

A Dive into Deep Learning

An essential skill for the next decade

October 10, 2021

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Lineup

What we'll discuss this afternoon

How the brain works

Building block of DNN

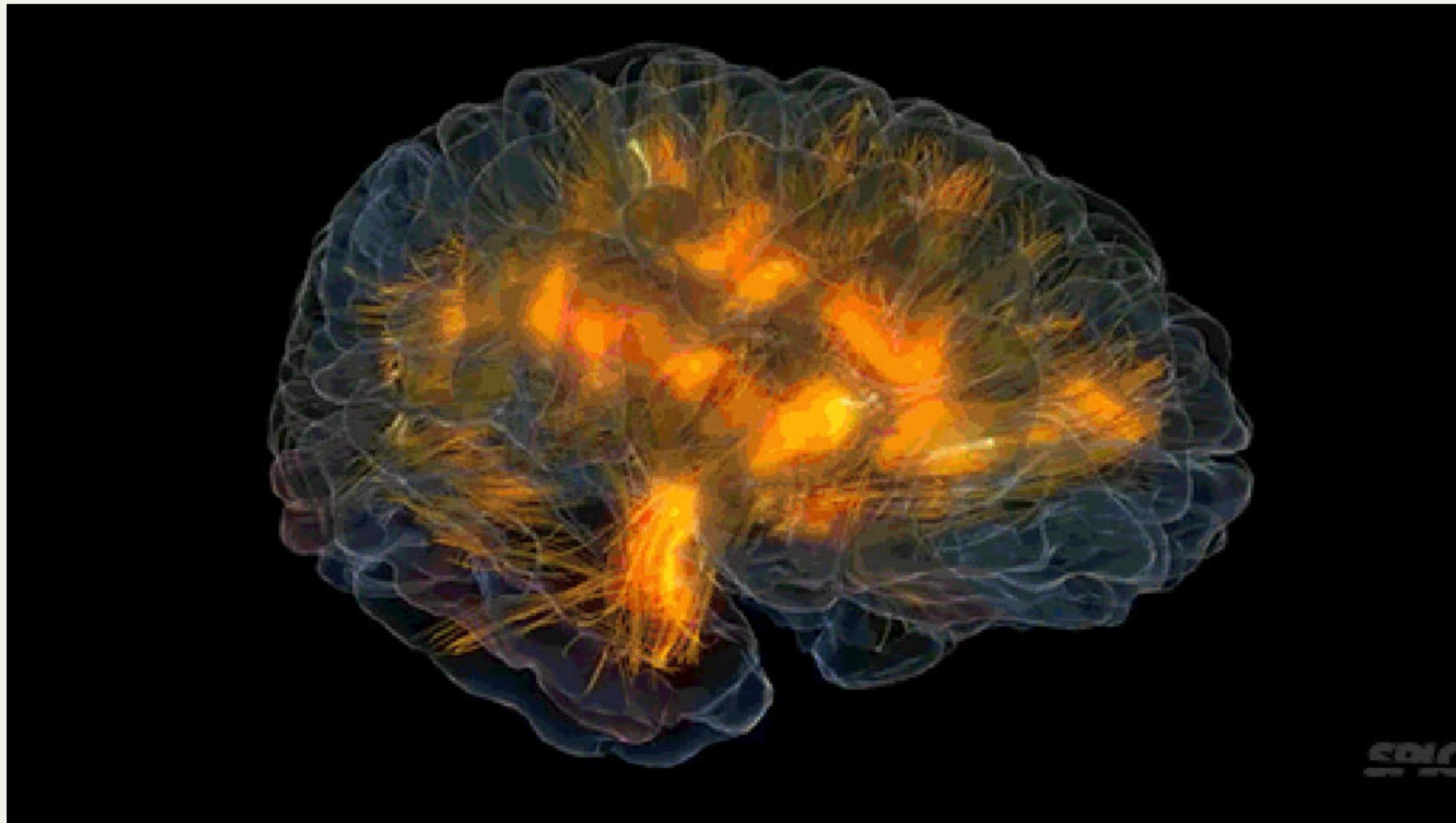
How models learn

DNNs in action

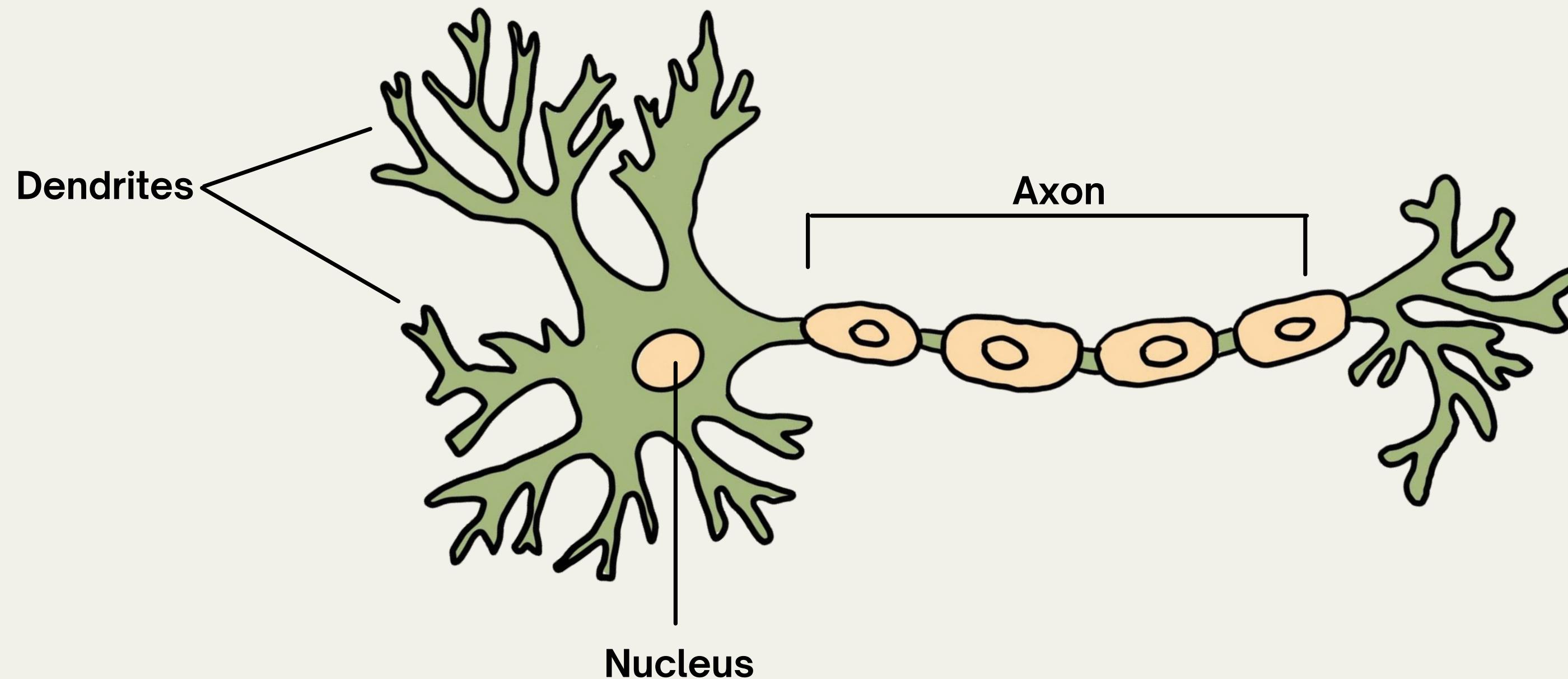
Blossoming areas

As a student ...

How human brain works

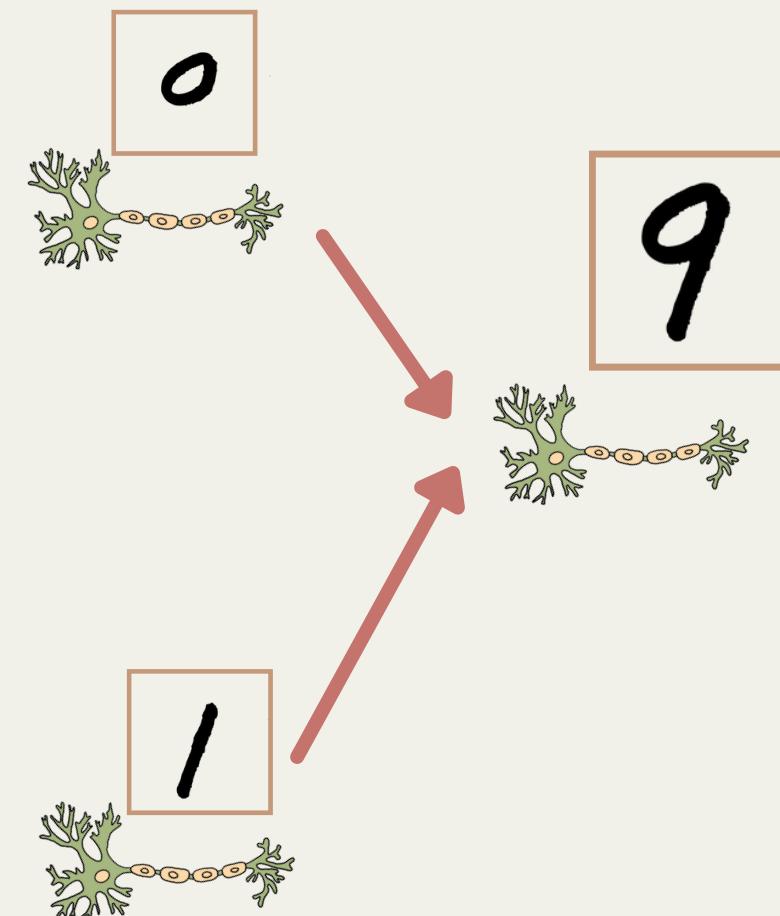


Biological Neuron

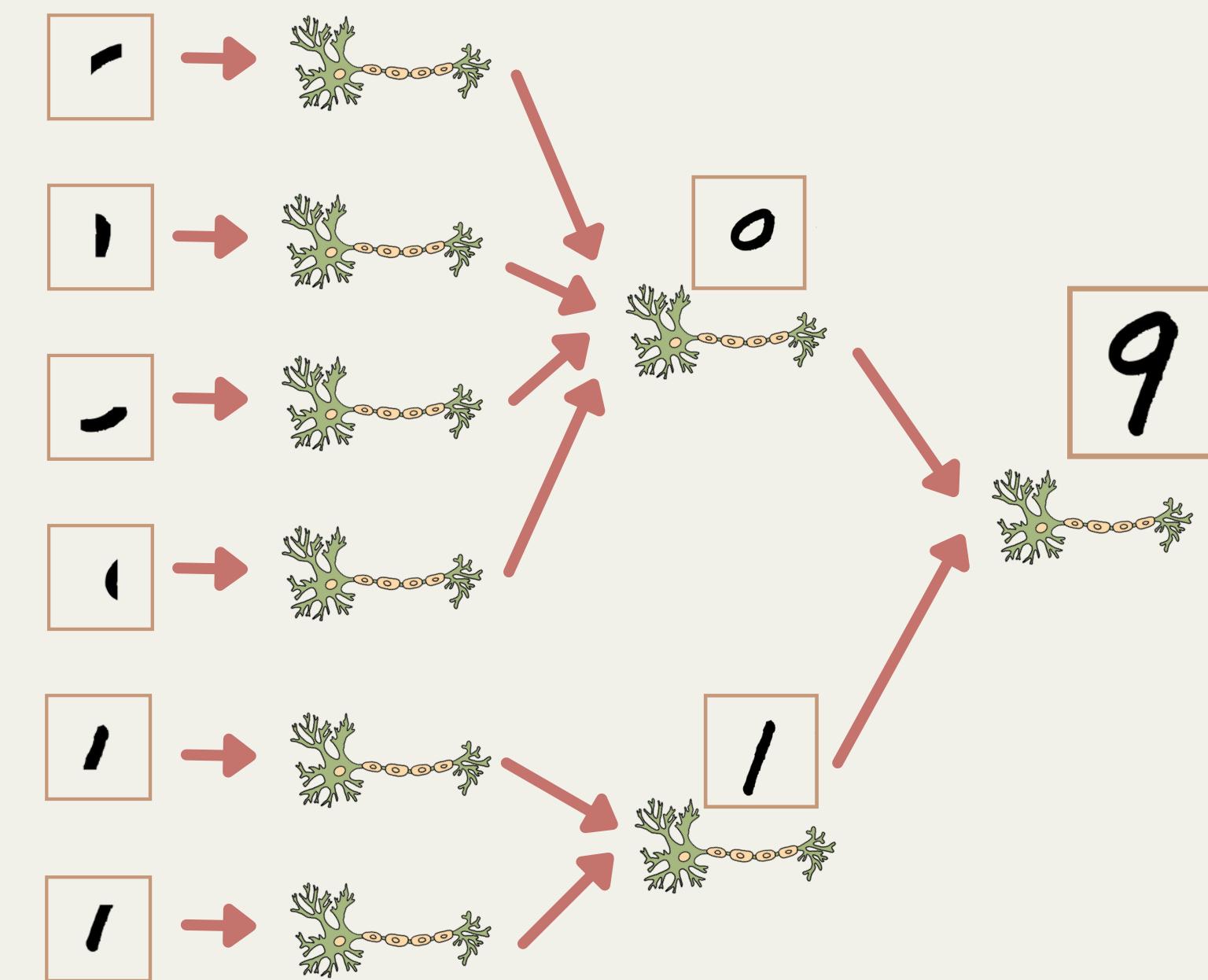
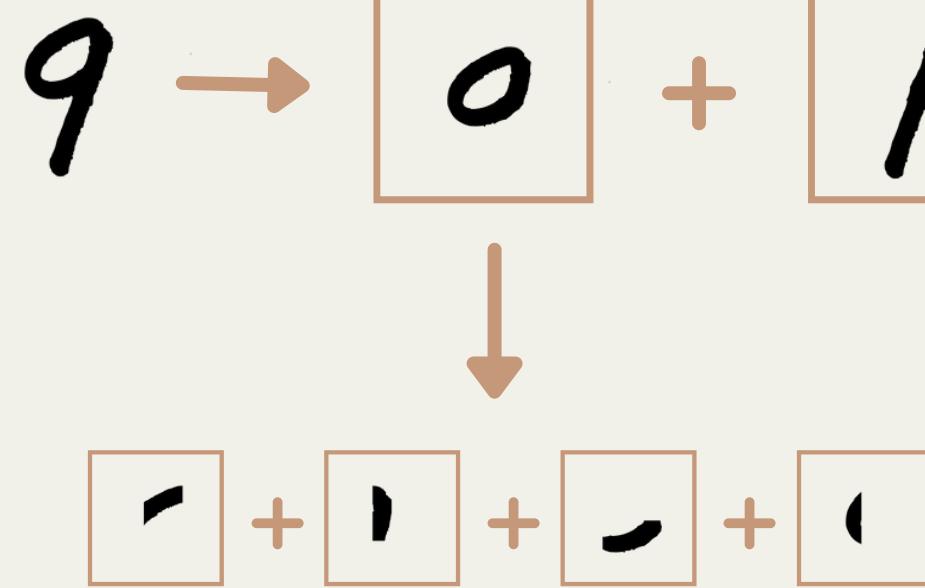


