

# A Dive into Deep Learning

An essential skill for the next decade

October 10, 2021

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B.Sc. Hons. in Software Engineering (UOK, Sri Lanka)*



Lineup

# What we'll discuss this afternoon

**How the brain works**

**Building block of DNN**

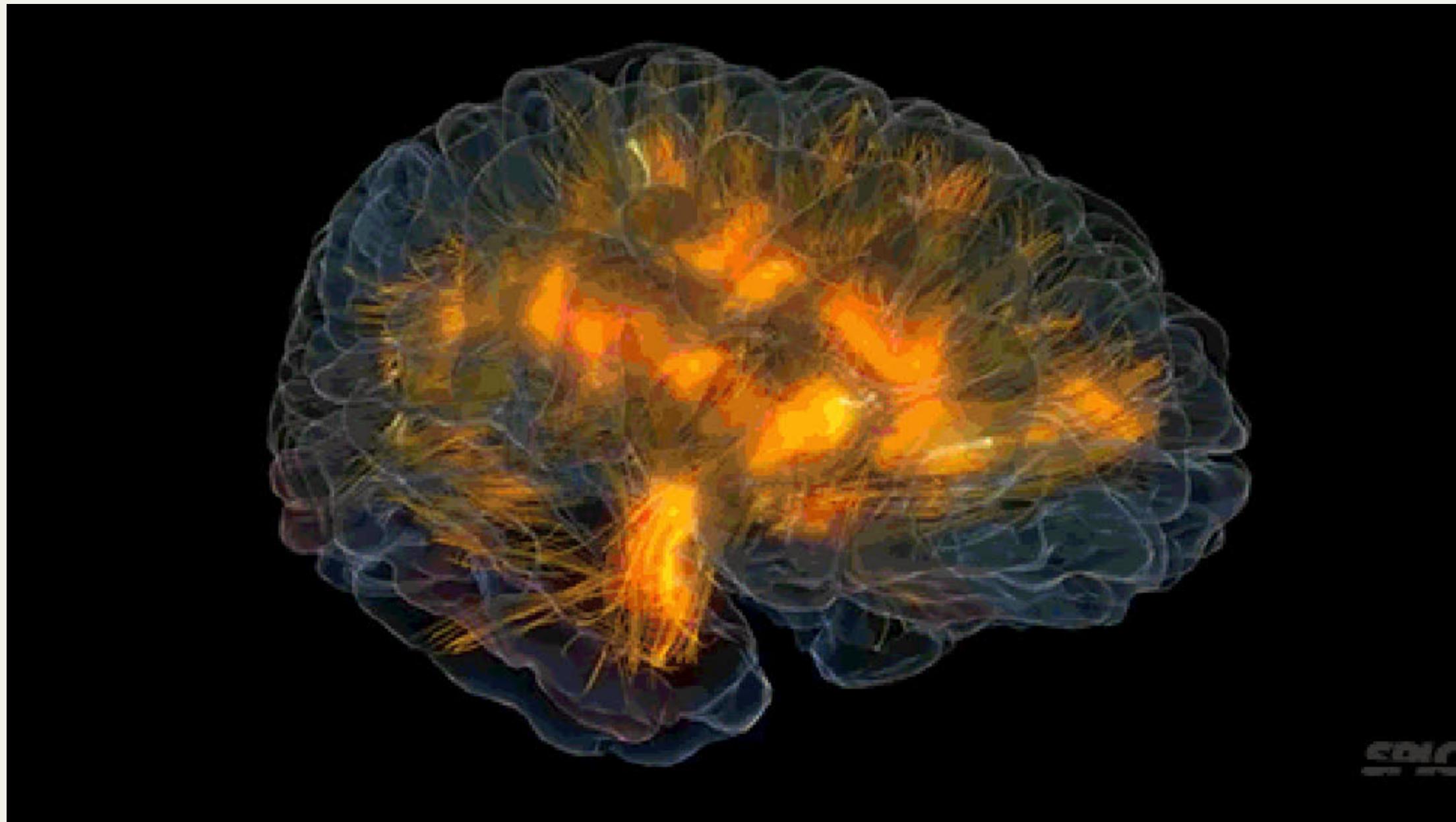
**How models learn**

**DNNs in action**

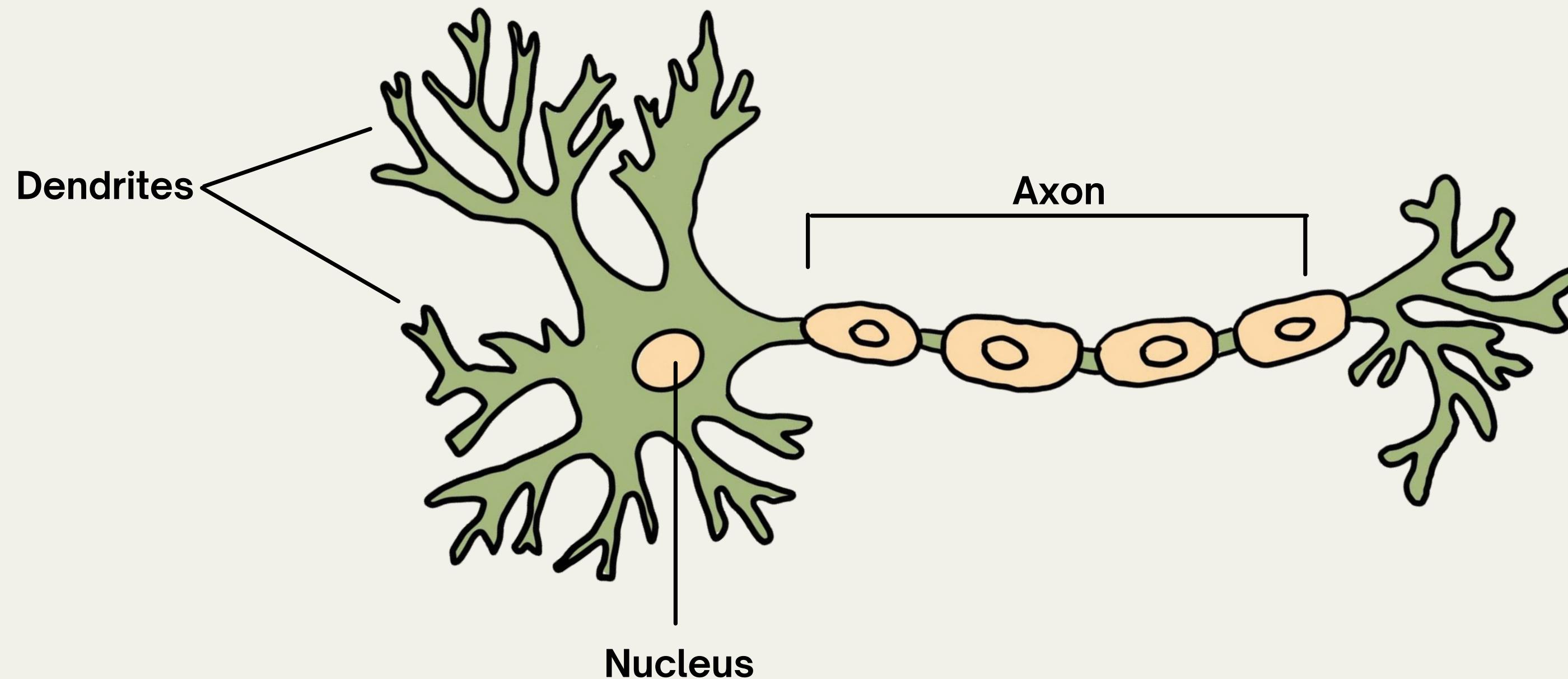
**Blossoming areas**

**As a student ...**

# How human brain works

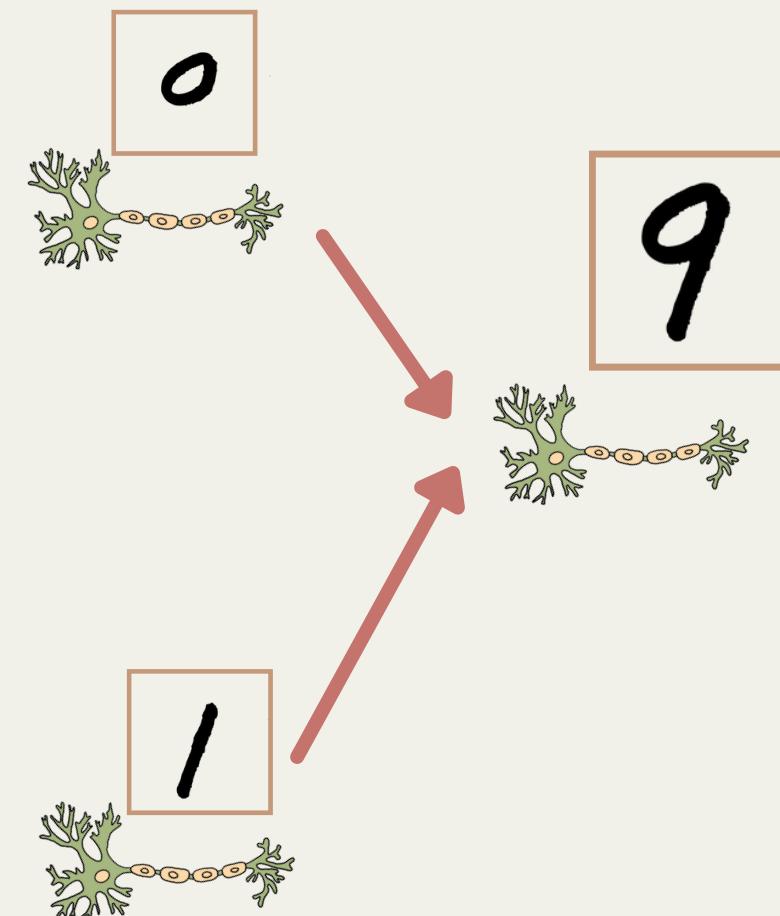


# Biological Neuron

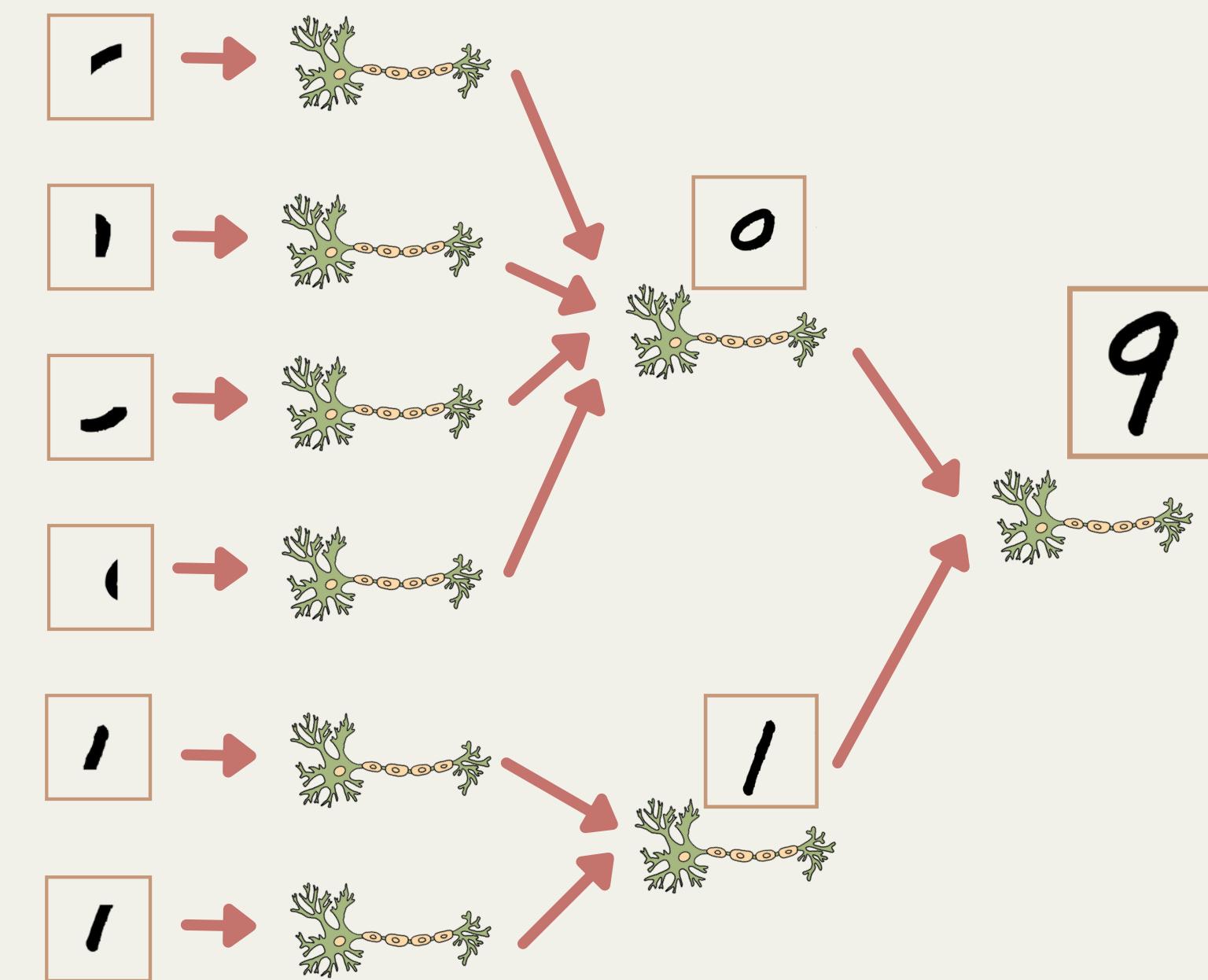
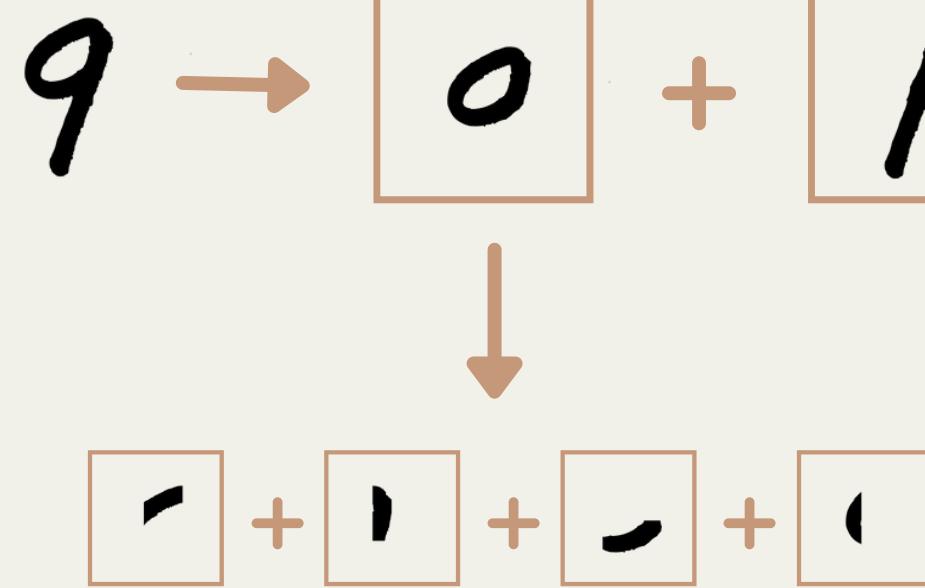


