WIPO Standing Committee on the Law of Patents (SCP): Presentations by AI technology experts

Prof. Rüdiger Urbanke (EPFL) and Prof. Daniel Sonntag (DFKI)

Agenda

- Intro: Artificial Intelligence (AI) algorithms and technologies
- AI concepts and their developments, including a state-of-the-art discussion on generative AI
- Large Language Models (LLMs) such as ChatGPT
- Beyond ChatGPT

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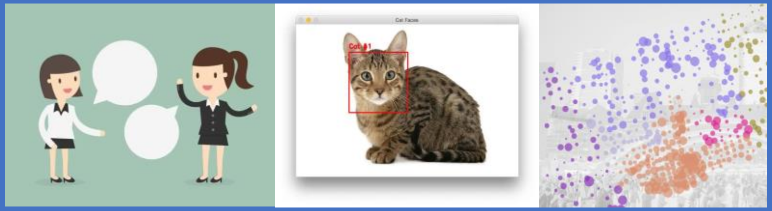
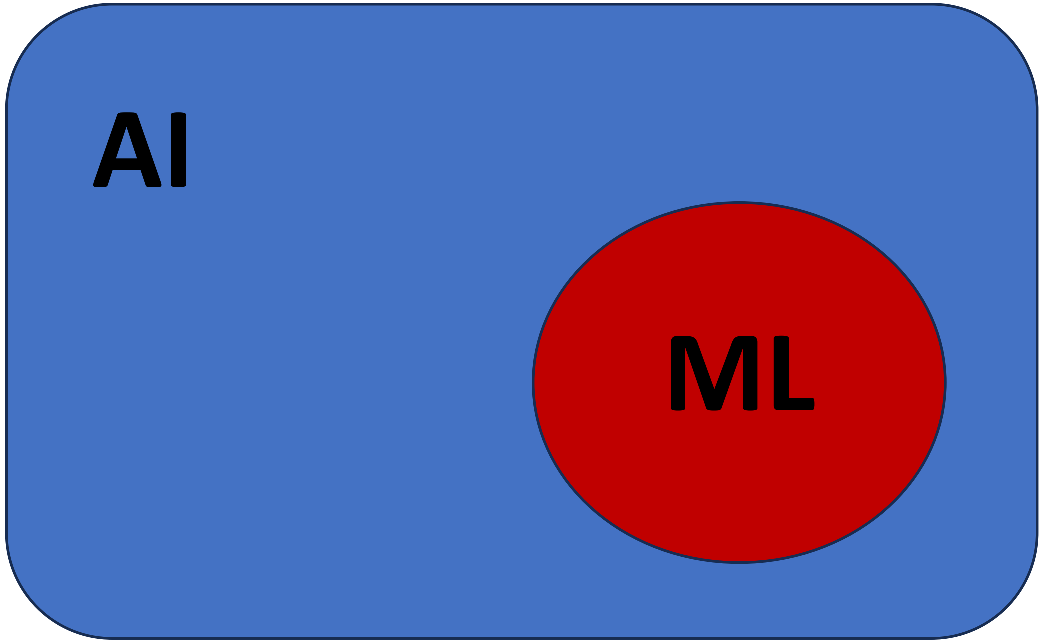
Dictionary: **AI** (Artificial Intelligence)

AI

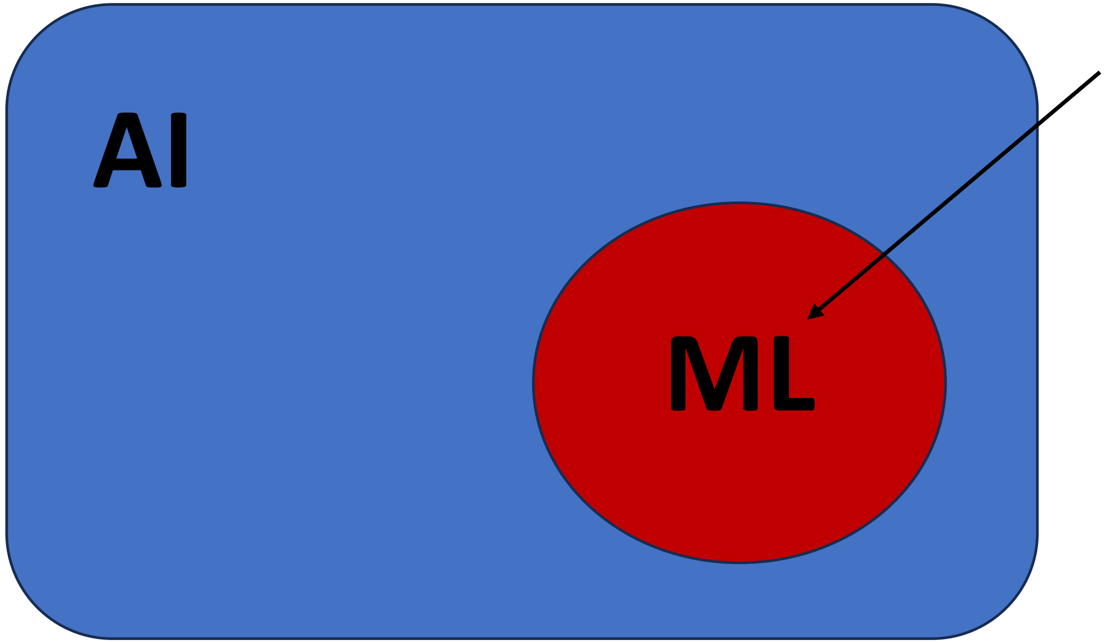
Creating systems capable of performing tasks that typically require human intelligence:



Dictionary: ML (Machine Learning)

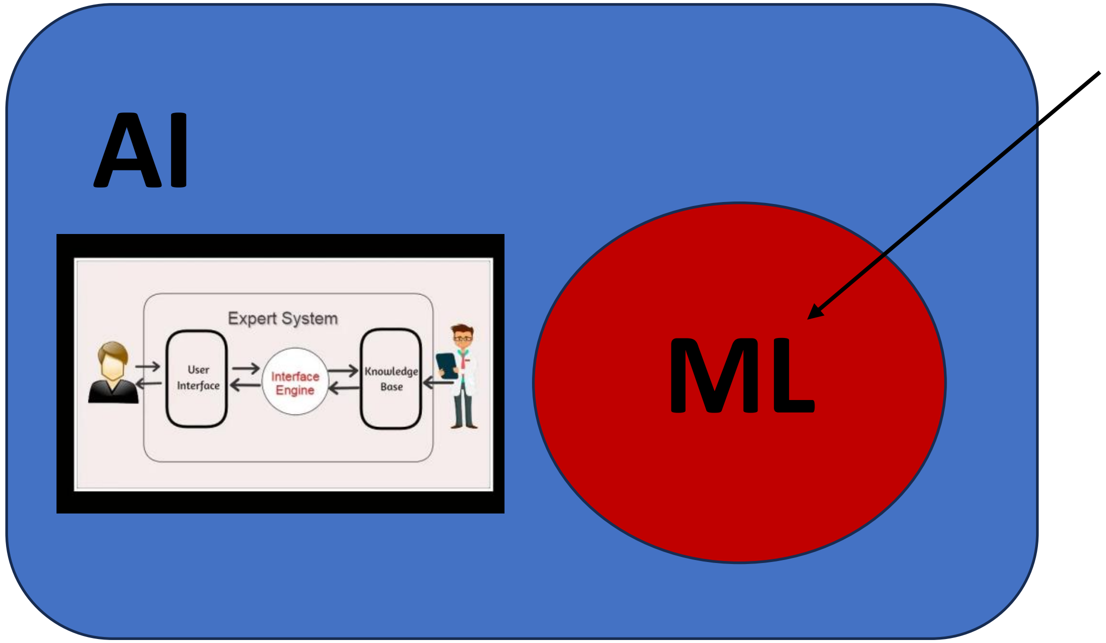


Dictionary: **ML**



algorithms and models that enable computers to learn from data **without being explicitly programmed**

Dictionary: **ML**



algorithms and models that enable computers to learn from data **without being explicitly programmed**

Dictionary: practically speaking

AI ~ ML

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AI history in thirty words

mid-20th century: emergence of academic discipline; rule based (expert systems); some limited success, but life is just too complex

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AI history in thirty words

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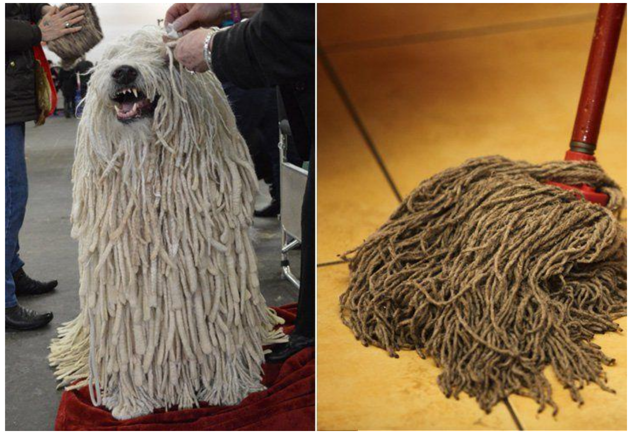
1990ties: statistical approach, compute probabilities of various outcomes; still dominant approach

