AI and its use in radiation research

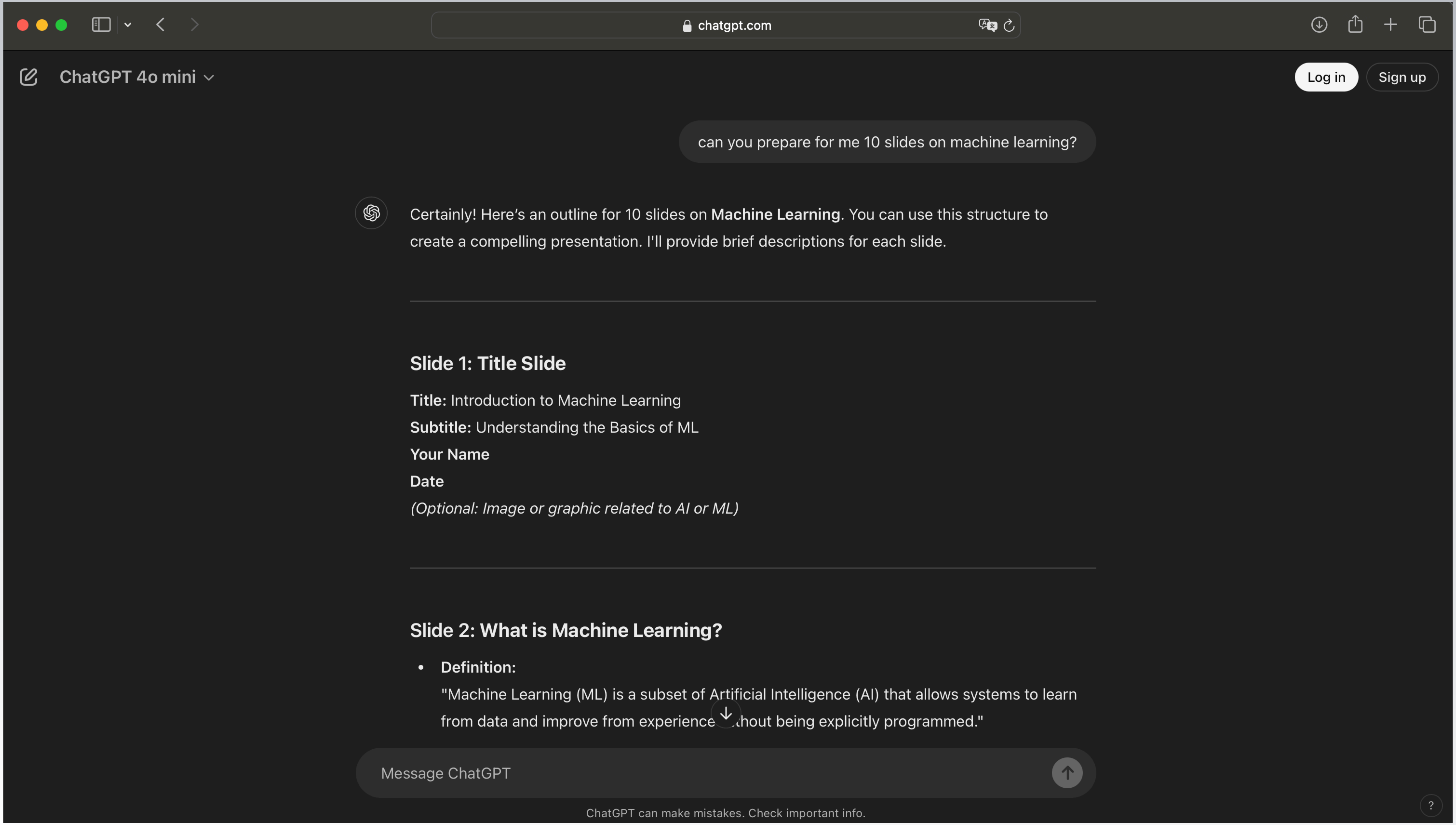
CELET 2024, Stockholm University

Beata Brzozowska, Faculty of Physics, University of Warsaw

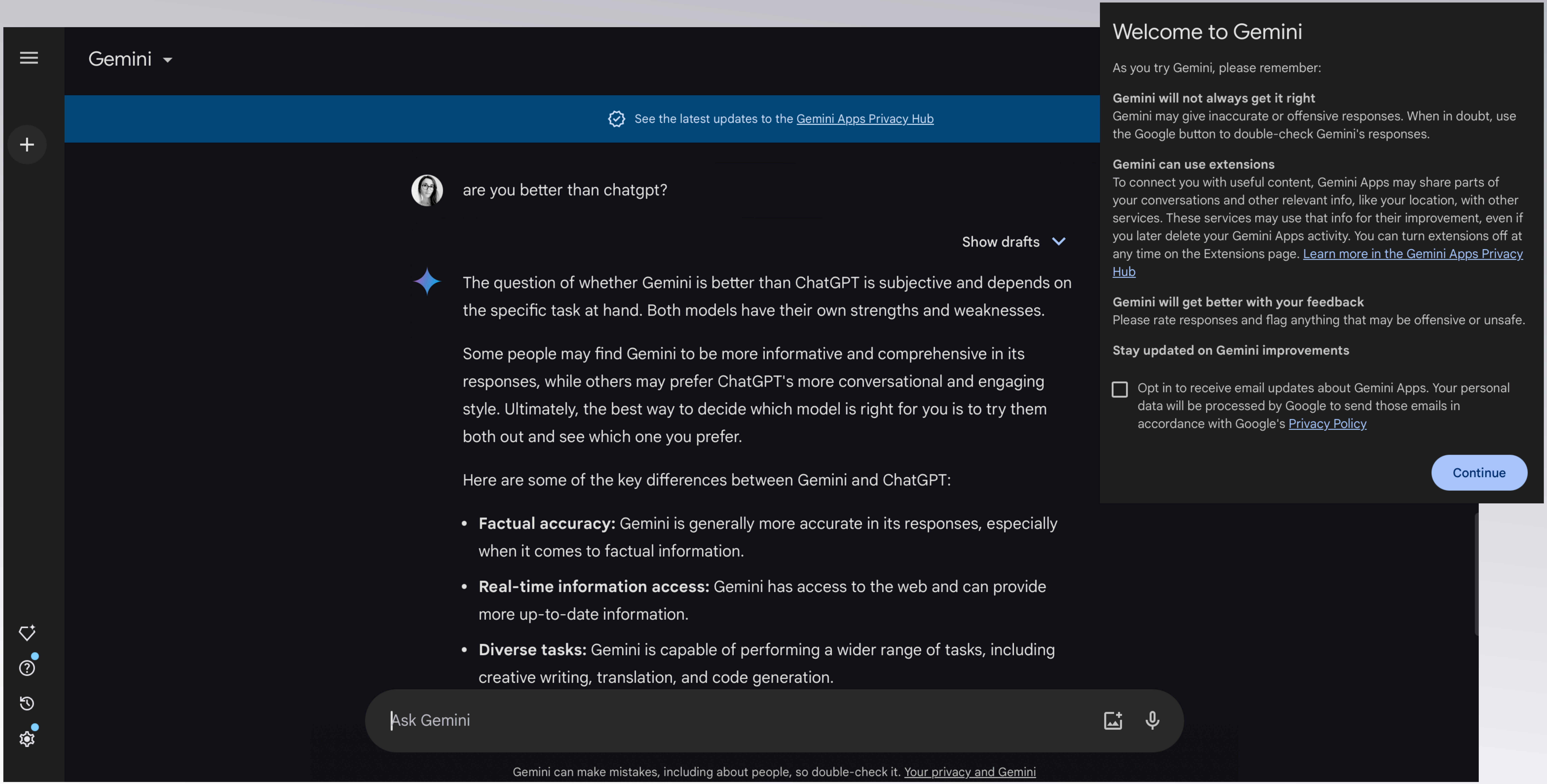
Agenda

- Basic information about AI
- Simple example: how to recognise numbers
- More sophisticated example: how to recognise dicentrics
- One pixel attack
- Some threads

chat.openai.com



bard.google.com



Artificial Intelligence

EU Artificial Intelligence Act

The Act ⌄ Implementation ⌄ Context ⌄ About us Newsletter ↗ EN ⌄

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Part of Chapter I: General Provisions

Article 3: Definitions

Date of entry into force:	According to:	Inherited from:
2 February 2025	Article 113(a)	Chapter I

See here for a full implementation timeline.

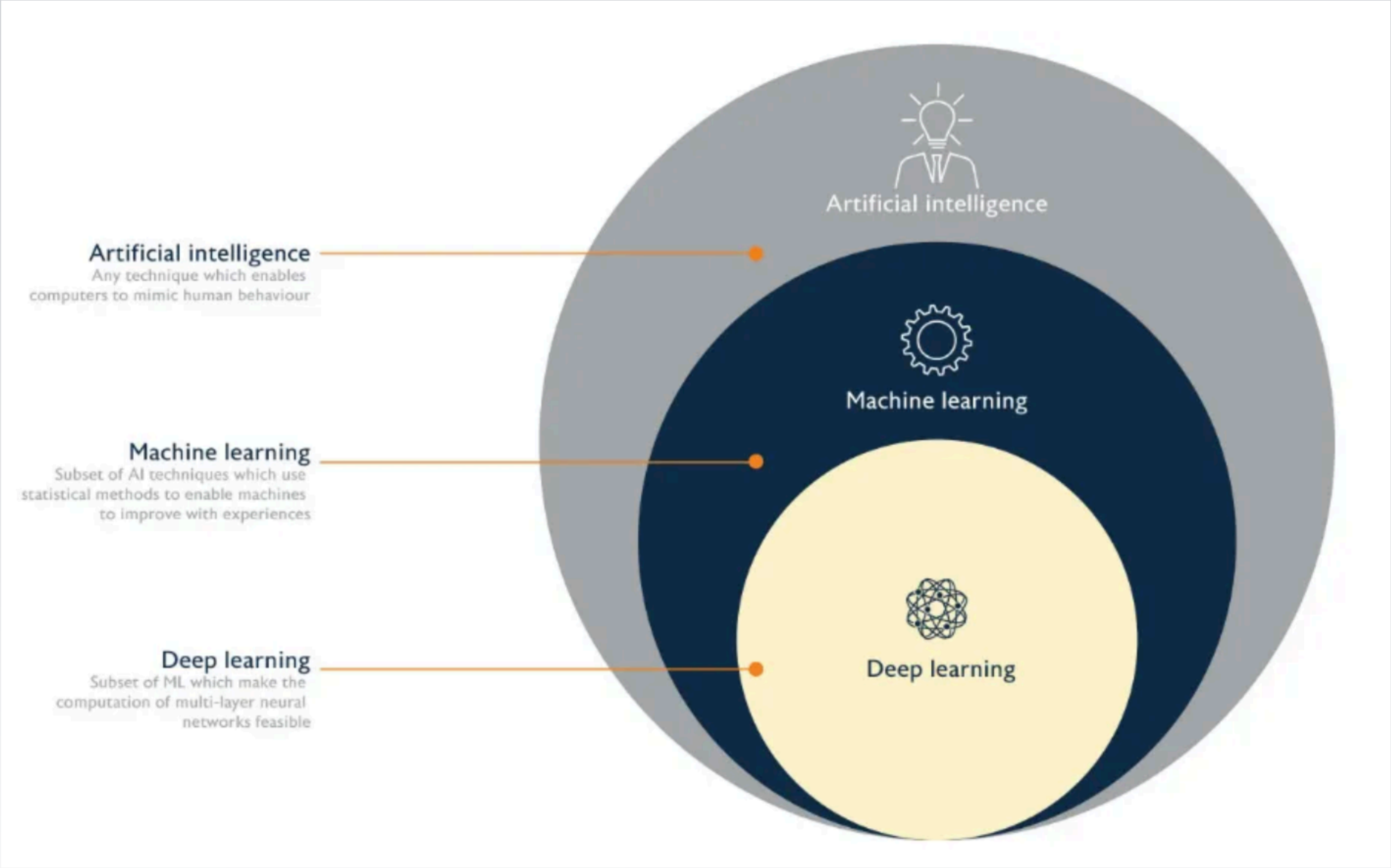
SUMMARY +

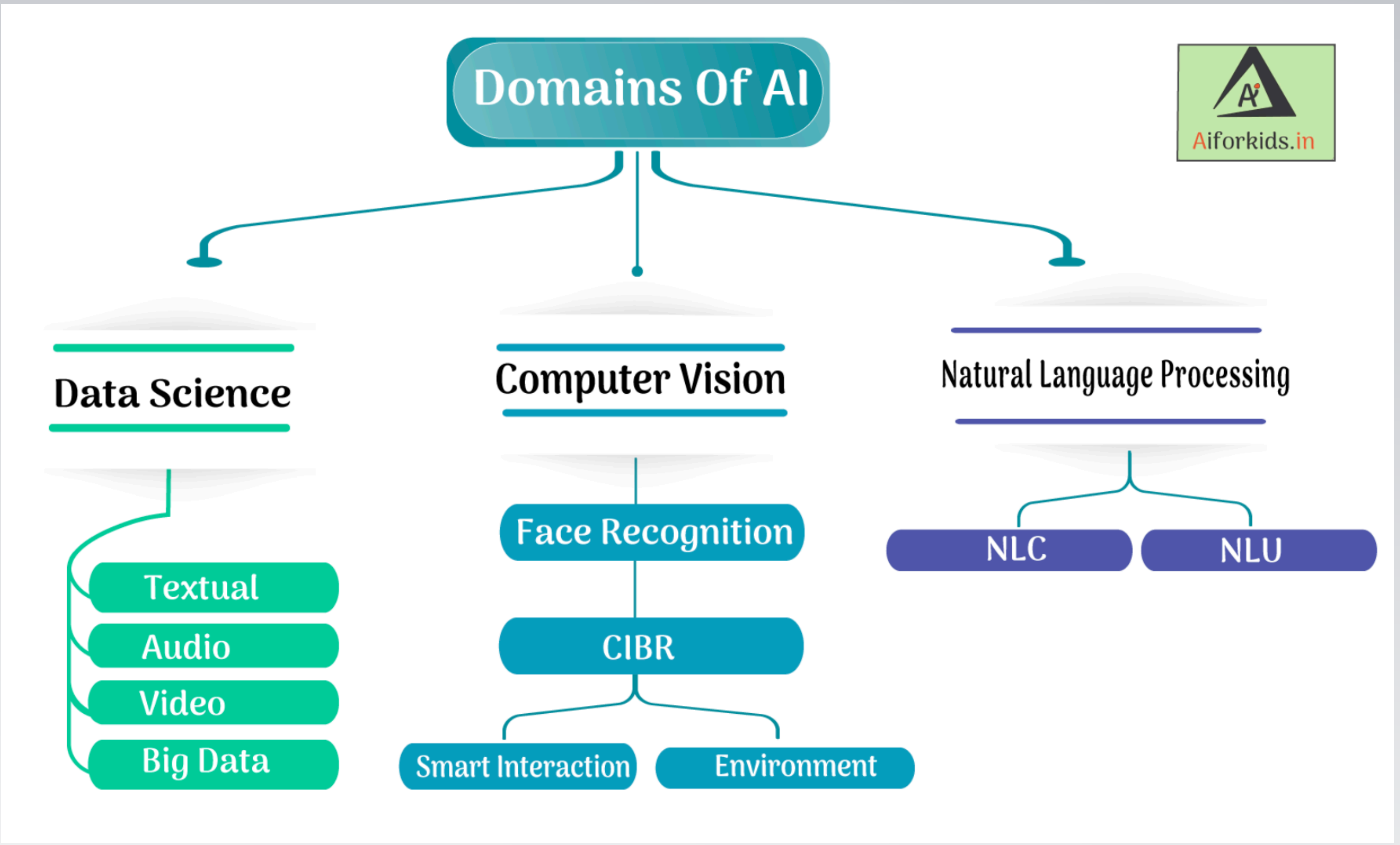
For the purposes of this Regulation, the following definitions apply:

(1) ‘AI system’ means a machine-based system that is designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment, and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments; Related: Recital 12

(2) ‘risk’ means the combination of the probability of an occurrence of harm and the severity of that harm;

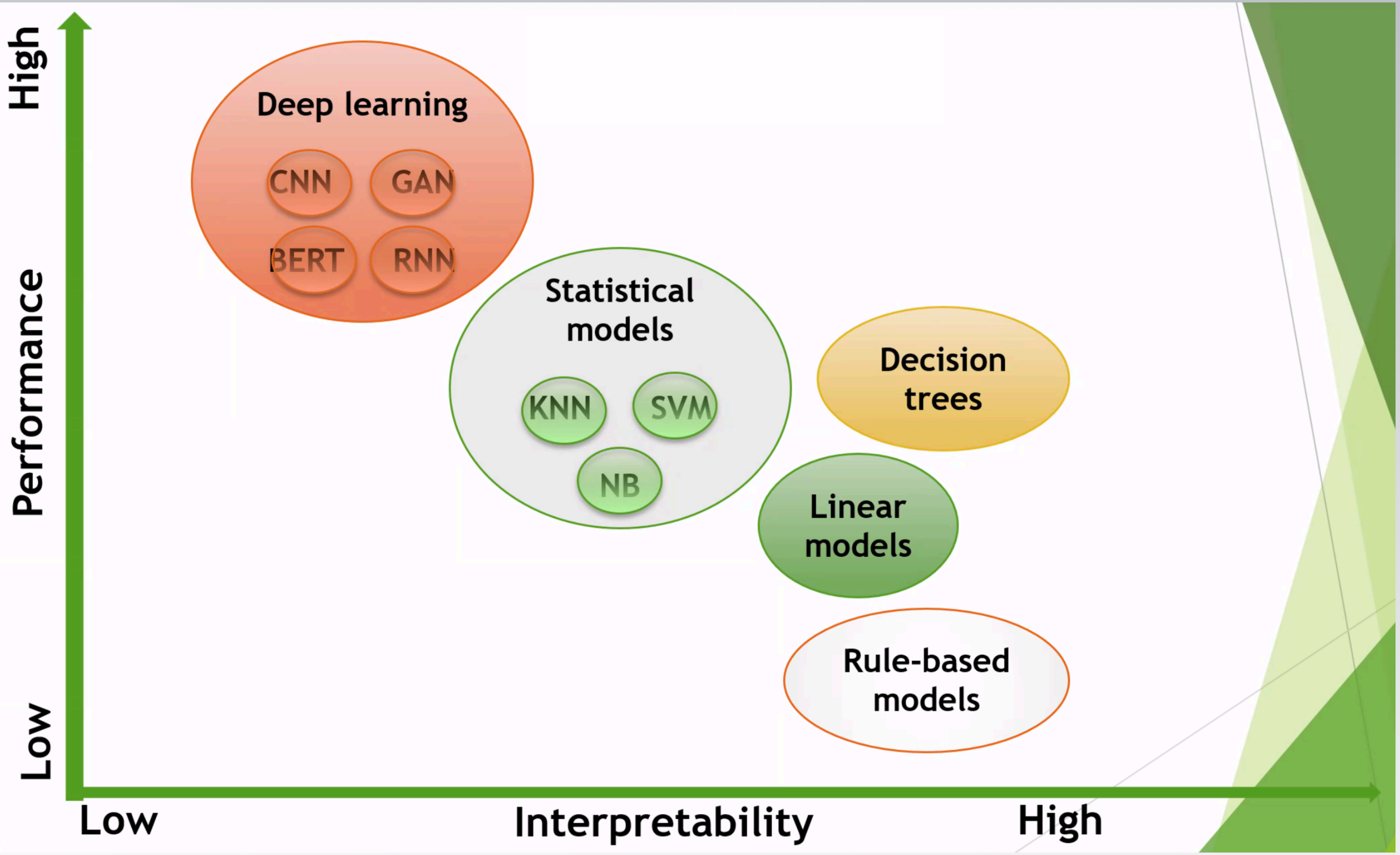
Artificial Intelligence (AI)



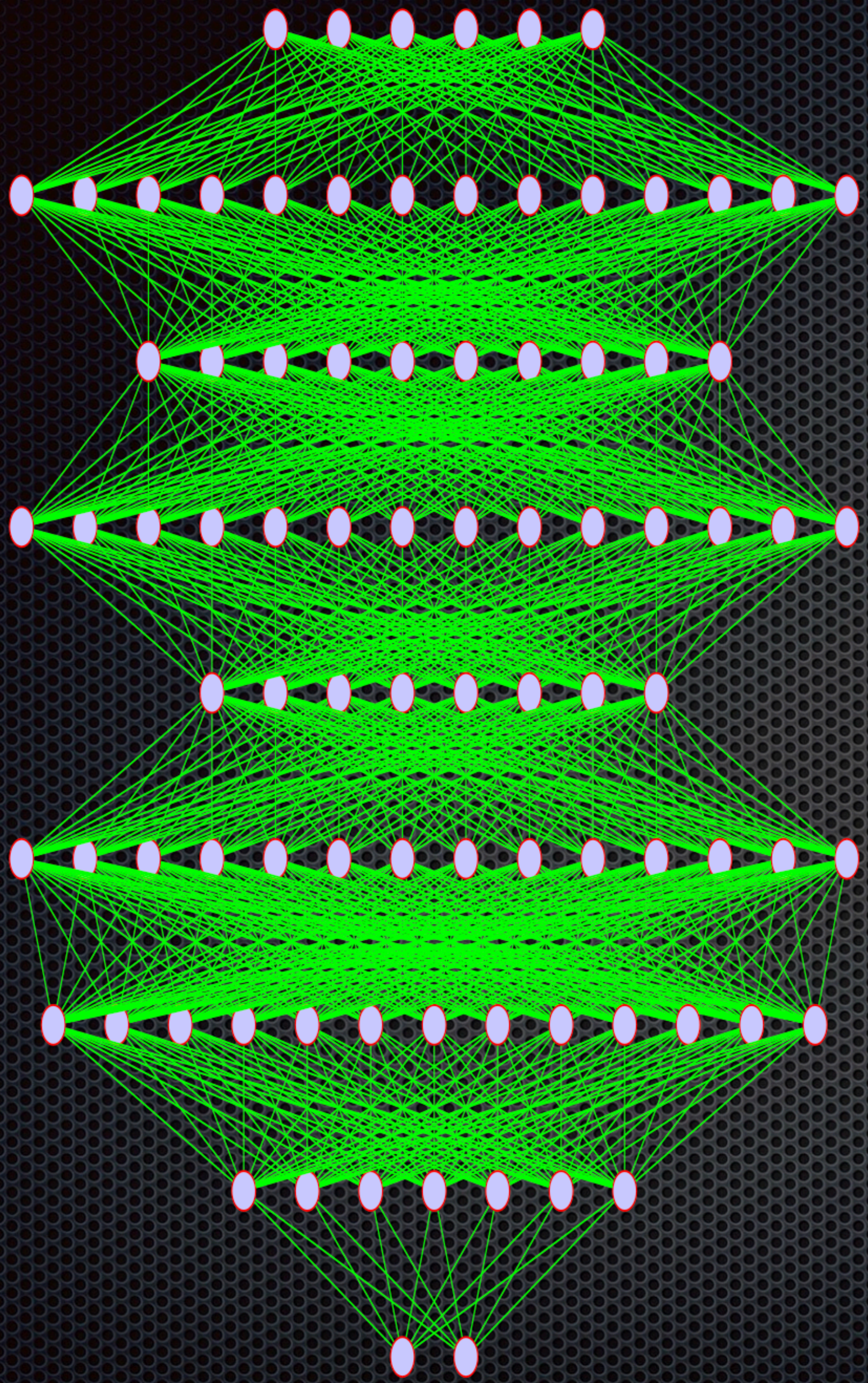


https://suryamaddula.medium.com/domains-of-artificial-intelligence-8046d0778f1a

Performance and interpretability



Lei Xing, The Role of AI in Clinical Radiation Oncology



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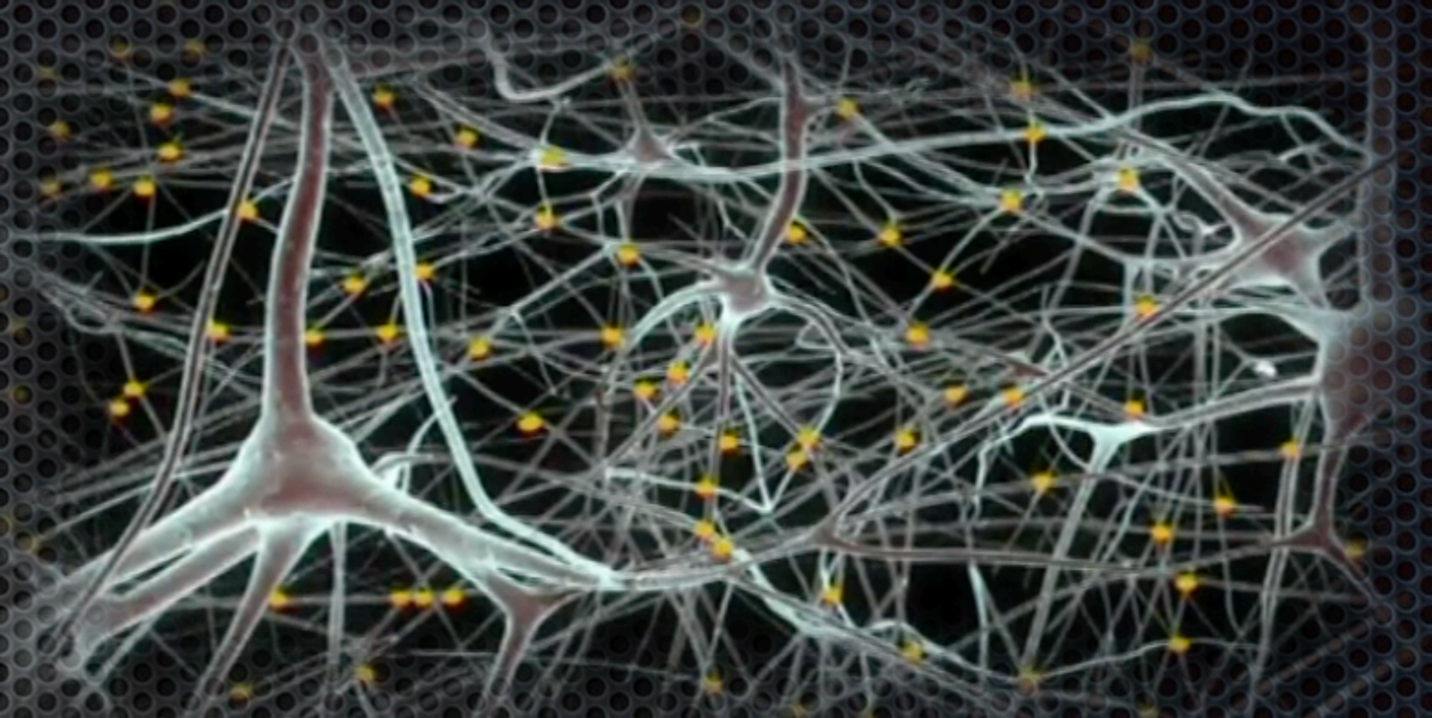
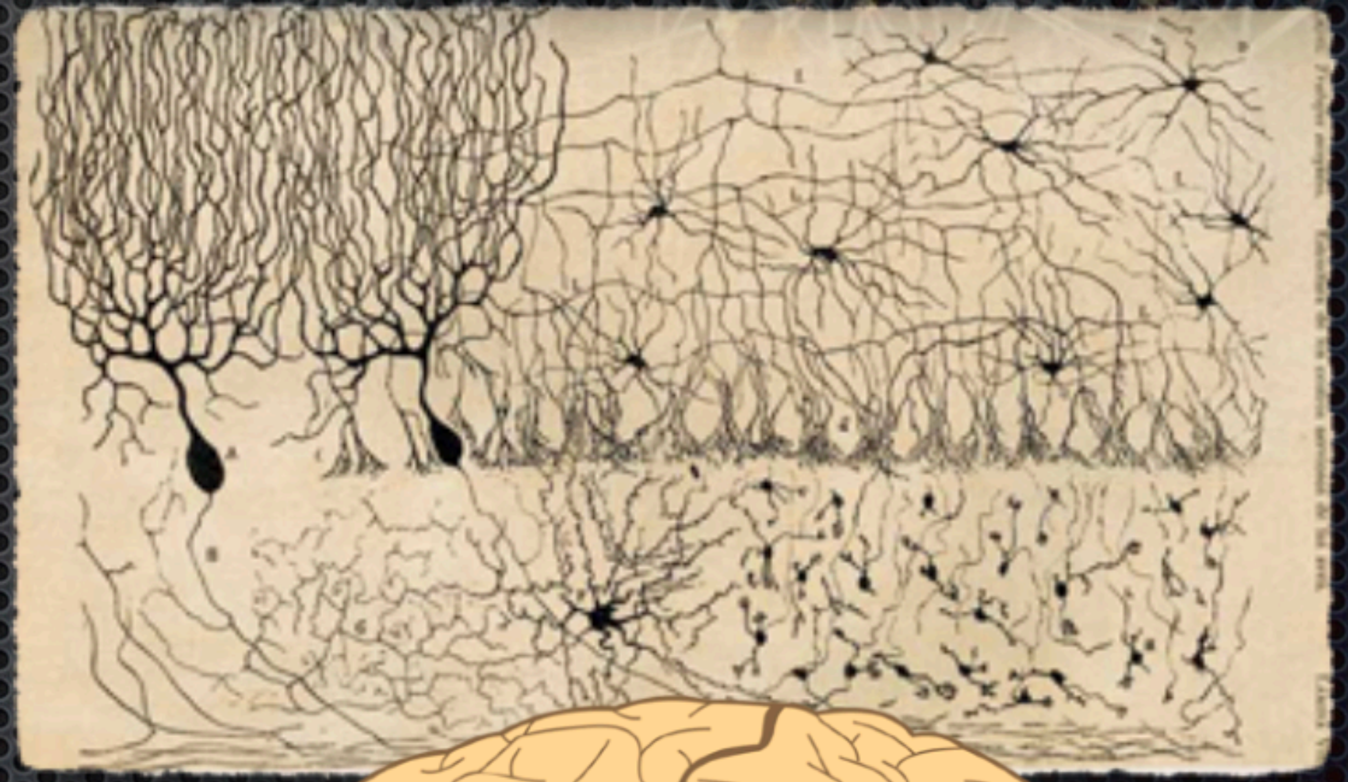
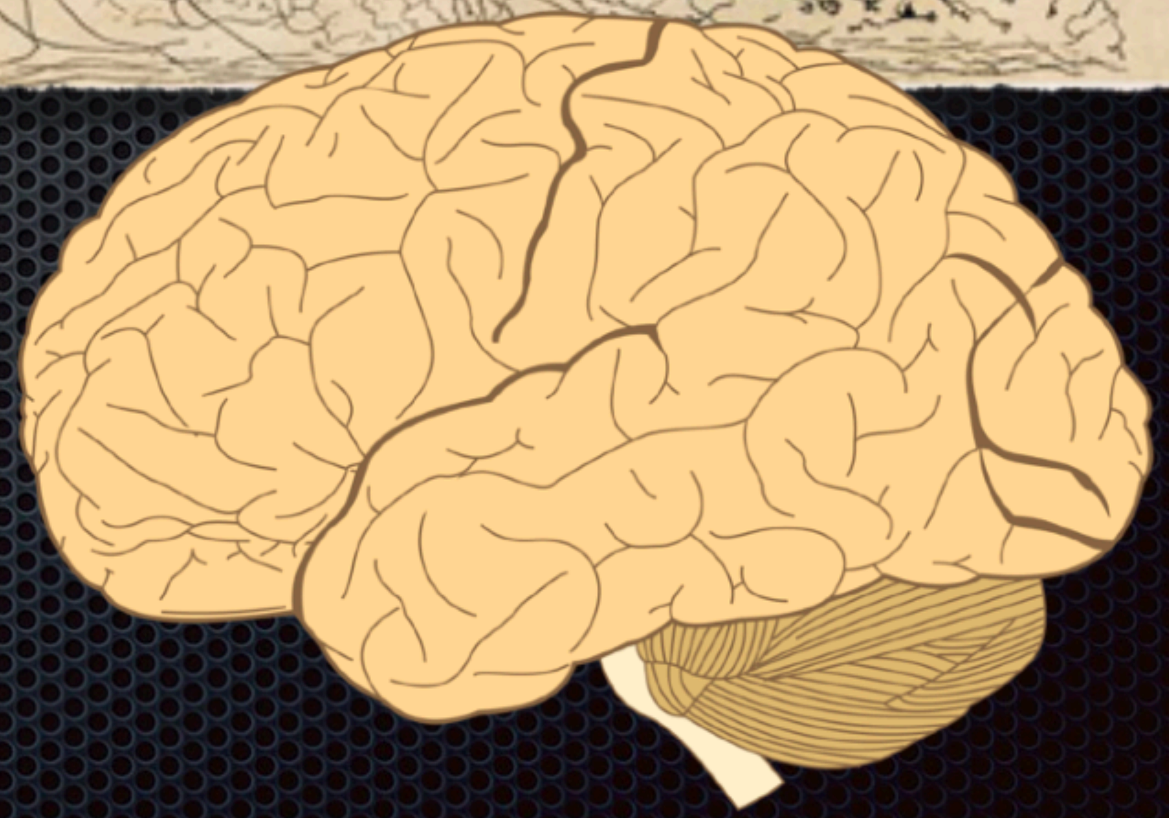
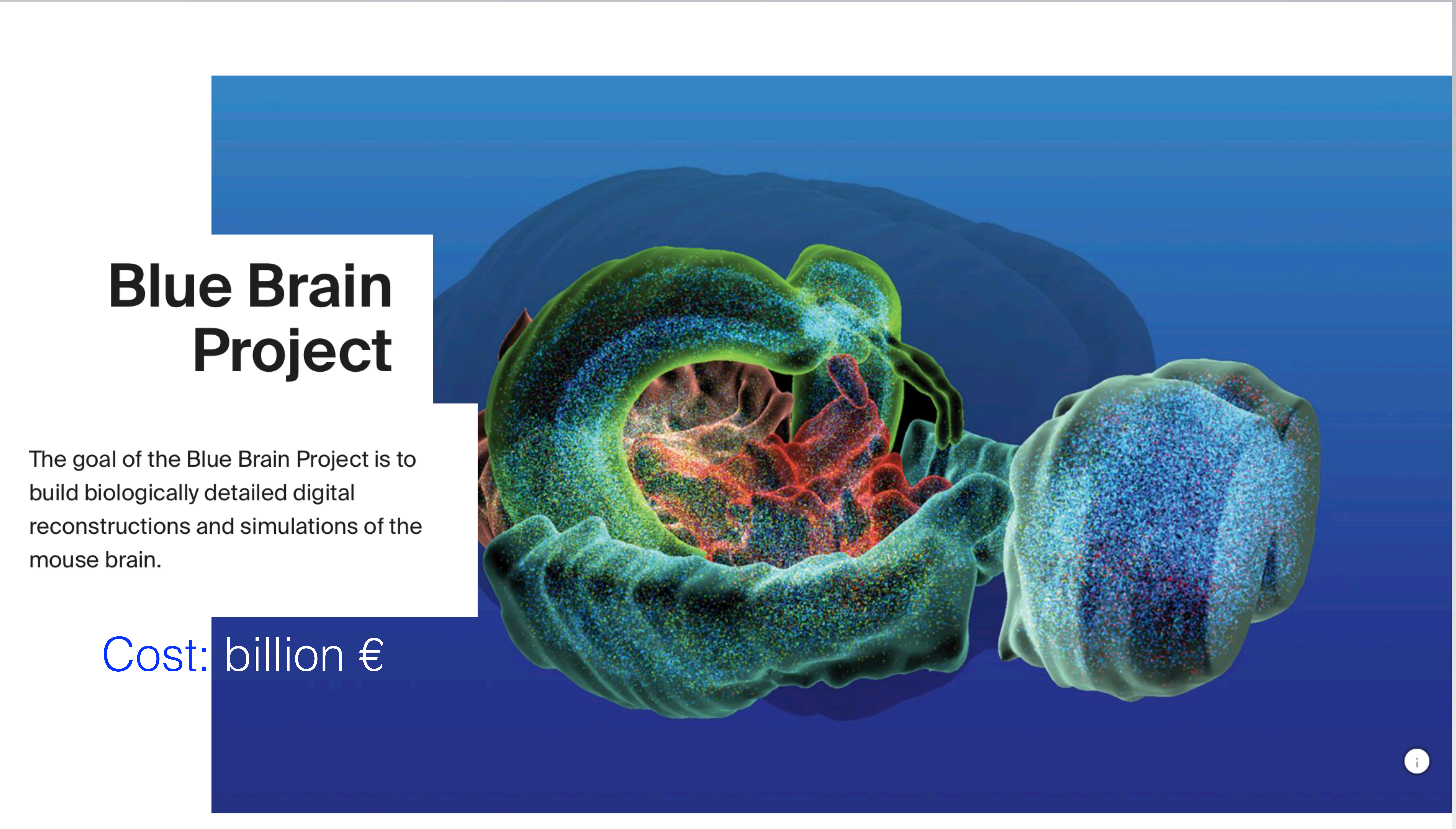