# How information flows

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



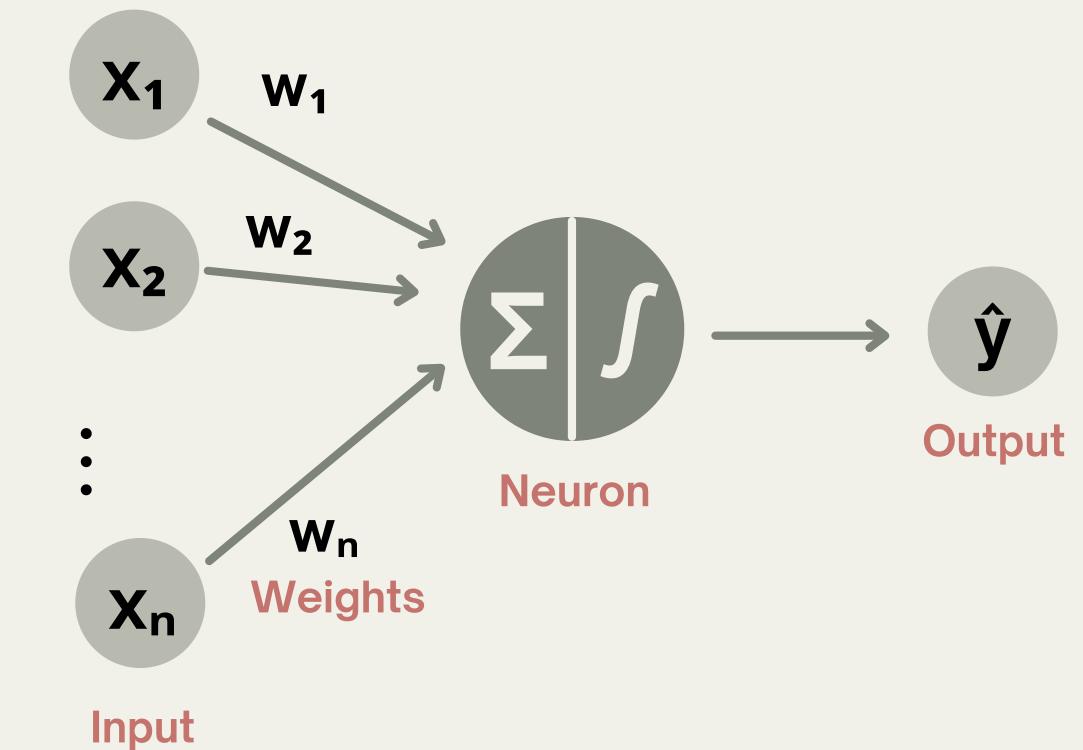
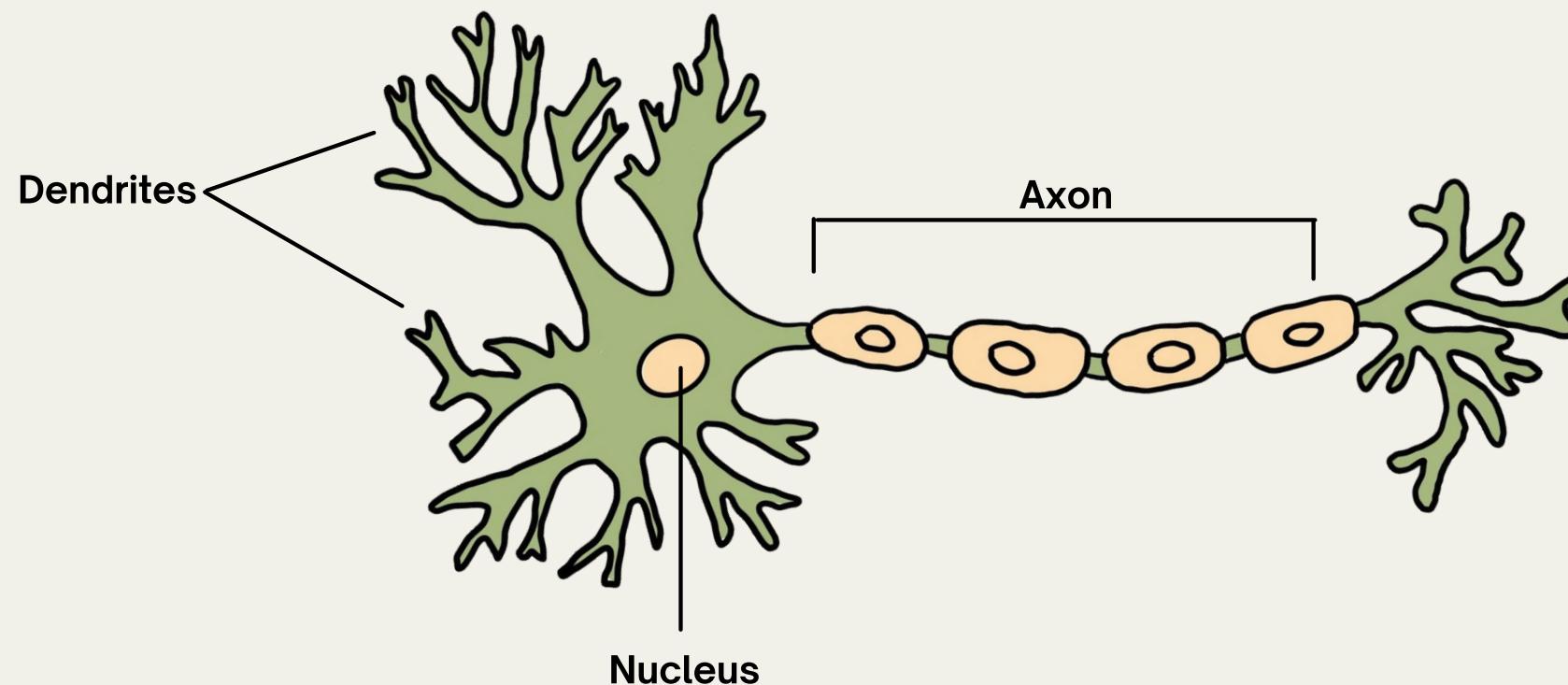
# How information flows



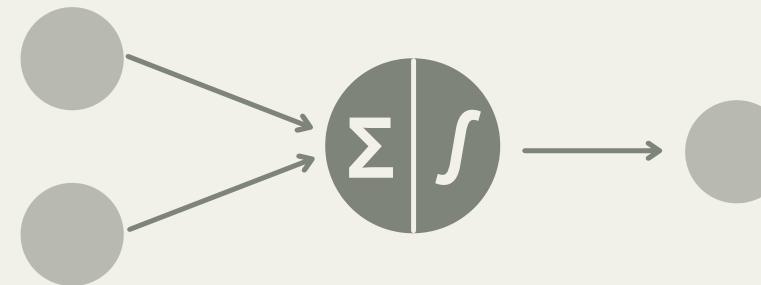
How can we use this  
to our advantage ?

# Perceptron

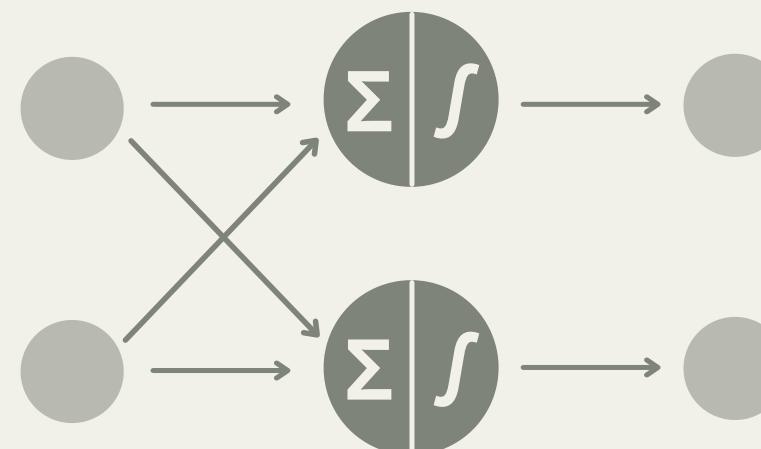
## Building Block of Deep Neural Networks



