کاربرد هوش مصنوعی در پژوهش و فناوریهای حوزه سلامت و پزشکی

Biomimetics

بیومیمتیک یک حوزه بین‌رشته‌ای است که در آن اصول مهندسی، شیمی و زیست‌شناسی برای ساخت مواد، سیستم‌های مصنوعی یا ماشین‌ها به کار گرفته می‌شود که عملکردهای آنها مشابه فرآیندهای زیستی است.

Outline

- ❑ Introduction of AI
- ❑ Application in Research
- ❑ Application in Technology

Artificial Intelegent (AI)

- Artificial intelligence is when mach d make decisions.
- AI enables computers to think as v

ChatGPT

Medical Data

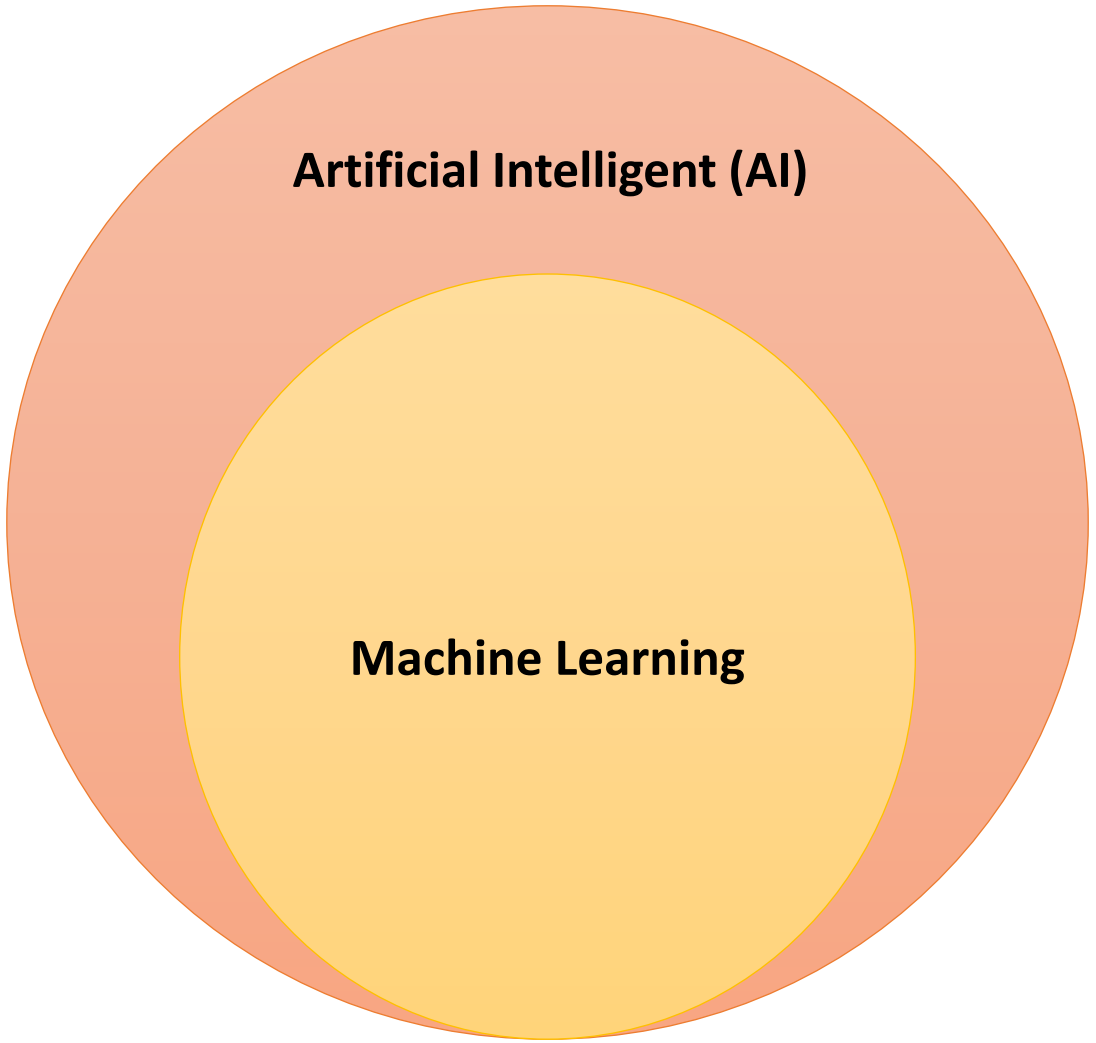
❖ Tabular

- Genomic Data
- Clinical Data
- Pharmaceutical Data
- Epidemiological data

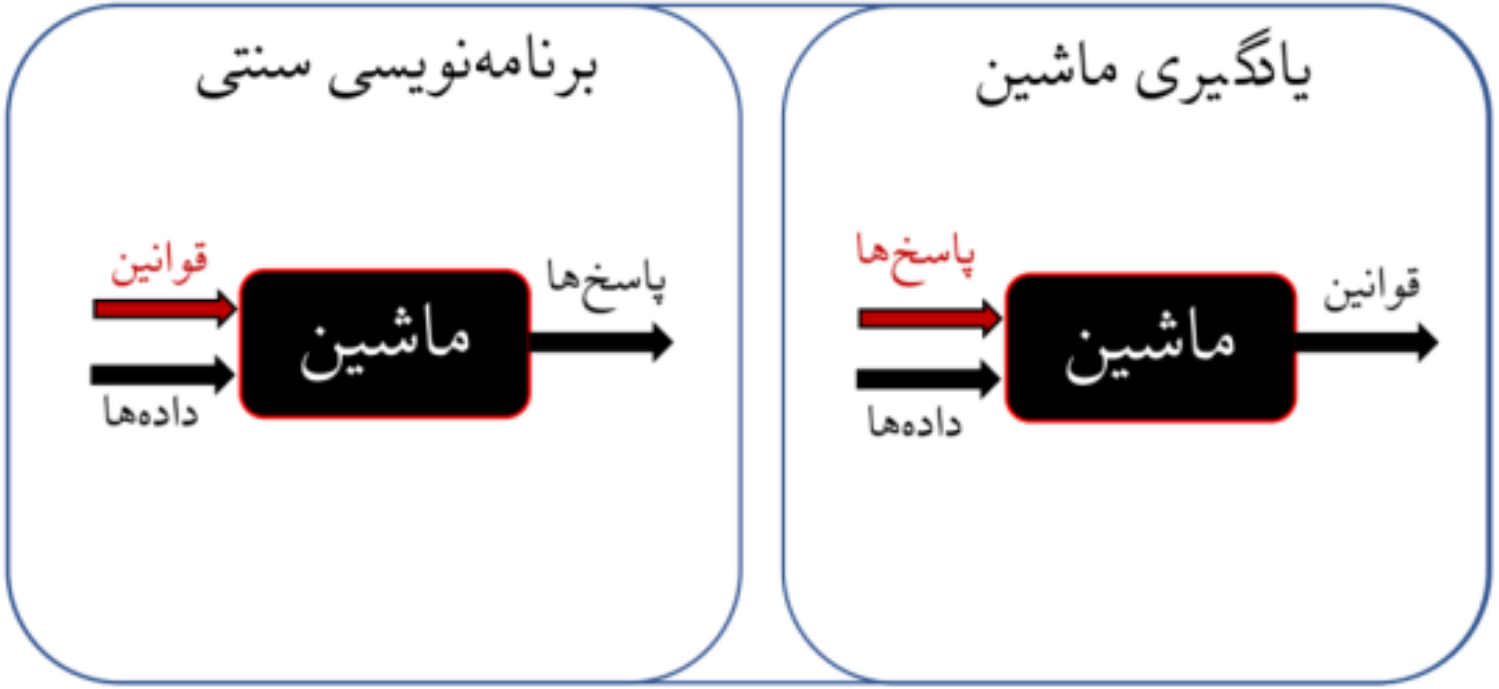
❖ Text Data

❖ Imaging Data

Machine Learning (ML)



Machine Learning



$$X \xrightarrow{R} Y$$

داده — قانون — پاسخ

Machine Learning

Example

Cat

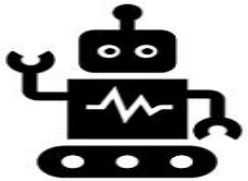
Dog

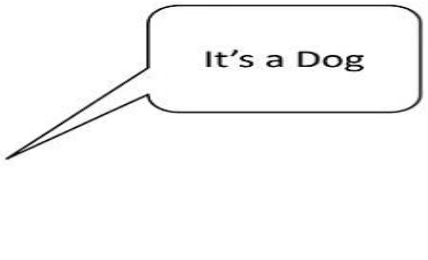
Bunny

Labelled pictures

We are **helping machine** to learn by **labeling each picture** with the name of the animal.

