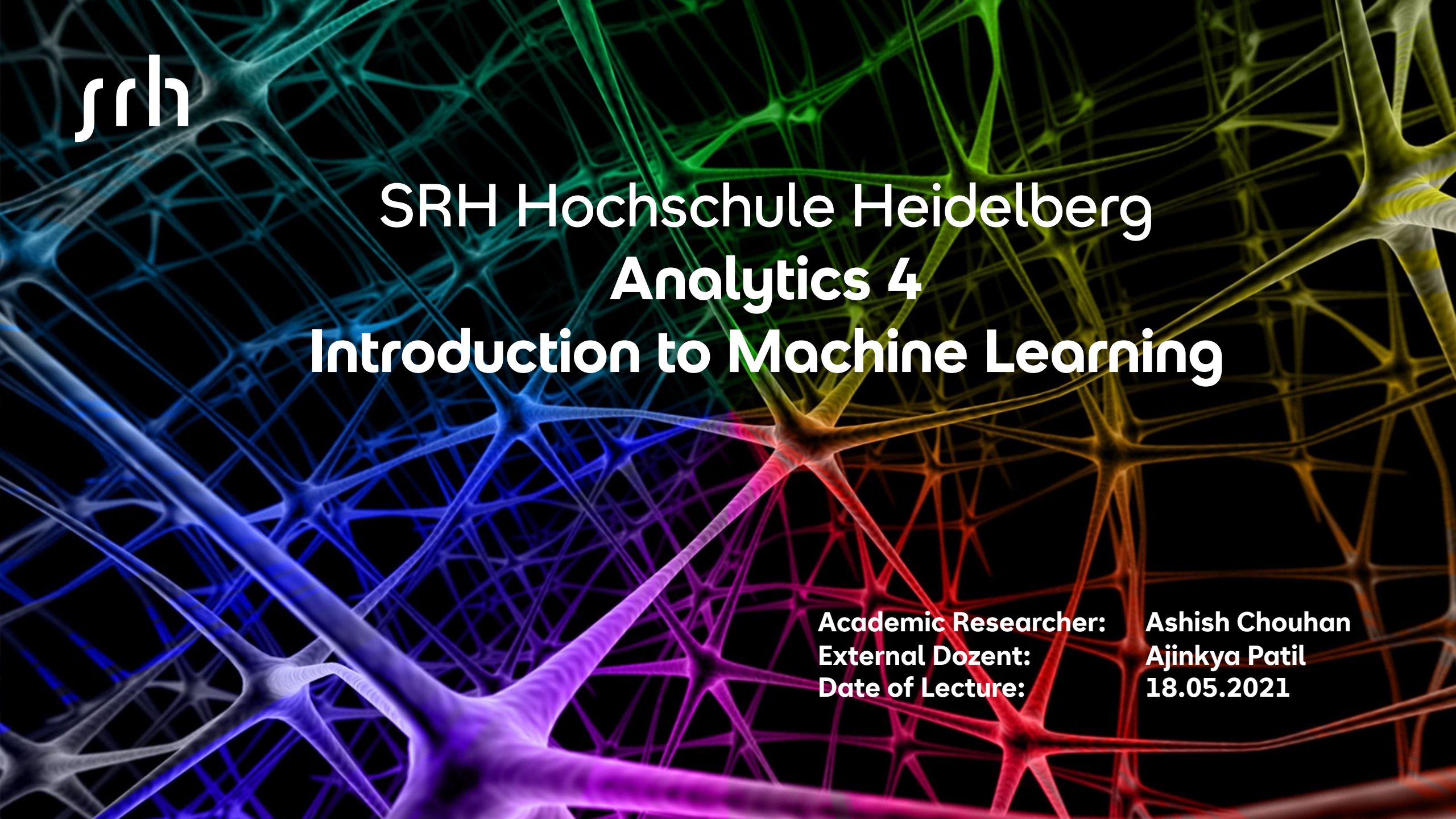


SRH Hochschule Heidelberg

Analytics 4

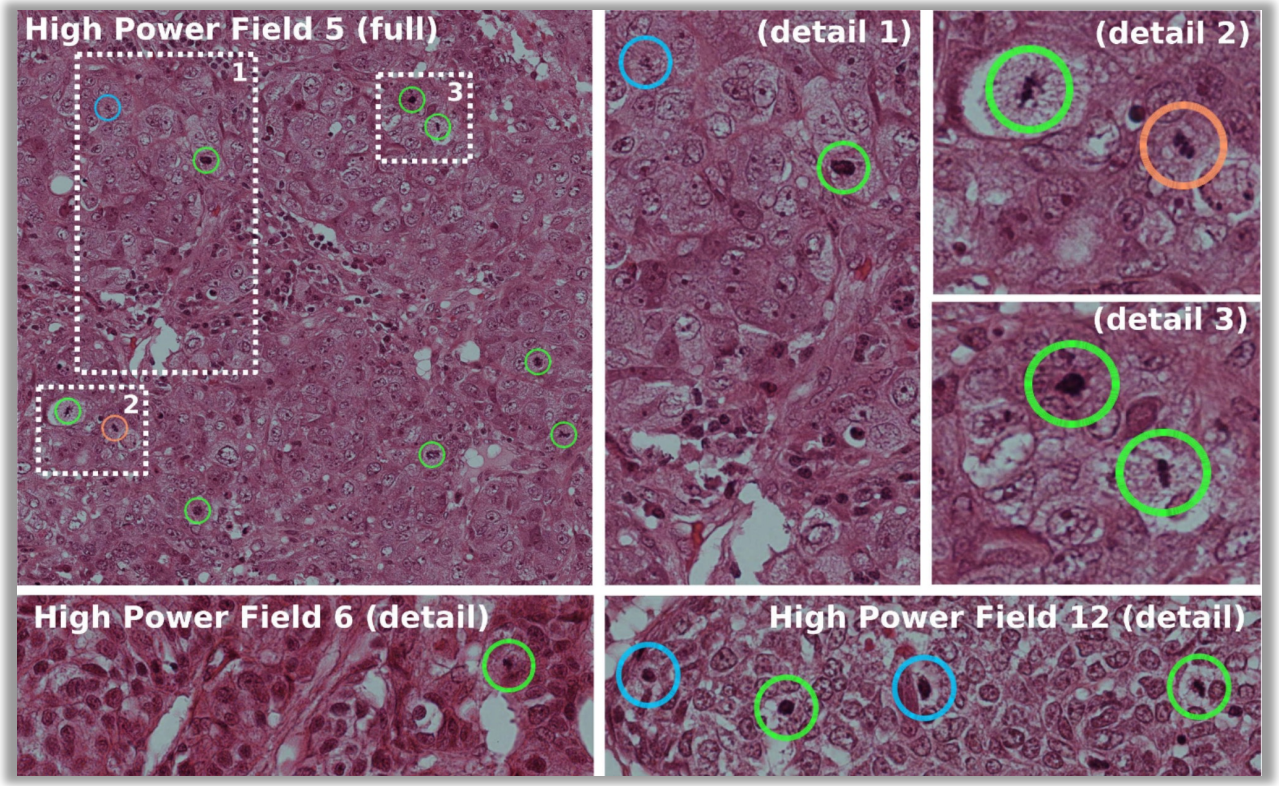
Introduction to Machine Learning

Academic Researcher: Ashish Chouhan
External Dozent: Ajinkya Patil

Date of Lecture: 18.05.2021

Why we need neural networks?

— Detecting Mitosis



Giusti, A., Caccia, C., Cireşari, D.C., Schmidhuber, J. and Gambardella, L.M., 2014, April. A comparison of algorithms and humans for mitosis detection. In *2014 IEEE 11th International Symposium on Biomedical Imaging (ISBI)* (pp. 1360-1363). IEEE.

Why we need neural networks?