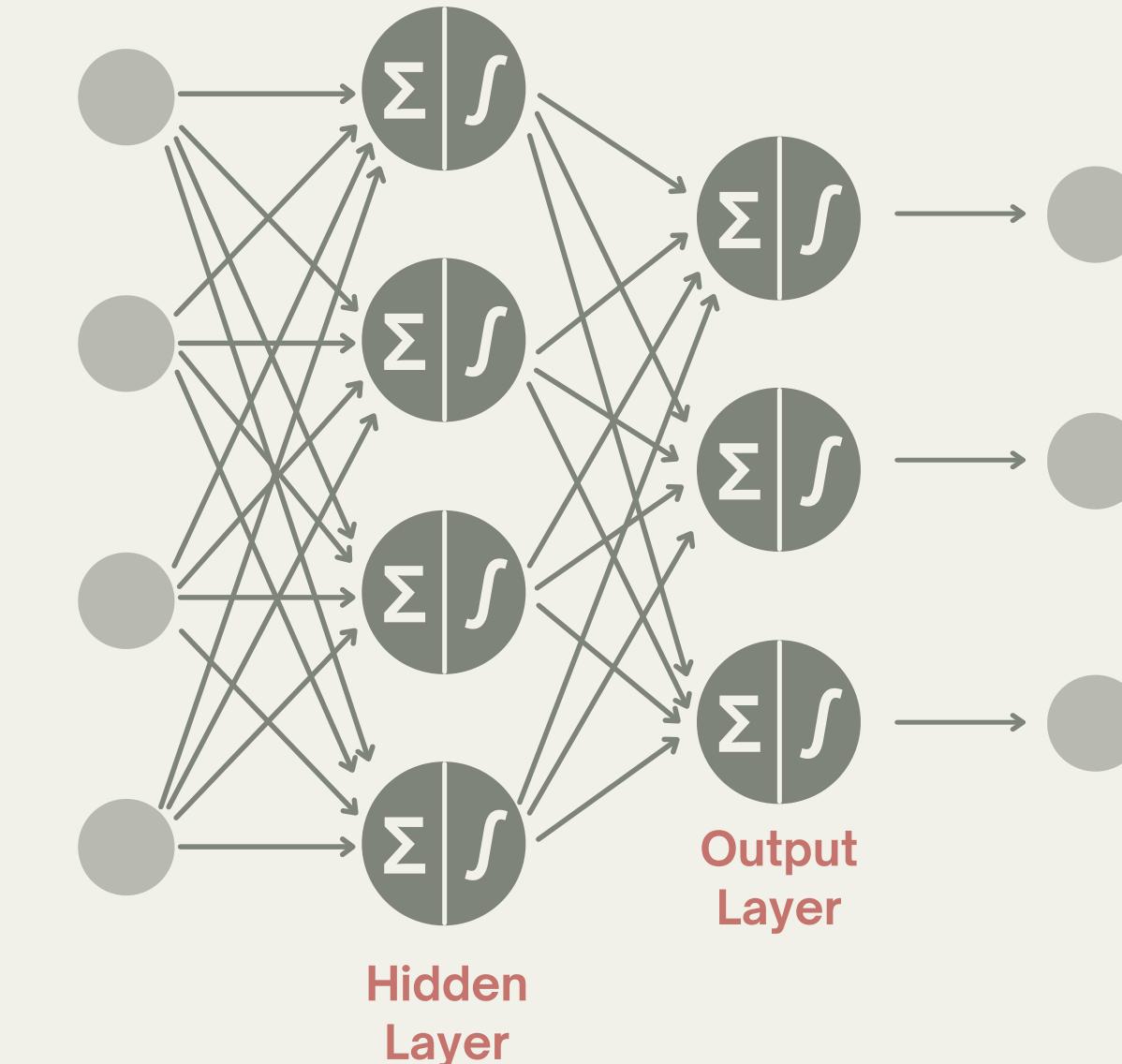
# Small steps towards DNN



Perceptron



Multi-output Perceptron



Single Layer Neural Network

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**

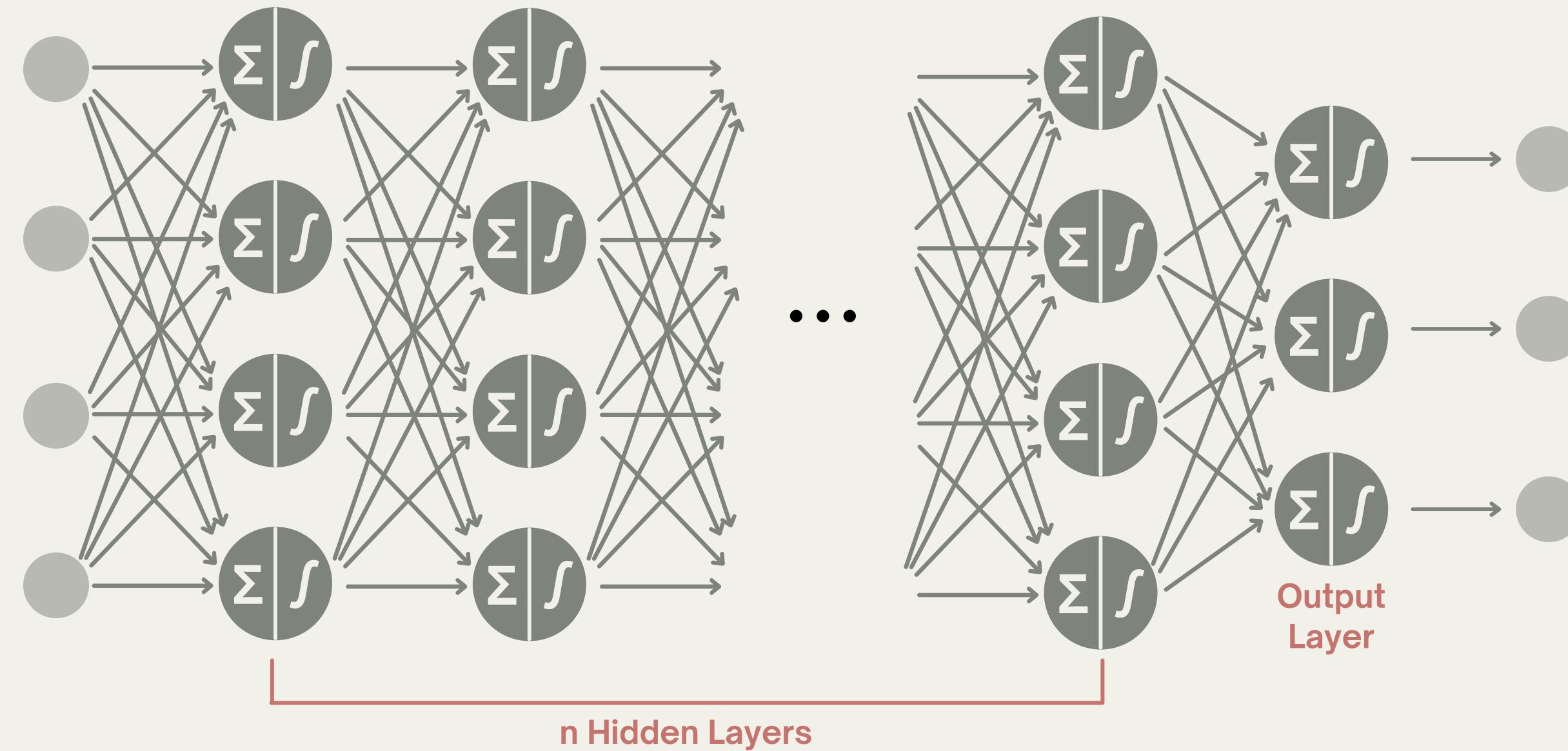
- GPU & TPU
- Cloud

03

## **Availability of advance software and programming concepts**

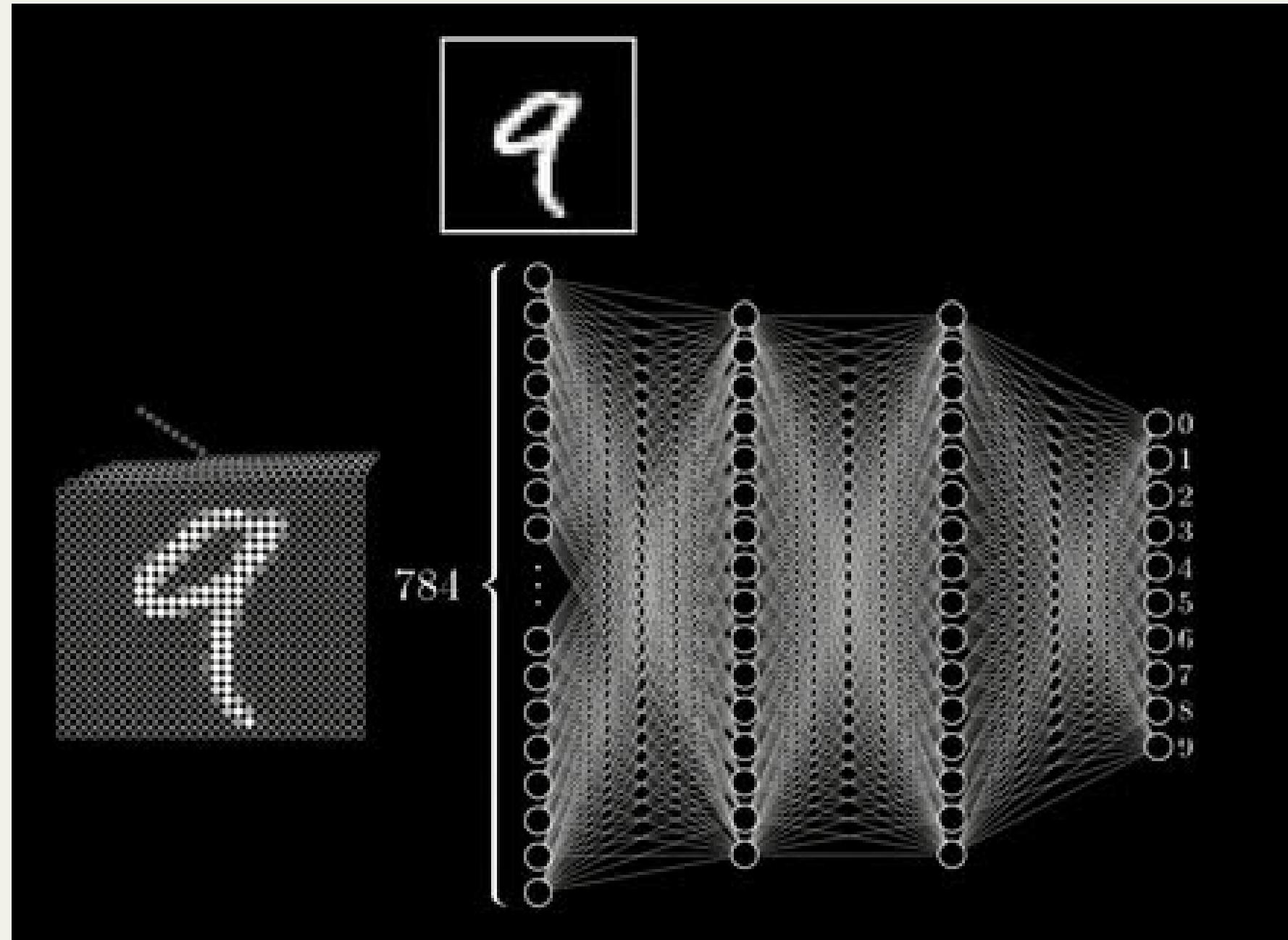
- High level APIs & libraries

# Deep Neural Network



Deep Neural Network

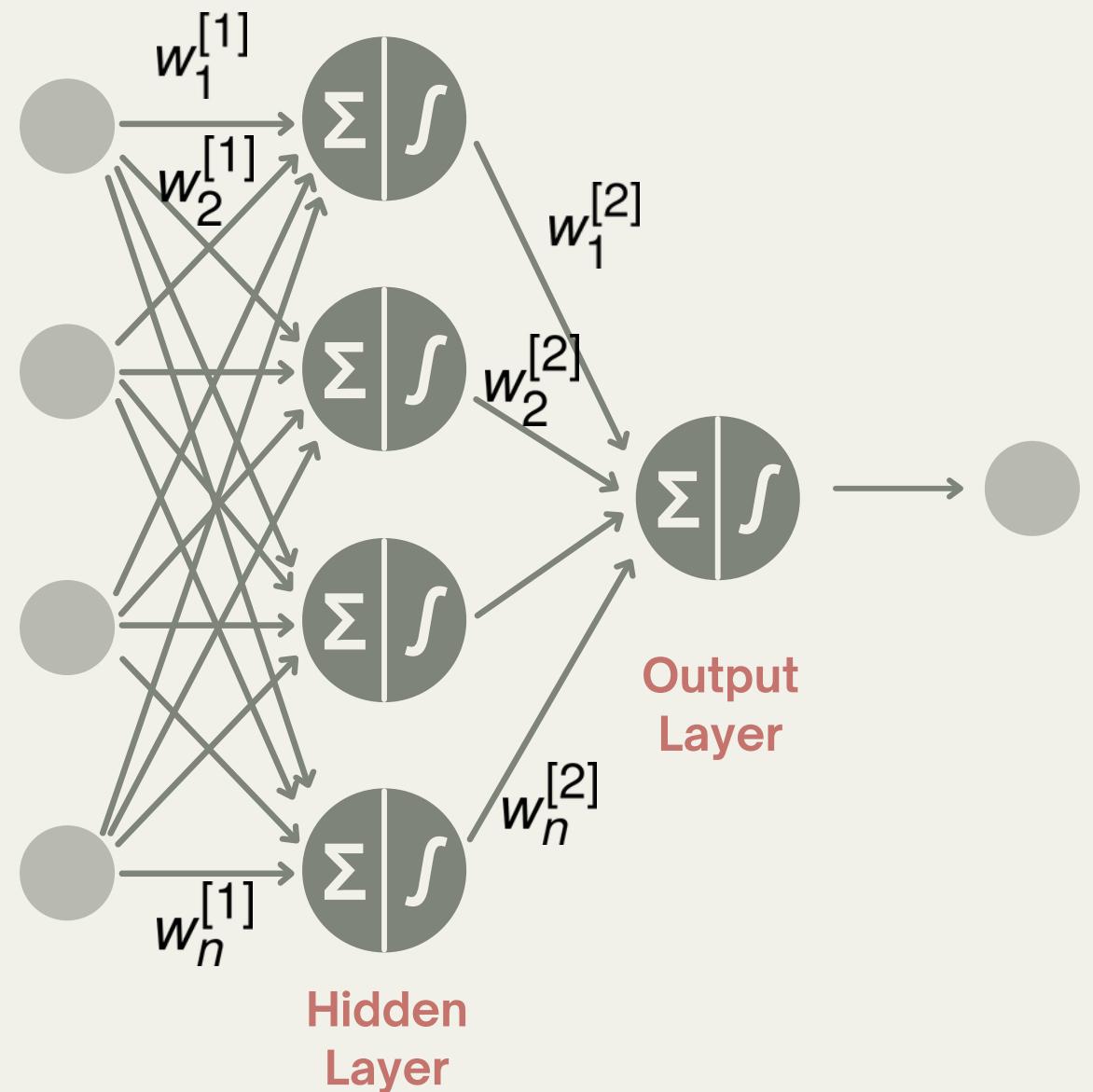
# Modeling it with Maths



Source: [3Blue1Brown](#)

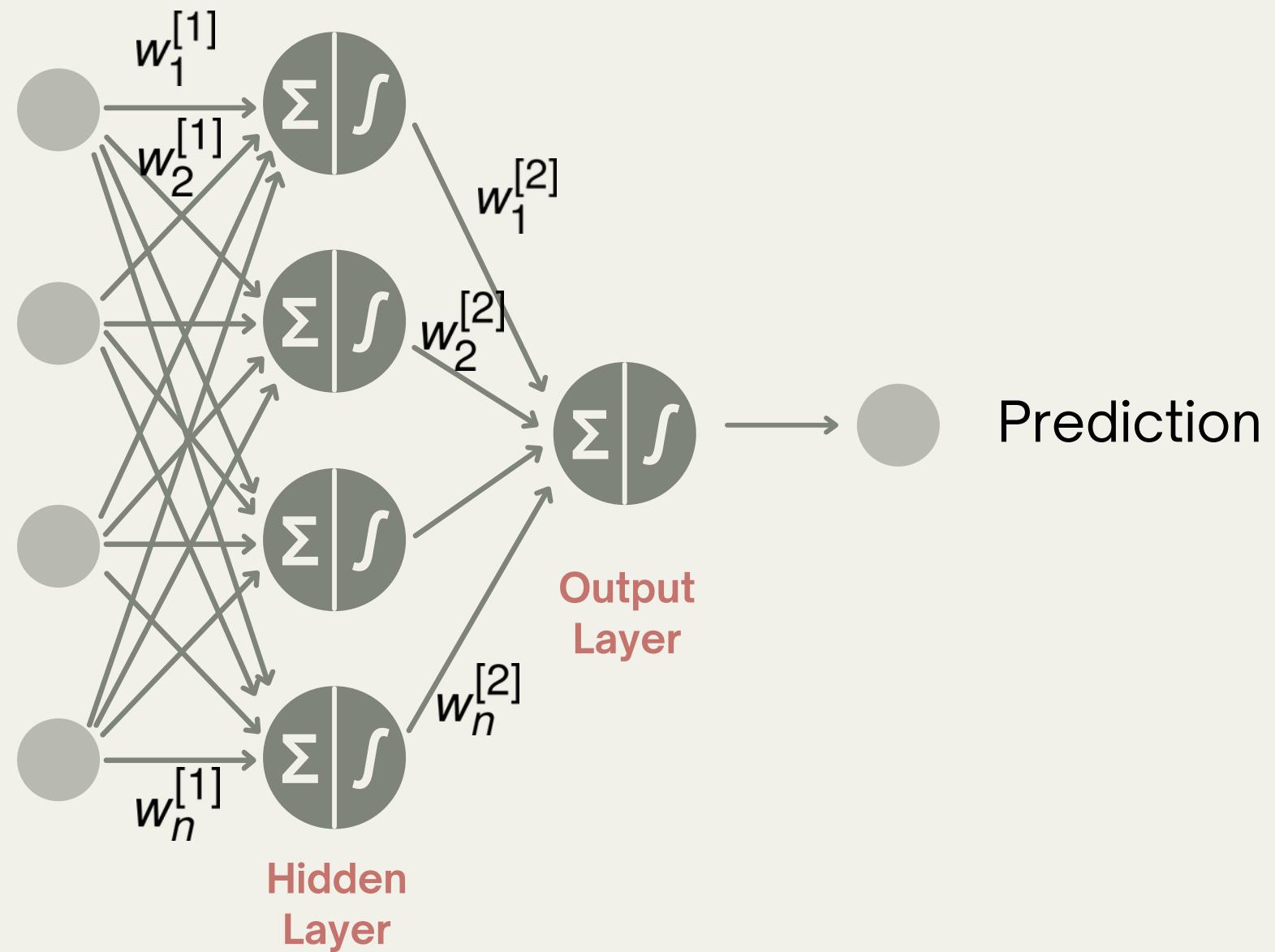
How can we get the  
model to do what we  
want ?

