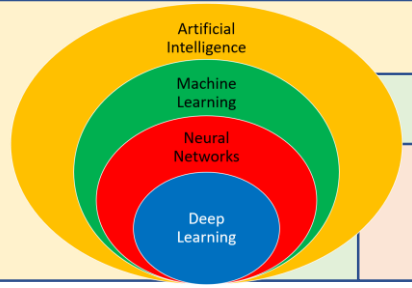


Artificial Intelligence (AI)

Machine Learning (ML)

Neural Networks (NNs)

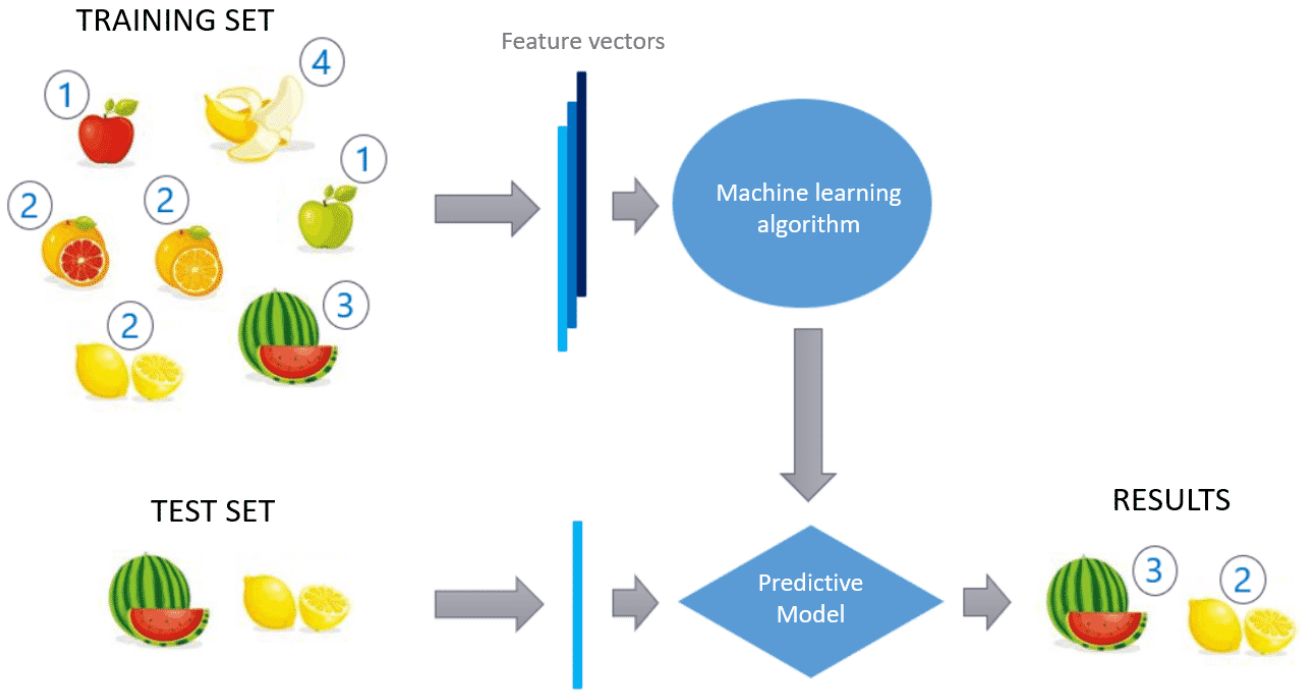
Deep Learning (DL)

Advanced Artificial Intelligence

Dr. Rastgoo

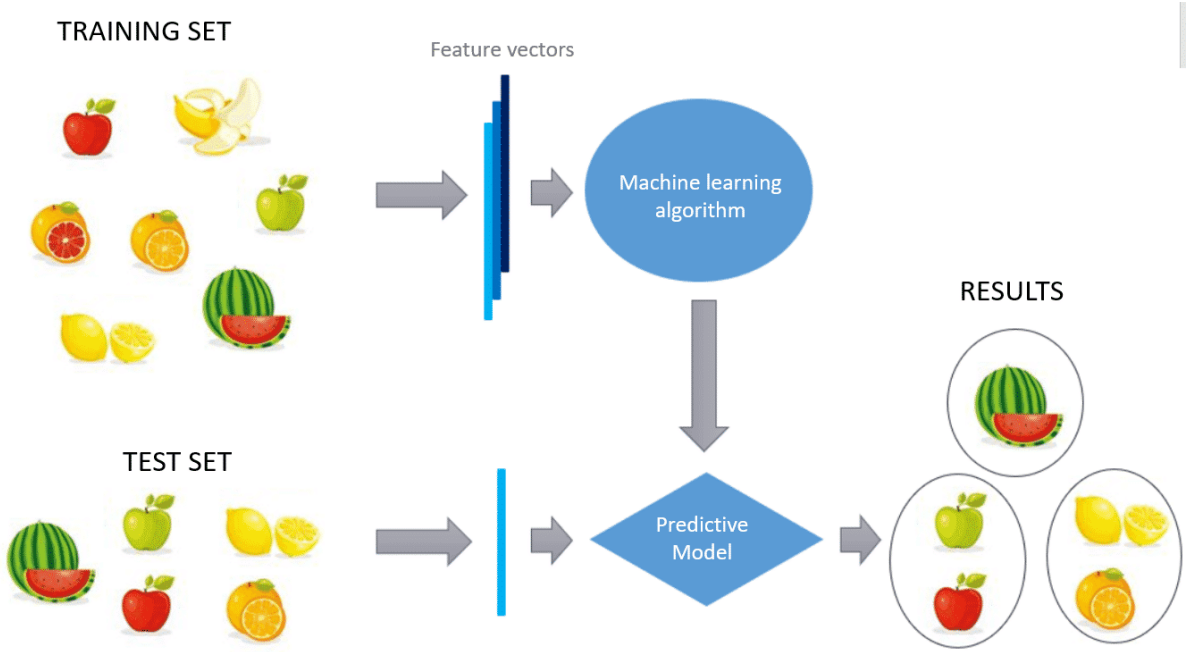
Machine learning methods

- **Supervised machine learning algorithms.** The system is able to provide targets for any new input after sufficient training.



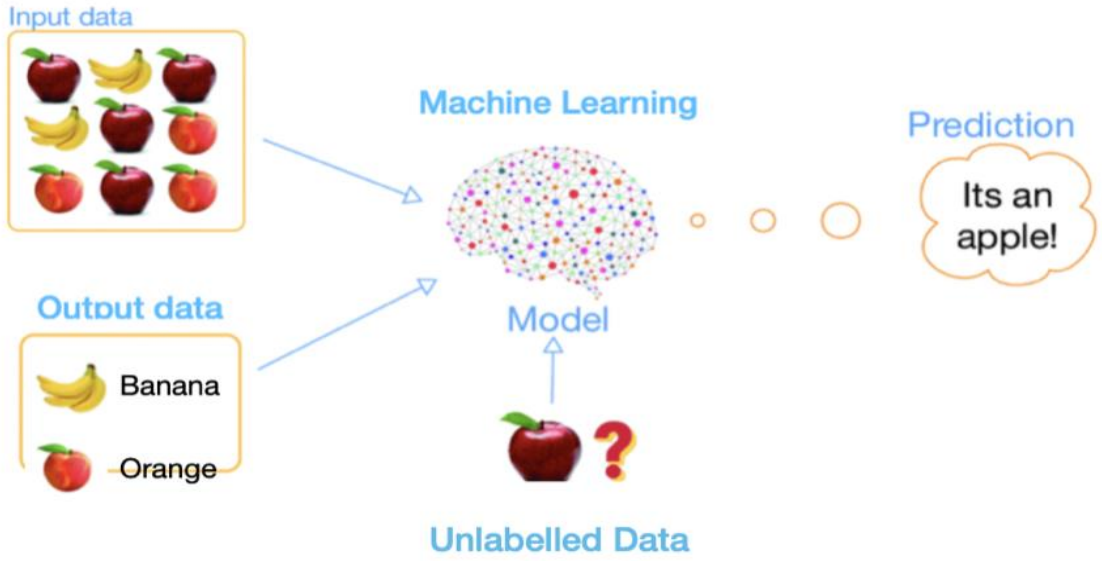
Machine learning methods

- **Unsupervised machine learning algorithms.** The system doesn't figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabeled data.



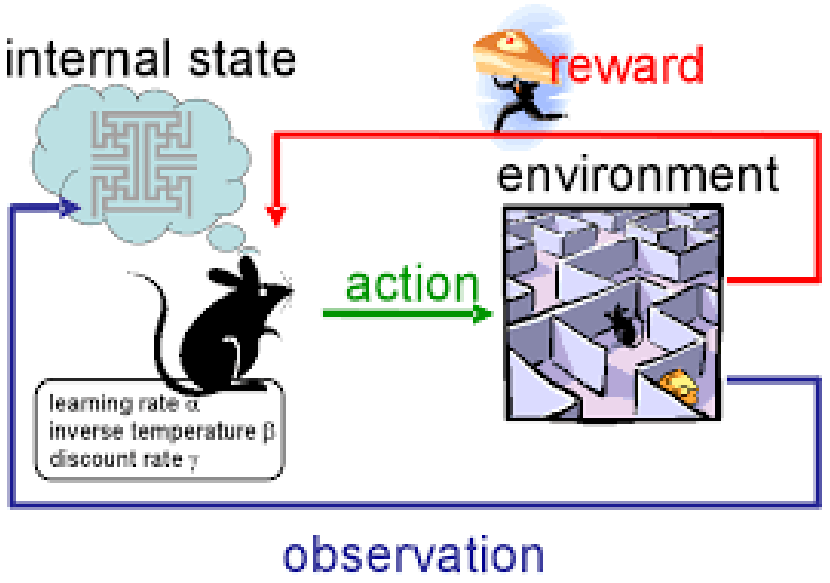
Machine learning methods

- **Semi-supervised machine learning algorithms.** Usually, semi-supervised learning is chosen when the acquired labeled data requires skilled and relevant resources in order to train it / learn from it.

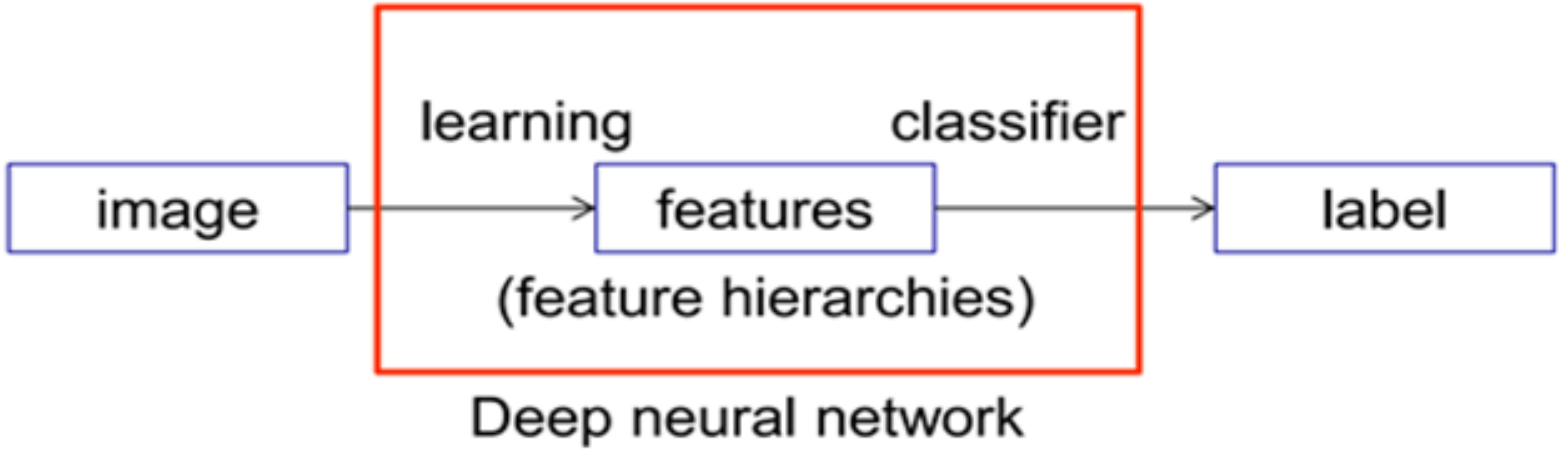


Machine learning methods

- **Reinforcement machine learning algorithms.** It is a learning method that interacts with its environment by producing actions and discovers errors or rewards (Trial and error search).

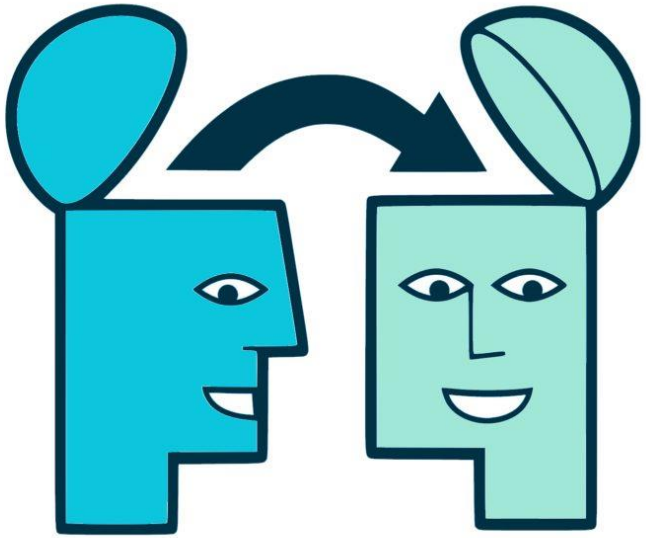


What is the “Deep Learning” ?