— Text Summarization

Gold Summary: Redpath has ended his eight-year association with Sale Sharks. Redpath spent five years as a player and three as a coach at sale. He has thanked the owners, coaches and players for their support.	Salience	Content	Novelty	Position	Prob.
Bryan Redpath has left his coaching role at Sale Sharks with immediate effect.	0.1	0.1	0.9	0.1	0.3
The 43 - year - old Scot ends an eight-year association with the Aviva Premiership side, having spent five years with them as a player and three as a coach.	0.9	0.6	0.9	0.9	0.7
Redpath returned to Sale in June 2012 as director of rugby after starting a coaching career at Gloucester and progressing to the top job at Kingsholm .	0.8	0.5	0.5	0.9	0.6
Redpath spent five years with Sale Sharks as a player and a further three as a coach but with Sale Sharks struggling four months into Redpath's tenure, he was removed from the director of rugby role at the Salford-based side and has since been operating as head coach .	0.8	0.9	0.7	0.8	**0.9**
'I would like to thank the owners, coaches, players and staff for all their help and support since I returned to the club in 2012.	0.4	0.1	0.1	0.7	0.2
Also to the supporters who have been great with me both as a player and as a coach,' Redpath said.	0.6	0.0	0.2	0.3	0.2

Nallapati, R., Zhai, F. and Zhou, B., 2017, February. Summarunner: A recurrent neural network-based sequence model for extractive summarization of documents. In *Thirty-First AAAI Conference on Artificial Intelligence.*

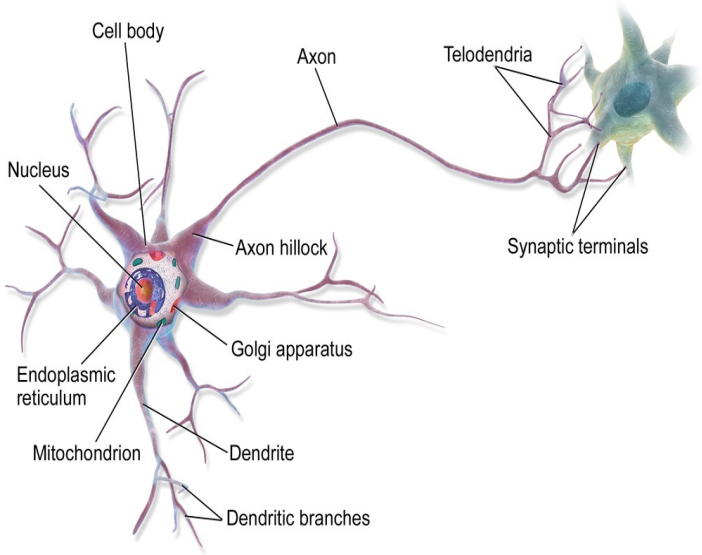
Why we need neural networks?

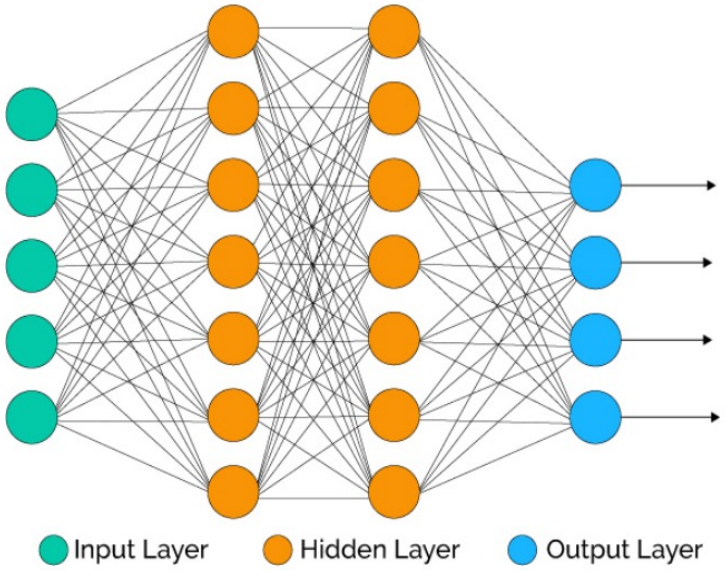
— Neural Style Transfer: Content image and style image

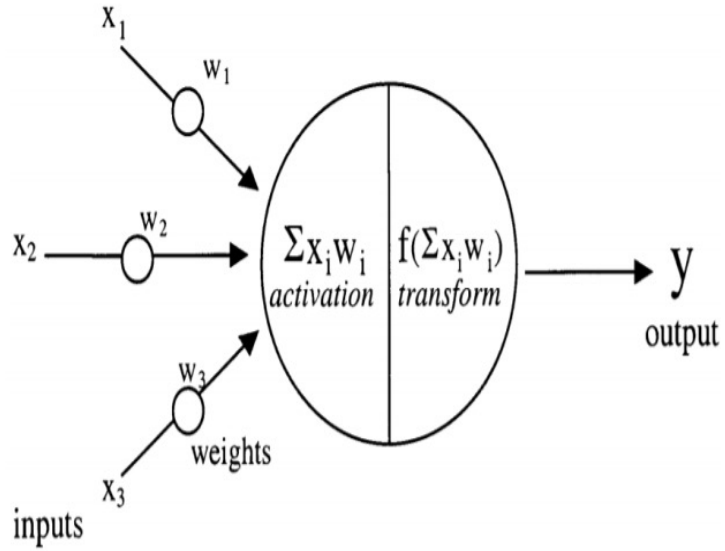
Gatys, L.A., Ecker, A.S. and Bethge, M., 2015. A neural algorithm of artistic style. *arXiv preprint arXiv:1508.06576*.

Course structure

— Introduction to Machine Learning (ML)

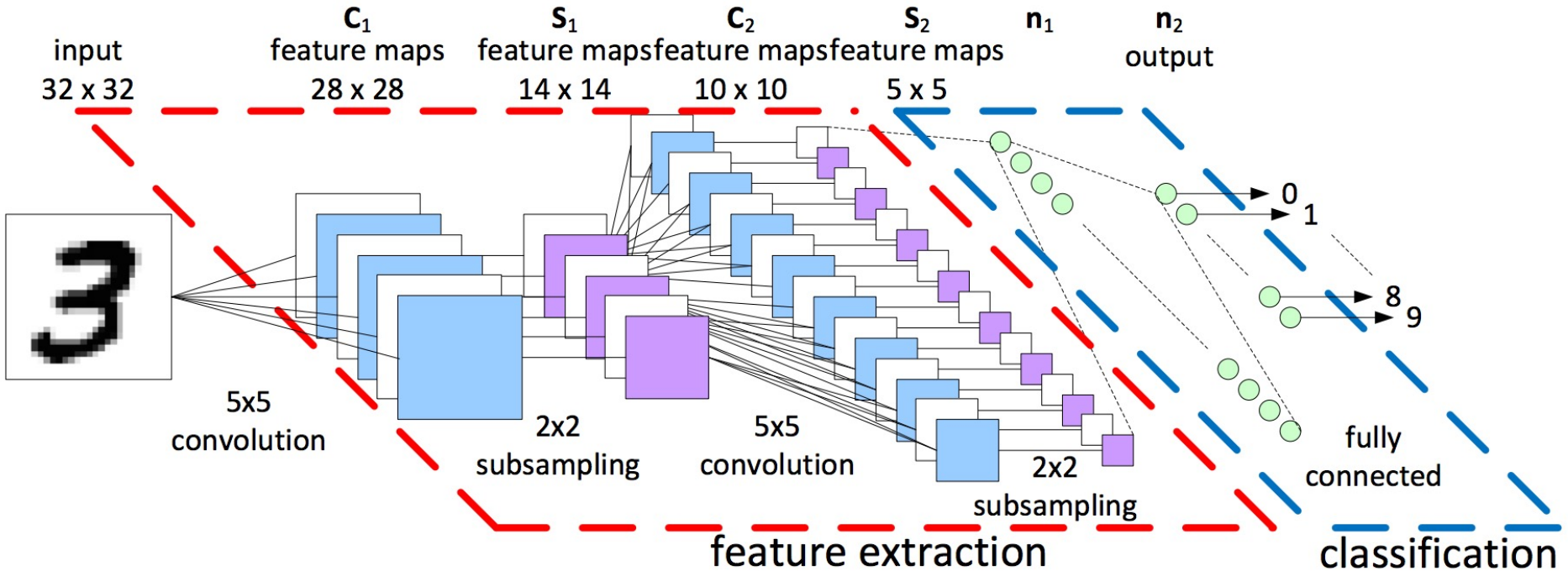






Course structure

- Introduction to Machine Learning (ML)
- Introduction to Convolutional Neural Network (CNN)

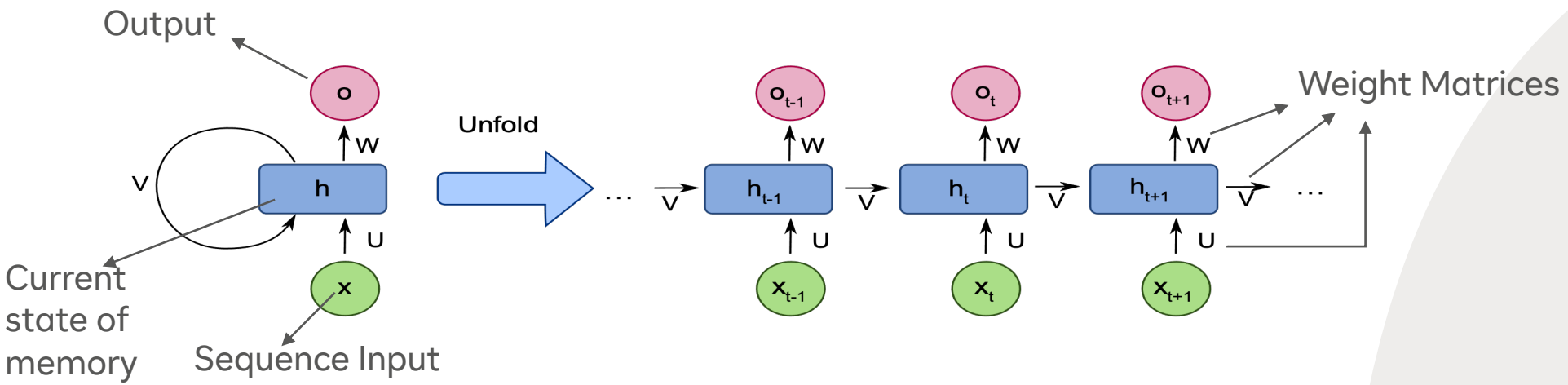


Course structure

- Introduction to Machine Learning (ML)
- Introduction to Convolutional Neural Network (CNN)
- GANs and Deep Auto Encoder (DAE)

Course structure

- Introduction to Machine Learning (ML)
- Introduction to Convolutional Neural Network (CNN)
- GANs and Deep Auto Encoder (DAE)
- Introduction to Recurrent Neural Network (RNN)



Course structure

- Introduction to Machine Learning (ML)
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- Introduction to Recurrent Neural Network (RNN)
- Long Short-Term Memory (LSTM)

Course structure

- Introduction to Machine Learning (ML)
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- Long Short-Term Memory (LSTM)

Note: Due to COVID Situation all classes will be held online.

