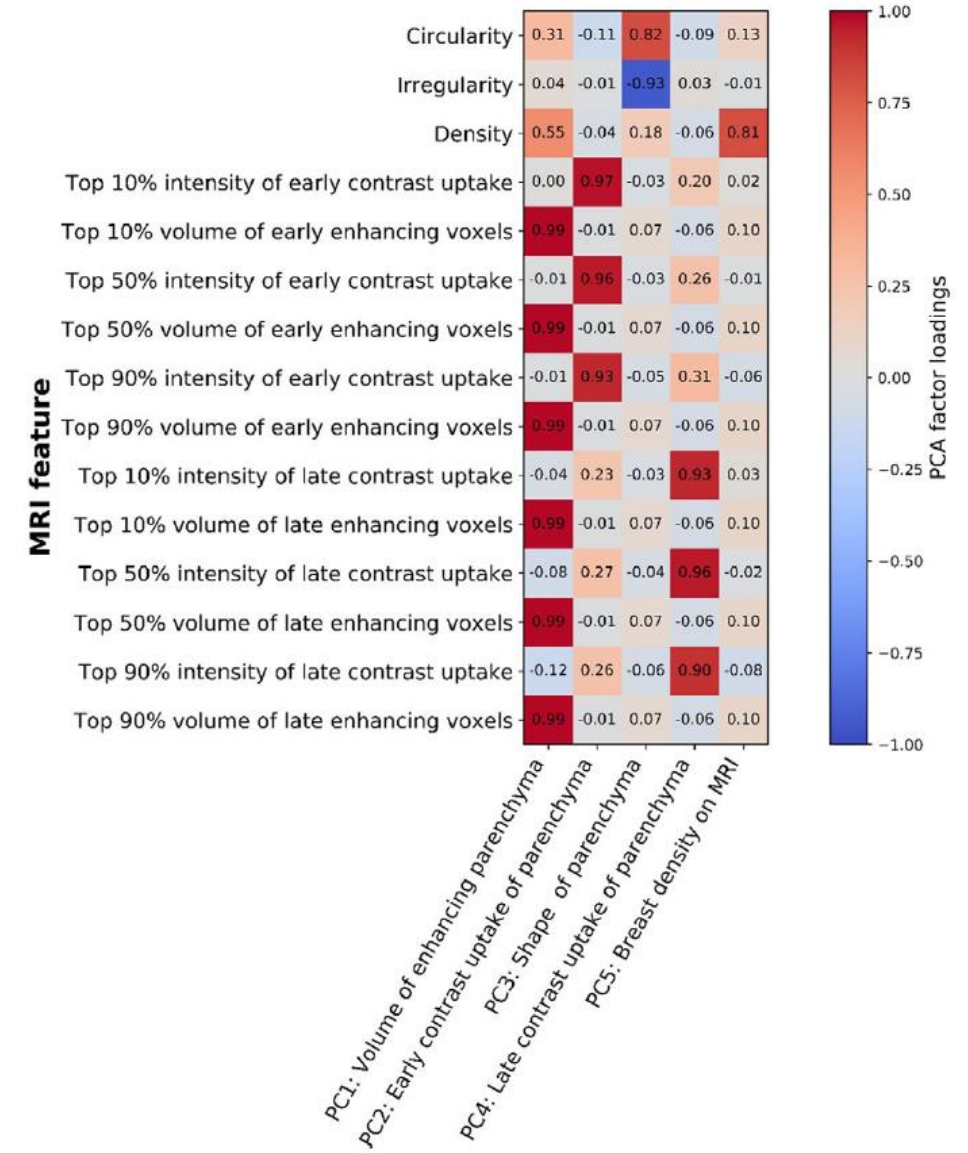
# Combinatie Unsupervised en Supervised Learning

## DENSE Risk Assessment



Wang H et al., Radiology, 2023

“Breast cancer occurs twice as often in women with high Breast Parenchymal Enhancement (BPE) on MRI than in women with low BPE”