How information flows

$$\begin{array}{r} 8 \rightarrow \boxed{0} + \boxed{0} \\ 9 \rightarrow \boxed{0} + \boxed{1} \end{array}$$



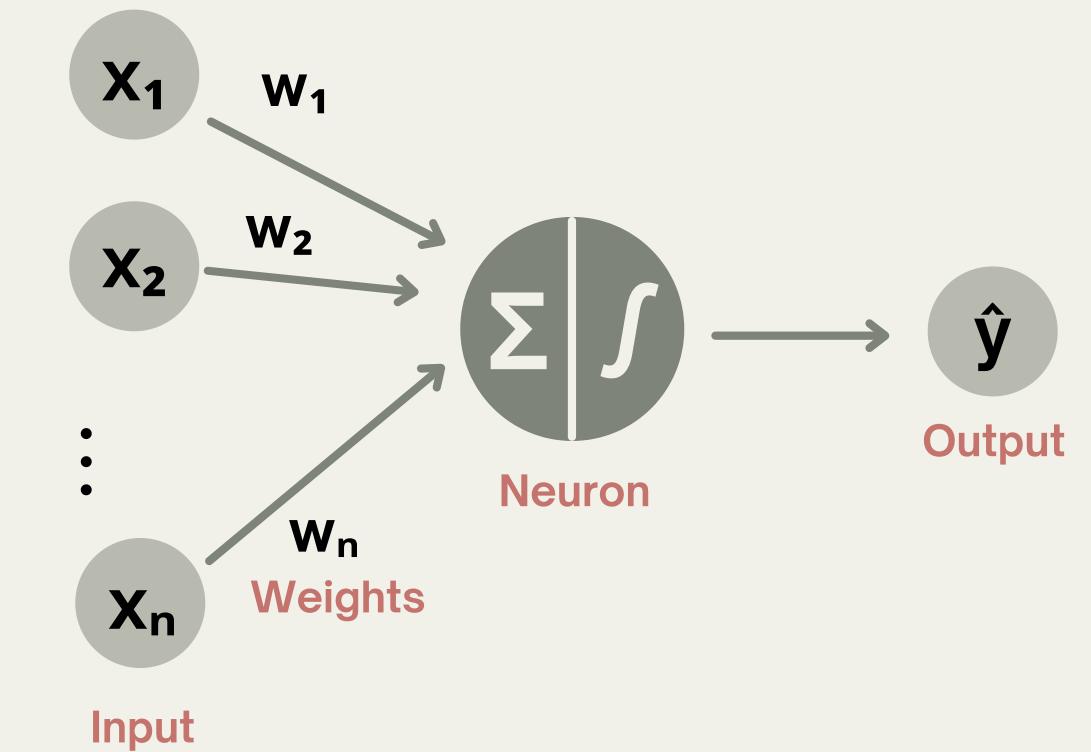
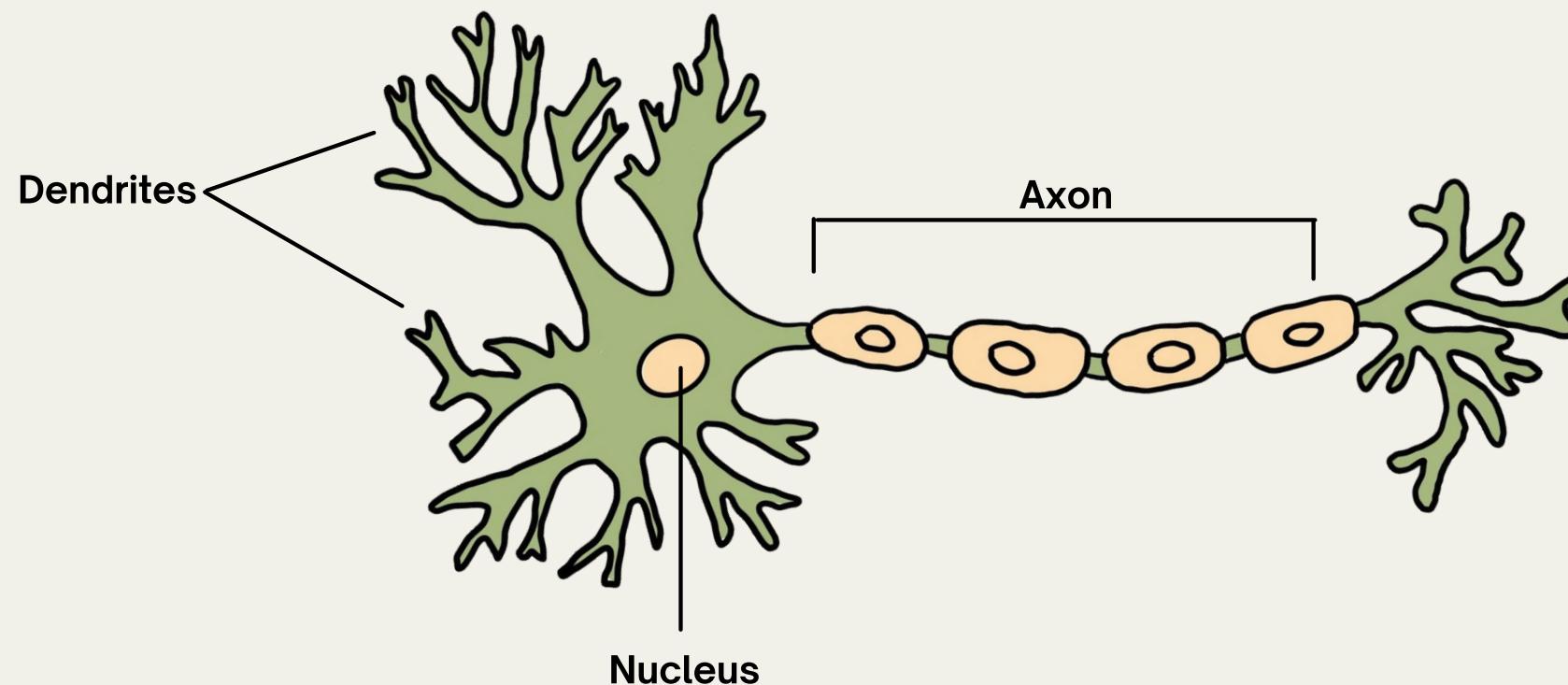
How information flows



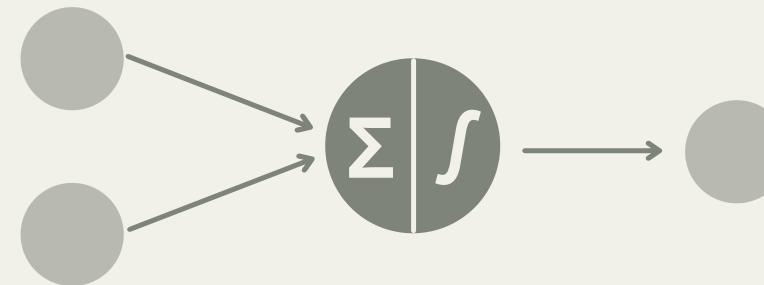
How can we use this
to our advantage ?

Perceptron

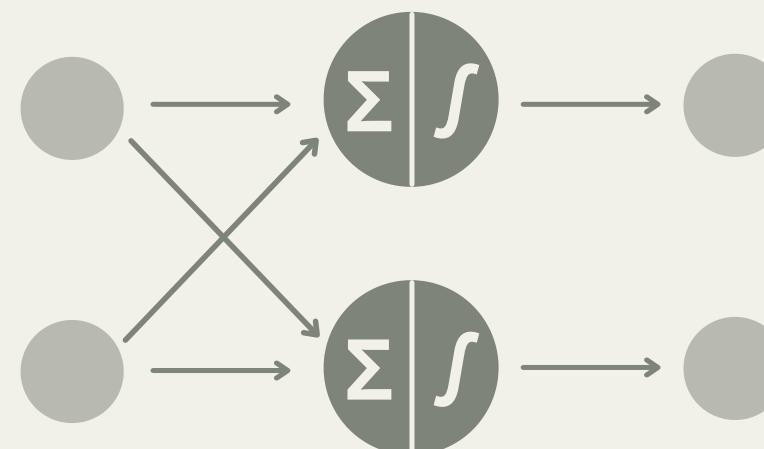
Building Block of Deep Neural Networks



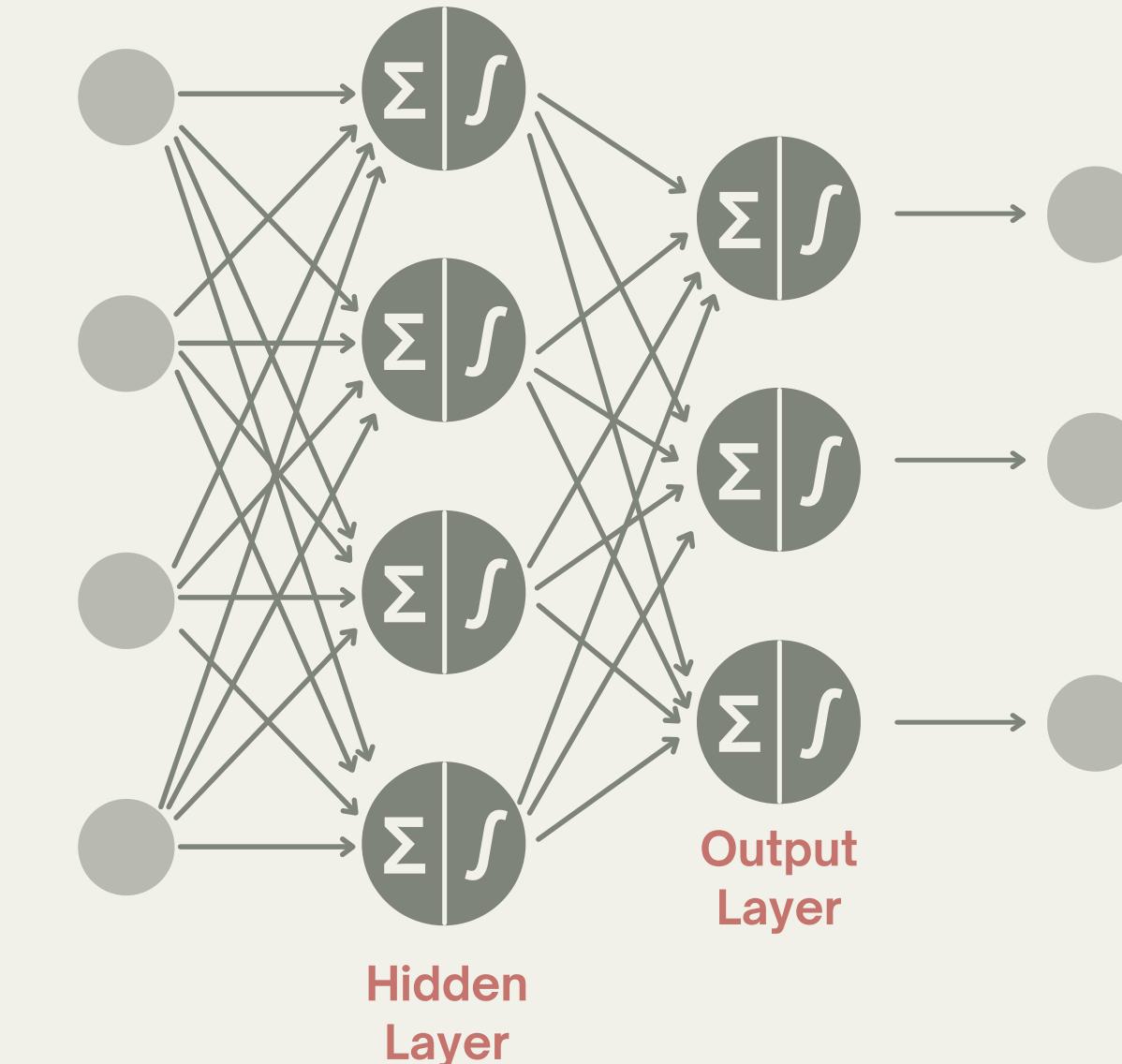
Small steps towards DNN



Perceptron



Multi-output Perceptron



Single Layer Neural Network

Hidden
LayerOutput
Layer

Why the progress was slow from Perceptron to DNN ? &

Why now ?

