

AI & face recognition

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Goals

- An inside view of the technology used for face recognition
- An introduction to AI
- Where AI is playing a role in the face recognition process
- Uses and abuses of face recognition

- 1960s: with funding from an unnamed intelligence agency, Woodrow Wilson Bledsoe creates first manual measurements using electromagnetic pulses.
- 1970s: Researchers Goldstein, Harmon, and Lesk establish 21 points of facial measurement
- 1988: Kirby and Sirovich establish normalized face image using fewer than 100 points of facial measurement using linear algebra.
- 1991: Turk and Pentland invent first crude automatic face detection from images.
- 1993: Defense Advanced Research Projects Agency (DARPA) creates the first basic database of facial images.
- 2002: A face recognition database of 856 people is used at Super Bowl XXXV. The experiment fails.
- 2003: DARPA database upgrades to 24-bit color facial images.
- 2004: National Institute of Standards and Technology creates the NIST test.
- 2009: Pinellas County Sheriff's Office creates forensic database.
- 2010: Facebook creates image identity auto-tagging using face recognition.
- 2011: Panama Airport installs first face recognition surveillance system.
- 2011: Body of terror mastermind Osama bin Laden positively identified using face recognition.
- 2013: FaceFirst reaches effective real time mobile match alerts over cellular connection.
- 2014: Automated Regional Justice Information System (ARJIS) deploys a cross-agency system in southern California, sharing criminal face recognition data across local, state and federal agencies.
- 2016: U.S. CPB deploys exit face recognition at Atlanta Airport.
- 2017: iPhone X becomes the world's top-selling phone with face recognition access control.
- 2018: FaceFirst achieves 150,000 facial points of measurement, including the ability to determine identity from 90-degree profile images.
- 2018: Japan announces that it will use face recognition to verify the identity of athletes at the 2020 Olympic Games.

Face recognition used in

- Public security
- Law enforcement and commerce
- Credit card verification
- Criminal identification
- Access control
- Human-computer intelligent interaction
- Digital libraries and information security