New picture





Example: Cardiac Disease

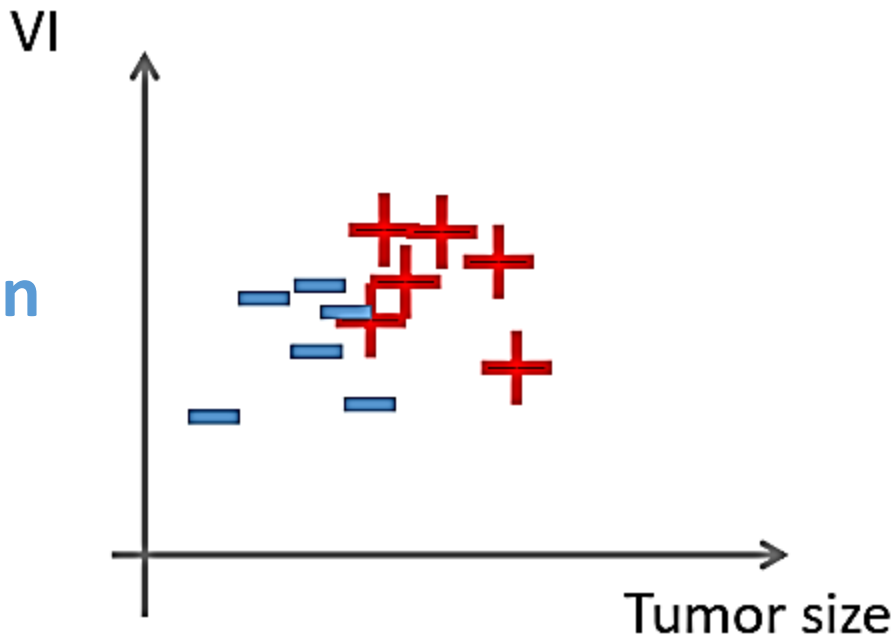
Features

Patients

	HBR	BS	…	Target
Patient1	90	9		1
Patient2	89	12	Pattern	0
Patient3	71	15		1
…	…			

Training data: Example

Classification



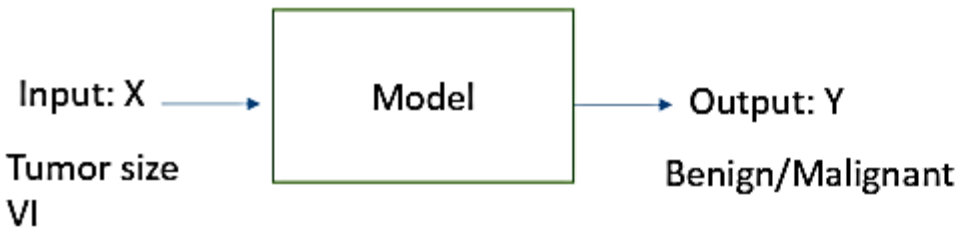
Training data

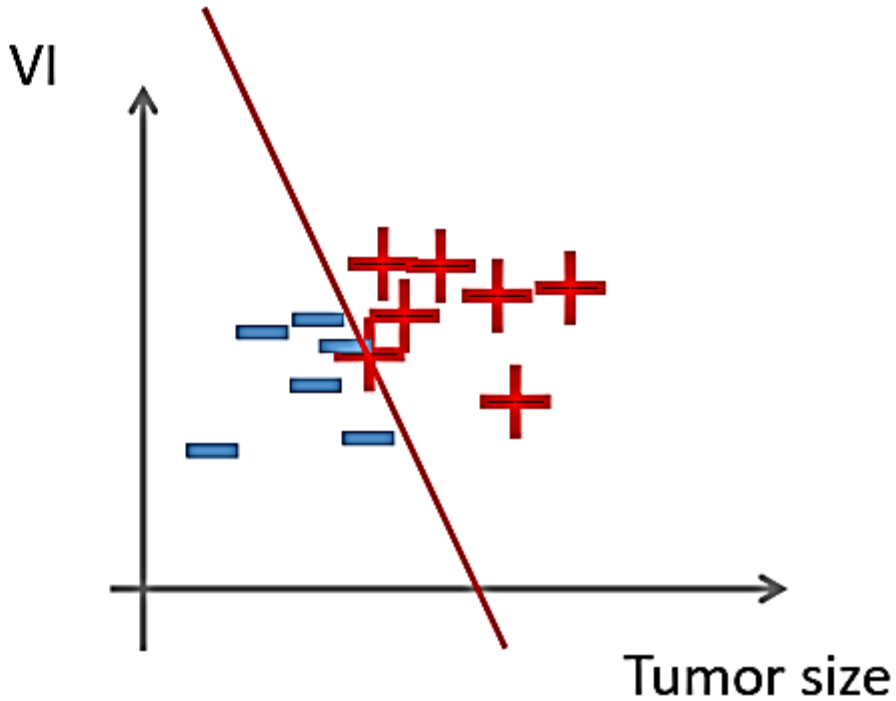
Tumor size	VI	Malignant	
0.9	2.3	0	−
3.5	2.6	0	−
2.6	3.3	0	−
2.7	4.1	0	−
1.8	3.9	0	−
3.5	3	1	+
4.2	3.7	1	+
4.9	4.5	1	+
3.9	4.5	1	+
5.8	4.1	1	+
6.1	2.6	1	+

Source: Dr. Mahdieh Soleymani, Sharif University

Classification

- Learn the function from inputs to outputs through training examples



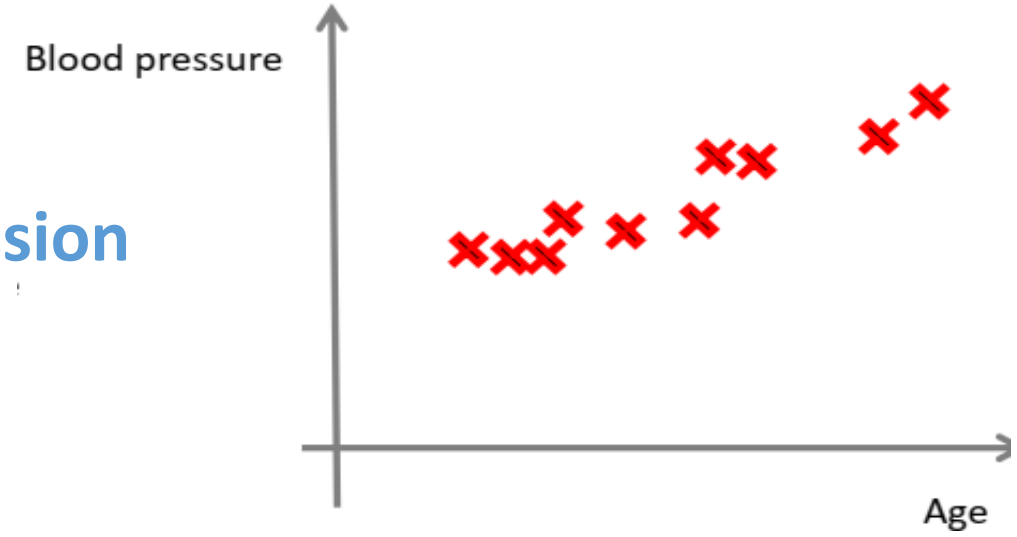


Example: Blood Pressure

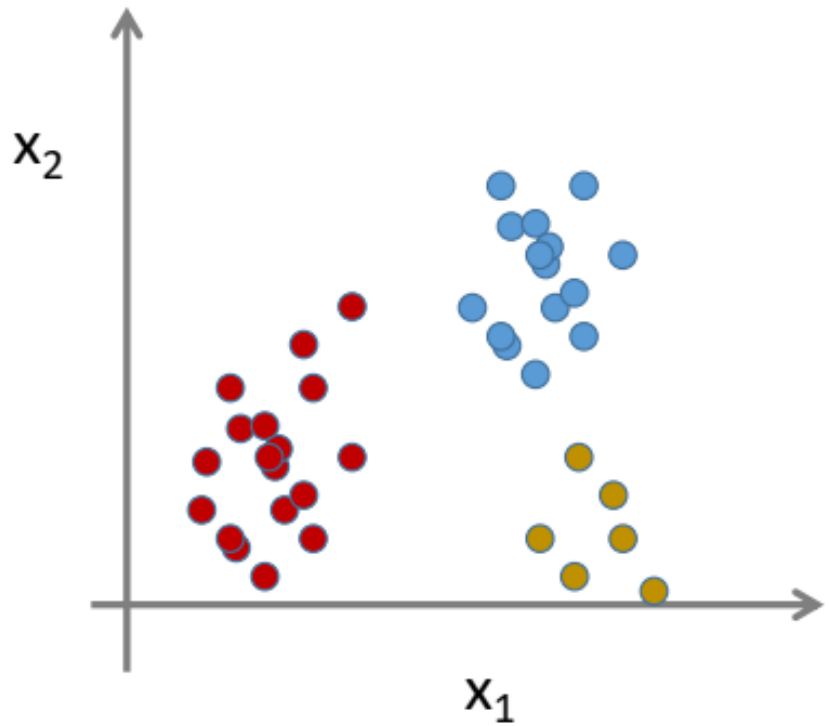
	AGE	GENDER	BMI	FAMILY HISTORY …	BP
Patient1	61	M	20	N	120/80
Patient2	55	W	18	Y	90/50
Patient3	71	M	32	Y	150/95
…	…	…			