dog 60%
mop 20%
alien 9%
other 1%



mop 60%
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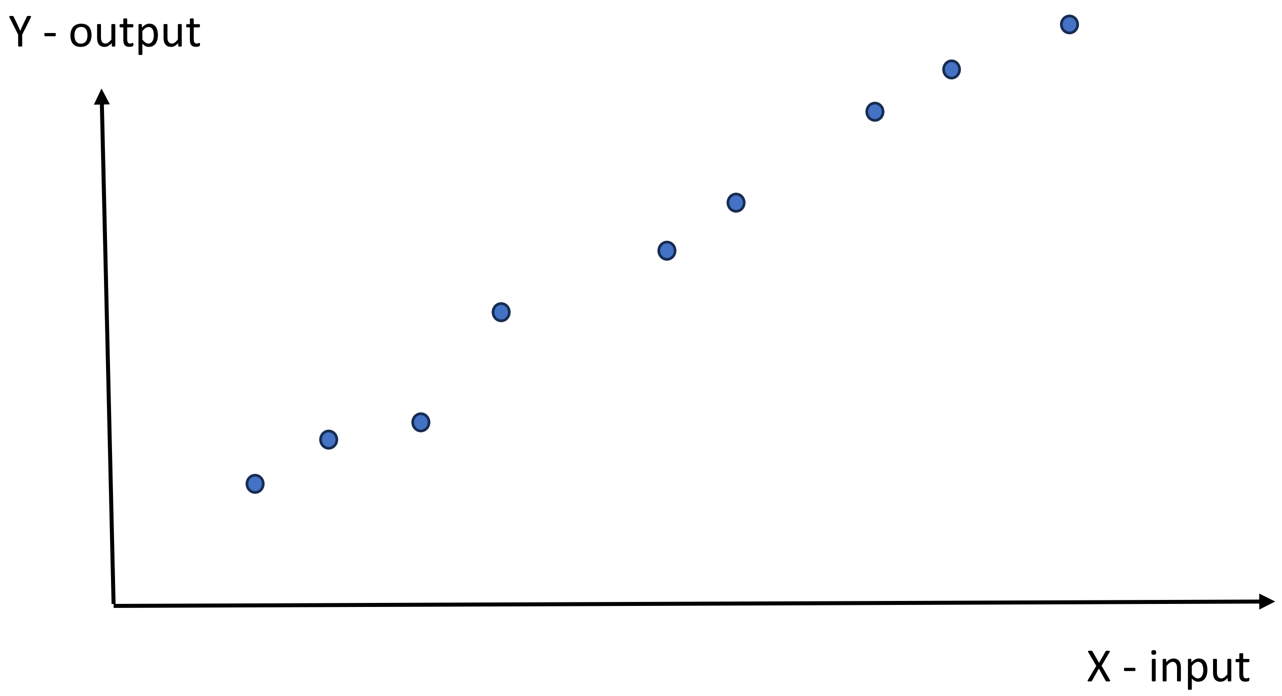
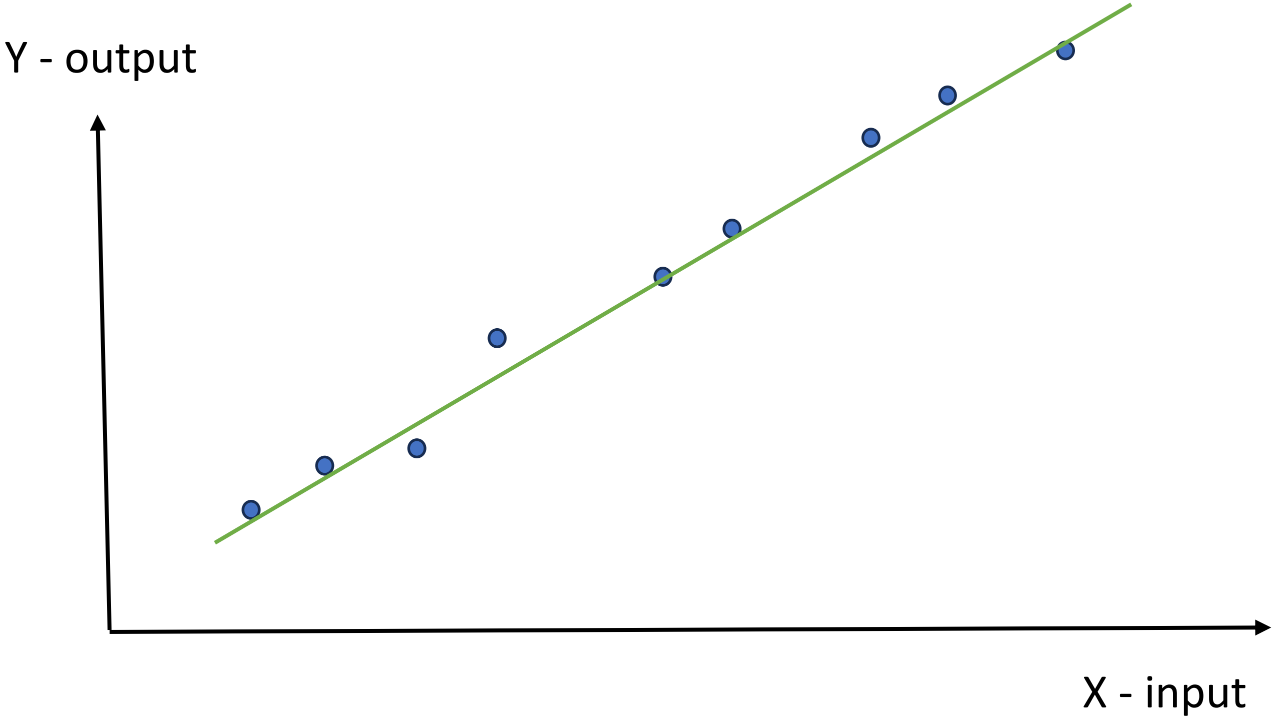
Learning from data



Learning from data



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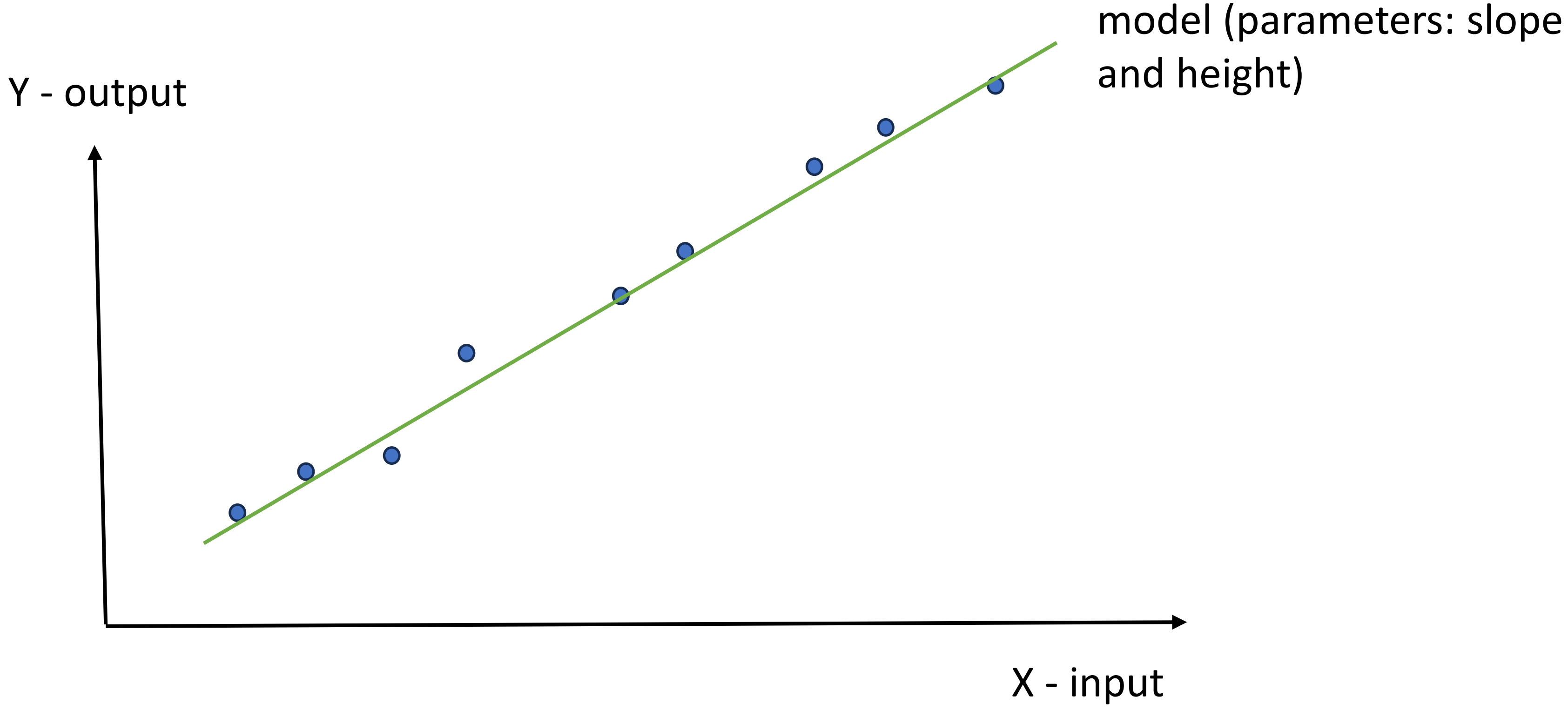
Dictionary: **Model**