01

Availability of Data

- Sensors
- Social media & Access to technology

02

Availability of advance & specialized hardware

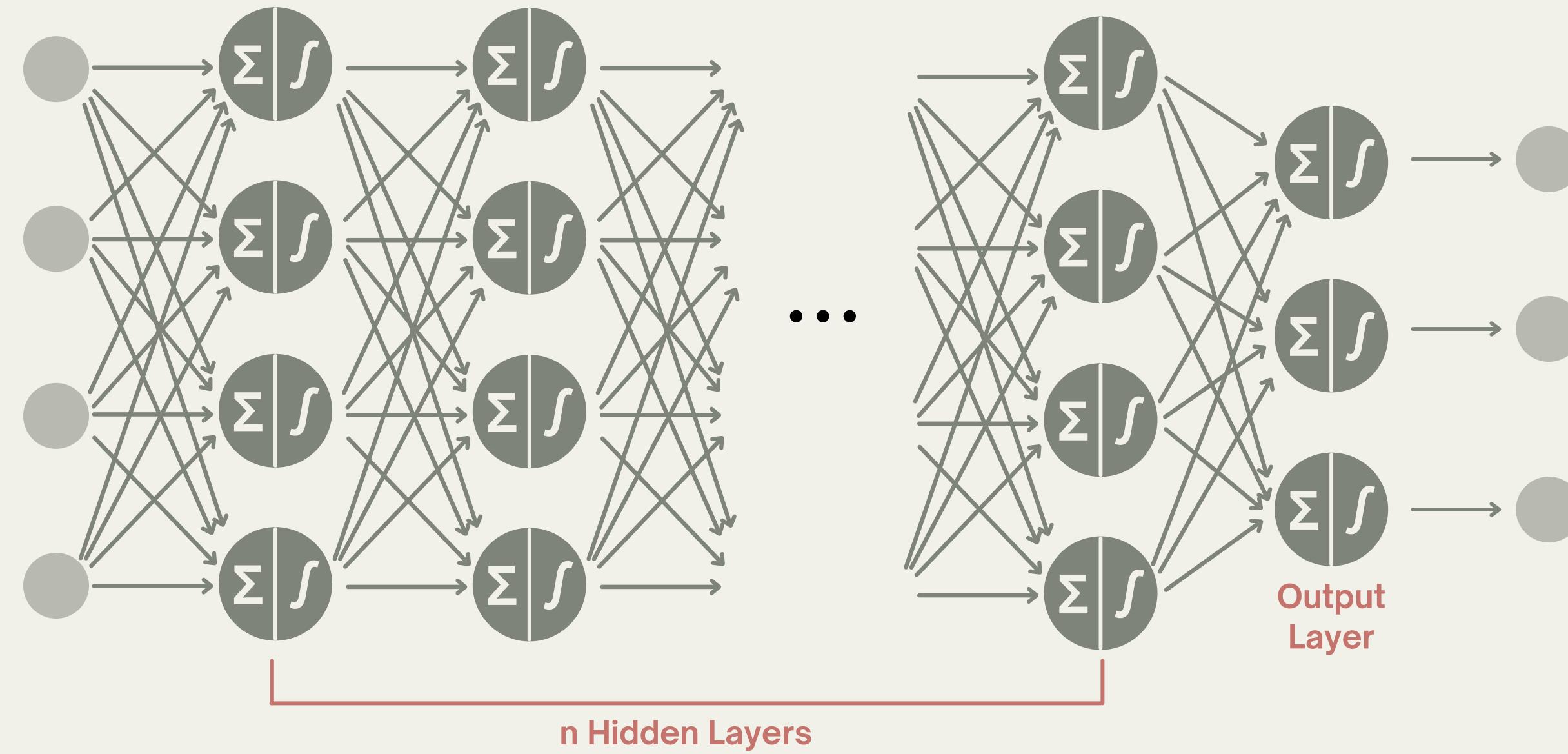
- GPU & TPU
- Cloud

03

Availability of advance software and programming concepts

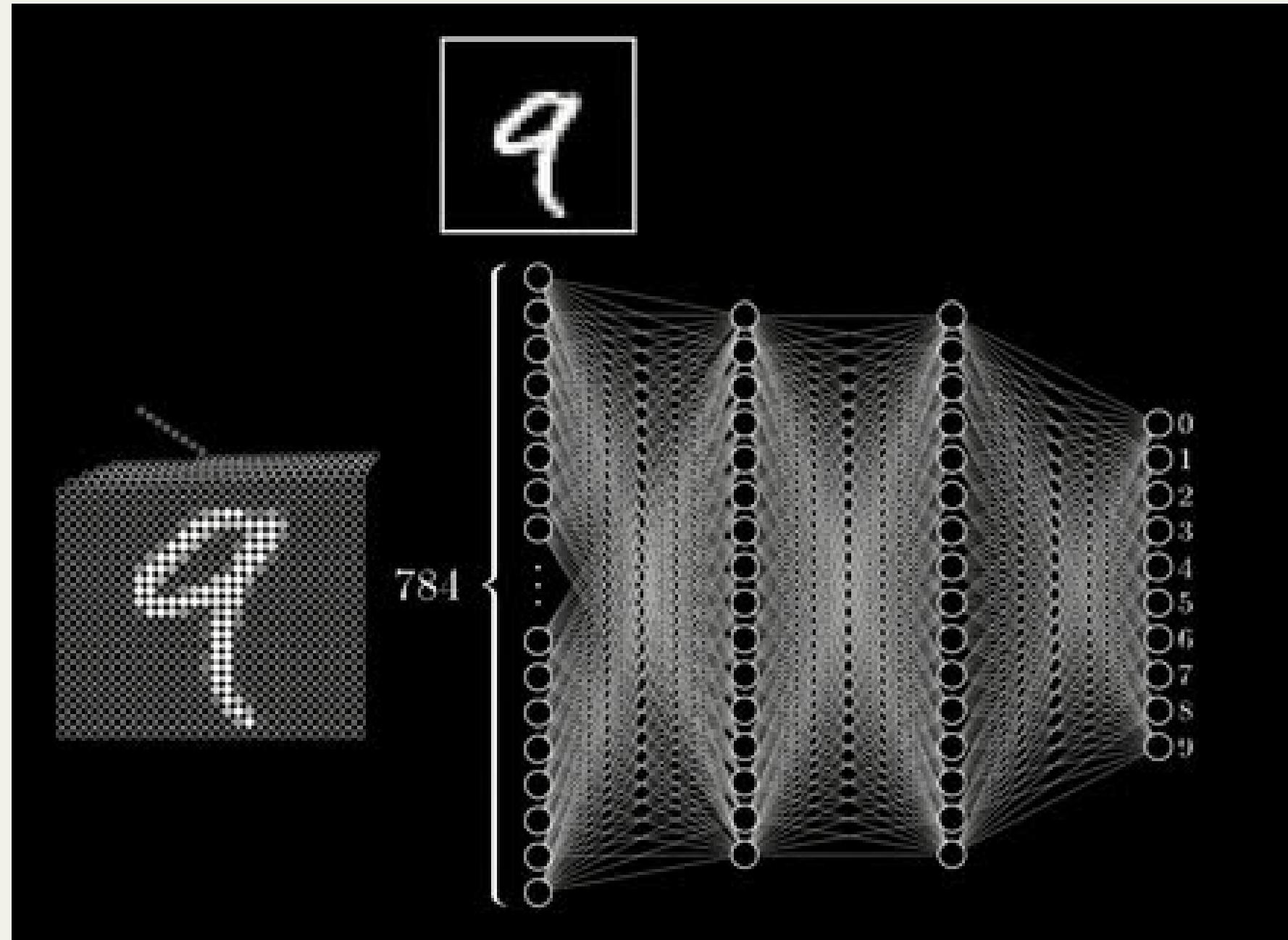
- High level APIs & libraries

Deep Neural Network



Deep Neural Network

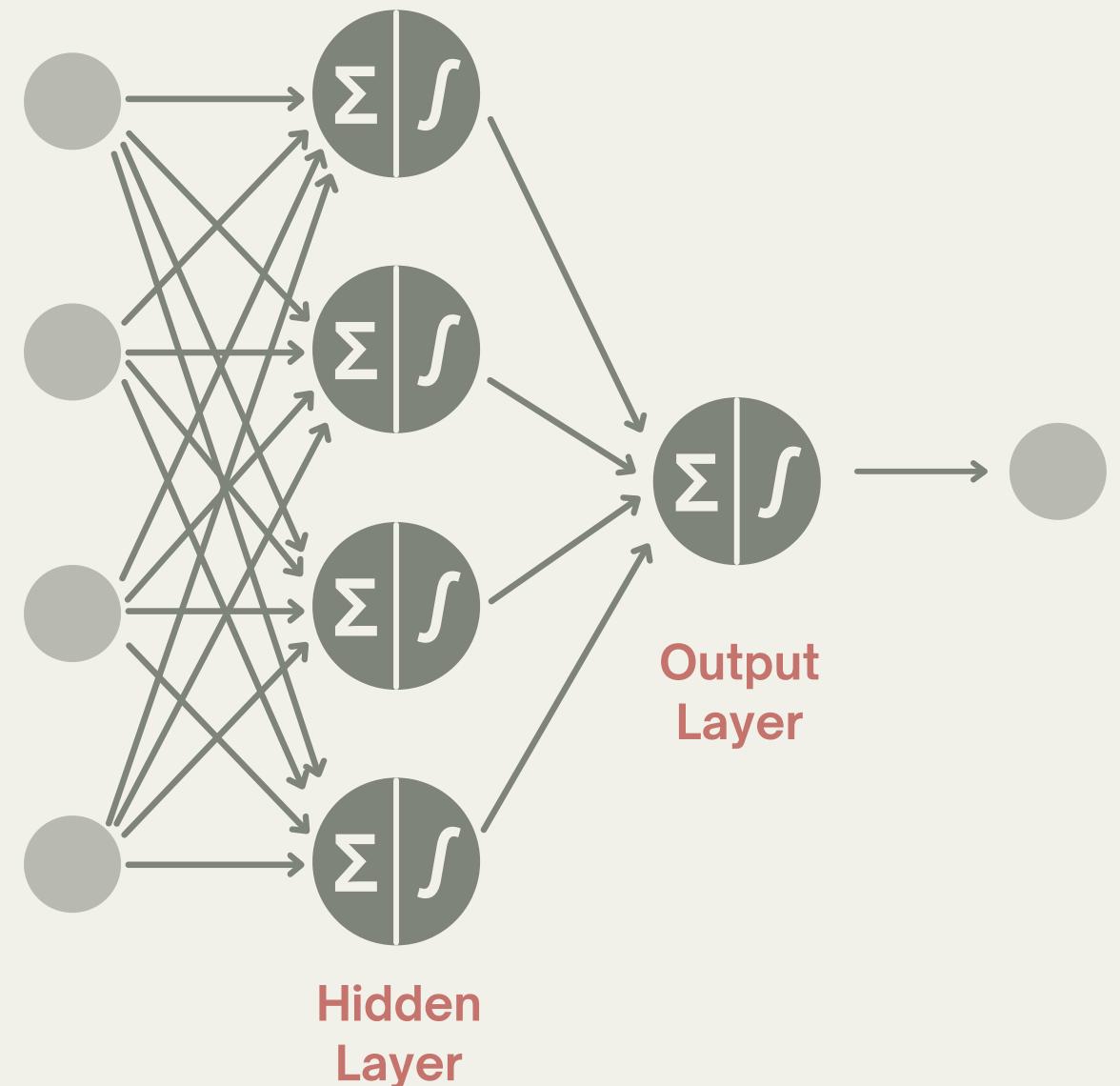
Modeling it with Maths



Source: [3Blue1Brown](#)

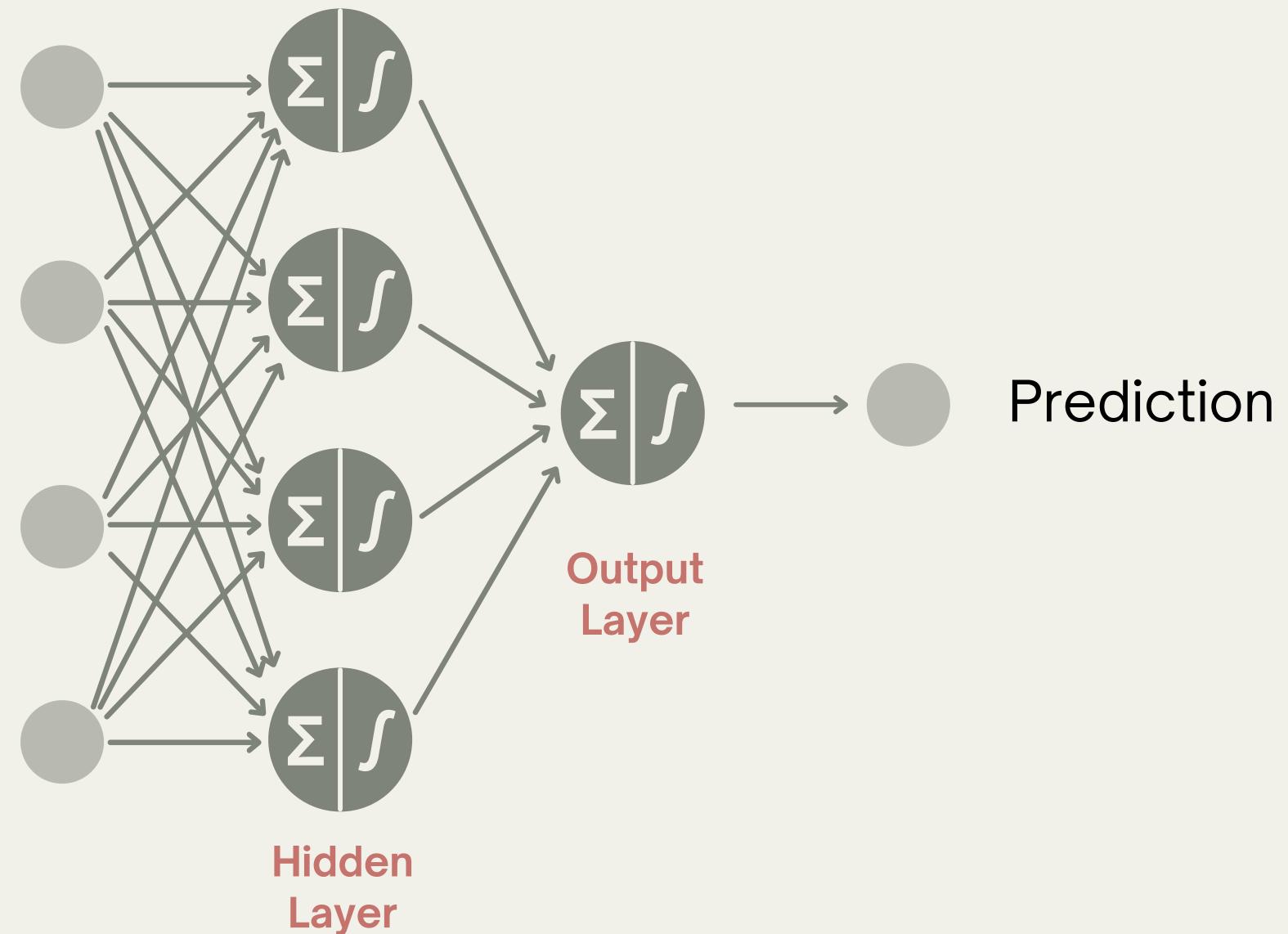
How can we get the
model to do what we
want ?