Function

Regression

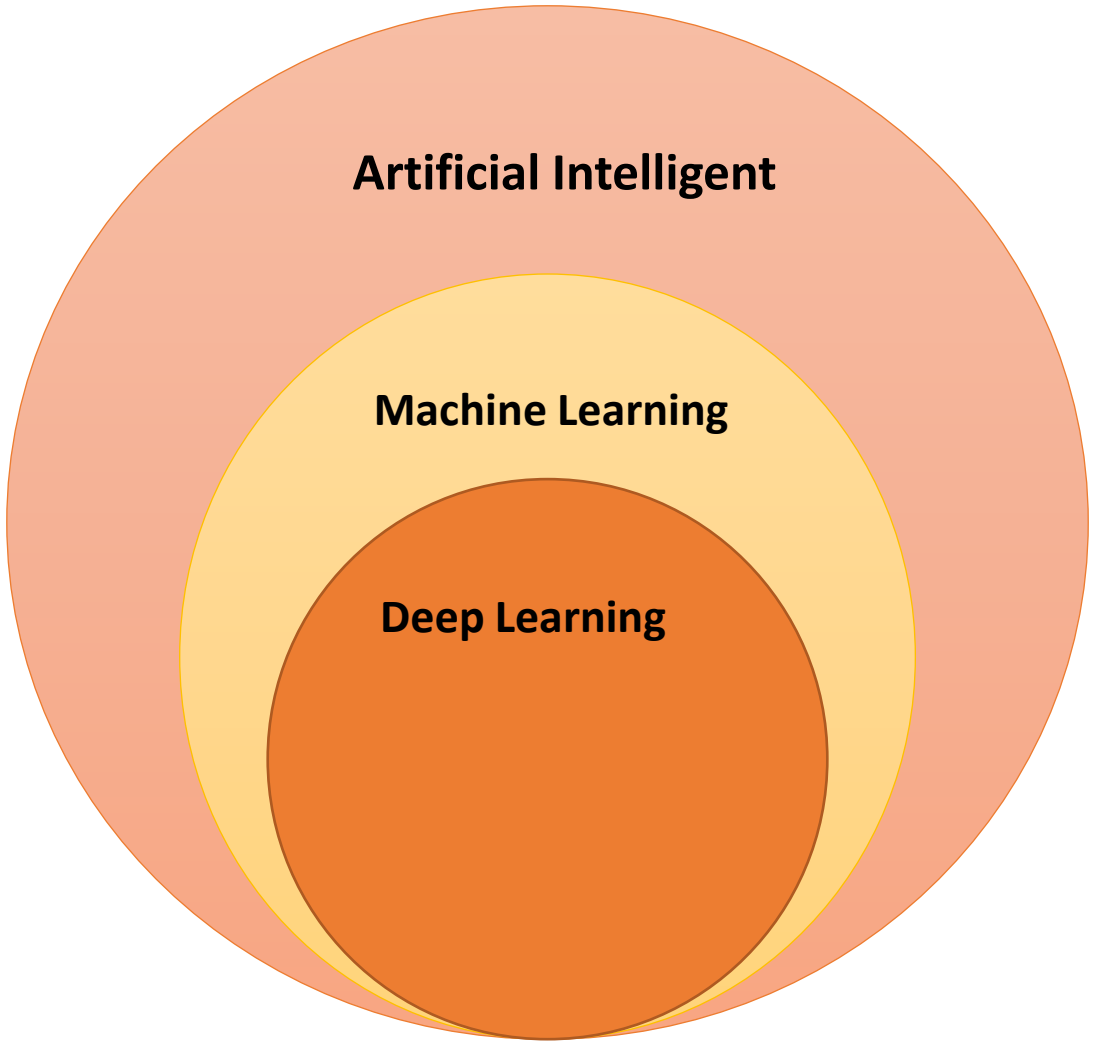


$$A \xrightarrow{F} B$$



Classification

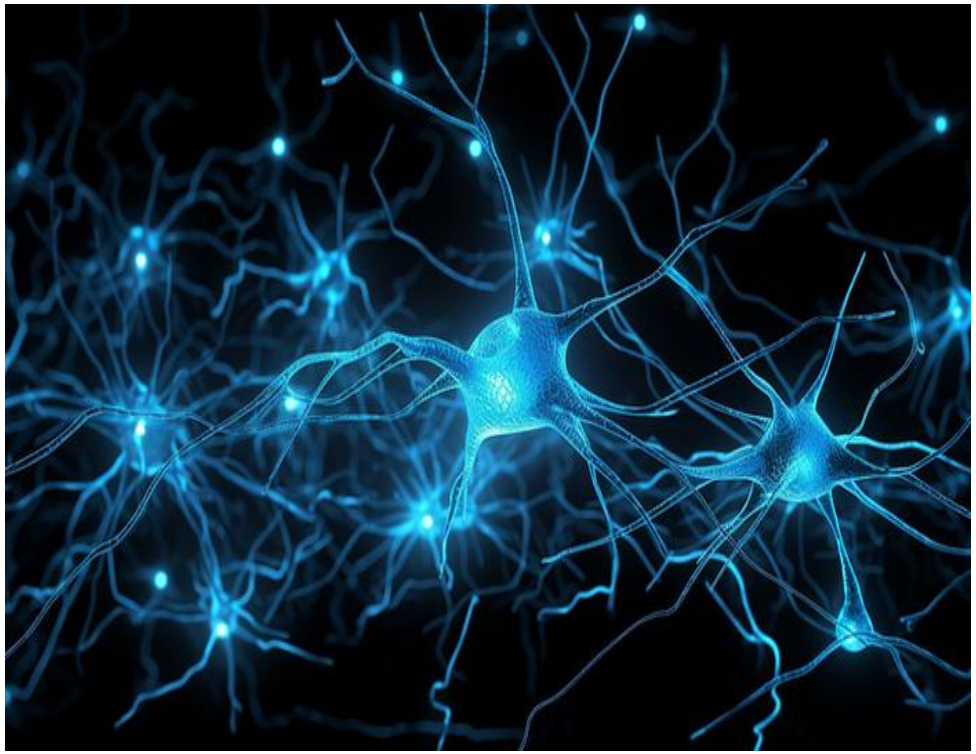
Deep Learning (DL)

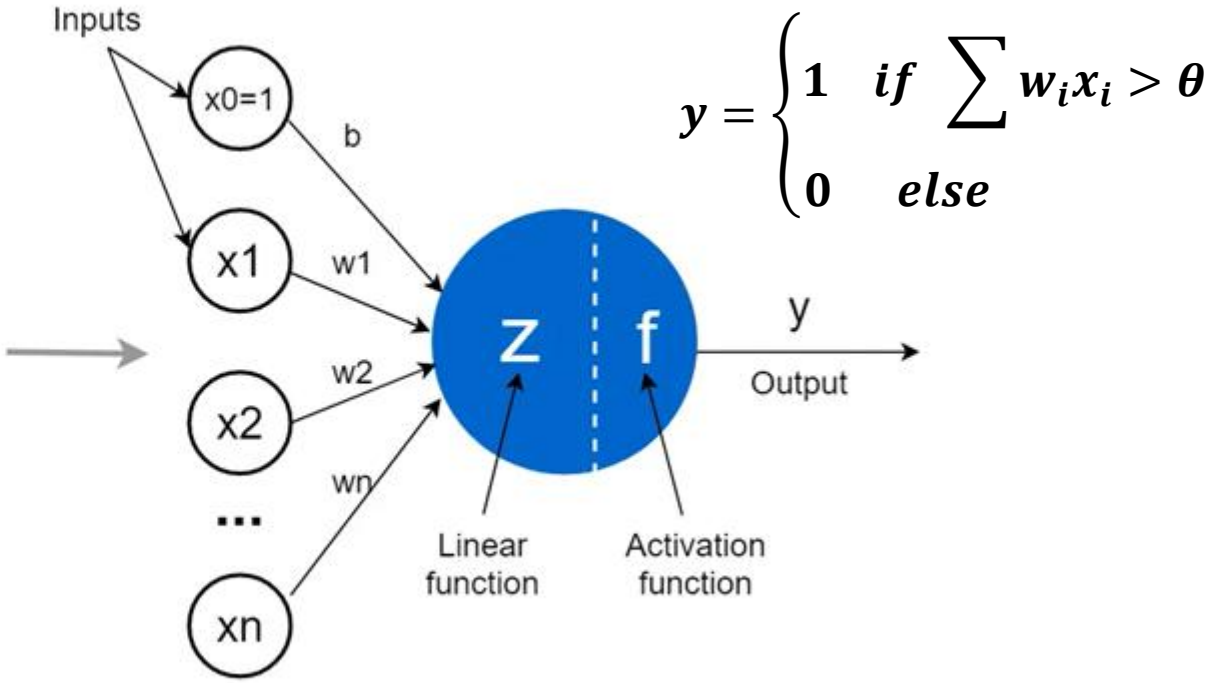


Deep Learning (DL)

❖ Artificial Neural Network (ANN)

Artificial neural network is a computational network designed **based on biological neural networks in human brain.**





$$y = \begin{cases} 1 & if \sum w_i x_i > \theta \\ 0 & else \end{cases}$$

/raja-gupta

Kid 1 — Panda's Eyes? = Yes

Kid 2 — Panda's Nose? = Yes

Kid 3 — Panda's Ears? = Yes

Kid 4 — Panda's Hand? = Yes

Kid 5 — Panda's Leg? = Yes

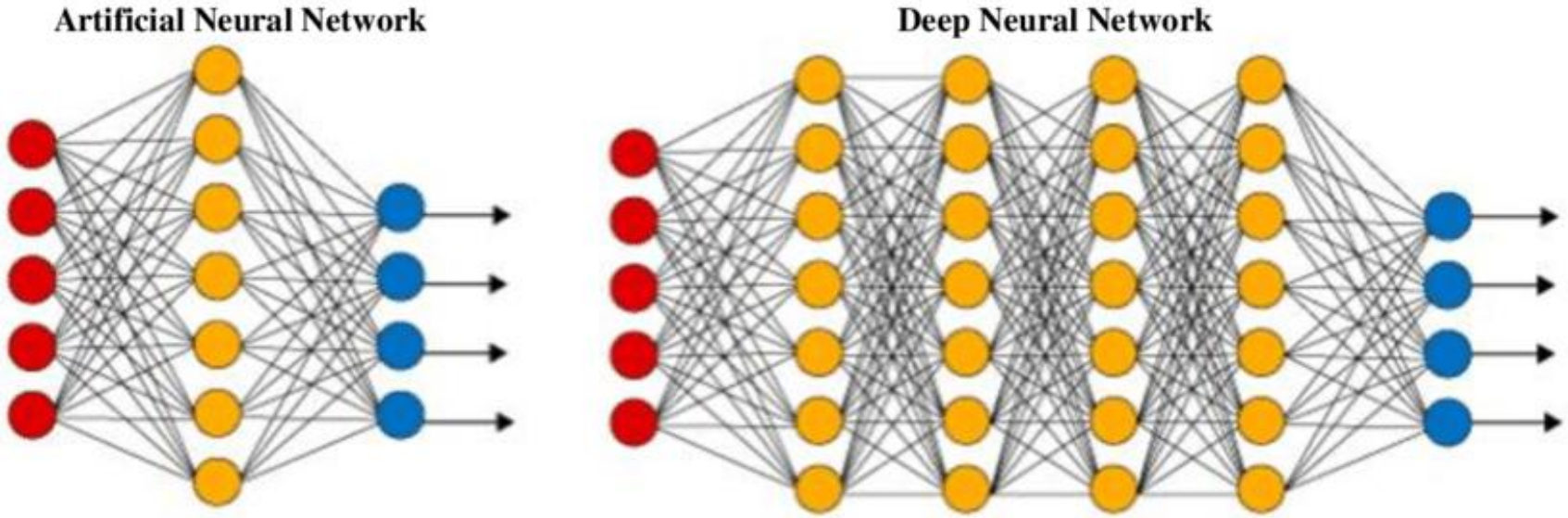
Kid 6 — Panda's Fur? = Yes

Kid 7 — Panda's Face? = Yes

Kid 8 — Panda's Body? = Yes

Kid 9 — Panda ? = Yes

Deep Learning (DL)



Input Layer

This is where information goes into the artificial neural network.