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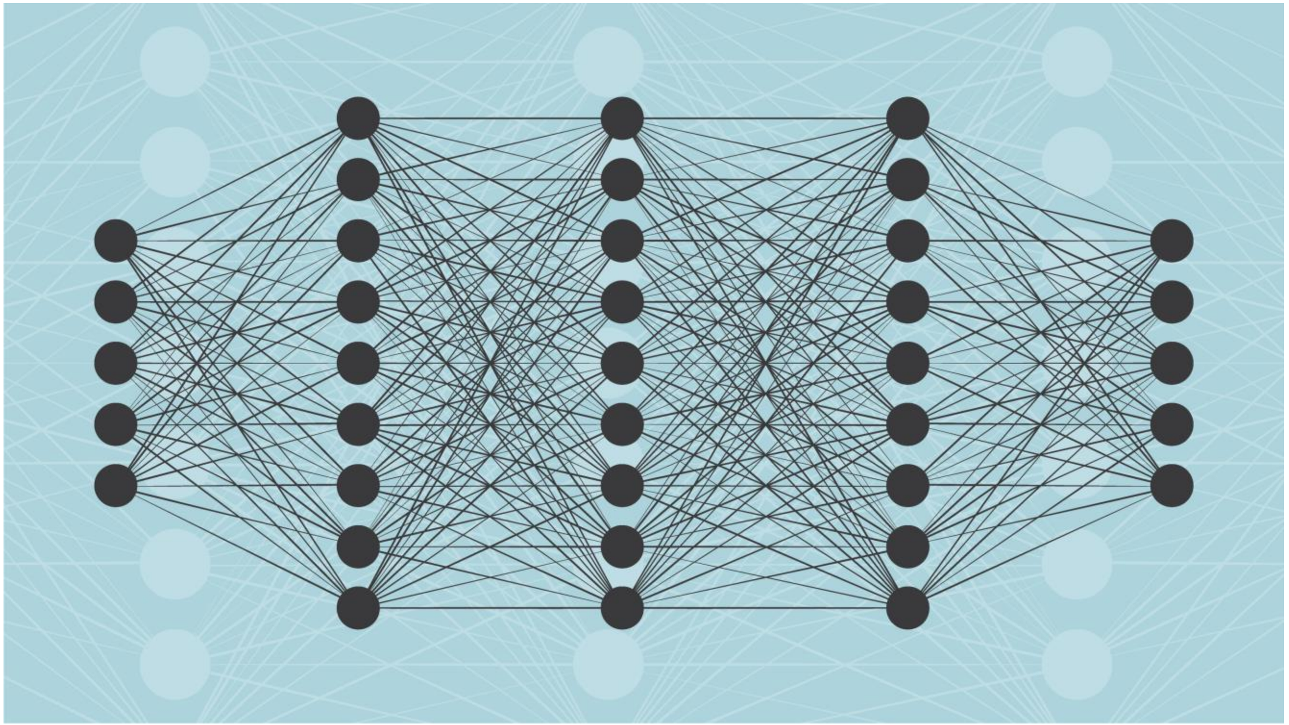
Dictionary: **Neural networks**



model (MANY parameters)

input

output

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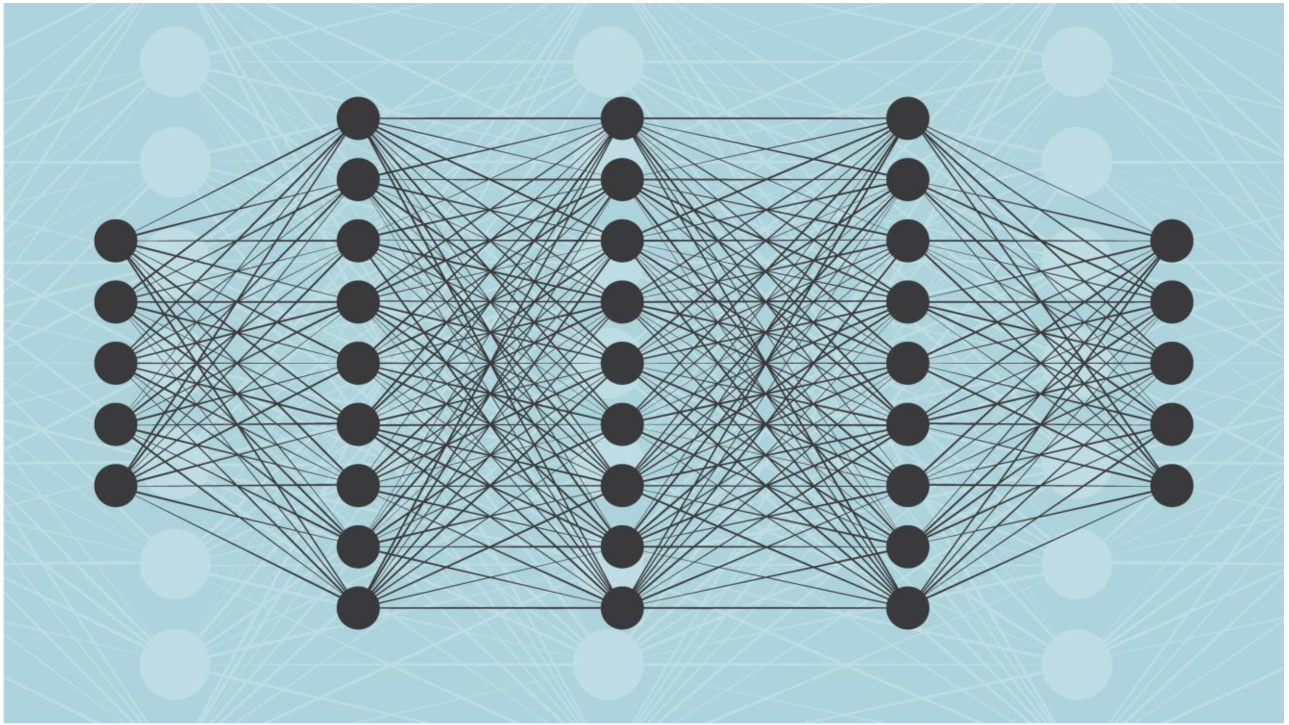
Dictionary: **Neural networks**



training = find suitable parameters

input

output

dog 100%

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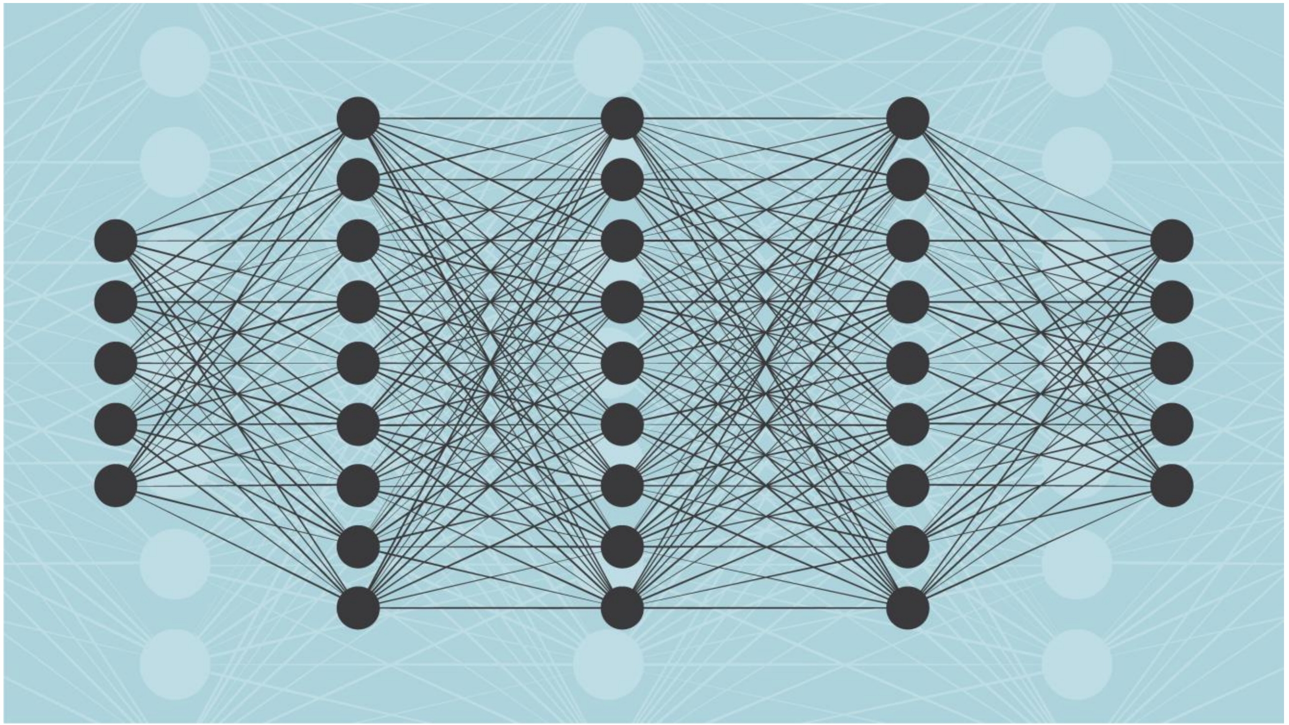
Dictionary: **Neural networks**