# Trainen van Machine Learning

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Reinforcement  
Learning

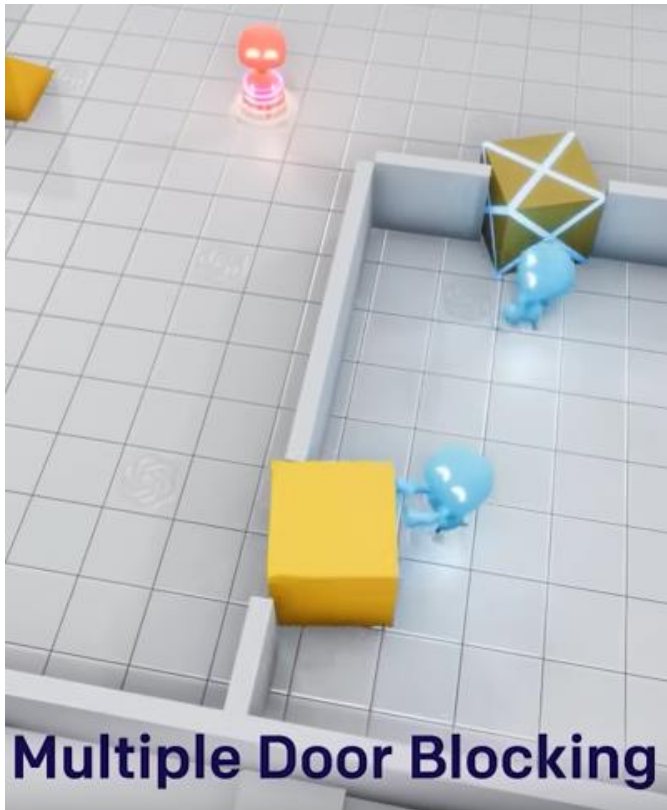
- De machine leert van zijn omgeving door middel van “rewards” en “penalties”
- Geen externe sturing nodig (unsupervised)
- Zoekt autonoom oplossingen door middel van trial-and-error
- Technieken: Q-learning



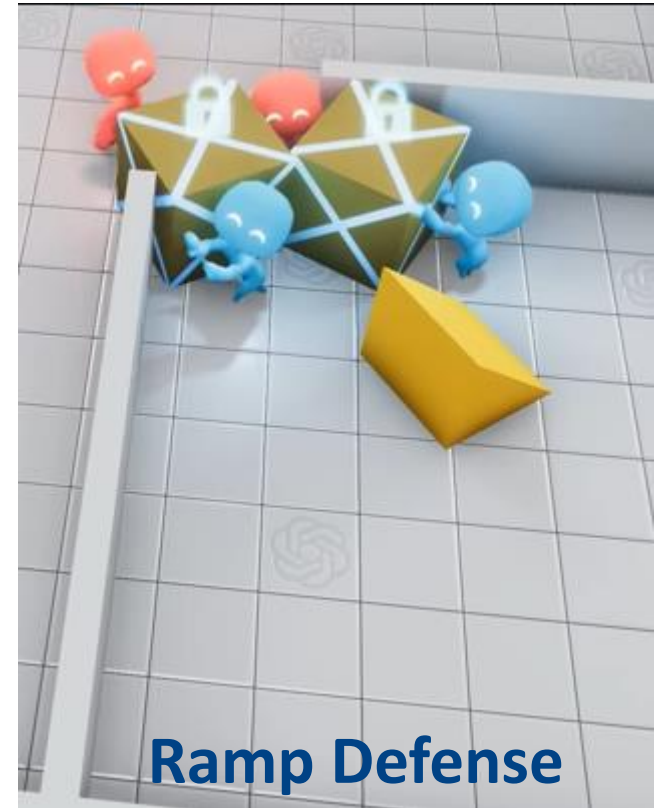
# Reinforcement Learning

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Verstoppertje leren: Blauw team (verstoppen) versus rood team (zoeken)



(OpenAI)