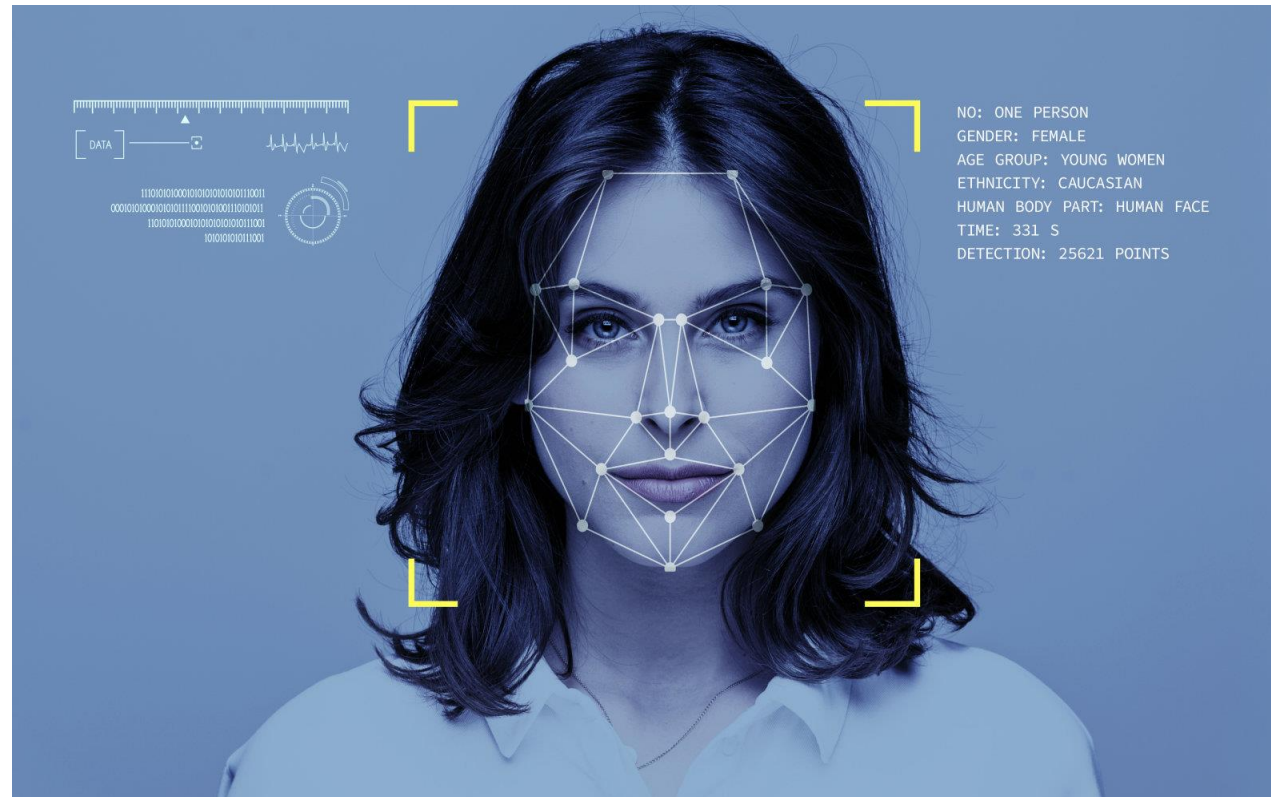
Difficult task because of

- Facial features such as beards, mustaches, and glasses may or may not be present and there is a great deal of variability among these components including shape, color and size.
- Pose: The images of a face vary due to the relative camera-face pose (frontal, tilted, profile, upside down).
- Facial expression and emotions: The appearance of faces is directly affected by a person's facial expression and emotions.
- Occlusion: Faces may be partially occluded by other objects. For an example, in an image with a group of people, some faces may partially occlude other faces (face identification).
- Image orientation: Face images directly vary for different rotations about the camera's optical axis.
- Imaging conditions: When the image is formed, factors such as lighting and camera characteristics affect the appearance of a face.
- Age: Images taken after one or two year's gap may not match with the images in database.

Basic Principles

- Facial recognition uses specific **landmarks** of the face such as:
 - Distance between the eyes
 - Width of the nose
 - Depth of the eye sockets
 - The shape of the cheekbones
 - The length of the jaw line
- This makes the **faceprint**, stored in a database
- Determined using 2D image