Exam structure

Important Dates:

- Submission of 1 Pager about Final Examination topic by **30th May 2021**.
- Submission of Presentation, Code, and Technical flow document by **20th July 2021**.
- 21st July 2021, 22nd July 2021, and 23rd July 2021: Final Examination.

Examination Pattern:

- Individual presentation for a selected **Neural Network Architecture**. (100% grade)
- 30 mins presentation each (20mins presentation + 10mins of Question-and-Answer Session).
- 20mins presentation comprises of explanation of Architecture and working Demo.

Exam structure

Expectation:

- Explain how the Neural Network Architecture functions (Considering an example)
- A working implementation of the Neural network Architecture Application on cloud infrastructure (Cloud Platform: AWS or Azure or GCP or using docker or Kubernetes).
- Summarize:
  - MLOps Pipeline + Neural Network Architecture Application

Exam structure

Grades Distribution:

- Neural Networks Architecture Explanation and Demo of Application (**40%)**
- Novelty with respect to the Application (Deployment on Cloud) (**30%**)
- Decision Making of Neural Networks for the Application through Comparison (**10%**)
- Introduction of the Topic, Grammar, Self-Explanatory, References Slide (**10%**)
- Completion of Presentation on Time (**5%**)
- Structure of the Presentation (**5%)**

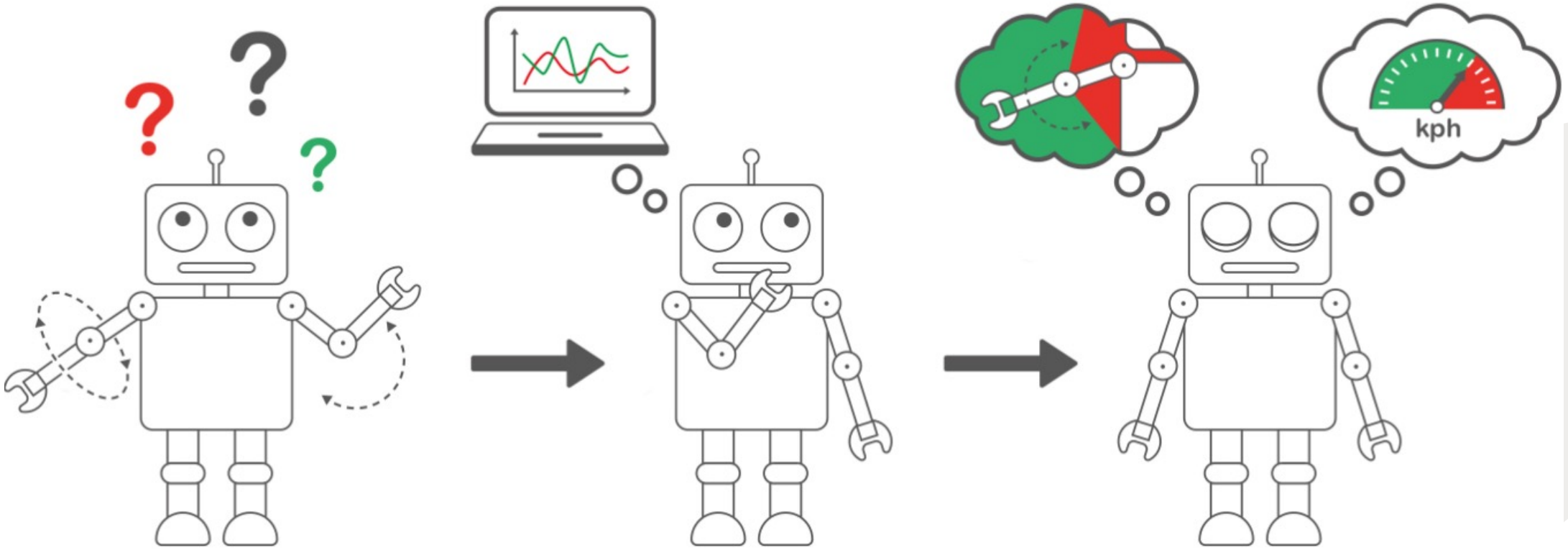
What is machine learning?

- "Machine learning is the science of getting computers to act without being explicitly programmed." – Stanford

- "Machine learning is based on algorithms that can learn from data without relying on rules-based programming."- McKinsey & Co.

- "A Computer Program is said to learn from experience *E* with respect to some class of tasks *T* and performance measure *P* if its performance at tasks in *T*, as measured by *P*, improves with experience *E*." - Tom M. Mitchell

What is machine learning?



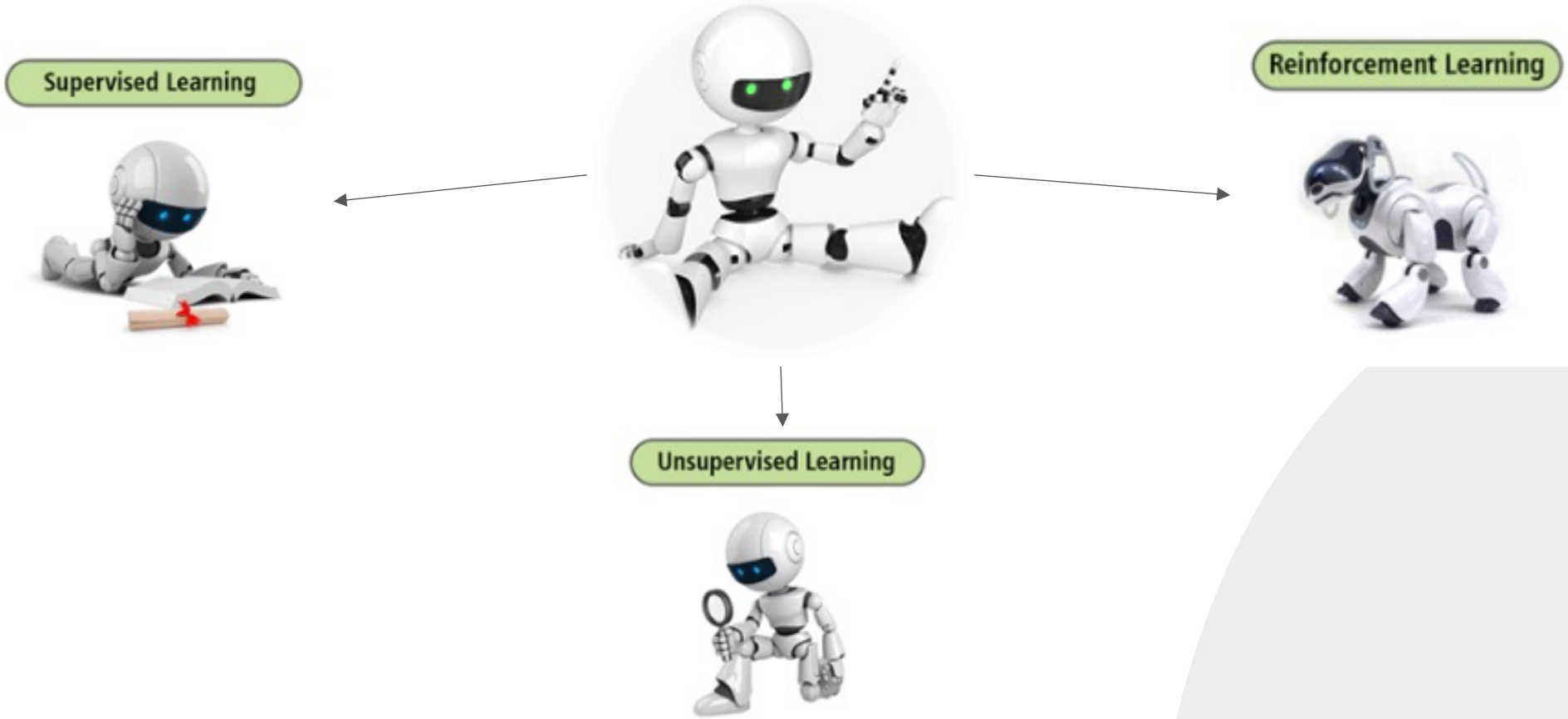
Machine Learning

- Generally speaking, Machine Learning is the science of getting computers to learn and act like humans do, and improve their learning.