training = find suitable parameters

input



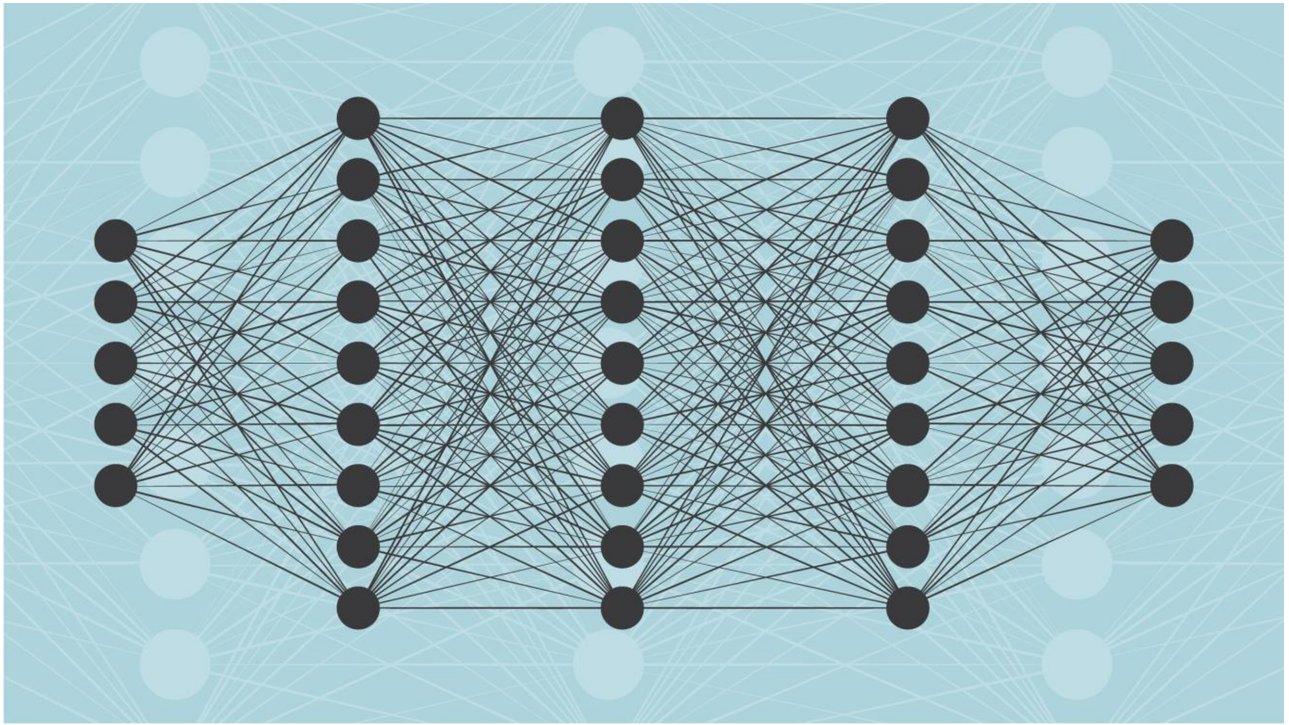
output

mop 100%

Dictionary: **Neural networks**

training = find suitable parameters

input



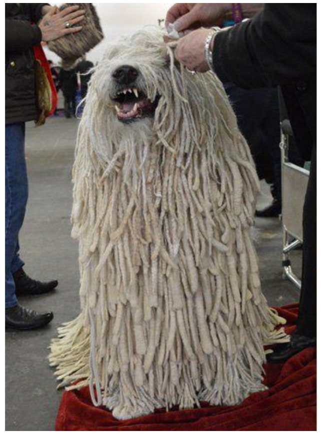
output

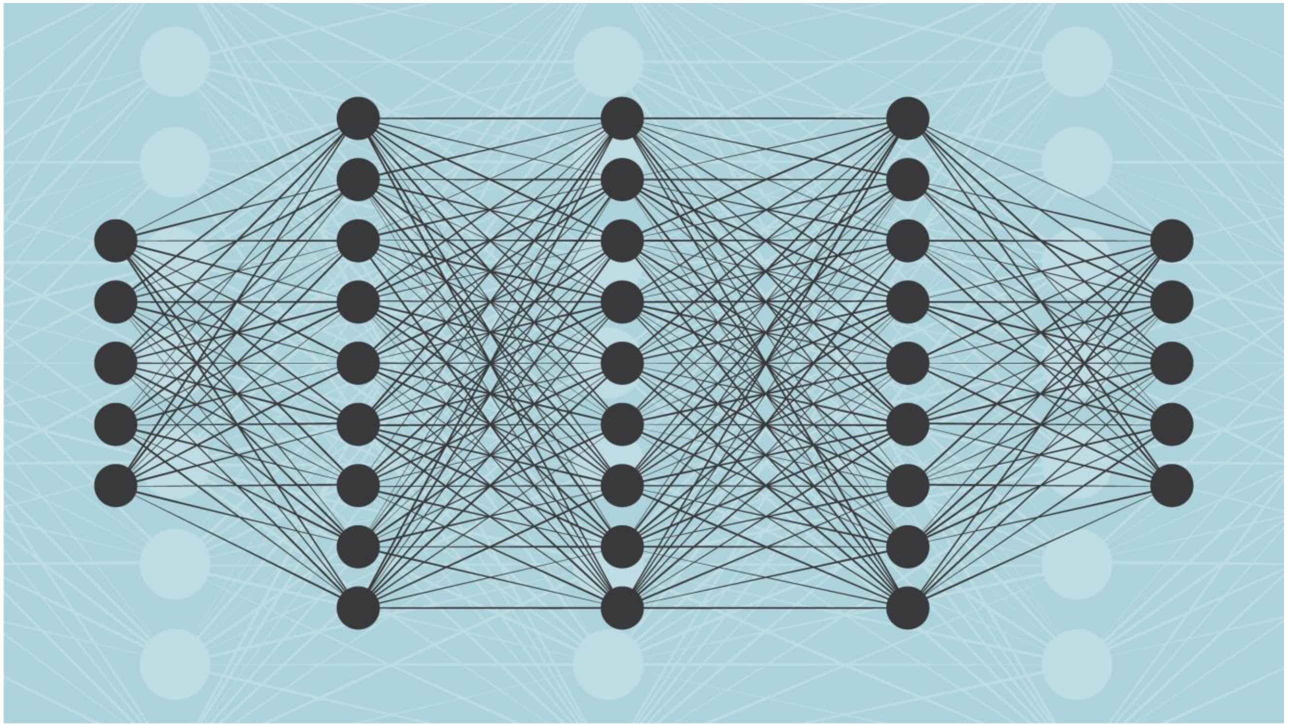
cat 100%

Dictionary: **Neural networks**

model (MANY parameters)

input

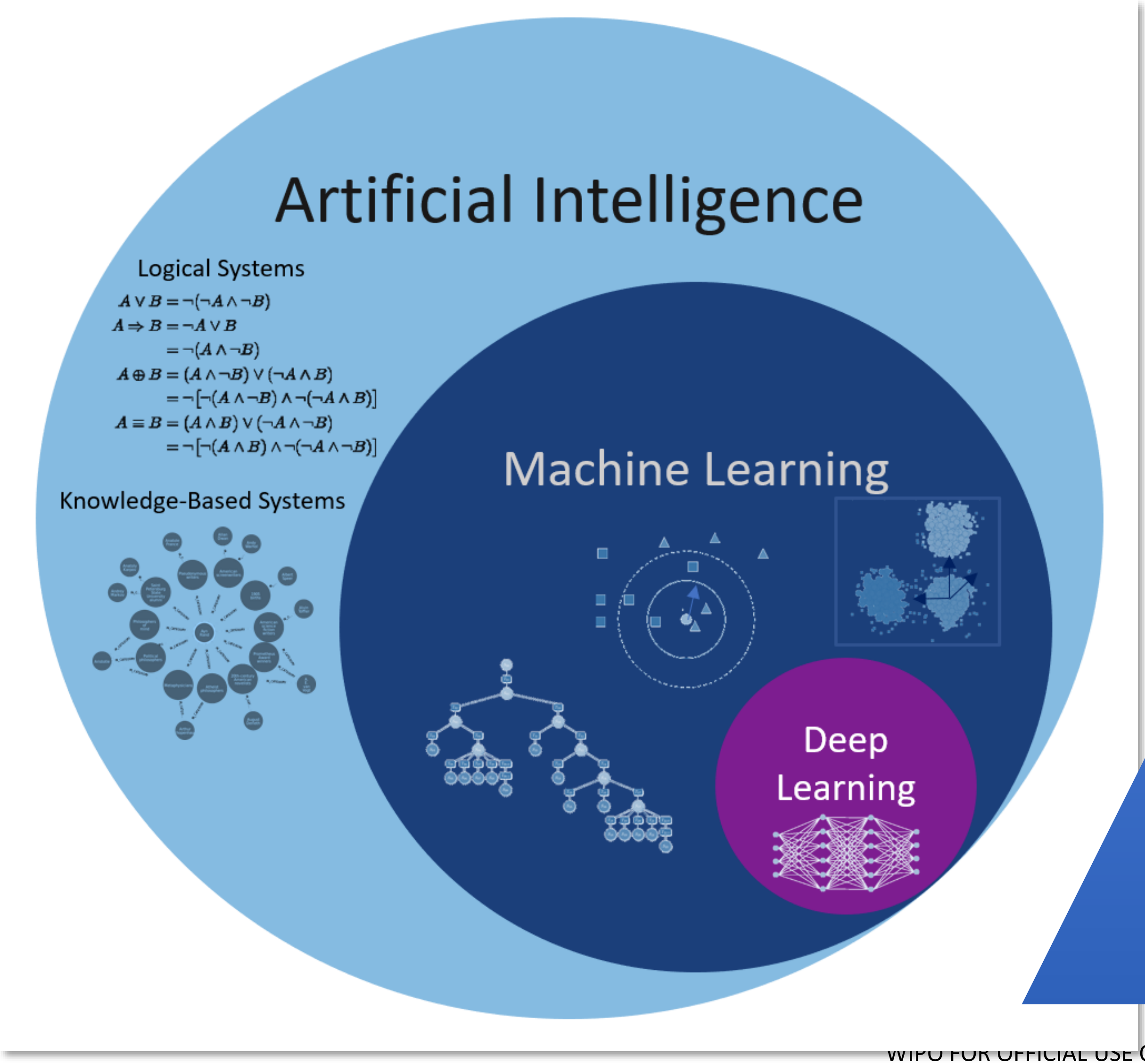




output

dog 60%
mop 20%
alien 9%
other 1%

Intelligence and AI Problem Statement


Artificial Intelligence
Logical Systems
$A \vee B = \neg(\neg A \wedge \neg B)$
$A \Rightarrow B = \neg A \vee B$
$= \neg(A \wedge \neg B)$
$A \oplus B = (A \wedge \neg B) \vee (\neg A \wedge B)$
$= \neg[\neg(A \wedge \neg B) \wedge \neg(\neg A \wedge B)]$
$A \equiv B = (A \wedge B) \vee (\neg A \wedge \neg B)$
$= \neg[\neg(A \wedge B) \wedge \neg(\neg A \wedge \neg B)]$
Knowledge-Based Systems
Machine Learning
Deep Learning

- Uncertainty
- Vagueness
- Incompleteness
- Resource Boundedness

Working definition

A software / hardware is intelligent if it

- Performs an intelligent function
- Can solve problems autonomously
- Reacts in real-time