How models learn



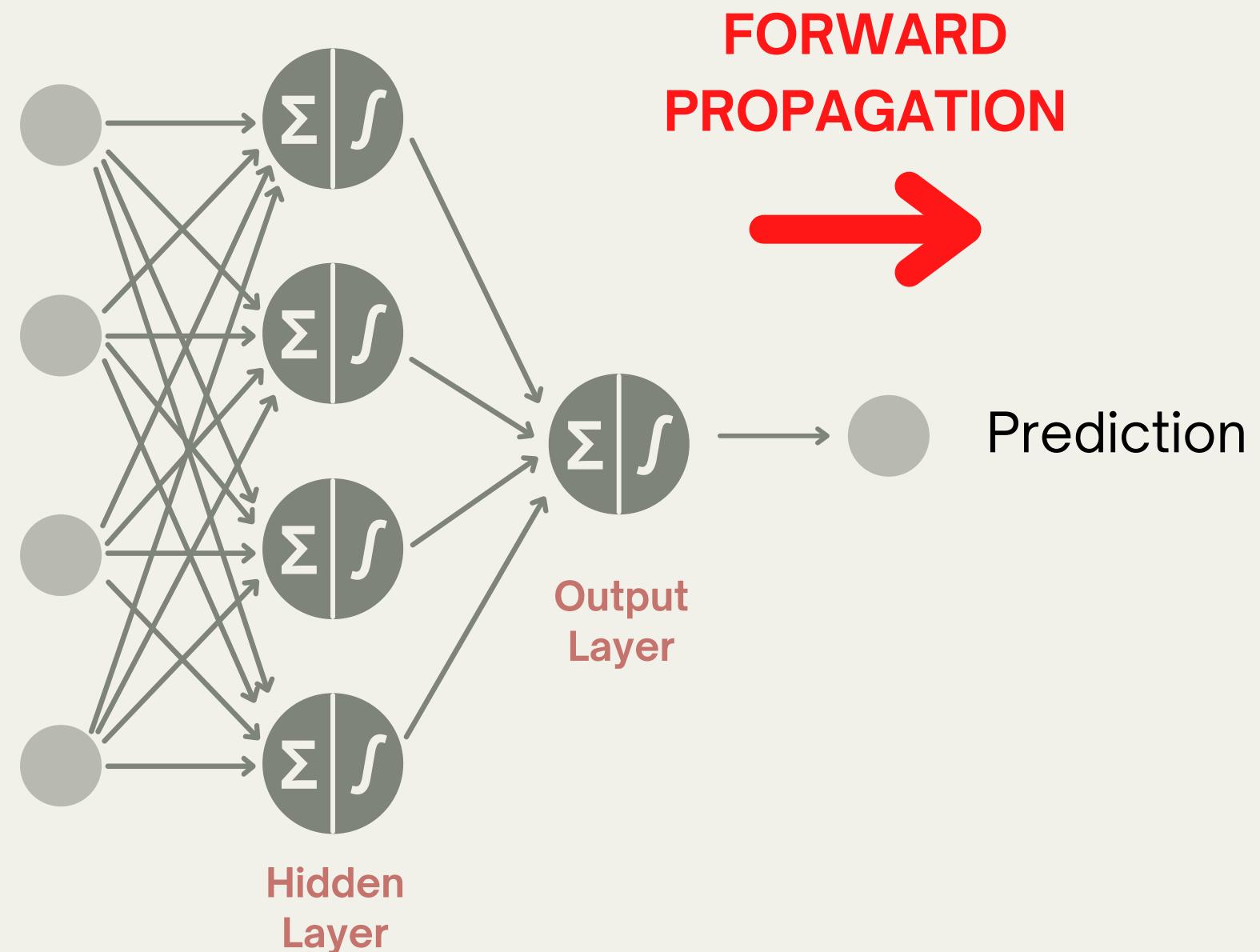
How models learn

9



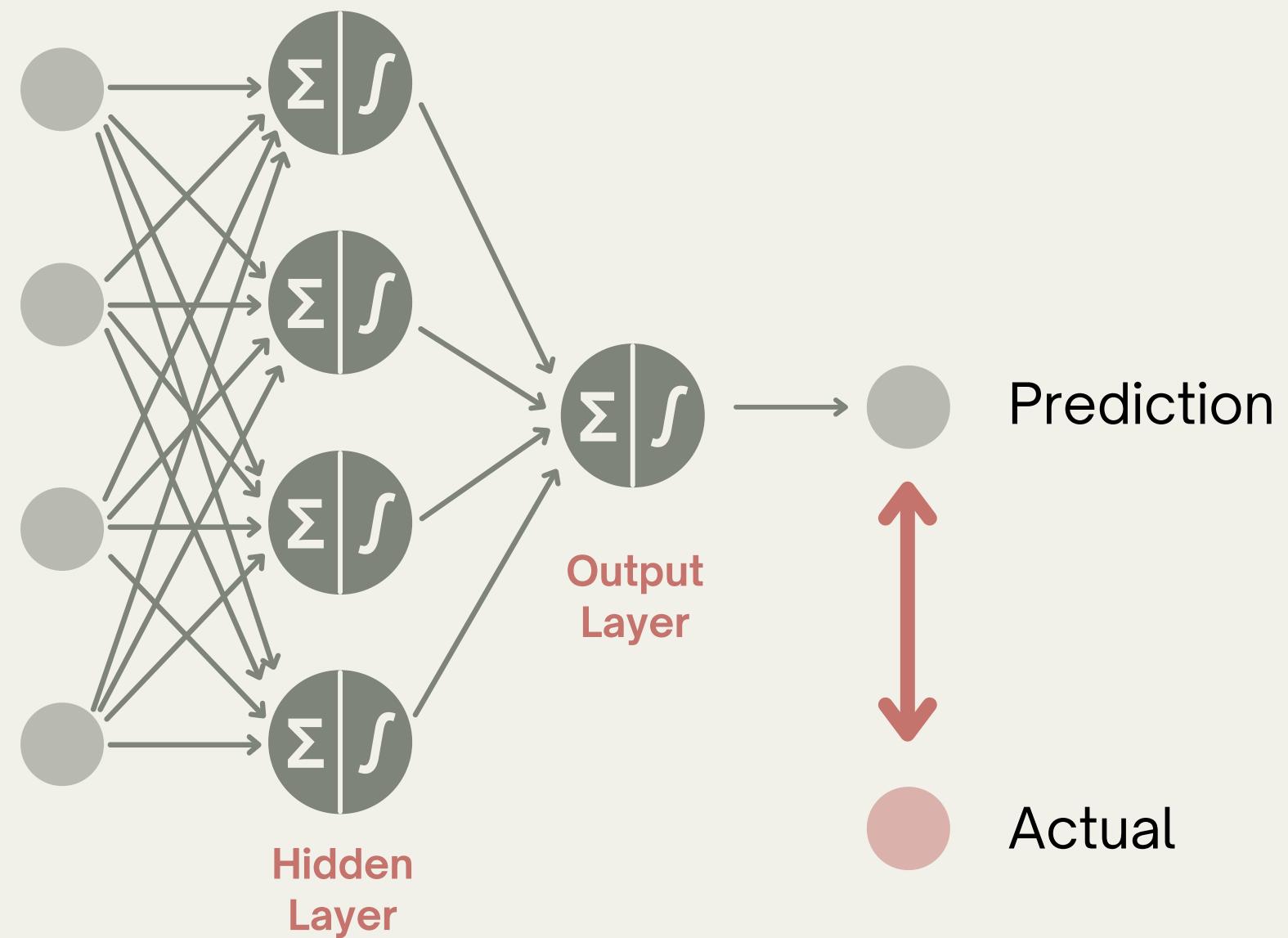
How models learn

9



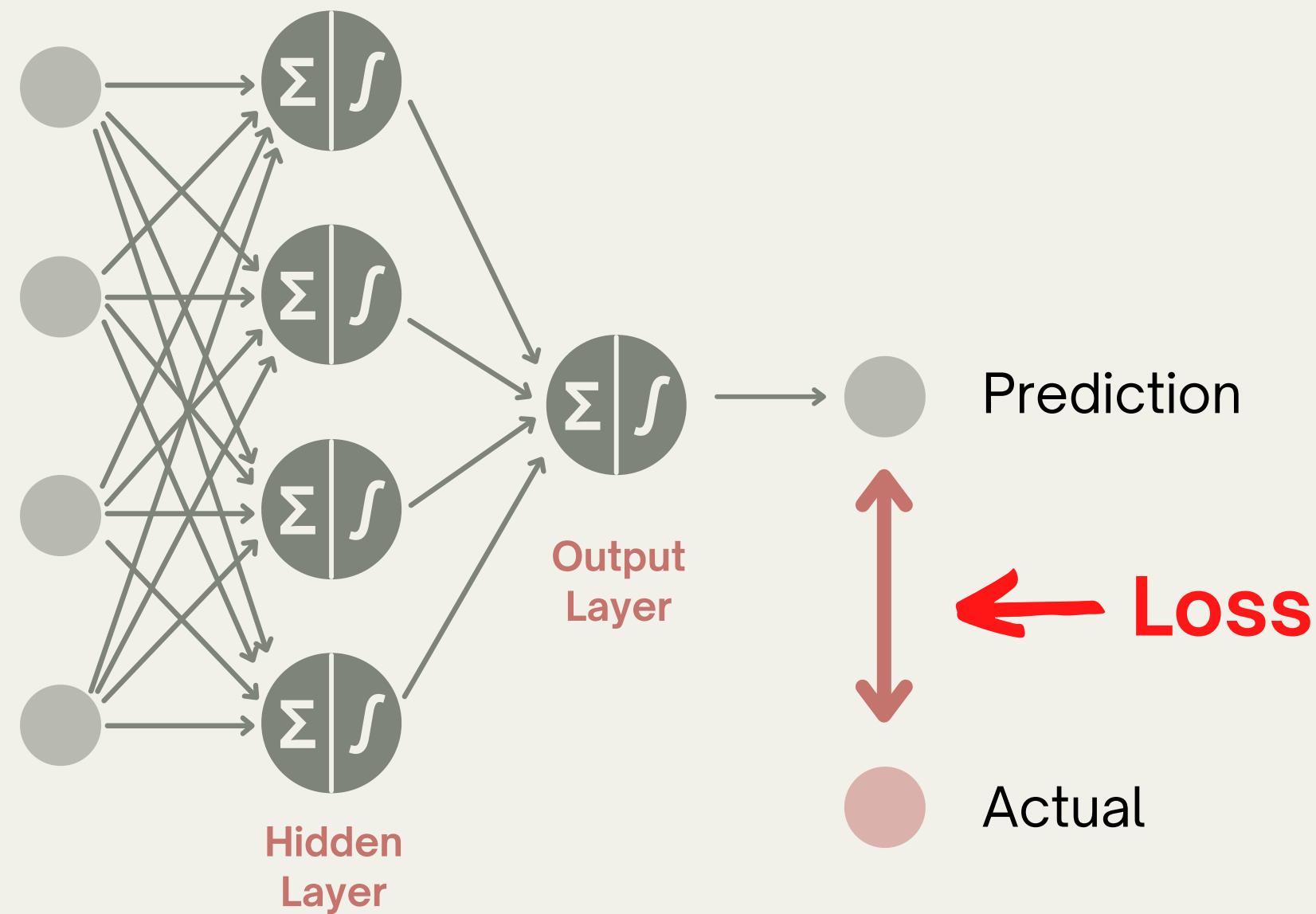
How models learn

9