# How models learn



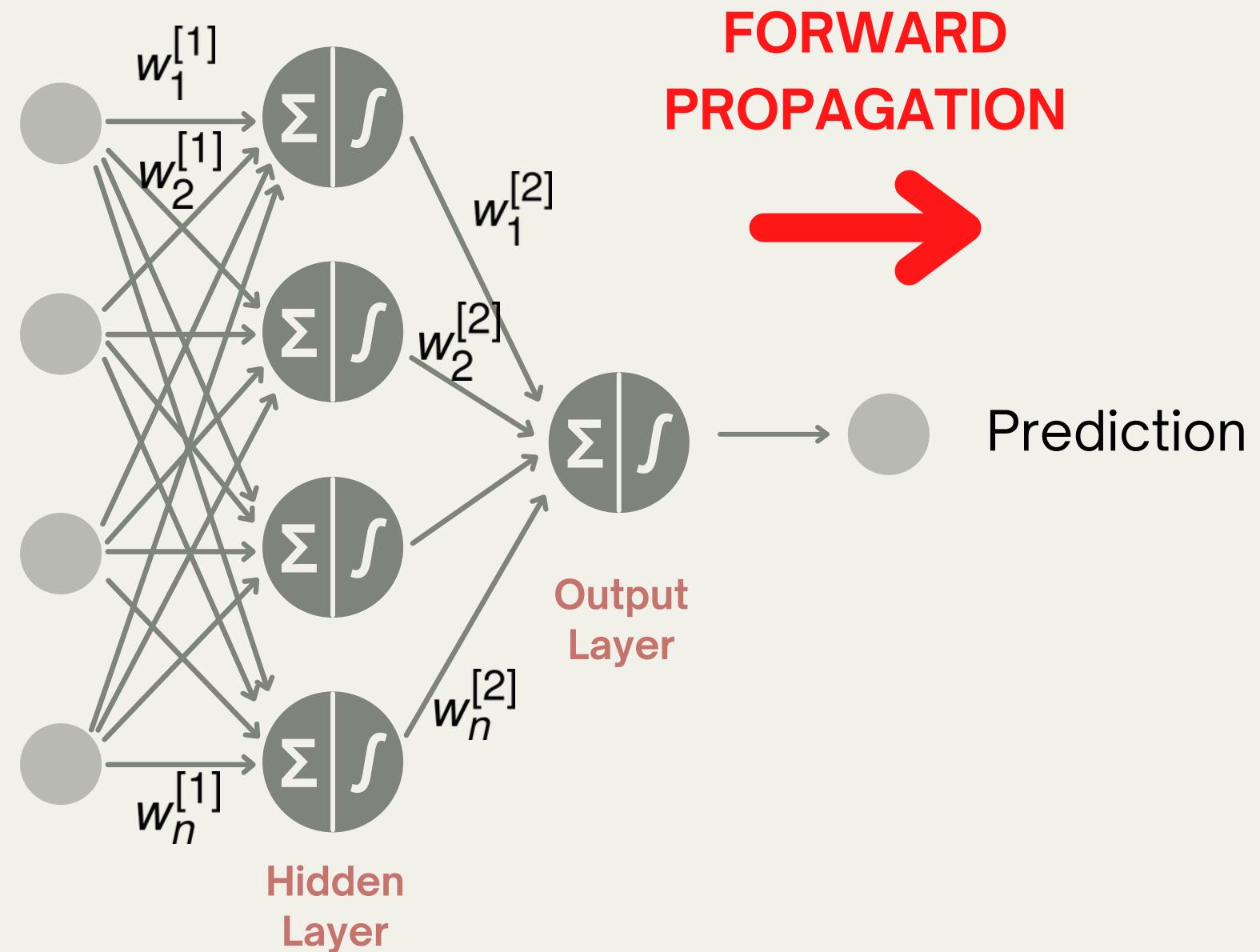
# How models learn

9



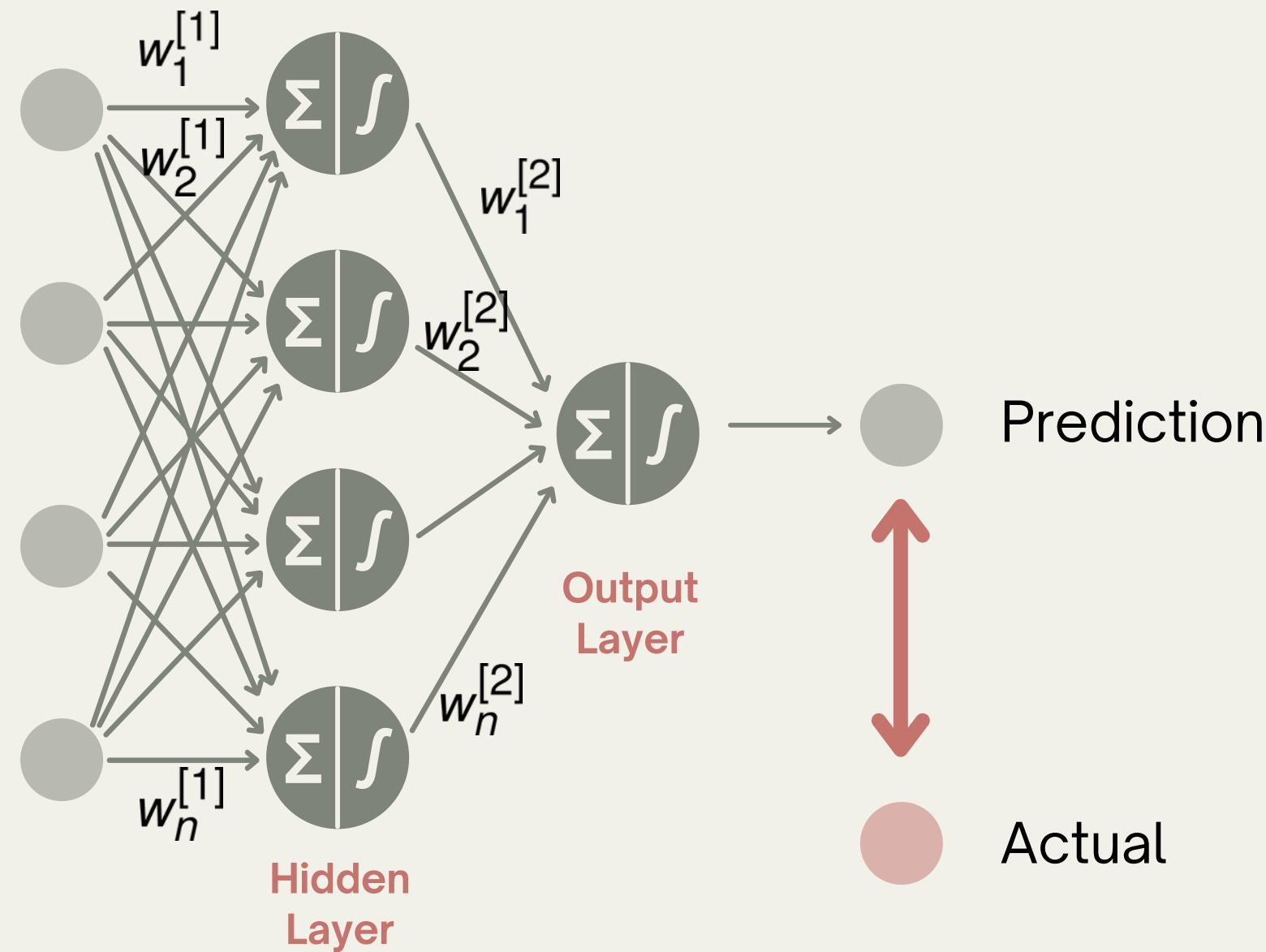
# How models learn

9



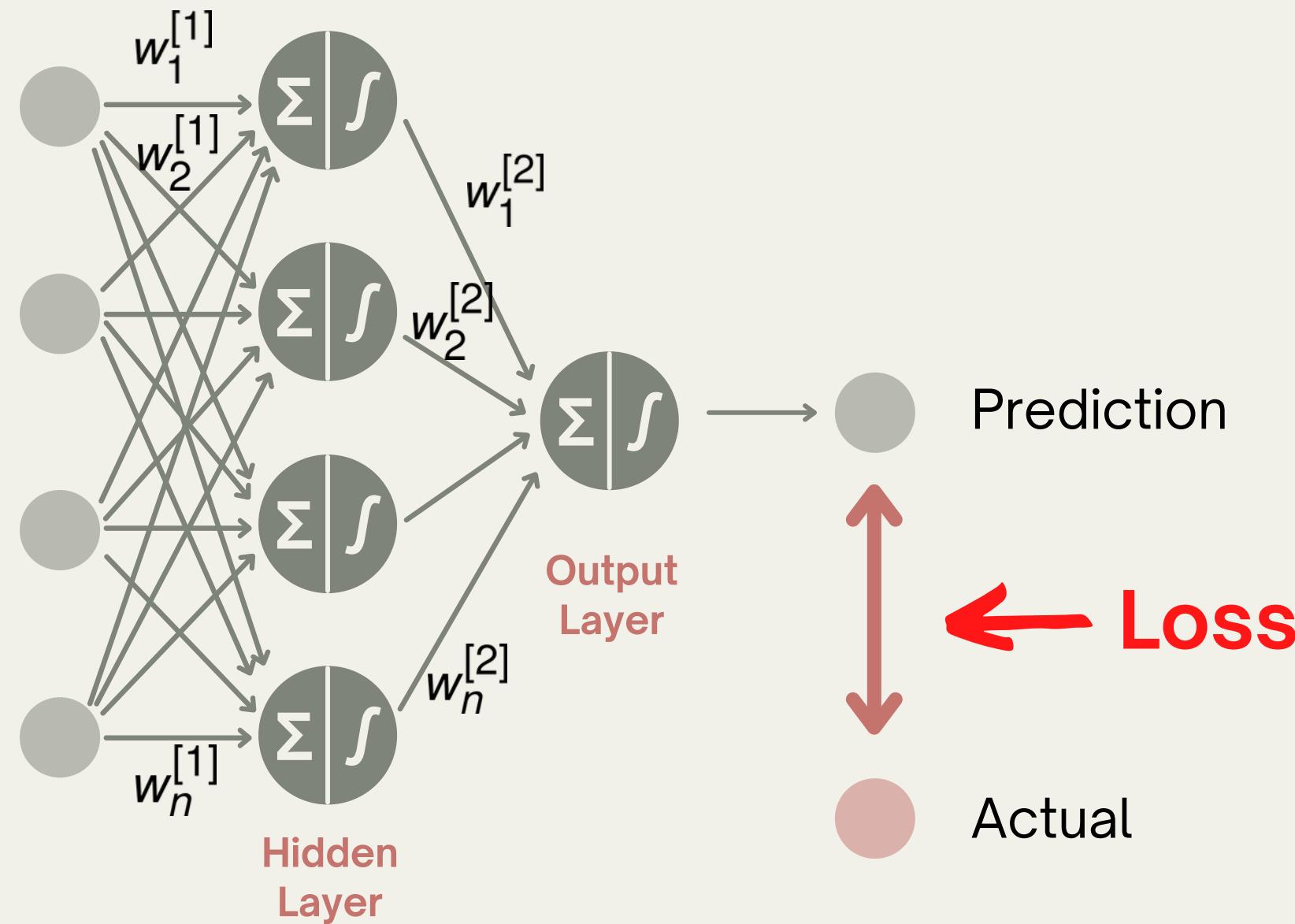
# How models learn

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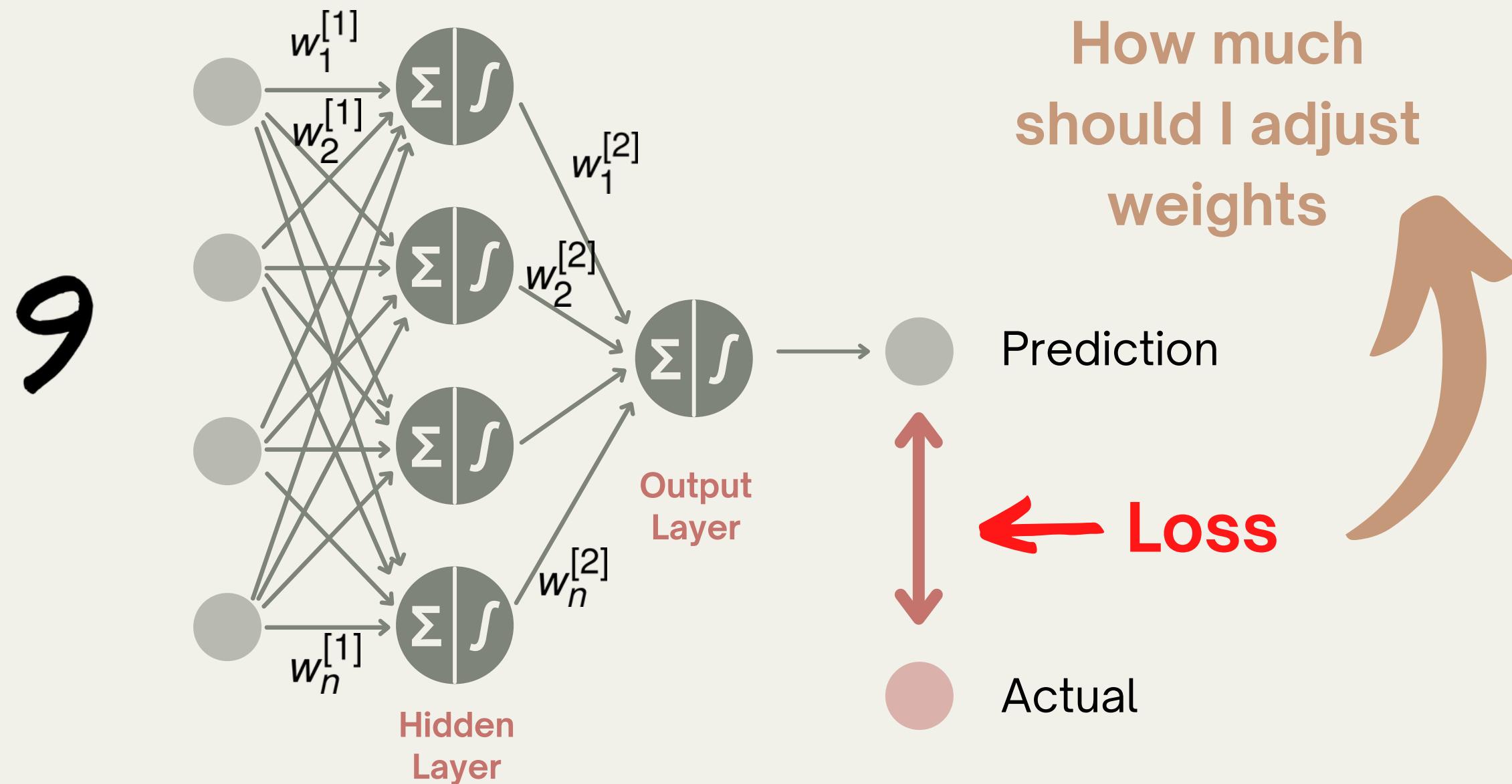