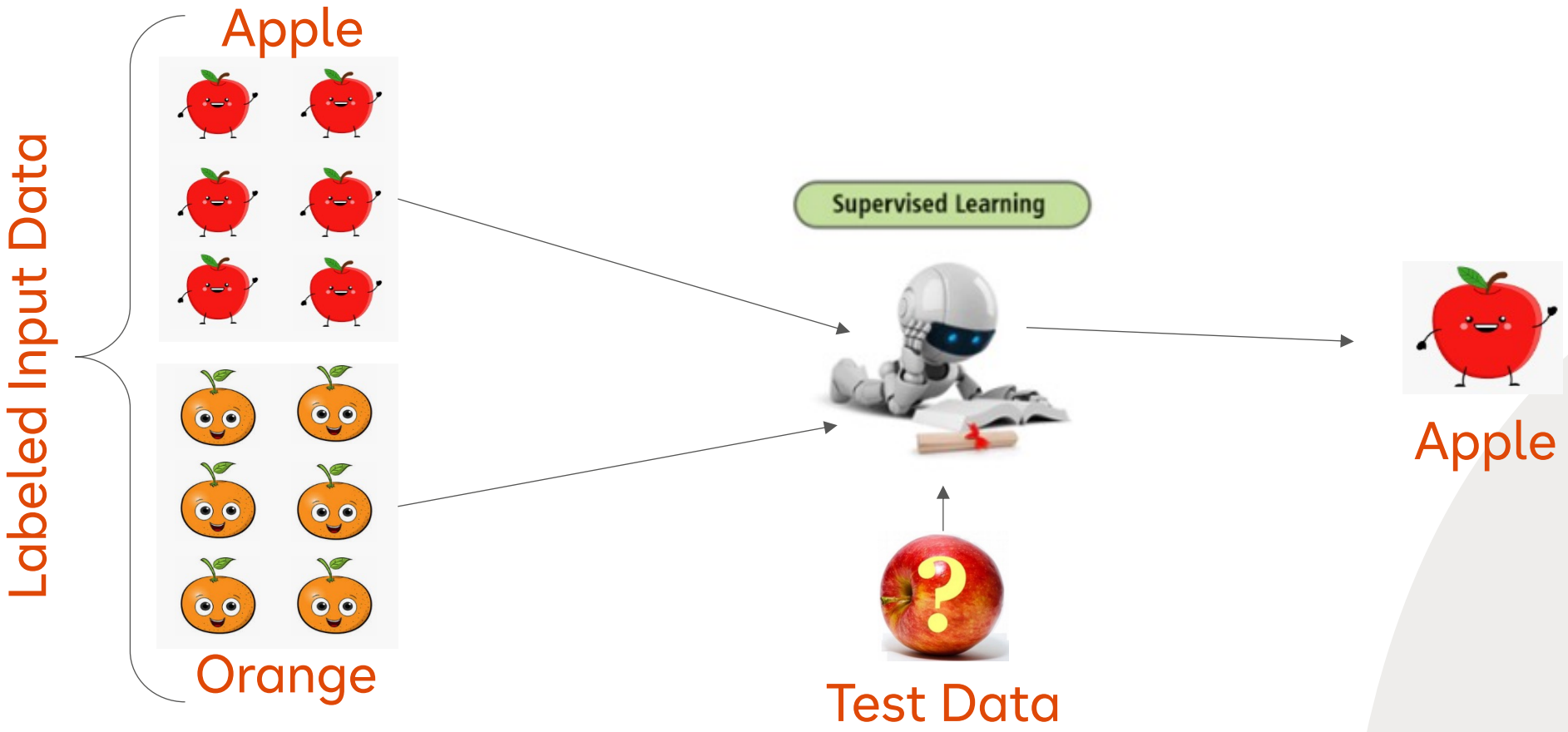
- Specifically, Machine learning (ML) is the study of algorithms and mathematical models that computer systems use to progressively improve their performance on a specific task.

- Algorithms build a mathematical model of sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task.