Piotr Durka, https://brain.fuw.edu.pl/edu/index.php/TI/Sztuczna_Inteligencja

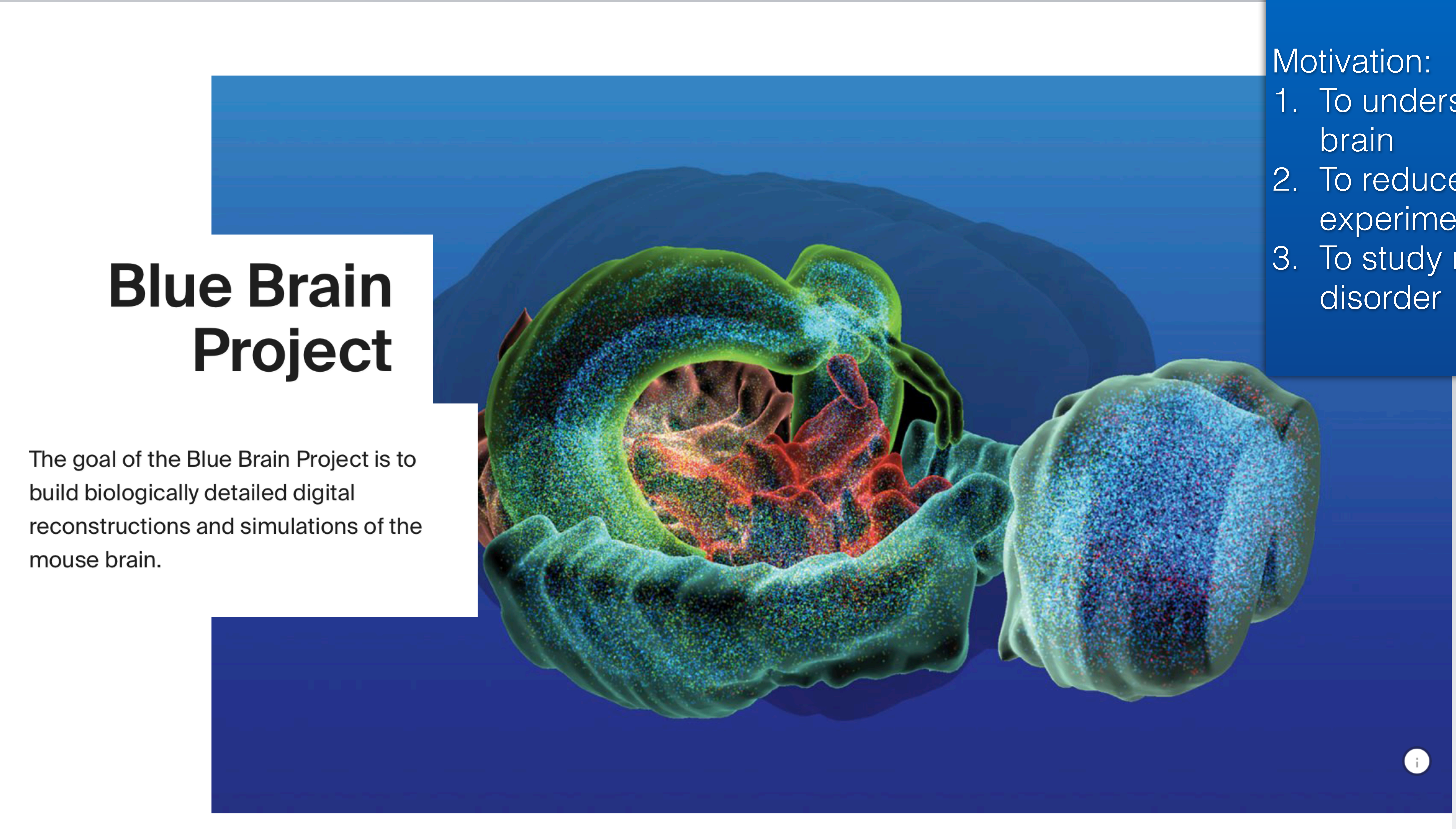
A brain is a supercomputer (H. Markram)



Cost: billion €

https://www.epfl.ch/research/domains/bluebrain/blue-brains-scientific-milestones/

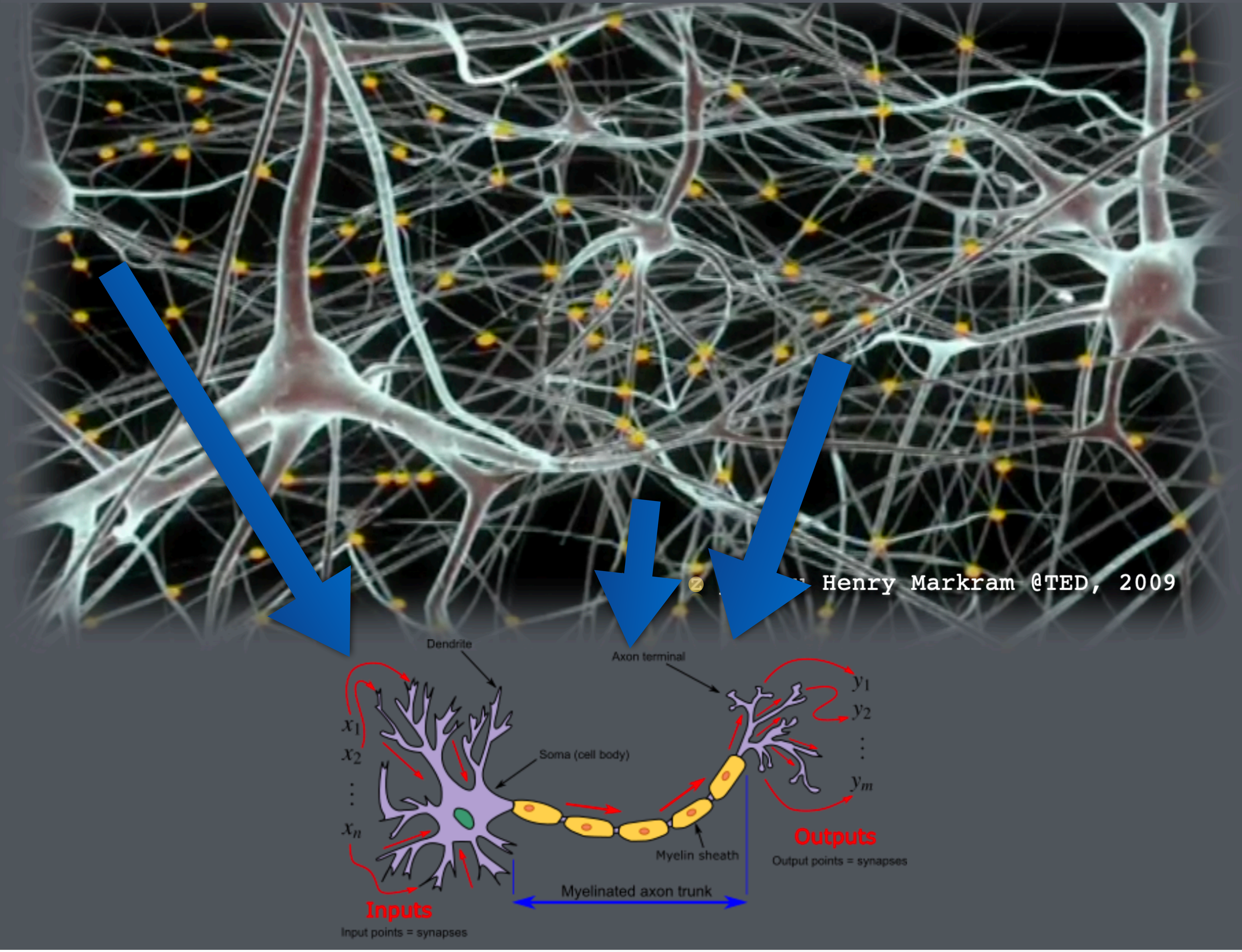
A brain is a supercomputer (H. Markram)



Motivation:

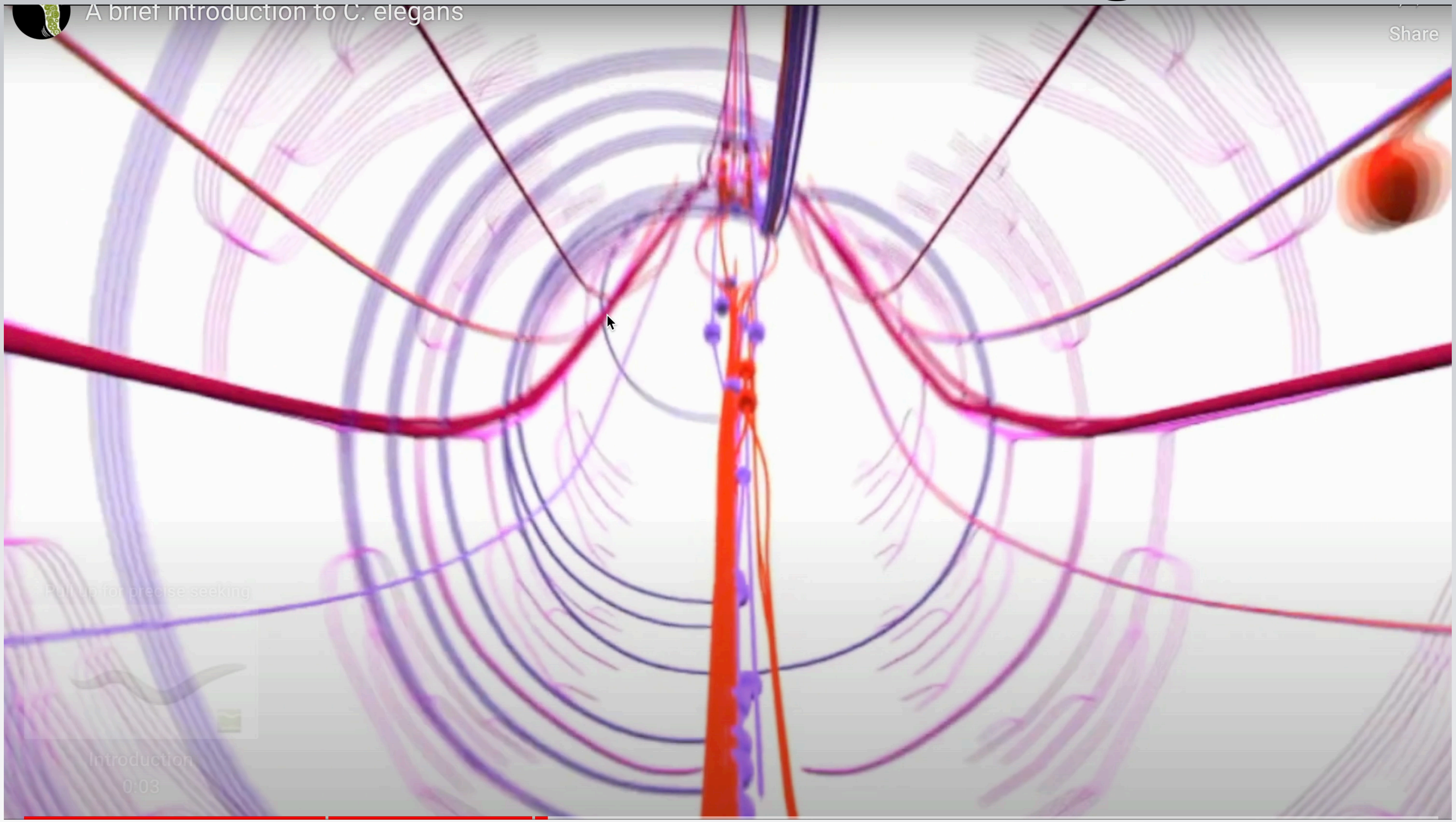
1. To understand a human brain
2. To reduce animal experimentation
3. To study mental disorder

https://www.ted.com/talks/henry_markram_a_brain_in_a_supercomputer?subtitle=en brain: ~86 000 000 000 neurons, up to 10 000 connections each



Piotr Durka, https://brain.fuw.edu.pl/edu/index.php/TI/Sztuczna_Inteligencja

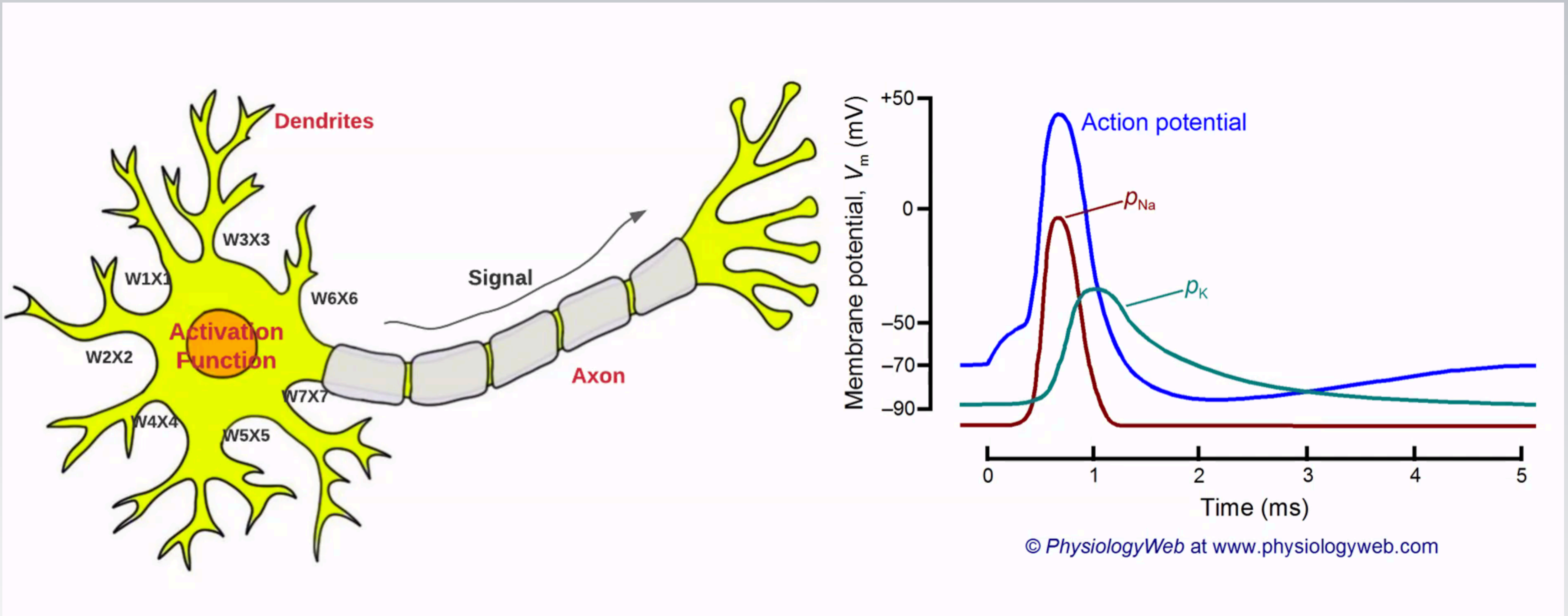
Caenorhabditis elegans



https://openworm.org/getting_started.html

The body consists of 959 somatic cells, of which 302 are neurons.

Neuron activity

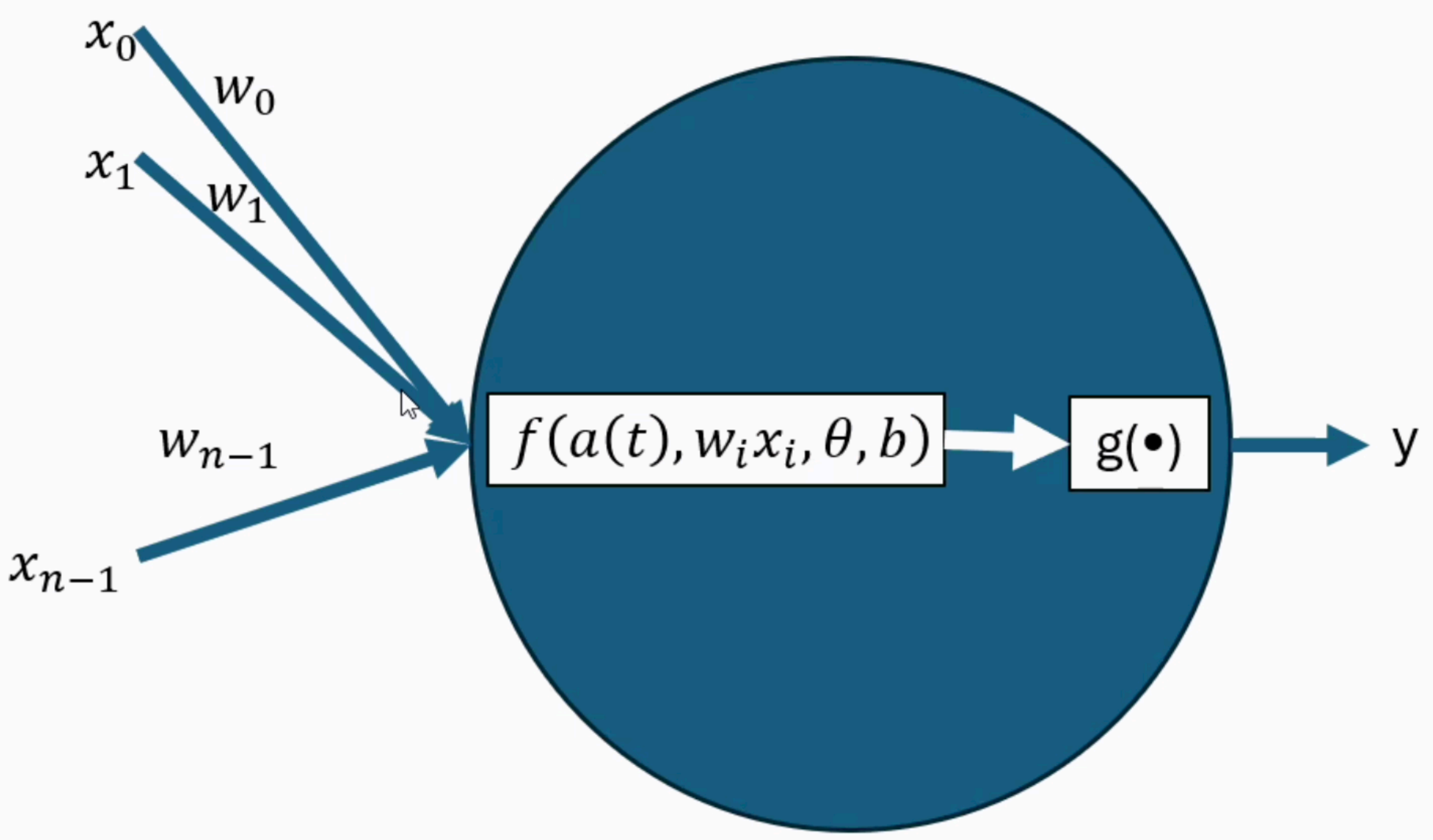


Keith Schubert, The Latest on CNN News: Understanding and Using Convolutional Neural Networks

Artificial neuron activity

- Inputs, x_i
- Output, y
- Activation function, f
- Activation(state), a
- Bias, b
- Threshold, θ

$$a(t+1) = f(a(t), w_i x_i, \theta, b)$$
$$y = g(a(t))$$



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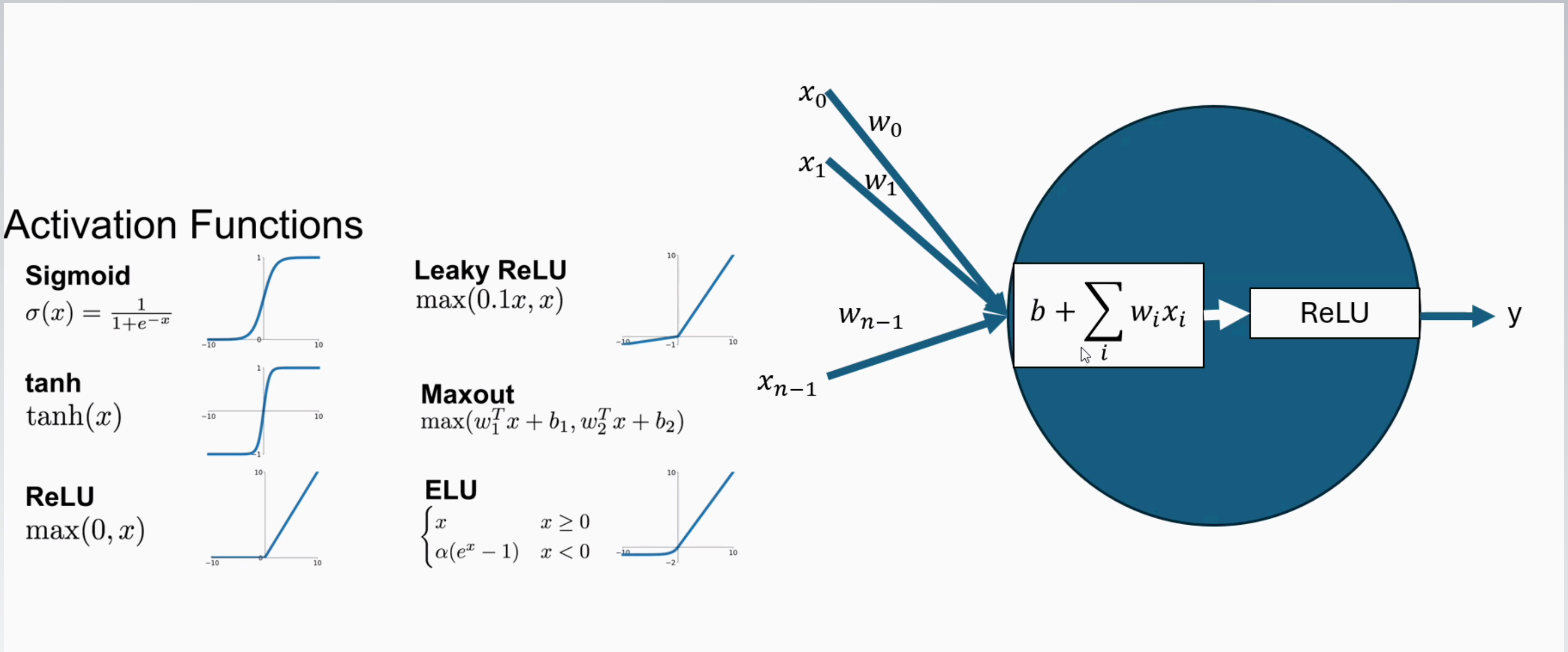
Activation functions



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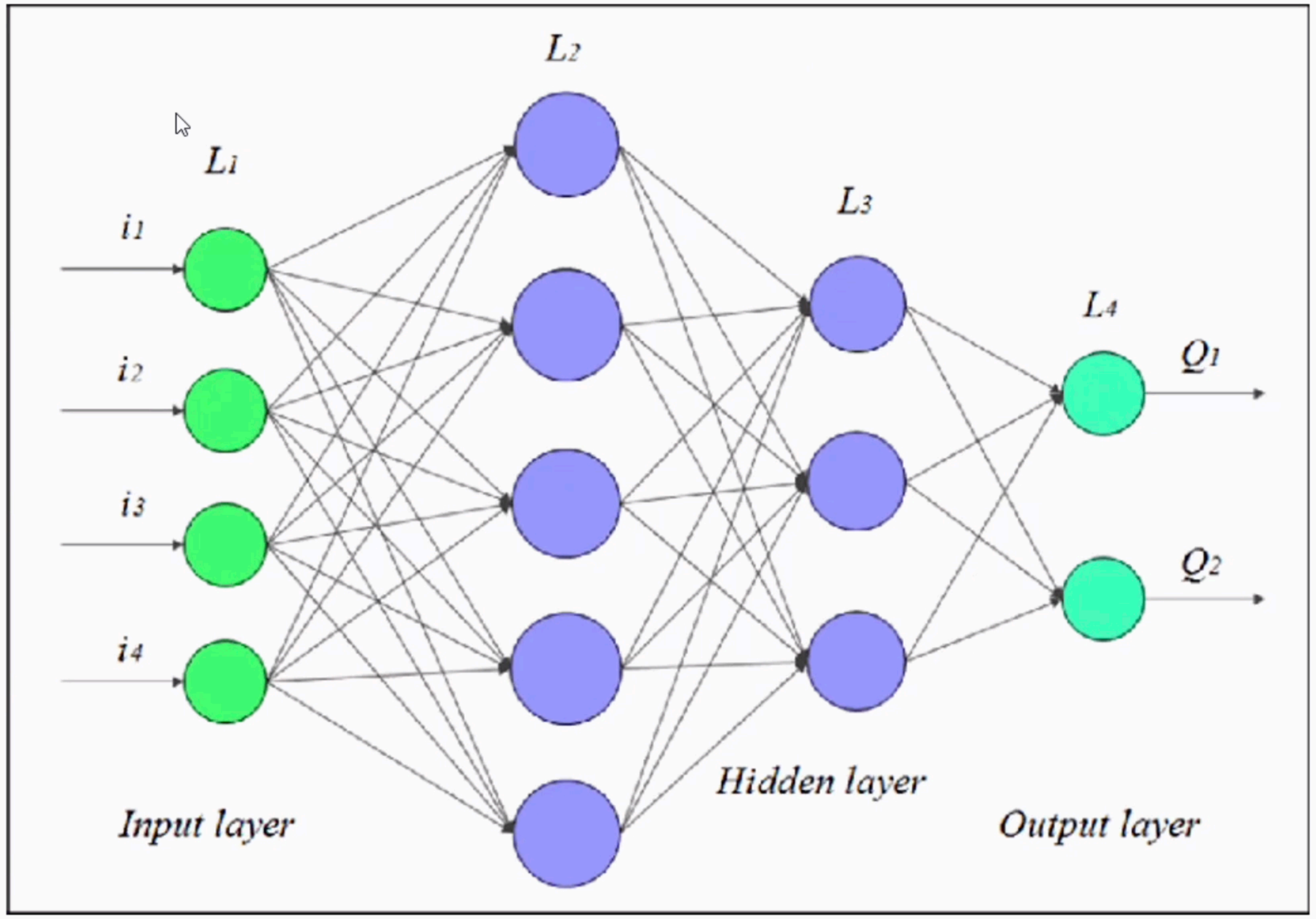
Neural network