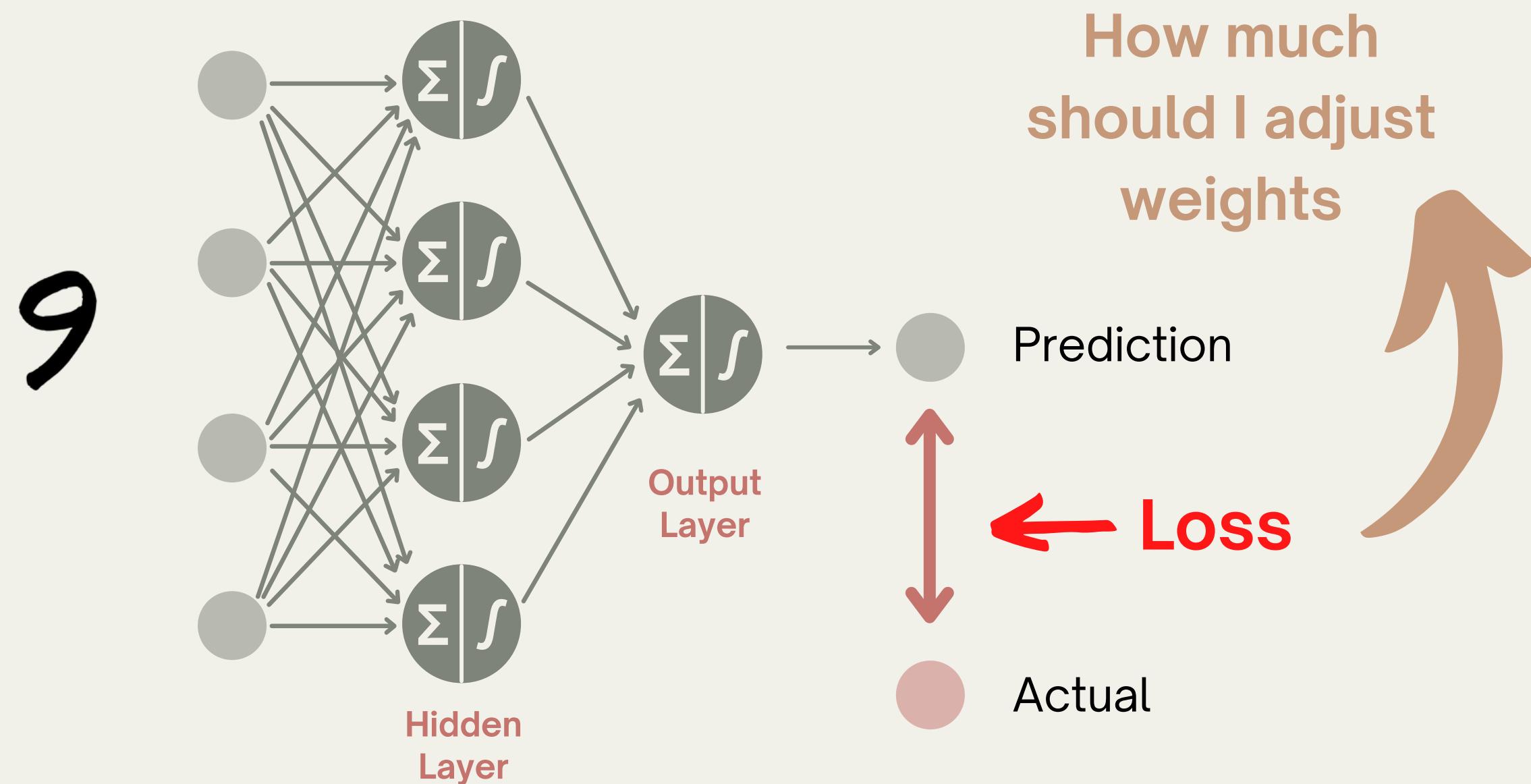


How models learn

9

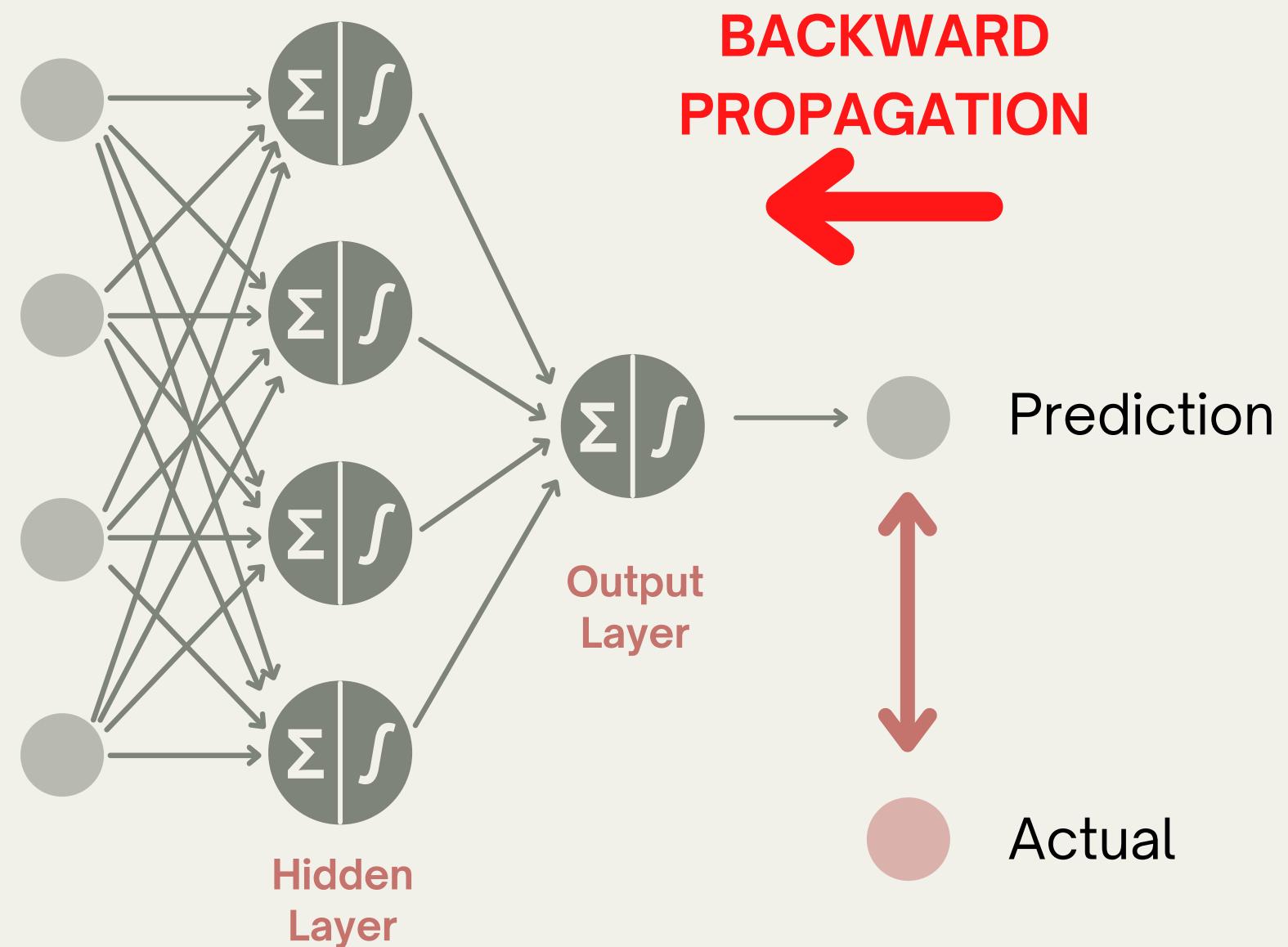


How models learn



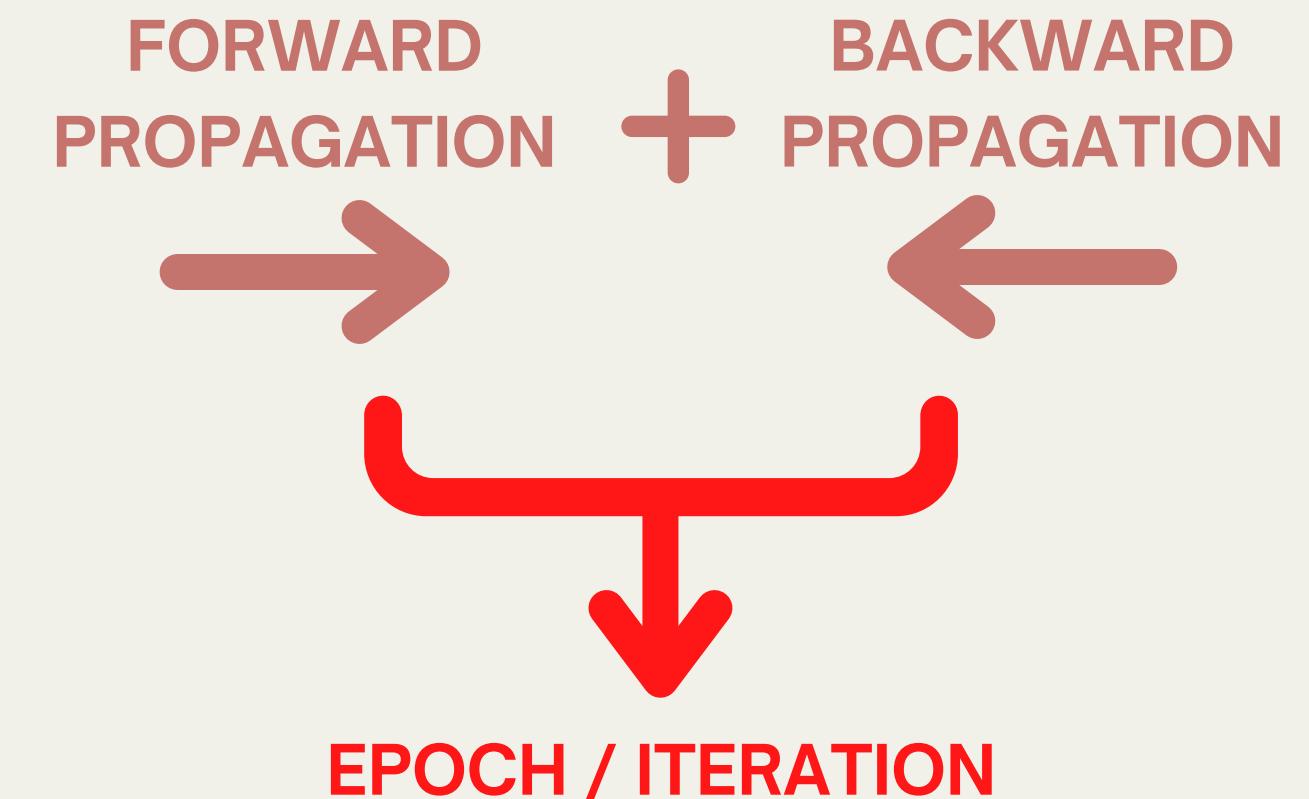
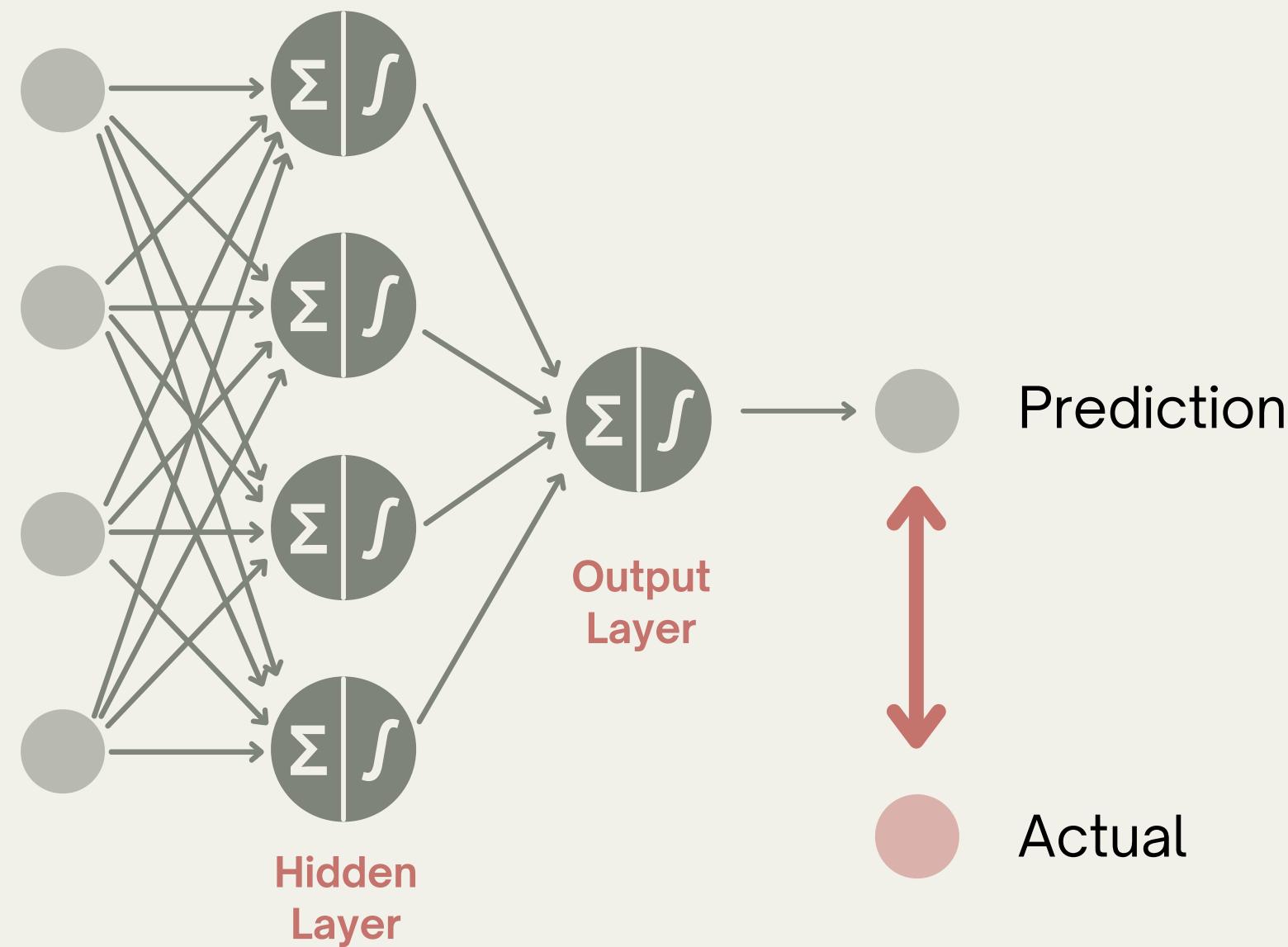
How models learn