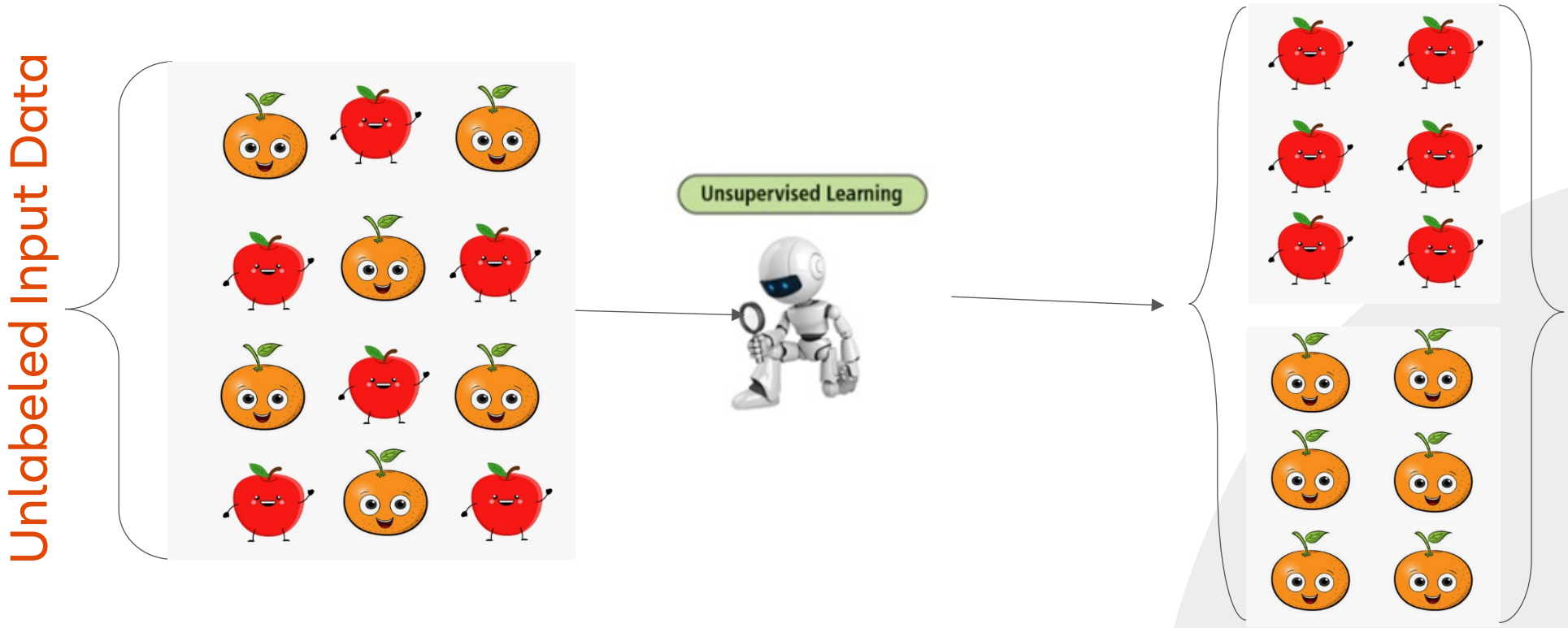
Types of machine learning



Types of machine learning



Types of machine learning



Types of machine learning

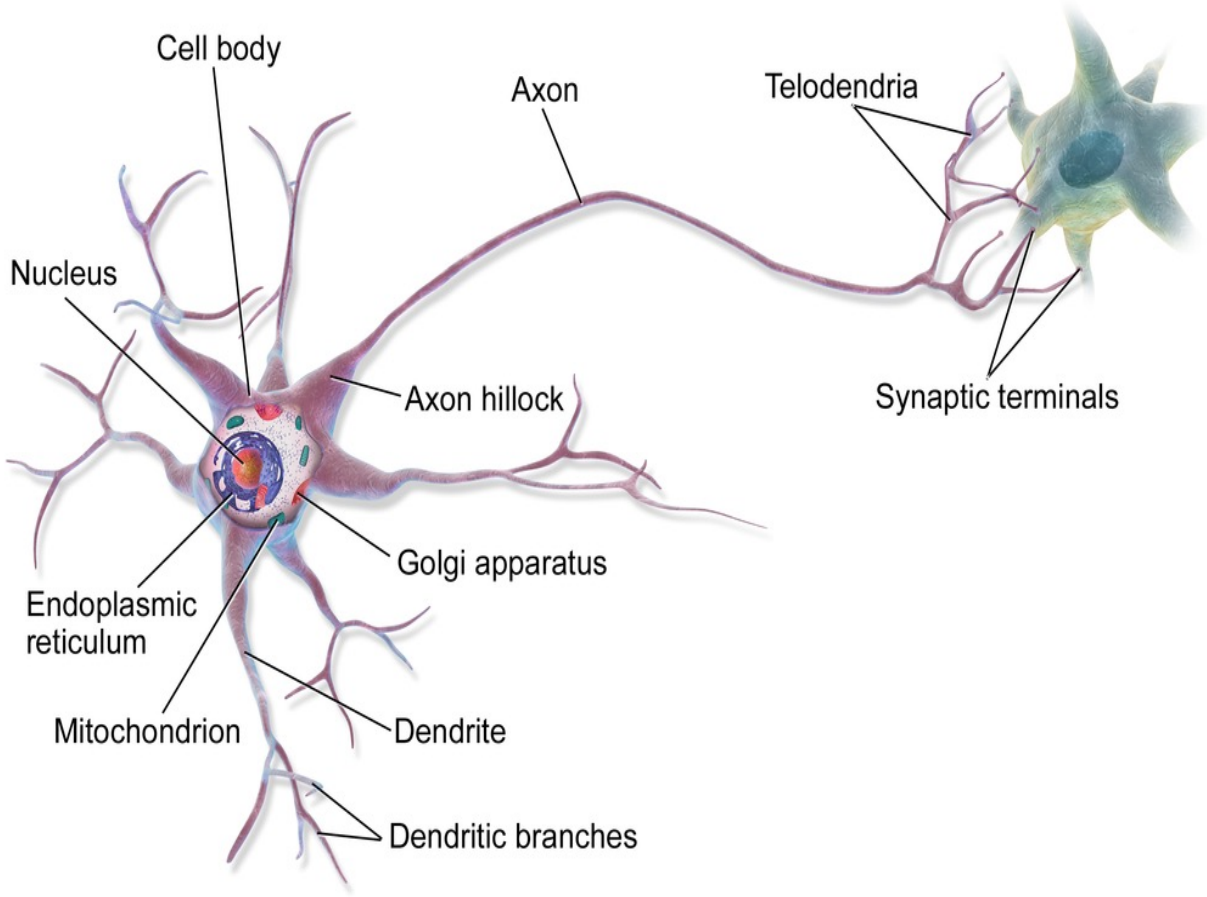
- No Previous Input Data
- Learn from Trial and Error

Supervised Learning Applications

- Predicting Prices (Regression).
- Fraud Detection (Classification).
- Collaborative Filtering (Product Recommendation)

Biological Neuron

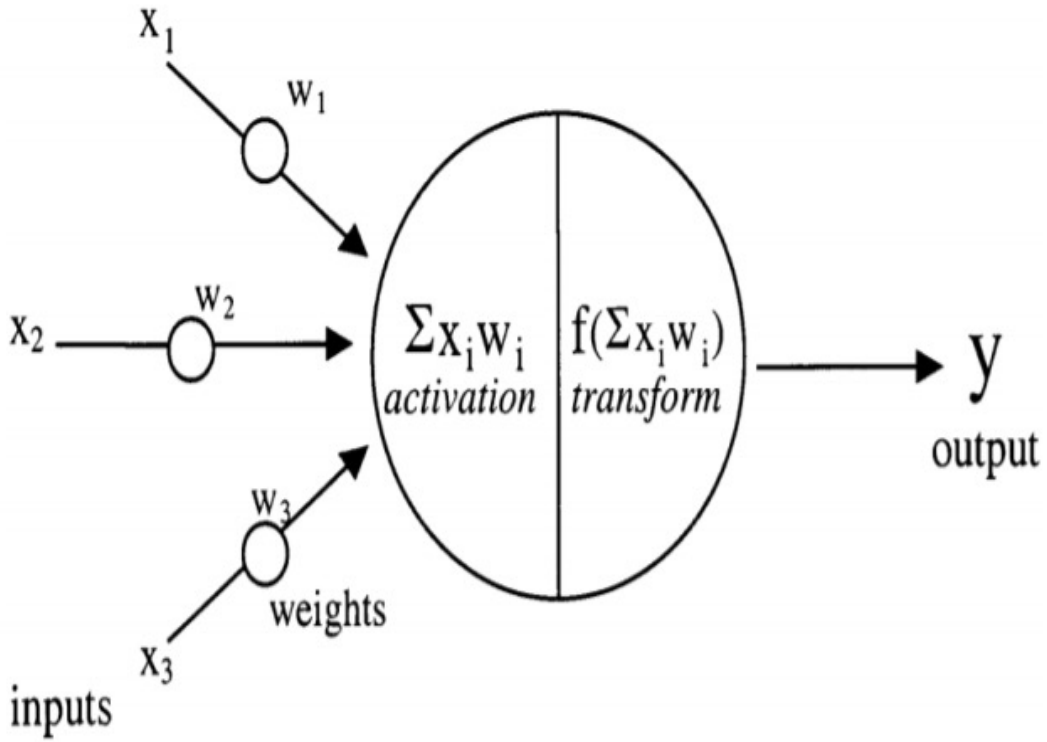
- Input comes from Dendrite
- Nucleus of a neuron creates a message/ Perform operation on input.
- Synapses, either gives an output or connects to new neurons.



Artificial Neuron

- Input : Features/ Weights (Numbers).
- Functions perform operation on the input data.
- Output of Neuron connect to new neurons or gives final output.

Formula = $w_1x_1+w_2x_2+w_3x_3....w_nx_n$



Biological neural network

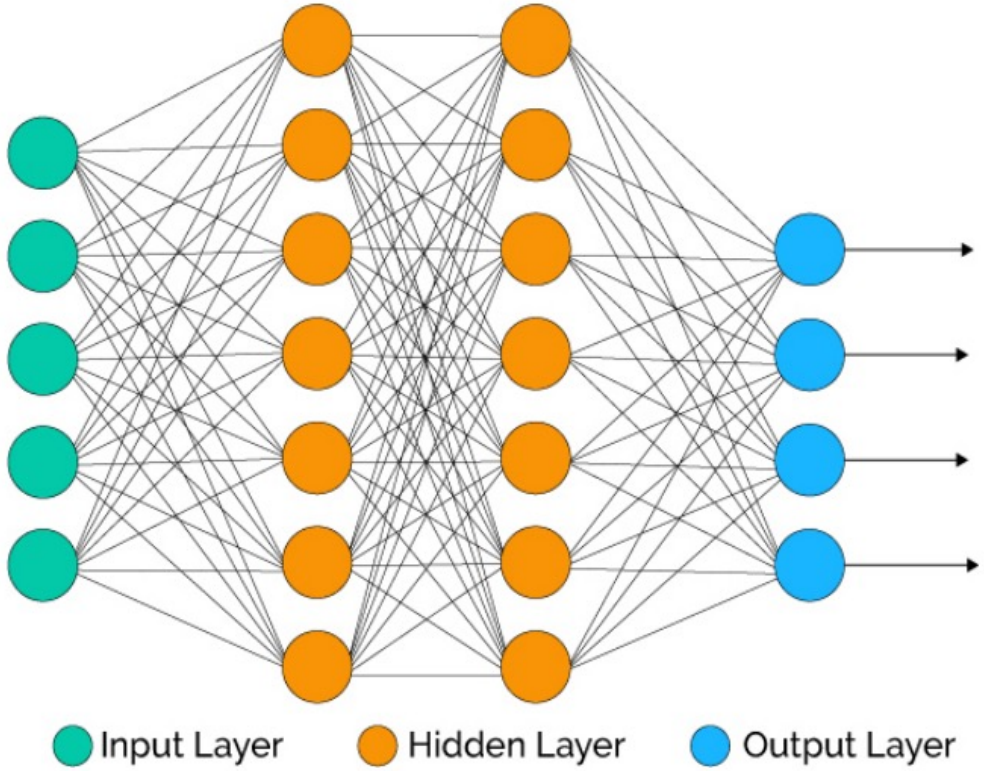
- Billions of Neurons Interconnected to each other processing different data manifests into a Brain.

- The Brain knows things from experiences which it has stored from previous encounters.

Artificial neural network

- Billions of Artificial Neurons Interconnected to each other processing different data manifests into a Artificial Neural Network.

- The Artificial Brain knows things from experiences /Examples which it has stored from previous encounters/Training/learnings.