- Matrix multiply at each layer
  $L_i = f(W_{\{i-1\}} L_{\{i-1\}})$
- Dense vs Sparse



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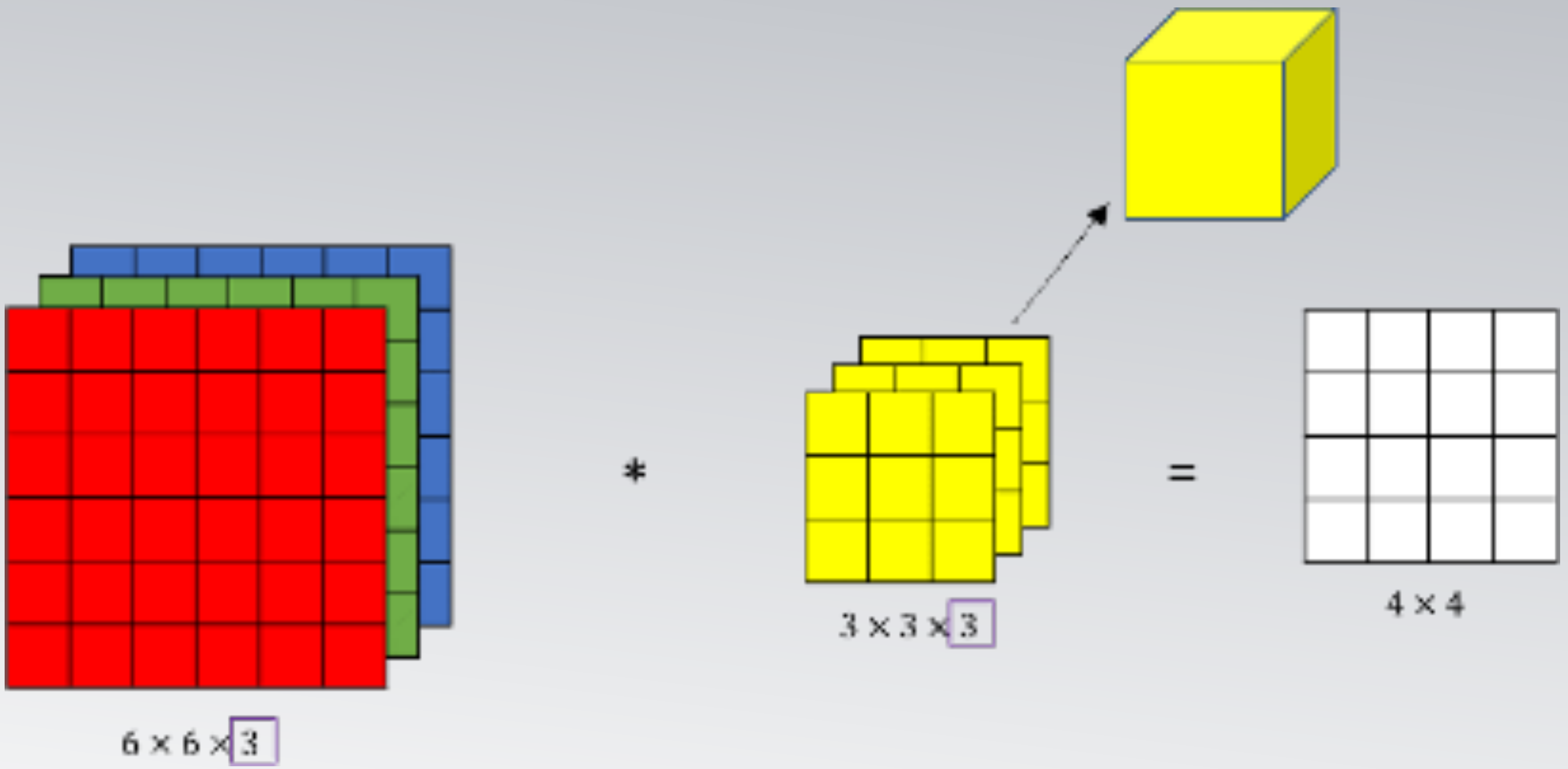
Convolutional Neural Network (CNN)



Convolution operations

$$\begin{bmatrix} 0 & 1 & 2 & 4 \\ 2 & 5 & 6 & 9 \\ 1 & 3 & 2 & 6 \\ 0 & 2 & 4 & 1 \end{bmatrix} * \begin{bmatrix} .2 & .2 & .1 \\ 0 & .3 & 0 \\ 0 & .2 & 0 \end{bmatrix} = \begin{bmatrix} \; & \; \\ \; & \; \end{bmatrix}$$

Keith Schubert, The Latest on CNN News: Understanding and Using Convolutional Neural Networks

Convolution operations

$$\begin{bmatrix} 0 & 1 & 2 & 4 \\ 2 & 5 & 6 & 9 \\ 1 & 3 & 2 & 6 \\ 0 & 2 & 4 & 1 \end{bmatrix} * \begin{bmatrix} .2 & .2 & .1 \\ 0 & .3 & 0 \\ 0 & .2 & 0 \end{bmatrix} = \begin{bmatrix} 2.5 & \\ & \end{bmatrix}$$

Keith Schubert, The Latest on CNN News: Understanding and Using Convolutional Neural Networks

Convolution operations

$$\begin{bmatrix} 0 & 1 & 2 & 4 \\ 2 & 5 & 6 & 9 \\ 1 & 3 & 2 & 6 \\ 0 & 2 & 4 & 1 \end{bmatrix} * \begin{bmatrix} .2 & .2 & .1 \\ 0 & .3 & 0 \\ 0 & .2 & 0 \end{bmatrix} = \begin{bmatrix} 2.5 & 3.2 \\ & \end{bmatrix}$$

Keith Schubert, The Latest on CNN News: Understanding and Using Convolutional Neural Networks

Convolution operations

$$\begin{bmatrix}0&1&2&4\\2&5&6&9\\1&3&2&6\\0&2&4&1\end{bmatrix} * \begin{bmatrix}.2&.2&.1\\0&.3&0\\0&.2&0\end{bmatrix} = \begin{bmatrix}2.5&3.2\\3.3&\end{bmatrix}$$

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Convolution operations

$$\begin{bmatrix} 0 & 1 & 2 & 4 \\ 2 & 5 & 6 & 9 \\ 1 & 3 & 2 & 6 \\ 0 & 2 & 4 & 1 \end{bmatrix} * \begin{bmatrix} .2 & .2 & .1 \\ 0 & .3 & 0 \\ 0 & .2 & 0 \end{bmatrix} = \begin{bmatrix} 2.5 & 3.2 \\ 3.3 & 4.5 \end{bmatrix}$$

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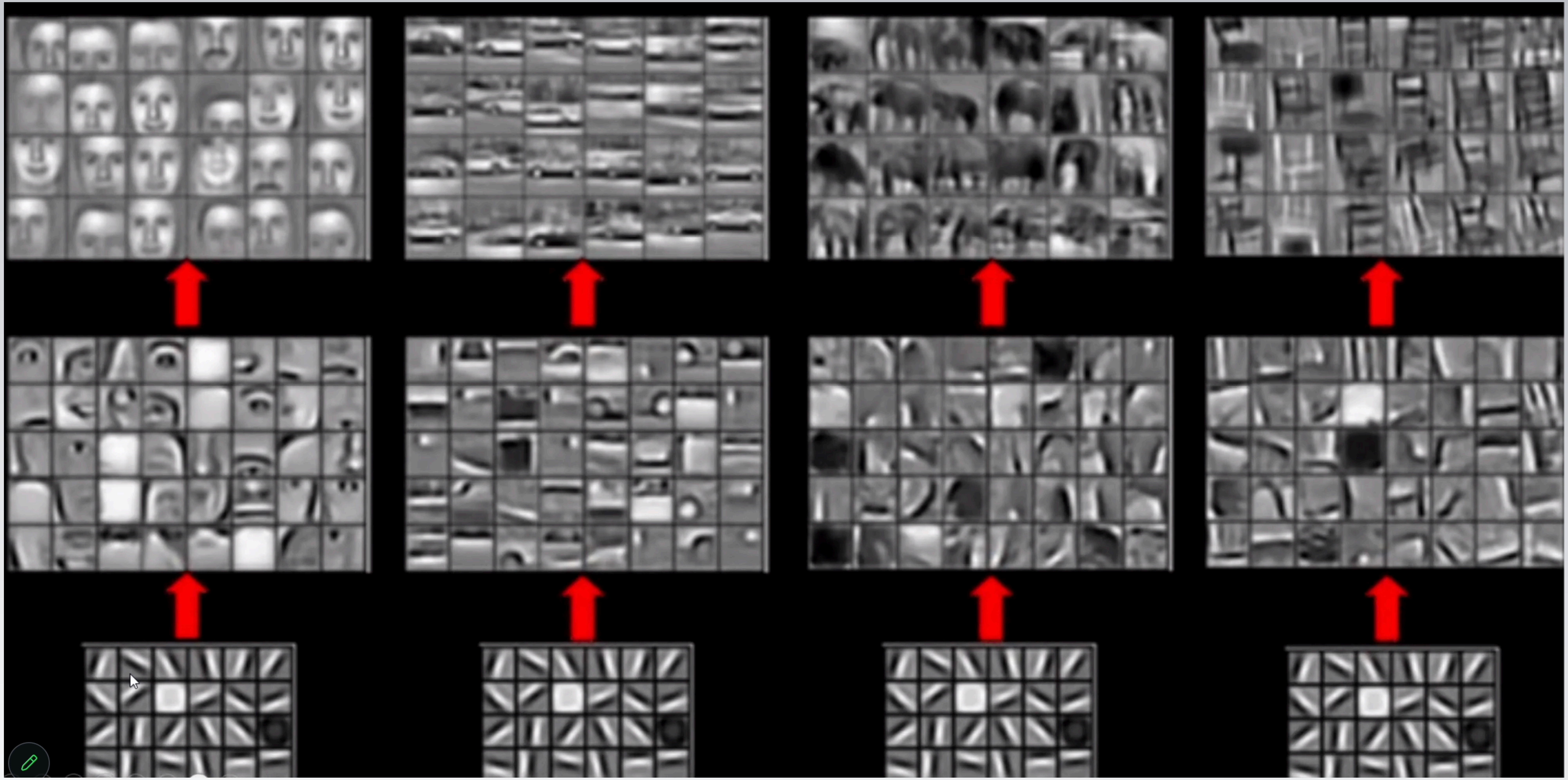
Image convolution



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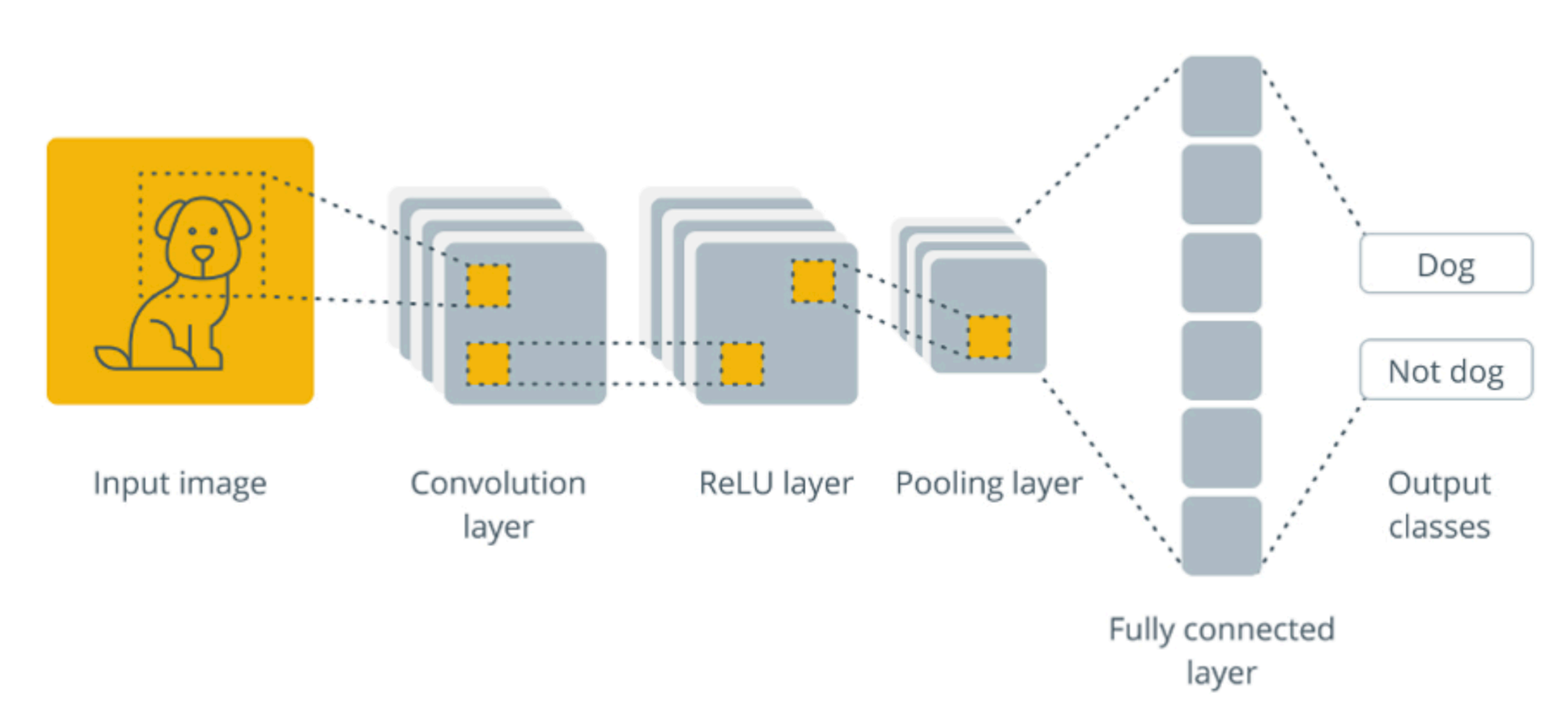
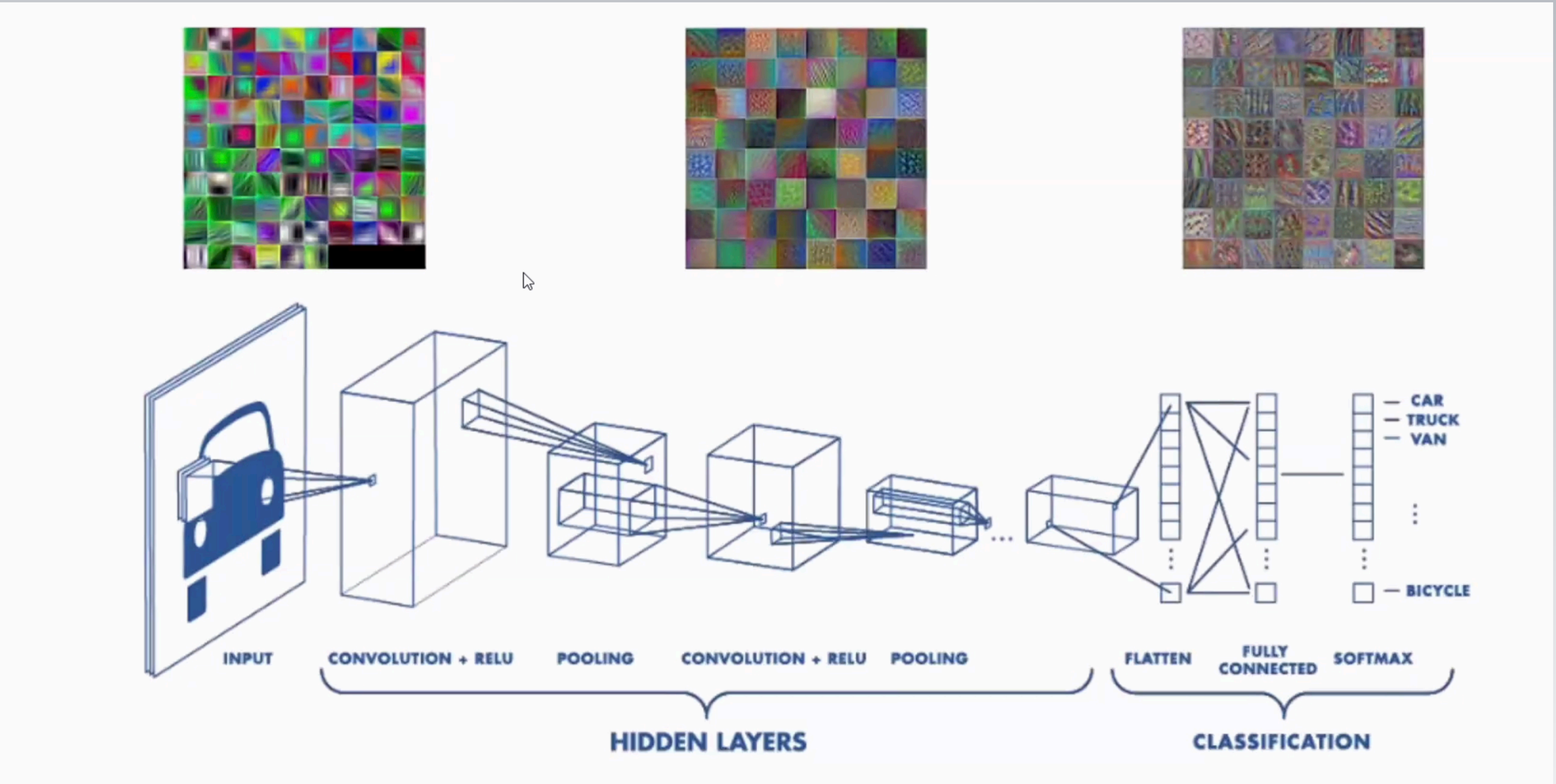
Convolutional Neural Network (CNN)



https://skyengine.ai/se/skyengine-blog/125-what-is-a-convolutional-neural-network

Network architecture



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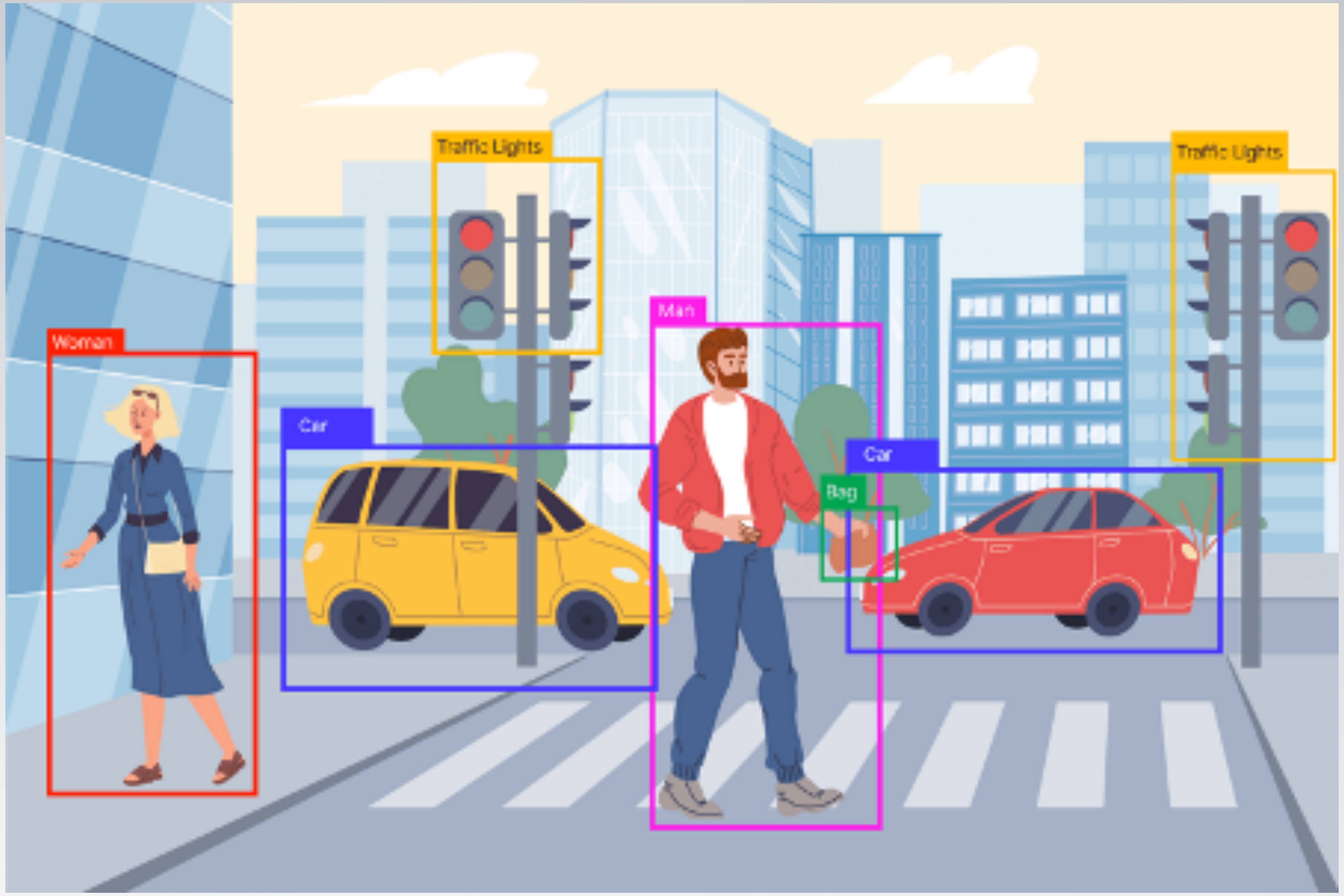
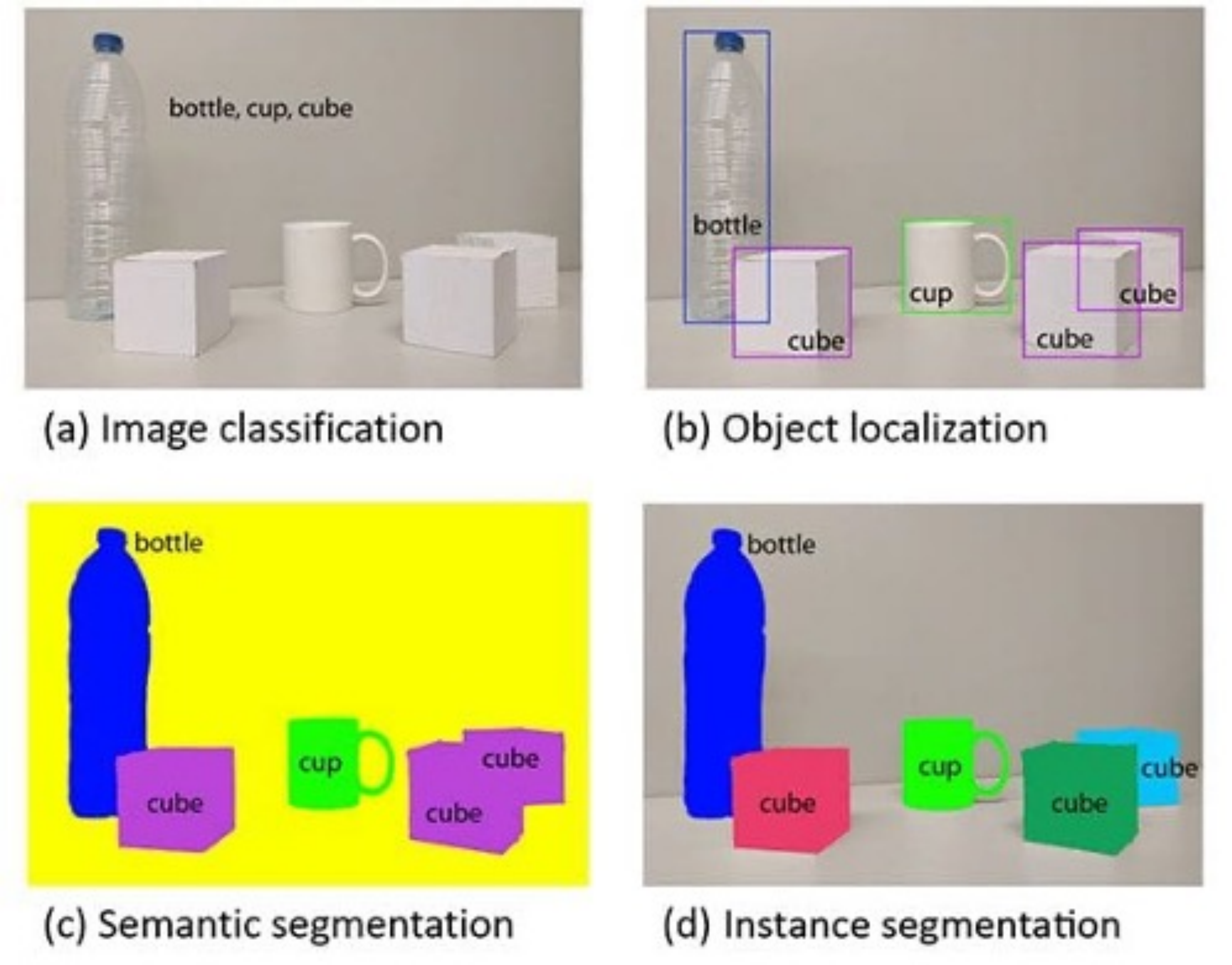
Object classification

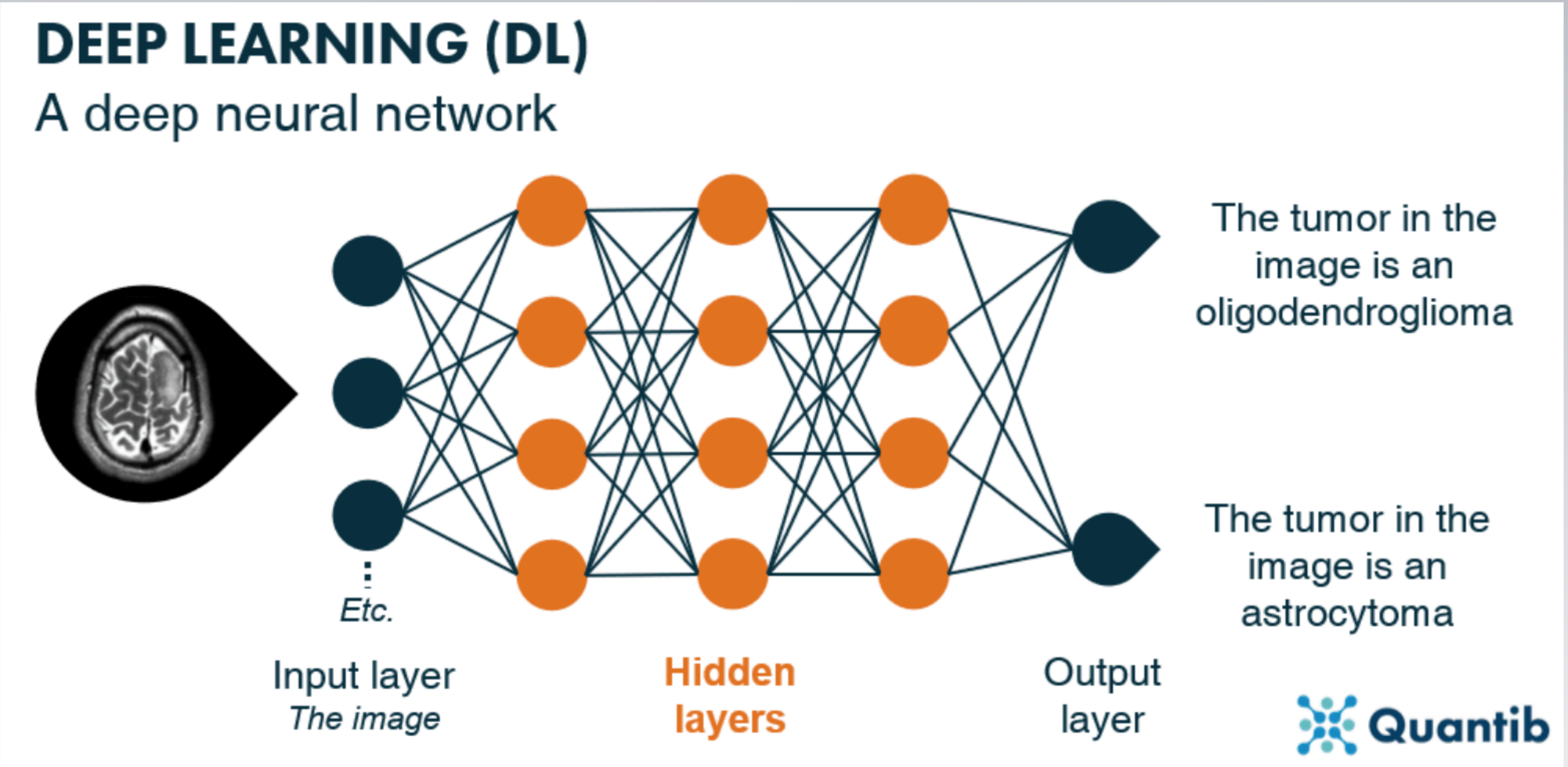




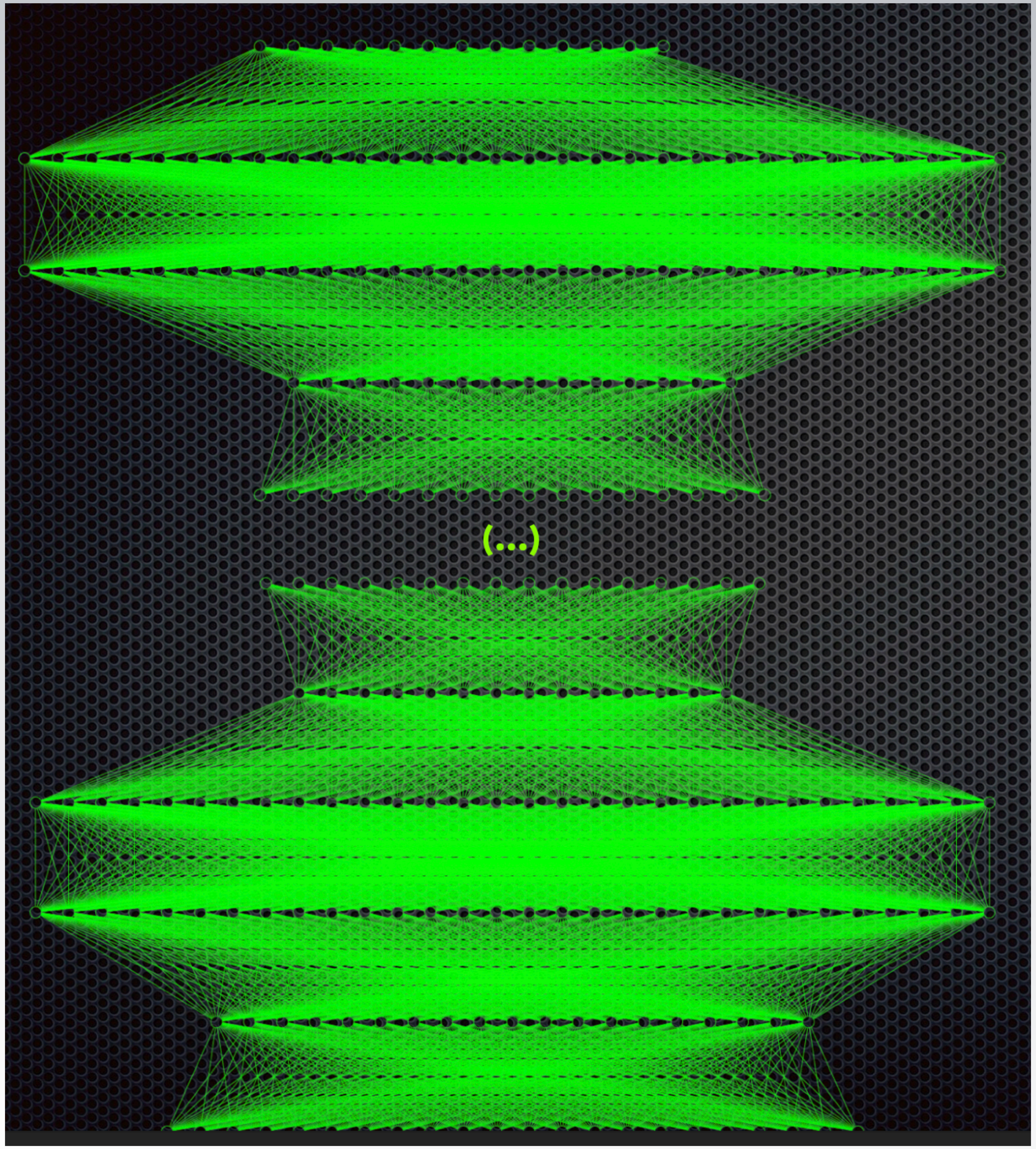
(a) Image classification (b) Object localization