Measures of AI

- Degree of autonomy
- Degree of task complexity (degree of freedom)
- Degree of efficiency and effectiveness of problem solving method

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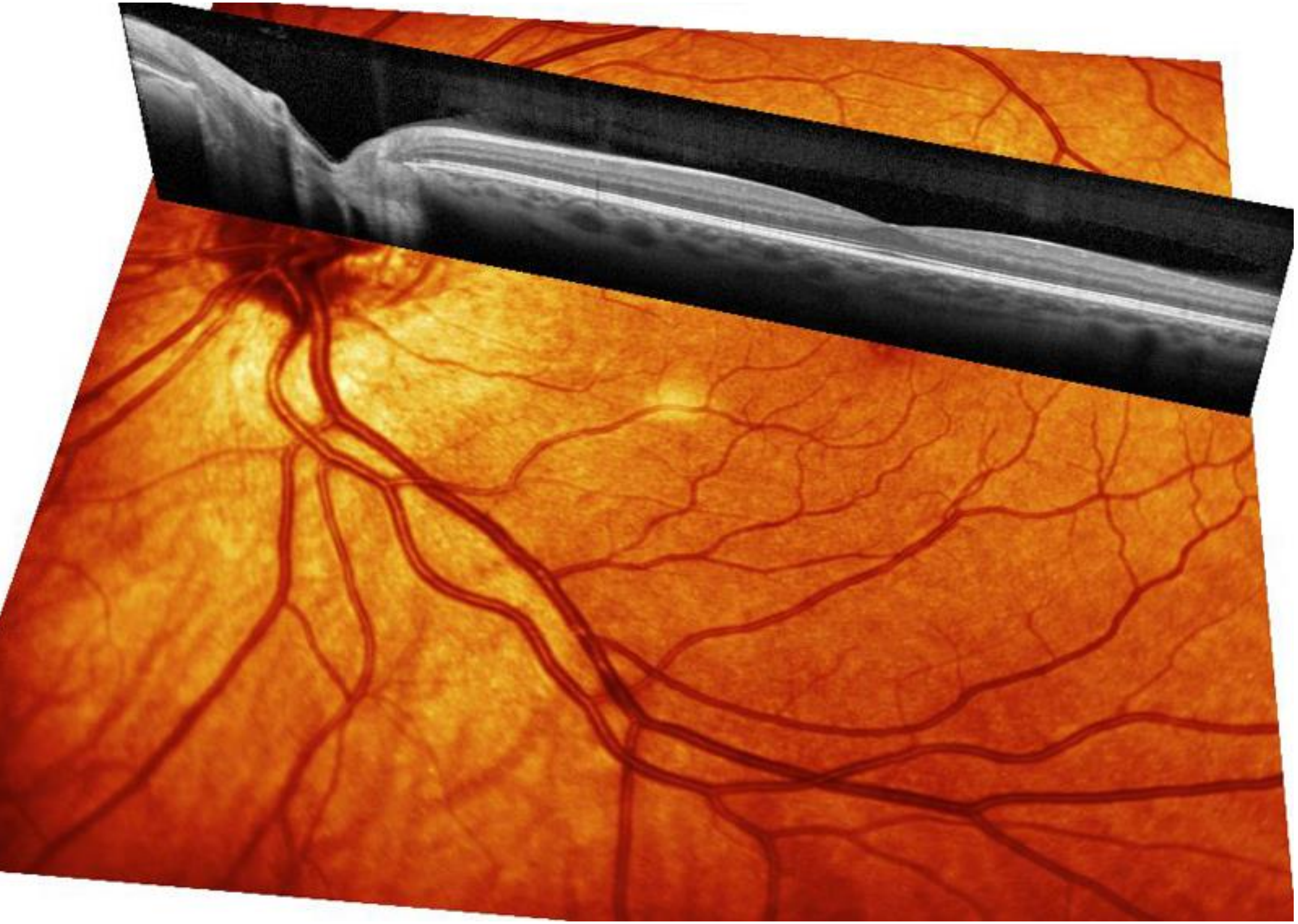
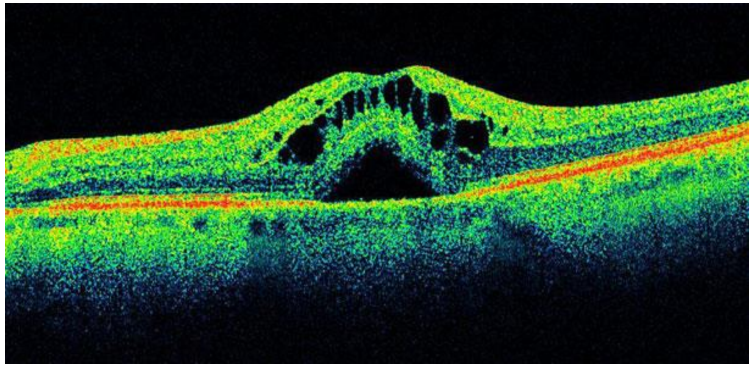
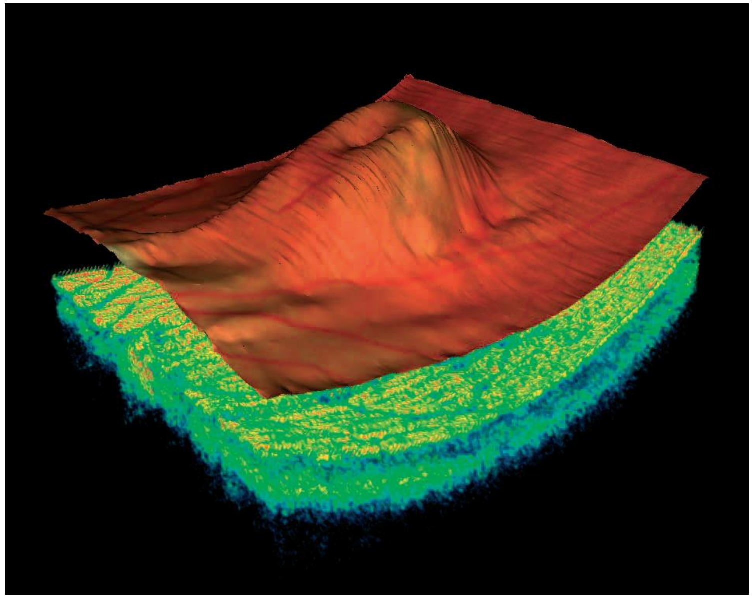
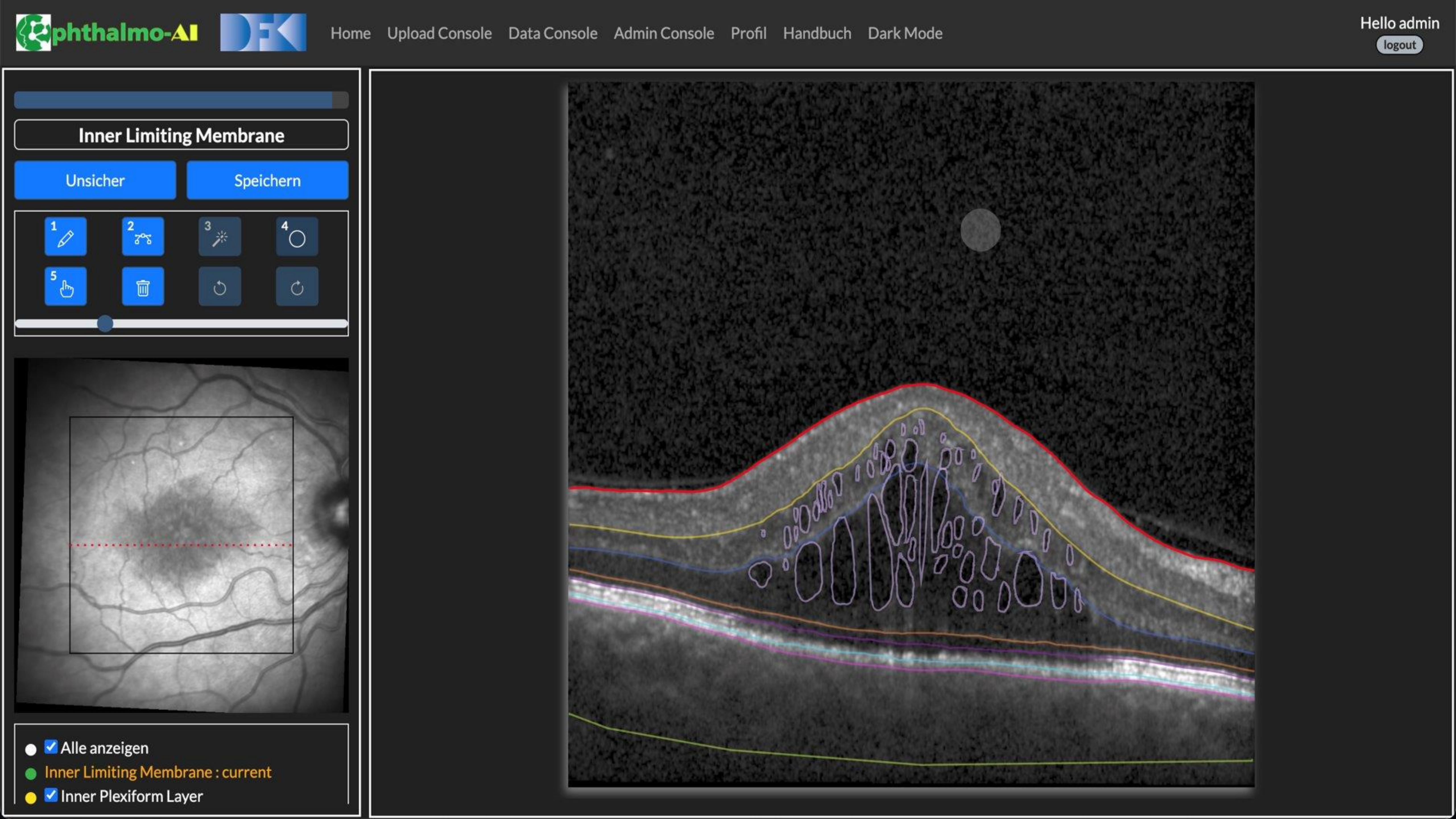
HEIDELBERG ENGINEERING