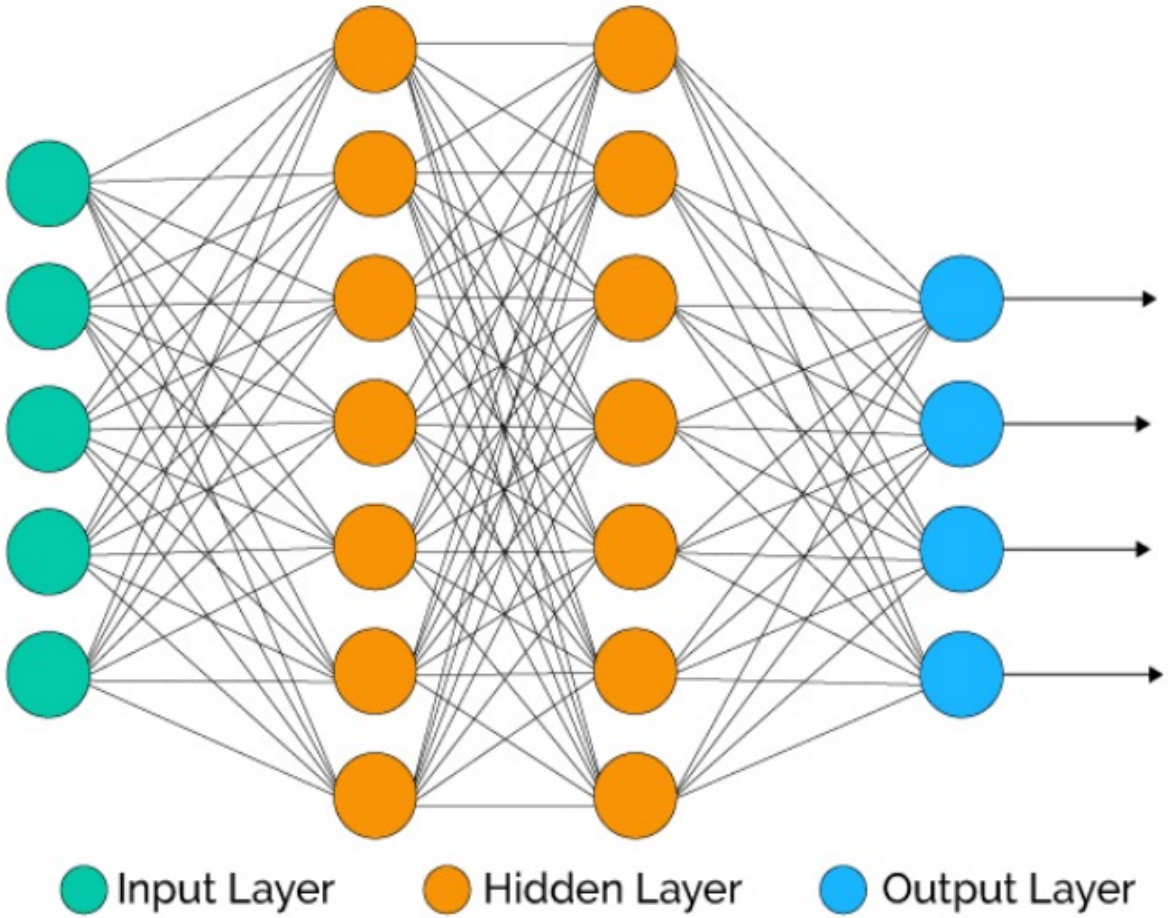


Types of Neural Networks

- Multilayer Perceptron Neural Network (Deep Neural Network)
- Recurrent Neural Networks
- Convolutional Neural Networks
- Generative Adversarial Networks
- Deep Autoencoders

Deep Neural Networks

- Contains more than 1 hidden layer.
- One Input and One Output Layer.
- Input Layers will take data from the outside world and pattern recognition will be done in hidden layers.
- Patterns are studied in a feed forward manner and error is calculated using back propagation.
- https://playground.tensorflow.org



Applications of Deep Neural Network

- Anomaly Detection
- Fraud Detection
- Predicting numbers (Prices of houses)
- Classification.

Recurrent Neural Networks

- Learns from sequential data and contexts, used mostly in NLP or Time Series Analysis.
- One Input and One Output Layer.
- Input Layers will take data from the outside world and pattern recognition will be done in hidden layers.
- Hidden layers have a sort of “memory” to remember context from few steps back.

Recurrent Neural Networks

- Limitation of Neural Networks is that their API is too constrained: they accept a fixed-sized vector as input (e.g. a frame in a large sequence) and produce a fixed-sized vector as output (e.g. probabilities of different classes).

- They accept an input vector x and give an output vector y. However, crucially this output vector's contents are influenced not only by the input you just fed in, but also on some history of inputs fed in in the past.

Application of RNN

- Language Modeling and Prediction
- Speech Recognition
- Time Series Analysis

Convolutional Neural Networks

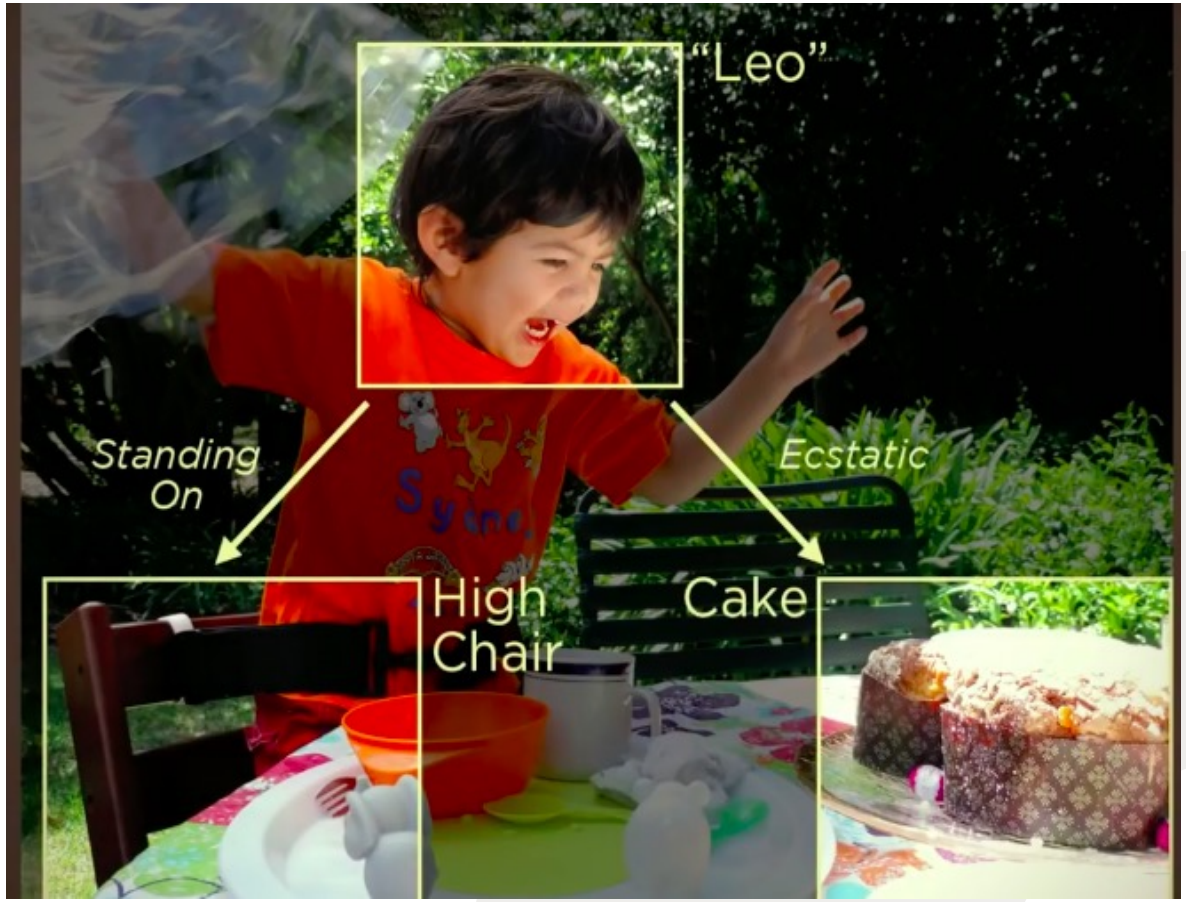
- A common CNN is composed of input layer, multiple hidden layer and an output layer. The hidden layers of a CNN typically consist of convolutional layers (extracts feature from images, detects edges and surfaces), pooling layers (reduces the spatial size of the representation).

- An CNN is well-suited to classify and process Images, Videos.