(c) Semantic segmentation (d) Instance segmentation

Object classification



Deep learning

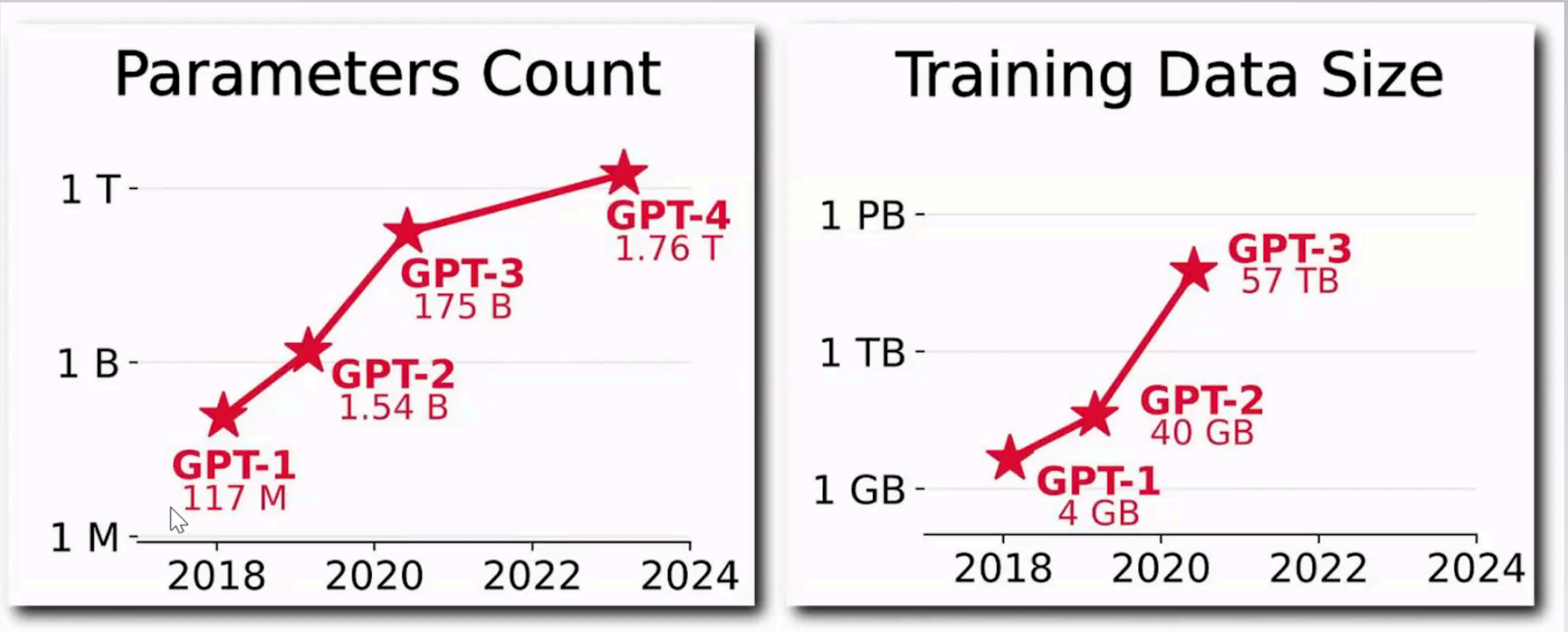


to ‘remember and recognise’ more than a few patterns

neural network must have more parameters (connection weights)

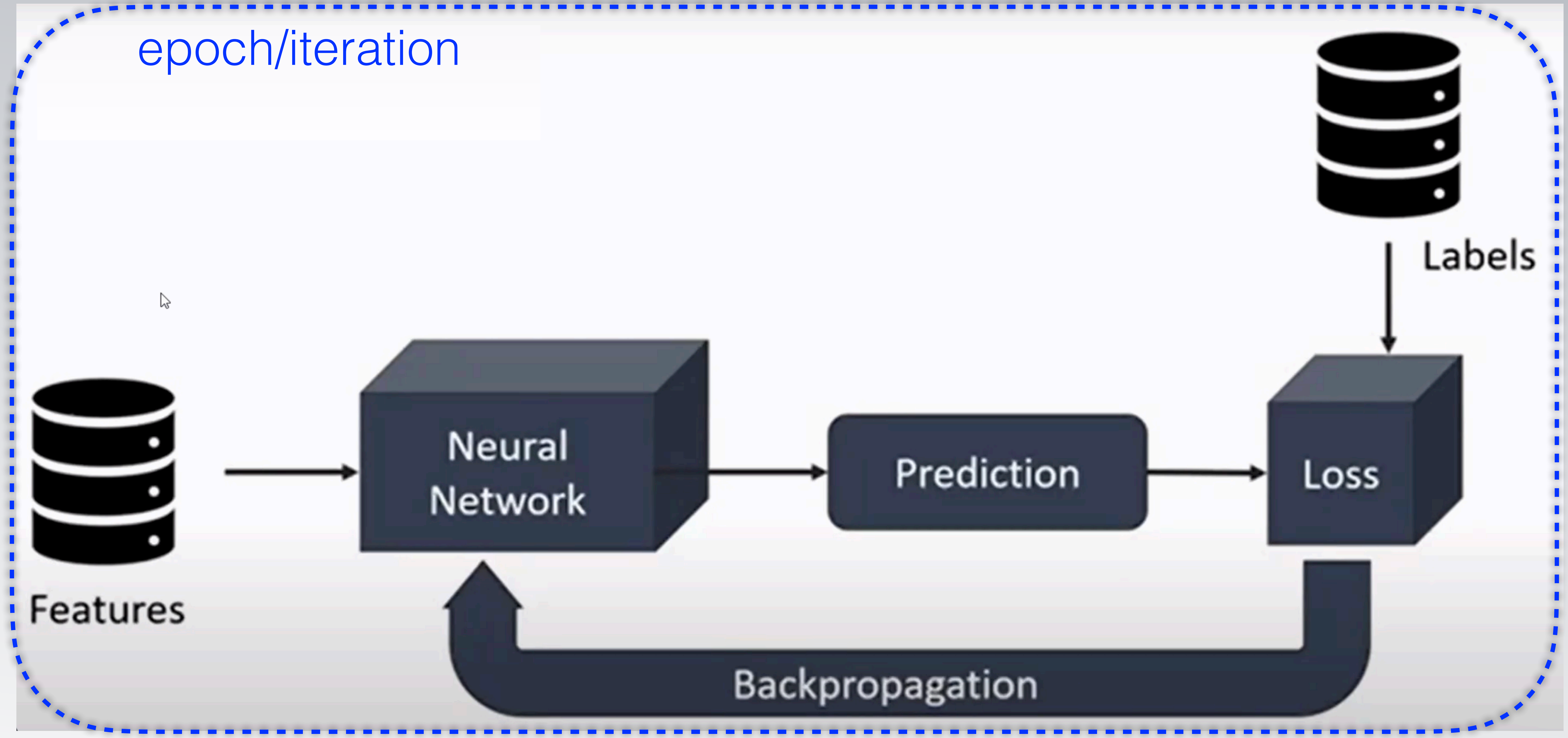
Model parameters

Model parameters



Lei Xing, The Role of AI in Clinical Radiation Oncology

Training cycle



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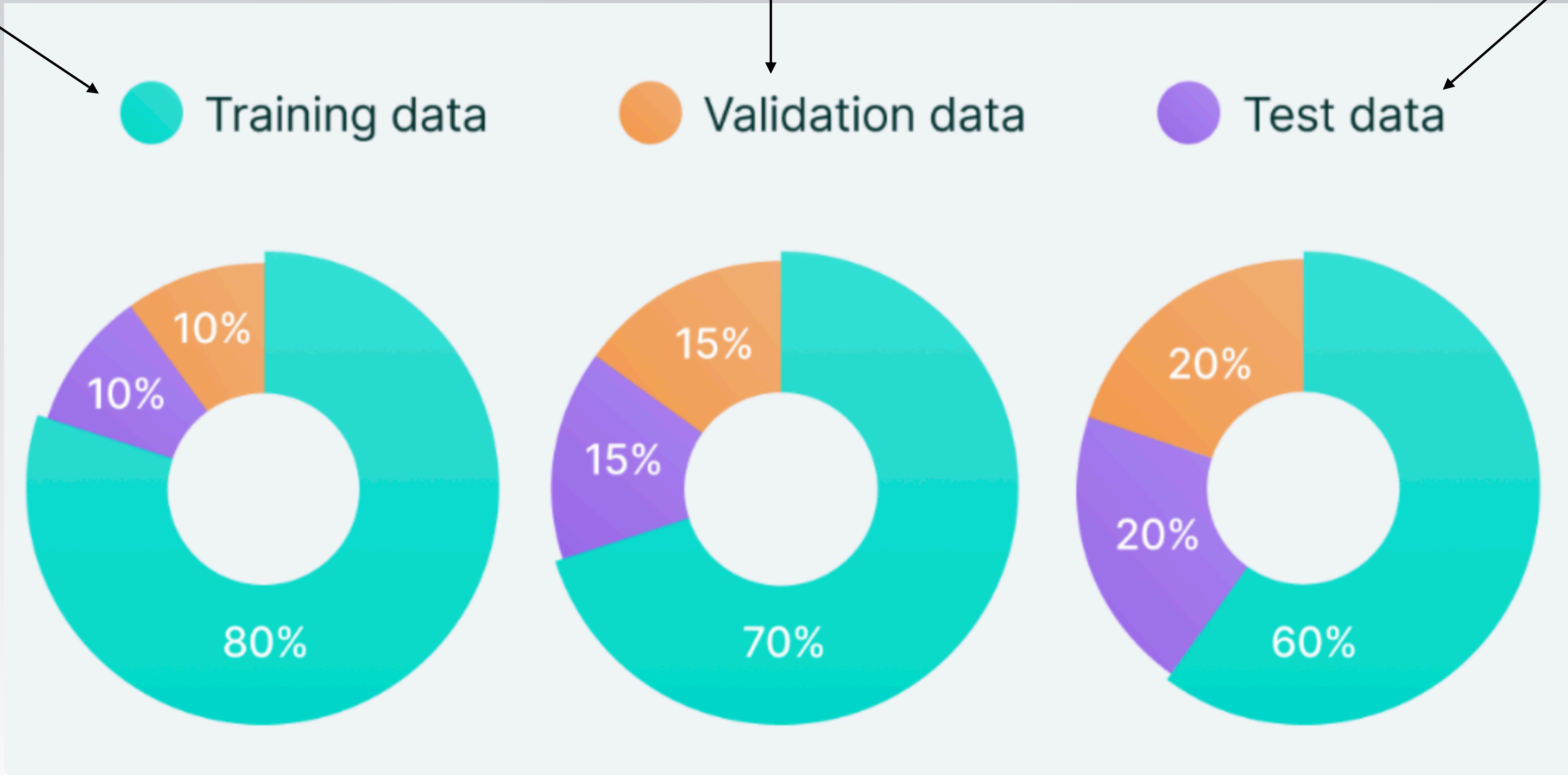
Data and training

to train the model

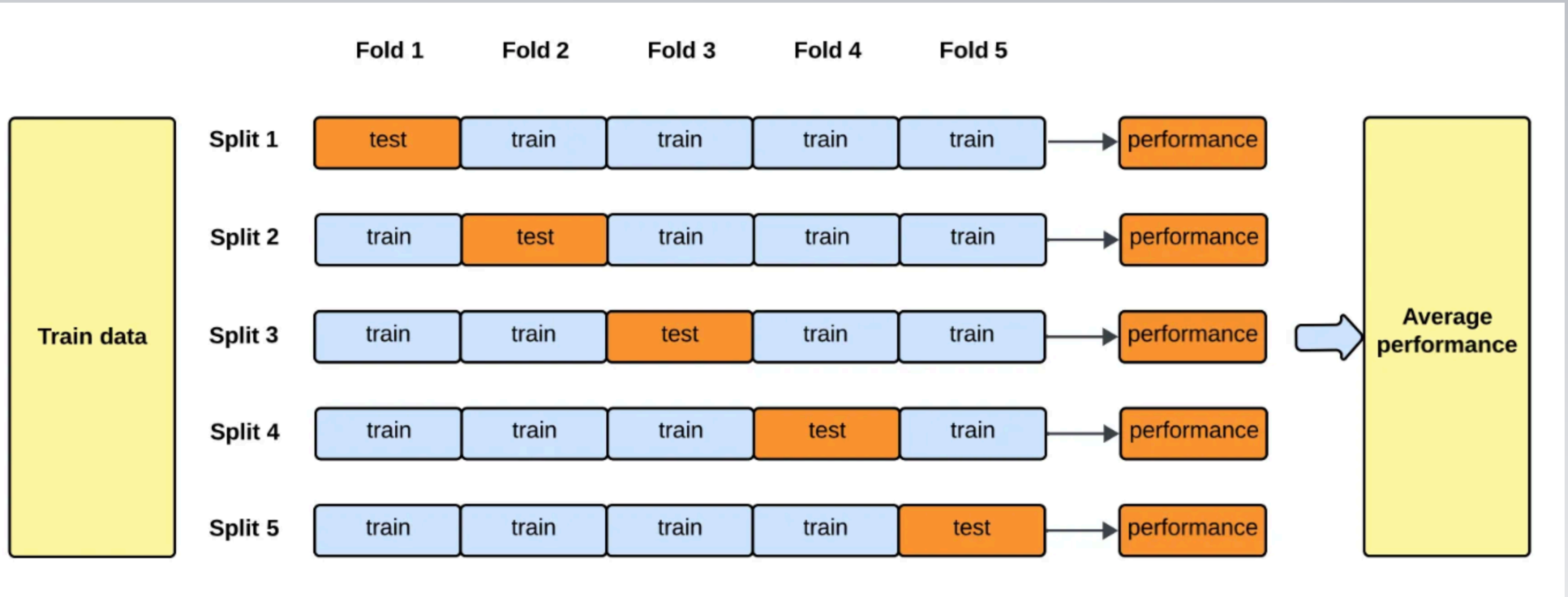
to track model parameters and avoid overfitting

to check the model performance on new data



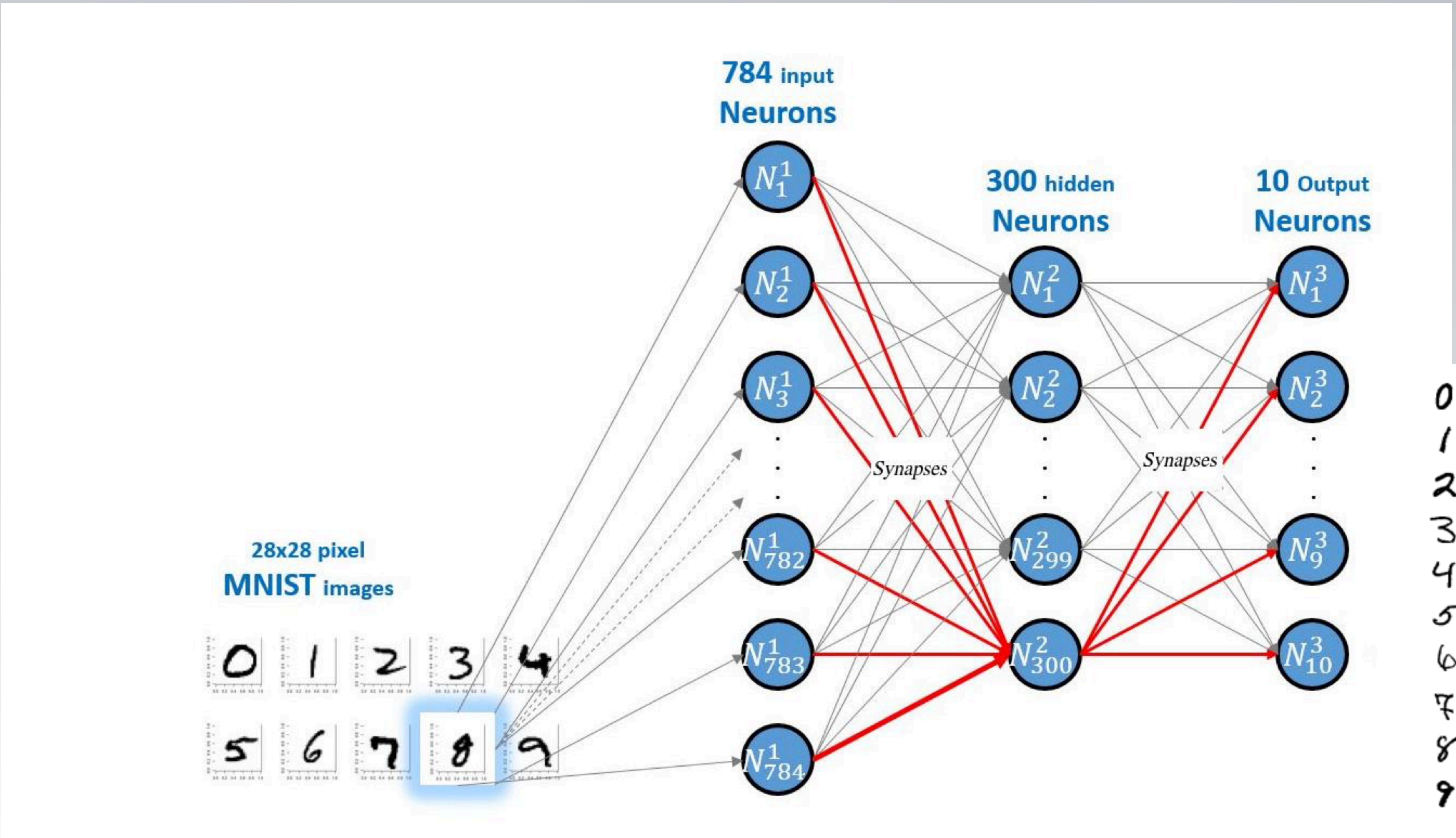
https://www.analyticsvidhya.com/blog/2023/11/train-test-validation-split/

K-fold cross-validation



https://towardsdatascience.com/how-to-cross-validation-with-time-series-data-9802a06272c6

Simple example



Modified National Institute of Standards and Technology (MNIST): database of handwritten digits

Nassim Abderrahmane. Hardware design of spiking neural networks for energy efficient brain- inspired computing. Artificial Intelligence [cs.AI]. Université Côte d'Azur, 2020. English. NNT: 2020COAZ4082

Simple example

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Alexamples / SimpleMnist.ipynb

bbrzozowska Add files via upload aba6c80 · 1 hour ago History

Preview Code Blame 75 lines (75 loc) · 2.15 KB Code 55% faster with GitHub Copilot Raw

Open in Colab

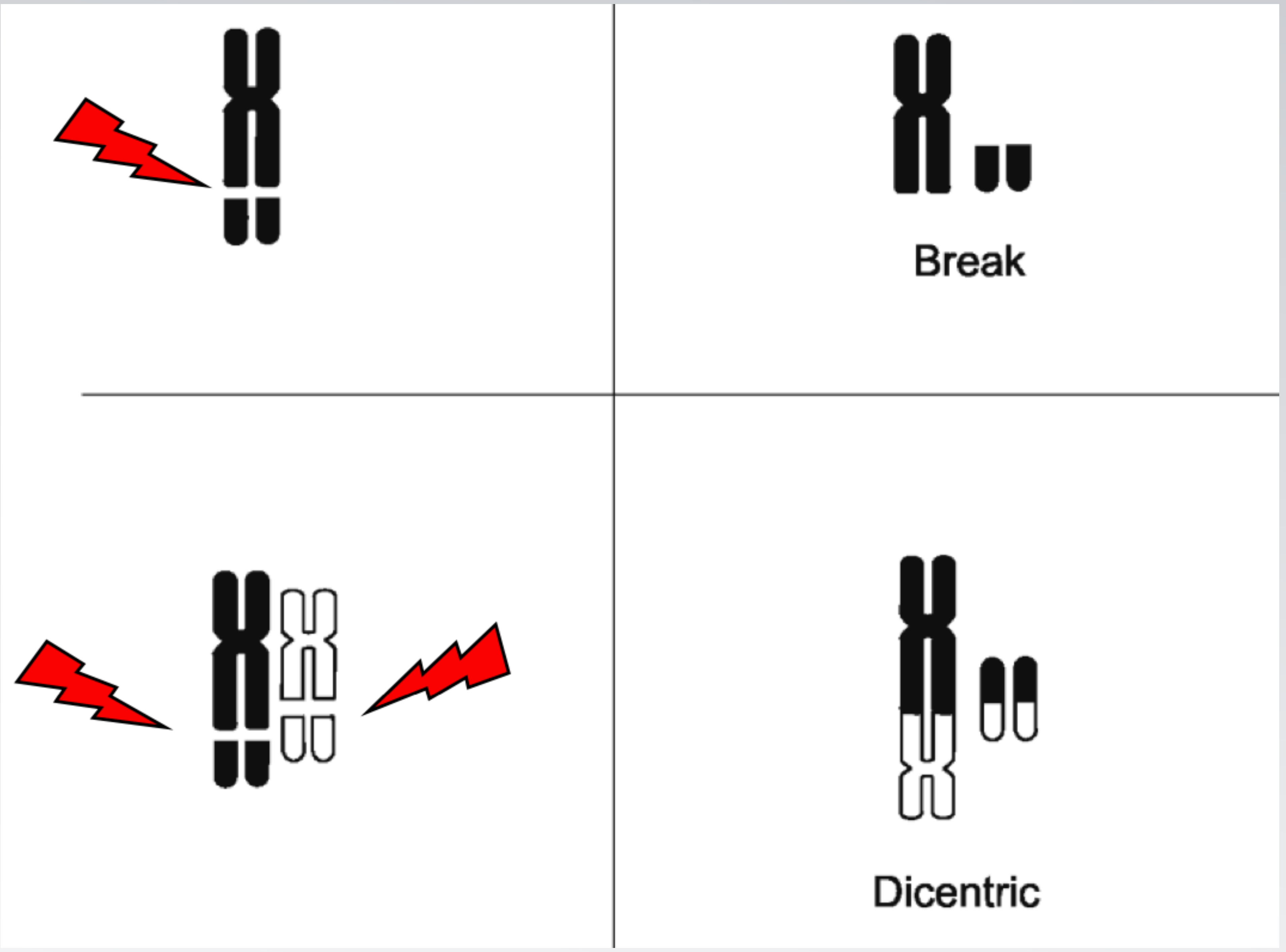
In [ ]:

```python
import tensorflow as tf
mnist=tf.keras.datasets.mnist
(x_train,y_train),(x_test,y_test)=mnist.load_data()
x_train,x_test=x_train/255.0,x_test/255.0
model=tf.keras.models.Sequential([
    tf.keras.layers.Flatten(input_shape=(28,28)),
    tf.keras.layers.Dense(128,activation='relu'),
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(10)
])
model.compile(optimizer='adam',
              loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])
model.fit(x_train, y_train, epochs=5)
model.evaluate(x_test,y_test,verbose=2)
probability_model=tf.keras.Sequential([
    model,
    tf.keras.layers.Softmax()
])
predictions=probability_model(x_test)
```

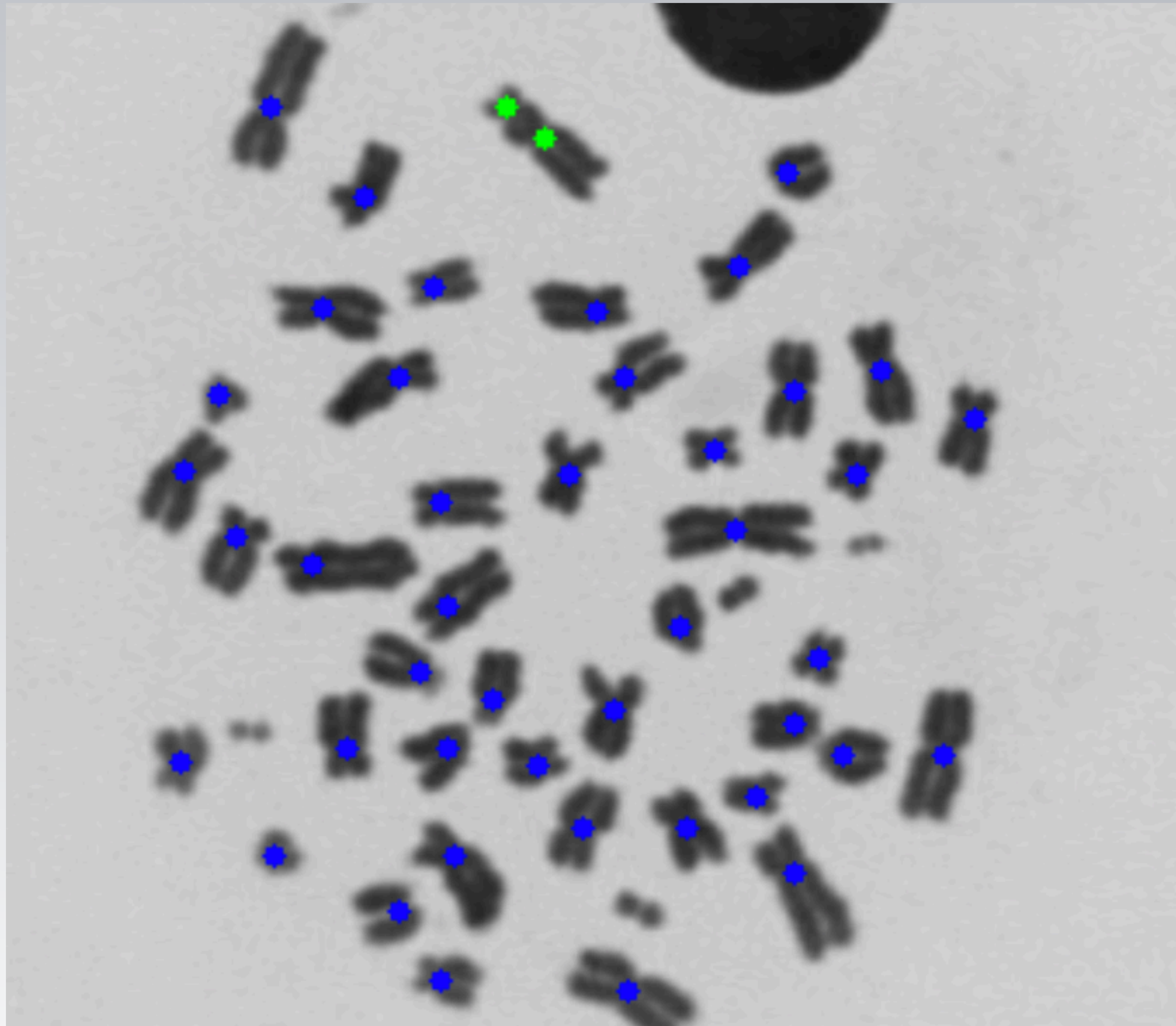
In [ ]:

```python
import matplotlib.pyplot as plt
```