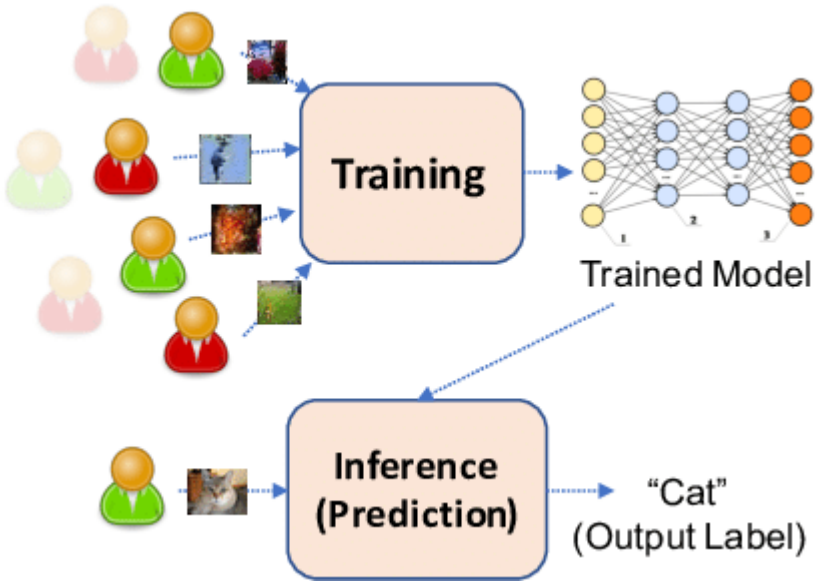
Learning methods in DL

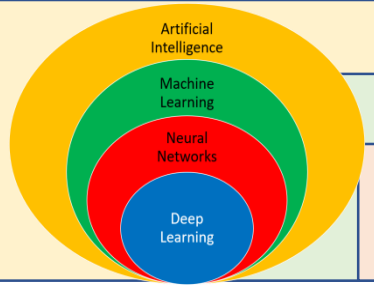
- **Transfer learning**. This process involves perfecting a previously trained model.



Learning methods in DL

- **Training from scratch**. This method requires a developer to collect a large labeled data set and configure a network architecture that can learn the features and model.





Deep learning examples

❖ Customer experience

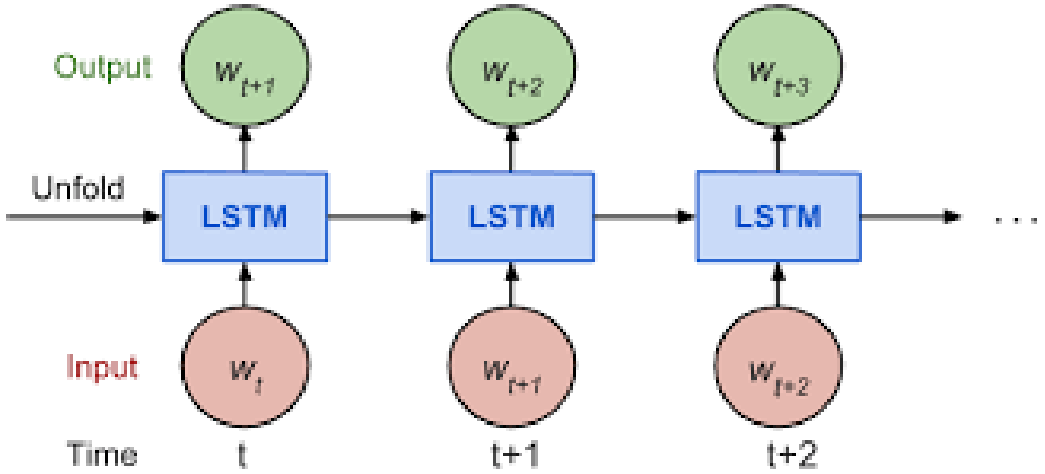
Microsoft has long used deep and machine learning, as well as neural networks, to enhance and develop their systems.

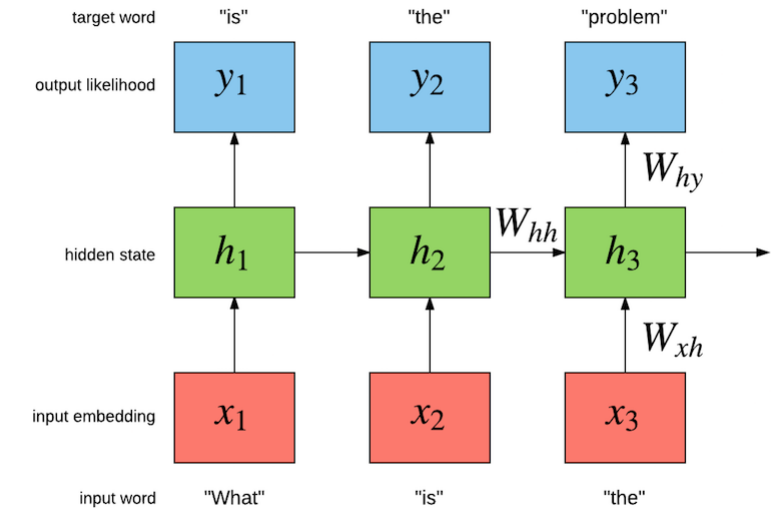
Improve the Customer Experience

Google has been using these systems to improve YouTube video recommendations for a number of years now.

Deep learning examples

❖ Text generation



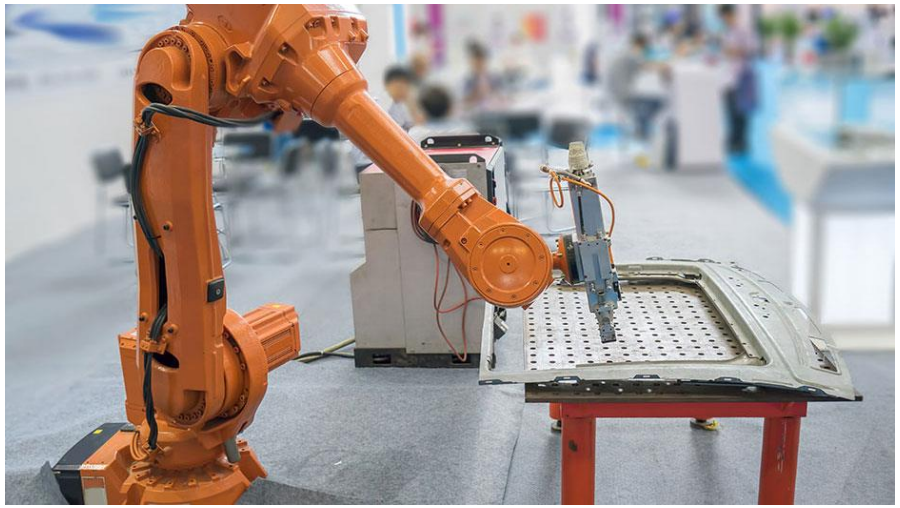


Deep learning examples

- **Aerospace and military**

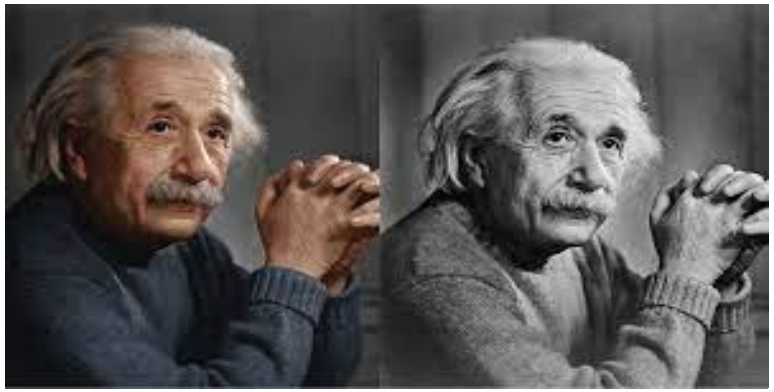
Learning methods in DL

- **Industrial automation**



Learning methods in DL

- **Colorization**



Learning methods in DL

- **Medical research**

Learning methods in DL

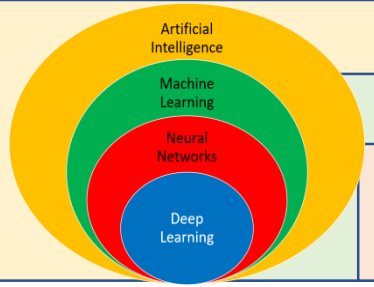
❖ Computer vision

Limitations and challenges

- The biggest limitation of deep learning models is they learn through observations. This means **they only know what was in the data on which they trained**.

Limitations and challenges

- The issue of **biases** is also a major problem for deep learning models.



Limitations and challenges

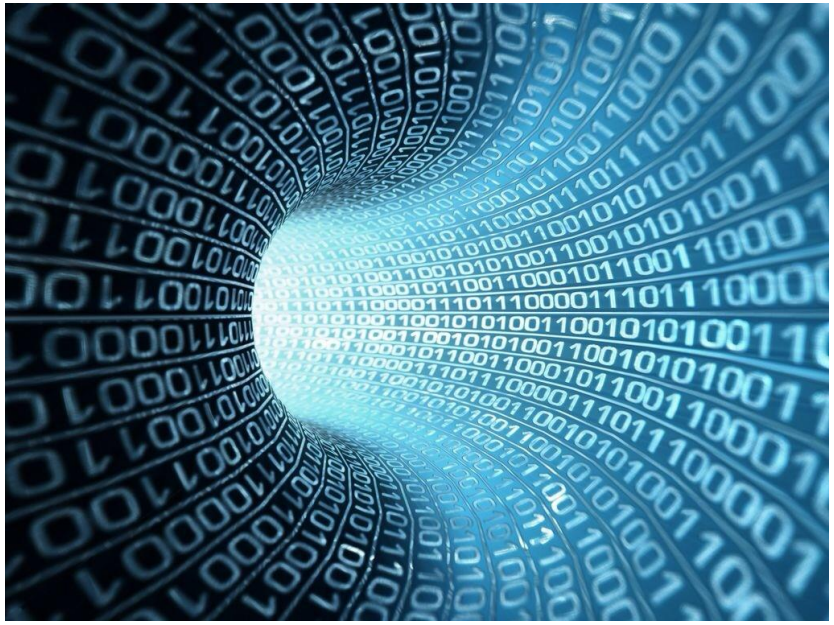
- The **learning rate** can also become a major challenge to deep learning models.

Limitations and challenges

- The **hardware** requirements for deep learning models can also create limitations.

Limitations and challenges

- Deep learning requires **large amounts of data**.

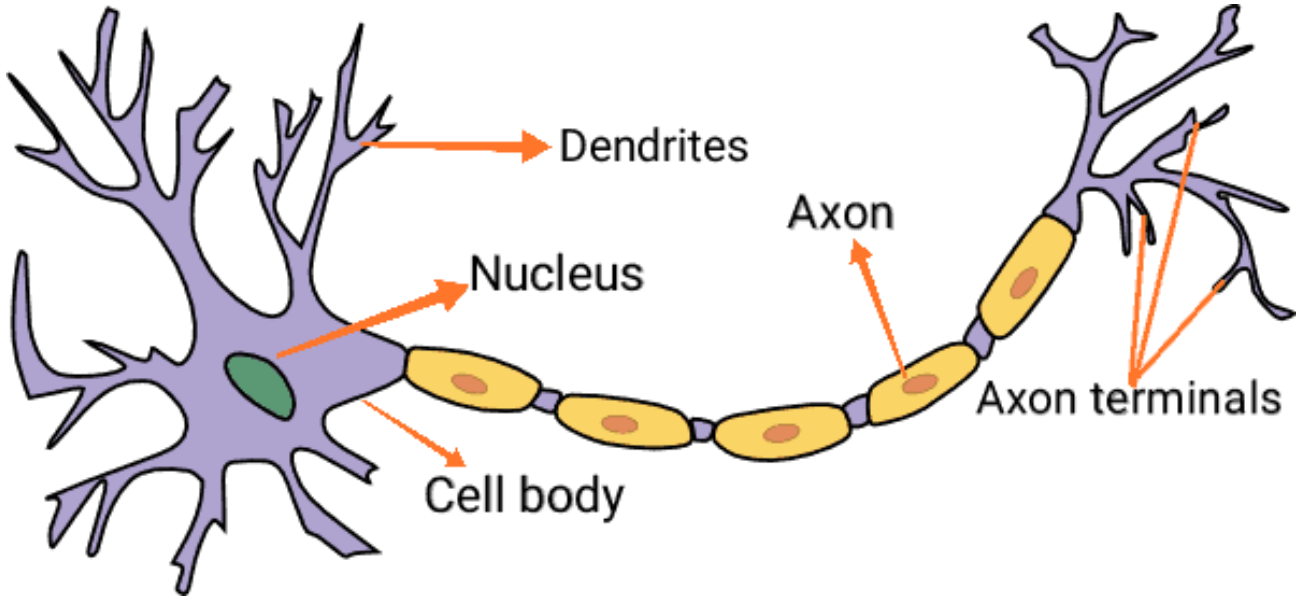


Limitations and challenges

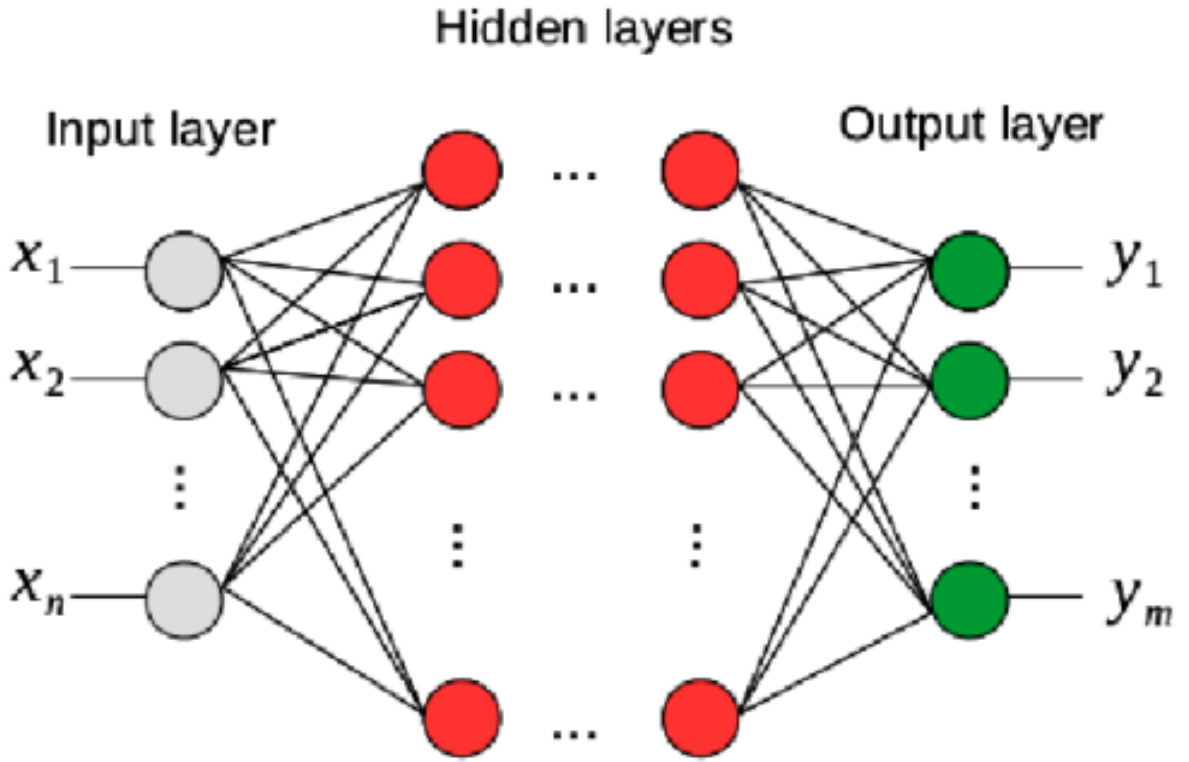
- They can deliver efficient and accurate solutions but only to **one specific problem** (Not multi-tasking).