9

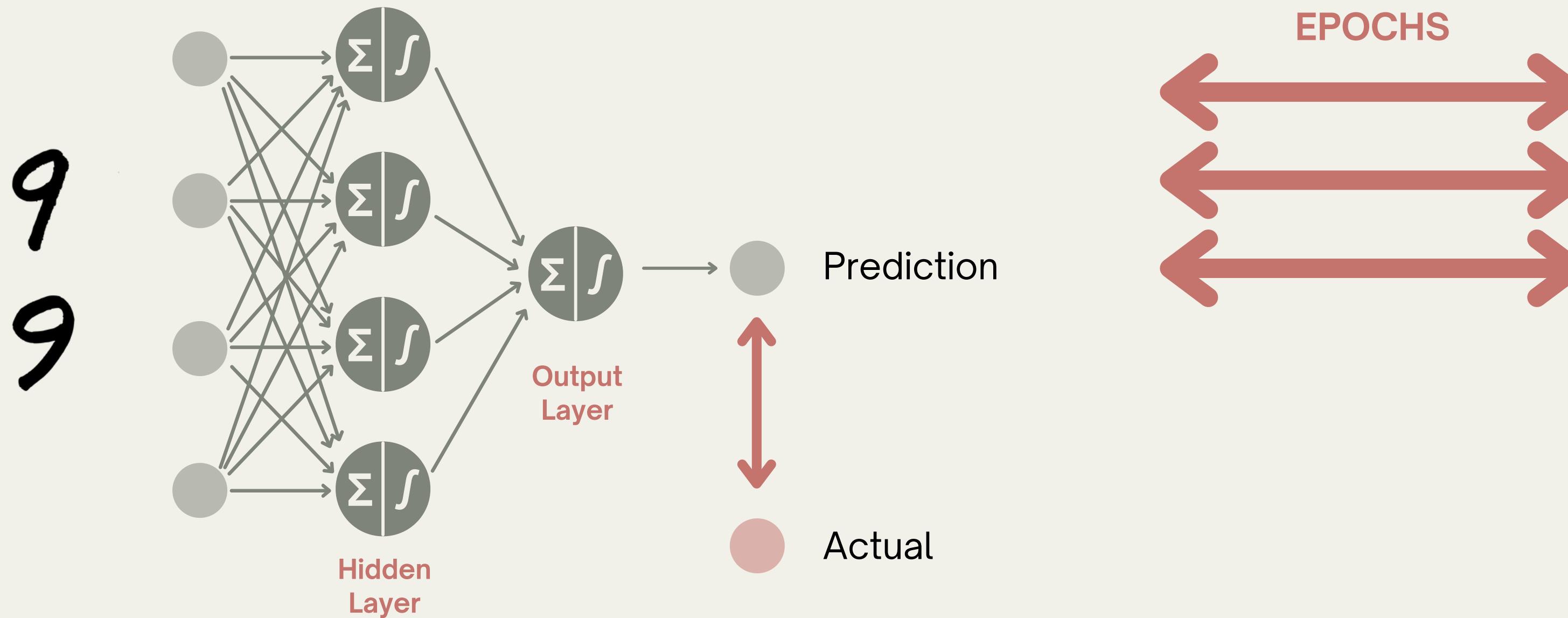


How models learn

9



How models learn



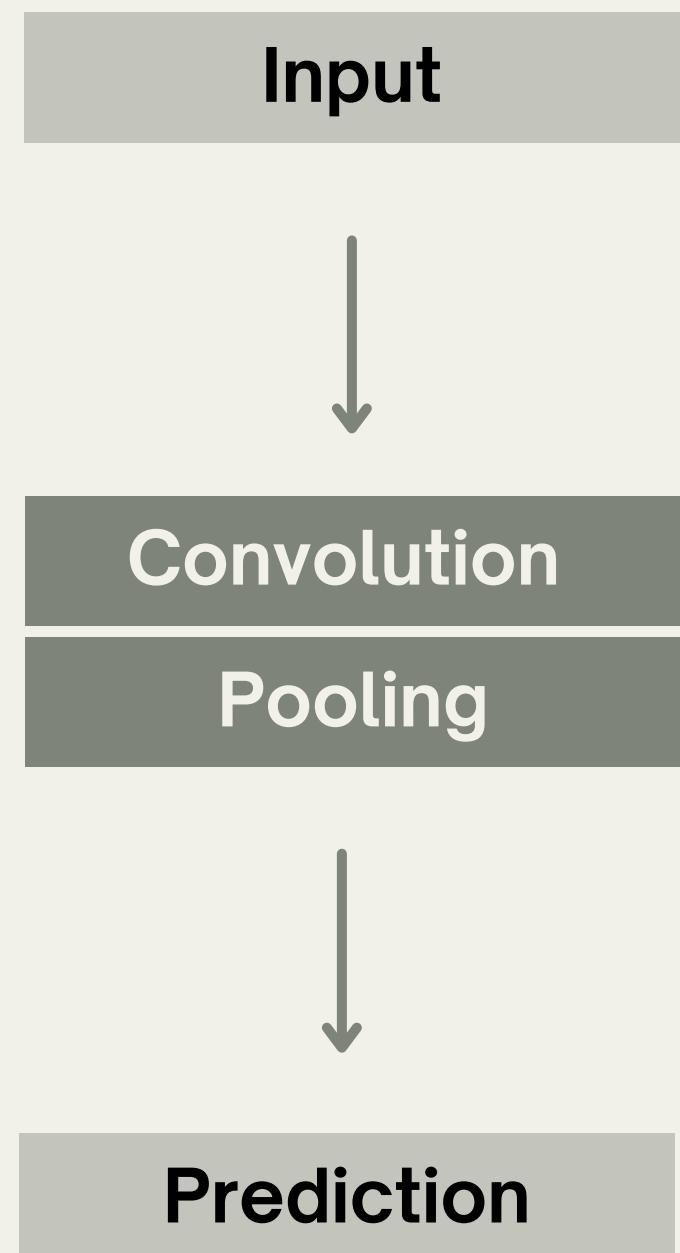
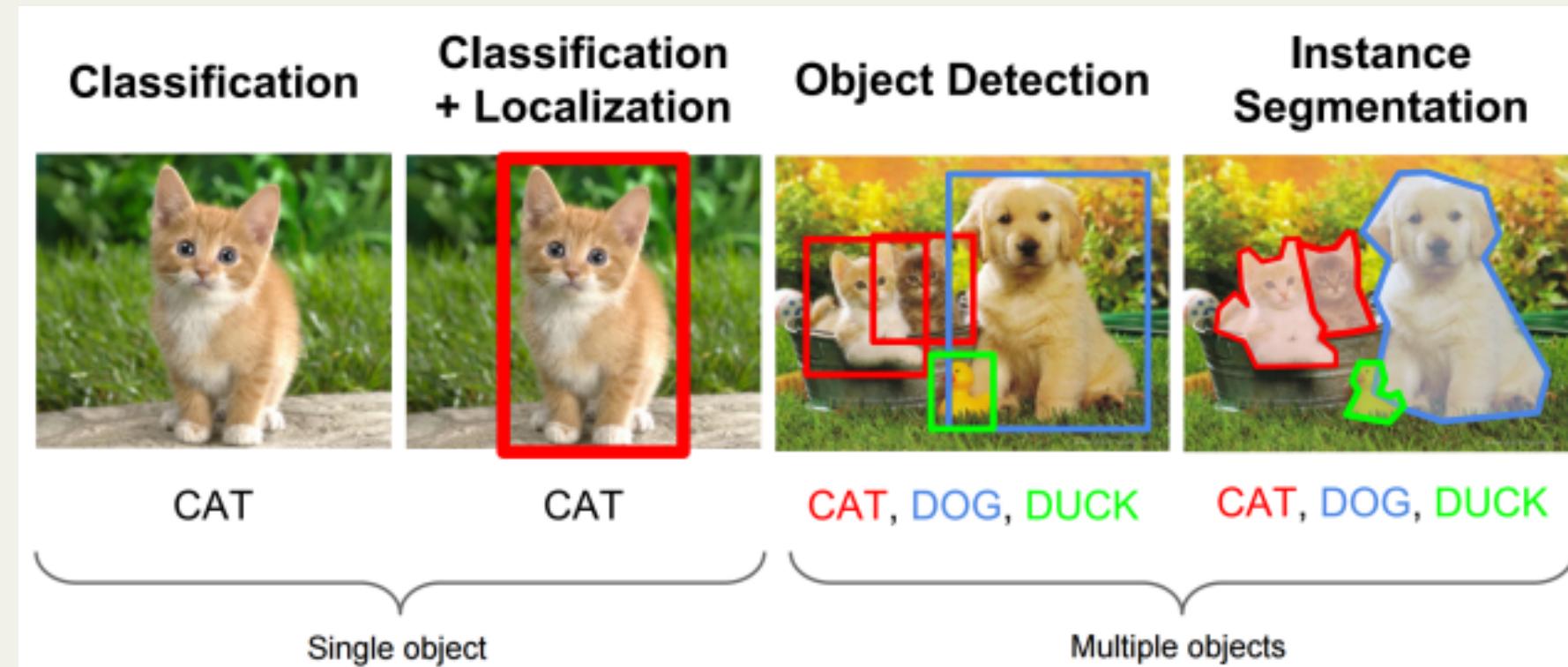
DNNs in Real World

What we can do with Deep Learning ?

CNN

Convolutional Neural Network

Main applications



CNN

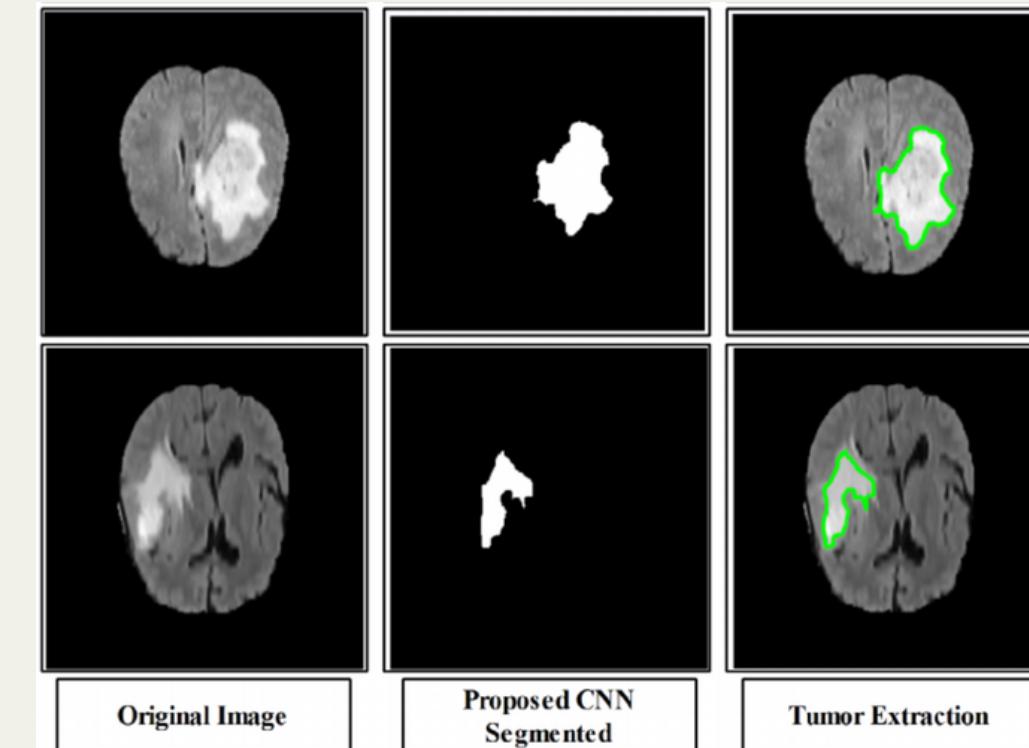
Convolutional Neural Network

CNNs in action:

- Computer vision
 - Medical imaging
 - Self driving cars
 - Colorizing historic images
 - Emotion detection
- Audio and Signal Processing
 - Music Genre Recognition



source: [tesla.com](https://www.tesla.com)



source: [1]



Colorized image



Grey scale image



Ground truth

source: [2]

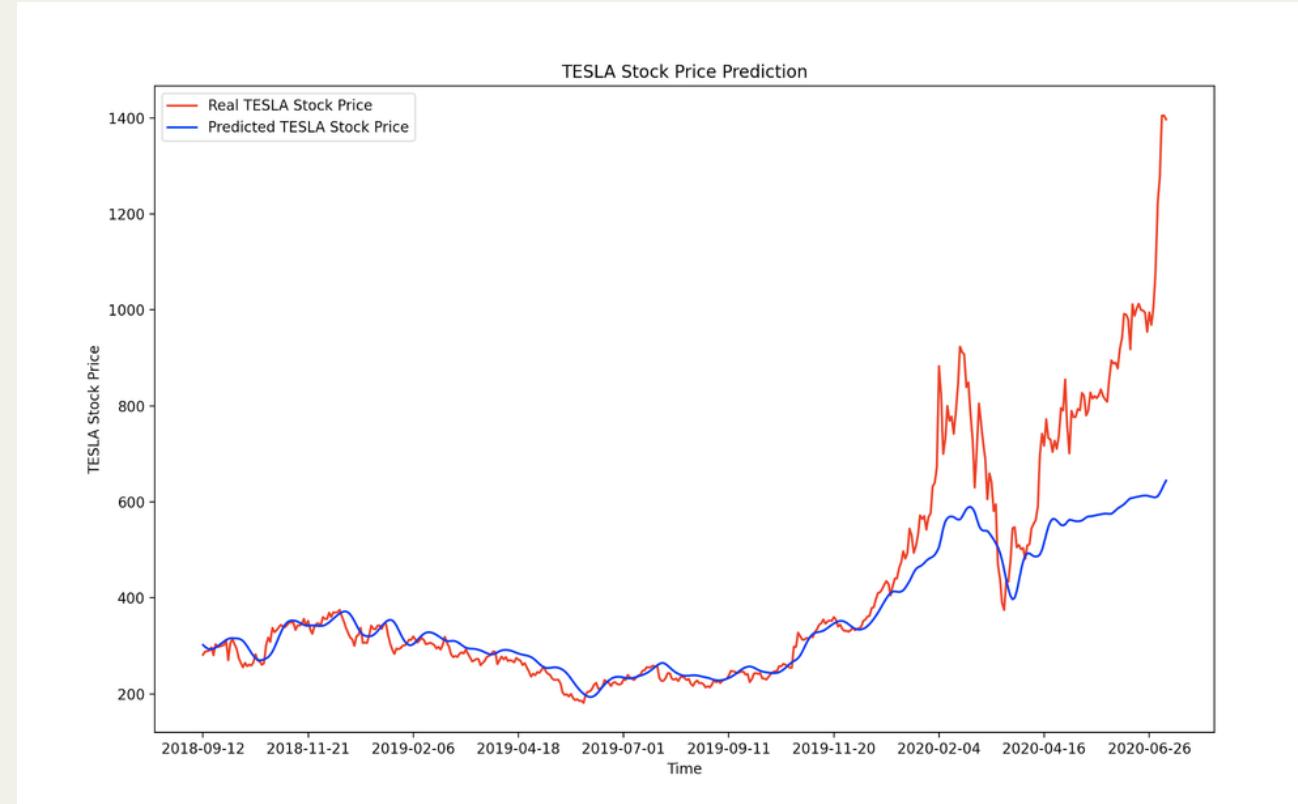
- [1] Rehman A, Khan MA, Saba T, Mehmood Z, Tariq U, Ayesha N. Microscopic brain tumor detection and classification using 3D CNN and feature selection architecture. *Microsc Res Tech*. 2021;84:133–149. <https://doi.org/10.1002/jemt.23597> REHMAN ET AL. 149
- [2] D. Varga and T. Szirányi, "Fully automatic image colorization based on Convolutional Neural Network," 2016 23rd International Conference on Pattern Recognition (ICPR), 2016, pp. 3691-3696, doi: 10.1109/ICPR.2016.7900208.