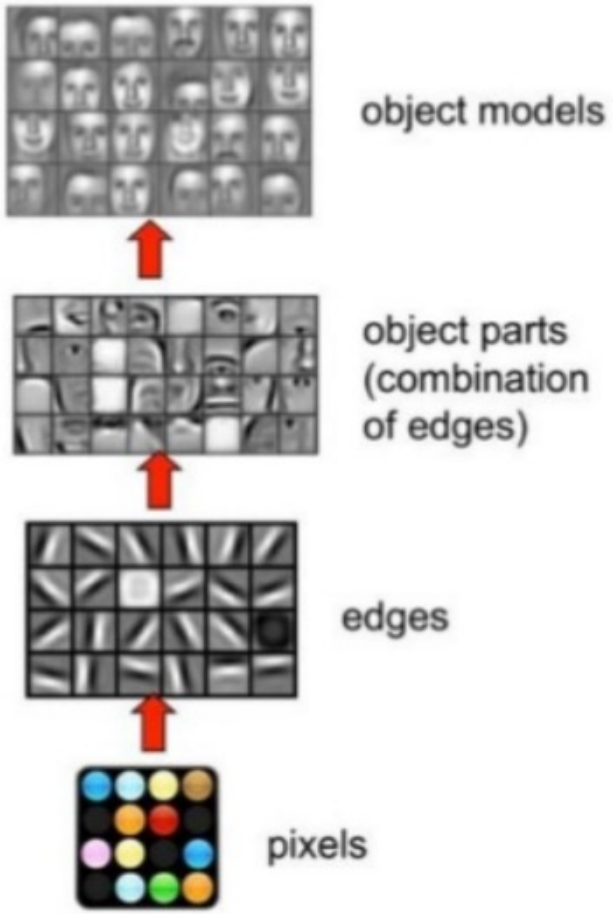
Convolutional Neural Networks

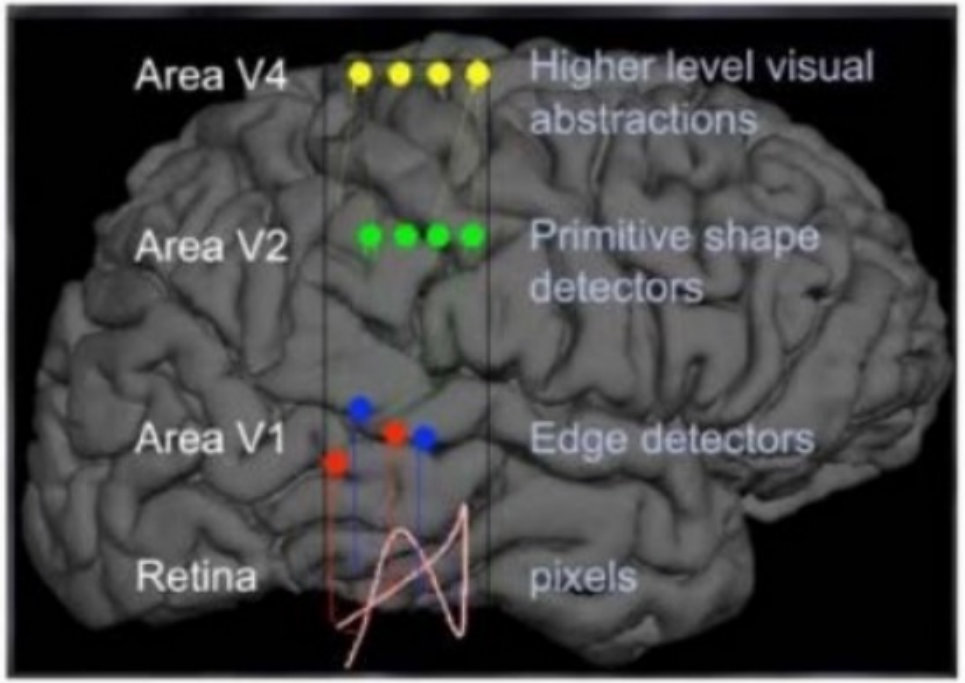
- It took nature over 500 million years to create a system to do this. The collaboration between the eyes and the brain, called the primary visual pathway, is the reason we can make sense of the world around us.

- Similar to how a child learns to recognize objects, we need to show an algorithm millions of pictures before it is be able to generalize the input and make predictions for images it has never seen before.

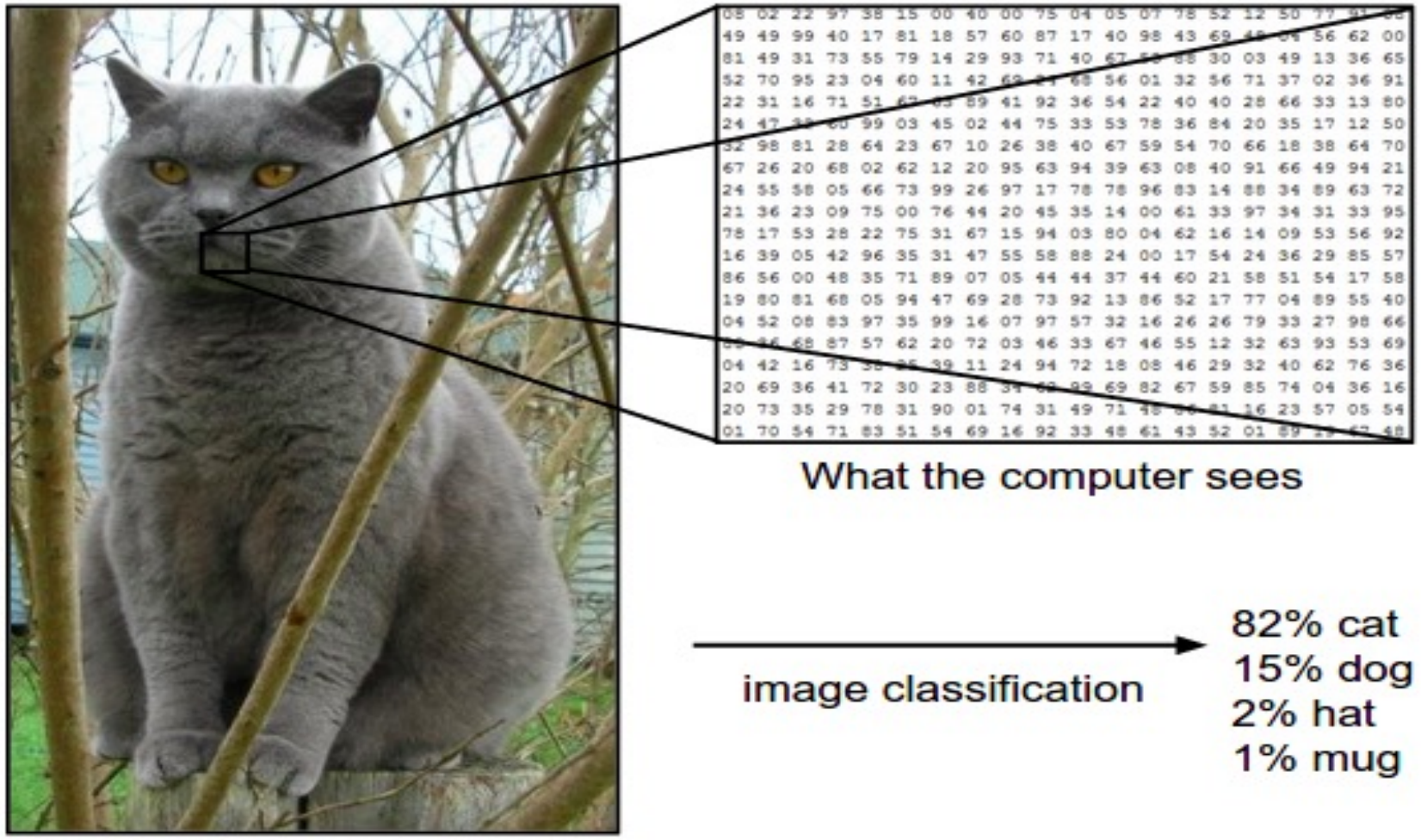


Convolutional Neural Networks





Convolutional Neural Networks



Visual Object Recognition Benchmarks (Project Adam)

- ImageNet 22k Image Classification

American Foxhound

English Foxhound

Applications of CNN

- Image Classification
- Face Recognition
- Scene Labeling
- Video Object Detection.
- Live video emotion detection. (https://github.com/omar178/Emotion-recognition#p1)

Generative Adversarial Networks (GANS)

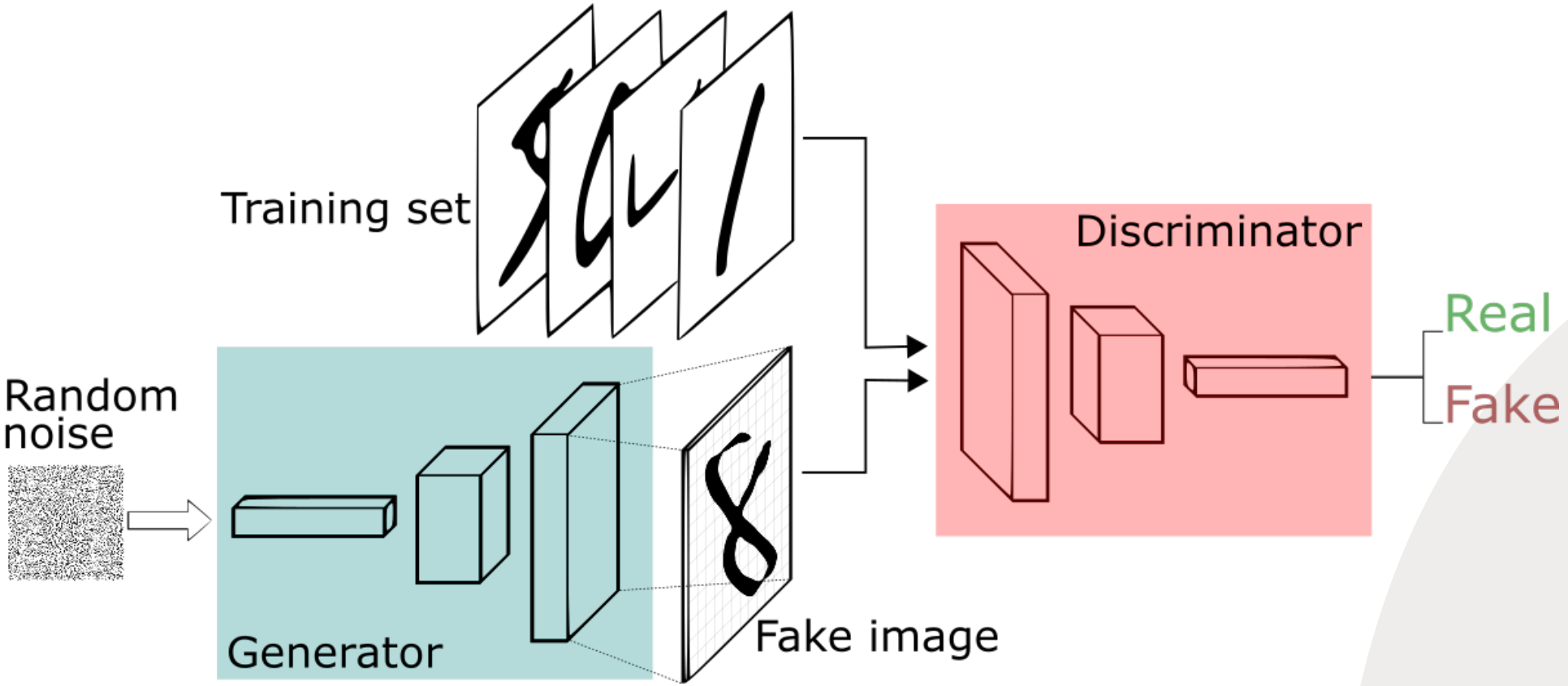
- One network generates candidates (generative) and the other (discriminative) evaluates them.