Output Layer

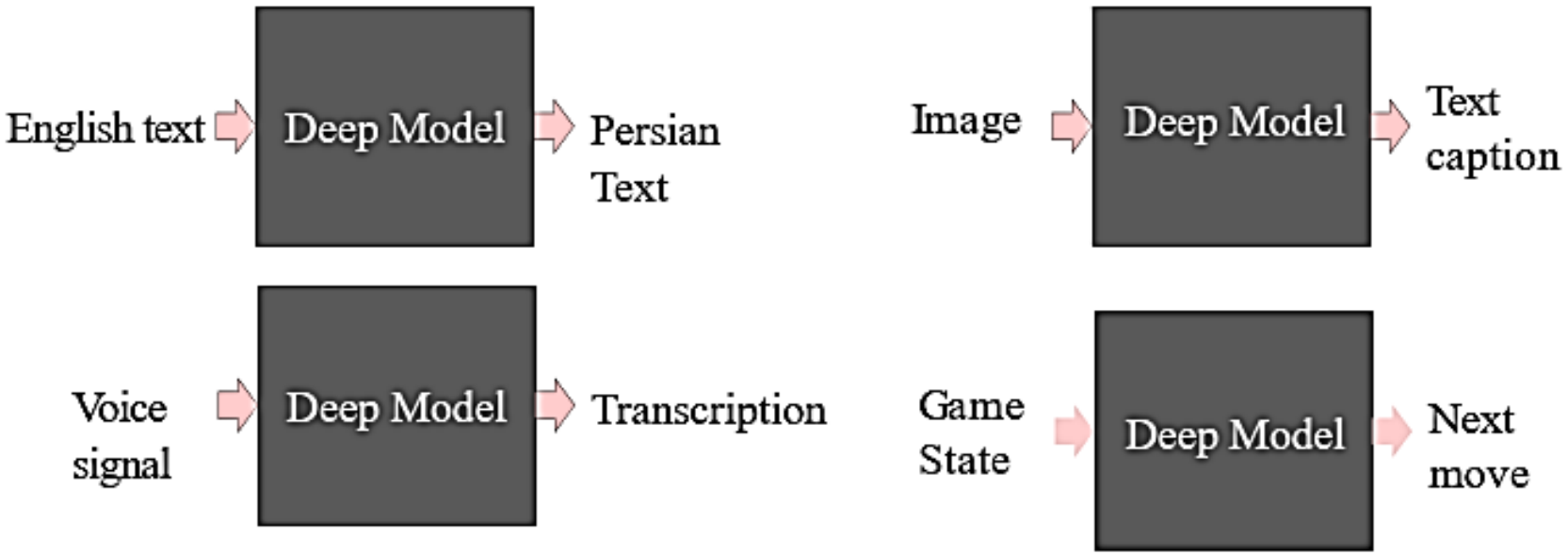
This is where the network gives the final result or answer. It’s the endpoint, where the network tells us what it has learned or decided.

Hidden Layers

These layers are in between the input and output layers.

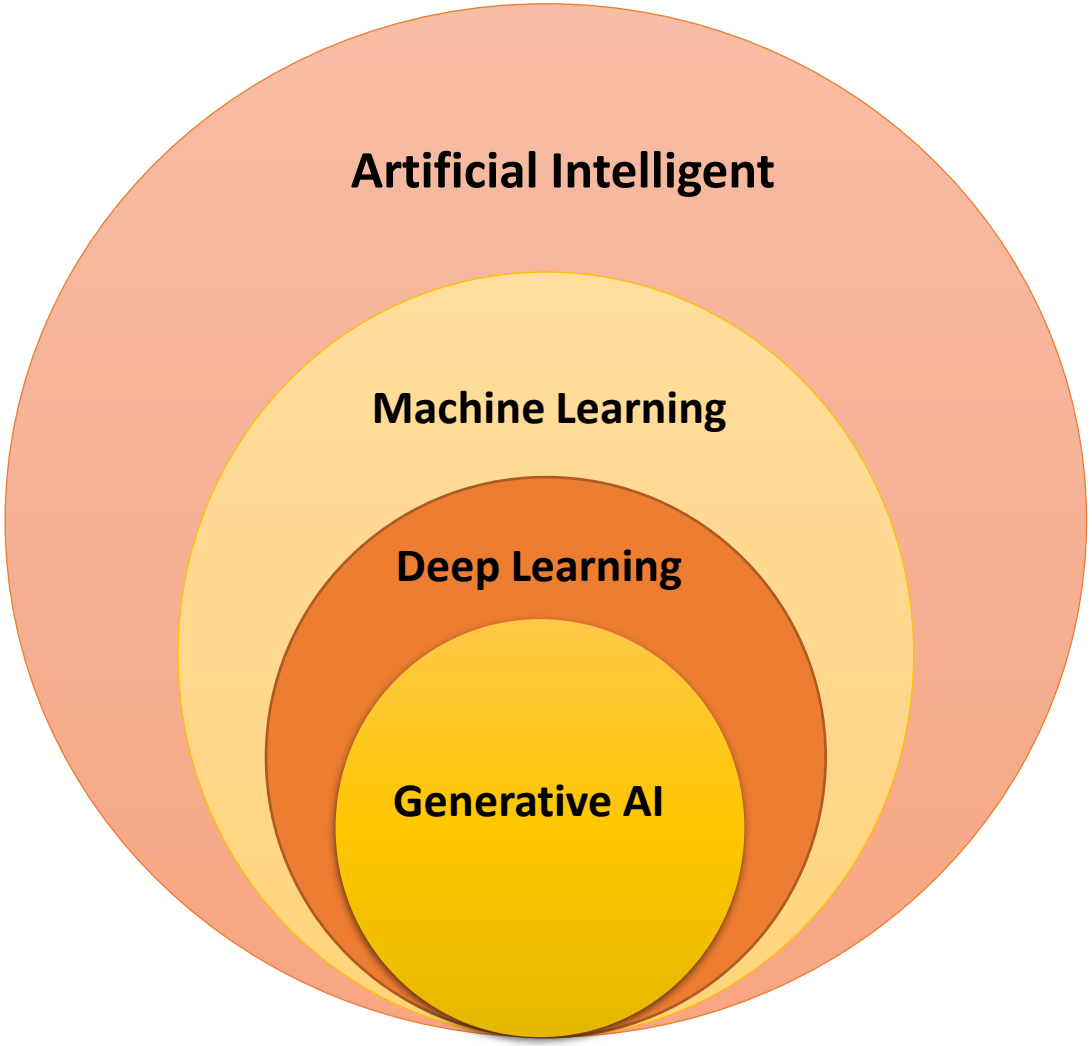
Neurons in these layers process information and help the network learn patterns and make decisions.

Deep Learning (DL)

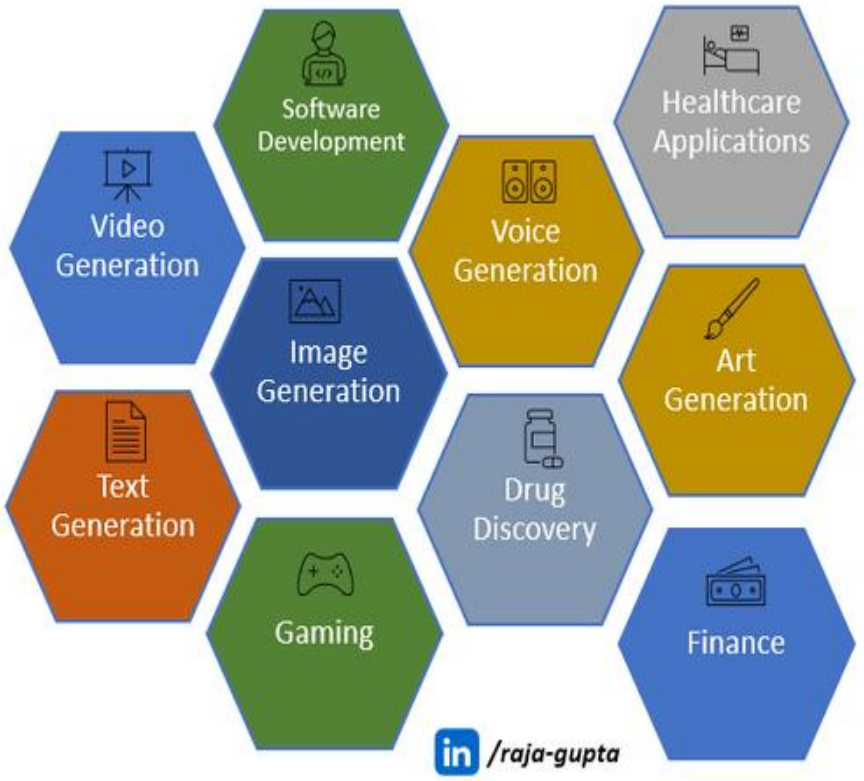


Machine Learning	Deep Learning
A type of artificial intelligence (AI) where computers learn from data without being explicitly programmed.	A subset of machine learning that uses deep neural networks with multiple layers to automatically learn and represent data.
Often uses simpler models with fewer parameters.	Involves complex models with a large number of parameters, especially in deep neural networks with multiple layers.
Effective with smaller datasets.	Often requires large amounts of labeled data for training.
Generally requires less computational power.	Demands significant computational resources, especially for training deep neural networks.
Models are often more interpretable.	Deep neural networks may be less interpretable due to their complexity.
Applied in a wide range of tasks, including regression, classification, and clustering.	Particularly powerful in complex tasks such as image and speech recognition, natural language processing, and game playing.
Can be more straightforward to implement and understand.	Tends to be more complex and may require specialized knowledge for effective implementation.

Generative AI: A type of artificial intelligence **that can create new things**, for example artwork, music, or even realistic images **without being explicitly told** what to create.



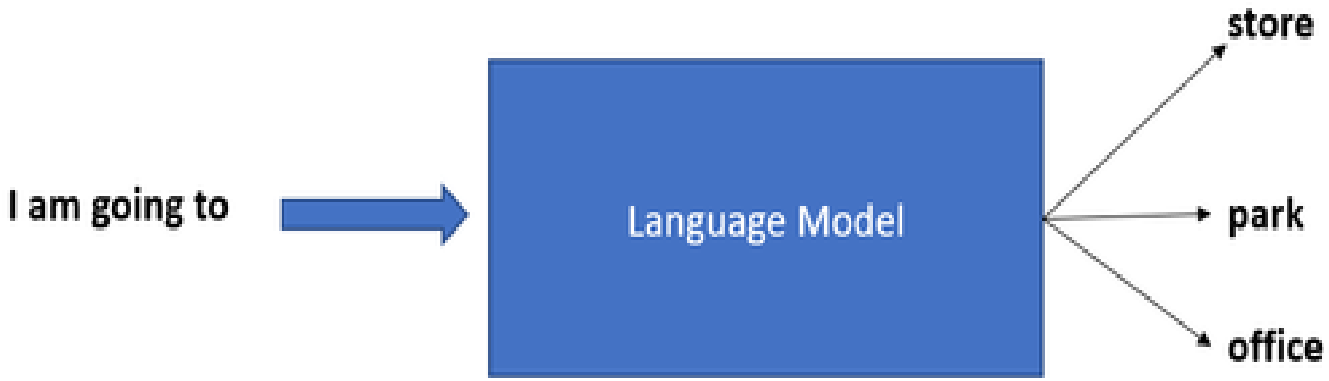
Applications:



Large language model (LLM)

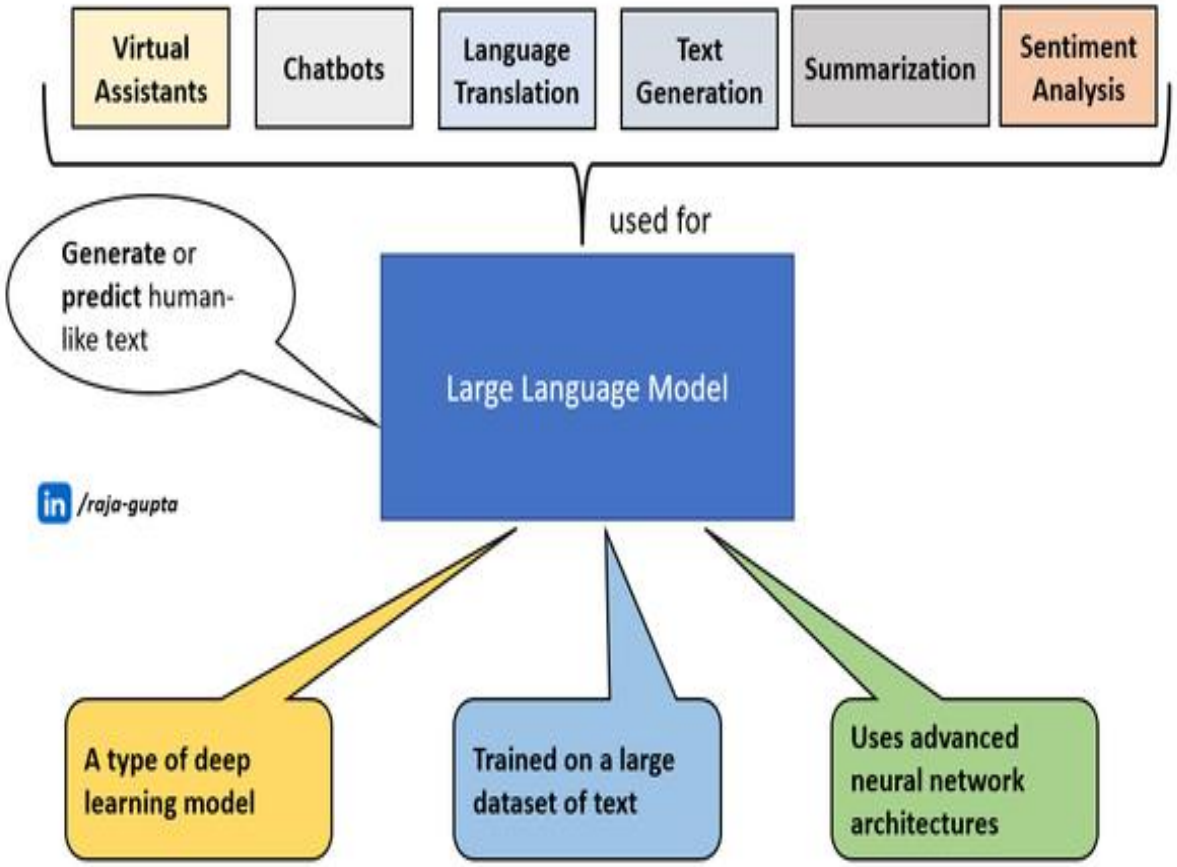
A large language model is a language model which is: a type of machine learning model

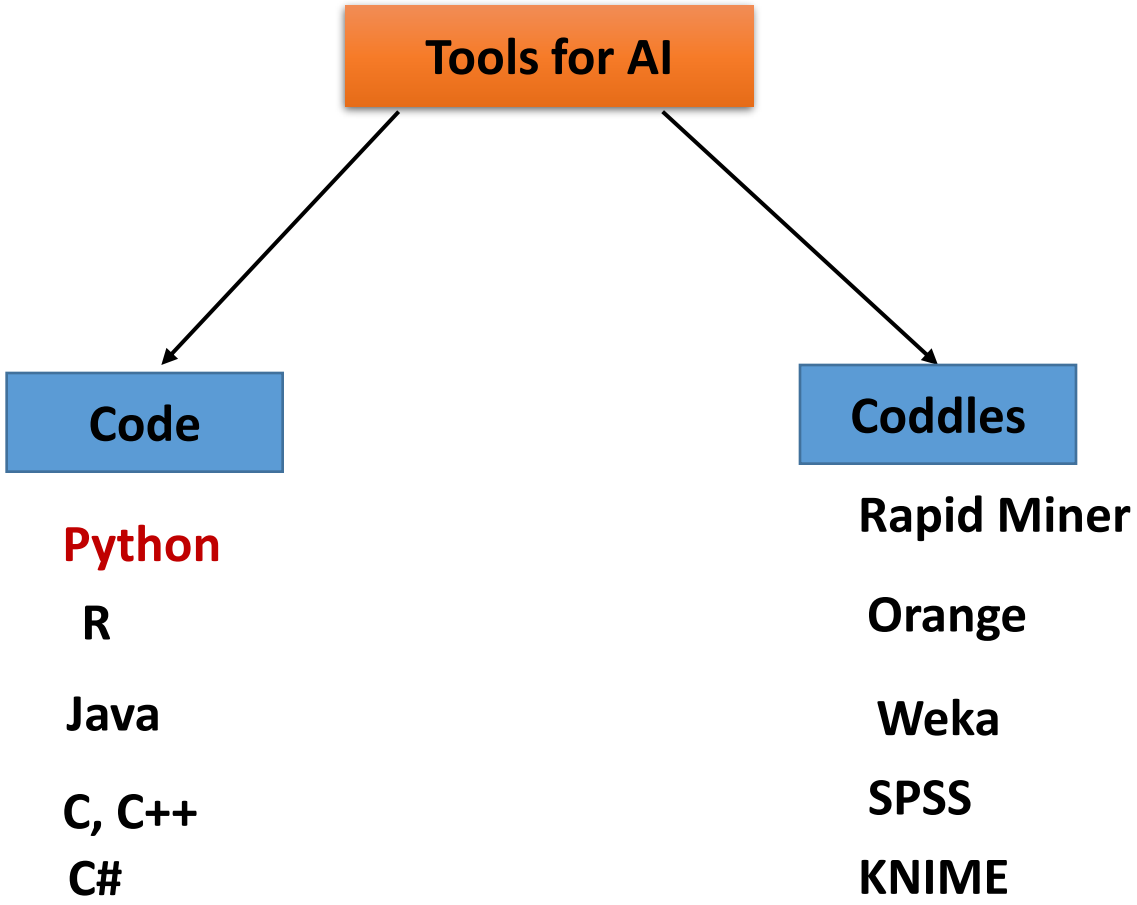
- that is trained on a large dataset of text
- and uses advanced neural network architectures
- to generate or predict human-like text.



Large language model:

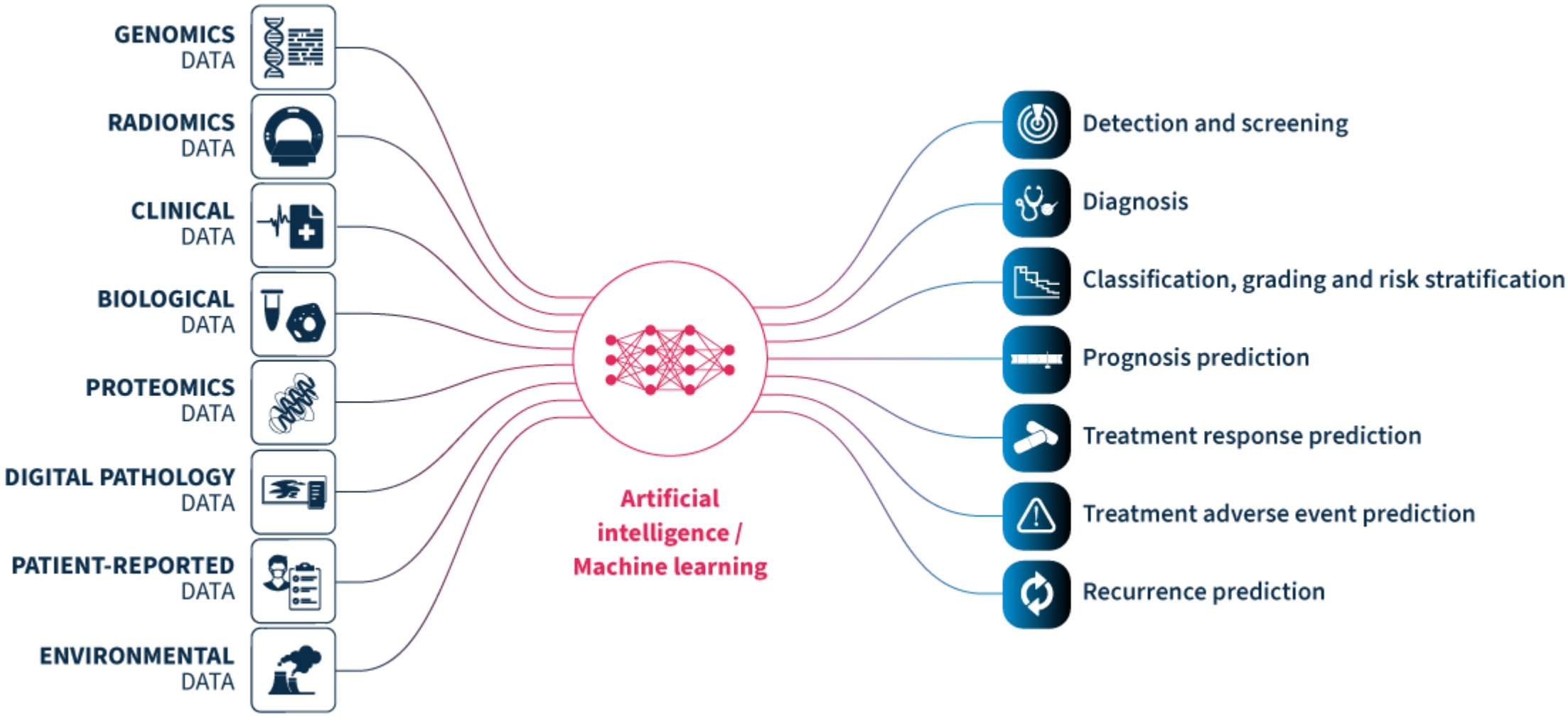
- **ChatGPT** → OpenAI
- **Alphacode** → DeepMind
- **GitHub Copilot** → OpenAI, GitHub
- **Gemini AI** → Google
- **Microsoft Copilot** → Microsoft
- **DALL-E** → OpenAI