Artificial Neural Networks (ANNs)

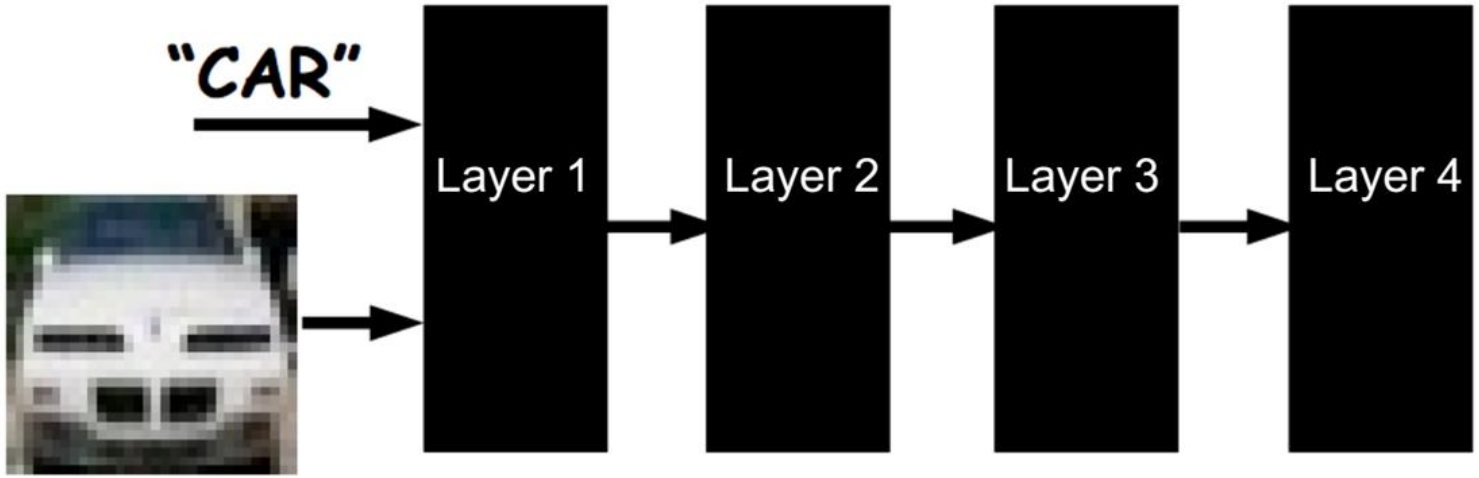
- ANNs are at the core of Deep Learning an advanced version of Machine Learning techniques.



The Neural Network Architecture



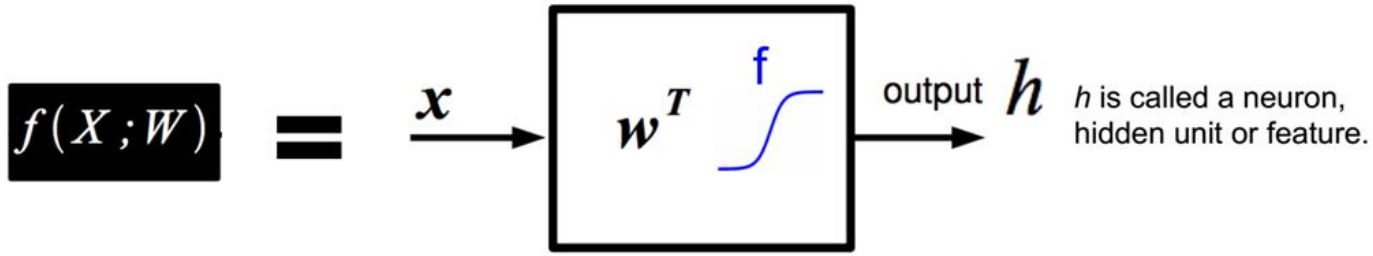
Intuition behind Deep Neural Networks

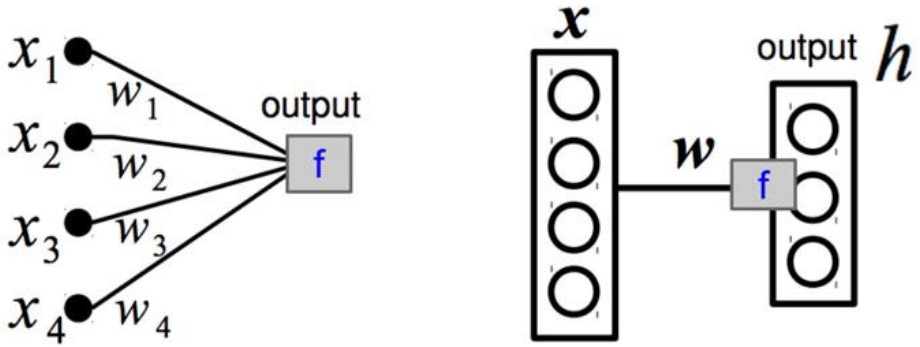


NOTE: Each black box can have trainable parameters.
Their composition makes a highly non-linear system.

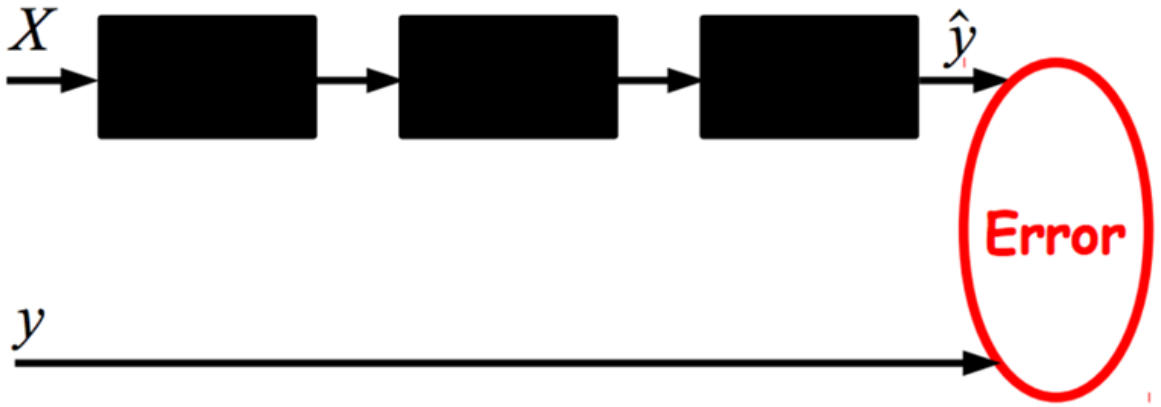
The final layer outputs a probability distribution of categories.

Graphical representation





Joint training architecture overview



NOTE: Multi-layer neural nets with more than two layers are nowadays called **deep nets**!!

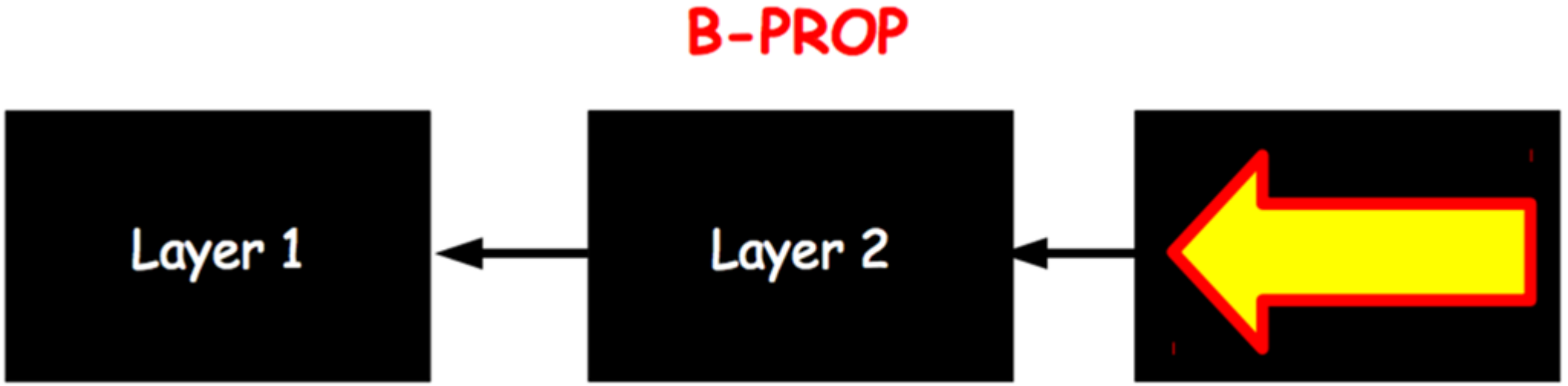
NOTE: User must specify number of layers, number of hidden units, type of layers and loss function.