<https://youtu.be/kopoLzvh5jY?feature=shared>

# Reinforcement Learning

## Toepassingen van Reinforcement Learning in beeldvormende oncologie schaaars

Medical Image Analysis 90 (2023) 102980



Contents lists available at [ScienceDirect](#)

Medical Image Analysis

journal homepage: [www.elsevier.com/locate/media](http://www.elsevier.com/locate/media)



### Spatiotemporal knowledge teacher–student reinforcement learning to detect liver tumors without contrast agents

Chenchu Xu <sup>a,b</sup>, Yuhong Song <sup>a</sup>, Dong Zhang <sup>c,\*</sup>, Leonardo Kayat Bittencourt <sup>d</sup>,  
Sree Harsha Tirumani <sup>d</sup>, Shuo Li <sup>e,\*</sup>

<sup>a</sup> School of Computer Science and Technology, Anhui University, Hefei, China

<sup>b</sup> Institute of Artificial Intelligence, Hefei Comprehensive National Science Center, Hefei, China

<sup>c</sup> Department of Electrical and Computer Engineering, University of British Columbia, Vancouver, Canada

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#### ARTICLE INFO

Keywords:  
contrast-free technology  
reinforcement learning  
Teacher–student framework  
Spatiotemporal ternary knowledge

#### ABSTRACT

Detecting Liver tumors without contrast agents (CAs) has shown great potential to advance liver cancer screening. It enables the provision of a reliable liver tumor-detecting result from non-enhanced MR images comparable to the radiologists' results from CA-enhanced MR images, thus eliminating the high risk of CAs, preventing an experience gap between radiologists and simplifying clinical workflows. In this paper, we proposed a novel spatiotemporal knowledge teacher–student reinforcement learning (SKT-RL) as a safe,

Xu C et al,  
Medical Image Analysis, 2023

# Take-Home messages

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Een eenduidige definitie van kunstmatige intelligentie (AI) is niet beschikbaar

De mate waarin AI kunstmatig intelligent is, is moeilijk vast te stellen

Radiomics en deep learning zijn allebei machine learning en vallen allebei onder AI

- Deep learning vergt in het algemeen grotere studiecohorten dan radiomics
- Narrow artificial intelligence kent vele toepassingen in de oncologie: risico-stratificatie, workflow optimalisatie, detectie, diagnose, medicijnen ontwikkeling, therapie response monitoring, etc.

Nieuwe ontwikkelingen in de AI maken het mogelijk om problemen te analyseren die mensen moeilijk in stapjes kunnen onderverdelen of output labels geven