More sophisticated example: dicentrics

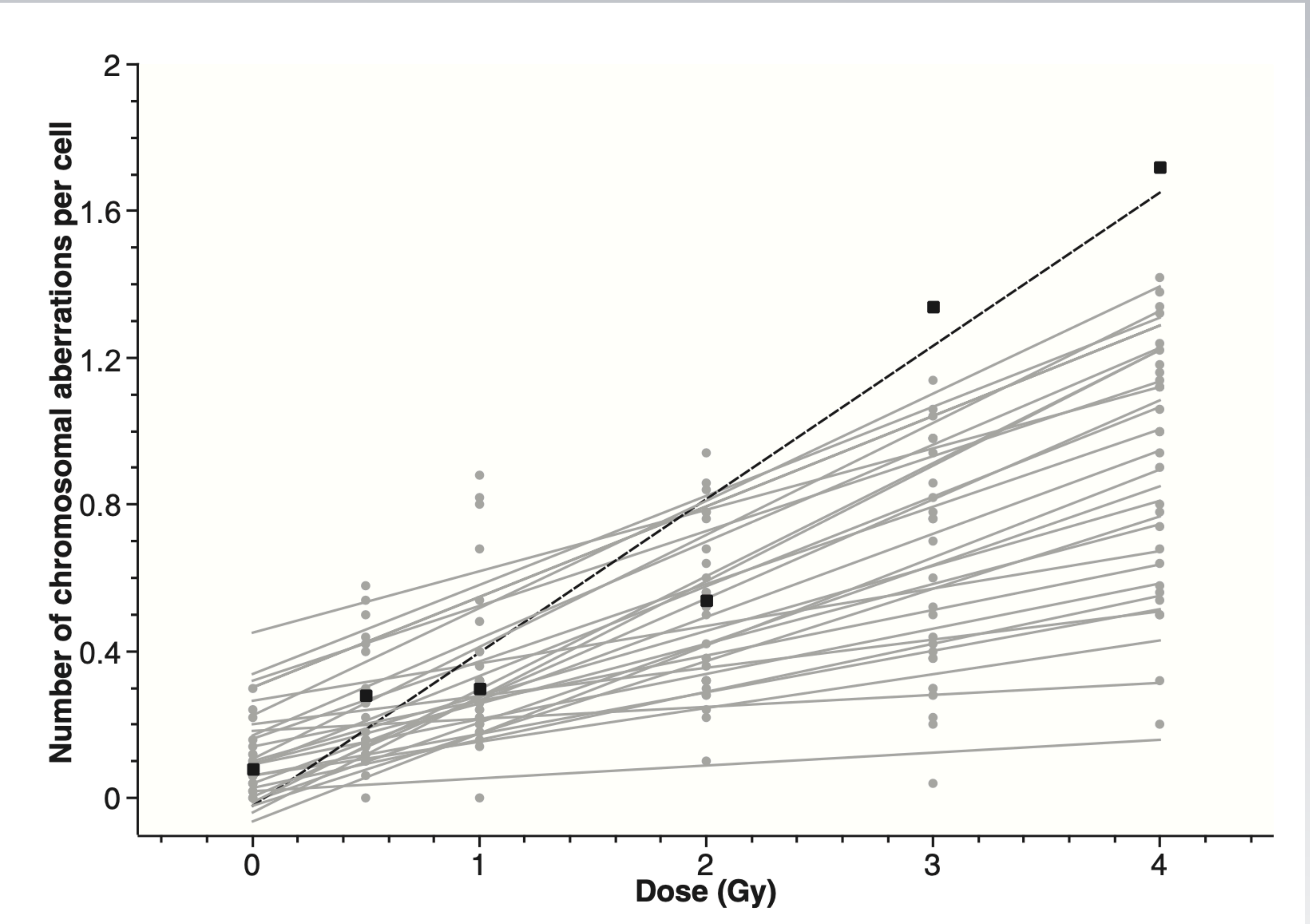


Courtesy of A. Wojcik



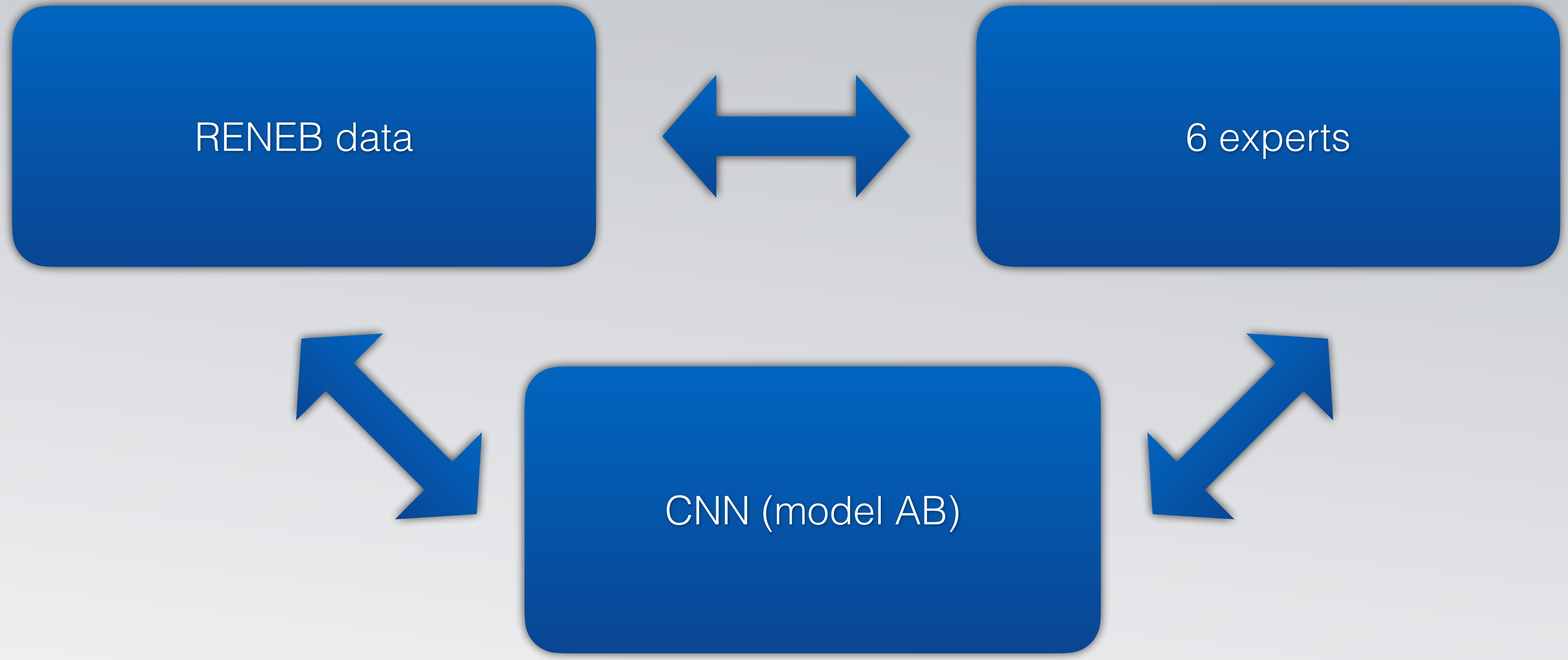
Courtesy of M. Głowacki

Precision of scoring chromosomal aberrations by CELOD participants



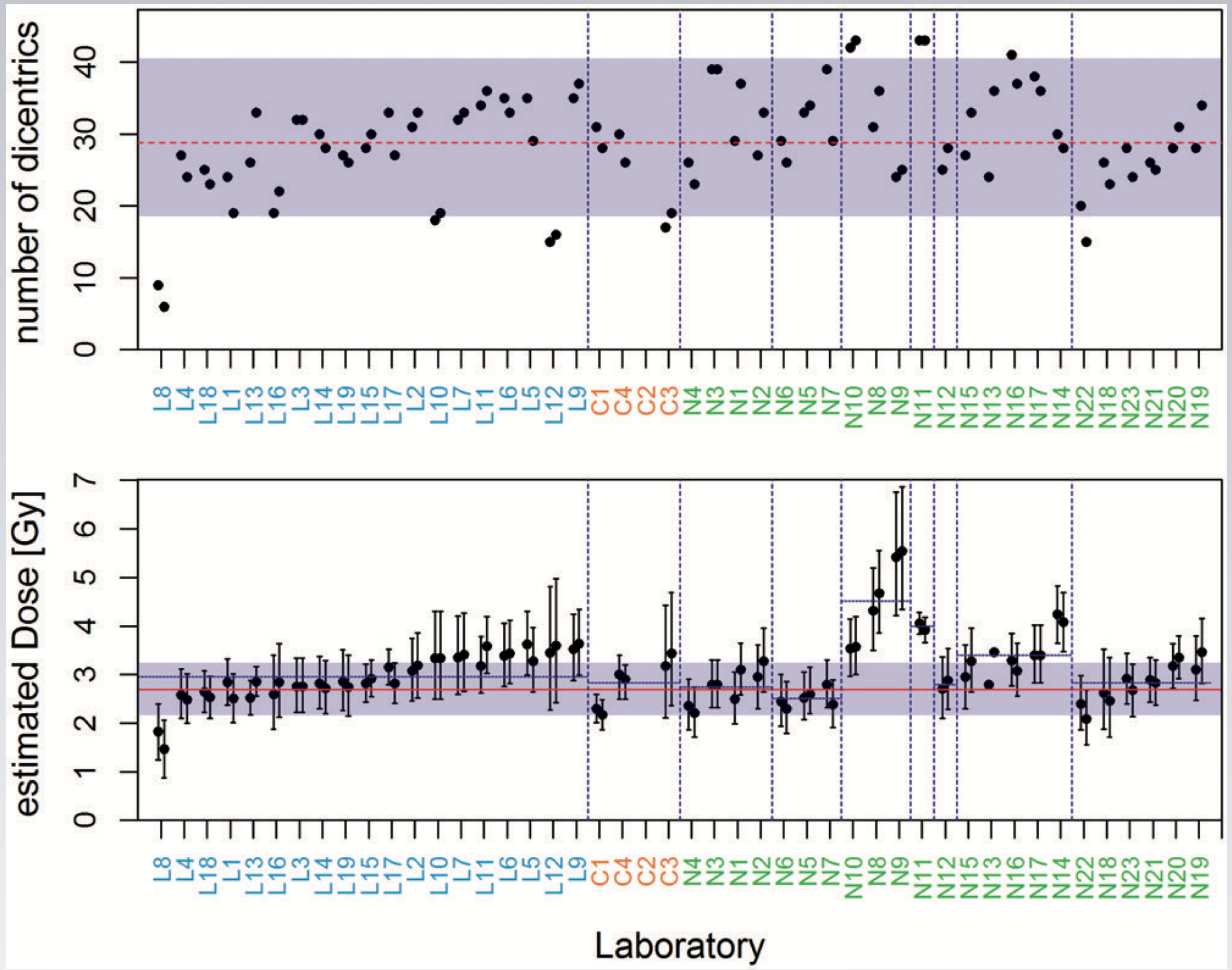
Gałecki et al. Precision of scoring radiation-induced chromosomal aberrations and micronuclei by unexperienced scorers, International Journal of Radiation biology 95(9): 1251–1258, 2019

Fast and precise scoring of dicentrics



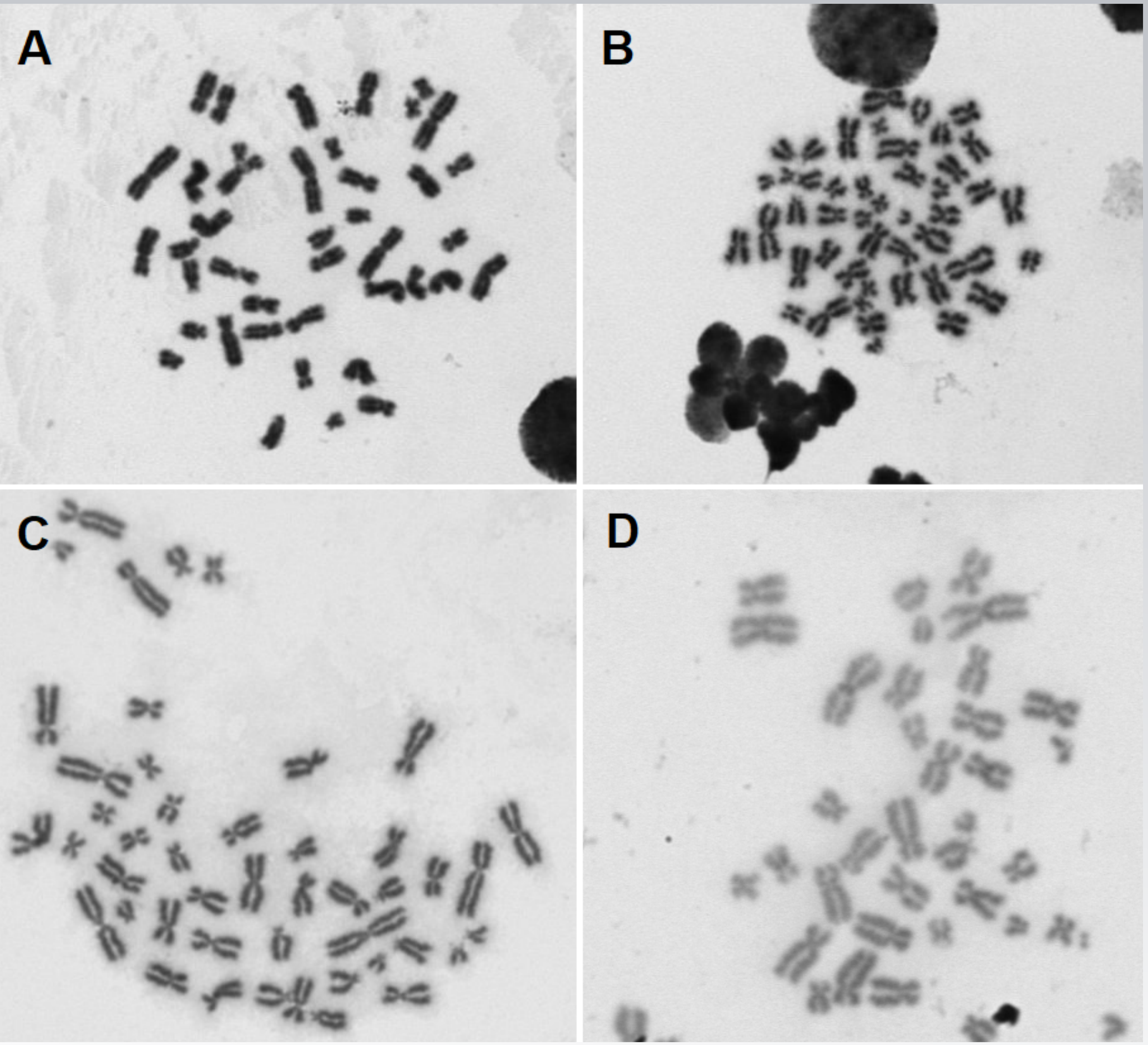
RENEB: laboratory network

- Running the European Network of Biological and retrospective Physical dosimetry (7th EU framework EURATOM Fission Programme);
- retrospective dose assessment in small-scale and large-scale nuclear & radiological emergency situations;
- assuring the high-level expertise of laboratories (intercomparison).



U. Oestreicher et al. RENEB intercomparisons applying the conventional Dicentric Chromosome Assay (DCA), International Journal of Radiation Biology 93: 20–29, 2017

Scoring DIC under the microscope



- blood samples collected from the 10 donors;
- irradiated in vitro with ^{60}Co;
- doses: 0 Gy, 0.25 Gy, 0.75 Gy, 1 Gy, 1.5 Gy, 2.5 Gy, 3 Gy, 4.5 Gy, and 5 Gy

Datasets

TRAINING set

- used for the training (including validation),
- spanning over 3000 images in total (all doses),
- 5 experts labeled the chromosomes.

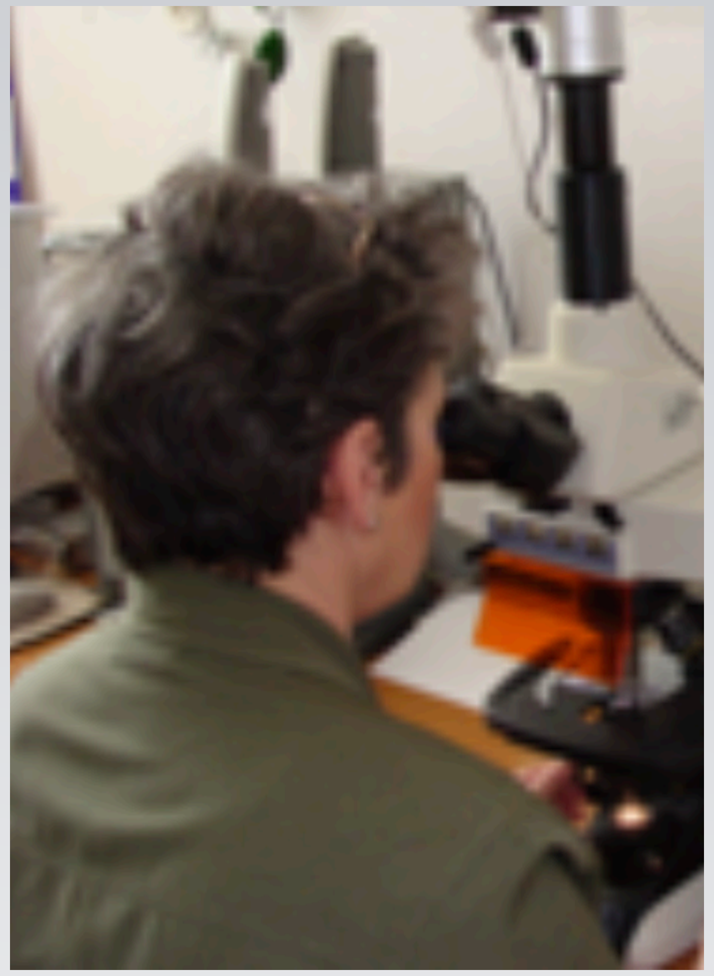
CALIBRATION set

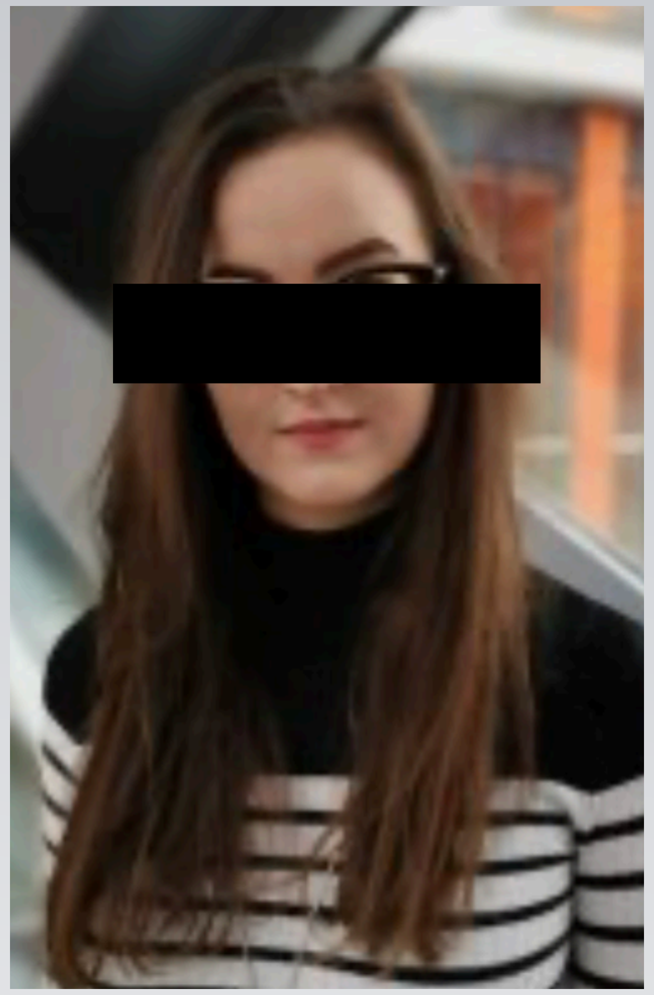
- consists of 300 images for each dose (0 Gy - 4.5 Gy),
- evaluated by an external (6th) expert,
- used to prepare a calibration curve to study the dose-response, as well as to evaluate the parameters of the final model.

TEST set

- consists of 50 images for each dose,
- no overlap with the CALIBRATION and TRAINING sets,
- evaluated by 5 experts and the model independently to assess their relative performance

Experts

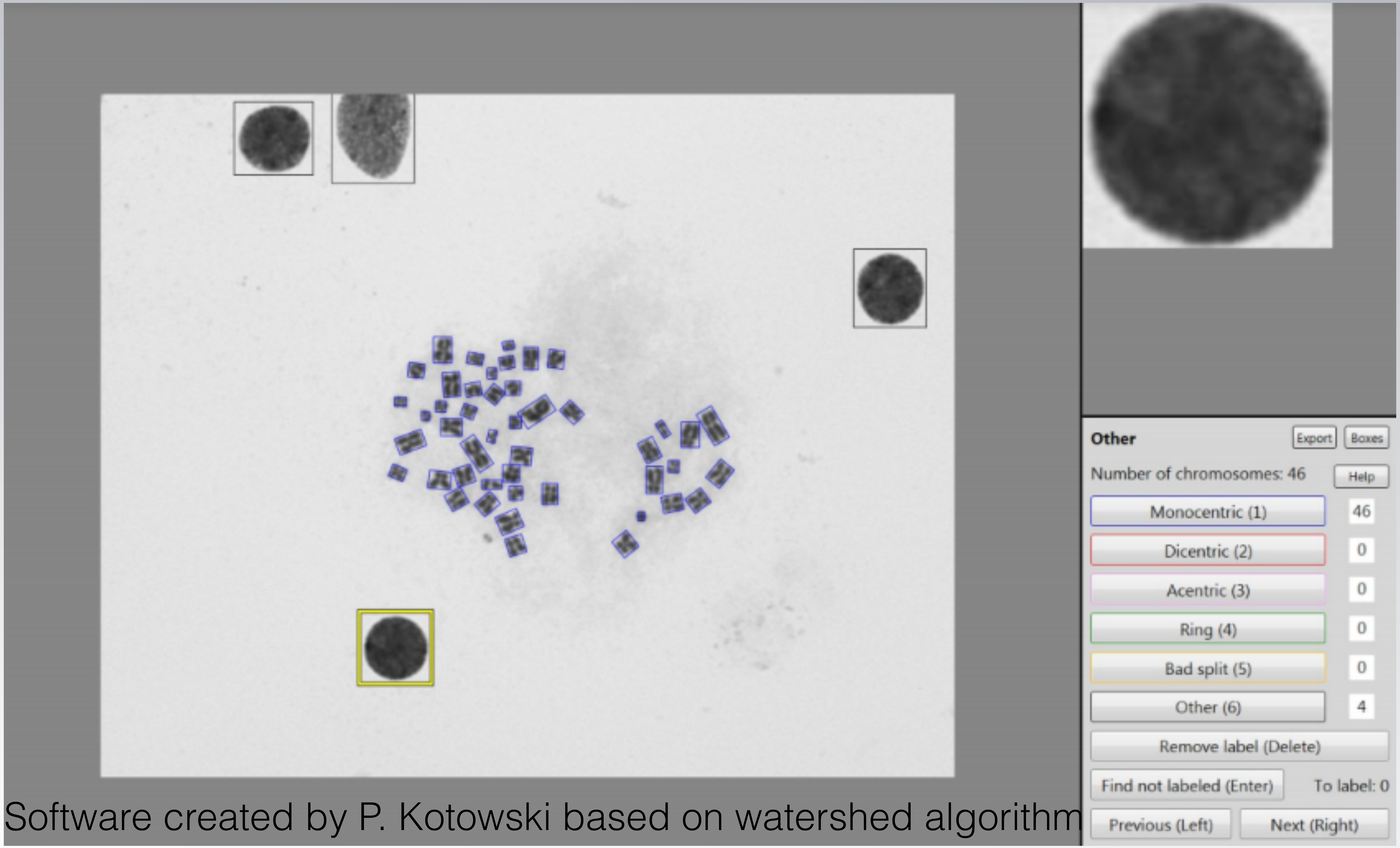





TRAINING and TEST sets (5 experts)

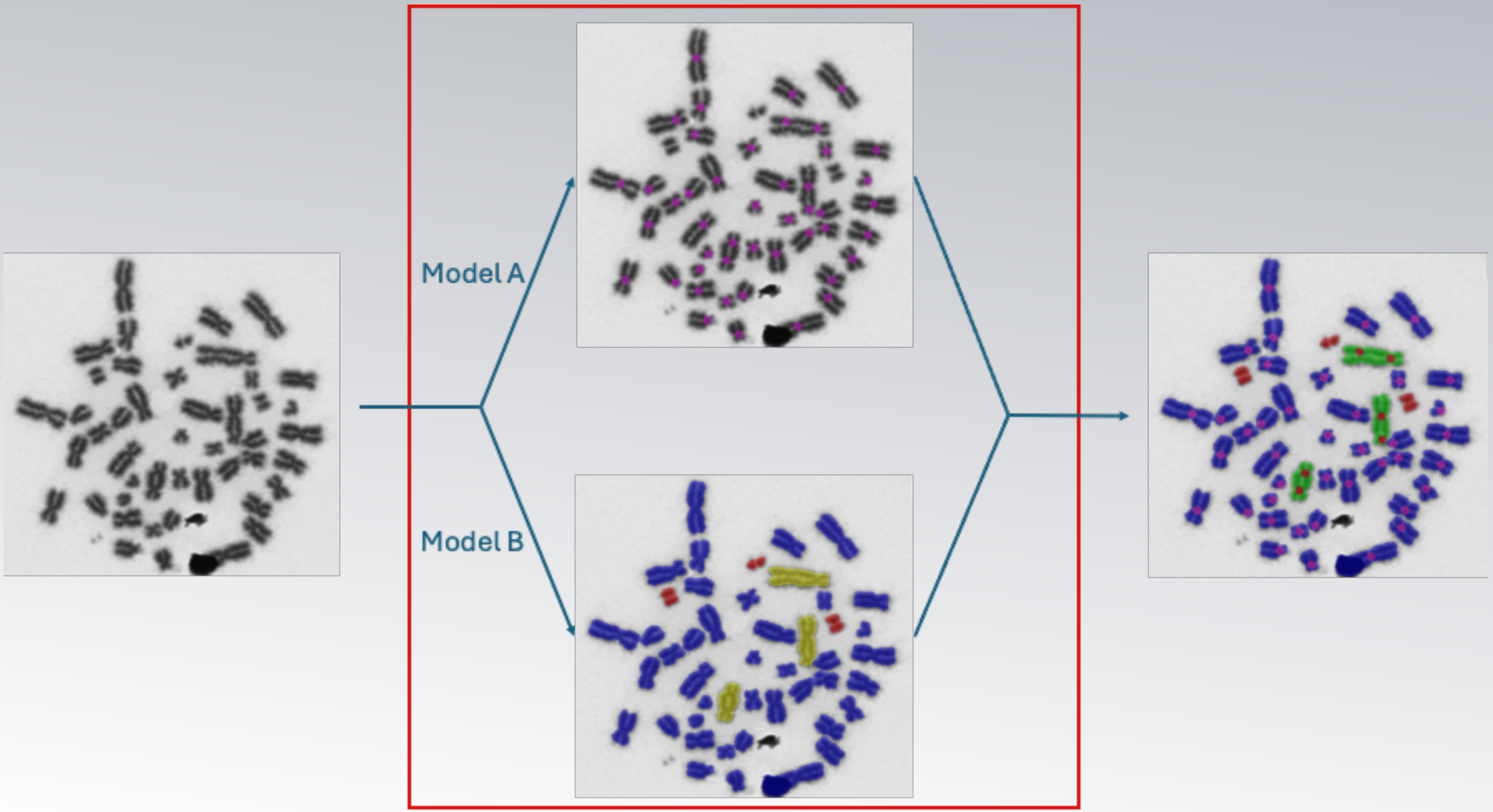
CALIBRATION set (1 expert)

Labeling by experts

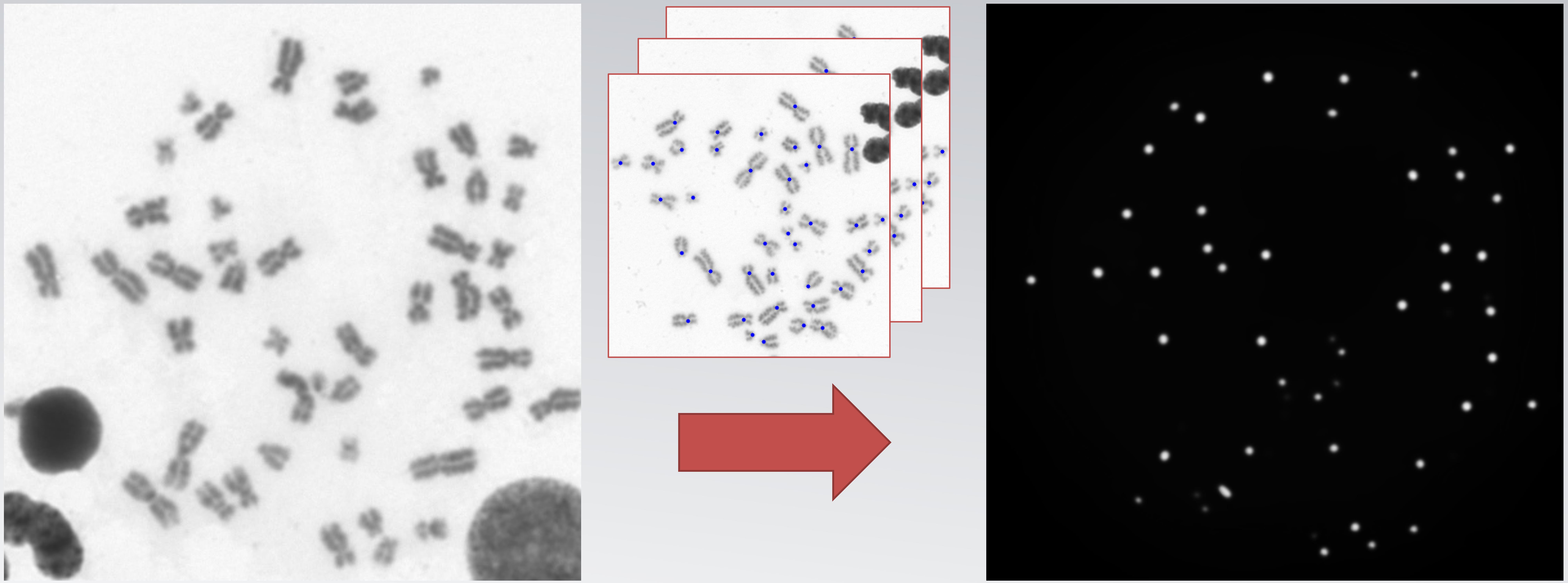


Software created by P. Kotowski based on watershed algorithm

Workflow of the model AB

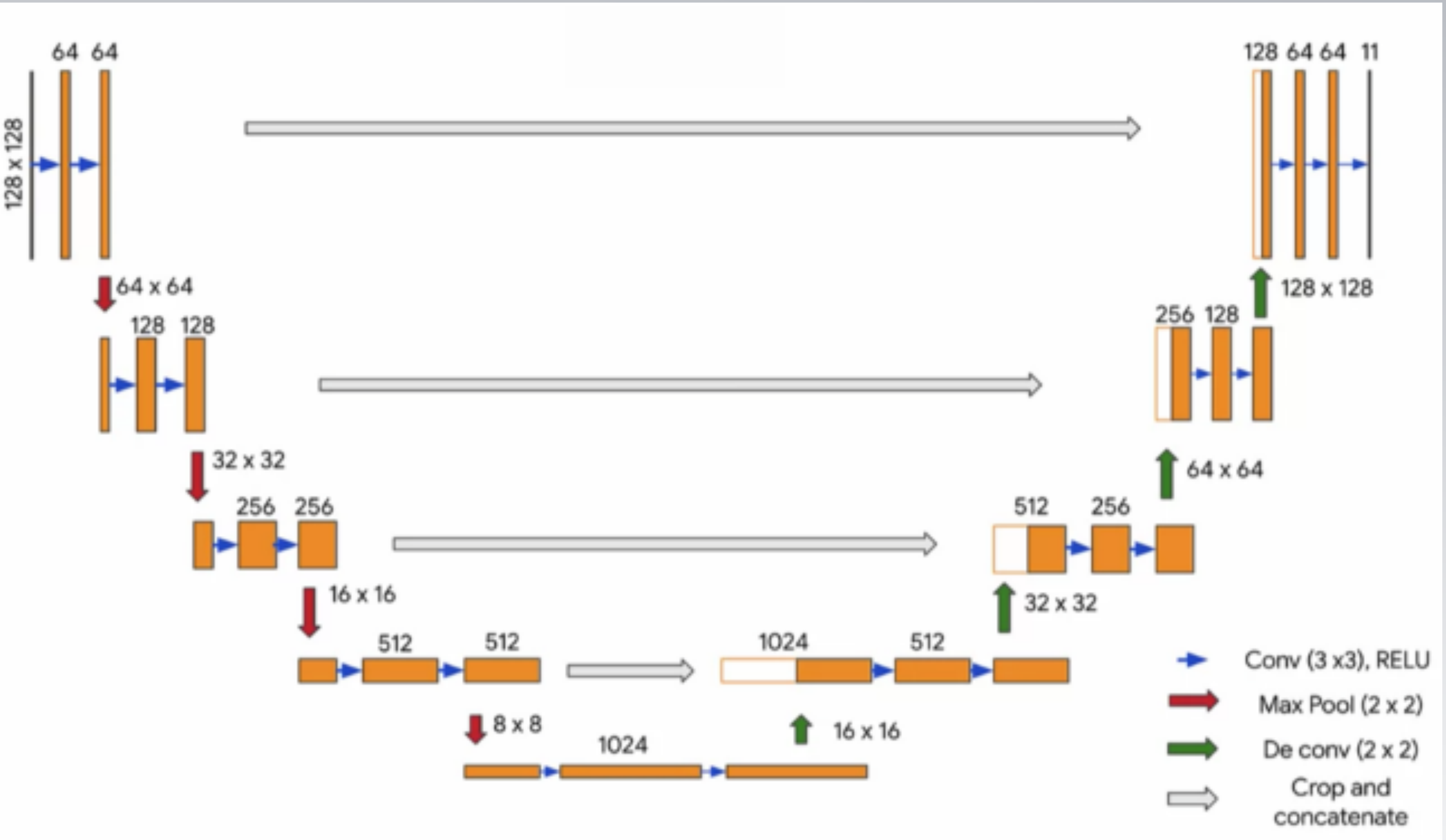


Model A: U-Net approach



M. Głowacki, Application of U-net type deep neural network in finding centromeres on microscopic images, Bachelor thesis @ University of Warsaw