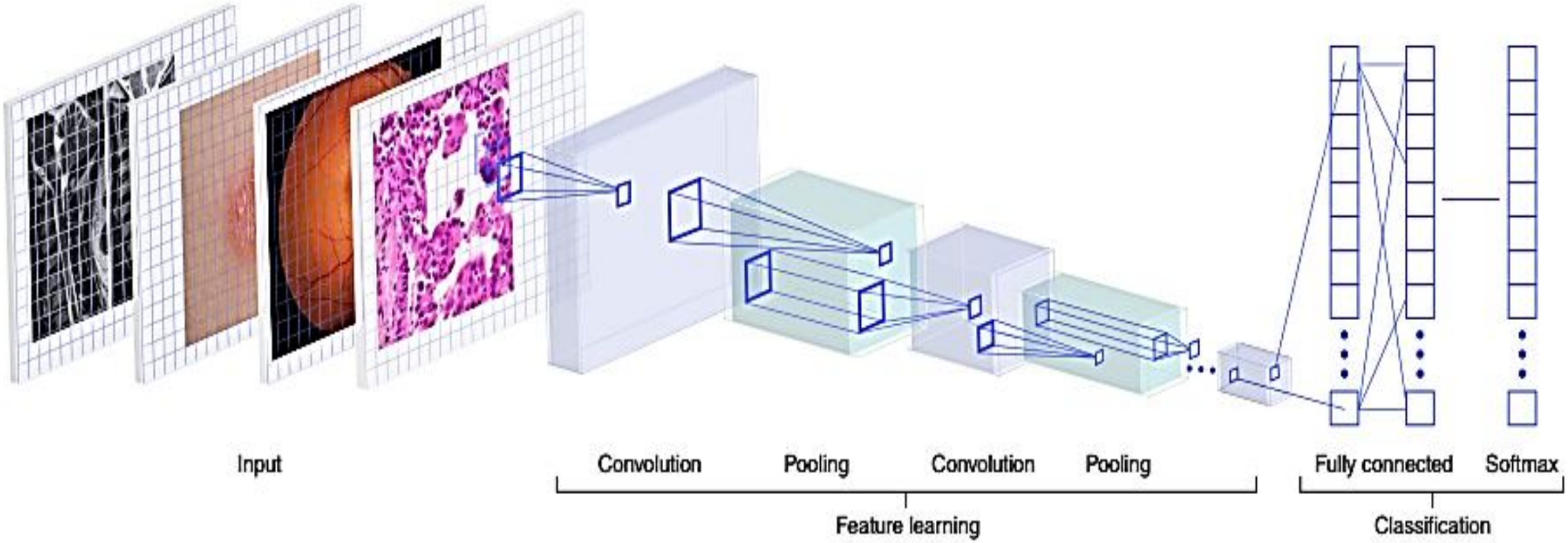

Tools for AI
Code
Coddles
Python
R
Java
C, C++
C#
Rapid Miner
Orange
Weka
SPSS
KNIME

Application in Research

Application of AI in Medicine

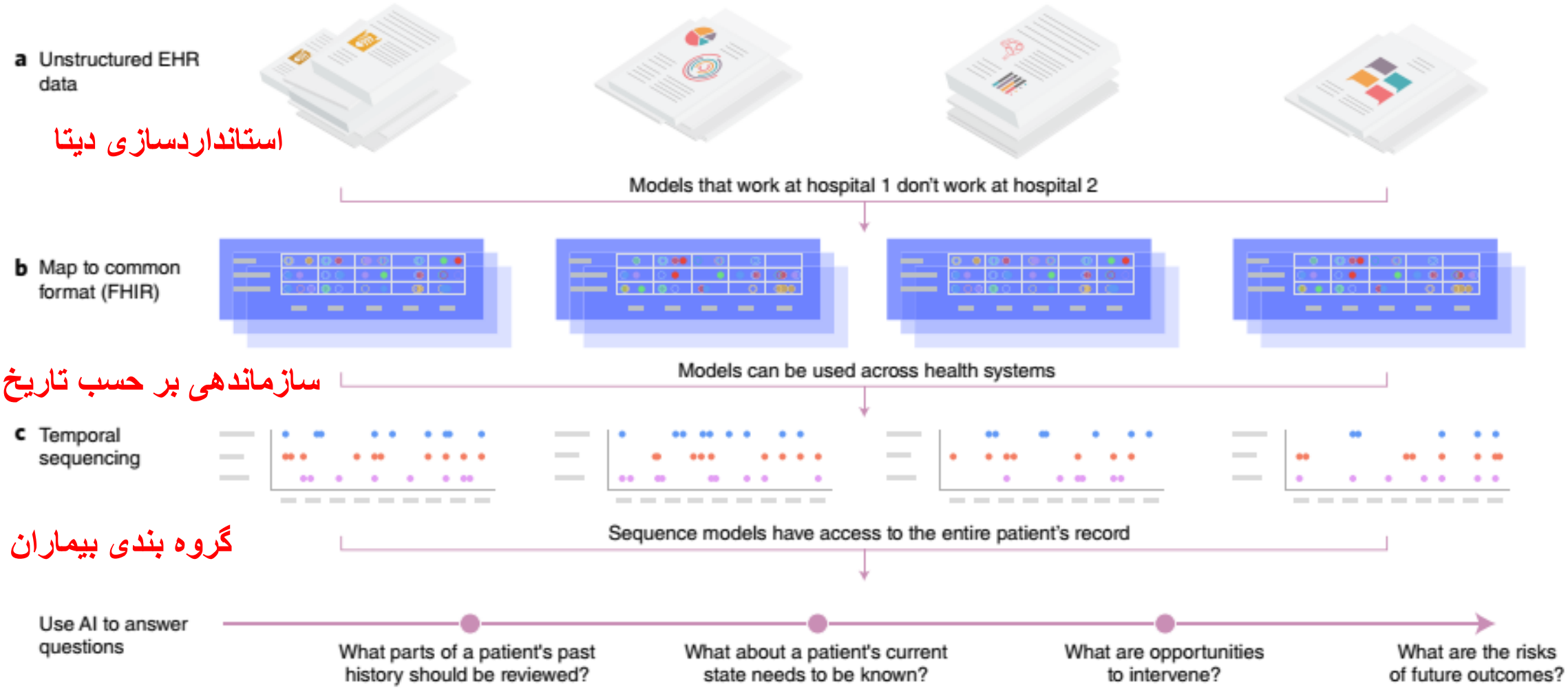


❖ Medical imaging



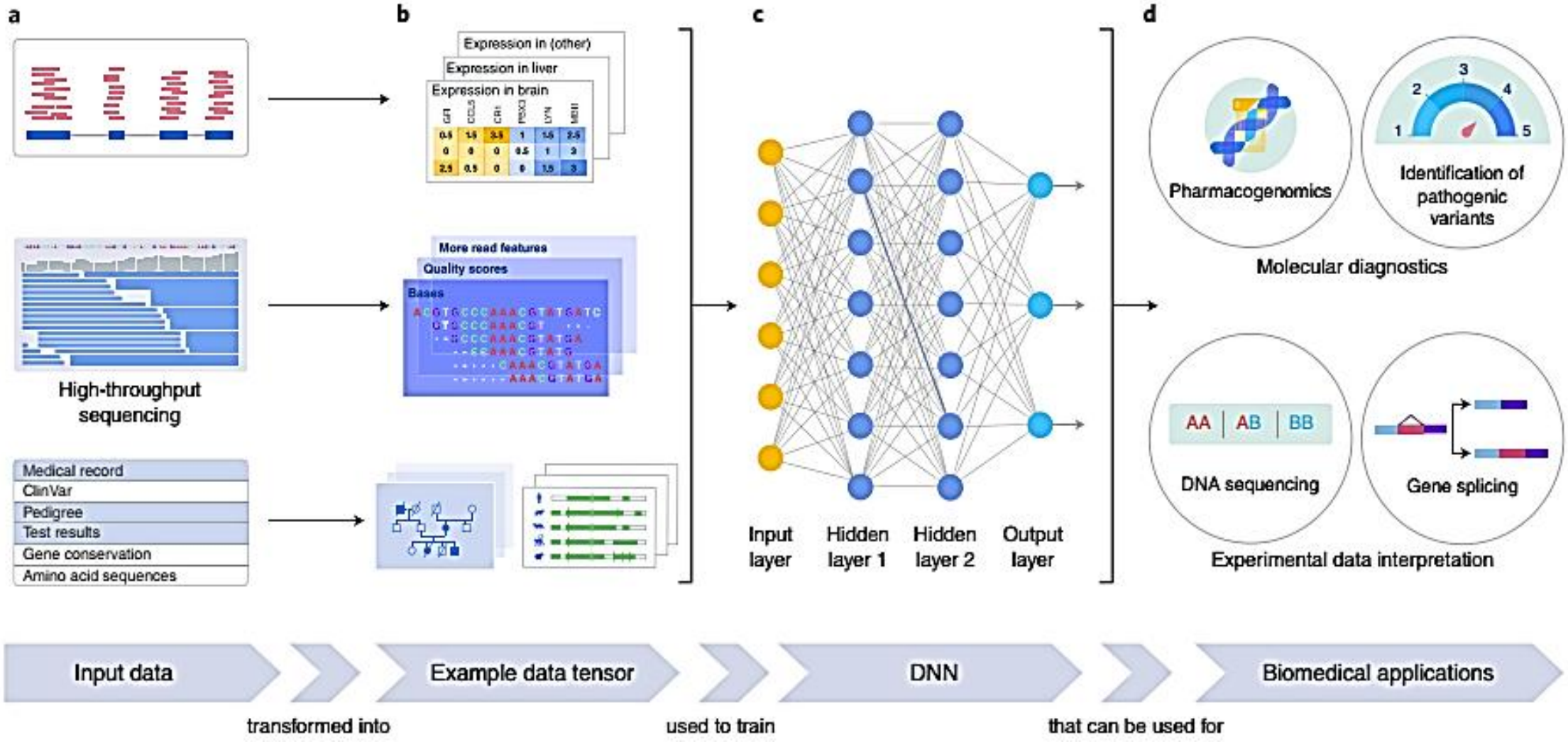
Esteva et al., A guide to deep learning in healthcare, Nature Medicine, 2019