OPTICAL COHERENCE TOMOGRAPHY (OCT)





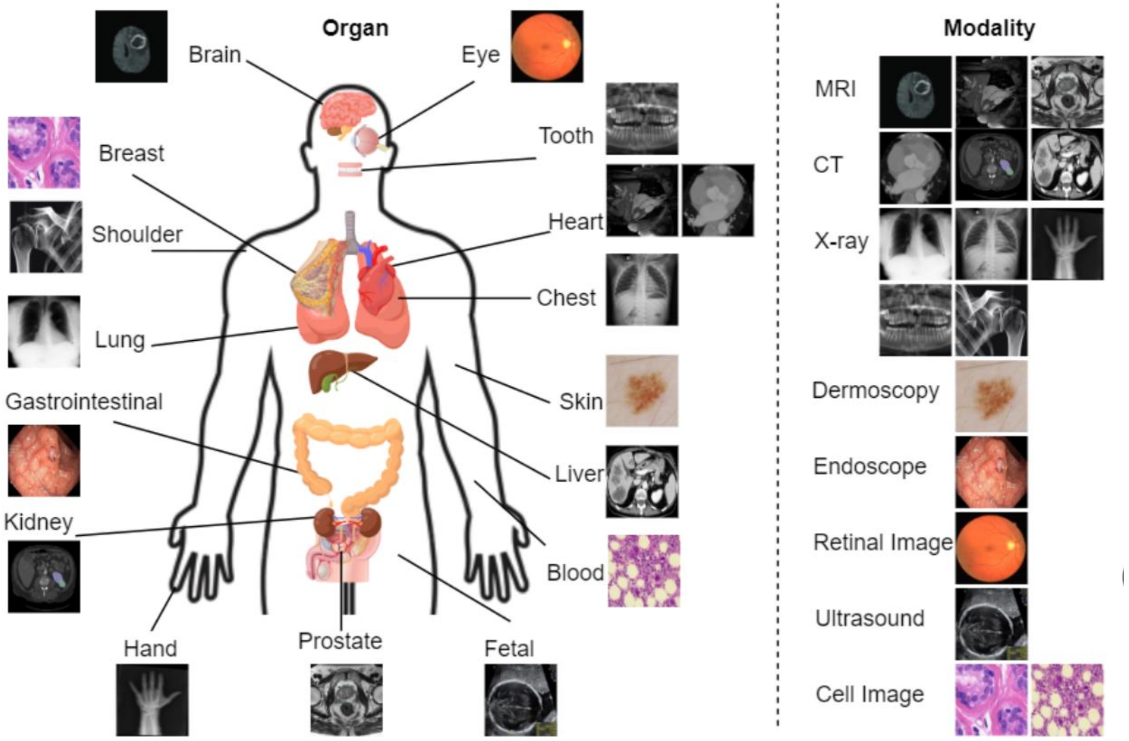




● ☑ Alle anzeigen

● Inner Limiting Membrane : current

● ☑ Inner Plexiform Layer



Foundation models
We collect ~ 55 datasets with **~1.3 million** medical images: capturing the structural constraints of feature embeddings through a combinatorial graph matching.

They can be trained efficiently end-to-end using modern gradient estimation techniques for black-box solvers.

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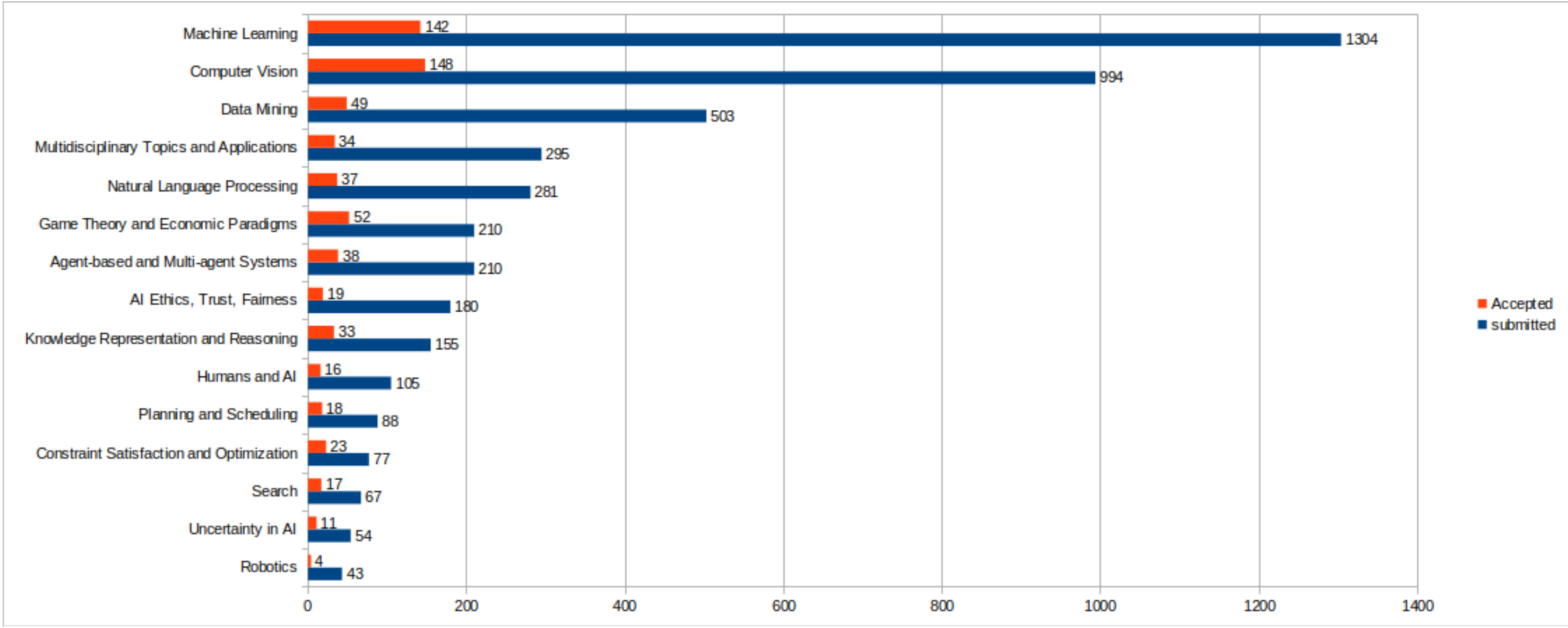
Submitted/Accepted Papers Per Keyword

IJCAI/2023 MACAO



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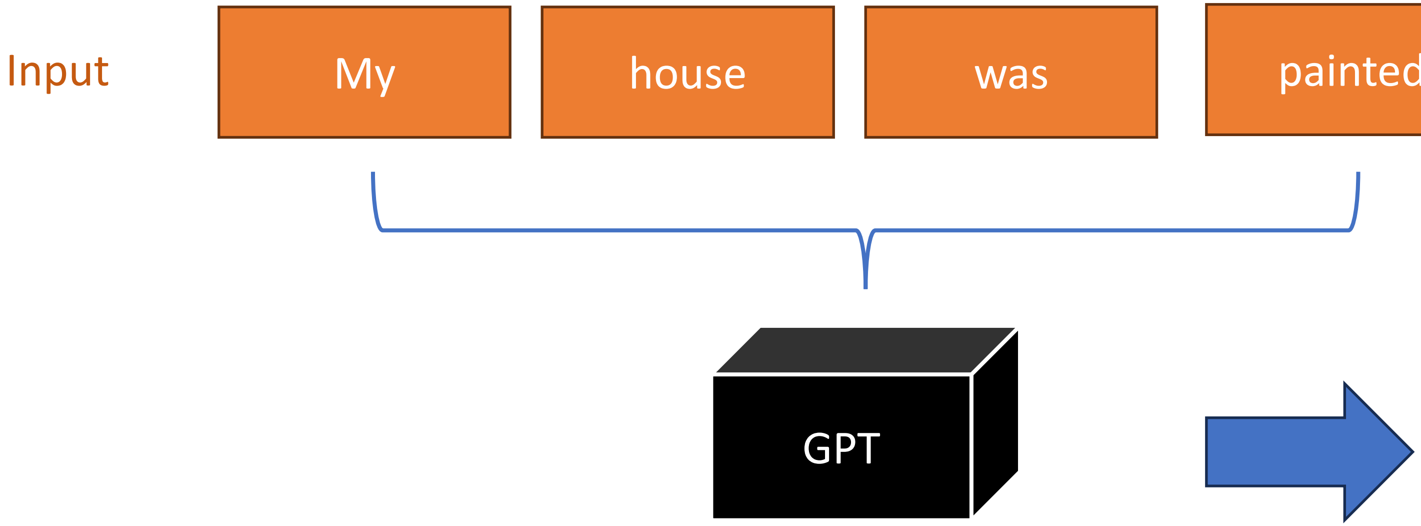
Generative AI

- The release of ChatGPT in November 2022 has brought so-called generative AI into the spotlight and to mainstream attention.
- Traditional AI systems are primarily used to analyze data and make predictions.
- Generative AI goes a step further by being able to create new data similar to its training data.
- Generate text of all sort and length.
- Generate multimedia content from text, or from text + images.
- Underlying network architectures are based on methods such as **transformers** (GPT for example stands for Generative Pre-trained Transfomer) or GANs (generative adversarial networks).
- These methods make it possible for generative AI to create new content, including audio, code, images, text, simulations, and videos.