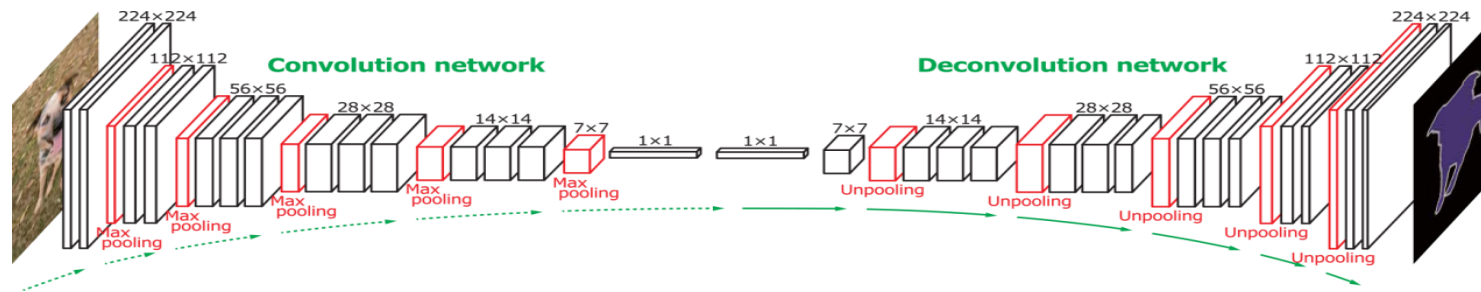




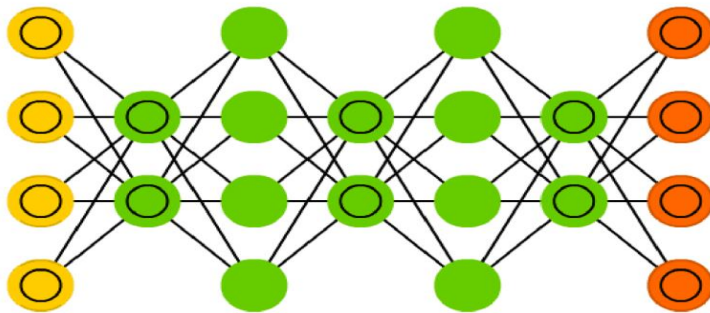
# Trainen van Kunstmatige Intelligentie

Een neurale netwerk met meer dan 1 hidden laag

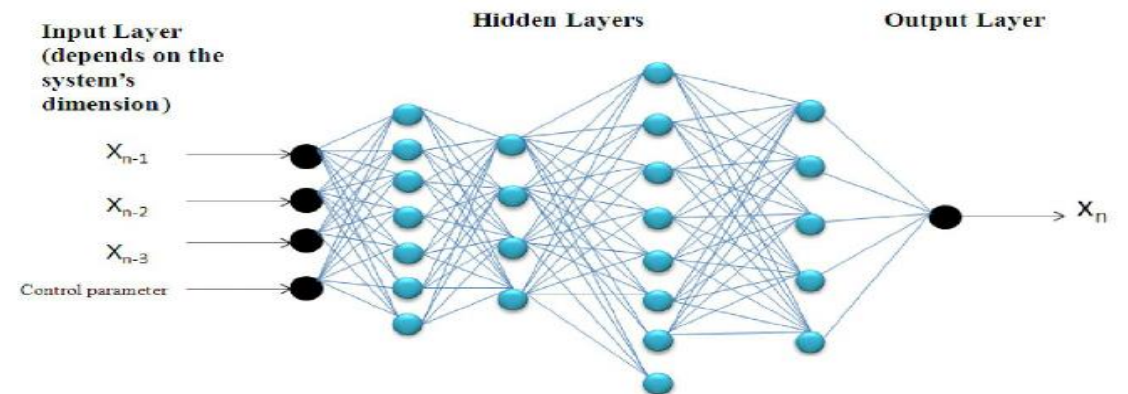
## Convolutional neural network (CNN)



## Deep belief network

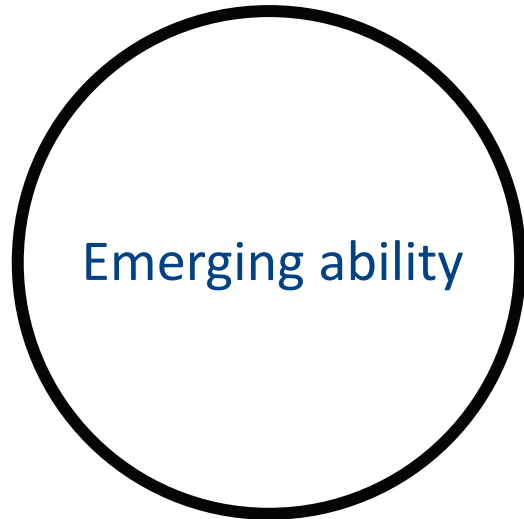


## Recurrent network



# Maar waarom lijkt kunstmatige intelligentie intelligent?

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**KG You**  
Sally is twice as old as Harry when Sally is 12. How old is Harry when Sally is 50?  
< 6/6 >

**ChatGPT**  
Let's first determine Harry's age when Sally is 12. If Sally is twice as old as Harry at that time, we can set up an equation:

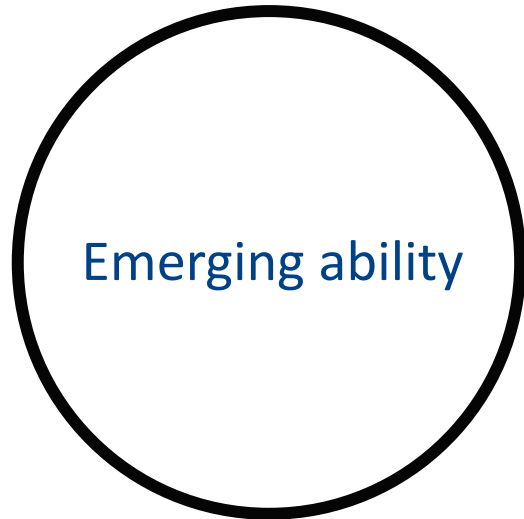
Sally's age = 2 \* Harry's age

When Sally is 12:  
12 = 2 \* Harry's age

Now, solve for Harry's age:  
Harry's age = 12 / 2  
Harry's age = 6

# Maar waarom lijkt kunstmatige intelligentie intelligent?

---



So, when Sally is 12, Harry is 6 years old.

Now, let's find the age difference between Sally and Harry:

Age difference = Sally's age - Harry's age

Age difference = 12 - 6

Age difference = 6 years

This age difference remains constant. So, if Sally is 50, Harry would be  $50 - 6 = 44$  years old. Therefore, Harry would be 44 years old when Sally is 50.

# Wat is kunstmatige intelligentie?



in·tel·li·gen·tie (de; v)

- 1 verstandelijk vermogen: *kunstmatige intelligentie* het met behulp van een computer nabootsen van het menselijk denken

## Kunstmatige intelligentie

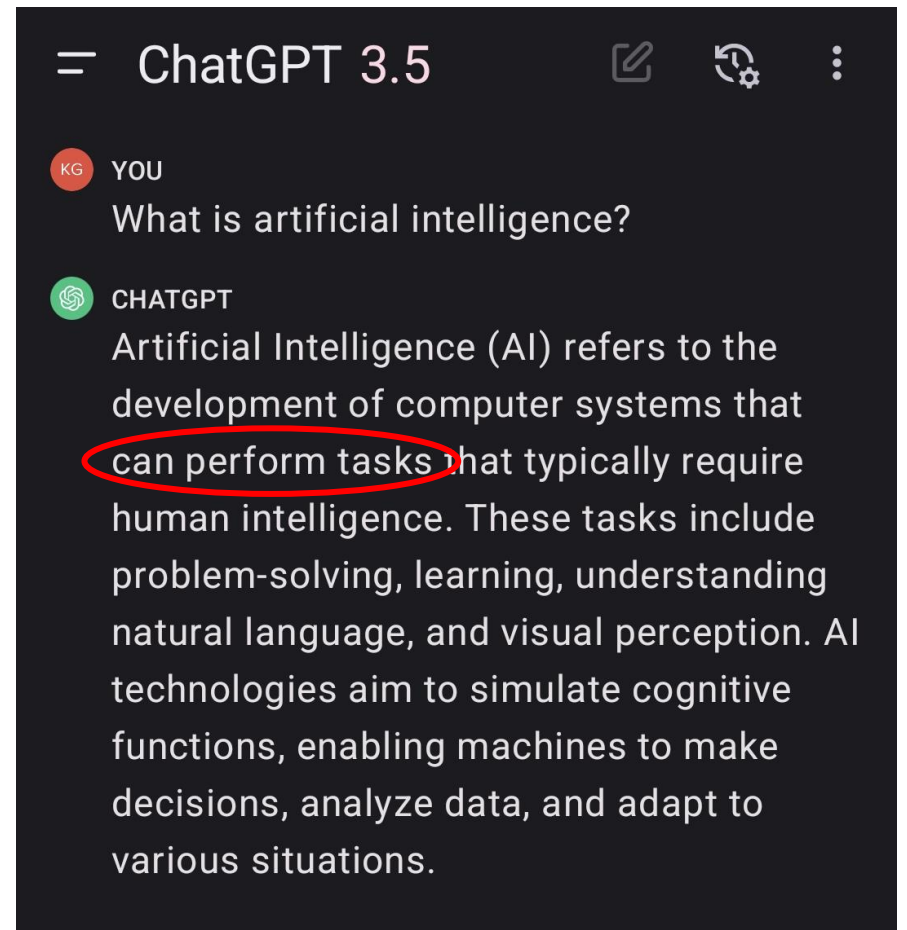
Kunstmatige intelligentie of artificiële intelligentie is de wetenschap die zich bezighoudt met het creëren van een artefact dat een vorm van intelligentie vertoont. [Wikipedia \(NL\)](#)