NNs training

NNs training

NNs training

NNs training

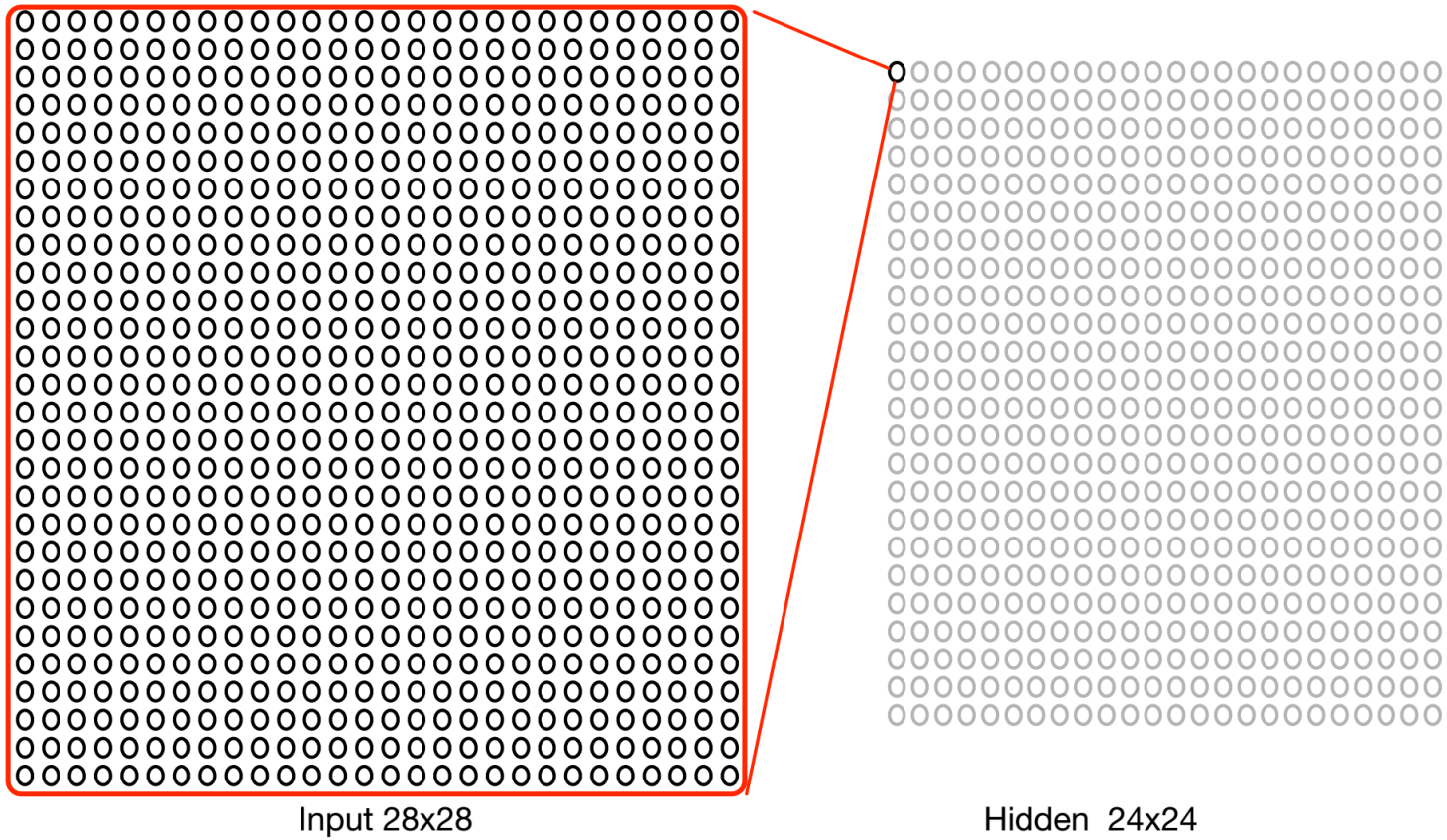


NNs training

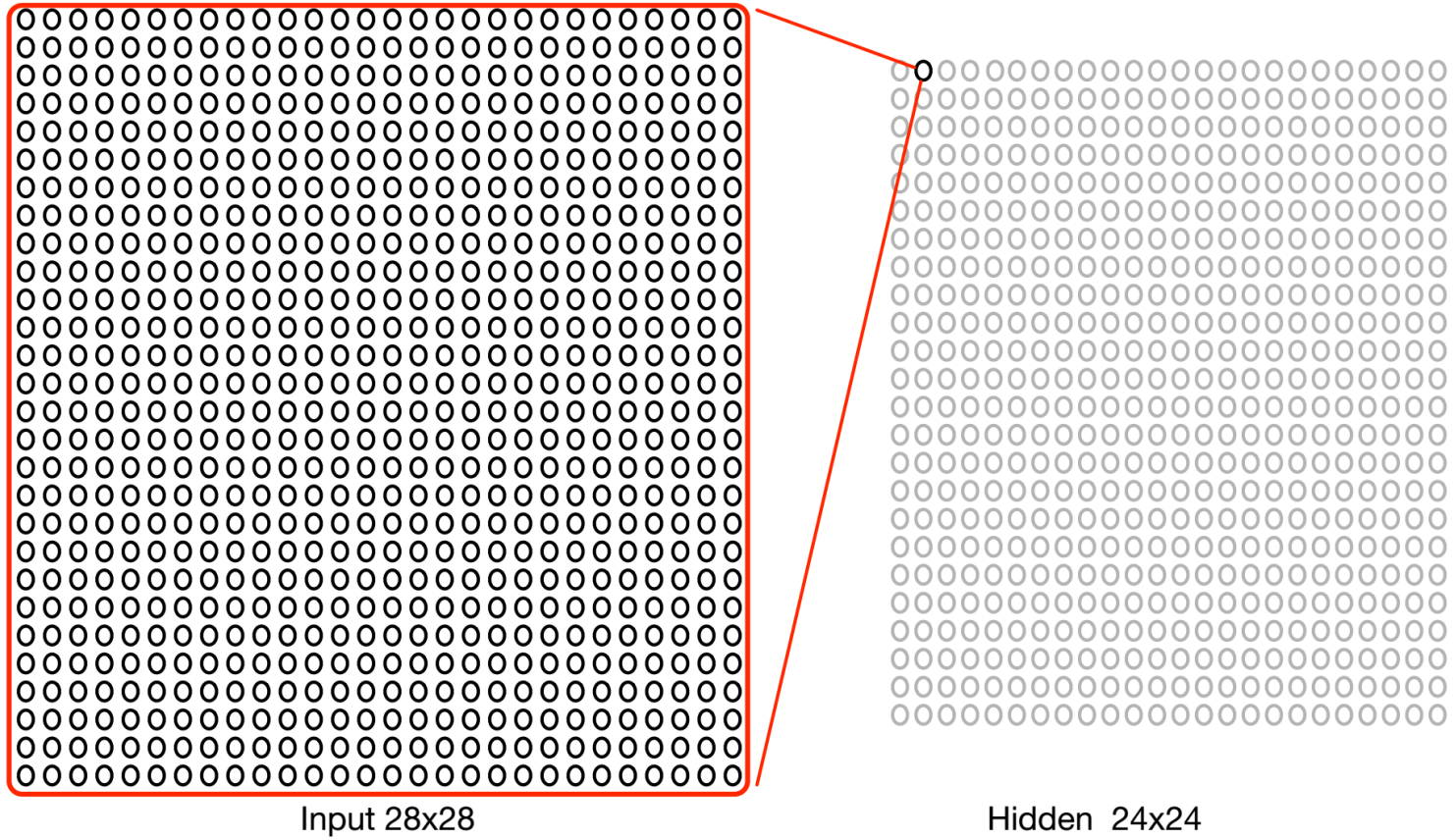
NNs training

Use gradient to update parameters $W \leftarrow W - \eta \frac{dL}{dW}$

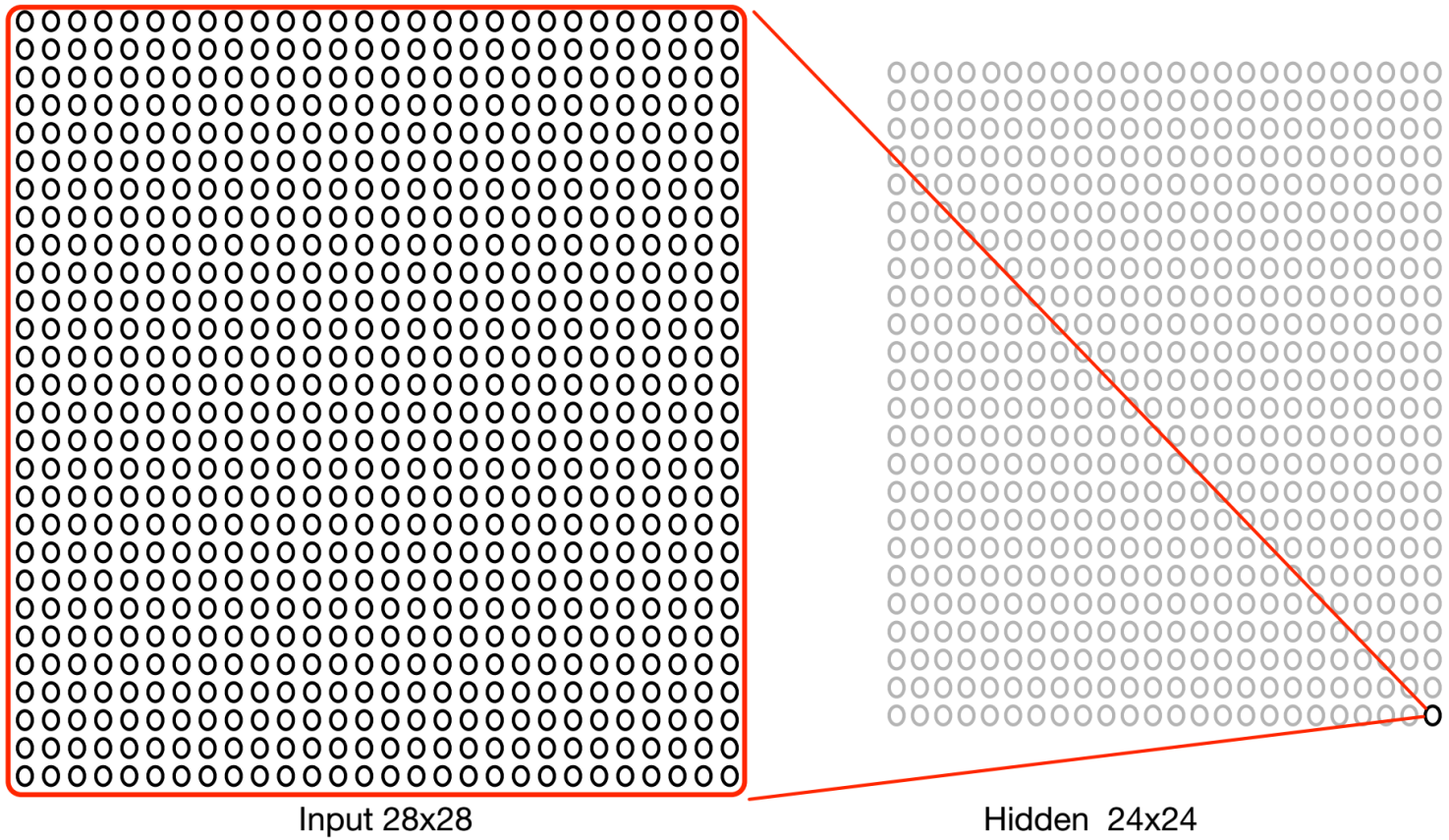
Traditional NNs



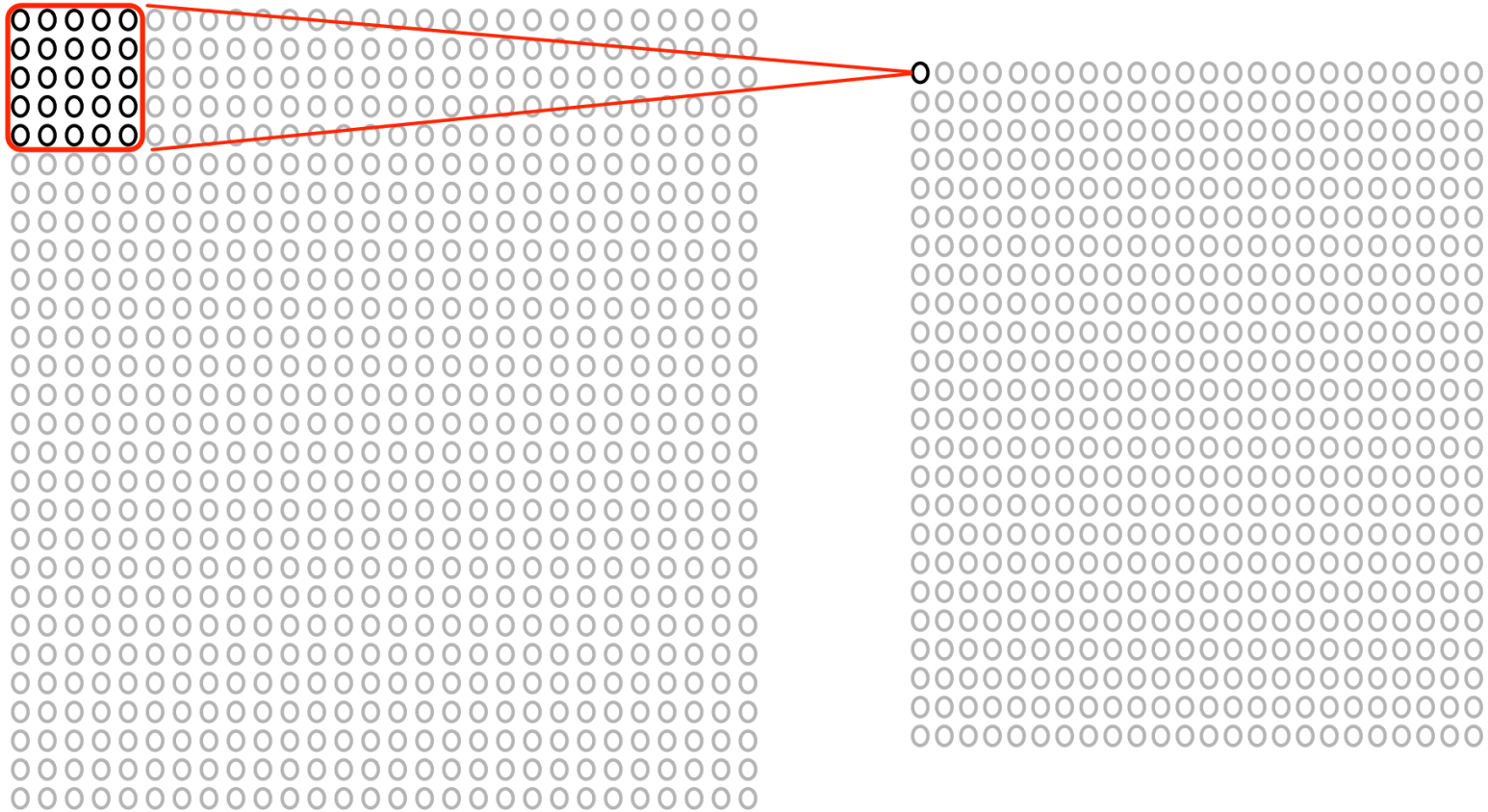
Traditional NNs



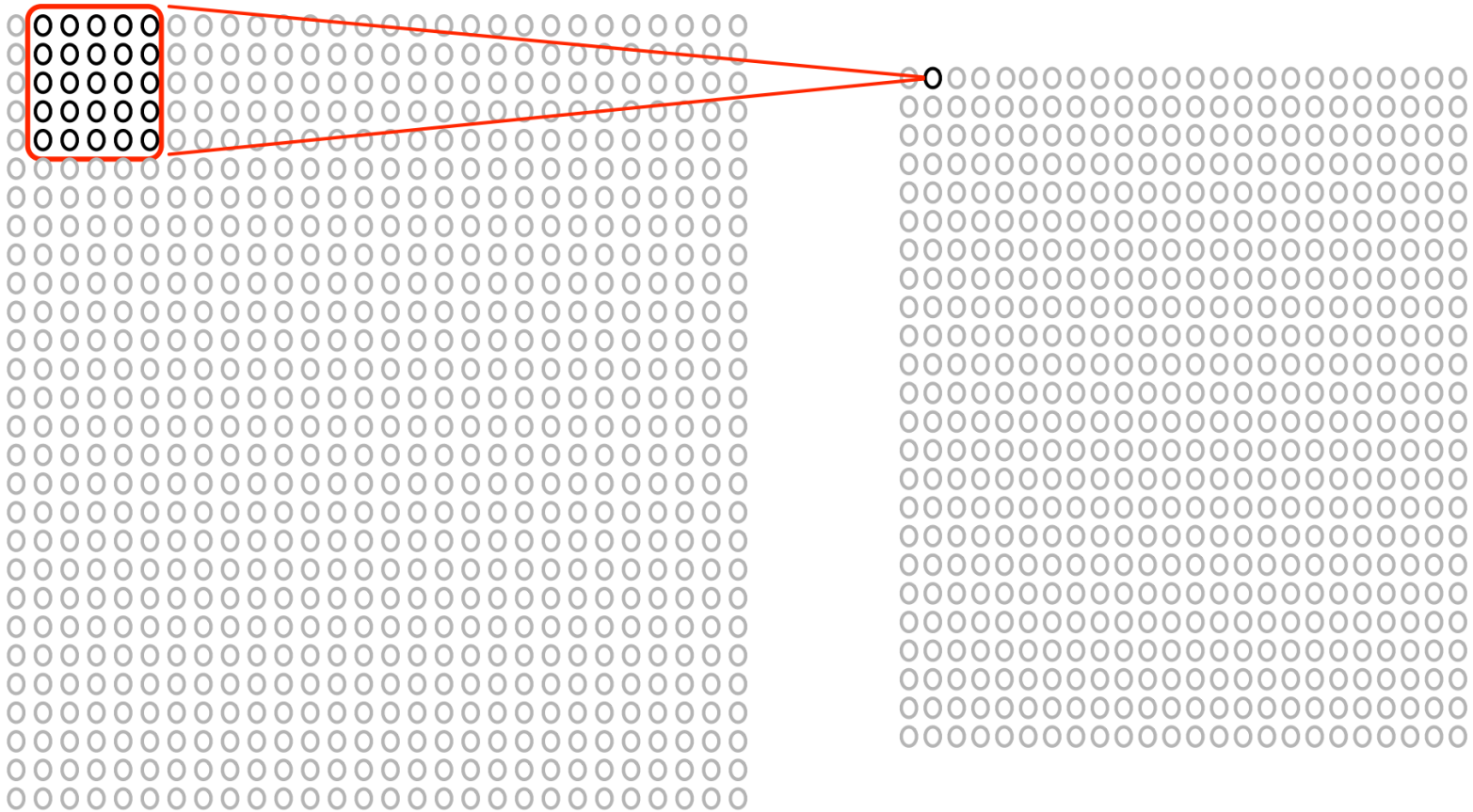
Traditional NNs



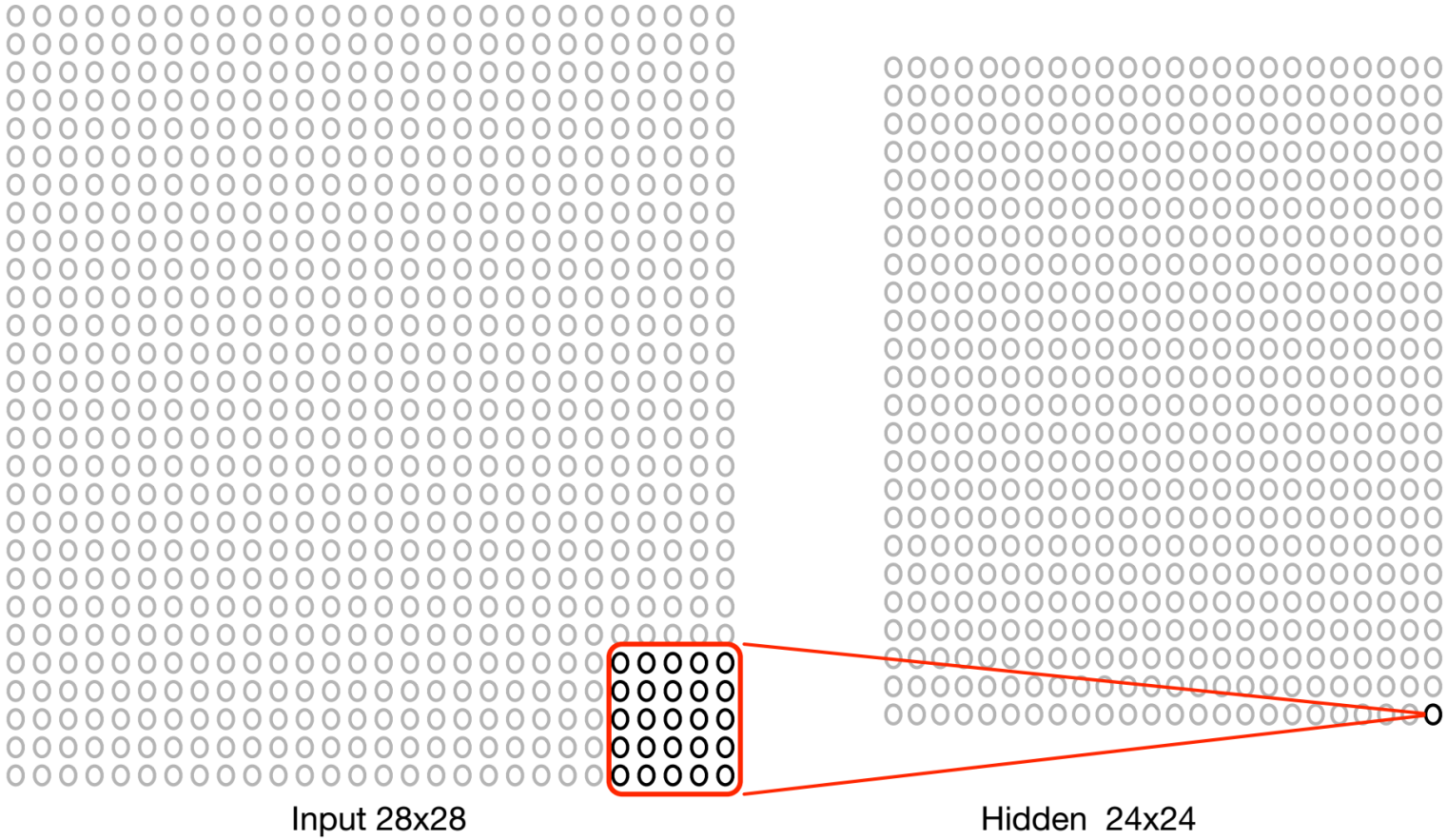
CNNs

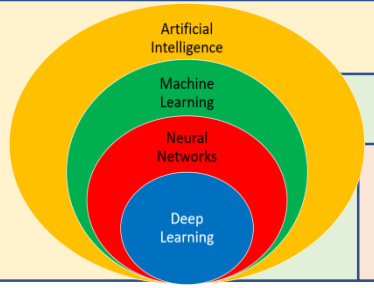


CNNs

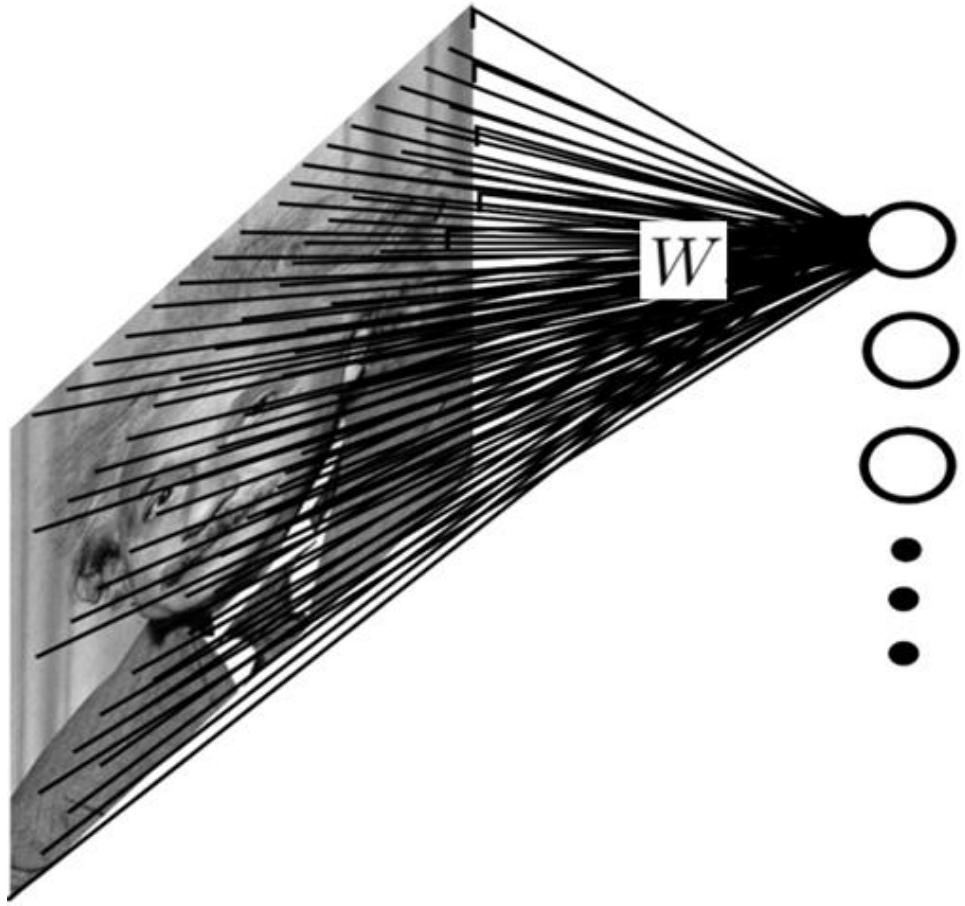


CNNs