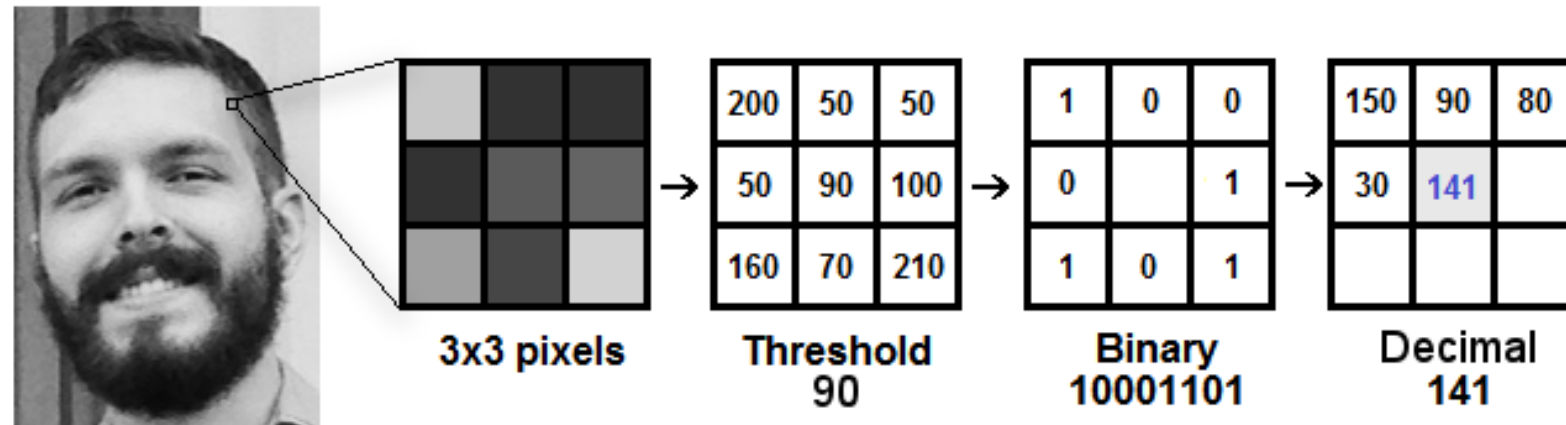
An example



NO: ONE PERSON
GENDER: FEMALE
AGE GROUP: YOUNG WOMEN
ETHNICITY: CAUCASIAN
HUMAN BODY PART: HUMAN FACE
TIME: 331 S
DETECTION: 25621 POINTS

There are other ways to encode the image

- Simple pixel encoding



3D face recognition, or video

- Adding more info such as :
 - Curve of the eye socket, nose



How it works

Detection

Alignment

Measurement

Representation

Matching

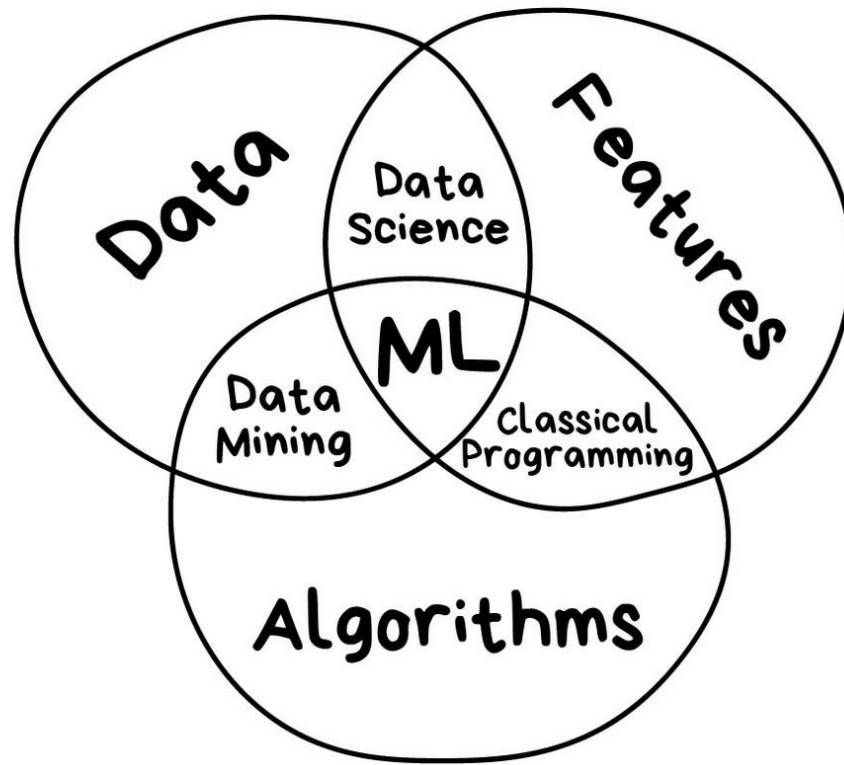
identification



Where is AI ?

- In the **matching** process: compares the image taken with a huge database

3 components of machine learning/AI



AI needs TONS of data

- Images come from different sources:
- Facebook/Apple/Google/Microsoft/.... Store millions of person's face
- they use it in their face recognition Algorithm





Statue of al-Khwārizmī carrying [Astrolabe](#) in
[Amir Kabir University](#), Tehran