## artificial intelligence

noun

1. The ability of a computer or other machine to perform those activities that are normally thought to require intelligence.





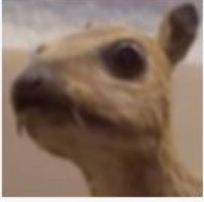
The American Heritage® Dictionary of the English Language, 5th Edition • More at [Wordnik](#)



OpenAI (2022)

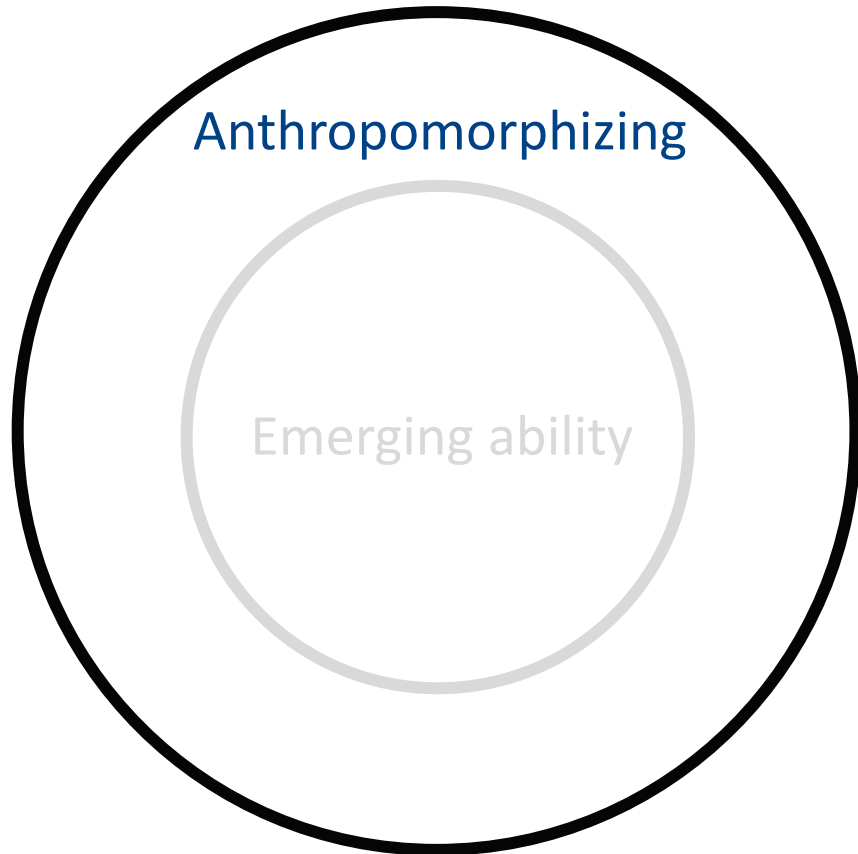
# Convolutional Neural Network (CNN)

Wat doen filters?