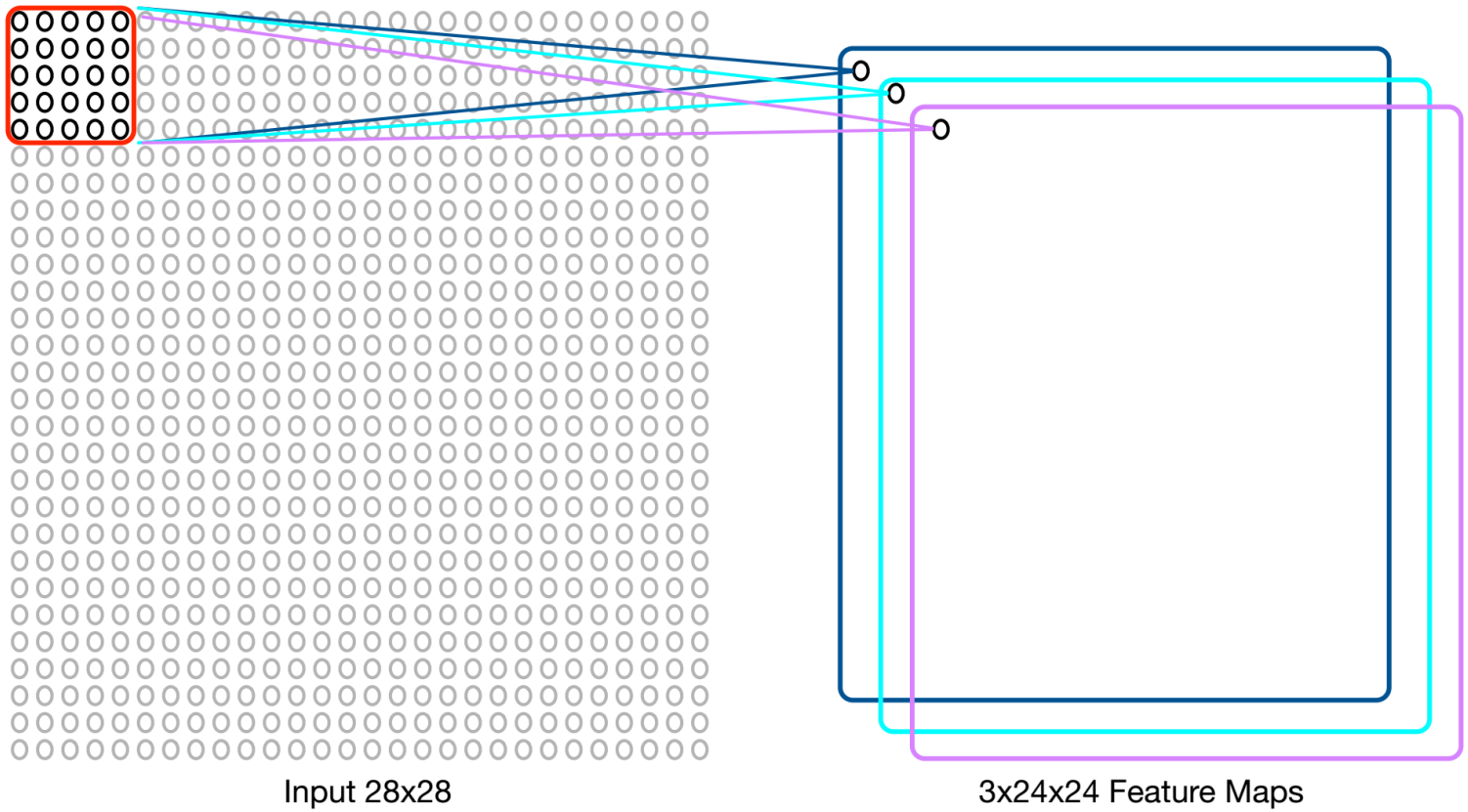
CNNs



3_0	3_1	2_2	1	0
0_2	0_2	1_0	3	1
3_0	1_1	2_2	2	3
2	0	0	2	2
2	0	0	0	1

12.0	12.0	17.0
10.0	17.0	19.0
9.0	6.0	14.0

CNNs



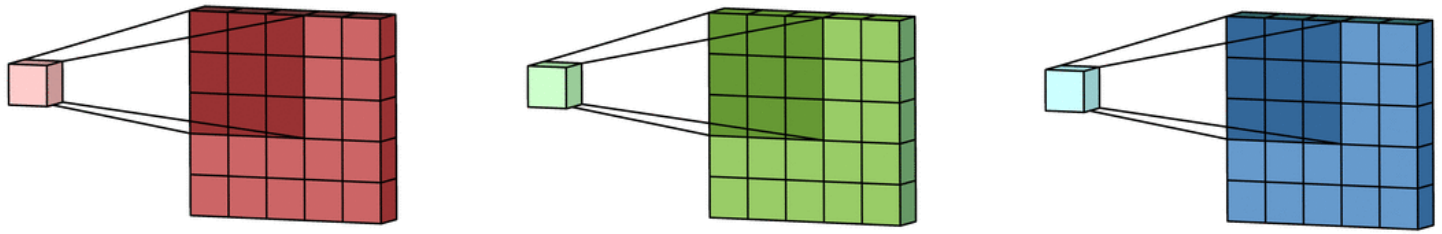
The multi-channel version

Red

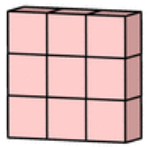
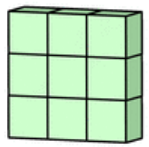
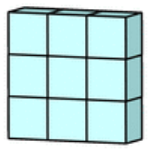
Green

Blue

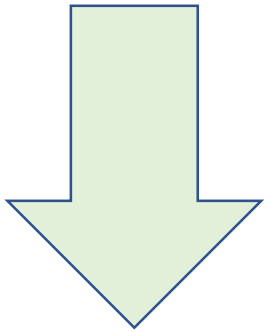
The multi-channel version



The multi-channel version

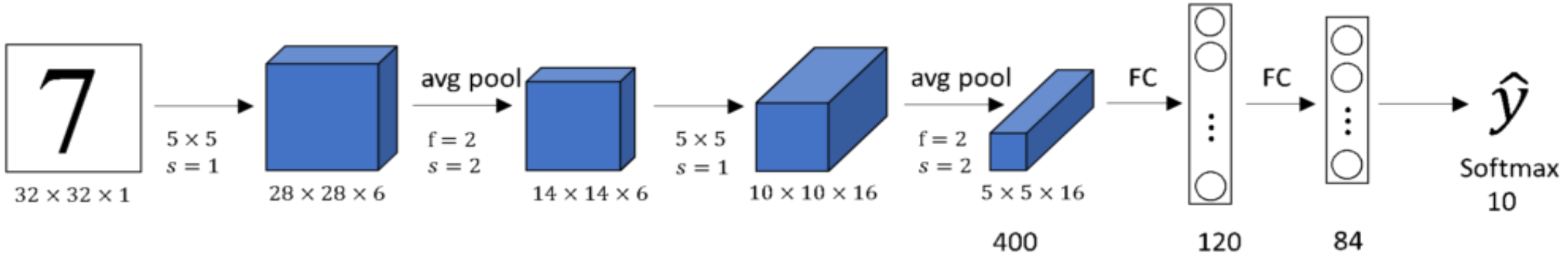




Convolutions are still linear transforms!