ChatGPT (OpenAI)



Word	Probability
blue	29%
red	21%
white	7%
…	…

also cf. LLaMA (Meta), Sparrow (DeepMind), Bard / LaMDA (Google)

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The GPT family – Numbers and facts

Version	Year	Data	Dataset size	# Parameters
GPT	2018	BookCorpus	4.5 GB	117.000.000
GPT-2	2019	WebText (Reddit)	40 GB	1.500.000.000
GPT-3	2020	Multiple datasets	570 GB	175.000.000.000
GPT-4	2023	unknown	unknown	unknown

Radford et al (2018). Improving Language Understanding by Generative Pre-Training.
Radford et al (2019). Language Models are Unsupervised Multitask Learners.
Brown et al. (2020). Language Models are Few-Shot Learners.
OpenAI (2023). GPT-4 Technical Report.

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Prompt patterns/templates for roles

Define ChatGPT role	Explanations	Chained Prompting
- Act as a Linux terminal - Act as "position" Interviewer - Act as a JavaScript Console - Act as an Excel Sheet - Act as an English Teacher - Act as a Plagiarism Checker - Act as an Advertiser	- Explain clearly - Explain uniquely - Explain detailed - Explain like I’m 5 - Explain with examples - Explain to 5th graders - Explain like Noam Chomsky - Explain detailed with examples - Explain to high school students	Write an article .. First give me the outline, which consists of a headline, a teaser, and several subheadings. [Output] Now write 5 different subheadings. [Output] Add 5 keywords for each subheading. [Output]

Adapted from various user blogs

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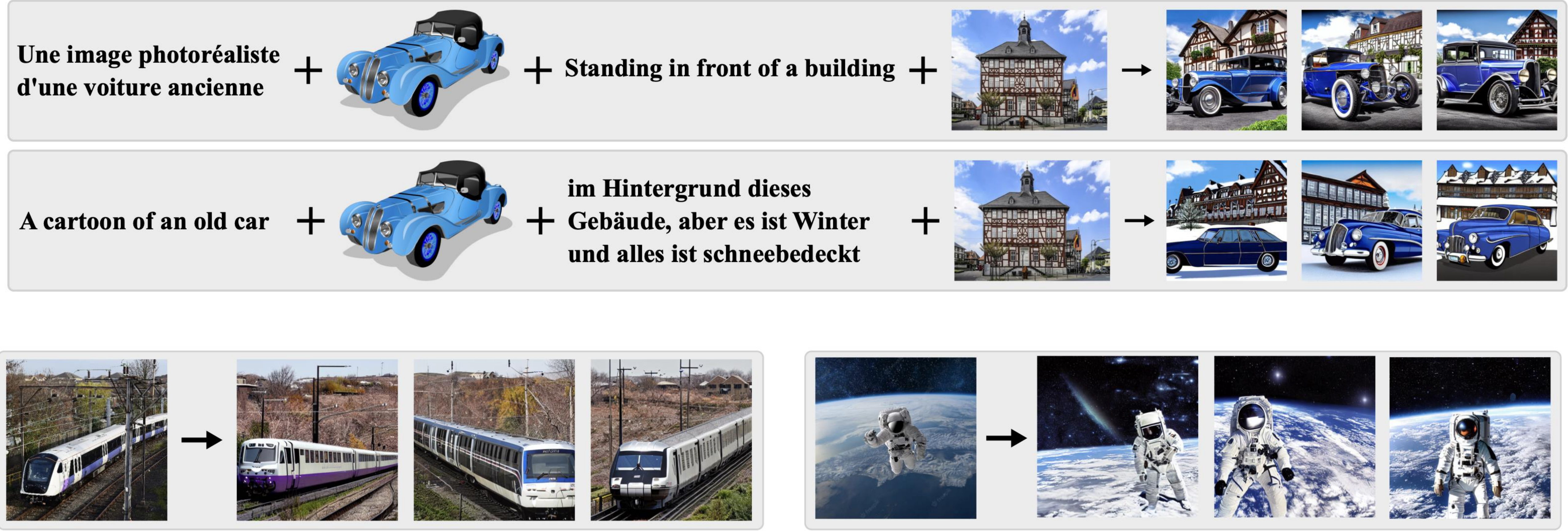
Multilingual, multimodal prompting and non-trivial variations


Une image photoréaliste d'une voiture ancienne
+
+
Standing in front of a building
+
→
A cartoon of an old car
+
+
im Hintergrund dieses Gebäude, aber es ist Winter und alles ist schneebedeckt
+
→
→
→

MultiFusion: Fusing Pre-Trained Models for Multi-Lingual, Multi-Modal Image Generation (2023), DFKI, HessianAI, University of Darmstadt et al.

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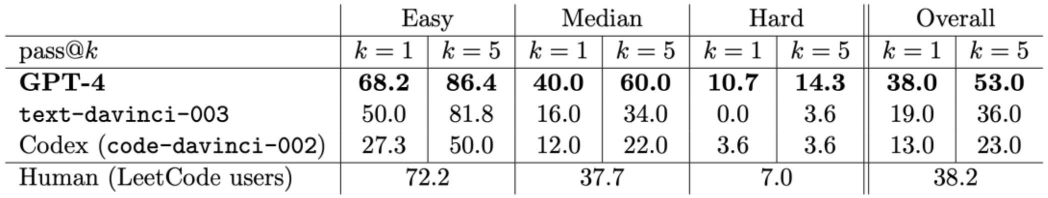
Questions?

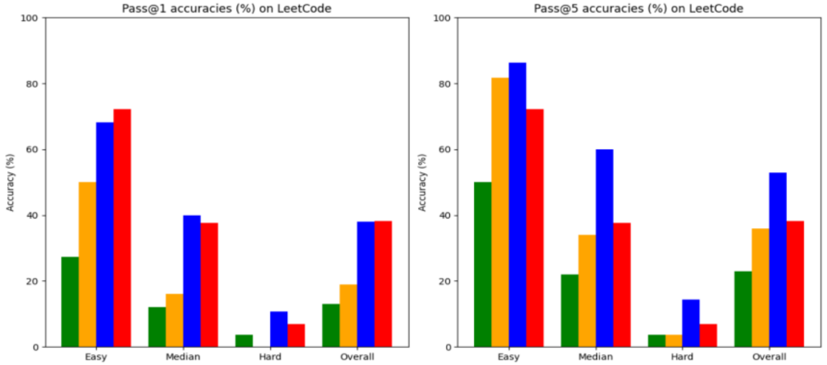


	Easy		Median		Hard		Overall	
pass@k	$k = 1$	$k = 5$	$k = 1$	$k = 5$	$k = 1$	$k = 5$	$k = 1$	$k = 5$
GPT-4	**68.2**	**86.4**	**40.0**	**60.0**	**10.7**	**14.3**	**38.0**	**53.0**
`text-davinci-003`	50.0	81.8	16.0	34.0	0.0	3.6	19.0	36.0
Codex (`code-davinci-002`)	27.3	50.0	12.0	22.0	3.6	3.6	13.0	23.0
Human (LeetCode users)	72.2		37.7		7.0		38.2	

→

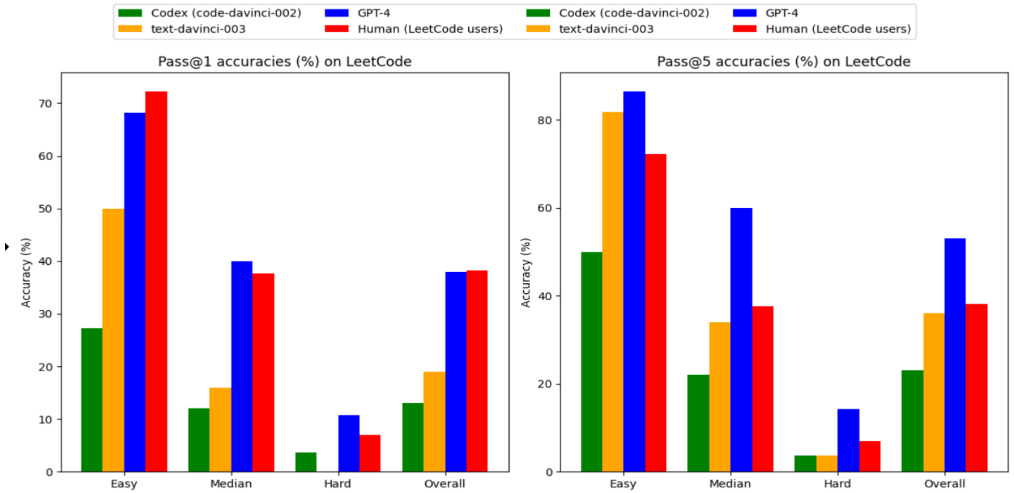
```
begin{document} \begin{tikzpicture}[every node/.style={align=center,minimum
width=4cm,minimum height=2cm,rectangle,outer sep=0pt},>=latex, decoration={
markings,% switch on markings mark=at position 0.25 with {\draw (-4pt,-4pt) --
(4pt,4pt);\draw (4pt,-4pt) -- (-4pt,4pt);}} ] \node (empty) {}; \node[below=of empty] (mech-
1) {mechanism\\descriptor}; \node[below=of mech-1] (mech-2) {mechanism\\descriptor};
\node[right=of empty] (event) {\textbf{event}\\caption}; \node[draw,right=of mech-1]
(process-1-1) {\textbf{process}\\caption}; \node[draw,right=of process-1-1] (process-1-2)
{\textbf{process}\\caption}; \node[draw,right=3cm of mech-2] (process-2-1)
{\textbf{intermediate process}}; \node[draw,right=of process-2-1] (process-2-2)
{\textbf{intermediate process}};  ……
```