U-net architecture

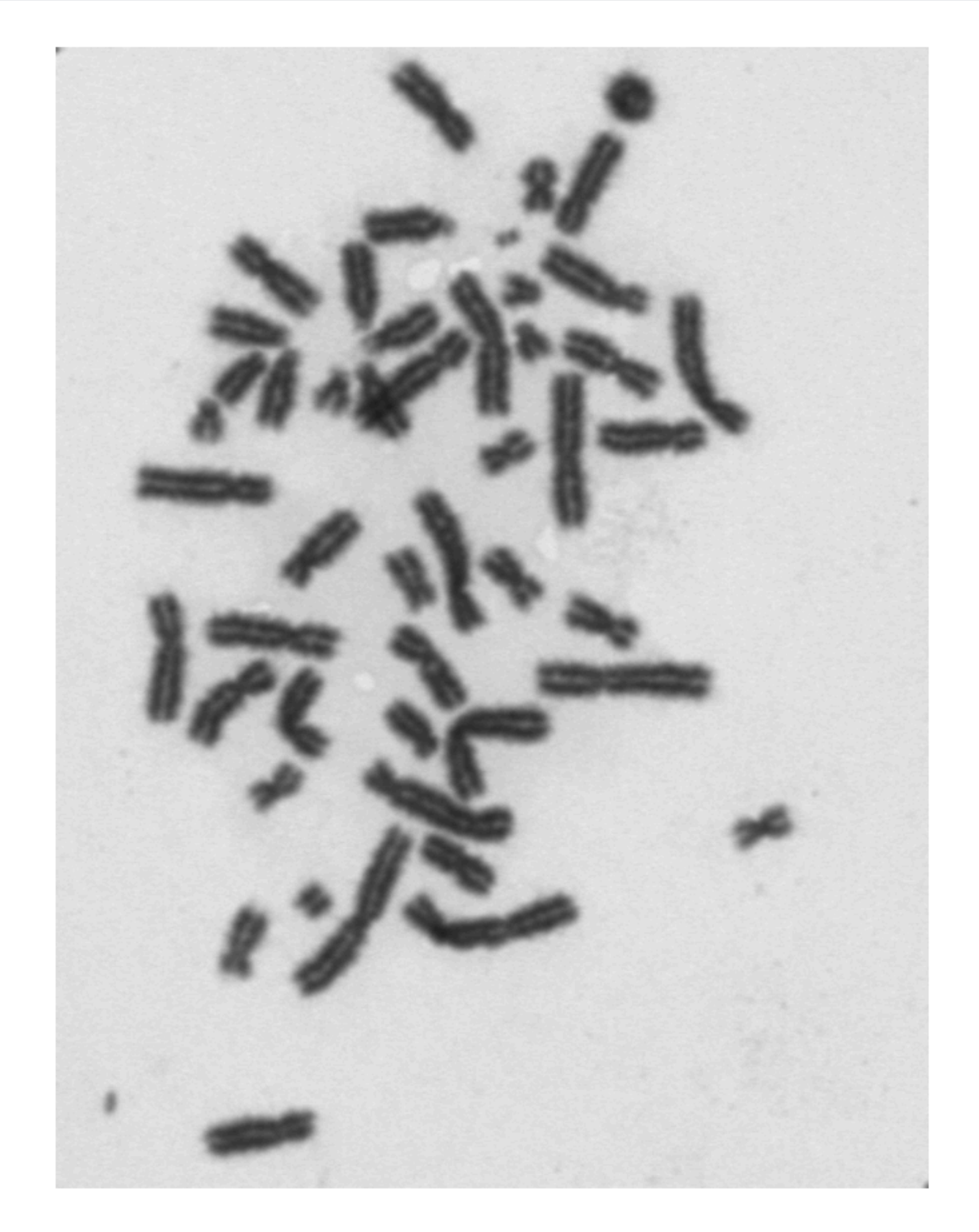


Model B: 2-stages image processing

Segmentation: chromosome detection

Classification: dicentric recognition

Images for training



original

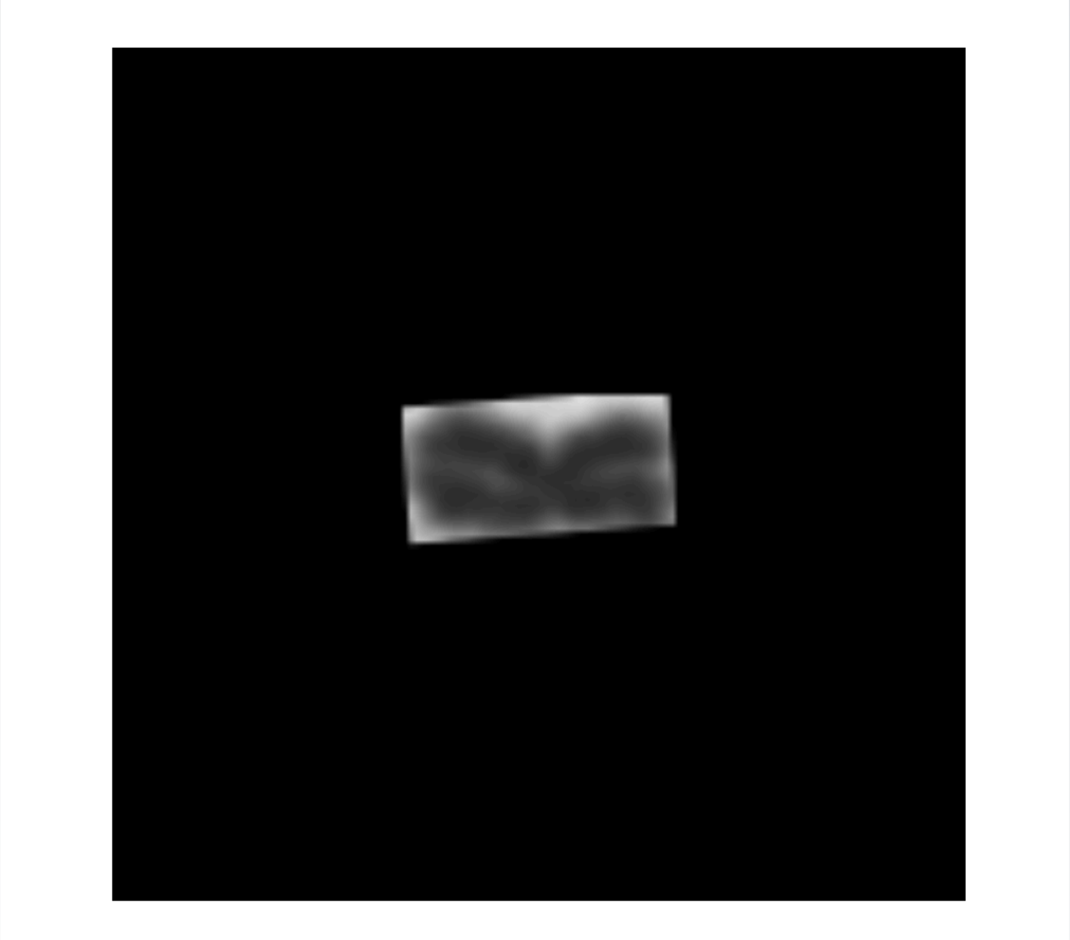
watershed with hidden bad splits

MaskR-CNN

Chromosome classification

Type	Training dataset	Test dataset
Monocentric	73 283	12 264
Dicentric	605	109
Acentric	686	84
Ring	28	2

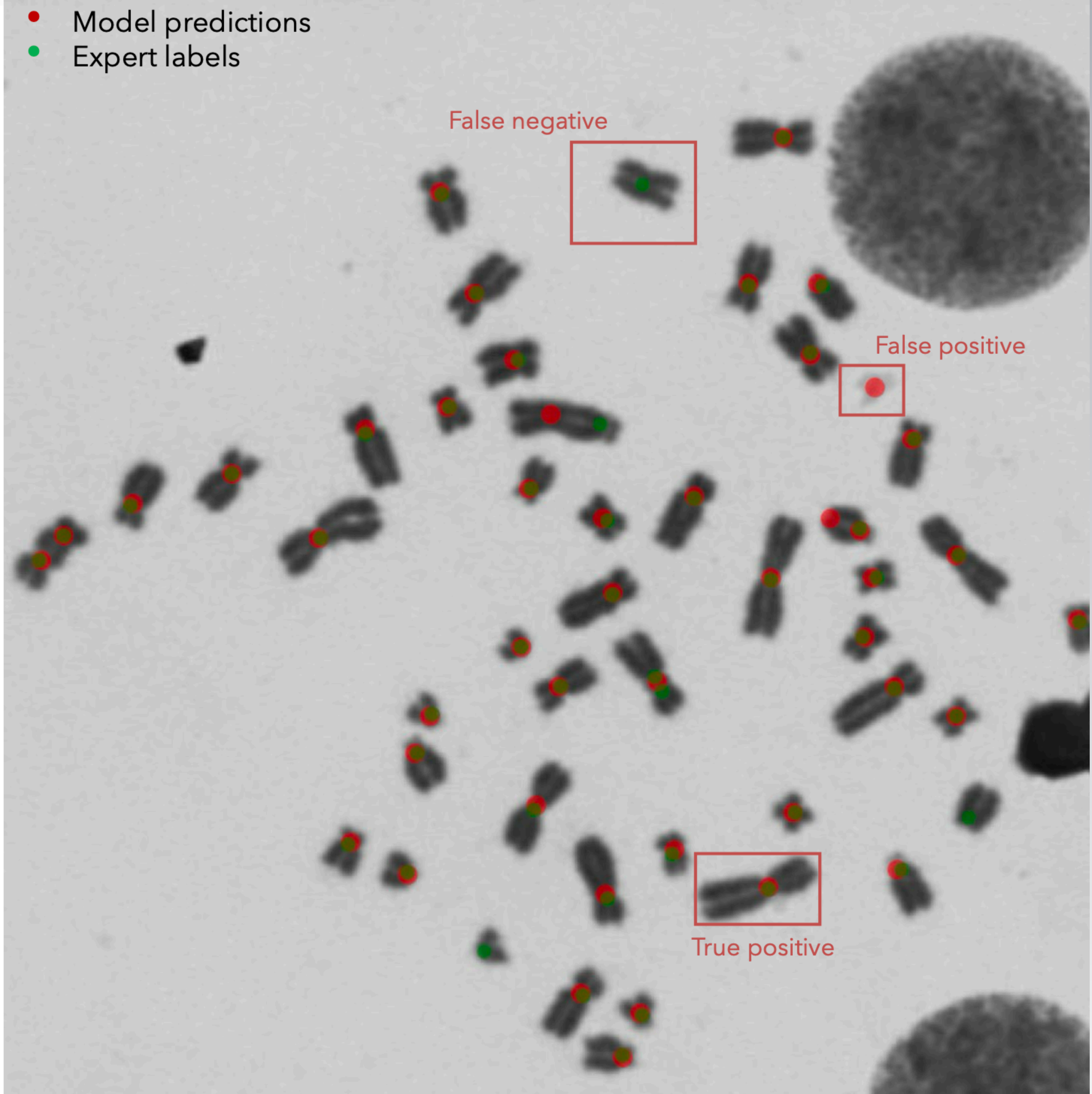
Final class was chosen as labeled by the most of the experts



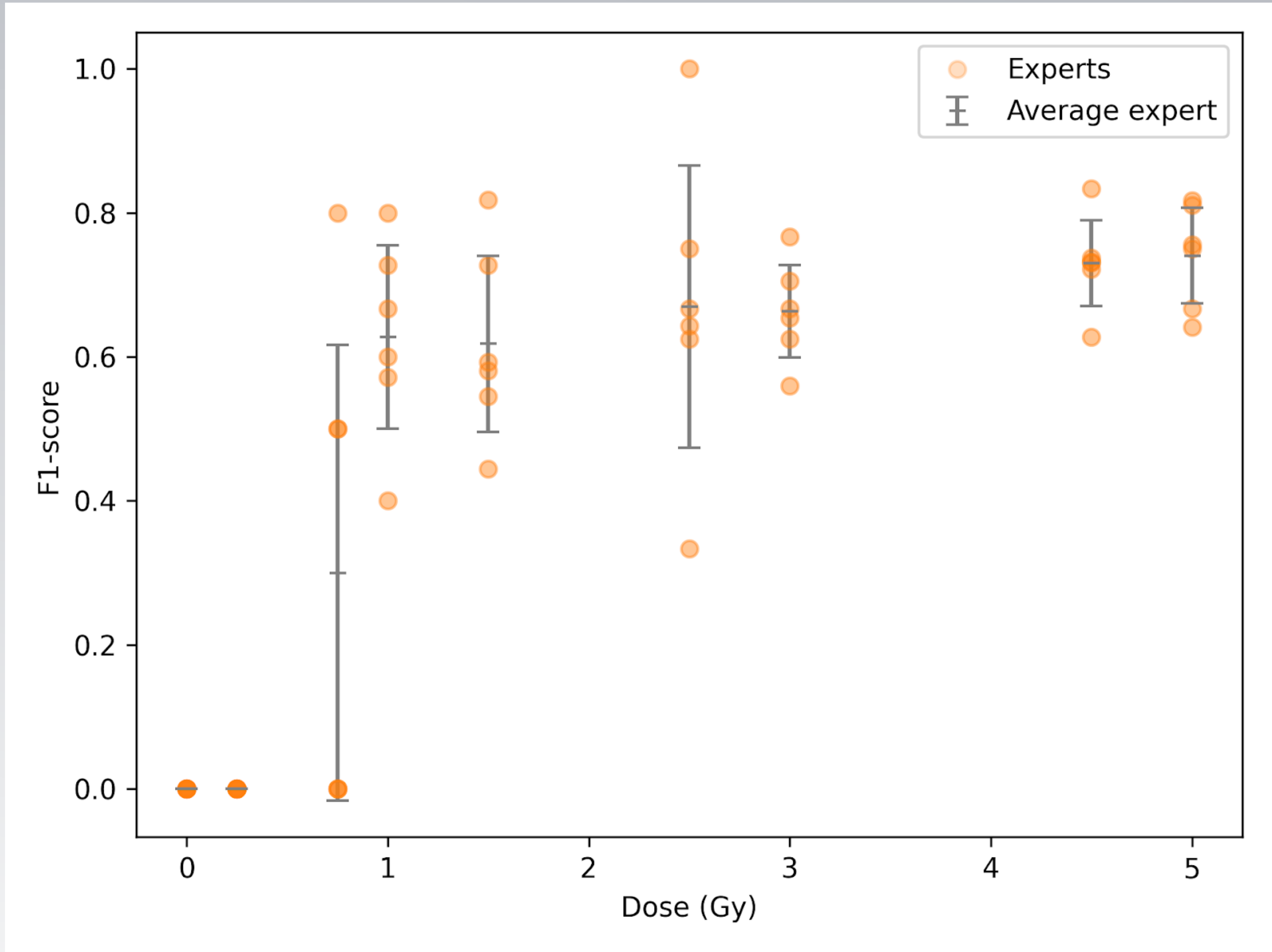
Performance estimation

$$F_1 = \frac{TP}{TP + \frac{1}{2}(FP + FN)}$$

- F1-score (predictive performance),
- its values is between 0 and 1,
- F1 = 1 means perfect prediction.

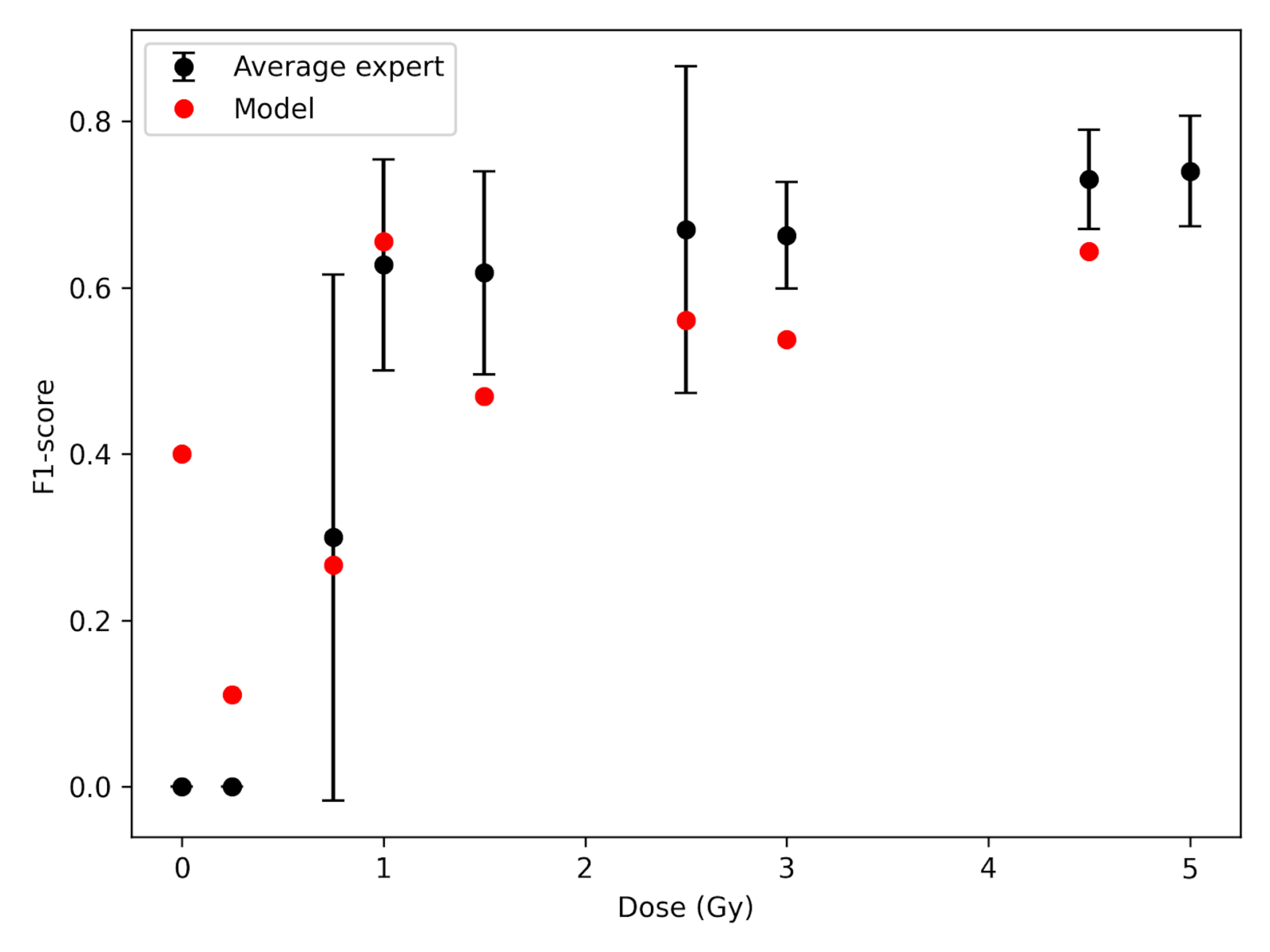


Expert performance



F1-scores for all pairs of experts per dose
For a pair of experts, its two permutations give the same F1-score

Expert and model performance

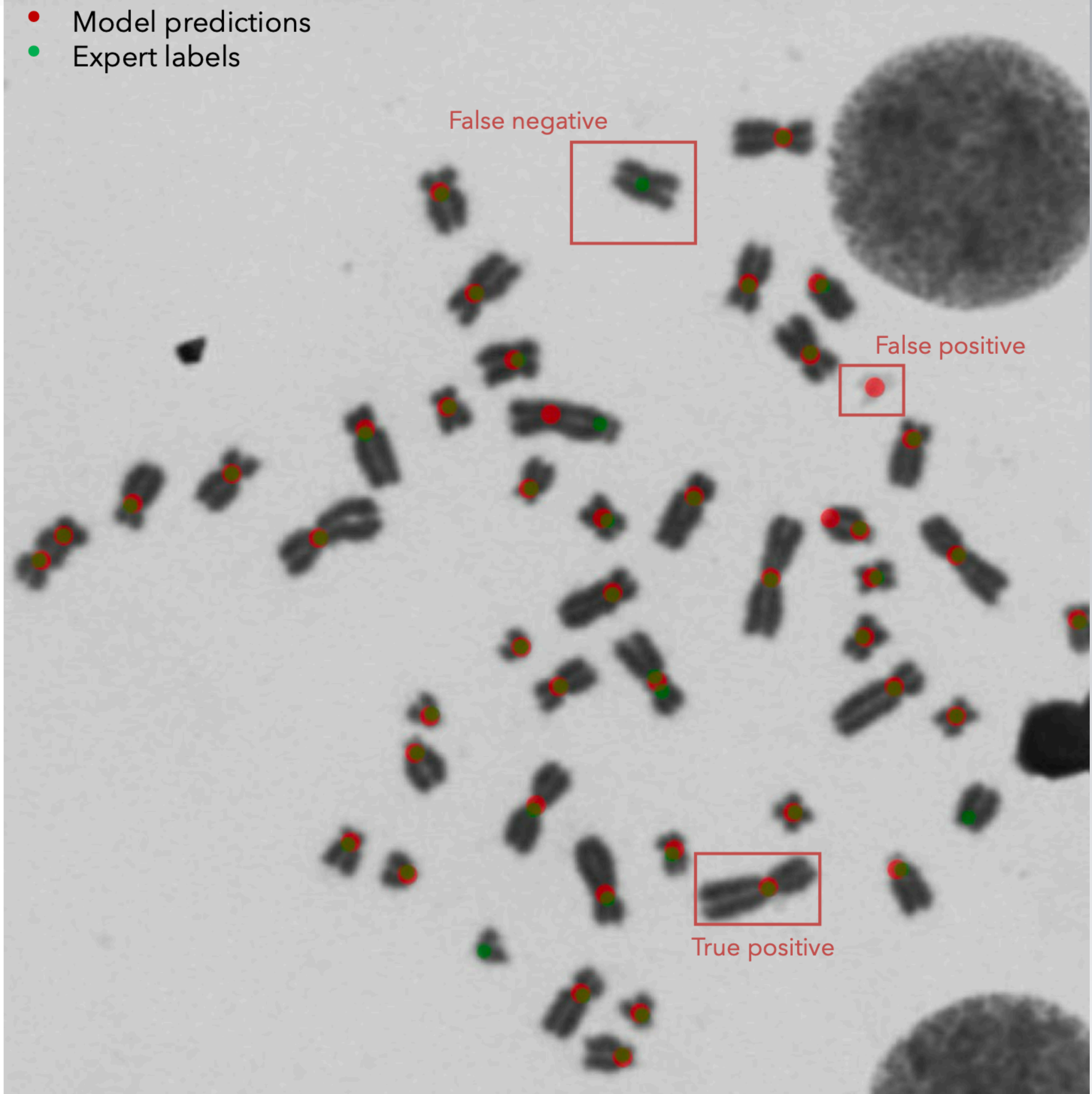


Performance estimation

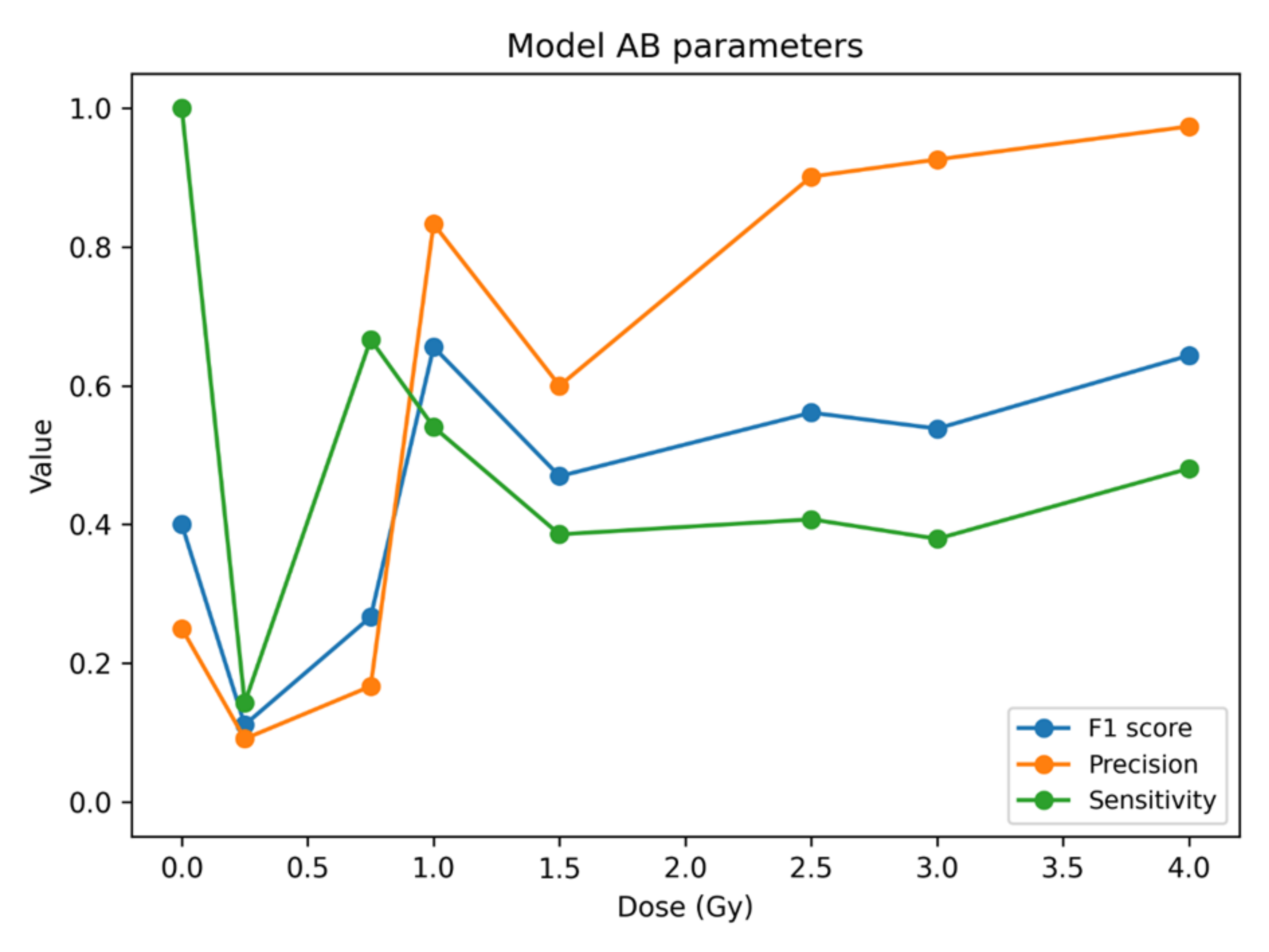
$$\text{Precision} = \frac{TP}{TP+FP}$$

$$\text{Sensitivity} = \frac{TP}{TP+FN}$$

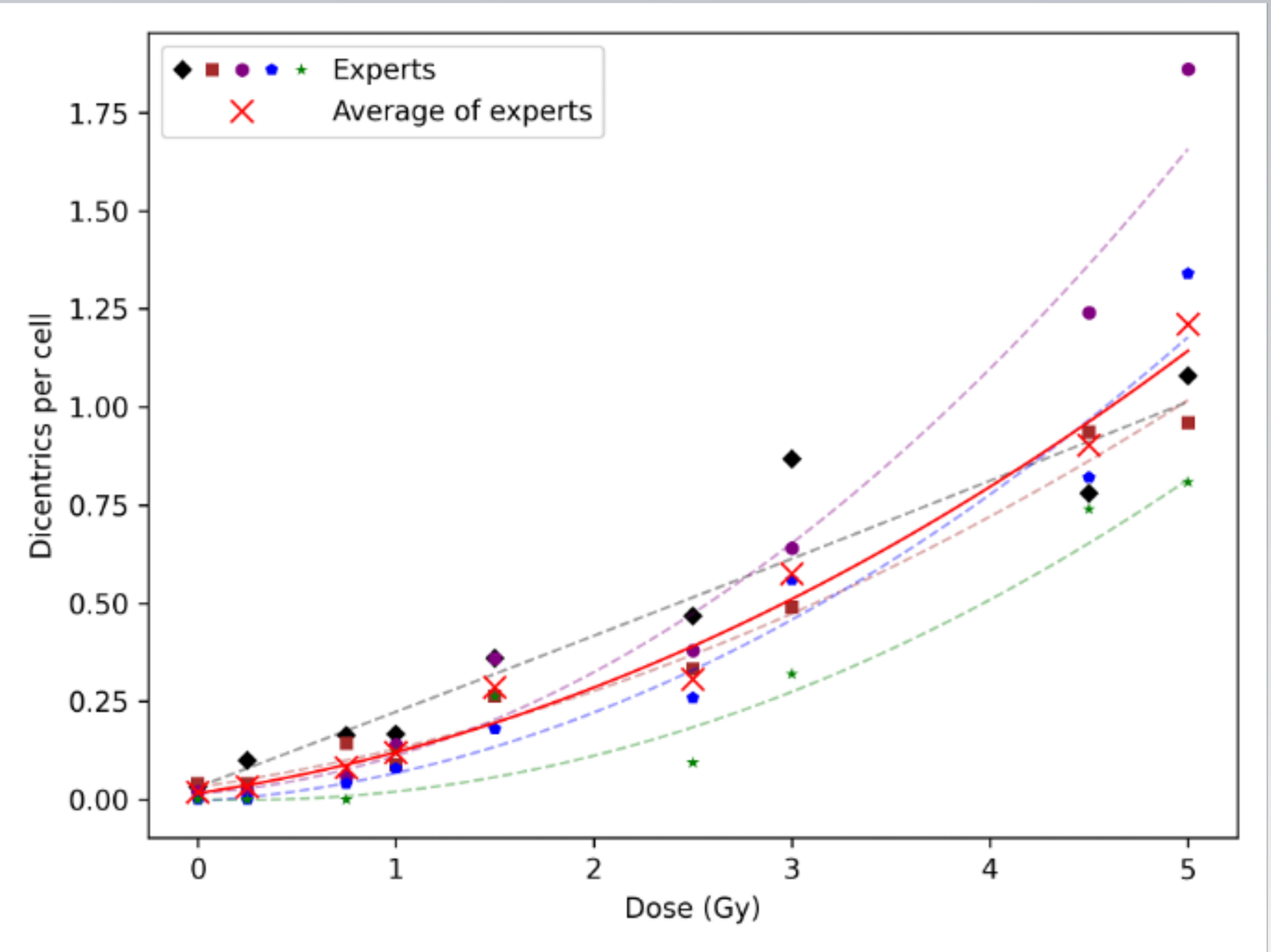
$$\text{F1-score} = \frac{2TP}{2TP+FP+FN}$$