Operation	Kernel $\omega$	Image result $g(x,y)$
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Ridge or edge detection	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	

# Waarom komt AI intelligent over?

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## Conway's Game of Life (a cellular automaton)

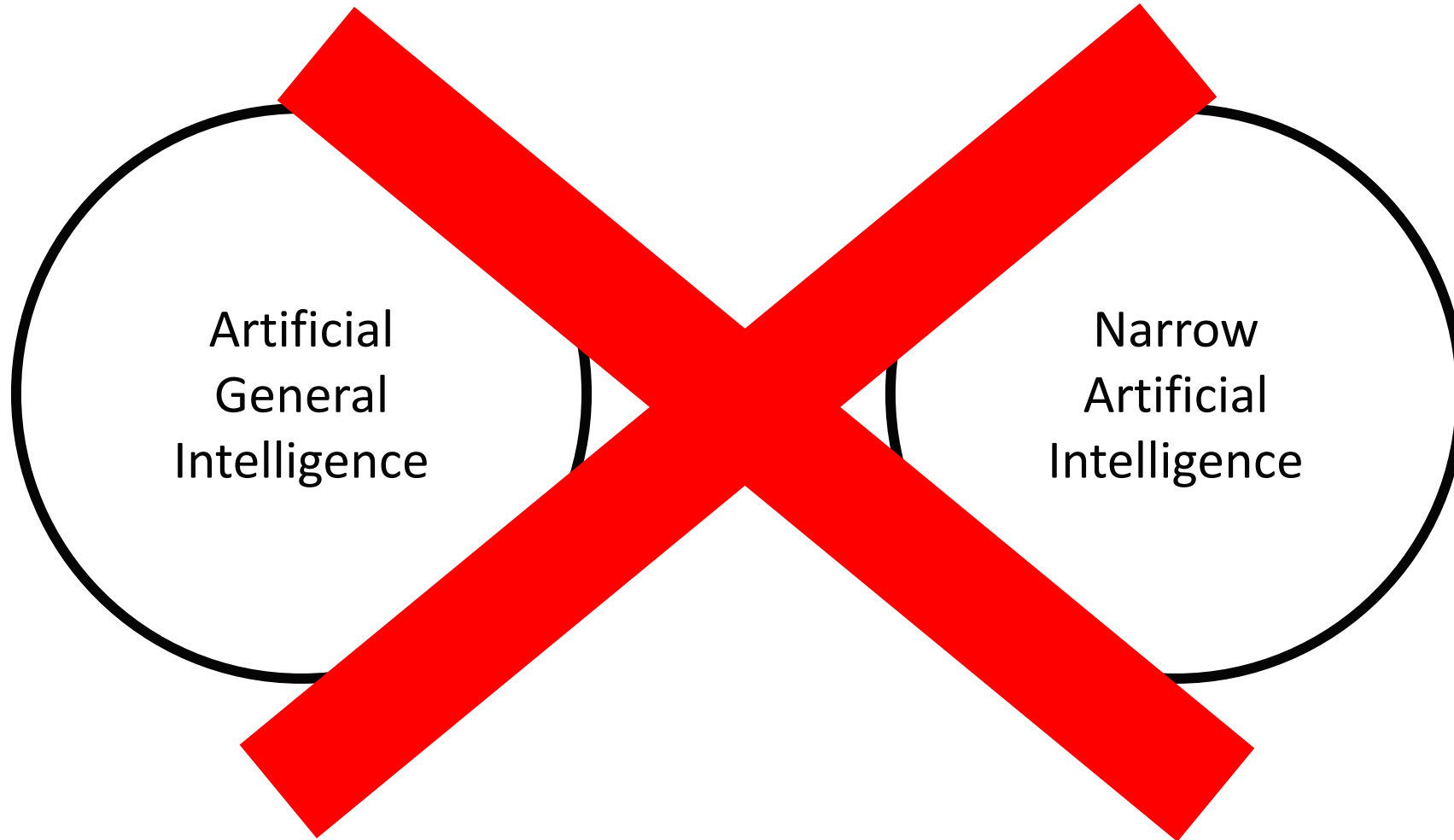


(Wikipedia.org)

Gardner, Martin (October 1970). "The fantastic combinations of John Conway's new solitaire game 'life'". *Mathematical Games*. *Scientific American*. Vol. 223, no. 4. pp. 120–123.