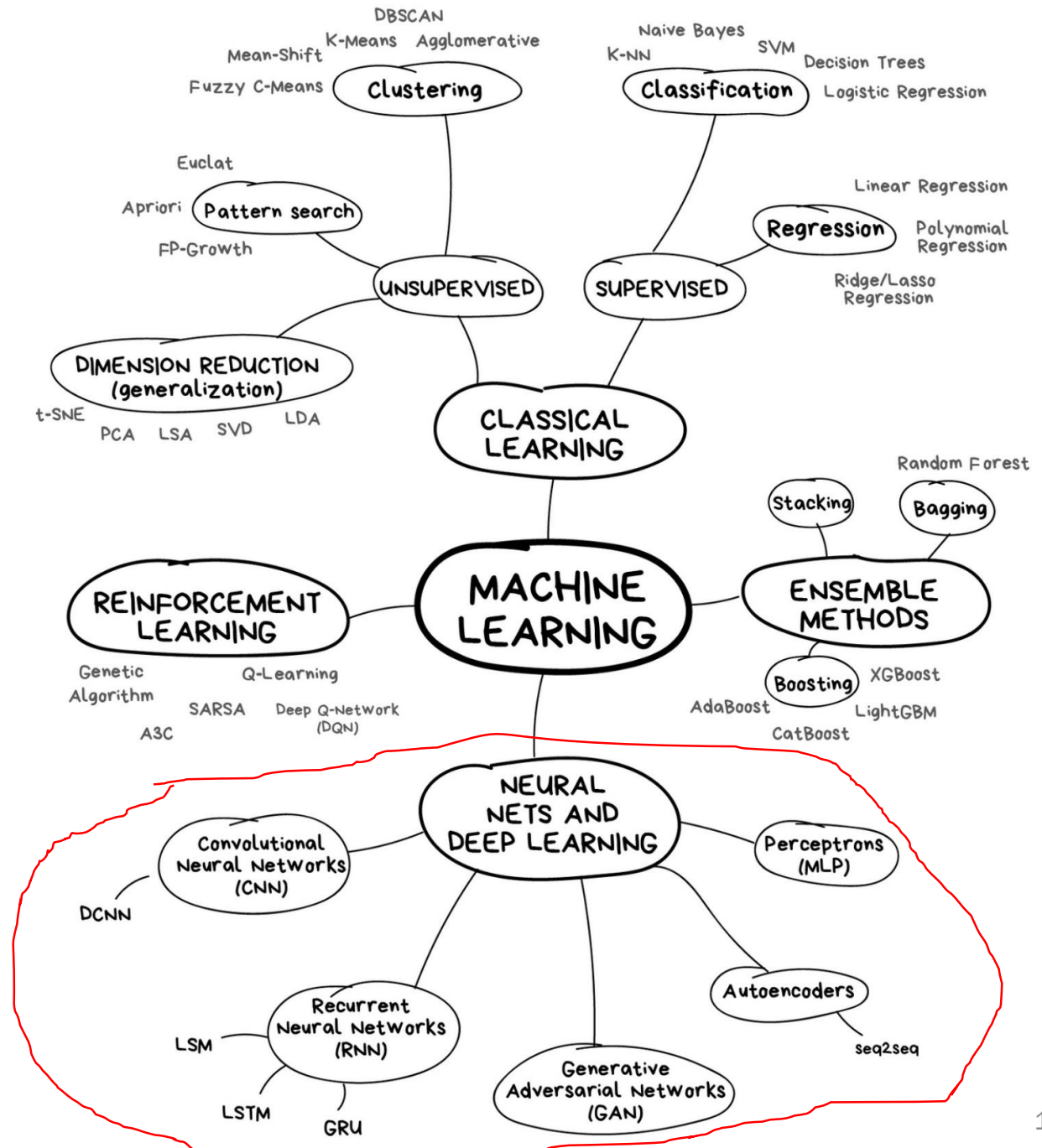
Algorithms

- The core of the process
- Each question will need a different algorithm
- But... without good data, an algorithm is useless

In [mathematics](#) and [computer science](#), an **algorithm** is a finite sequence of [well-defined](#), computer-implementable instructions, typically to solve a class of problems or to perform a computation

Scary picture!