# How models learn

9

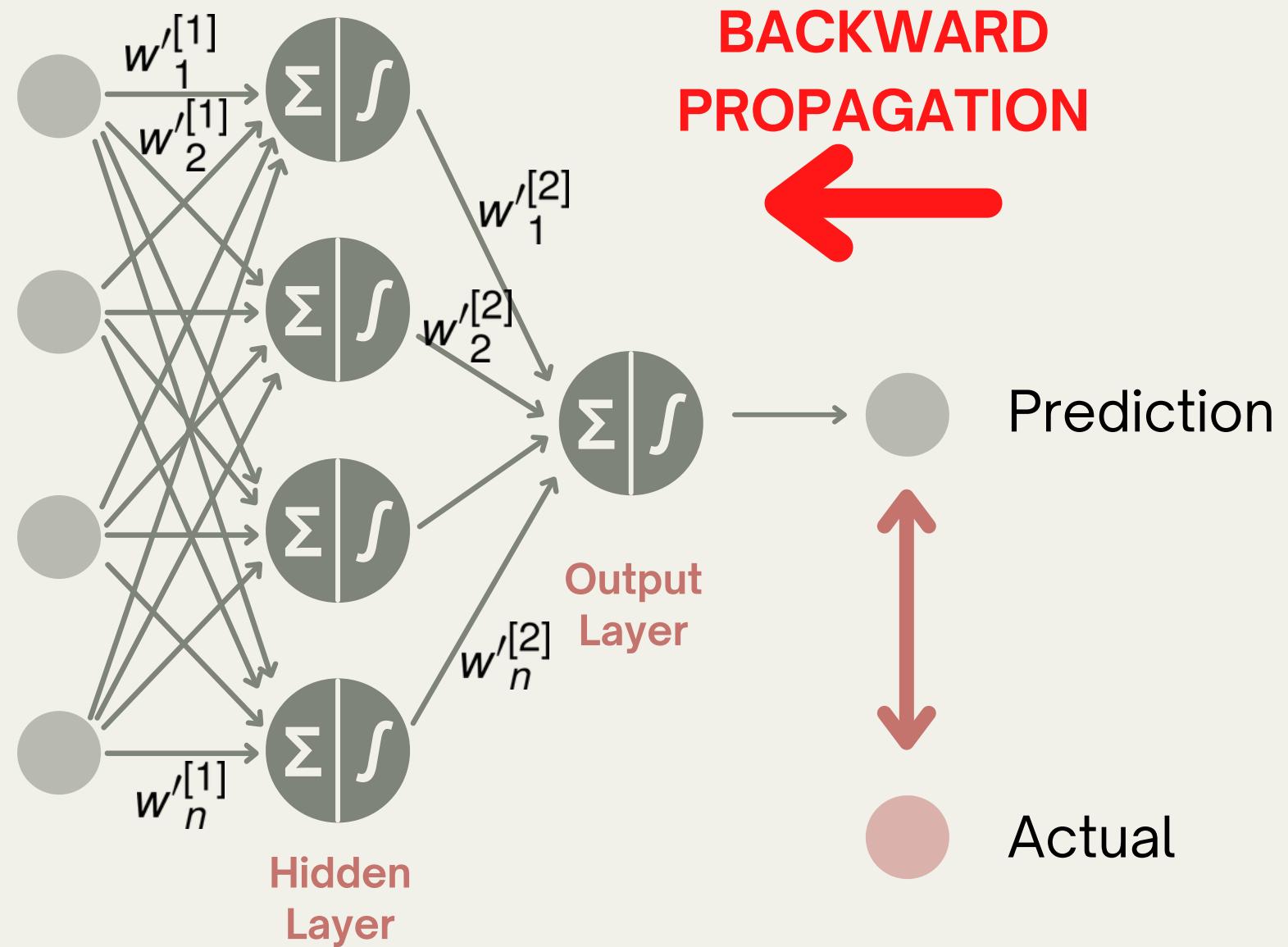


# How models learn



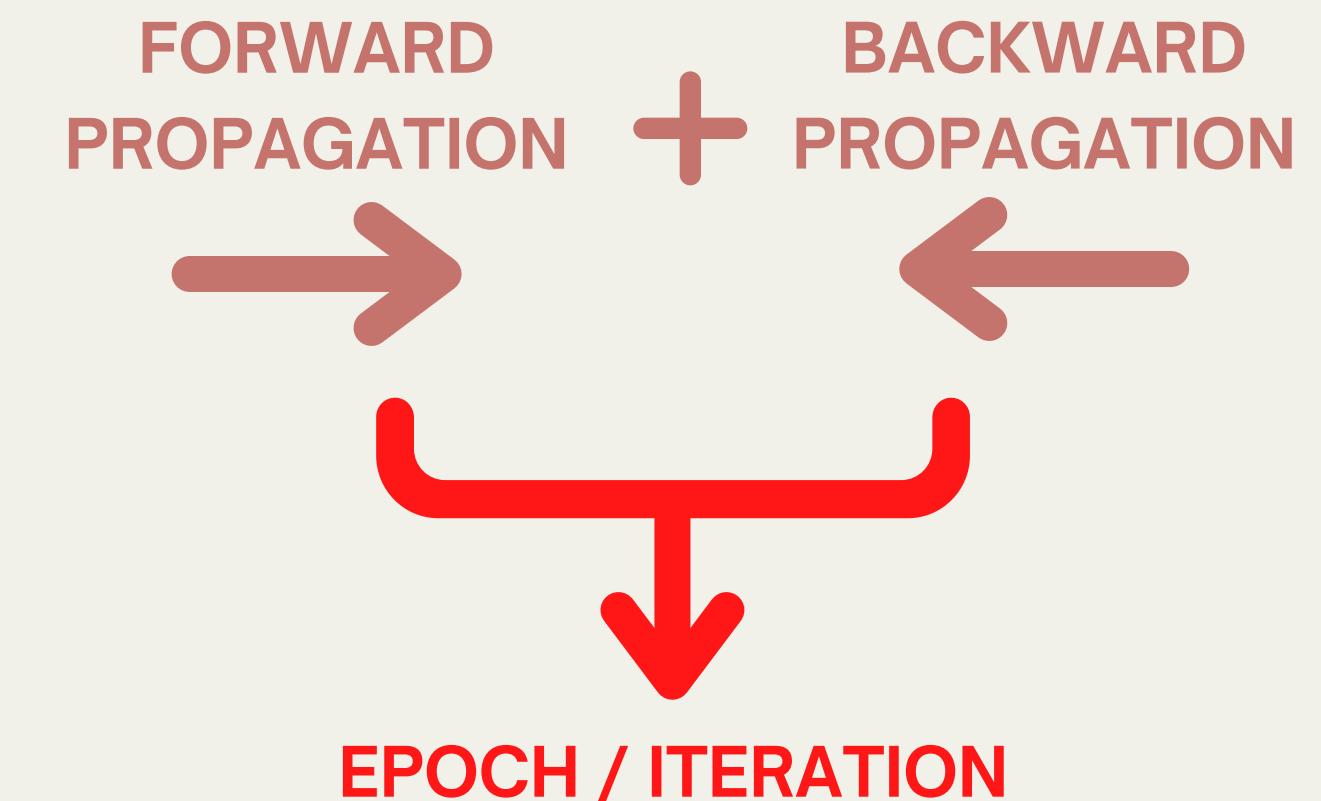
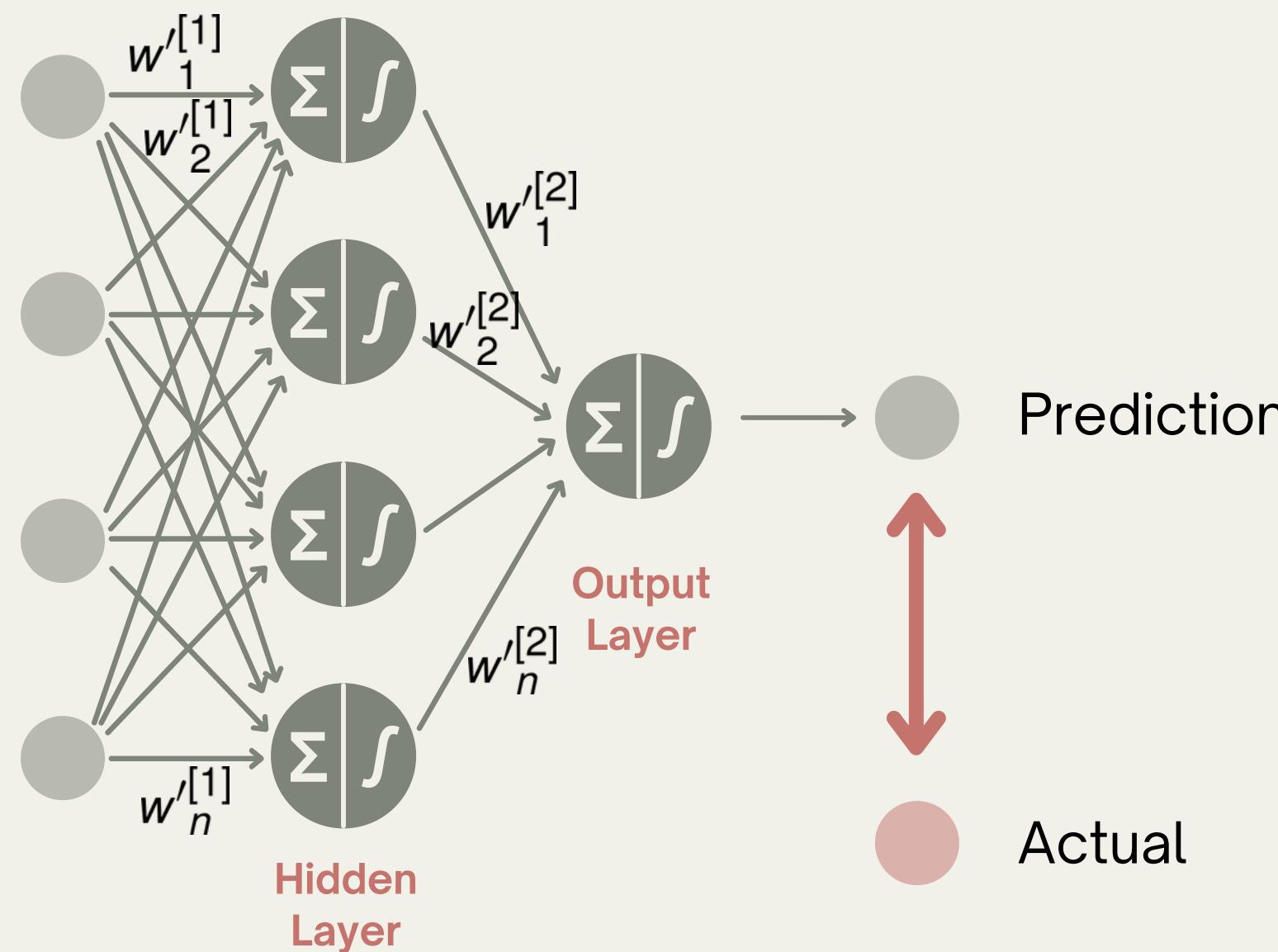
# How models learn

