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Artificial Intelligence

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What do you know about AI?

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Artificial Intelligence

Artificial Intelligence is the **science** and **art** of making computers **smart**!

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Why now!

Data is everywhere!

Cool gamers!!

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AI is around you!

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AI Workflow

Problem Statement

Data Collection → Data Pre-processing

AI Modelling

Tests & Validation → Deployment

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Machine Learning

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Problem Statement

Study environment

Discipline

Previous score

Predict Students' Academic Performance ?/20

Extracurricular Activity

Well-being

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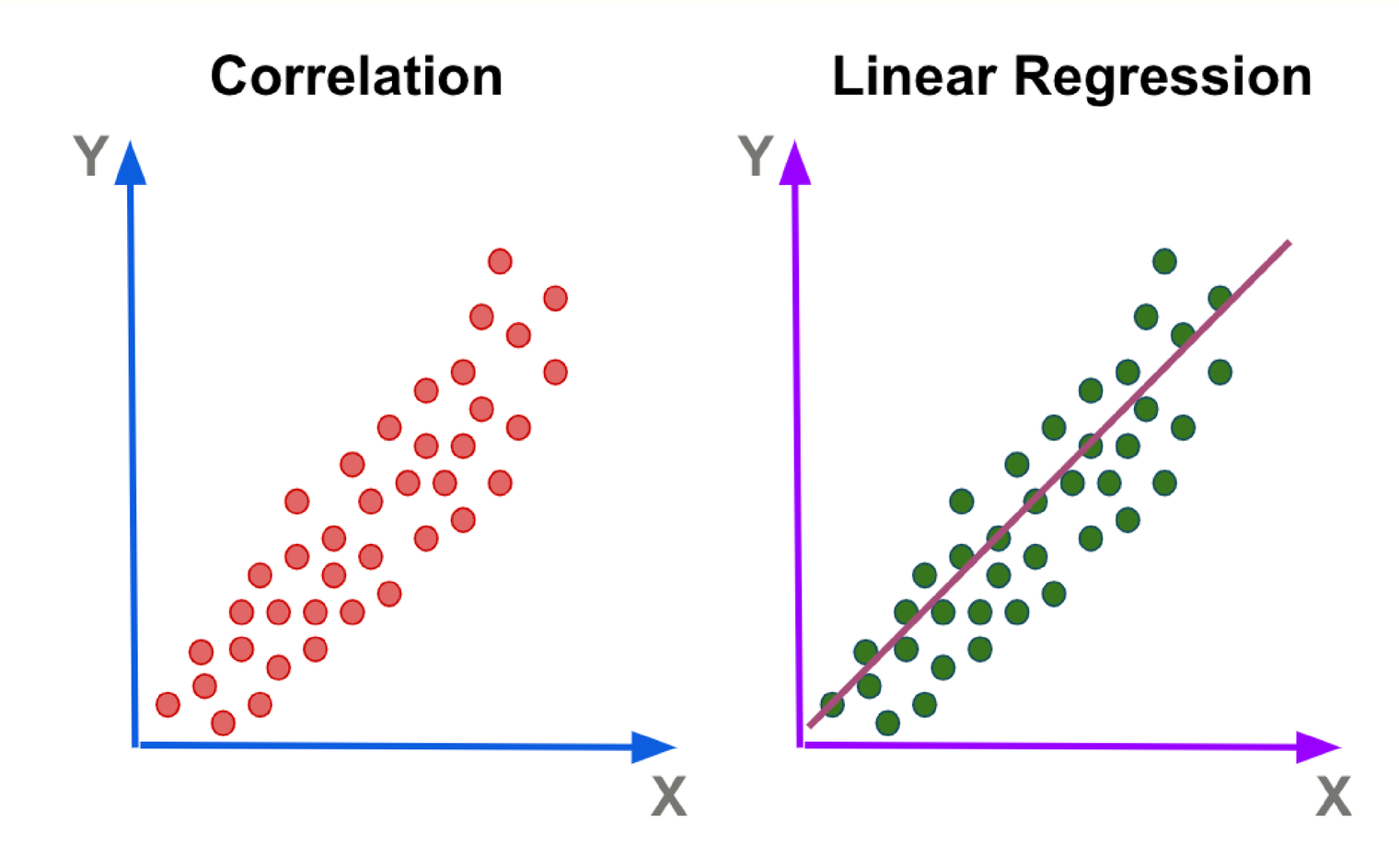
Linear Regression



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Formulation

Feature Vector (X) = [x1, x2, x3, ... , xn]

Parameters (W, b) = [w1, w2, w3, ... , wn], b

Prediction (y) = w1*x1 + w2*x2 + ... + wn*xn + b

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Intuition

The **prediction** will be evaluated by **weighting** every **feature** in our input additional to a **baseline** value

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How to become smart ?