A global view of all the areas of today's different types of machine learning



Many face recognition libraries, mostly open source

- opencv



Facebook data: over 400 meg of data

- Places you visited
- Photos shared
- Videos
- Search history
-

about_you	File folder
ads	File folder
apps_and_websites	File folder
comments	File folder
dating	File folder
events	File folder
following_and_followers	File folder
friends	File folder
groups	File folder
likes_and_reactions	File folder
location	File folder
marketplace	File folder
messages	File folder
other_activity	File folder
pages	File folder
payment_history	File folder
photos_and_videos	File folder
portal	File folder
posts	File folder
profile_information	File folder
saved_items_and_collections	File folder
search_history	File folder
security_and_login_information	File folder
stories	File folder
your_places	File folder
index.html	Firefox HTML Document



Data

- In order to learn you need data:
 - Detecting spam ? Get tons of spam messages
 - Want to forecast stocks? Find the price history
 - Want to find out user preferences? Parse their activities on Facebook
- There are two ways to collect data:
 - Manual : very expensive
 - Automatic: the Google example, [here](#) and [there](#)
- Data is very hard to collect.

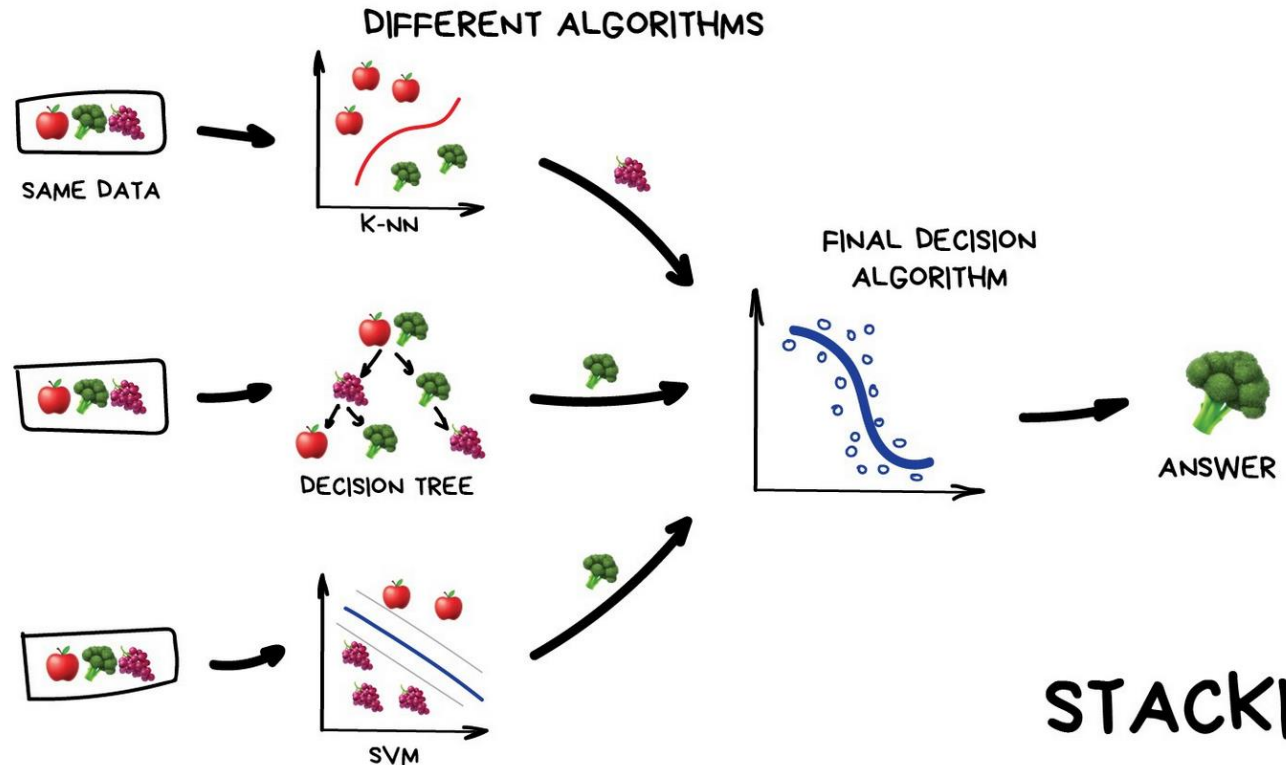


Features

- These are the parameters used for machine learning
- Variables like car price, temperature...
- But what about cat images? Maybe the ear shape...