9

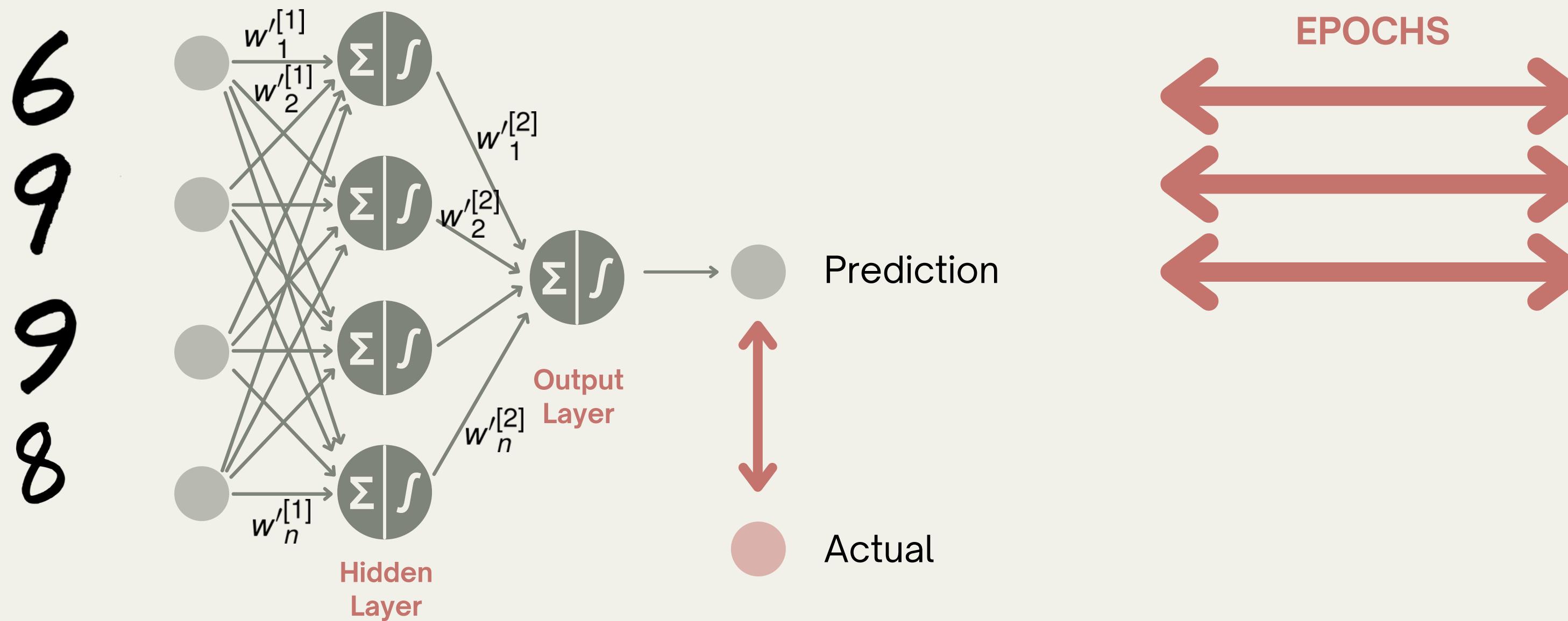


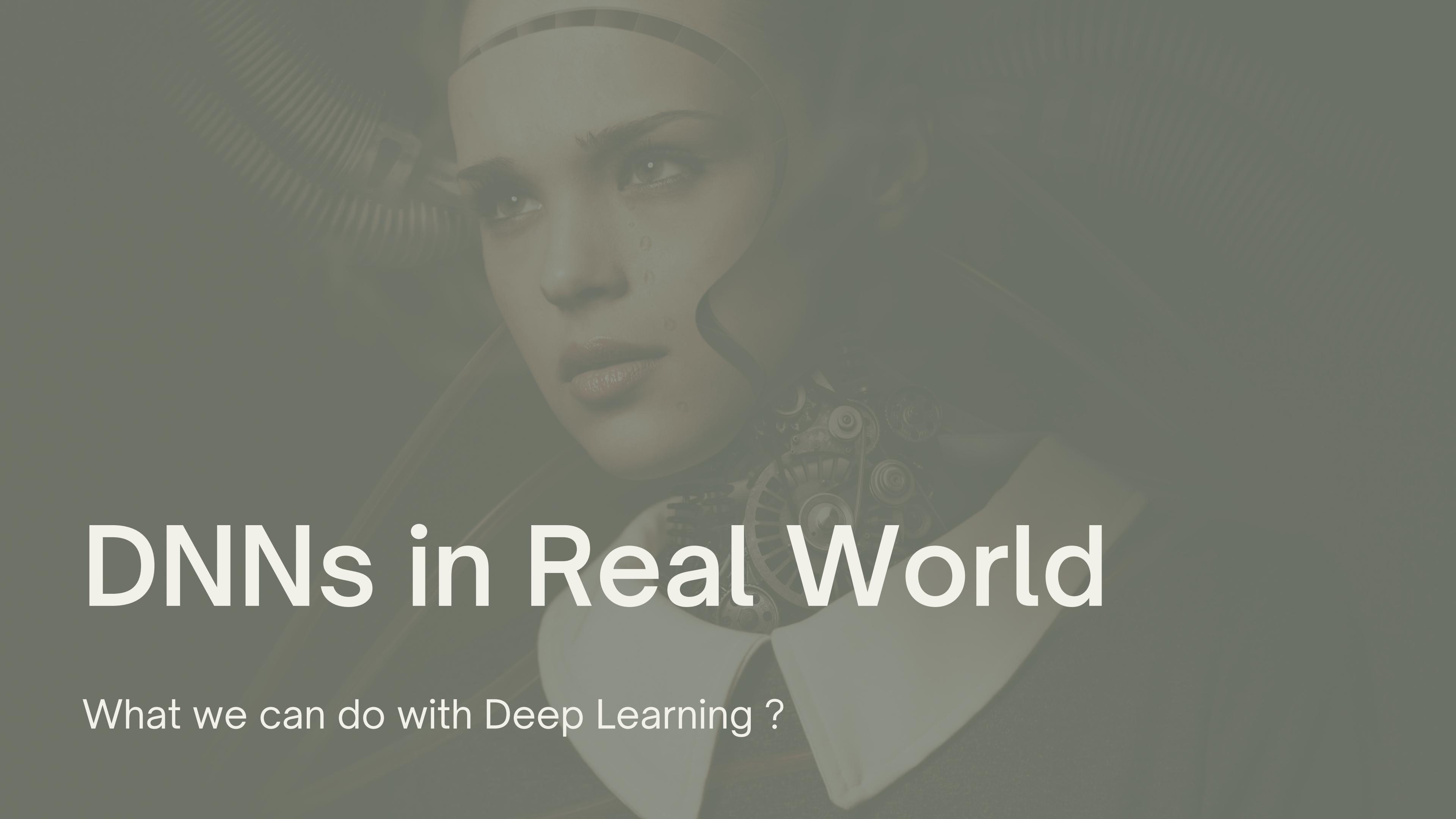
# How models learn

9



# How models learn



A woman with a steampunk-style mechanical head and gears.

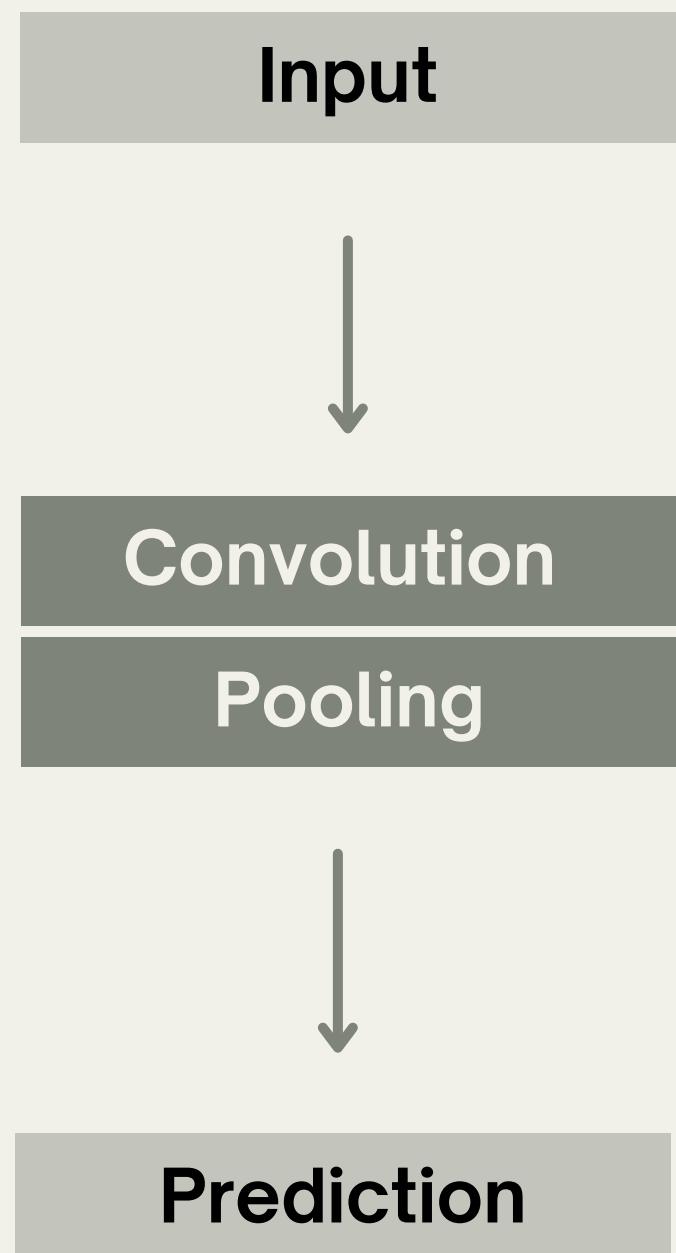
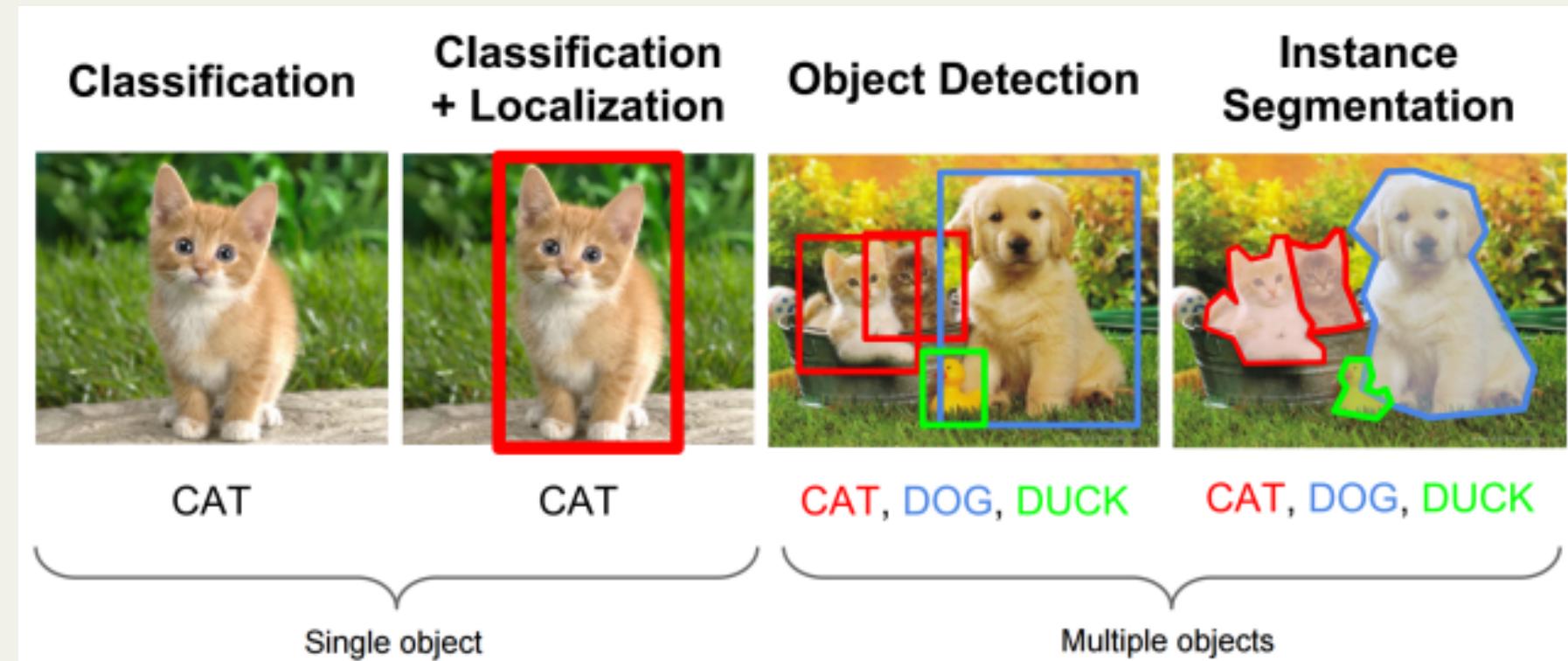
# DNNs in Real World

What we can do with Deep Learning ?

# CNN

## Convolutional Neural Network

Main tasks



# CNN

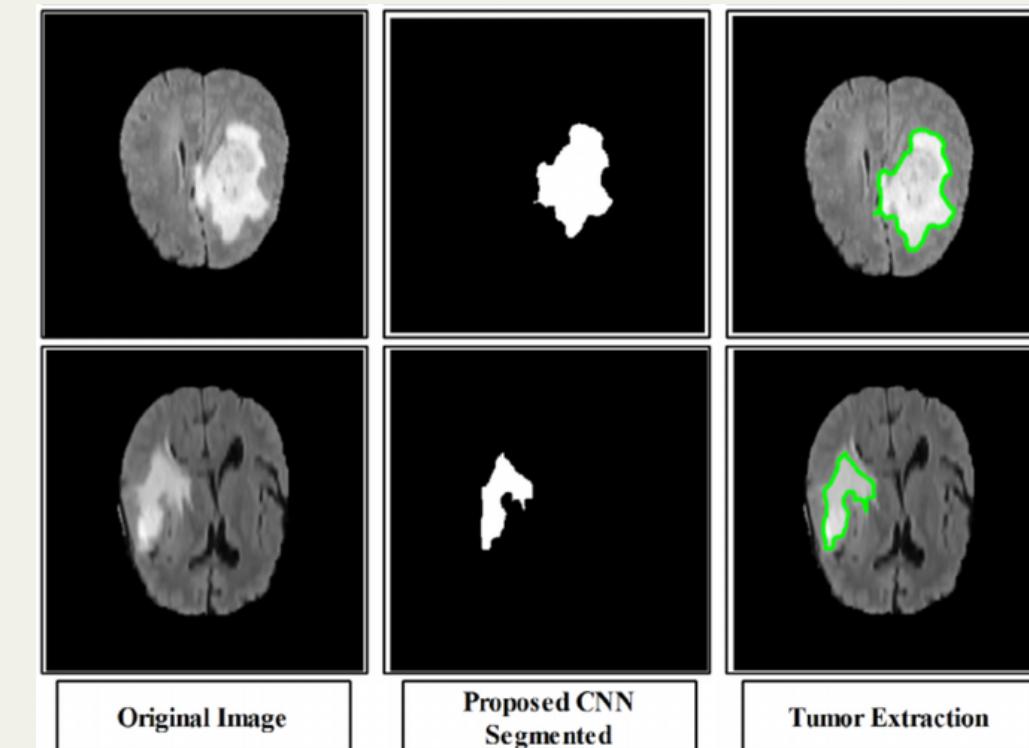
## Convolutional Neural Network

CNNs in action:

- Computer vision
  - Face recognition
  - 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]

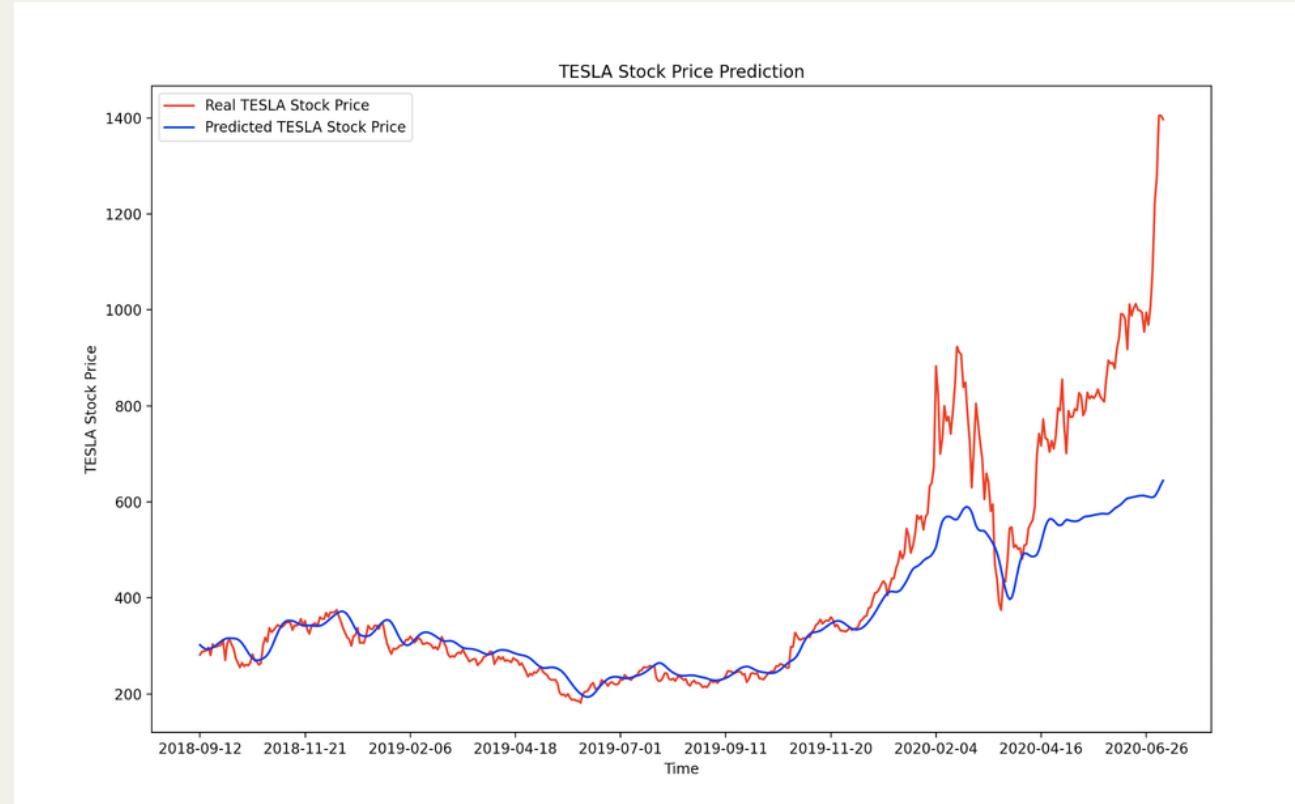
- [1] Rehman A, Khan MA, Saba T, Mehmood Z, Tariq U, Ayesha N. Microscopic brain tumor detection and classification using 3D CNN and feature selection architecture. *Microsc Res Tech*. 2021;84:133–149. <https://doi.org/10.1002/jemt.23597> REHMAN ET AL. 149
- [2] D. Varga and T. Szirányi, "Fully automatic 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