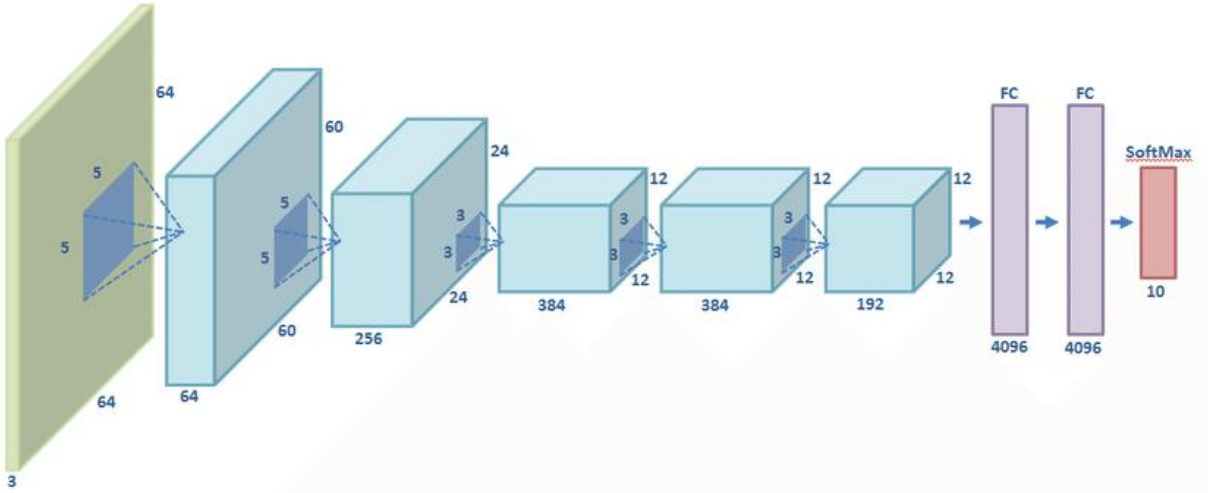


Using Fully Connected Layers for adding non-linearity!

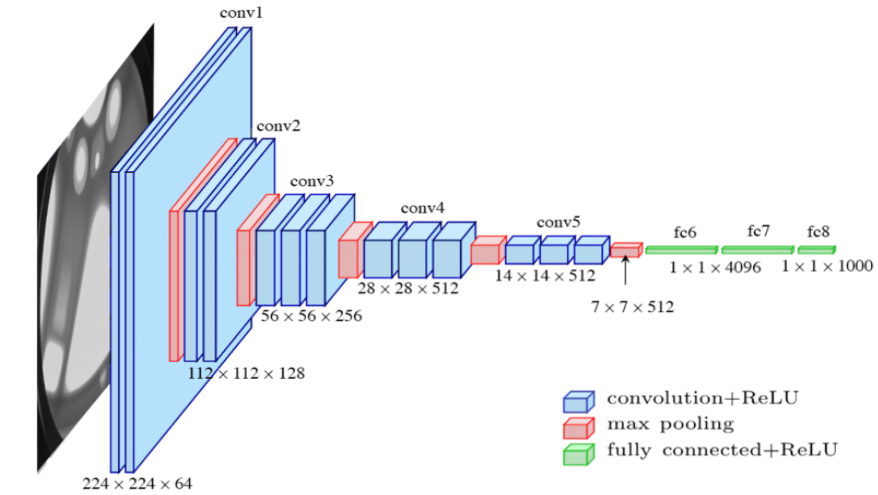
LeNet−5!



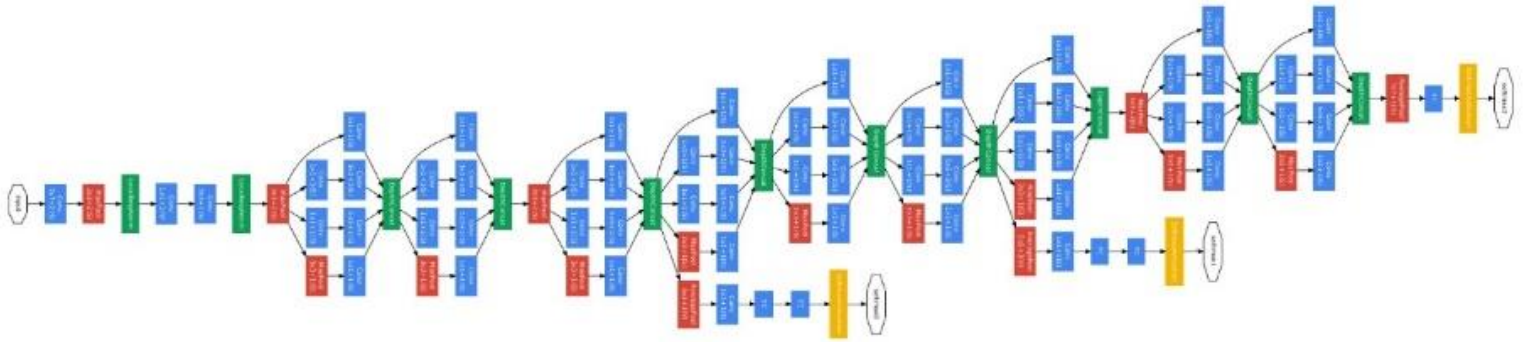
AlexNet!



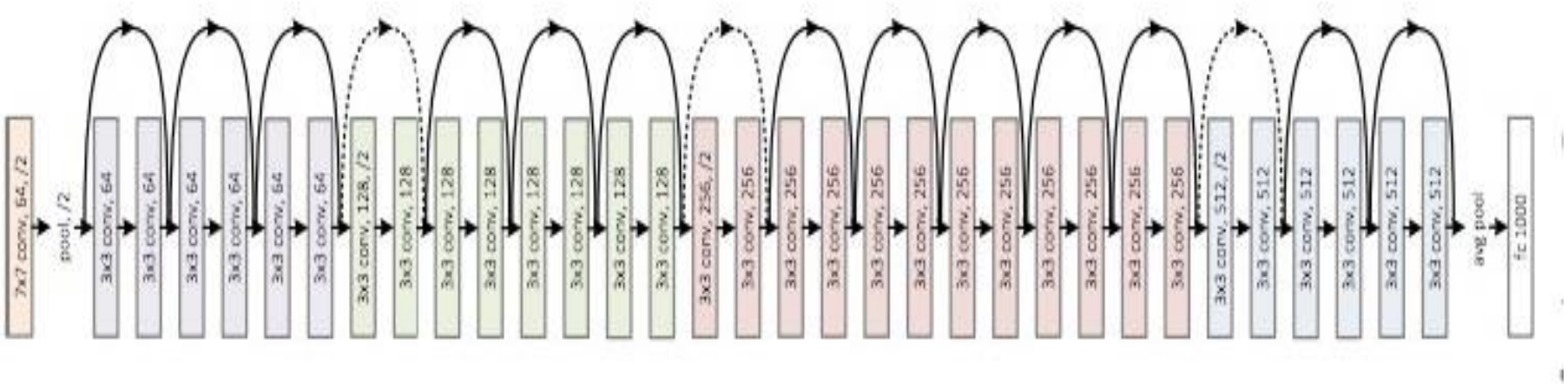
VGG16 and VGG19!

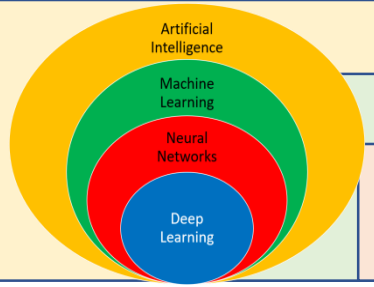


GoogleNet (Inception v1)!



ResNet50!


7x7 conv, 64, /2
pool, /2
3x3 conv, 64
3x3 conv, 128, /2
3x3 conv, 128
3x3 conv, 256, /2
3x3 conv, 256
3x3 conv, 512, /2
3x3 conv, 512
avg pool
fc 1000



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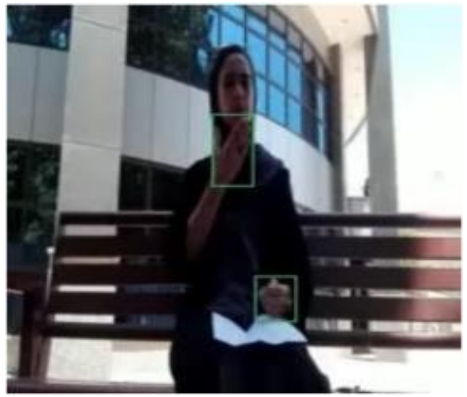
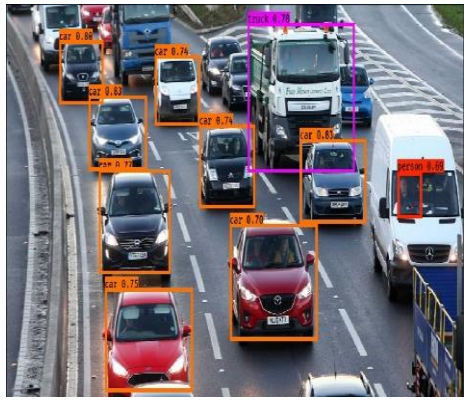
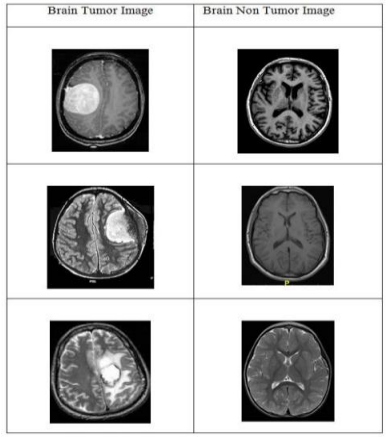
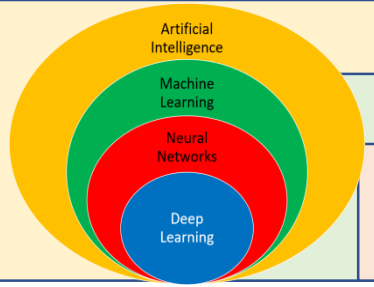
Applications!









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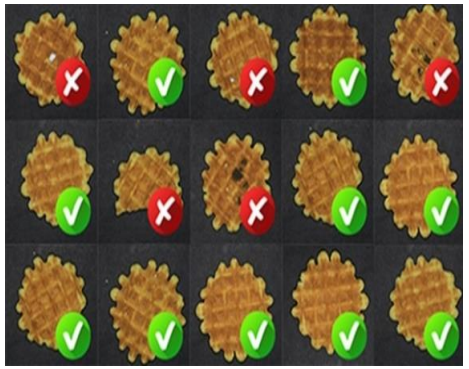
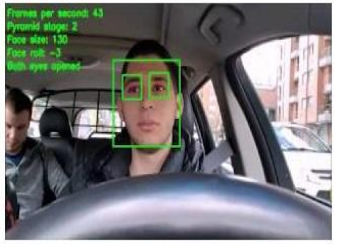
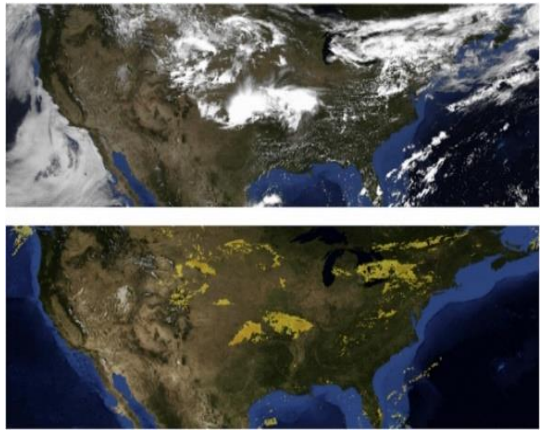
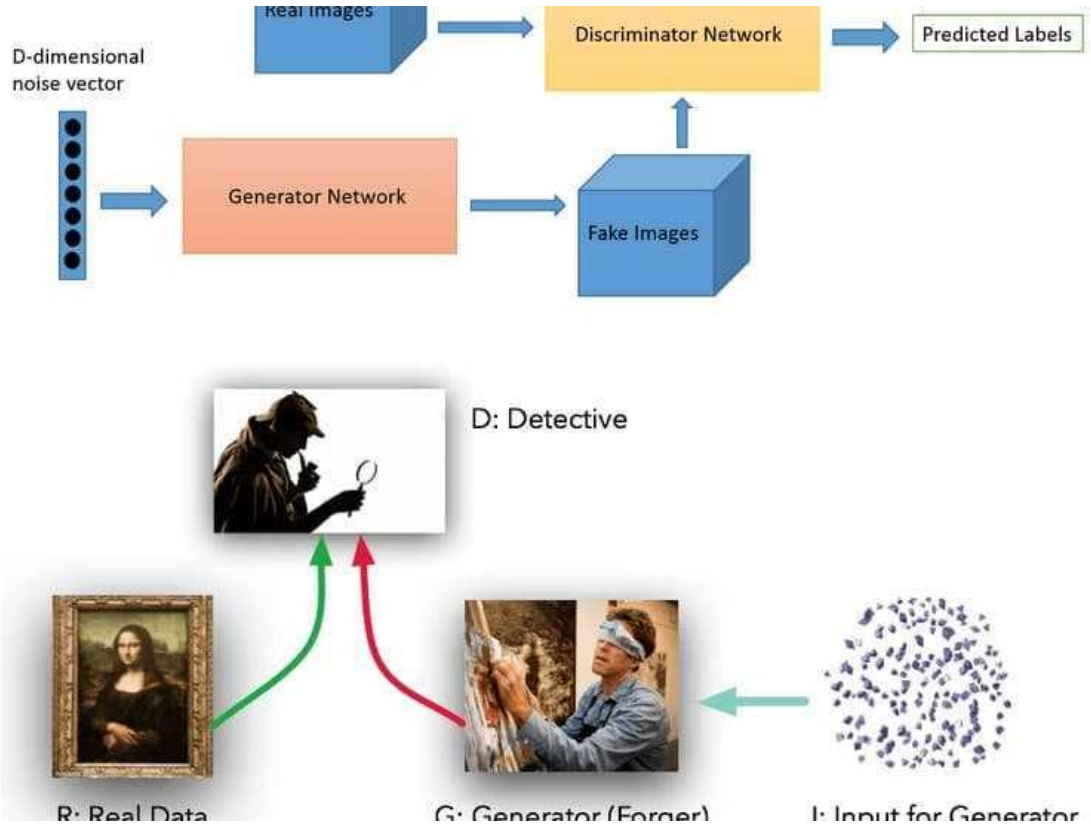
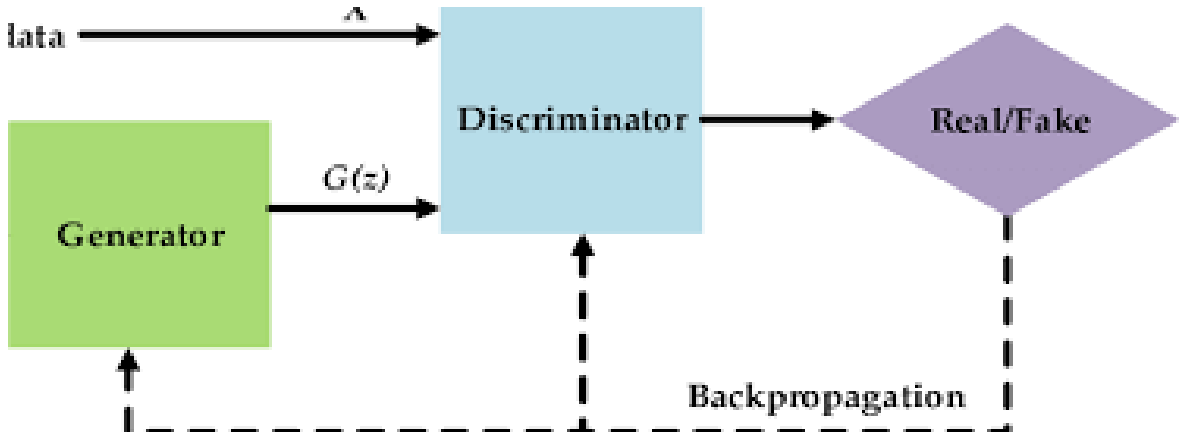