RNN

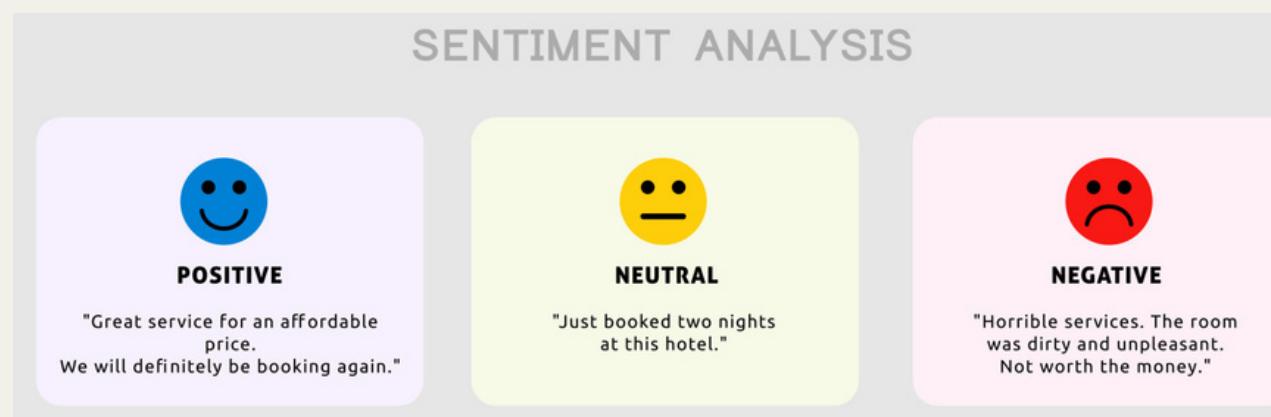
Recurrent Neural Network

RNNs in action:

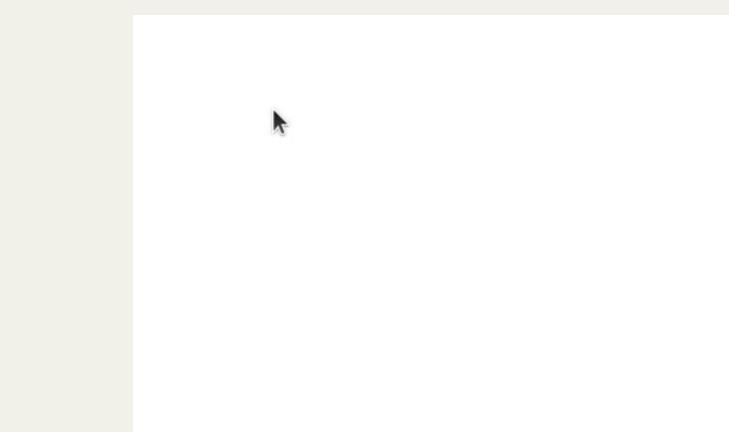
- Natural Language Processing
- Time series analysis
- Music Generation
- Drawing Generation



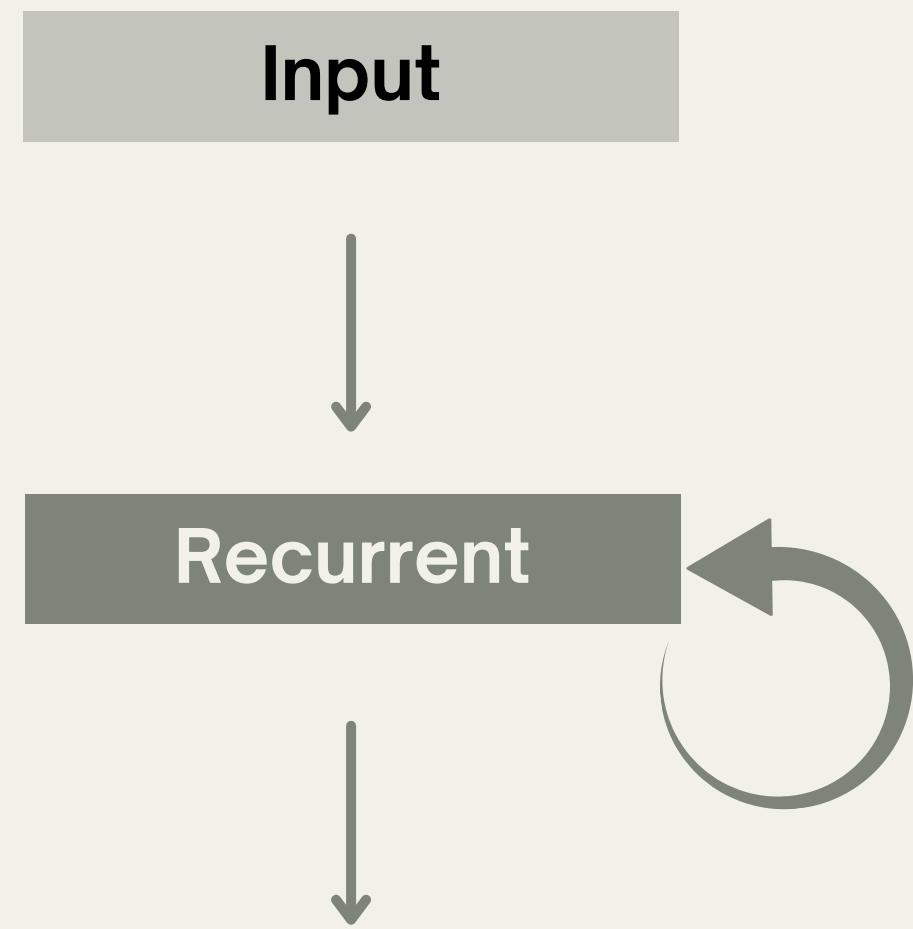
source: [1]



source: [2]

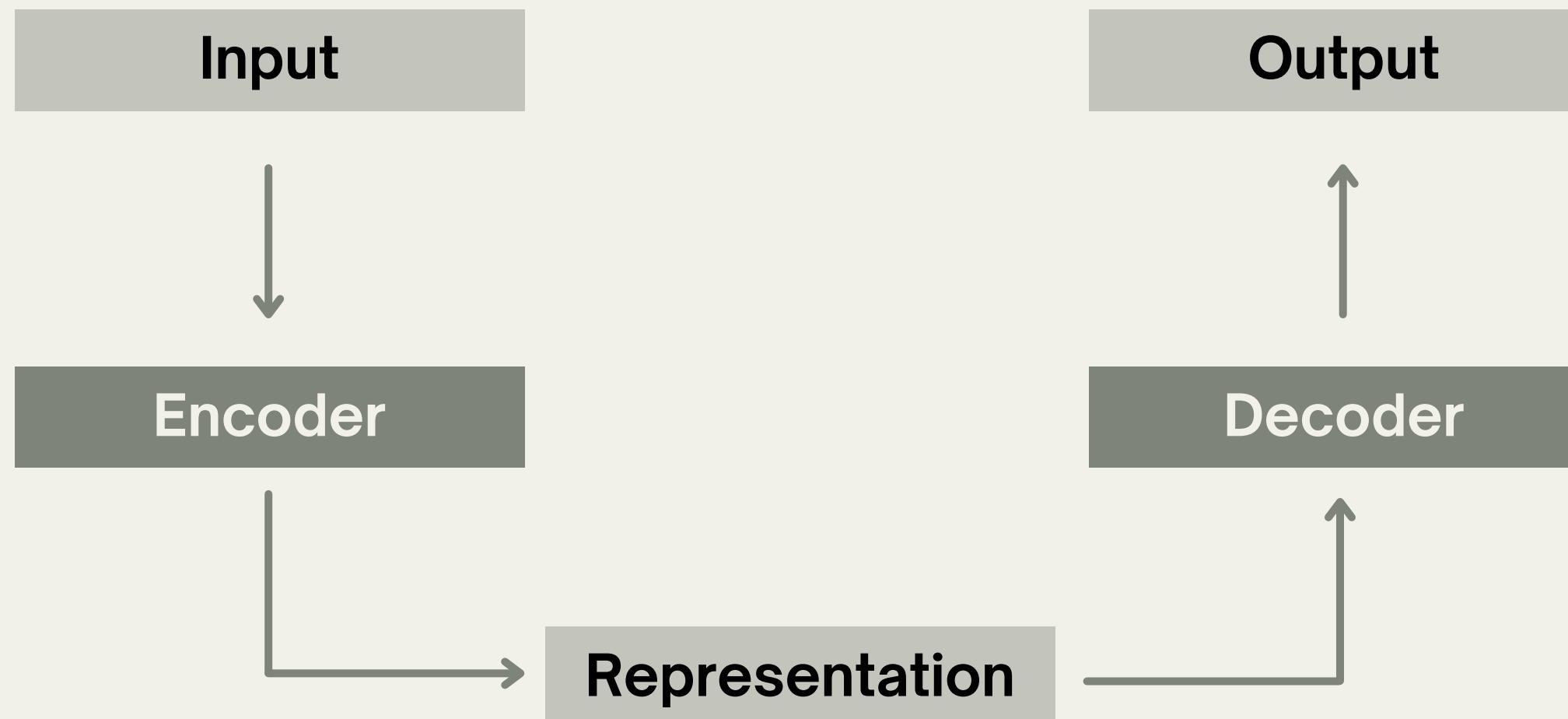


source: [3]



- [1] Loukas, S., 2020. LSTM Time-Series Forecasting: Predicting Stock Prices Using An LSTM Model. [online] Medium.
- [2] Dabhade, V., 2021. Conducting Social Media Sentiment Analysis: A Working Example. [online] Express Analytics.
- [3] magenta.tensorflow.org/assets/sketch_rnn_demo

Encoder - Decoder



Applications:

- Machine Translation
- Image captioning
- Anomaly detection

GAN

Generative Adversarial Network

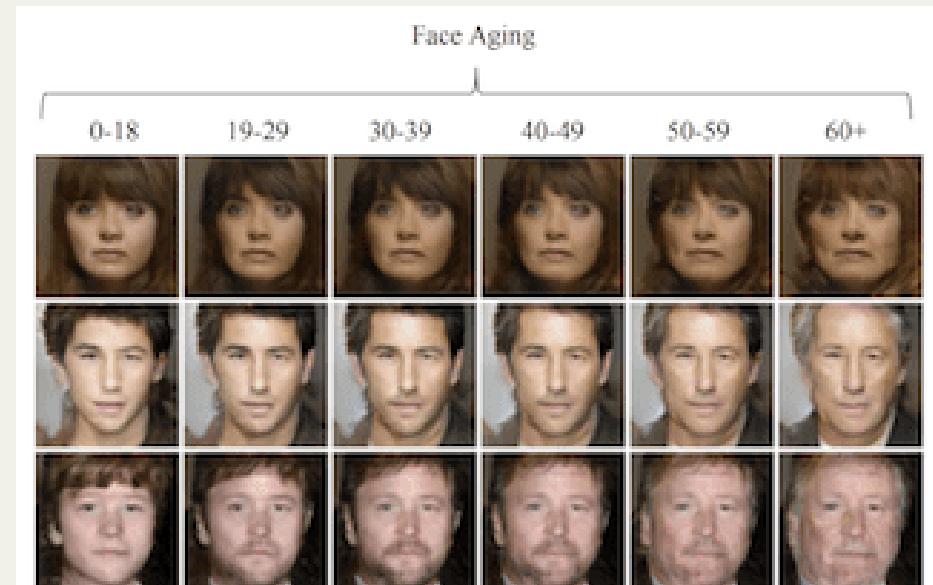


GANs in action:

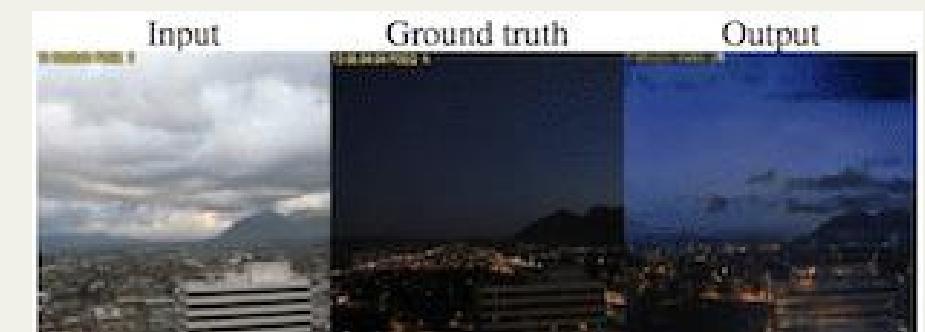
- Anomaly Detection
- Music Generation
- Cartoon Character Generation
- Text-to-Image Translation
- Image-to-Image Translation
- Face Aging



source: [1]



source: [3]



source: [2]

[1] Jin, Y., Zhang, J., Li, M., Tian, Y., Zhu, H. and Fang, Z., 2017. Towards the Automatic Anime Characters Creation with Generative Adversarial Networks.

[2] Isola, P., Zhu, J., Zhou, T. and Efros, A., 2016. Image-to-Image Translation with Conditional Adversarial Networks.

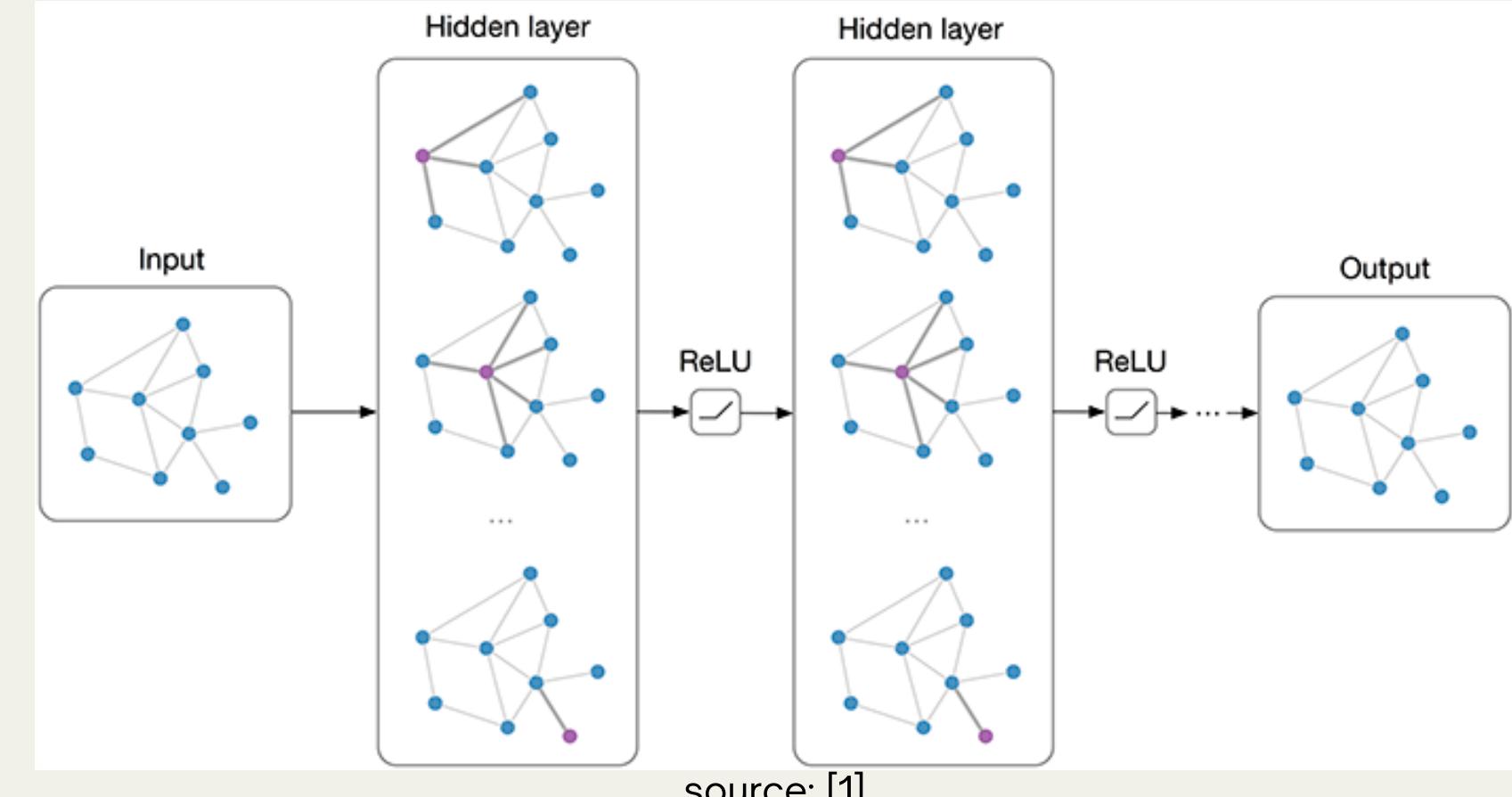
[3] G. Antipov, M. Baccouche and J. Dugelay, "Face aging with conditional generative adversarial networks," 2017 IEEE International Conference on Image Processing (ICIP)

GNN

Graph Neural Network

GNNs in action:

- Natural Language processing: semantic understanding
- Link prediction: Recommendations
- Molecular Fingerprints: predict the properties of a new molecule
- Drug discovery: Protein Interface Prediction
- Healthcare: clinical decision support
- ETA prediction of Google Maps



source: [1]

[1] Kipf, T., 2016. How powerful are Graph Convolutional Networks?. [online] Tkipf.github.io.