❖ Electronic Health Records (EHRs)

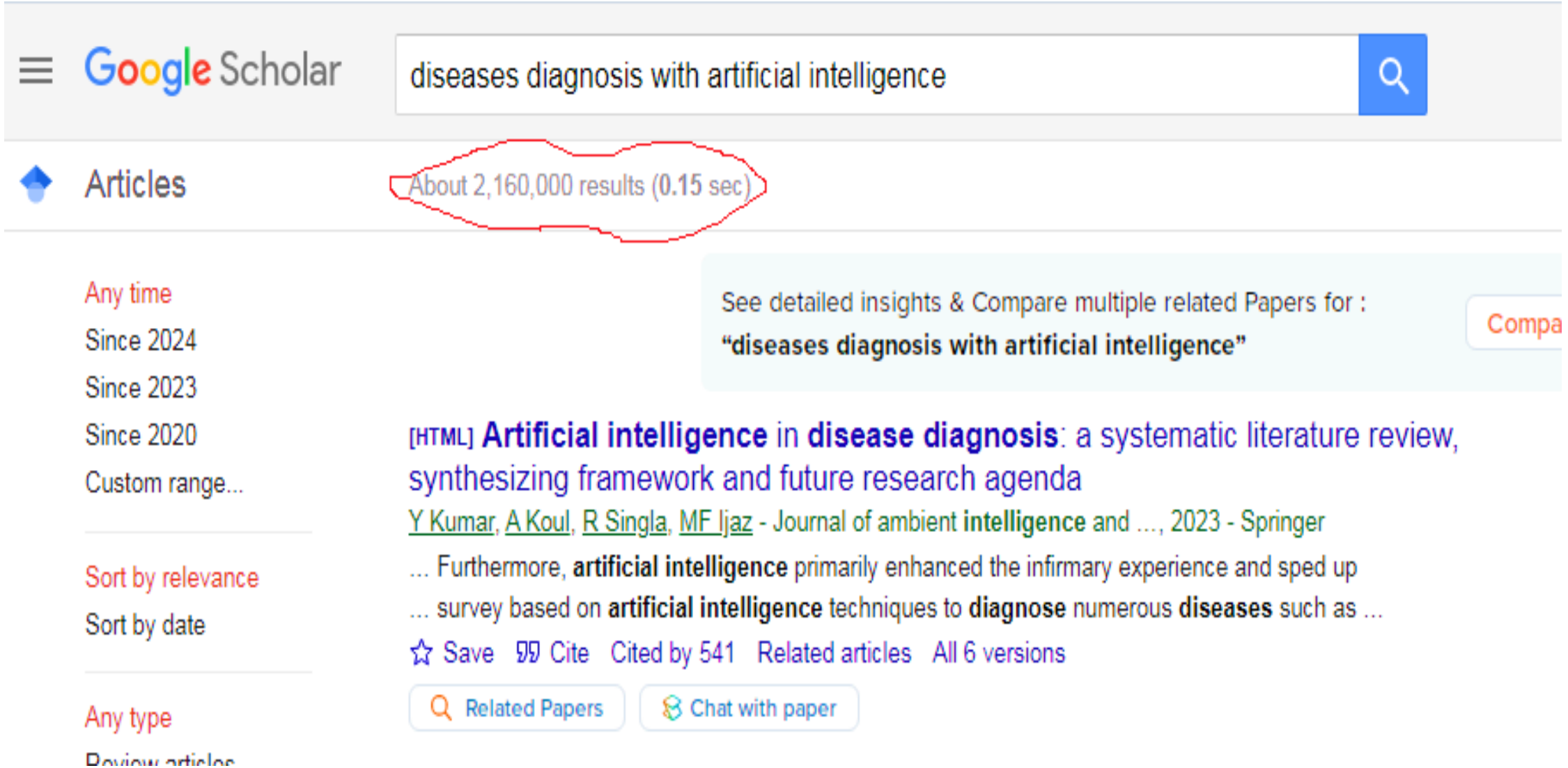


Esteva et al., A guide to deep learning in healthcare, Nature Medicine, 2019

❖ Genomics


a
b
c
d
Expression in (other)
Expression in liver
Expression in brain
More read features
Quality scores
Bases
High-throughput sequencing
Medical record
ClinVar
Pedigree
Test results
Gene conservation
Amino acid sequences
Input layer
Hidden layer 1
Hidden layer 2
Output layer
Pharmacogenomics
Identification of pathogenic variants
Molecular diagnostics
AA
AB
BB
DNA sequencing
Gene splicing
Experimental data interpretation
Input data
Example data tensor
DNN
Biomedical applications
transformed into
used to train
that can be used for

Diseases Diagnosis



Application in Technology

Starting with a problem

vs

Starting with a solution

The most important mistake founders make:

Not solving a real problem;
Building a solution in search of problem.

AI in Startups

AI as a tool:

- Automation
- Ideation
- Solution Task

www.perplexity.ai

Self Diagnosis Apps, for Patients and Doctors

ADA - apple

WebMD

K health

Symptomate

Ada Health

ada

Supporting better health outcomes and clinical excellence with intelligent technology.

Berlin based

Health Advice and Chatbot Asistance

- Everyday millions of people turn to the Internet for health information and treatment advice
- In Australia, around 80% of people search the Internet for health information, and nearly 40% seek guidance online for *self-treatment*
- In the US, almost two-thirds of adults search the Web for health information and roughly one-third utilize it for *self-diagnosis*
- A recent study showed that half of the patients investigated their symptoms on search engines before visiting emergency departments
- Search engines (e.g., Google and Bing) are exceptional tools for educating people, but they may facilitate misdiagnosis!
- Some governments have even launched "Don't Google It" advertising campaigns to urge their residents to avoid assessing their health using search engines

Health Advice and Chatbot Asistance

- In contrary, AI-based symptom checkers are tools that can assist patients in self-diagnosing themselves
- They are constantly and instantly available!
- Studies show that more than 15 million people use symptom checkers per month, a number that is likely to keep growing
- However, the utility and promise of symptom checkers cannot be materialized if they do not prove to be accurate in self-diagnosis

Chatbot in Health

- Market : $1.2 billion by 2032, from $196 million in 2022
- Over a hundred startup in heathcare chatbot

Tracxn Customers Offerings Company Pricing Login Sign Up Schedule Demo

Top Funding Rounds in last 2 years

Company	Funding Round
Ada (2011, Germany)	$90.5M - Series B
Woebot Health (2020, New Zealand)	$90.0M - Series B
Ada (2011, Germany)	$30.0M - Series B
Syllable (2016, United States)	$28.0M - Series B
Synapse Medicine (2017, France)	$28.0M - Series B
Loyal (2015, United States)	$12.5M - Series A
Wefight (2017, France)	$11.8M - Series A
Orbita (2015, United States)	$9.0M - Series A
Synapse Medicine (2017, France)	$8.0M - Series A
Patientco (2009, United States)	$2.9M - Series B

One Remission

Making the lives of cancer survivors easier

New York-based

Babylon Health

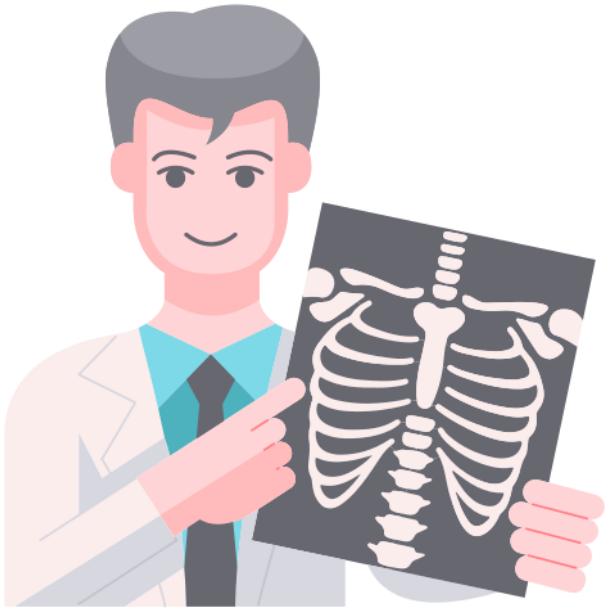
offers AI consultation based on personal medical history and common medical knowledge as well as live video consultation with a real doctor

Buoy

The chatbot thoroughly asks you about the details of your medical state and offers you

Boston-based

AI in Radiology



Radiology uses self-learning artificial intelligence algorithms to analyze medical images, such as X-rays, MRIs, and CT scans, and assist radiologists with diagnostics, treatment prescription, and patient care.