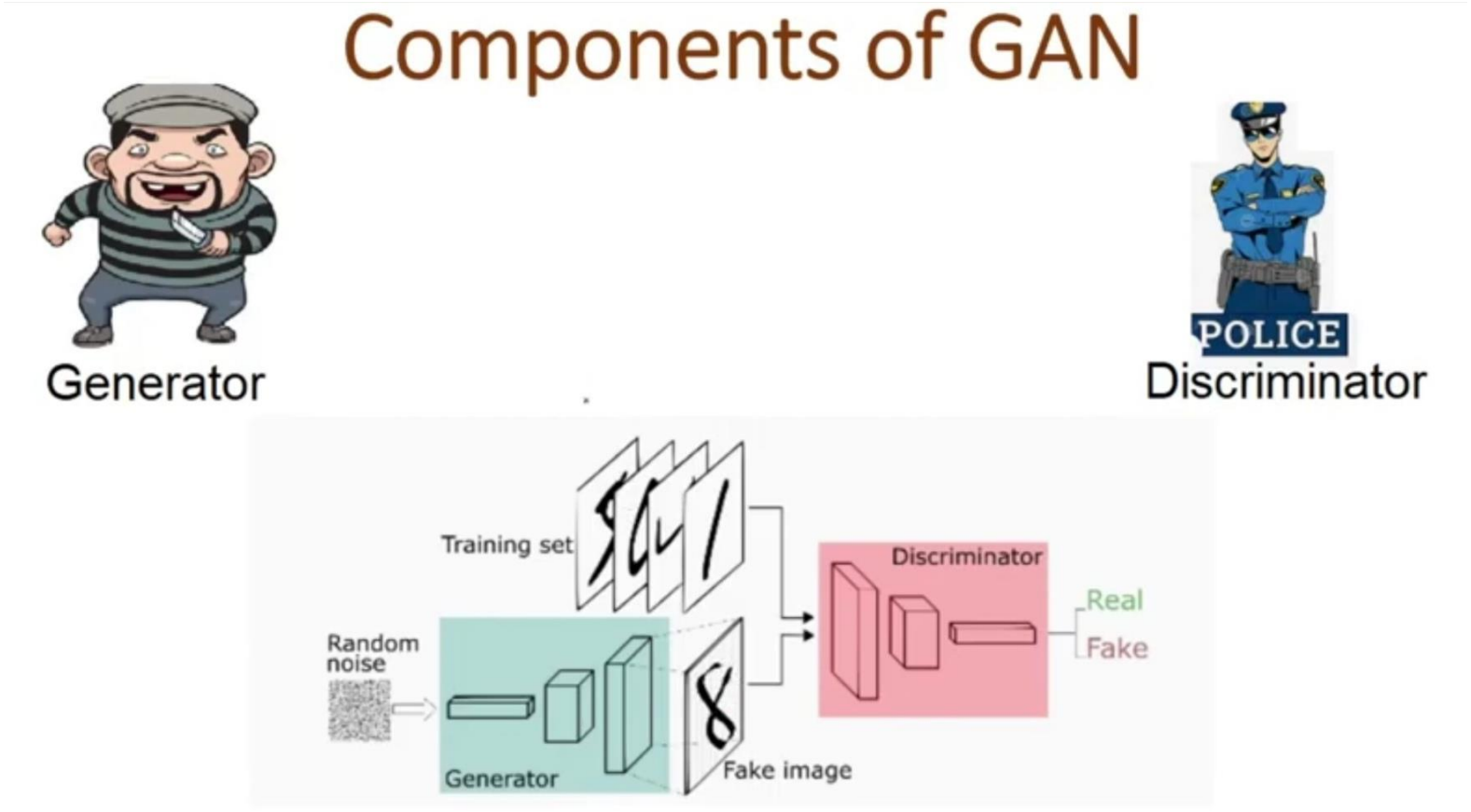


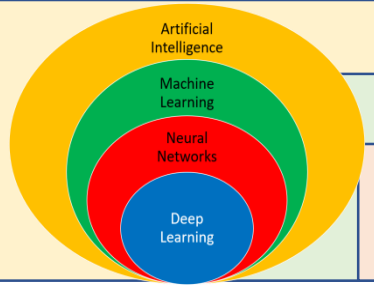
Generative Adversarial Network (GAN)





Generative Adversarial Network (GAN)





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Generative Adversarial Network (GAN)

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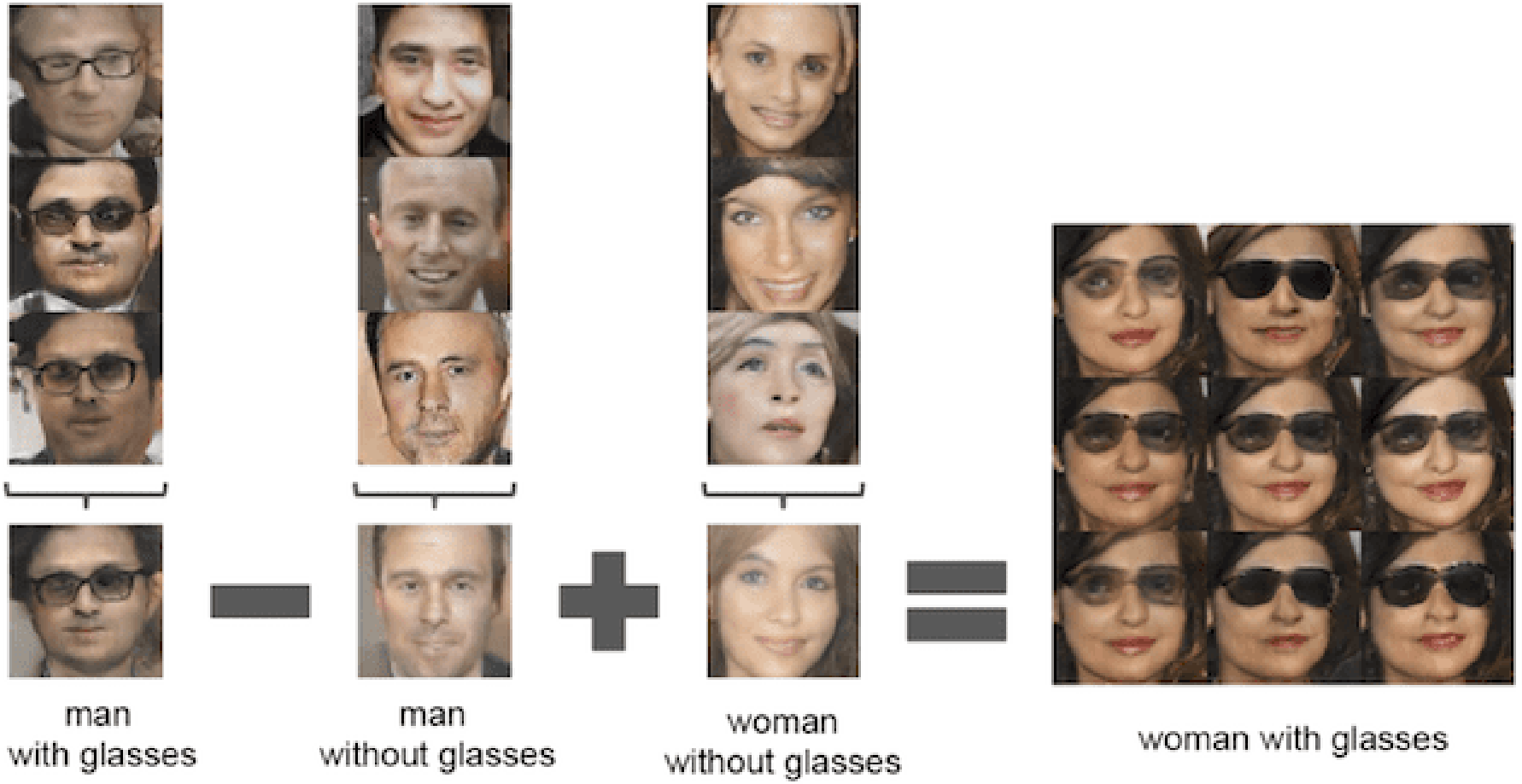

Generative Adversarial Network (GAN)

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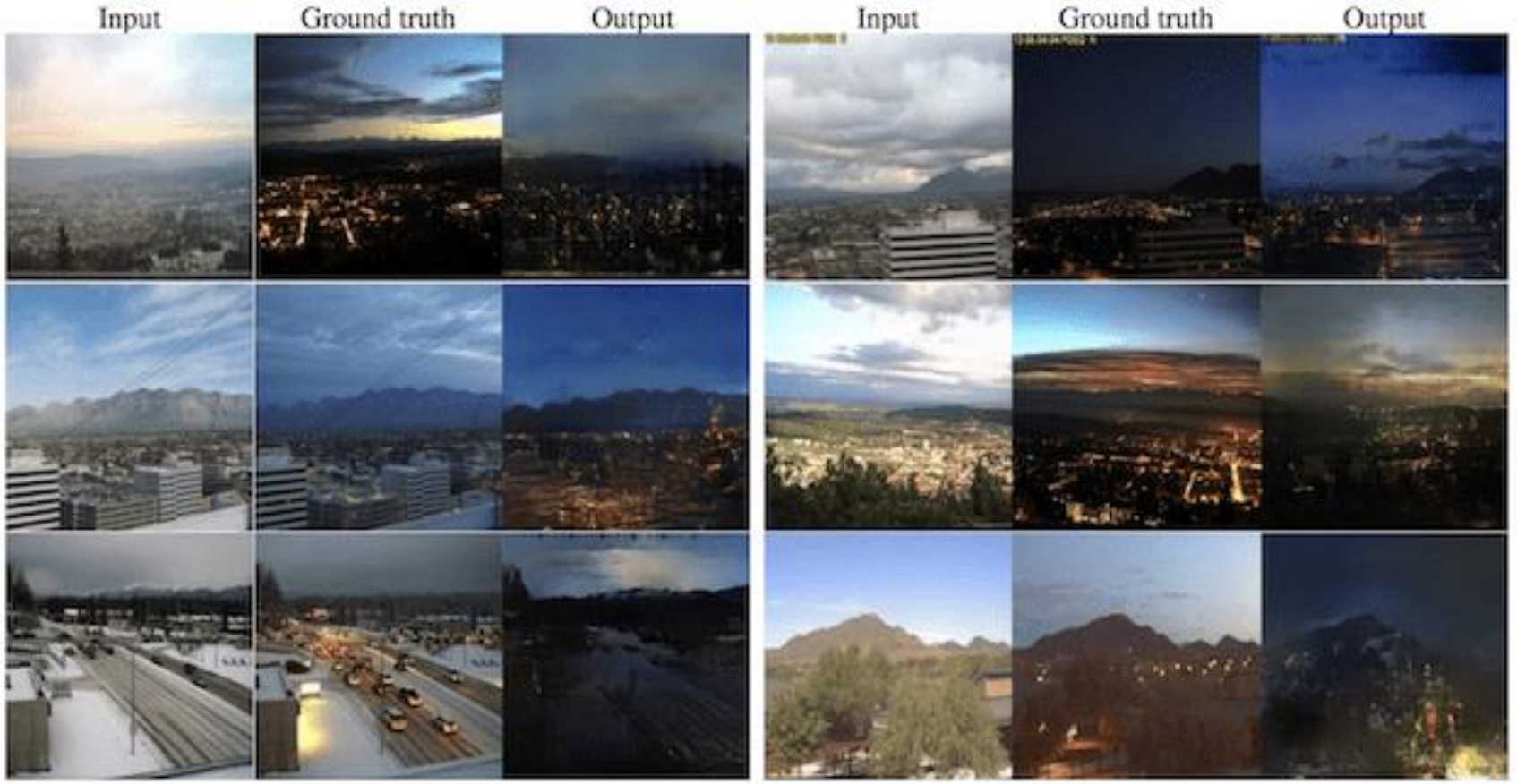


Generative Adversarial Network (GAN)