# Artificial General Intelligence (AGI)

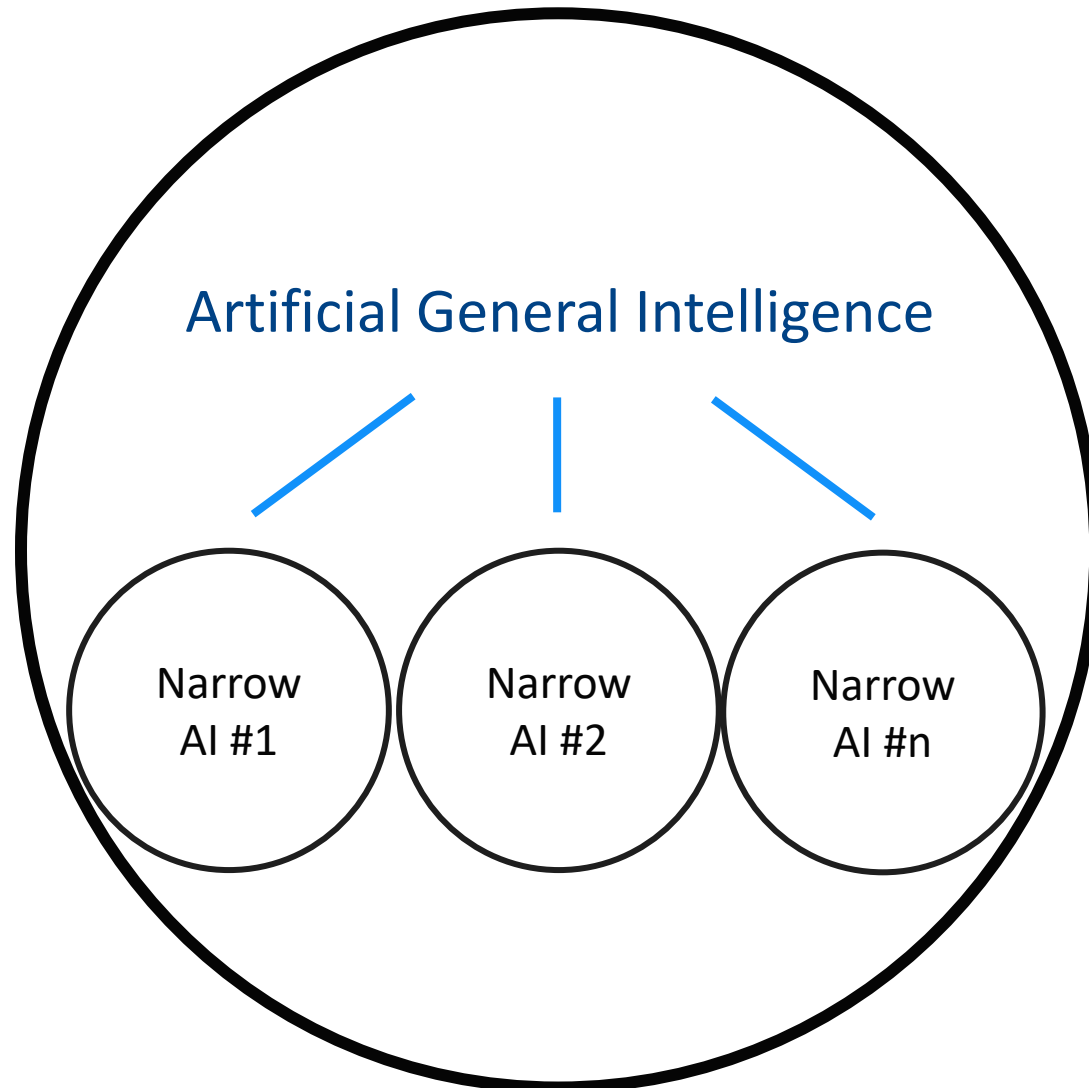
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# Artificial General Intelligence (AGI)

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E.g.:

- 'Plugins'
- 'Mixture of Experts' (MOE)

# Waarom komt AI intelligent over?

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