Ensemble methods: Random Forest

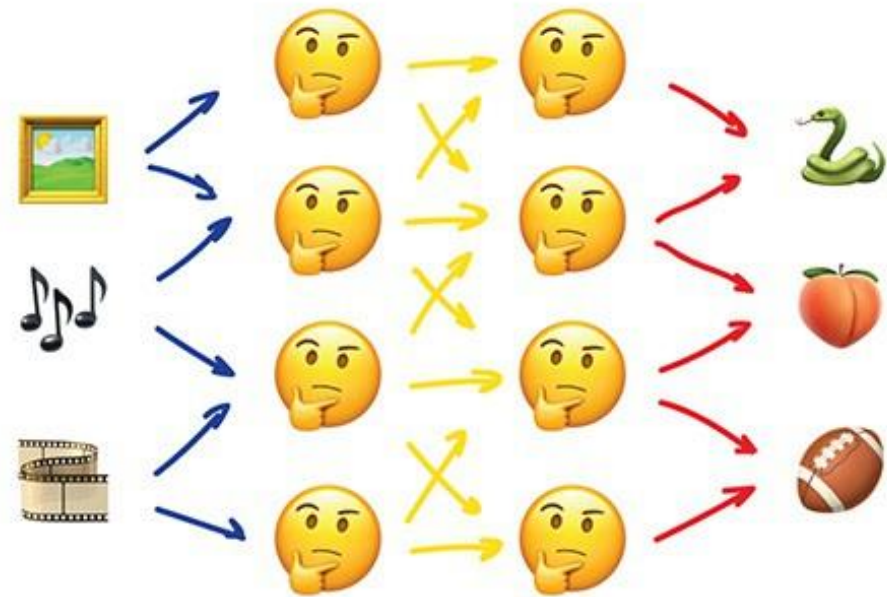
- Using many different inefficient algorithms creating ensembles (sets) to solve the same problem and forcing them to correct each other.
- Very efficient
- Used in
 - Computer vision
 - Object detection



Neural networks

Used for :

- Replacement of all the algorithms above
- Object identification
- ...