↙



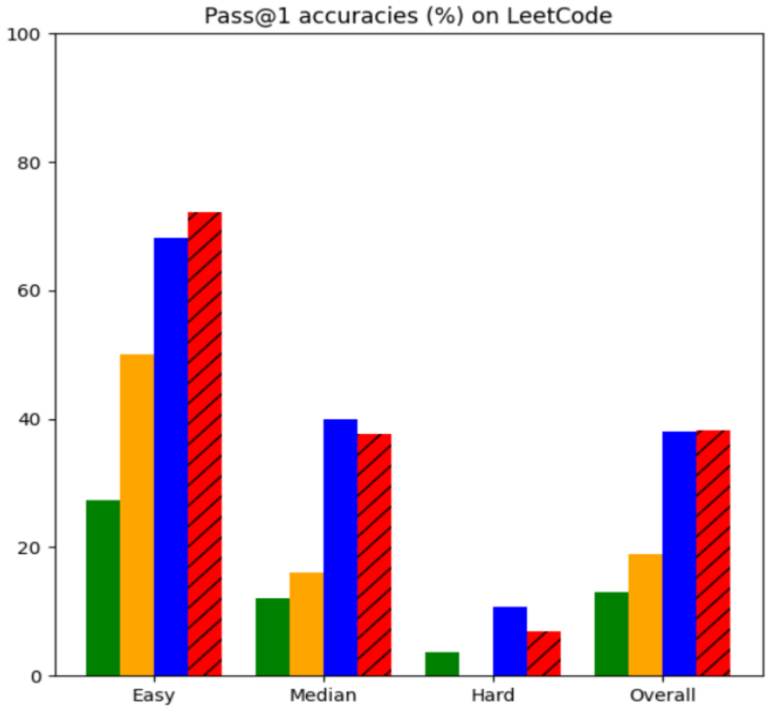
Can you make both plots have the same range in the y axis? And the legend has each model name twice.

↓



→

Is there a way to make the **'Human' bar** more distinctive, to separate it from the other 3?



Sparks of Artificial General Intelligence: Early experiments with GPT-4, Mircosoft Research 2023

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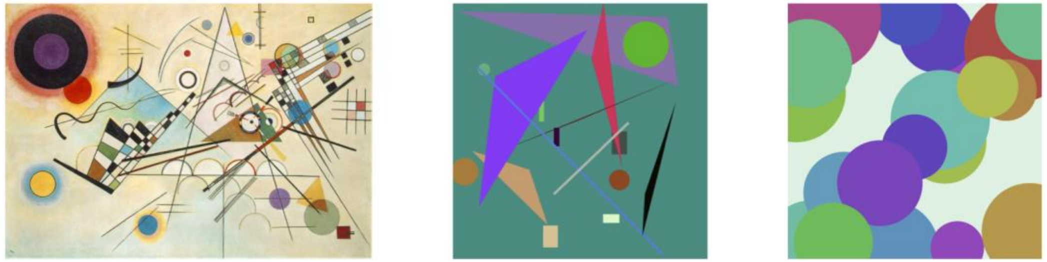
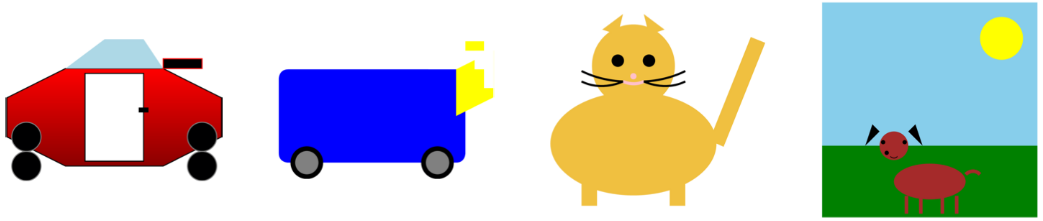
Python code for image generation

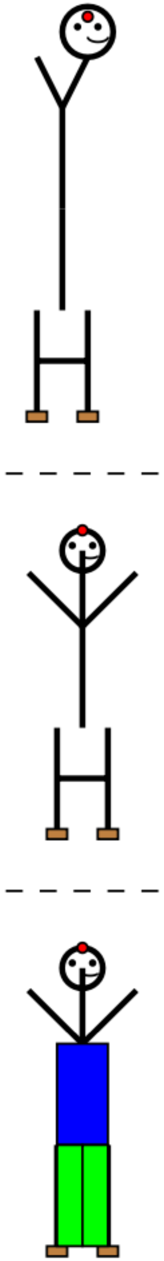
```
<!DOCTYPE html>
<html> <head>
<title>Kandinsky Generator</title> </head>
<body>
<button id="generate-button">Generate Kandinsky Painting</button> <canvas
id="kandinsky"></canvas>
<script>
const canvas = document.getElementById('kandinsky'); const ctx =
canvas.getContext('2d');
function generateKandinsky() {
// Set the canvas size to a random value between 500 and 800 pixels
canvas.width = Math.floor(Math.random() * 300 + 500); canvas.height =
Math.floor(Math.random() * 300 + 500);
// Set the background color to a random pastel color
ctx.fillStyle = `hsl(${Math.random() * 360}, 50%, 90%)`; ctx.fillRect(0, 0,
canvas.width, canvas.height);
// Draw a random number of circles with random sizes, positions, and colors
const numCircles = Math.floor(Math.random() * 20 + 10); for (let i = 0; i <
numCircles; i++) {
const x = Math.random() * canvas.width; const y = Math.random() *
canvas.height; const radius = Math.random() * 100 + 50; ctx.beginPath();
ctx.arc(x, y, radius, 0, 2 * Math.PI);
ctx.fillStyle = `hsl(${Math.random() * 360}, 50%, 50%)`; ctx.fill();
} }
// Add an event listener to the button to generate a new Kandinsky painting
when clicked
const button = document.getElementById('generate-button');
button.addEventListener('click', generateKandinsky);
// Generate an initial Kandinsky painting
generateKandinsky(); </script>
</body> </html>
```

“Produce javascript code which generates random images in the style of the painter Kandinsky”



SVGs generated by GPT-4 for the classes automobile, truck, cat, dog.





Sparks of Artificial General Intelligence: Early experiments with GPT-4, Mircosoft Research 2023

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Beyond **ChatGPT**

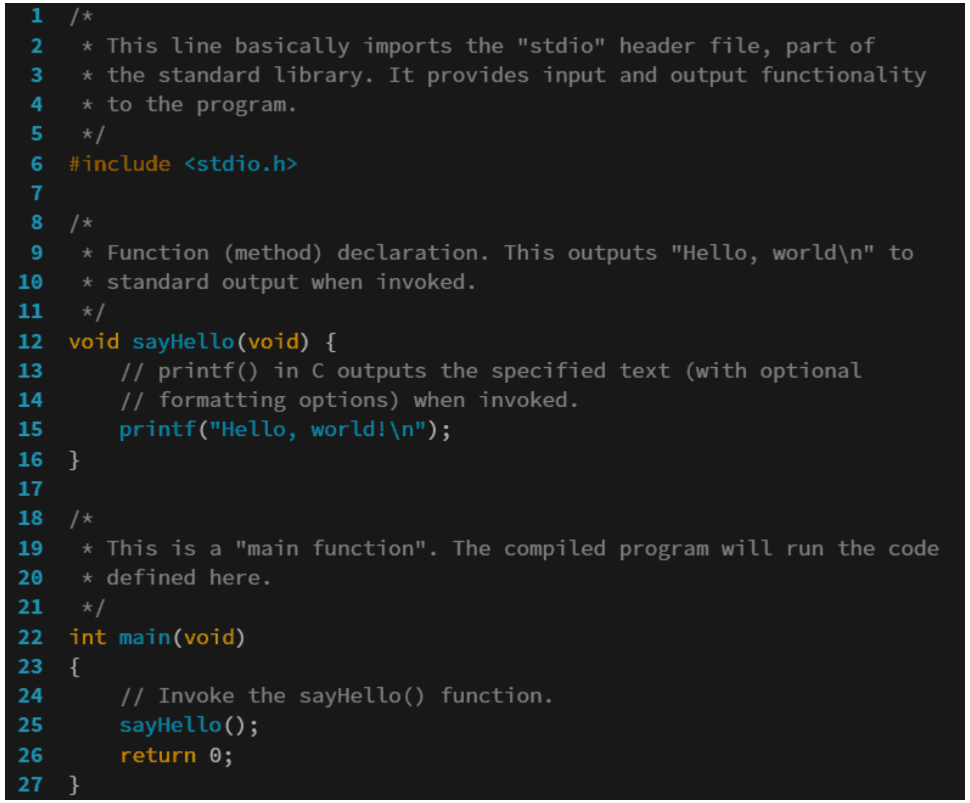
Languages: English

Beyond **ChatGPT**

Languages: English

Beyond **ChatGPT**

Languages: English



```
/*
 * This line basically imports the "stdio" header file, part of
 * the standard library. It provides input and output functionality
 * to the program.
 */
#include <stdio.h>

/*
 * Function (method) declaration. This outputs "Hello, world\n" to
 * standard output when invoked.
 */
void sayHello(void) {
    // printf() in C outputs the specified text (with optional
    // formatting options) when invoked.
    printf("Hello, world!\n");
}

/*
 * This is a "main function". The compiled program will run the code
 * defined here.
 */
int main(void)
{
    // Invoke the sayHello() function.
    sayHello();
    return 0;
}
```

Beyond ChatGPT – What is a language?

formal language

alphabet

grammar

well-formed sequences

Beyond **ChatGPT – What is a language?**

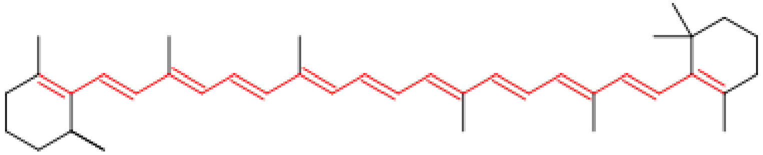
formal language

alphabet

grammar

well-formed sequences

SMILES



CC1CCC/C(C)=C1/C=C/C(C)=C/C=C/C(C)=C/C=C/C=C(C)/C=C/C=C(C)/C=C/C2=C(C)/CCCC2(C)C

Thanks for your attention!