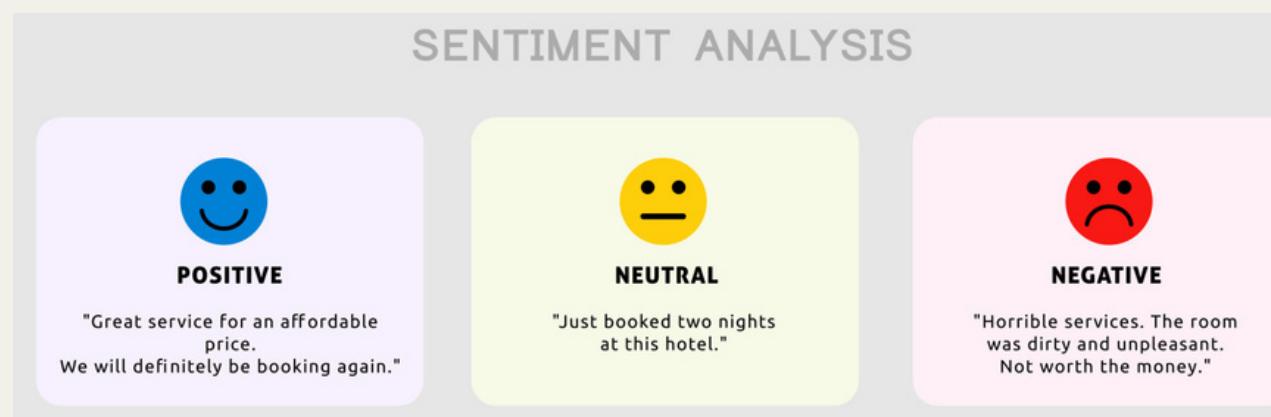
## Recurrent Neural Network

RNNs in action:

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



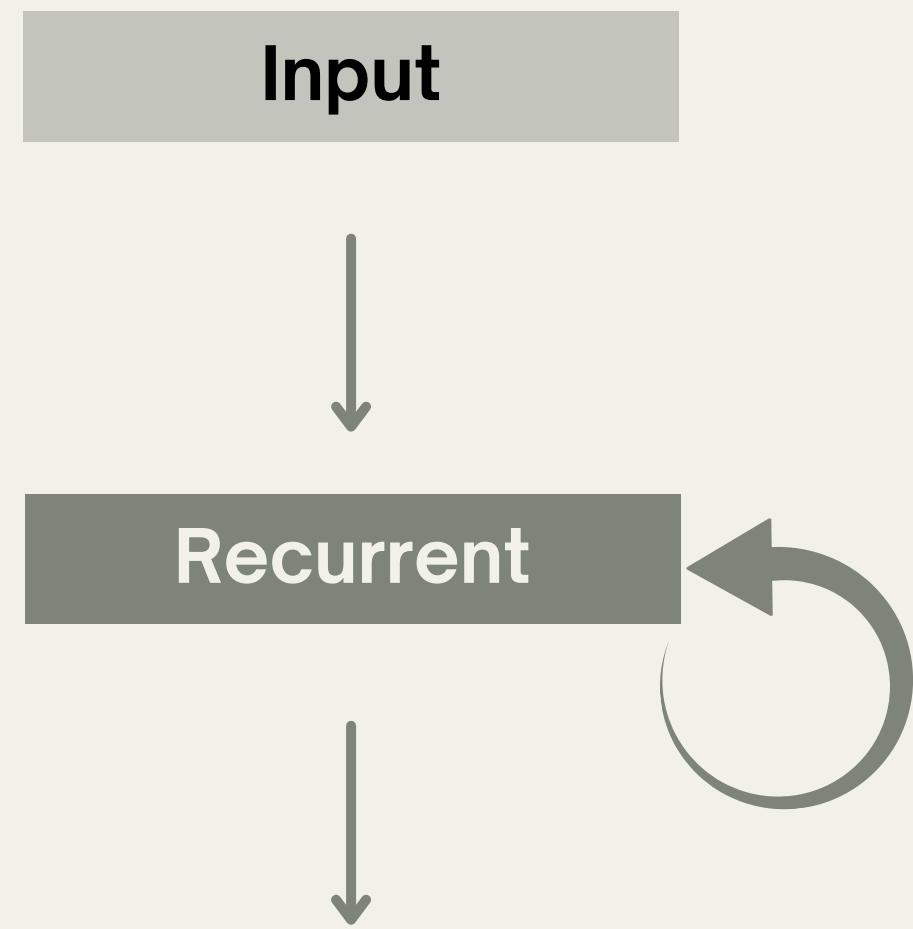
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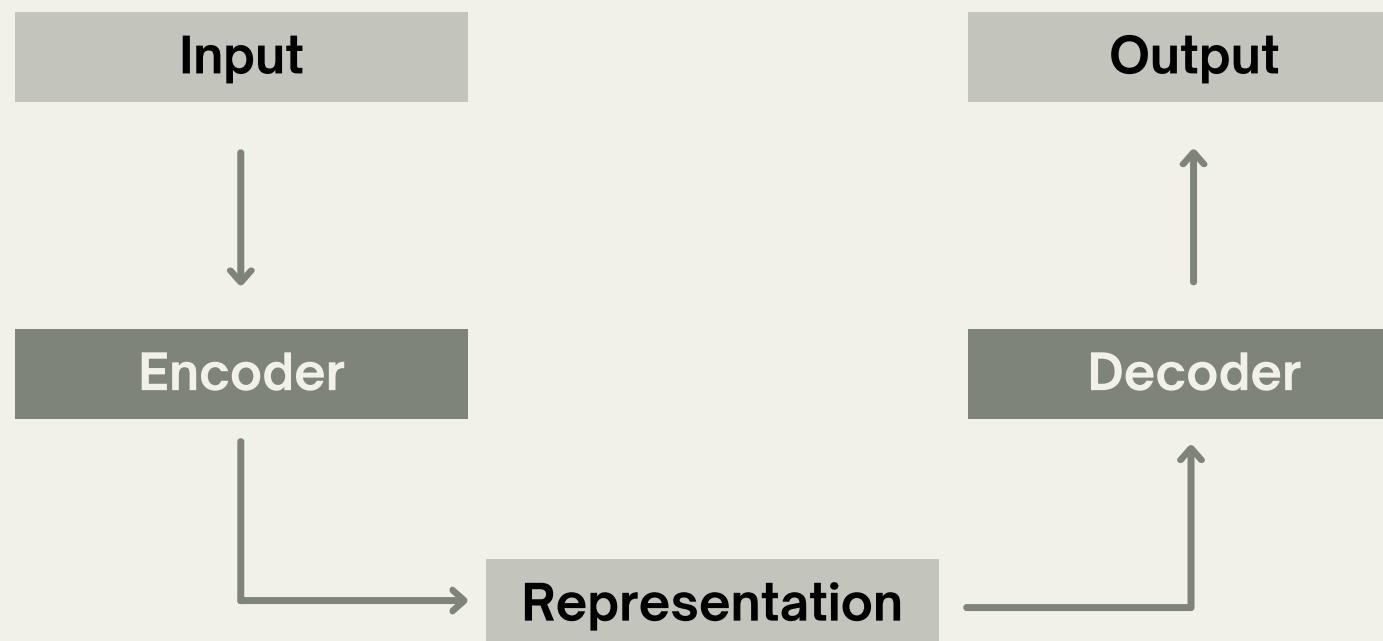


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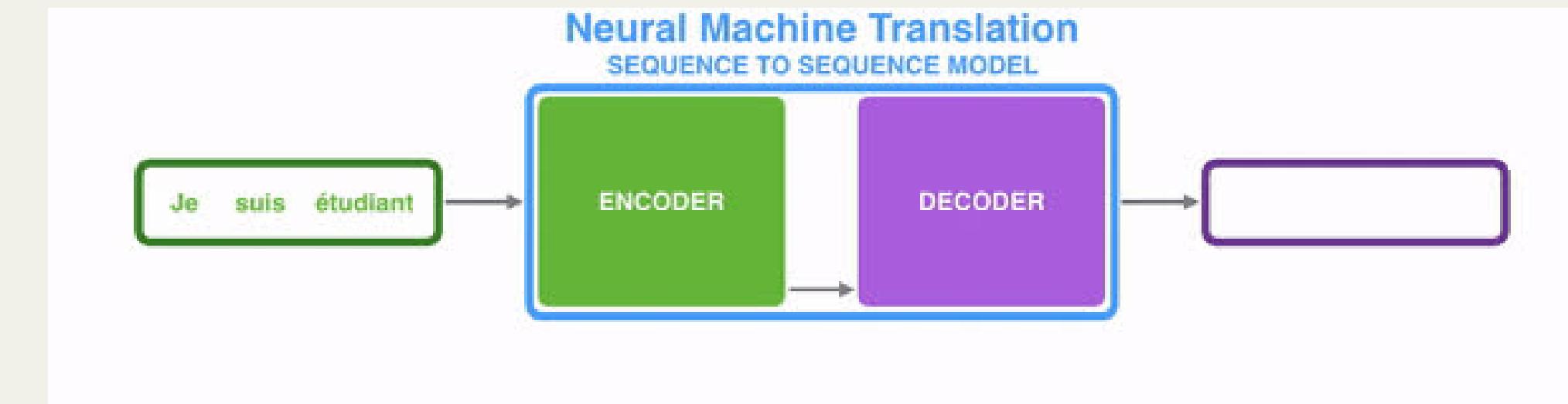
- [1] Loukas, S., 2020. LSTM Time-Series Forecasting: Predicting Stock Prices Using An LSTM Model. [online] Medium.
- [2] Dabhade, V., 2021. Conducting Social Media Sentiment Analysis: A Working Example. [online] Express Analytics.
- [3] [magenta.tensorflow.org/assets/sketch\\_rnn\\_demo](https://magenta.tensorflow.org/assets/sketch_rnn_demo)

# Encoder - Decoder



## Applications:

- Machine Translation
- Image captioning
- Anomaly detection



[1] Alammar, J., 2018. Visualizing A Neural Machine Translation Model (Mechanics of Seq2seq Models With Attention). [online] Jalamar.github.io.

# GAN

## Generative Adversarial Network

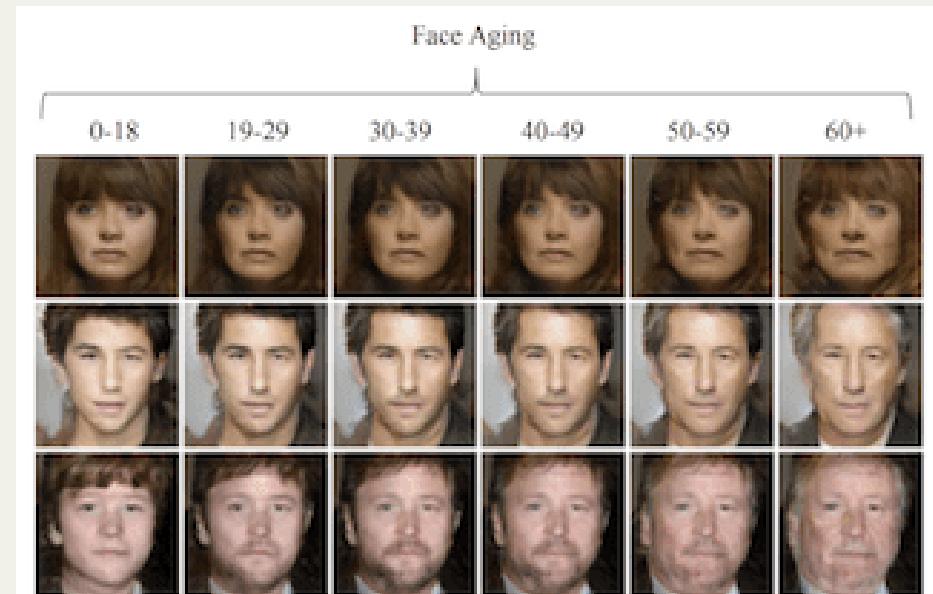


GANs in action:

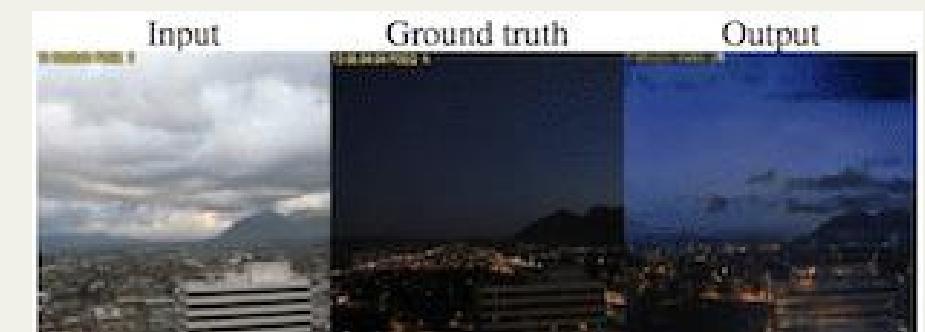
- Anomaly Detection
- Music Generation
- Cartoon Character Generation
- Text-to-Image Translation
- Image-to-Image Translation
- Face Aging



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.