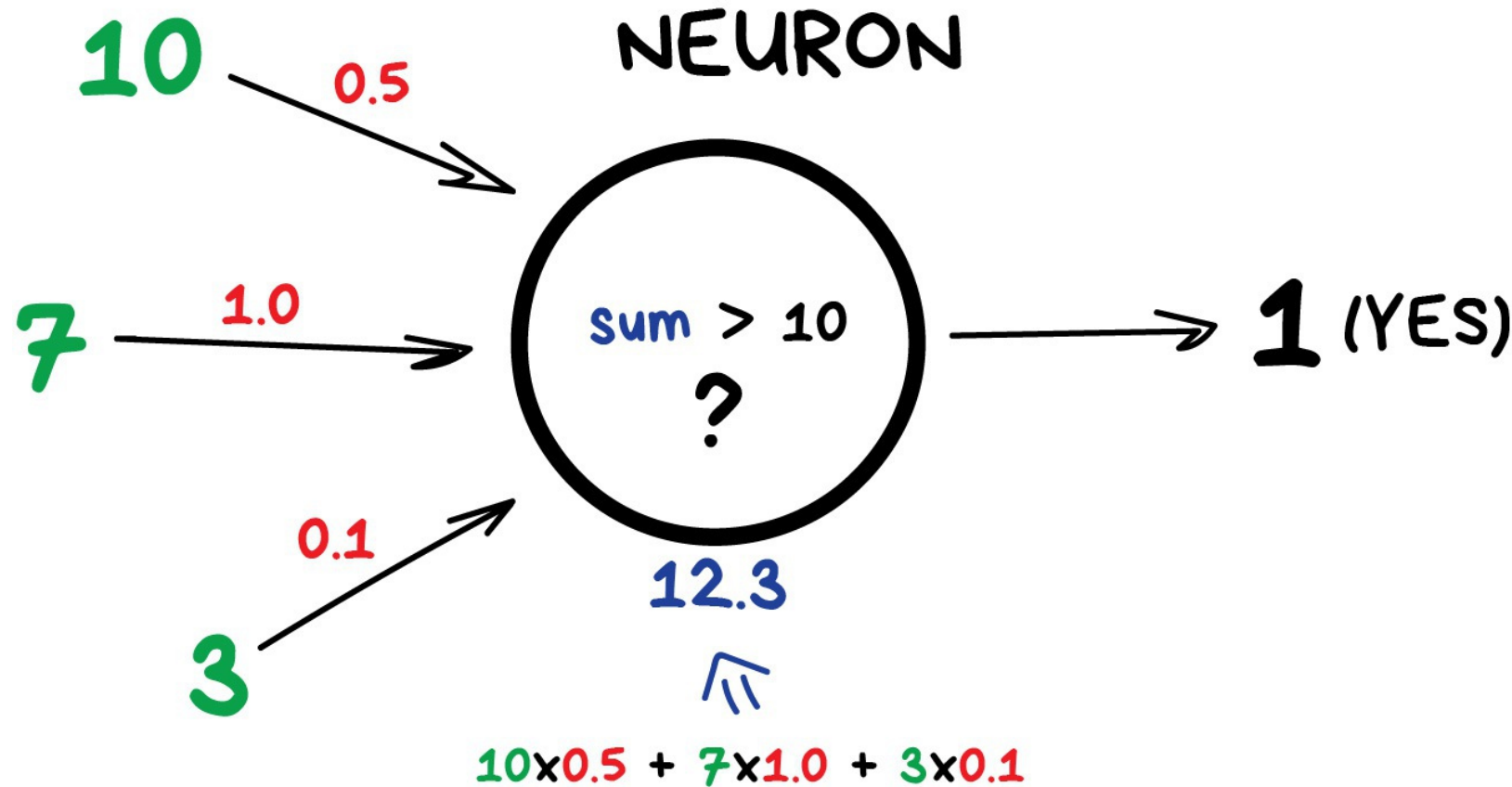
Neural Networks

Neural networks

Mimics neurons and synapses in the brain
(very bad analogy)

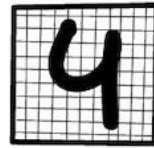
It's more like a network
of functions and links