Precision and sensitivity of the model



Dose-effect curve: comparison between experts



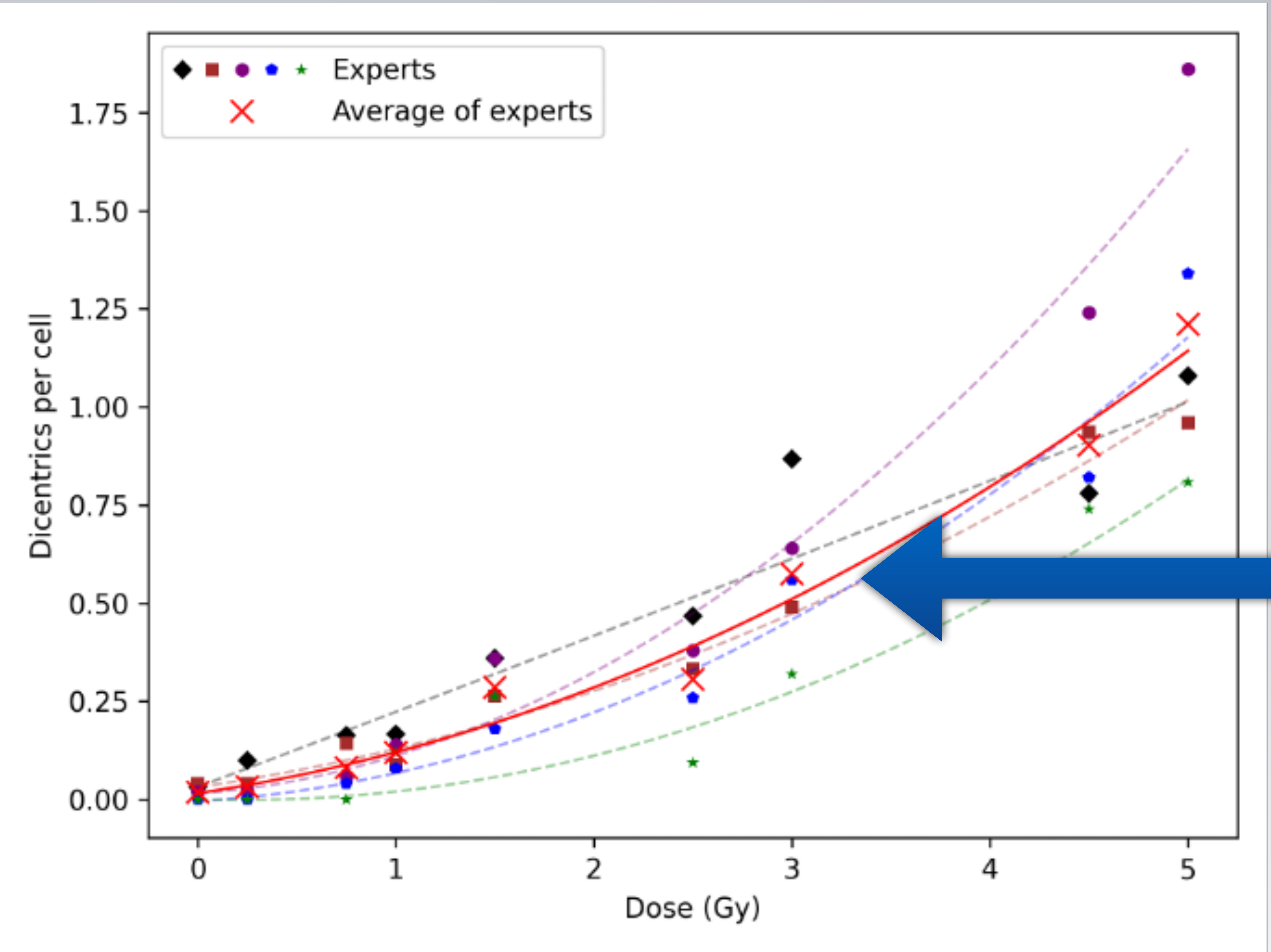
$$y = \alpha D^2 + \beta D + c,$$

$$CV_\alpha = \frac{SD\bar{\alpha}}{\bar{\alpha}} \cdot 100\% = 58\%$$

$$CV_\beta = \frac{SD\bar{\beta}}{\bar{\beta}} \cdot 100\% = 110\%$$

TEST set (5 experts)

Dose-effect curve: comparison between experts



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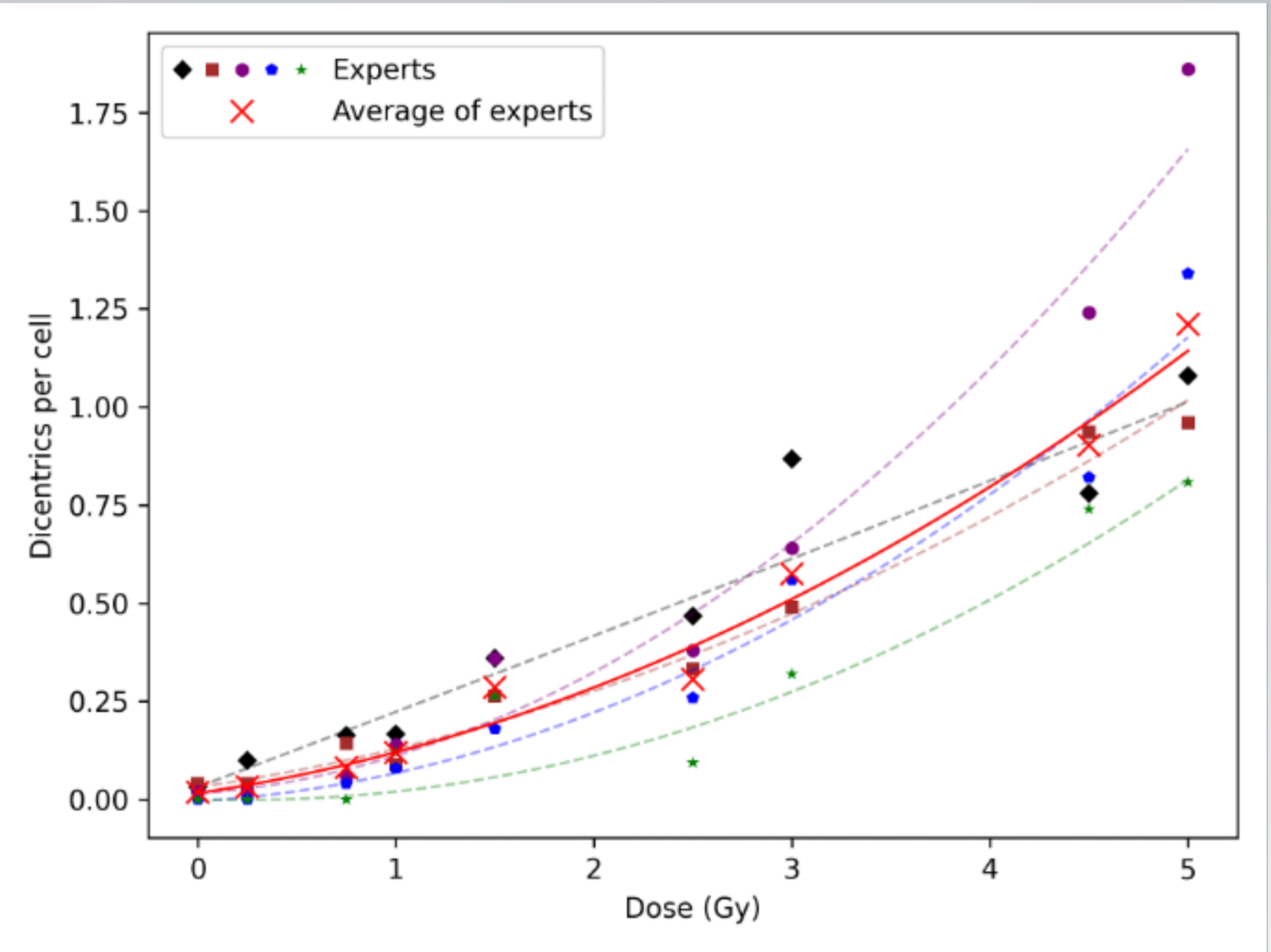
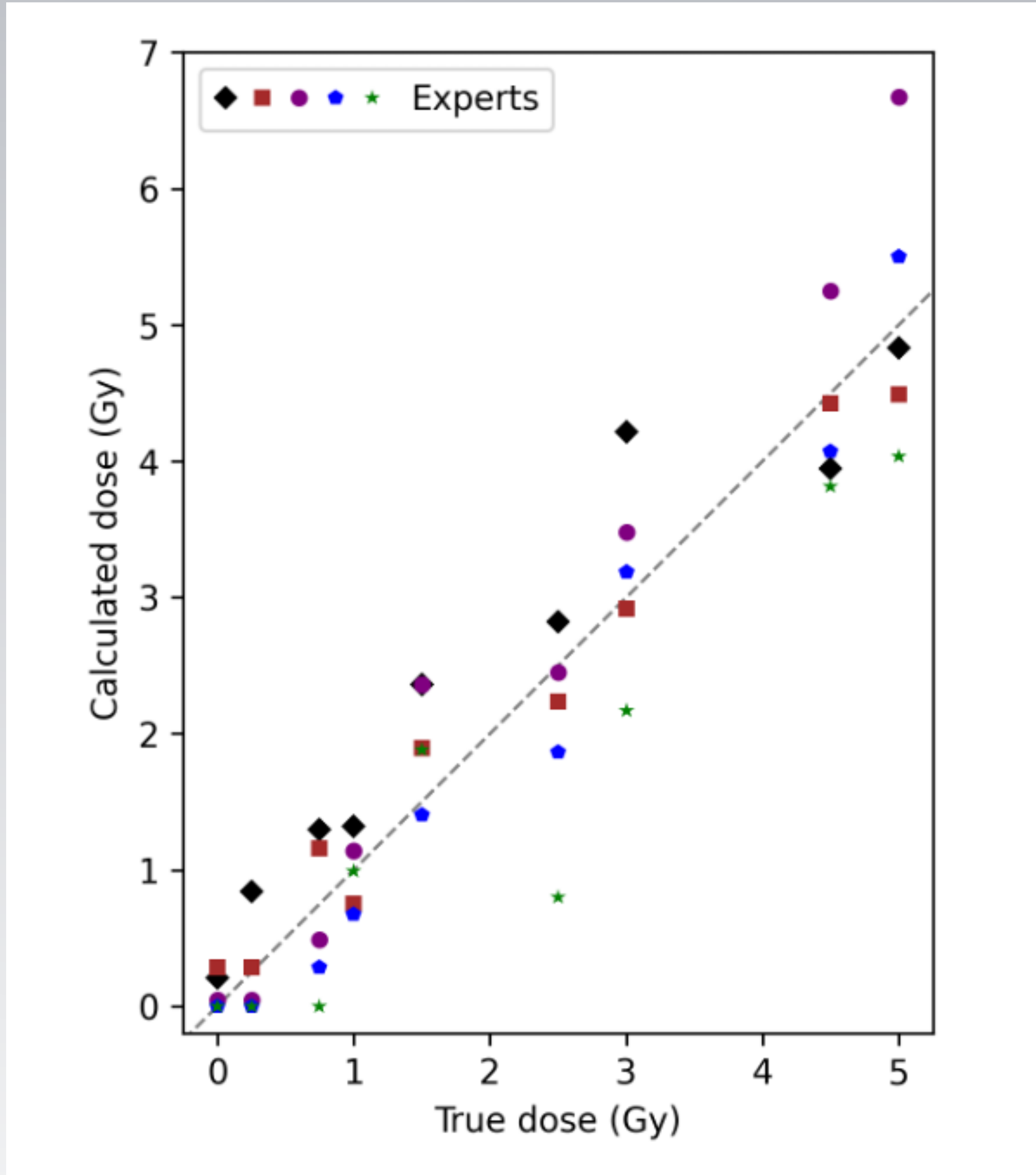
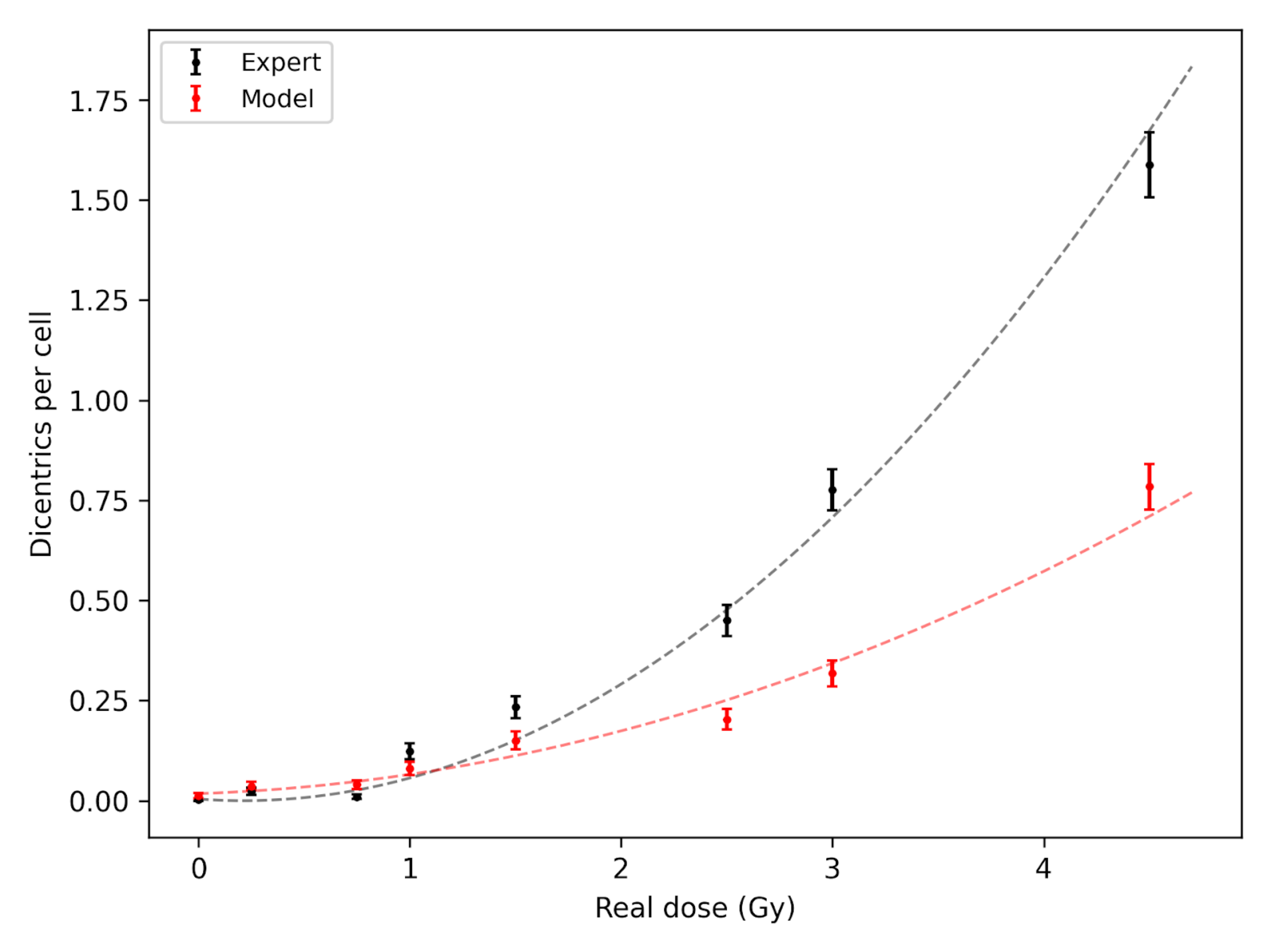




RMSE = 0.59 Gy

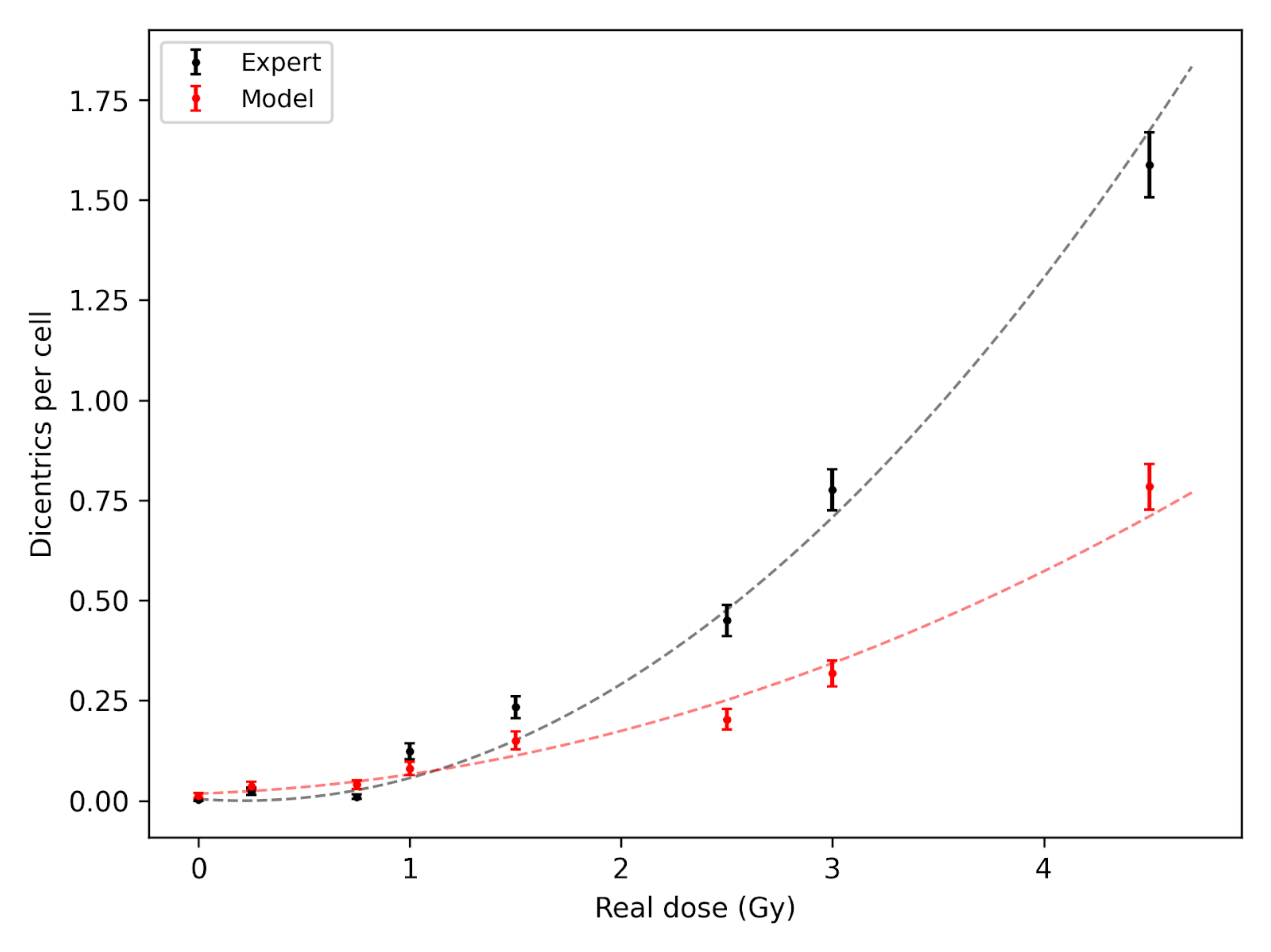
Dose-effect curve: expert vs. model

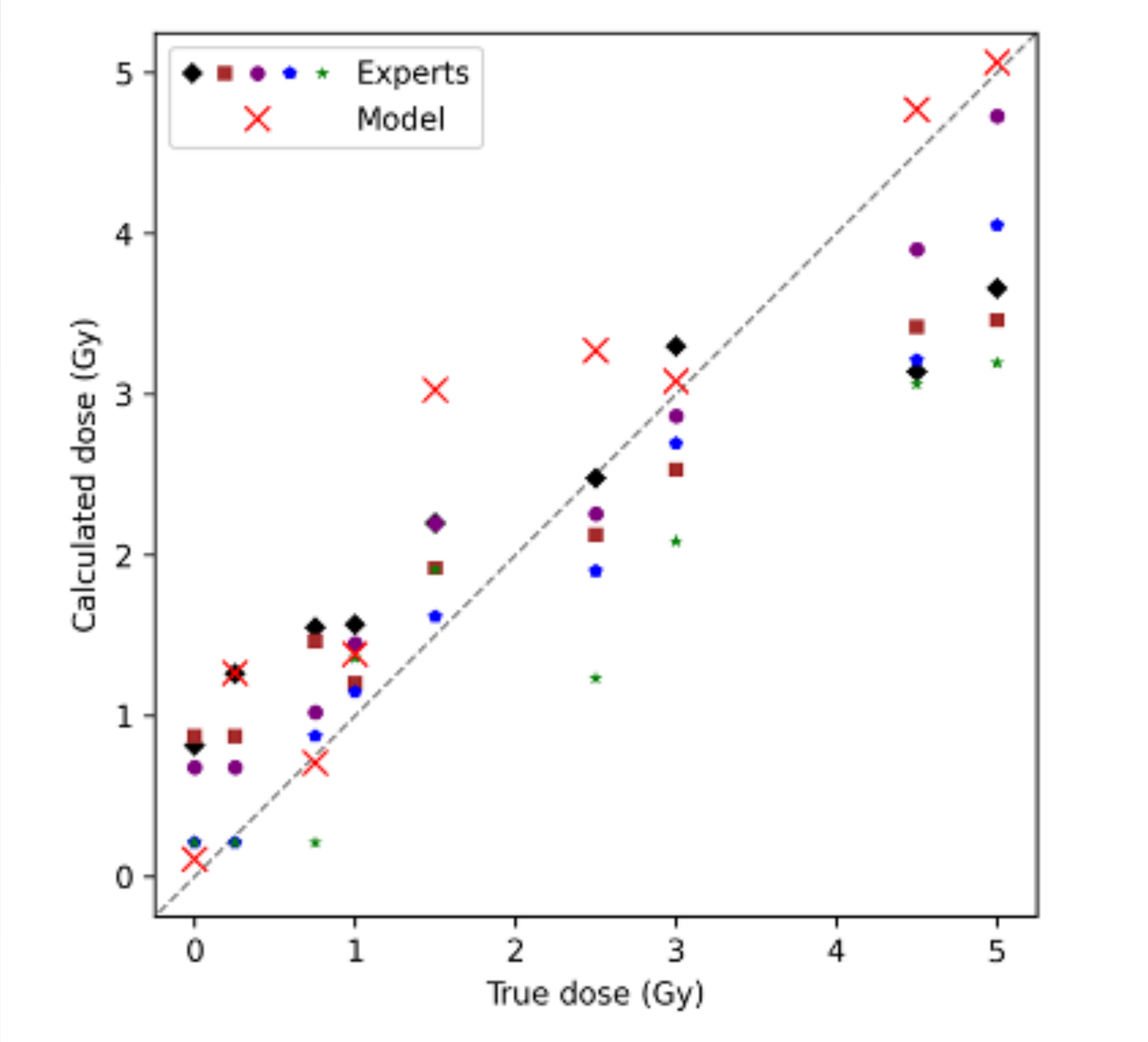


$$y = \alpha D^2 + \beta D + c,$$

CALIBRATION set (1 expert)

Dose estimation by experts and model





$RMSE_{exp}$ = 0.76 Gy
$RMSE_{mod}$ = 0.68 Gy

http://studenci.fuw.edu.pl/~mg394990/MaksChroms/

Welcome to *MaksChroms* website!

What's new?

(22.02.2023) The manual is available! Please see the *Downloads* section.

(20.01.2023) First beta release of *MaksChroms* is available! Please see the *Downloads* section.

About *MaksChroms*

MaksChroms is a software for analysis of chromosomes on microscopic images. It uses four different deep neural networks to autonomously detect and classify chromosomes into one of four categories – monocentric, acentric, dicentric and others. *MaksChroms* allows for manual inspection and custom modification of generated results in a convenient way. It also estimates the radiation dose absorbed by the sample, using embedded dose curve, or based on the calibration data provided by the user. *MaksChroms* prediction results, as well as calibration curve, can by exported to .csv files.

Our Team

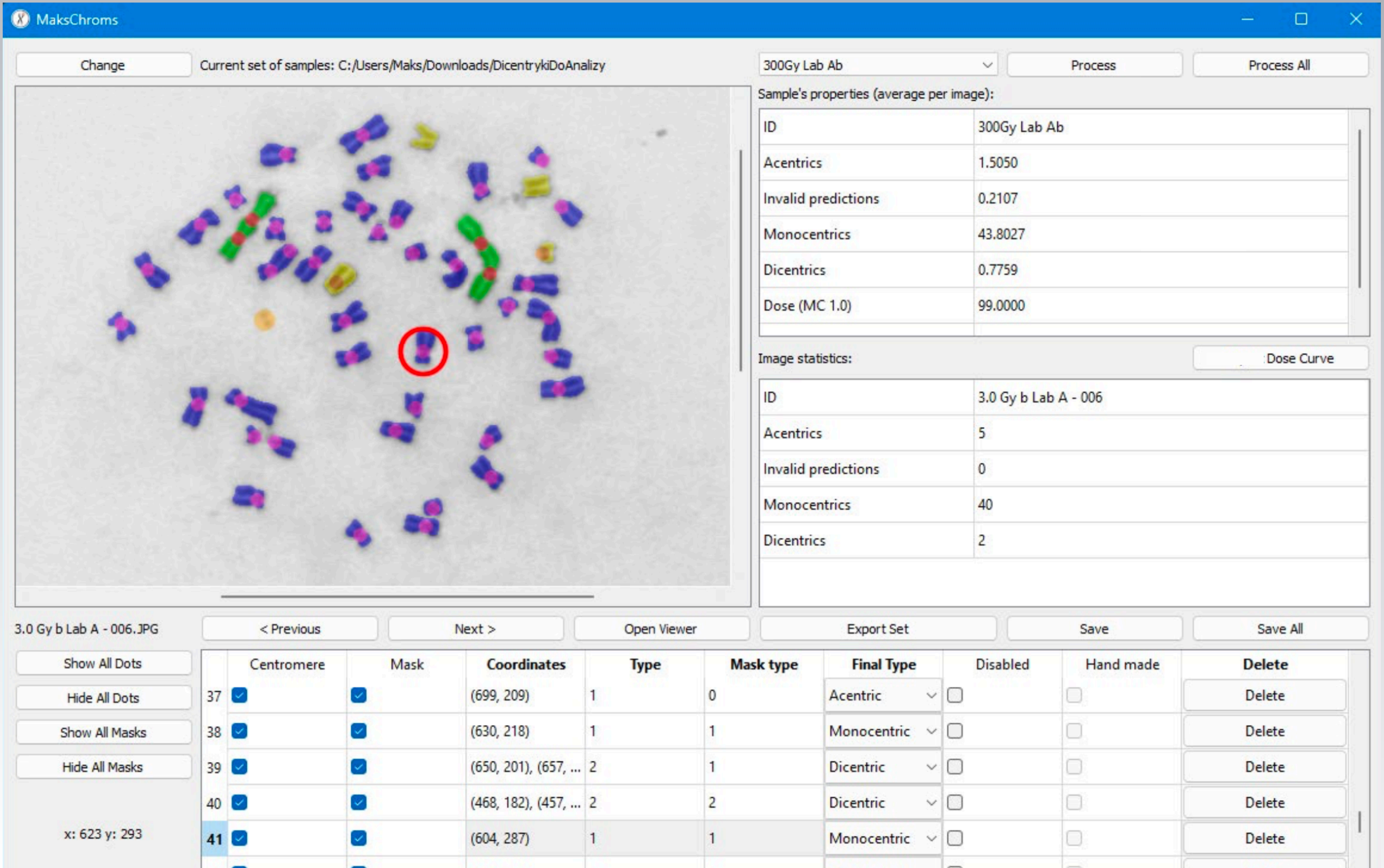
Member	Contribution	Email address
dr Beata Brzozowska	Project coordination	Beata.Brzozowska@fuw.edu.pl
dr Józef Ginter	Project coordination	Jozef.Ginter@fuw.edu.pl
Maksymilian Głowacki	Software development	m.glowacki10@uw.edu.pl

System requirements

MaksChroms was developed and tested on Windows 10 (64-bit). It may work out of the box on other (64-bit) Windows distributions as well.

Please report any bugs directly to m.glowacki10@uw.edu.pl.

Downloads


MaksChroms
Change
Current set of samples: C:/Users/Maks/Downloads/DicentrykiDoAnalizy
300Gy Lab Ab
Process
Process All
Sample's properties (average per image):
ID 300Gy Lab Ab
Acentrics 1.5050
Invalid predictions 0.2107
Monocentrics 43.8027
Dicentrics 0.7759
Dose (MC 1.0) 99.0000
Image statistics:
Dose Curve
ID 3.0 Gy b Lab A - 006
Acentrics 5
Invalid predictions 0
Monocentrics 40
Dicentrics 2
3.0 Gy b Lab A - 006.JPG
< Previous
Next >
Open Viewer
Export Set
Save
Save All
Show All Dots
Hide All Dots
Show All Masks
Hide All Masks
x: 623 y: 293
Centromere Mask Coordinates Type Mask type Final Type Disabled Hand made Delete
37 (699, 209) 1 0 Acentric Delete
38 (630, 218) 1 1 Monocentric Delete
39 (650, 201), (657, ... 2 1 Dicentric Delete
40 (468, 182), (457, ... 2 2 Dicentric Delete
41 (604, 287) 1 1 Monocentric Delete

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Józef Ginter
Maksymilian Głowacki
Maria Kowalska
Maria Szoła
Adrianna Tartas

ROBOTEC AI
Paweł Kotowski

Contact: m.glowacki10@student.uw.edu.pl

AI in medicine

Segmentation and treatment planning

Image reconstruction and multimodality imaging

Radiation dosimetry and quality assurance

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Lei Xing, The Role of AI in Clinical Radiation Oncology

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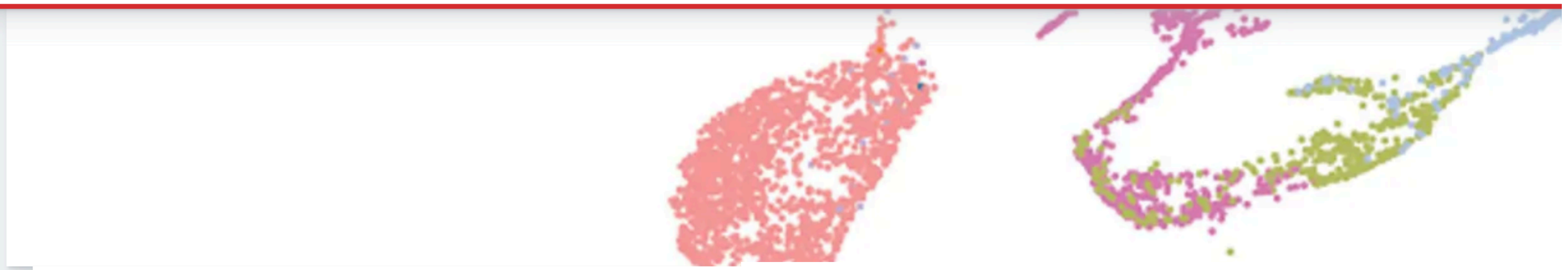

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A New AI Tool Predicts G

An artificial intelligence tool, scGPT, ca
disrupting genes, and pinpoint which g

Carissa Wong, PhD
Aug 21, 2023 | 4 min read

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Article | Published: 07 August 2024

A generalist vision–language foundation model for diverse biomedical tasks

an, Yixin Liu, Jun Yu, Zhengliang Liu, Xun Chen, Brian
n Zhou, Sunyang Fu, Wei Liu, Tianming Liu, Xiang Li
ng Li, Hongfang Liu & Lichao Sun

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Article | Published: 19 March 2024

A visual-language foundation model for computational pathology

Ming Y. Lu, Bowen Chen, Drew F. K. Williamson, Richard J. Chen, Ivy Liang, Tong Ding, Guillaume Jaume, Igor Odintsov, Long Phi Le, Georg Gerber, Anil V. Parwani, Andrew Zhang & Faisal Mahmood

Nature Medicine **30**, 863–874 (2024) | Cite this article

Lei Xing, The Role of AI in Clinical Radiation Oncology

Explainable Artificial Intelligence (XAI)

One pixel attack

- segmenting the image at the first stage;
- applying a nature-inspired algorithm to find the optimal pixel able to modify the decision of the deep learning model.