BY MAKING MISTAKES ☺

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Loss function

$$\text{MSE} = \frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2$$

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How to become really smart ?

BY RUNNING DOWN THE HILL ☺

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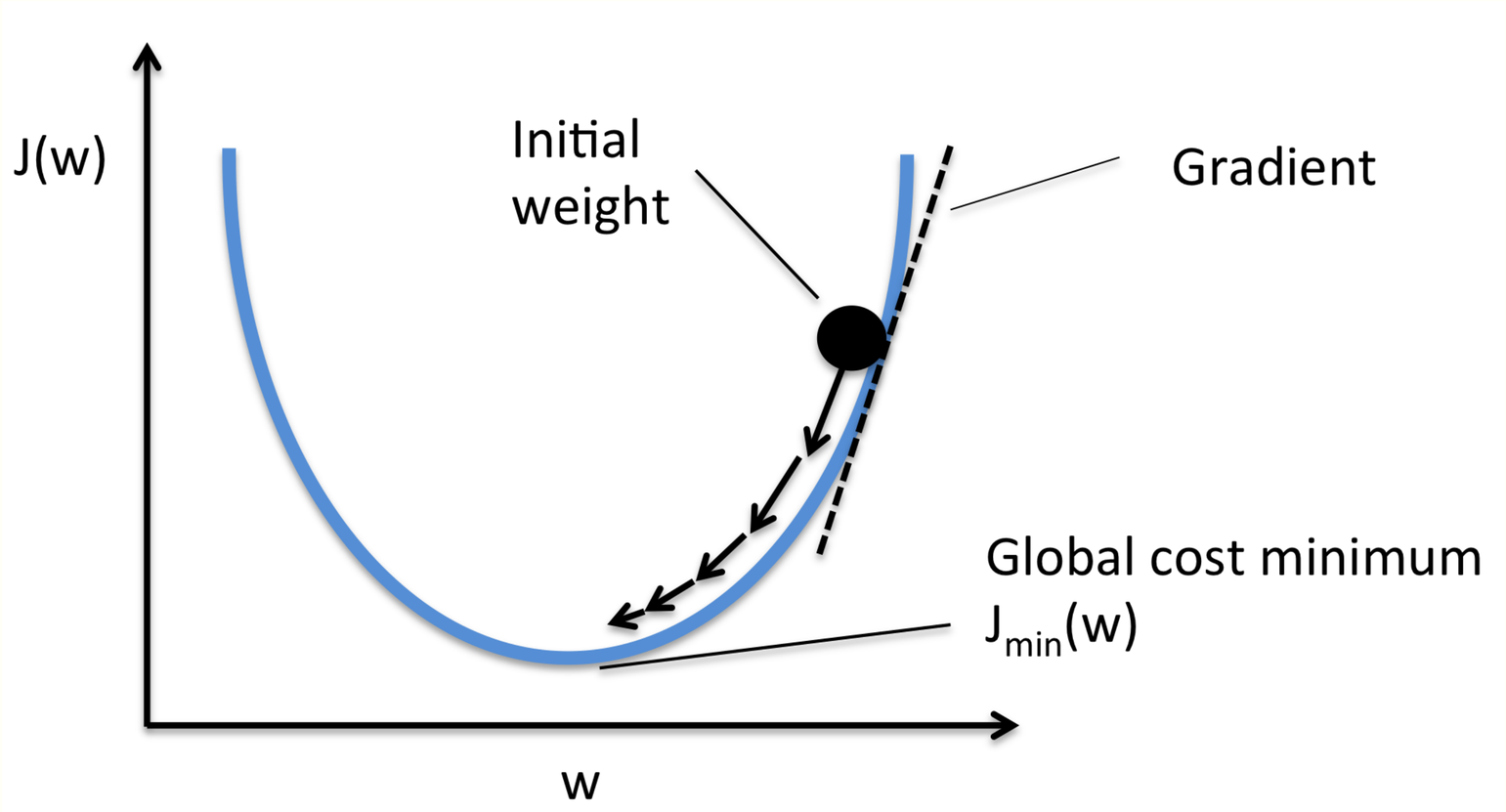
Gradient Descent