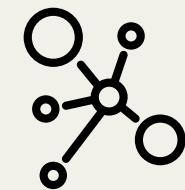
Blossoming areas



Unbiased AI



AI for healthcare



Federated learning



Explainable AI



Self supervised
Computer Vision



Ethics in AI



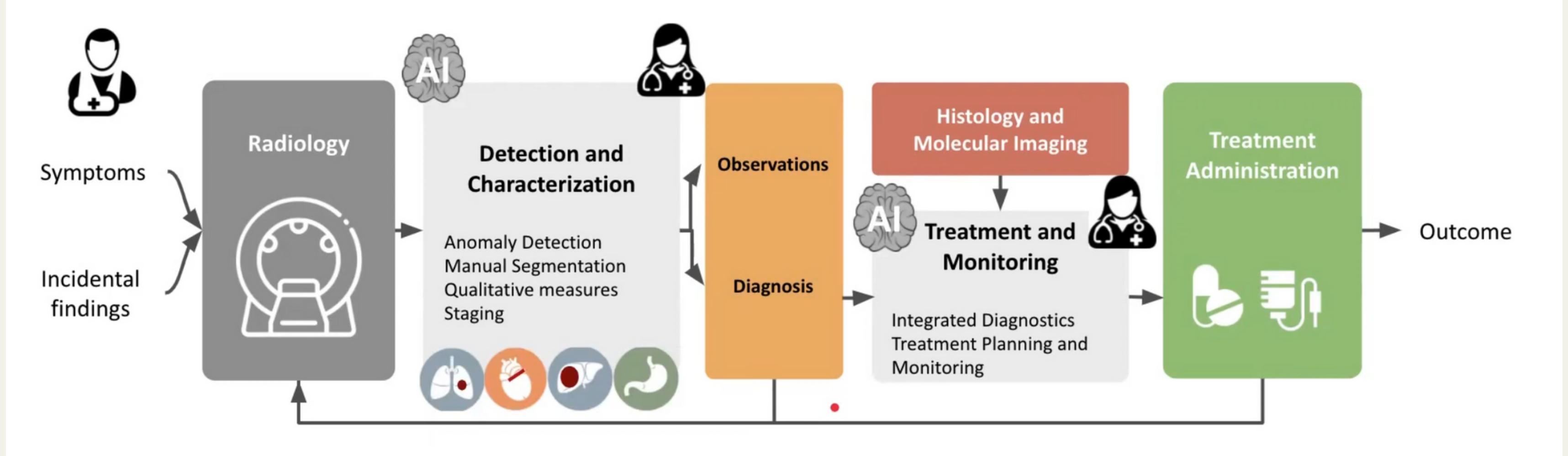
Unbiased AI



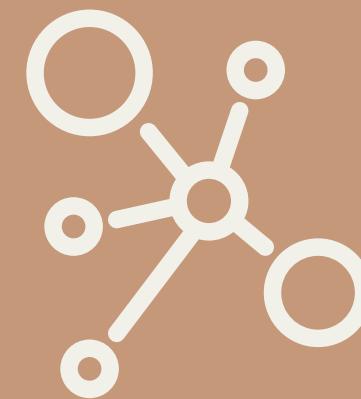


AI for Healthcare





[1] Bi WL, Hosny A, Schabath MB, Giger ML, Birkbak NJ, Mehrtash A, Allison T, Arnaout O, Abbosh C, Dunn IF, Mak RH, Tamimi RM, Tempny CM, Swanton C, Hoffmann U, Schwartz LH, Gillies RJ, Huang RY, Aerts HJWL. Artificial intelligence in cancer imaging: Clinical challenges and applications. CA Cancer J Clin. 2019 Mar;69(2):127-157. doi: 10.3322/caac.21552. Epub 2019 Feb 5. PMID: 30720861; PMCID: PMC6403009.



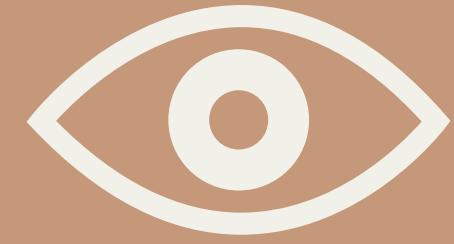
Federated Learning





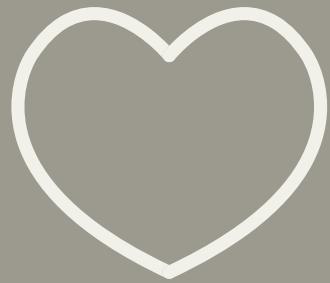
Explainable AI





Self-supervised Computer vision





Ethics in AI



Ethics in AI



2014



2015

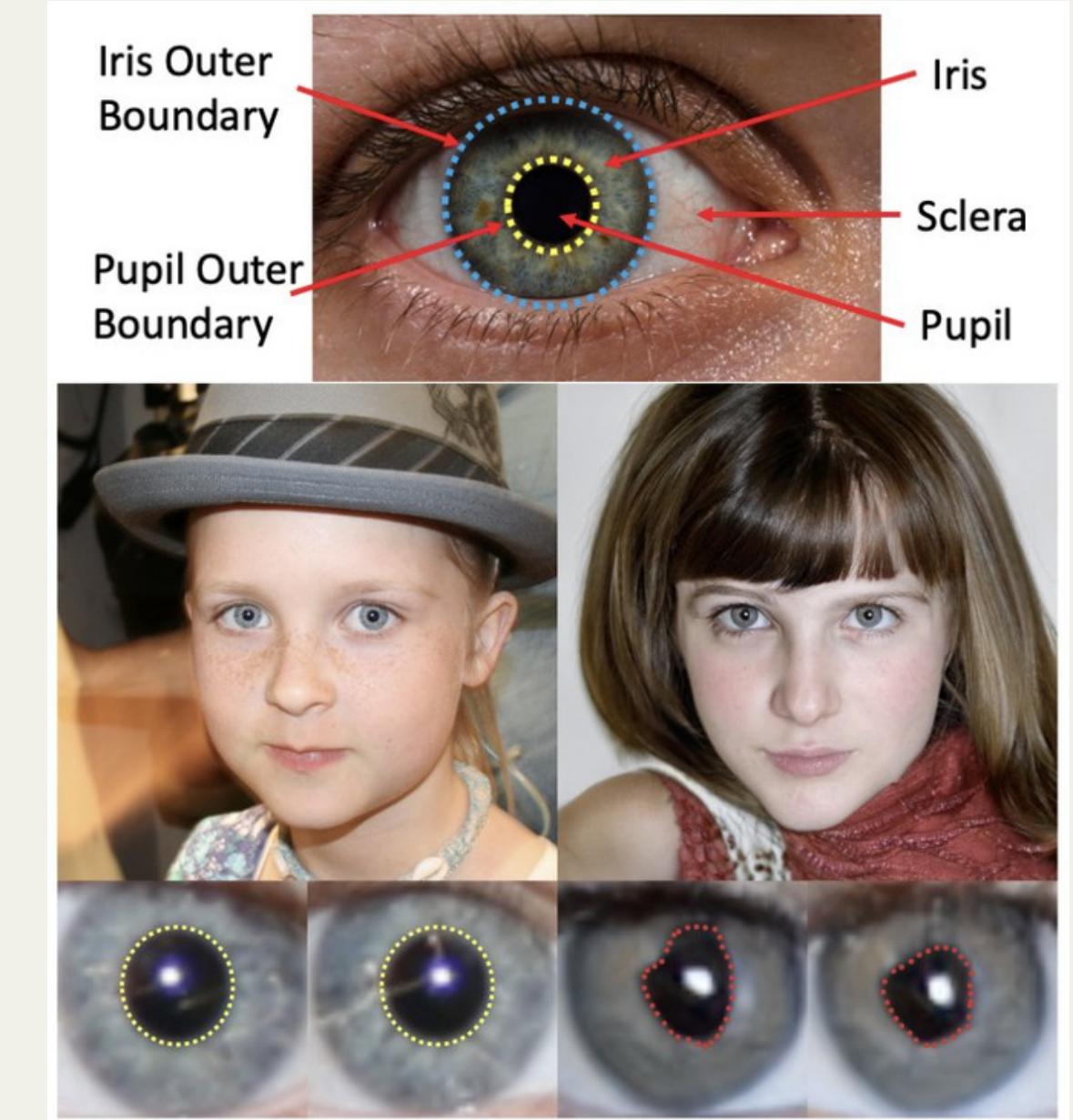


2016



2017

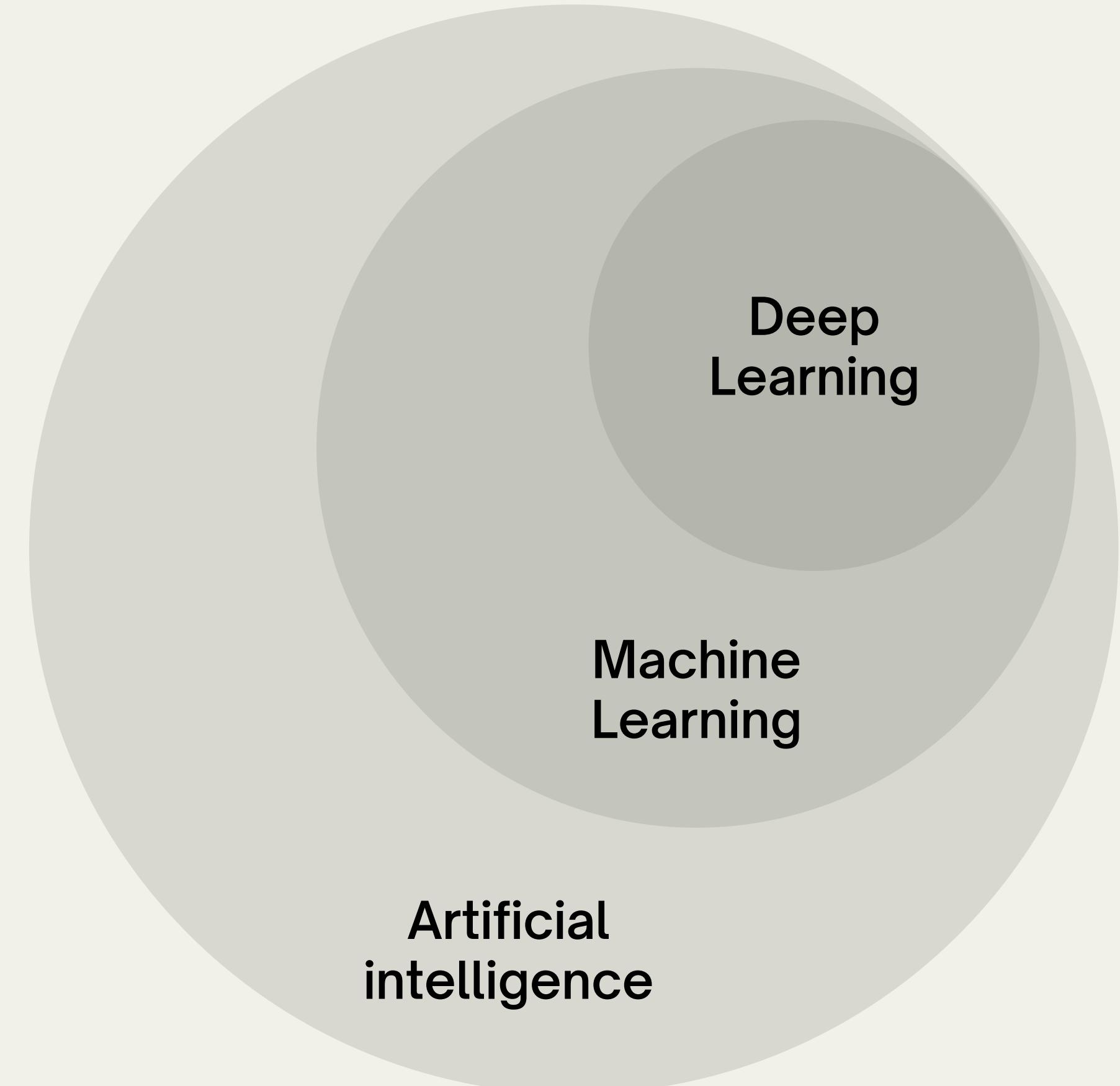
source: [1]



source: [2]

- [1] Brundage, M., Avin, S., Clark, J., Toner, H., Eckersley, P., Garfinkel, B., Dafoe, A., Scharre, P., Zeitzoff, T., Filar, B., Anderson, H., Roff, H., Allen, G., Steinhardt, J., Flynn, C., hÉigeartaigh, S., Beard, S., Belfield, H., Farquhar, S., Lyle, C., Crootof, R., Evans, O., Page, M., Bryson, J., Yampolskiy, R. and Amodei, D., 2018. The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation. [online] arXiv.org.
- [2] Guo, H., Hu, S., Wang, X., Chang, M. and Lyu, S., 2021. Eyes Tell All: Irregular Pupil Shapes Reveal GAN-generated Faces. [online] arXiv.org.

Important Terminology



As a student...

Start; you don't have to know everything

Explore and find your interest

Applied research is **EQUALLY** important

Keep up with the latest news

Blogging, tweeting & sharing what you learn

Resource Page

MIT 6.S191

CS109 Data Science - University of Harvard

Data Science Specialization - John Hopkins University

Machine Learning and Deep Learning Specialization by Andrew Ng

Reinforcement Learning Specialization by Alberta Machine Intelligence Institute

Some youtube channels: 3Blue1Brown, KhanAcademy, Yannic Kilcher

For more resources ...

Thank you!

Questions are welcome!



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