Many interconnected
layers



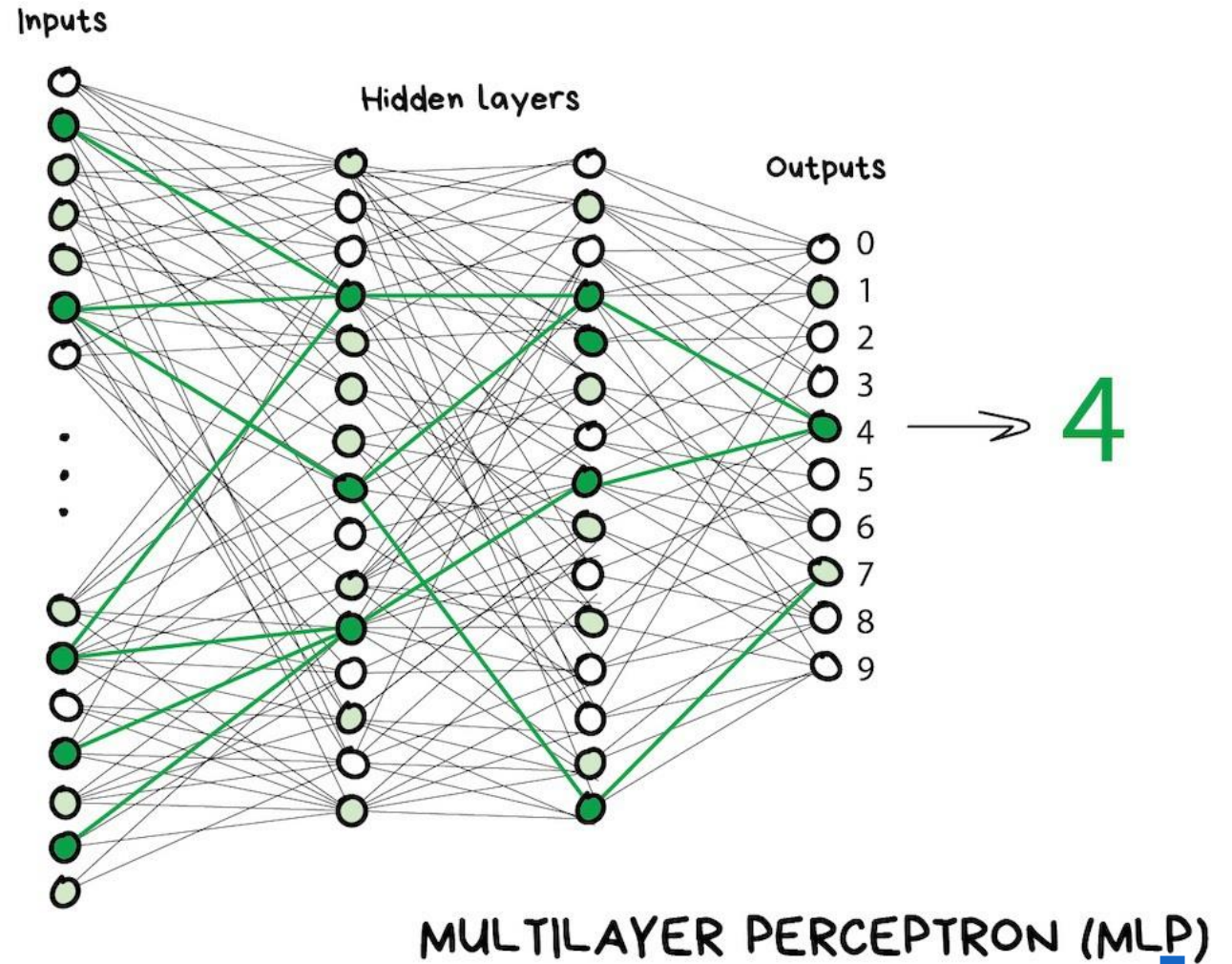
Neural networks

Old idea rediscovered
because of GPUs since it
is very computationally
expensive



1 pixel
=
1 input

Many open-source
libraries available now
(tensorflow, pytorch)



Some areas where AI is already at work

- Waze, google maps: uses **anonymized** data to estimate the traffic
- Uber , Lyft : for ETAs for rides, estimated meal delivery times on UberEATS, computing optimal pickup locations, as well as for fraud detection.
- Google: for detecting spam.
- Turnitin: plagiarism detection using a similarity algorithm.
- Mobile Check Deposits
- Credit Decisions
- Facebook: suggesting new friends via face recognition
- Voice-to-Text
- Create music work
- Detect breast cancer as good as expert.
- Chatbot



References

- <https://www.facefirst.com/blog/how-face-recognition-evolved-using-artificial-intelligence/>
- https://www.cyberlink.com/stat/technology/enu/tech_face.jsp?affid=2581_1_478&gclid=CjwKCAiA1L_xBRA2EiwAgcLKA2gYwHgTq9BBFfOCijTN-sWkukw3sTV1NkcSRC15iz8DIBrw0JnasBoCL34QAvD_BwE
- <https://www.alibaba.com/showroom/3d-face-recognition-camera.html>
- <https://towardsdatascience.com/face-recognition-for-beginners-a7a9bd5eb5c2>
- <https://face-recognition.readthedocs.io/en/latest/installation.html>

References

- <http://www.jfrankle.com/>
- https://vas3k.com/blog/machine_learning/
- <https://en.wikipedia.org/wiki/Algorithm>
- https://en.wikipedia.org/wiki/Logistic_regression
- <https://www.nvidia.com/en-us/deep-learning-ai/>
- <https://www.cbc.ca/news/health/ai-mammograms-breast-cancer-1.5412679>
- <https://emerj.com/ai-sector-overviews/everyday-examples-of-ai/>
- <https://openai.com/blog/musenet/>