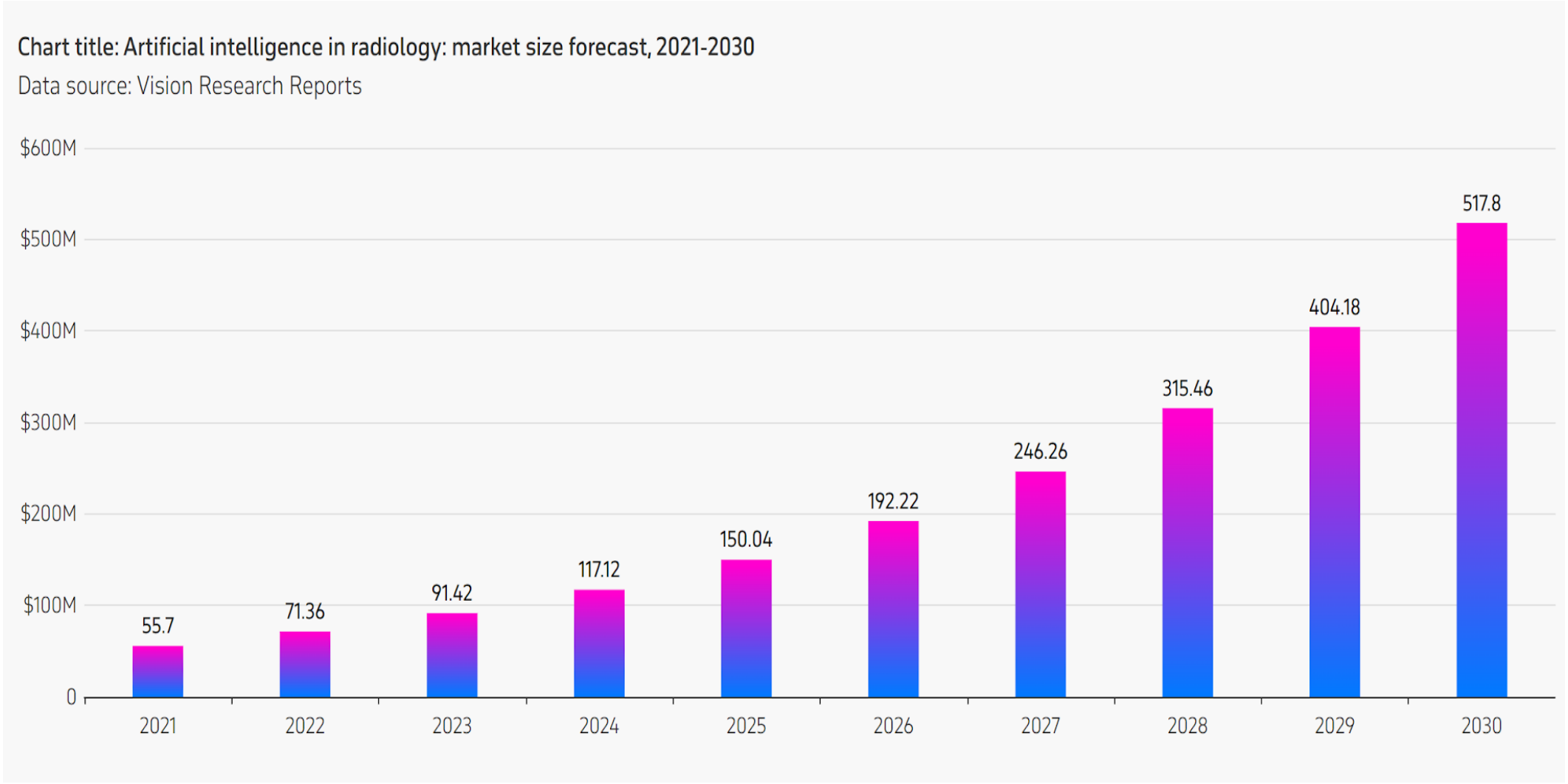


Chart title: Artificial intelligence in radiology: market size forecast, 2021-2030
Data source: Vision Research Reports
$600M
$500M
$400M
$300M
$200M
$100M
0
55.7
71.36
91.42
117.12
150.04
192.22
246.26
315.46
404.18
517.8
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030

AI in radiology market statistics

30%

of radiologists use AI in their clinical practices

American College of Radiology

20%

plan to purchase AI tools in the near future

American College of Radiology

36.7%

AI in the global radiology market CAGR from 2021 to 2030

Vision Research Reports

10 AI use cases in radiology

1 Enhancing cardiac imaging
2 Classifying brain tumors
3 Spotting vertebral fractures
4 Detecting Alzheimer's disease
5 Diagnosing ALS
6 Assisting with radiology reporting & data-related tasks
7 Detecting breast cancer
8 Dose optimization
9 Detecting pneumonia
10 Detecting LVO

Med-Flamingo

Med-Flamingo: A Multimodal Medical Few-shot Learner

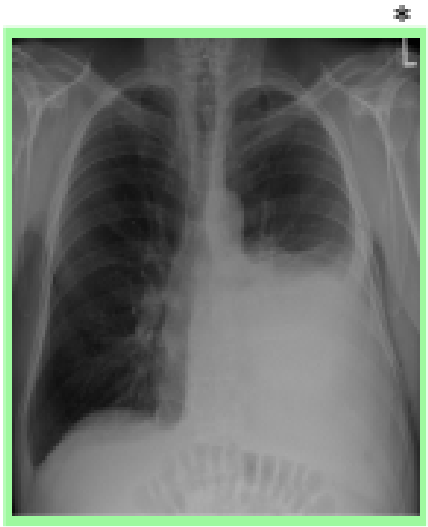
2023 – snap-standford

Applications of Med-Flamingo:

- Visual Question Answering (VQA) in Medicine
- Medical Image Captioning
- Medical Rationale Generation

Med-Flamingo

32-year-old man presents to ER 15 mins after 7-feet fall onto a wooden post. Symptoms: severe pain, rapid breathing, vitals: pulse 135/min, respirations 30/min, BP 80/40 mm Hg. (...)



Question: What is the most likely diagnosis?

Med-Flamingo

Blunt trauma to the left lung with hemothorax.

✅ Correct diagnosis
✅ Correct pathology, left-sided.

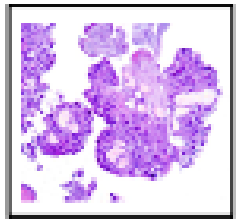
Baseline

The patient has a left-sided pneumothorax.

✅ Correct side, but
❌ Wrong diagnosis / pathology

**Chest X-ray image showing hemothorax following blunt chest trauma*

A 60-year-old man presents to the physician with a 1-week history of lower back pain. Notably, he has experienced painless hematuria on several occasions over the past 2 months. During the physical examination, localized tenderness is identified over the lumbar spine. Further investigations, including a CT scan, reveal multiple osteolytic lesions in the lumbar vertebrae, while cystoscopy detects a 4-cm mass in the right lateral wall of the bladder. Additionally, a photomicrograph of a biopsy specimen is provided.



Microscopic image of urothelial cancer (models cannot see this caption)

Question: What represents the most significant risk factor for this patient's condition?

Answer: The strongest risk factor for this patient's condition is smoking.

Med-Flamingo

✅ Correct diagnosis
✅ Risk factor provided

Answer: The patient has a diagnosis of metastatic prostate cancer.

Baseline

❌ Wrong diagnosis
❌ No risk factor provided

Medical Training

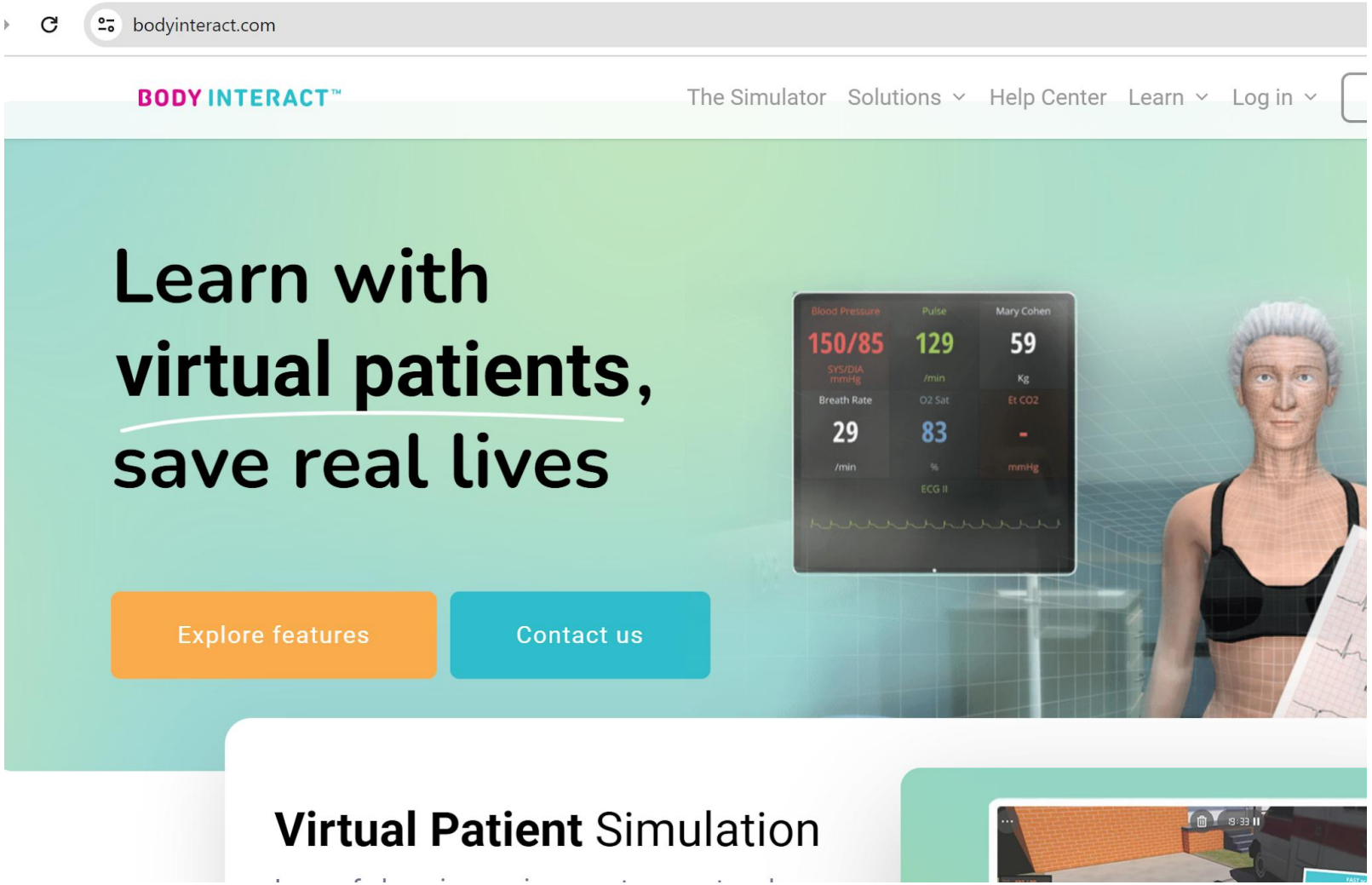
- Leverage social media platforms to engage learners.
- Utilize virtual reality (VR) and augmented reality (AR) to offer training opportunities.
- Create simulations for experiential learning.

Leverage social media platforms to engage learners.

- **DailyRounds**: A network that offers case studies and discussions, making it ideal for doctors who want to share and learn from real-world medical cases.
- **Virtual Doctors Lounge**: The Virtual Doctors Lounge platform serves as a virtual meeting space for physicians to discuss medical cases, share insights, and seek advice from peers.
- **Among Doctors**: A community where healthcare professionals can network, collaborate, and share their expertise.
- **Student Doctor Network Forum**: An invaluable resource for students and practicing doctors alike, this forum provides a space for educational discussions and career advice.
- **Sermo**: Known for its large network of verified physicians, Sermo offers a platform for medical surveys, discussions, and collaboration on patient care.
- **Doximity**: Often dubbed as 'LinkedIn for doctors,' Doximity provides a professional

- Utilize virtual reality (VR) and augmented reality (AR) to offer training opportunities.

- Create simulations for experiential learning



Ethical challenges of AI in medicine

- Confidentiality of patient information
- Hallucination

Thank you