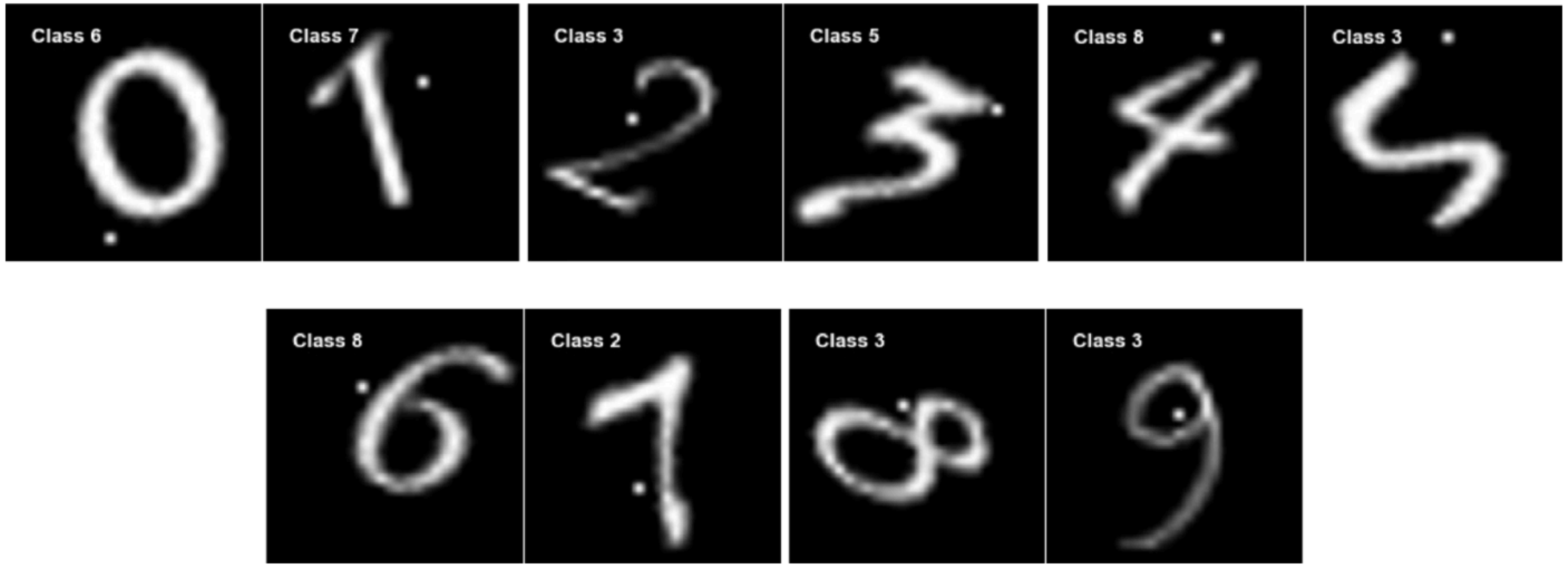


Fig. 7. Some adversarial images with their corresponding classes achieved after the attack when using CNN.

Ali, Y. M. B. (2023). One-pixel and x-pixel adversarial attacks based on smell bees optimization algorithm. *Future Generation Computer Systems*, *149*, 562-576.

How does it work?

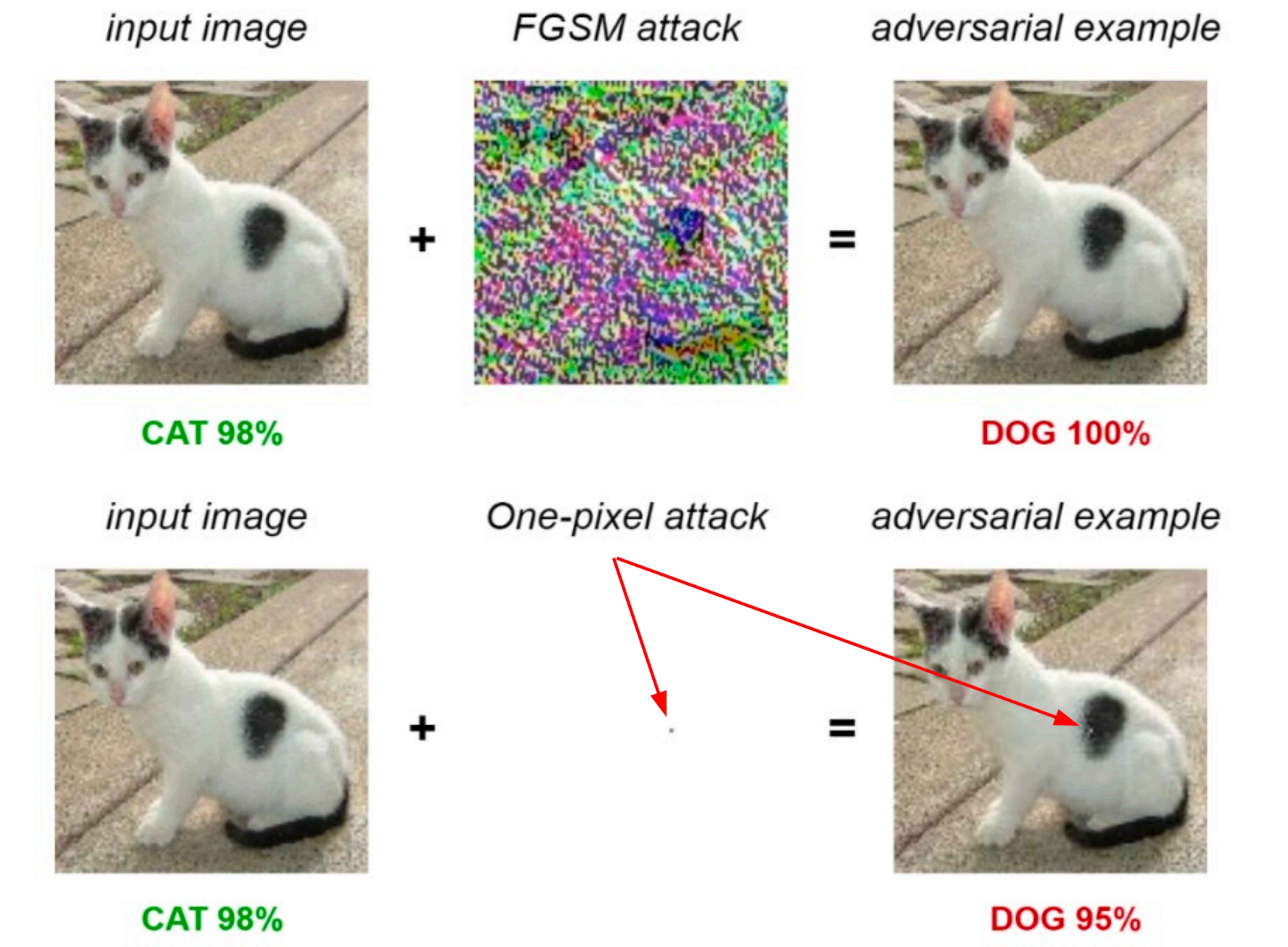


Fig. 1. Illustration of the FGSM and one-pixel attacks.

Klawikowska et al. Explainable AI for Inspecting Adversarial Attacks on Deep Neural Networks, https://doi.org/10.1007/978-3-030-61401-0_14

One pixel attack

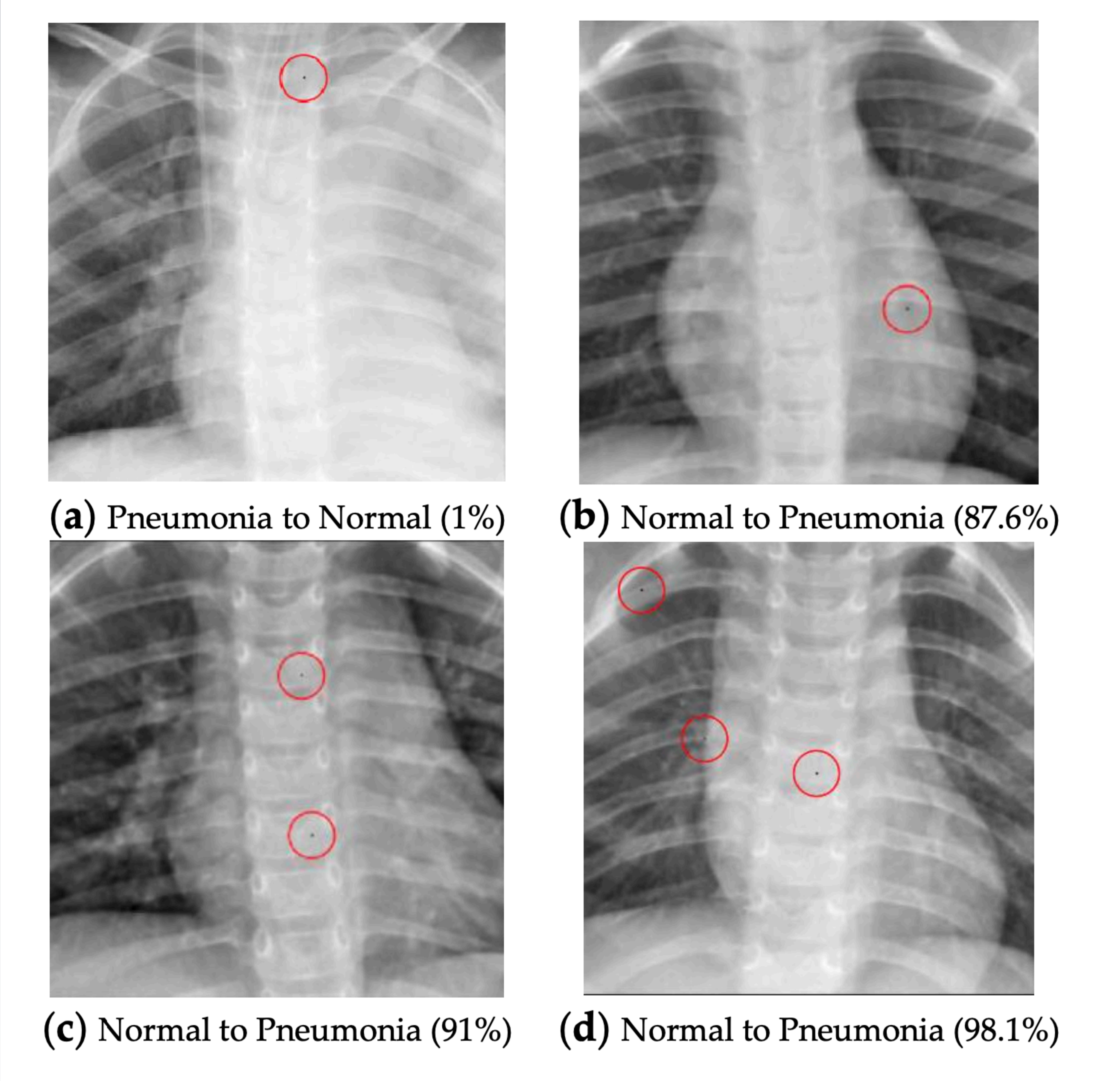
Name	Number of Data	Number of Class	Original Size of Image	Type of Dataset	Color Information	Type of Image
Derma	10,015	7	600 × 450	Multi-class	Color	Dermatoscopic
Pneumonia	5856	2	(384~2916) × (127~2713)	Multi-class	Greyscale	X-ray
OCT	109,309	4	(1, 3) × (384~1536) × (277~512)	Multi-class	Greyscale	Optical Coherence Tomography
COVID-19	30,530	3	1024 × 1024	Multi-class	Greyscale	X-ray
Chest	112,120	14	1024 × 1024	Binary-class Multi-label	Greyscale	X-ray

Pneumonia
88% precision, 100% recall

Normal
100% precision, 65% recall

Tsai, M.-J.; Lin, P.-Y.; Lee, M.-E. Adversarial Attacks on Medical Image Classification. Cancers 2023, 15, 4228. https://doi.org/10.3390/ cancers15174228

Multi-pixel attack



- the success rate of converting normal images into pneumonia images is positively correlated with the number of perturbed pixels
- transforming pneumonia images into normal images does not yield successful results, even with an increase in the perturbed pixels.

Tsai, M.-J.; Lin, P.-Y.; Lee, M.-E. Adversarial Attacks on Medical Image Classification. Cancers 2023, 15, 4228. https://doi.org/10.3390/ cancers15174228

AI hallucinations

Ethics and Information Technology (2024) 26:38
https://doi.org/10.1007/s10676-024-09775-5

ORIGINAL PAPER

ChatGPT is bullshit

Michael Townsen Hicks[1] · James Humphries[1] · Joe Slater[1]

Published online: 8 June 2024

Abstract
Recently, there has been considerable interest in large language models: machine learning systems which produce
like text and dialogue. Applications of these systems have been plagued by persistent inaccuracies in their output; t
often called "AI hallucinations". We argue that these falsehoods, and the overall activity of large language models,
understood as *bullshit* in the sense explored by Frankfurt (On Bullshit, Princeton, 2005): the models are in an ir
way indifferent to the truth of their outputs. We distinguish two ways in which the models can be said to be bul
and argue that they clearly meet at least one of these definitions. We further argue that describing AI misreprese
as bullshit is both a more useful and more accurate way of predicting and discussing the behaviour of these syst

Keywords Artificial intelligence · Large language models · LLMs · ChatGPT · Bullshit · Frankfurt · Assertion ·
Content

AI/LLM systems do not usually give the sources of the answers and information generated, instead sometimes giving sources that do not exist.

Ethics and Information Technology (2024) 26:46
https://doi.org/10.1007/s10676-024-09785-3

CORRECTION

Correction: ChatGPT is bullshit

Michael Townsen Hicks[1] · James Humphries[1] · Joe Slater[1]

Published online: 11 July 2024

Correction to: Ethics and Information Technology (2024) 26:38
https://doi.org/10.1007/s10676-024-09775-5

In this article, there are multiple corrections as listed below,

The sentence beginning, 'Solutions such as…' must be Solutions such as connecting the LLM to a database don't work because, if the models are *trained* on the database, then the words in the database affect the probability that the chatbot will add one or another word to the line of text it is generating.

The sentence beginning, 'We will argue….' must be 'We will argue that these falsehoods aren't hallucinations later.'

The sentence beginning 'In Sect. 3.2 we consider…….' must be 'In our final section, we consider whether ChatGPT

having any intentions at all, and we'll go into this in more depth in the next section'.

The sentence beginning, 'In Sect. 1, we argued….' must be 'Earlier, we argued that ChatGPT is not designed to produce true utterances; rather, it is designed to produce text which is indistinguishable from the text produced by humans. It is aimed at being convincing rather than accurate'.

The sentence, 'We will consider these questions in more depth in Sect. 3.2.2.' must be 'We will consider these questions in more depth below.'

The sentence beginning 'We don't think…….' must be 'We don't think that ChatGPT is an agent or has intentions in precisely the same way that humans do (see Levinstein and Herrmann (forthcoming) for a discussion of the issues here).

Quality of training data

Cornell University

We gratefully acknowledge support fr
member instit

arXiv > cs > arXiv:2311.16822

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Computer Science > Machine Learning

[Submitted on 28 Nov 2023 (v1), last revised 17 Jun 2024 (this version, v2)]

Large Language Models Suffer From Their Own Output: An Analysis of the Self-Consuming Training Loop

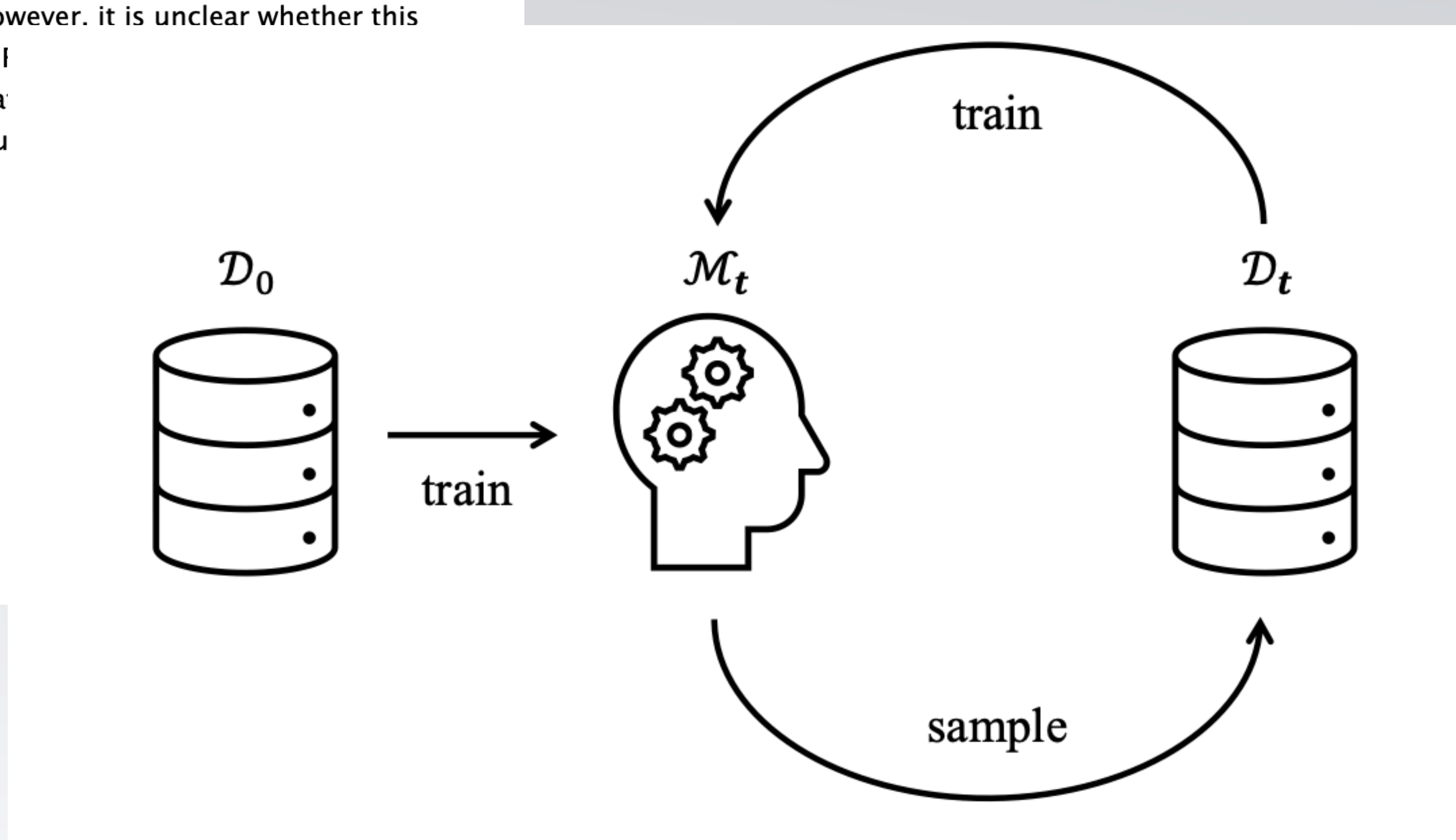
Martin Briesch, Dominik Sobania, Franz Rothlauf

Large Language Models (LLM) are already widely used to generate content for a variety of online platforms. As we are not able to safely distinguish LLM-generated content from human-produced content, LLM-generated content is used to train the next generation of LLMs, giving rise to a self-consuming training loop. From the image generation domain we know that such a self-consuming training loop reduces both quality and diversity of images finally ending in a model collapse. However, it is unclear whether this alarming effect can also be observed for LLMs. Therefore, we present the first study investigating the self-consuming training loop for LLMs. I
method based on logic expressions that allows us to unambiguously verify the correctness of LLM-generated content, which is difficult for na
the self-consuming training loop produces correct outputs, however, the output declines in its diversity depending on the proportion of the u
slow down this decline, but not stop it. Given these concerning results, we encourage researchers to study methods to negate this process.

Subjects: **Machine Learning (cs.LG)**; Computation and Language (cs.CL); Neural and Evolutionary Computing (cs.NE)
Cite as: arXiv:2311.16822 **[cs.LG]**
(or arXiv:2311.16822v2 **[cs.LG]** for this version)
https://doi.org/10.48550/arXiv.2311.16822

Submission history

From: Martin Briesch [view email]
[v1] Tue, 28 Nov 2023 14:36:43 UTC (643 KB)
[v2] Mon, 17 Jun 2024 07:07:30 UTC (760 KB)



Copyrights of training data

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Artists Score Major Win in Copyright Case Against AI Art Generators

The court declined to dismiss copyright infringement claims against the AI companies. The order could implicate other firms that used Stable Diffusion, the AI model at issue in the case.

BY WINSTON CHO AUGUST 13, 2024 1:09PM

Reuters World US Election Business Markets Sustainability Legal Breakingviews Technology

Litigation | Copyright | Appellate | Intellectual Property | Litigation

Artist sues after US rejects copyright for AI-generated image

By Blake Brittain

September 26, 2024 7:41 PM GMT+2 · Updated a month ago

Aa

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Scrutinising the Commission How the EU works Economy and budget Ukraine Migration All topics

Topics > Digital > Artificial intelligence > EU AI Act: first regulation on artificial intelligence

EU AI Act: first regulation on artificial intelligence

The use of artificial intelligence in the EU will be regulated by the AI Act, the world's first comprehensive AI law. Find out how it will protect you.

Published: 08-06-2023
Last updated: 18-06-2024 - 16:29
6 min read

Table of contents

Climate change

BUSINESS

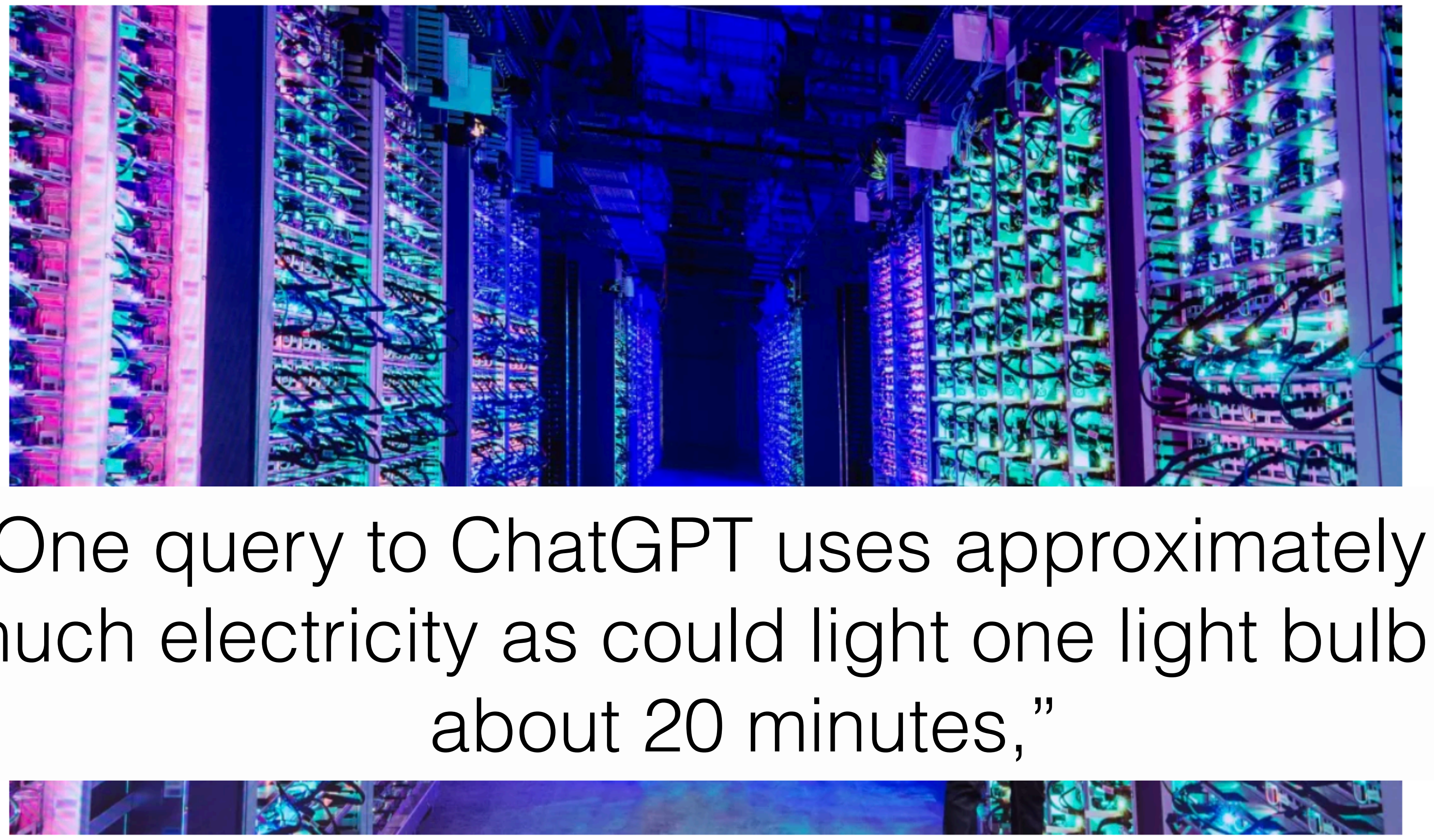
AI brings soaring emissions for Google and Microsoft, a major contributor to climate change

JULY 12, 2024 · 5:13 AM ET

Dara Kerr

3-Minute Listen

+ PLAYLIST



“One query to ChatGPT uses approximately as much electricity as could light one light bulb for about 20 minutes,”

AI's Dual Role in Climate Change

AI's impact on climate change is multifaceted, with both positive and negative potentials.

Negative Impacts:

- **Energy Consumption:** Training and running AI models, particularly large language models, requires significant computational power, which often relies on energy-intensive data centers.
- **Carbon Footprint:** The energy consumption associated with AI can contribute to greenhouse gas emissions and climate change.

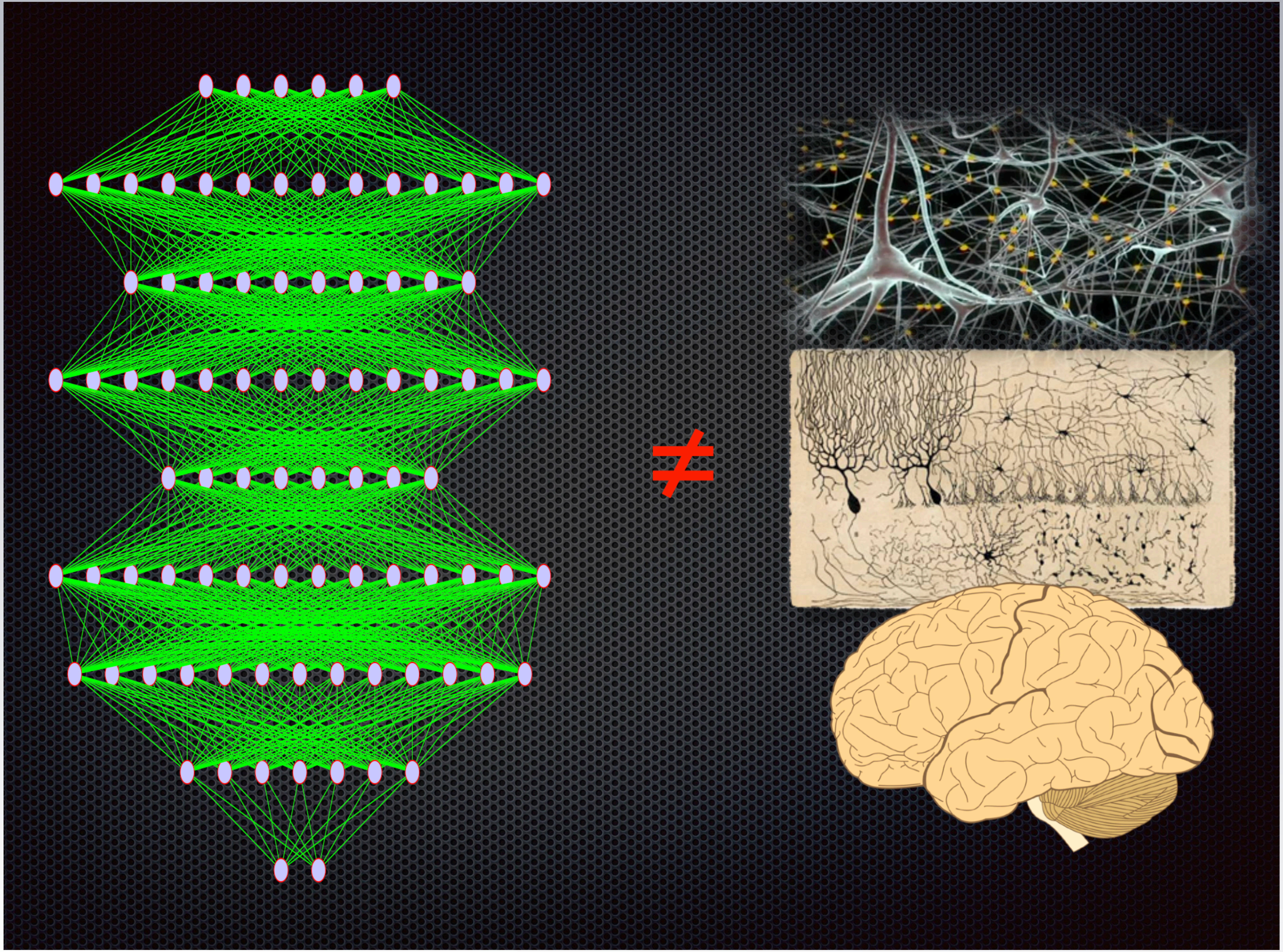
Positive Impacts:

- **Climate Mod** understanding
- **Renewable E** energy system managing ene

Yes, **AI** can both positively and negatively impact **climate change**. While AI technologies have the potential to contribute to sustainability efforts and help mitigate the effects of climate change, they can also have unintended environmental consequences. Here's an overview of how AI impacts climate change from both perspectives:

Positive Impacts of AI on Climate Change:

1. **Energy Efficiency Improvements:**
   - **Smart Grids:** AI can optimize electricity distribution through smart grids, reducing energy waste and improving the efficiency of renewable energy sources like wind and solar. This helps lower carbon emissions by ensuring that energy is used more efficiently.
   - **Building Management Systems:** AI-driven systems can control heating, ventilation, and air conditioning (HVAC) systems in buildings to optimize energy use, reducing the carbon footprint of commercial and residential spaces.
2. **Renewable Energy Optimization:**



Piotr Durka, https://brain.fuw.edu.pl/edu/index.php/TI/Sztuczna_Inteligencja

Moravec (1988): "it is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility"

Moravec, Hans (1988), *Mind Children*, Harvard University Press

Pinker (1994): "the main lesson of thirty-five years of AI research is that the hard problems are easy and the easy problems are hard"

Pinker, Steven (September 4, 2007) [1994], *The Language Instinct*, Perennial Modern Classics, Harper

Thank you for your attention!

Contact: beata.brzozowska@fuw.edu.pl