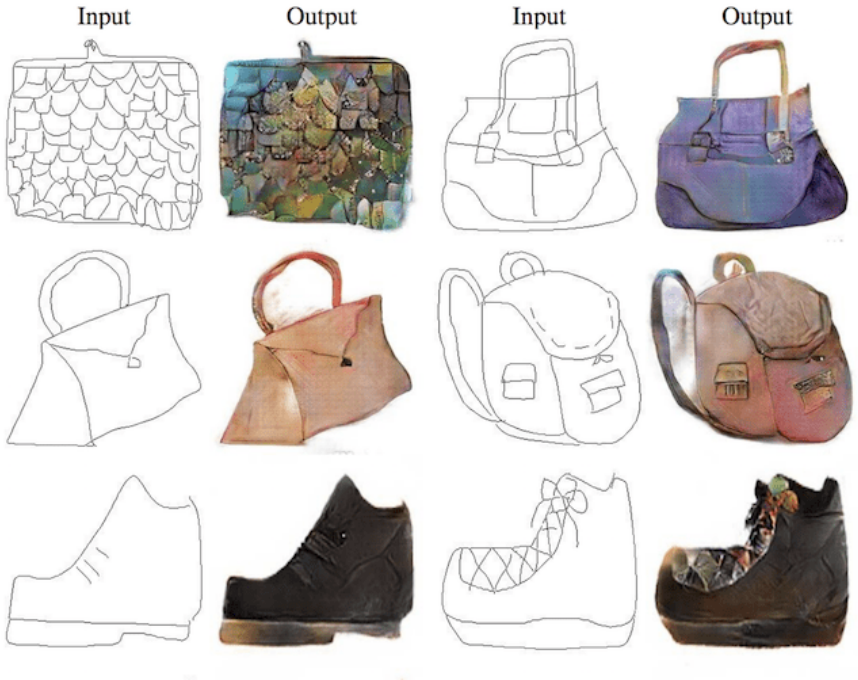
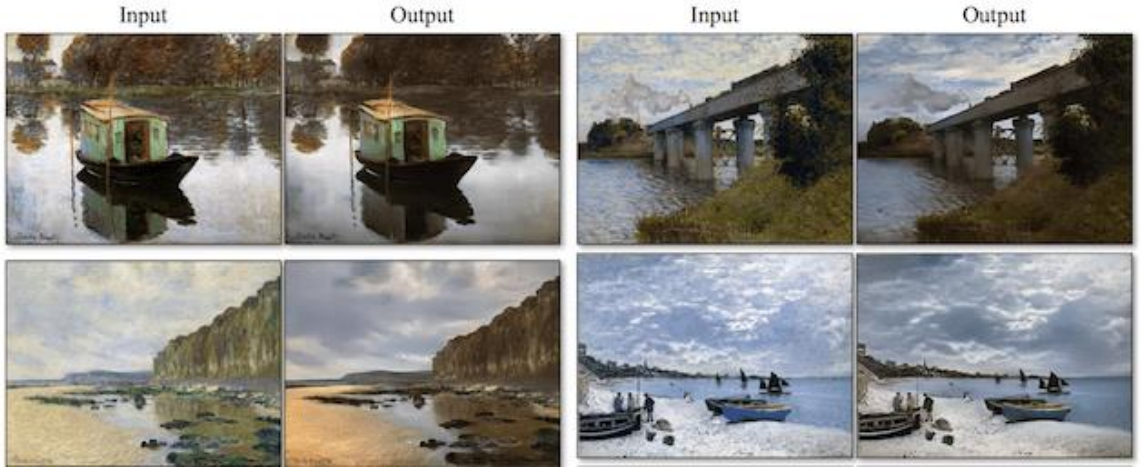
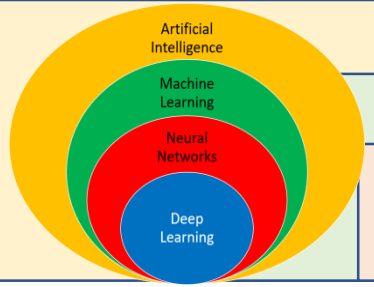


Image to Image Translation



Translation from photograph to artistic painting style.



Artificial Intelligence (AI)

Machine Learning (ML)

Neural Networks (NNs)

Deep Learning (DL)

Generative Adversarial Network (GAN)

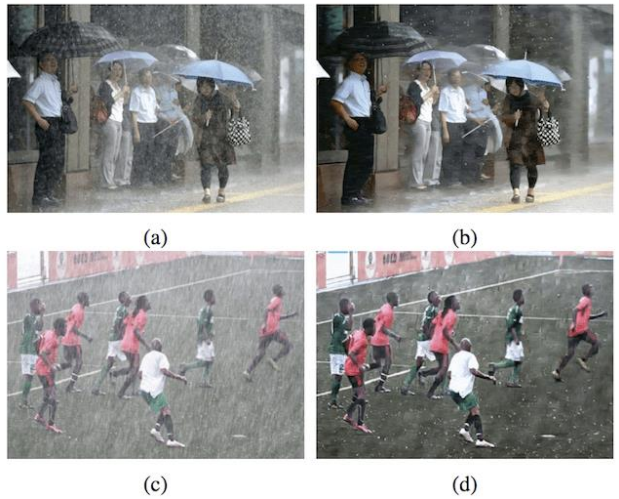
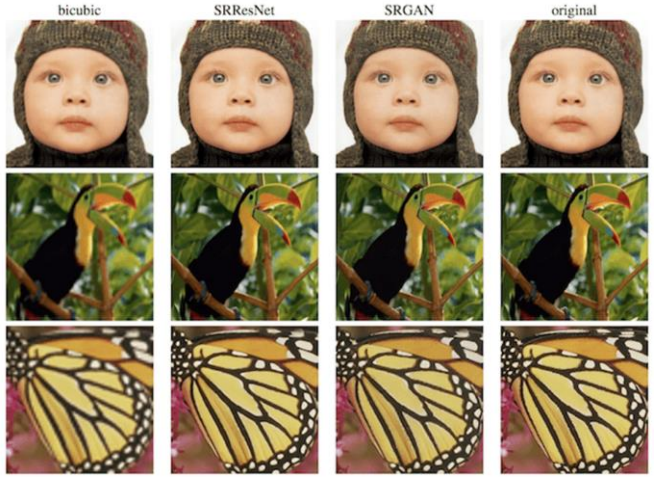


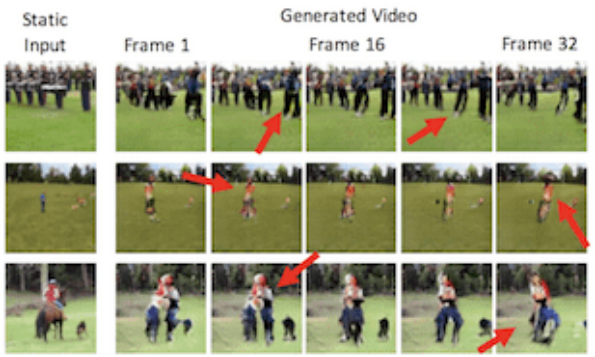
Image Edition (Remove or add an object)



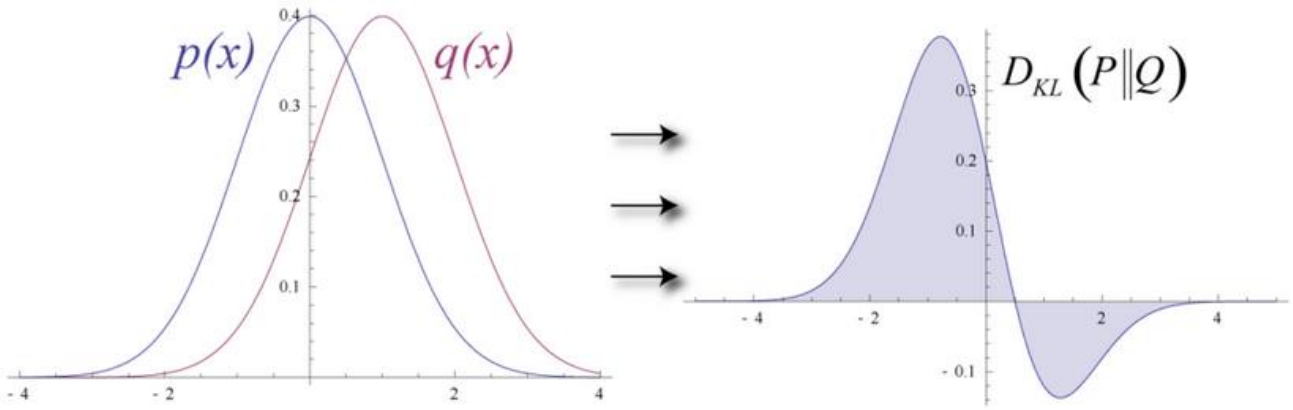
Super-resolution

Image inpainting

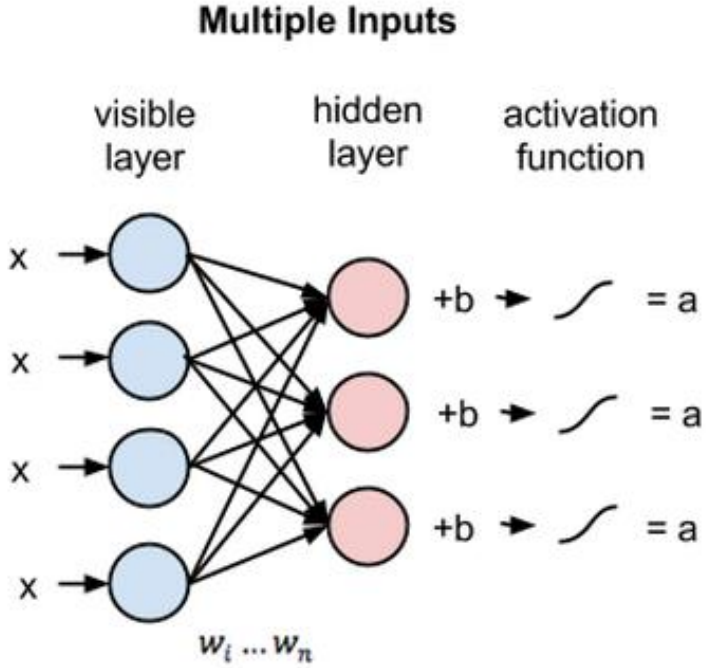
Video prediction



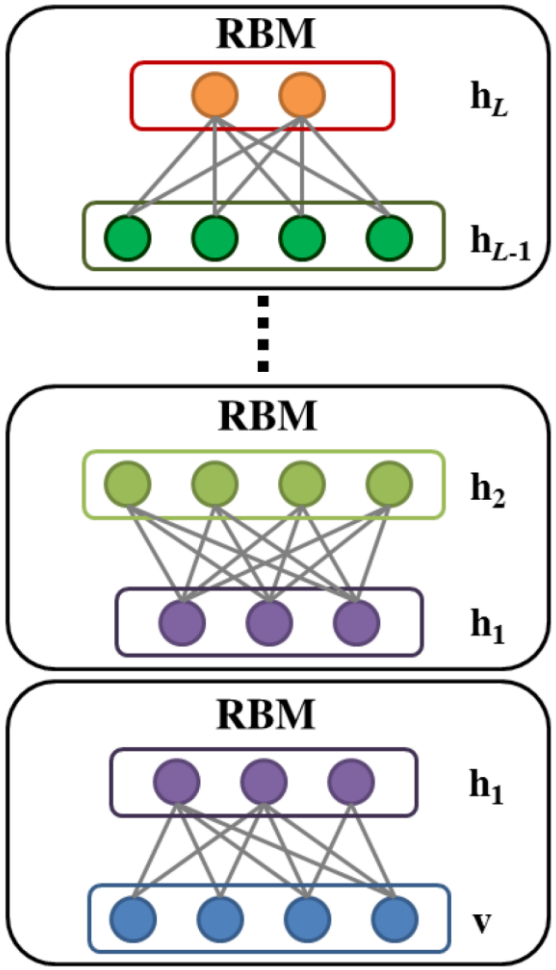
Restricted Boltzmann Machine (RBM)



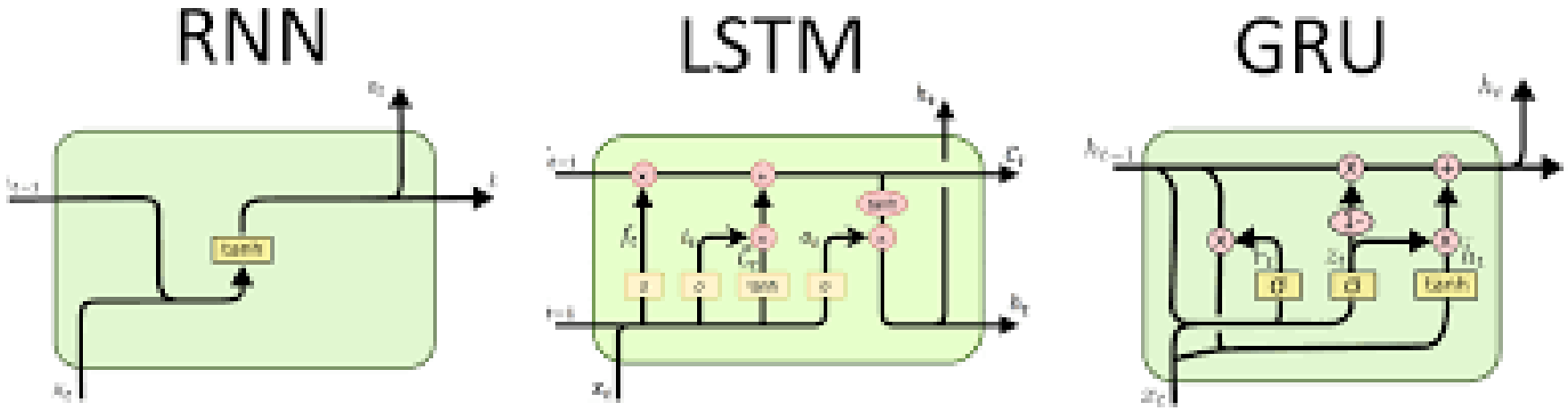
input



Deep Belief Network (DBN)



RNN, LSTM, and GRU

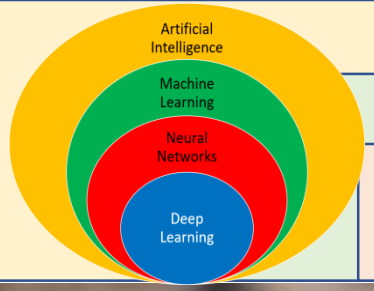


RNN, LSTM, and GRU

- For some classes of data, the order in which we receive observations is important. As an example, consider the two following sentences:

- "I'm sorry... it's not you, it's me."
- "It's not me, it's you... I'm sorry."

- These two sentences are communicating quite different messages, but this can only be interpreted when considering the sequential order of the words.



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