- A known dataset serves as the initial training data for the discriminator. Training the discriminator involves presenting it with samples from the dataset, until it reaches some level of accuracy.

- Samples synthesized by the generator are evaluated by the discriminator.

- So that the generator produces better images, while the discriminator becomes more skilled at flagging synthetic images.

Generative Adversarial Networks (GANS)



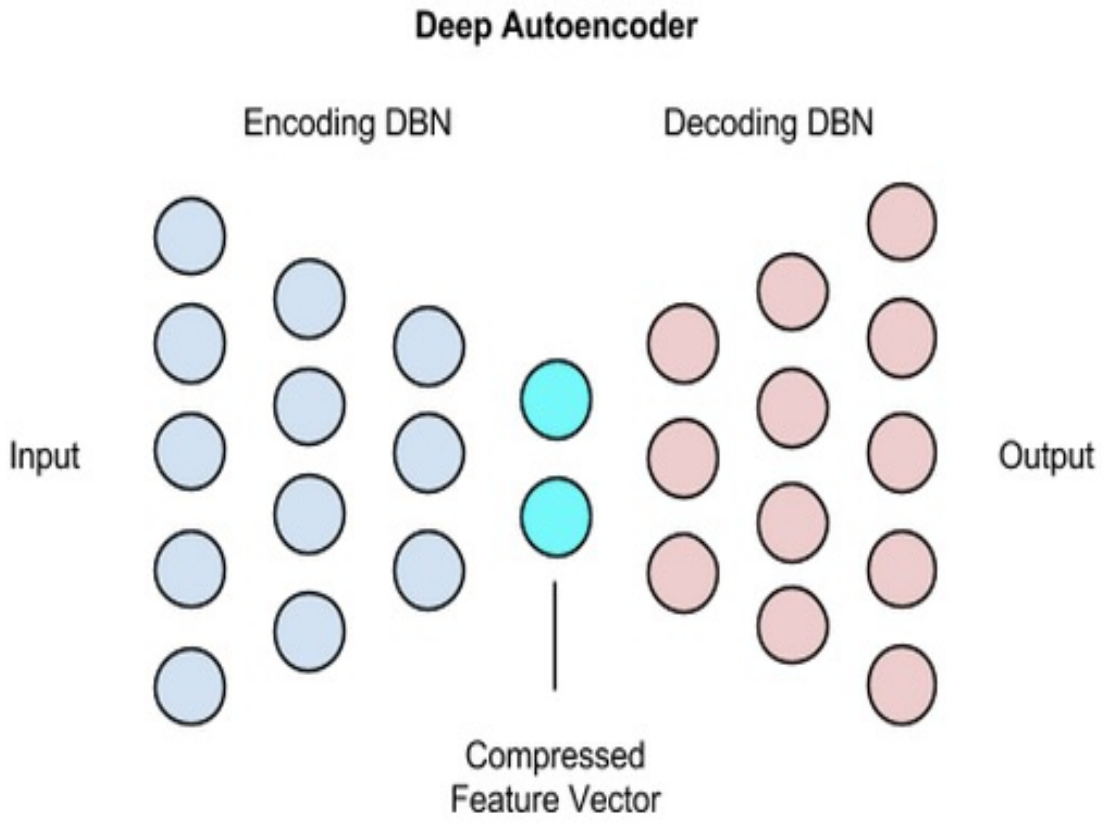
GANS Applications

- Reenacting Videos (https://www.youtube.com/watch?v=MVBe6_o4cMI)
- Artificial Art Creation
- Transferring patterns of Old paintings to new images.
- Map design in Gaming.

Deep Autoencoders

- A deep autoencoder is composed of two networks that typically have four or five shallow layers representing the encoding half of the net, and second set of four or five layers that make up the decoding half.

- Encoding half compresses the input data and decoding tries to decompresses on the output layer.



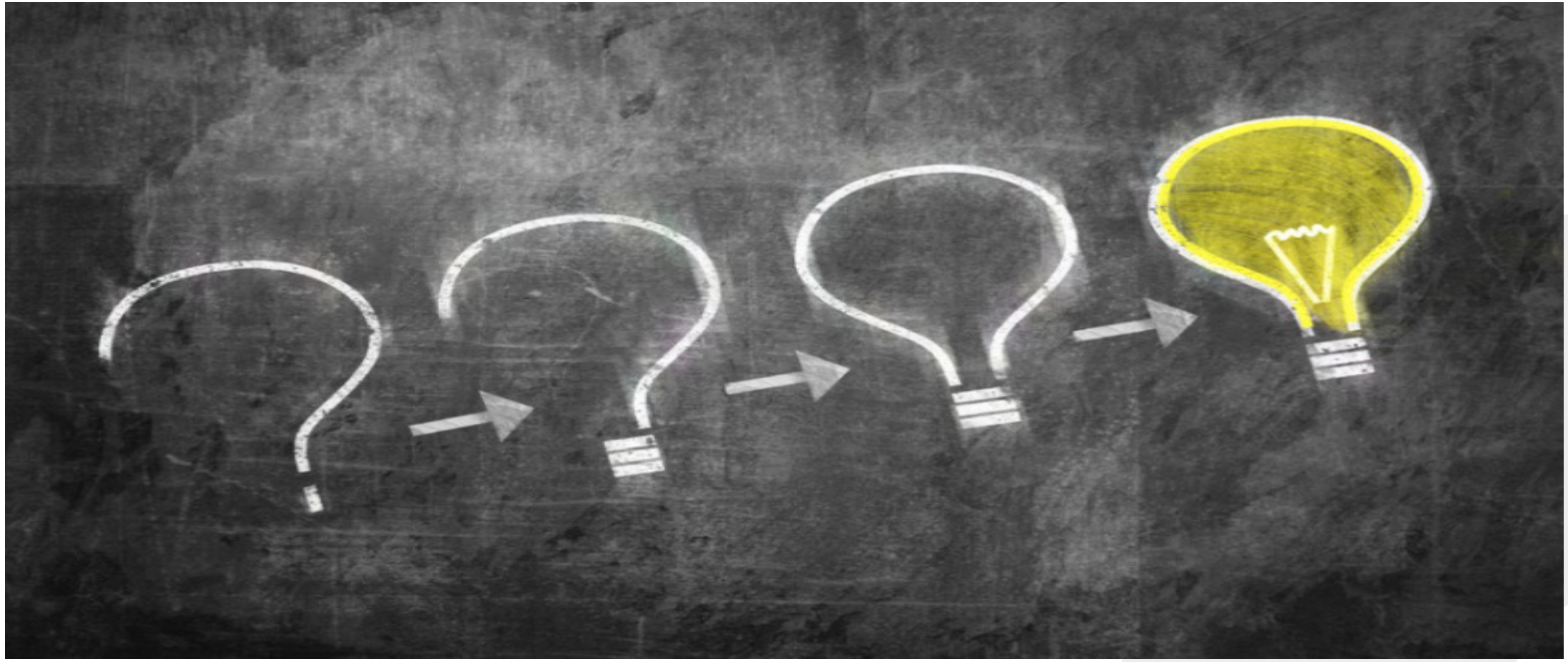
Deep autoencoder Applications

- Image Search
- Data Compression
- Image Denoising

References for Online Learning

- Machine Learning by Stanford University – Coursera, Andrew Ng.
- Deep Learning Specialization – deeplearning.ai
- Enterprise Deep Learning with TensorFlow, Open.sap.com
- Cs231n – Stanford https://www.youtube.com/results?search_query=cs231n
- Cs229 – ML Stanford https://www.youtube.com/results?search_query=cs229
- O'Reilly, Hands on Machine Learning With Scikit-Learn & TensorFlow
- End-to-End Machine Learning with TensorFlow on GCP, Coursera

Questions?



Vielen Dank für deine Aufmerksamkeit!

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