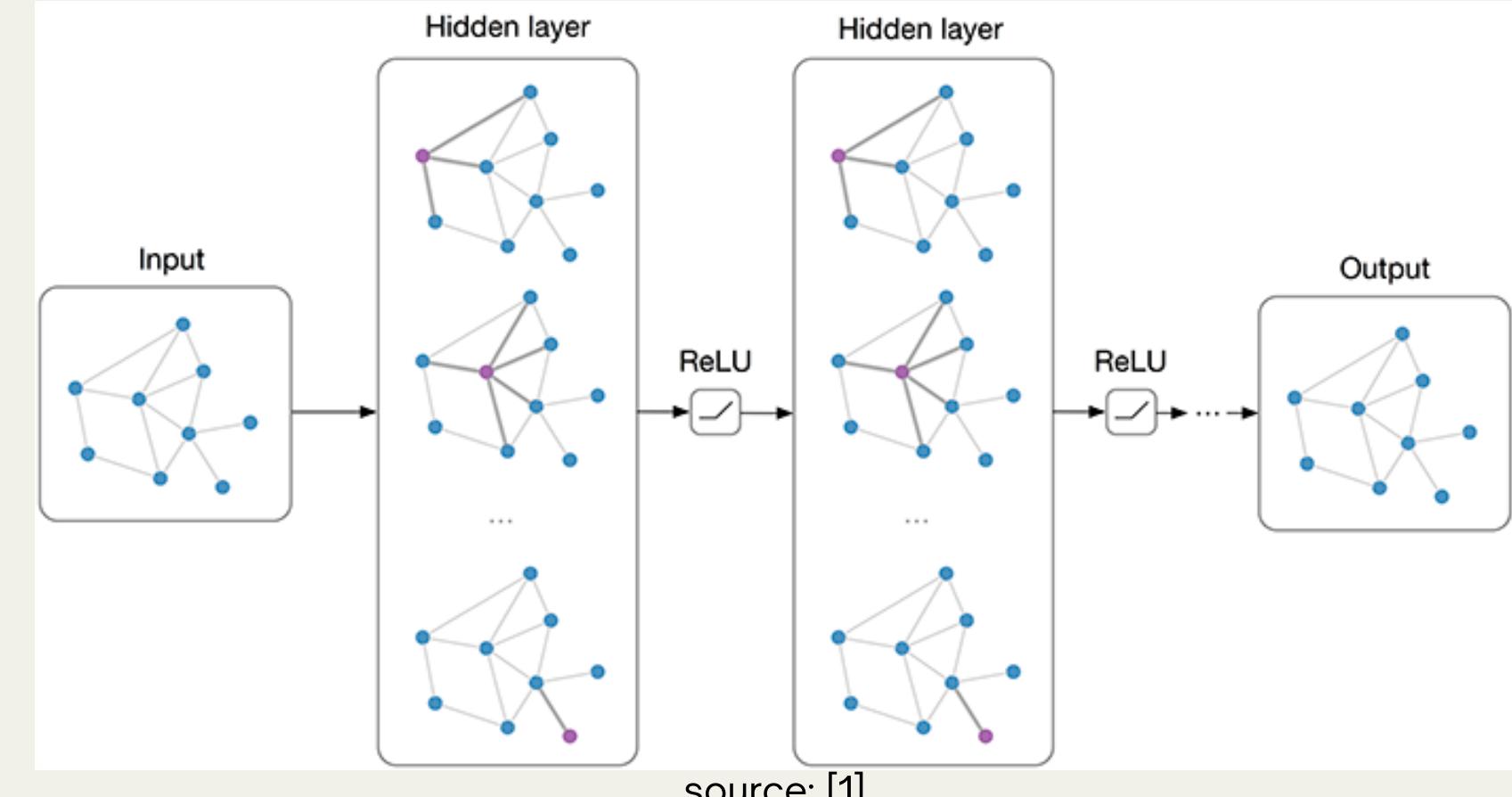
[3] G. Antipov, M. Baccouche and J. Dugelay, "Face aging with conditional generative adversarial networks," 2017 IEEE International Conference on Image Processing (ICIP)

# 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.

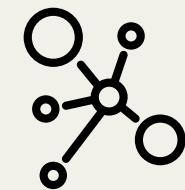
# Blossoming areas



Unbiased AI



AI for healthcare



Federated learning



Explainable AI



Self supervised  
Computer Vision



Ethics in AI



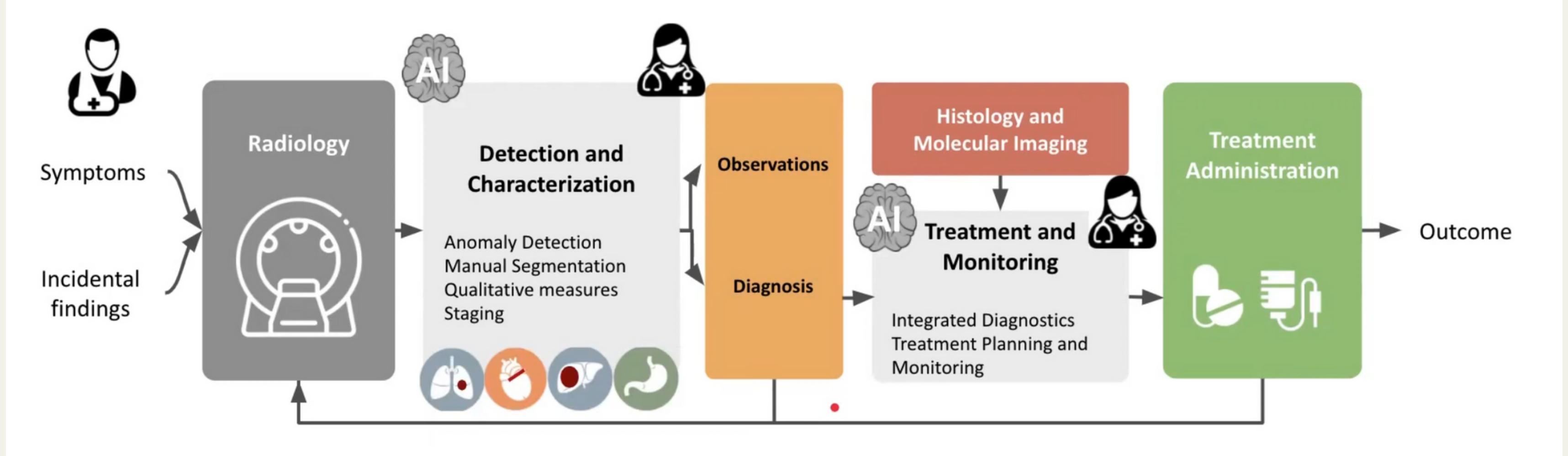
# Unbiased AI



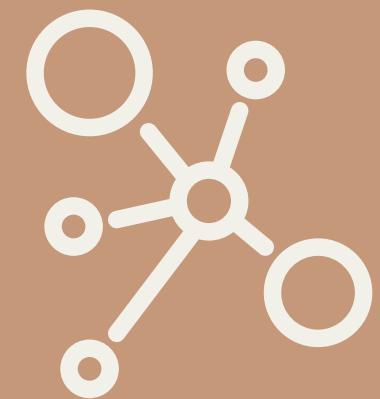


# AI for Healthcare

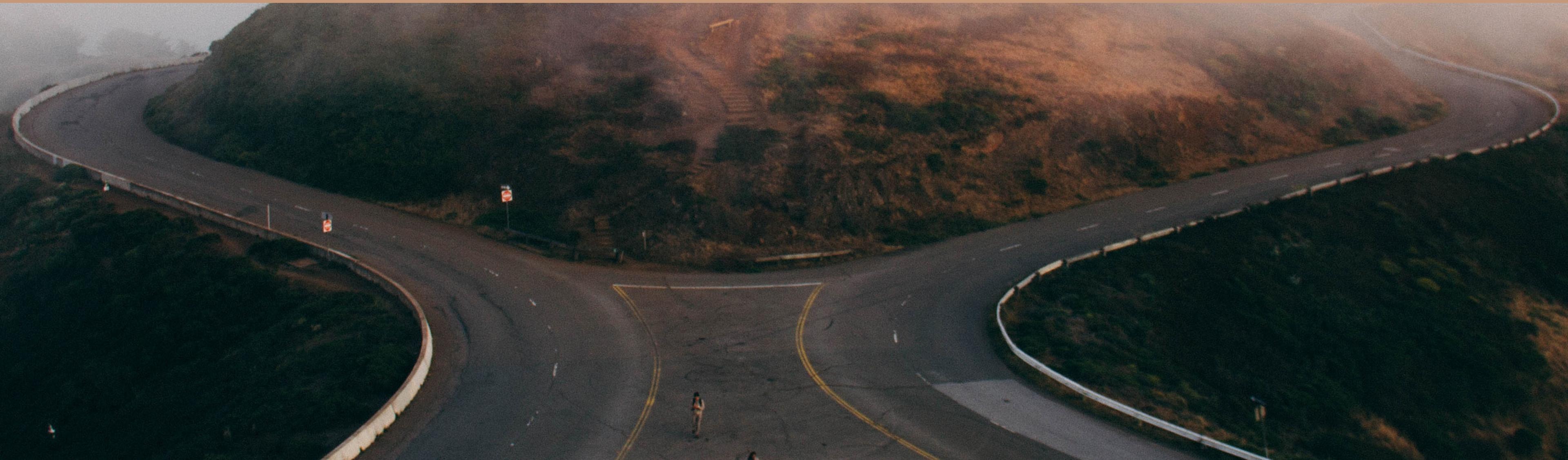


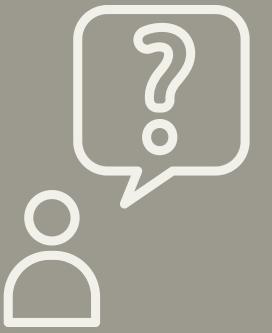


[1] Bi WL, Hosny A, Schabath MB, Giger ML, Birkbak NJ, Mehrtash A, Allison T, Arnaout O, Abbosh C, Dunn IF, Mak RH, Tamimi RM, Tempany CM, Swanton C, Hoffmann U, Schwartz LH, Gillies RJ, Huang RY, Aerts HJWL. Artificial intelligence in cancer imaging: Clinical challenges and applications. CA Cancer J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



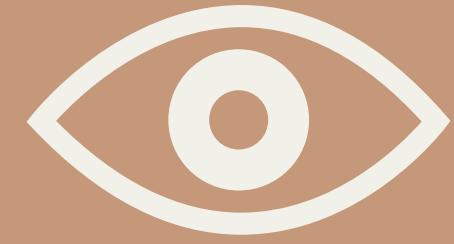
# Federated Learning





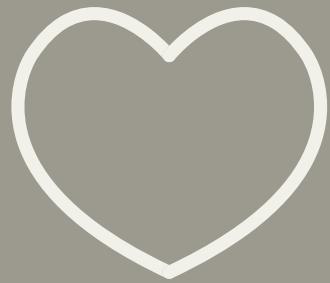
# Explainable AI





# Self-supervised Computer vision





# Ethics in AI



# Ethics in AI



2014



2015

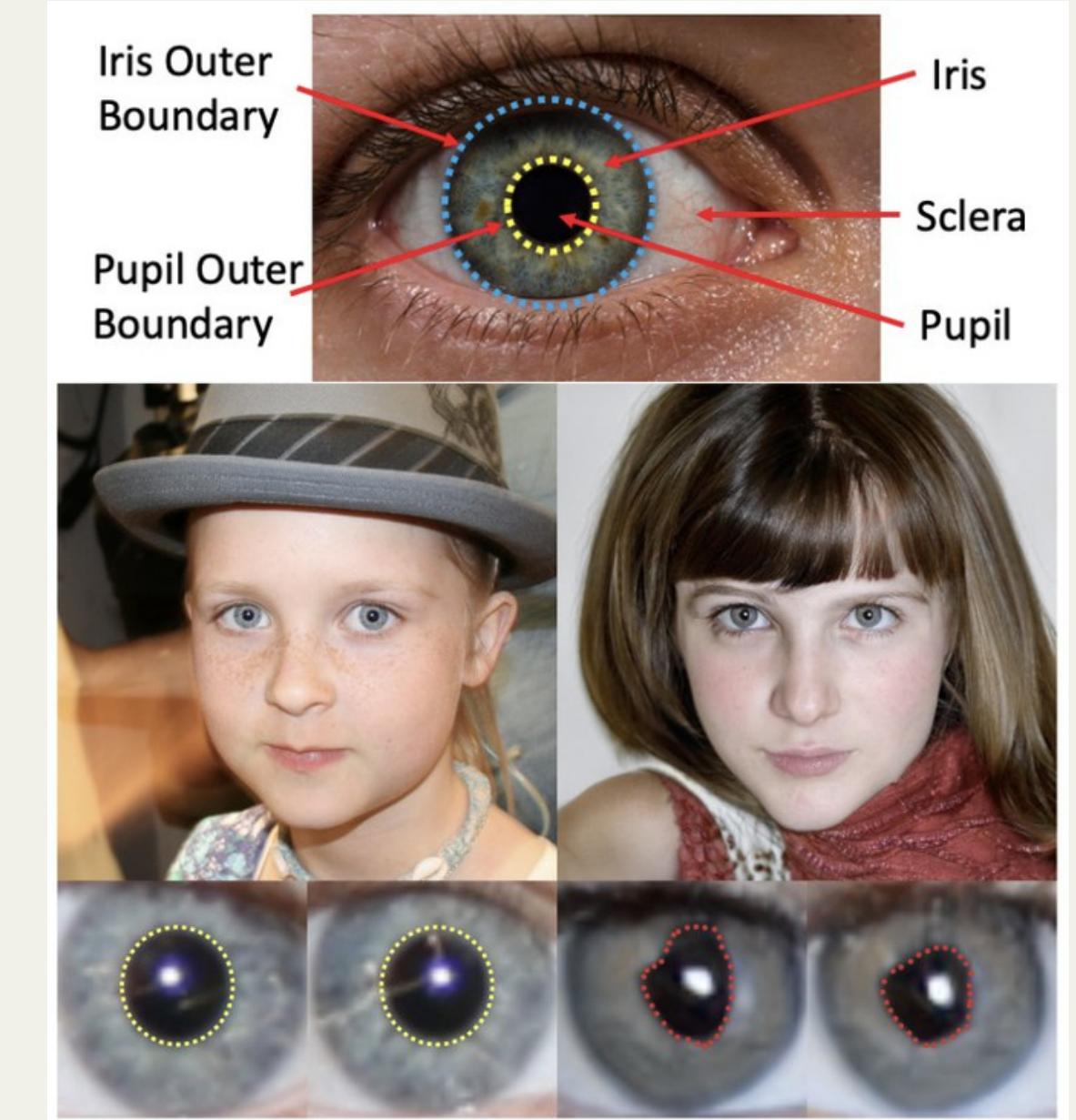


2016



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.

# 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

Blogs: Jay Alammar Blog

Some youtube channels: 3Blue1Brown, KhanAcademy, Yannic Kilcher, Intuitive Machine Learning, 2 minute papers

For more resources ...

# Thank you!

Questions are welcome!



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