Everything together

- W, b initialized randomly, learning_rate
- For every epoch:
  - For every pair (X,y):
    - Prediction = WX + b
    - Loss = MSE(Y, Prediction)
    - Param(i) -= learning_rate x gradient

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Problem Statement

Study environment

Discipline

Previous score

Predict Success/Failure of a Student

Extracurricular Activity

Well-being

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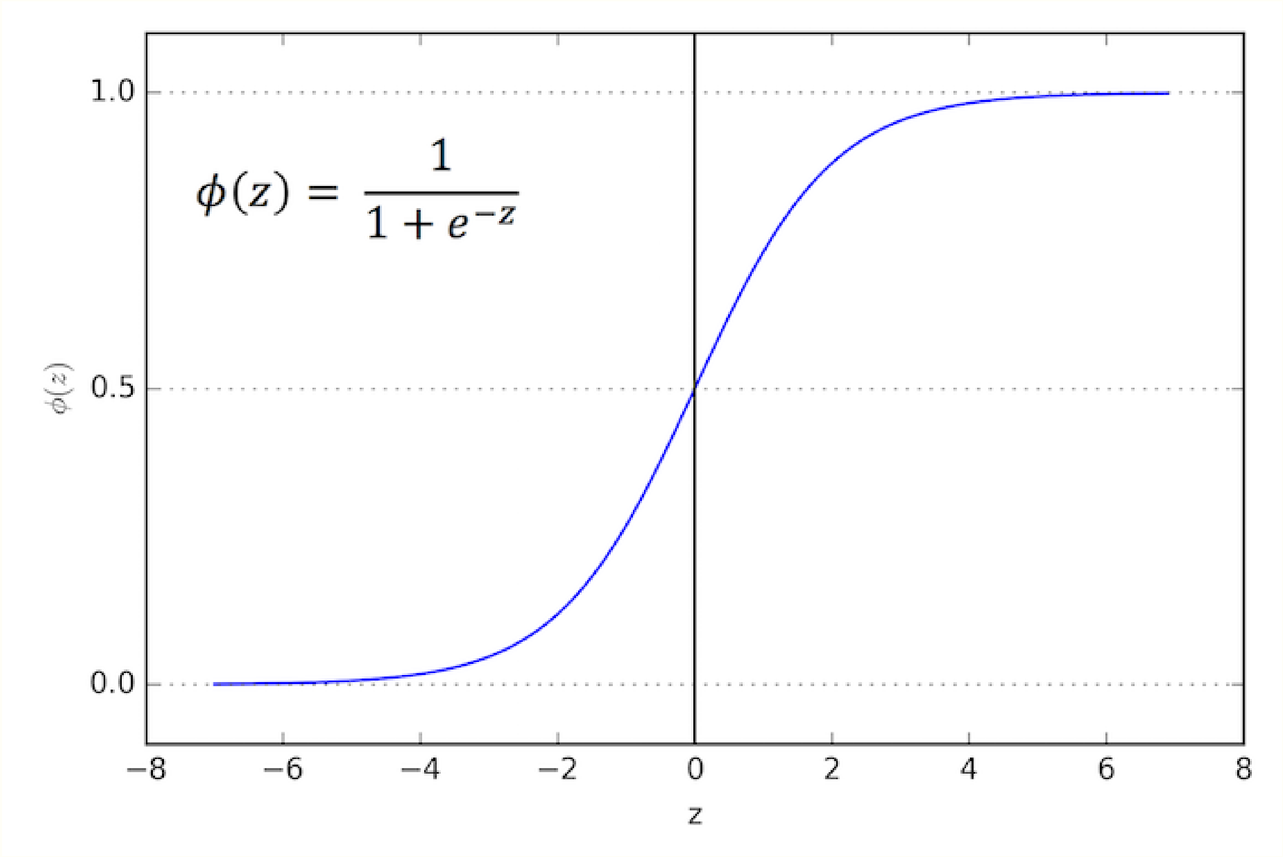
Logistic Regression



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Formulation

Feature Vector (X) = [x1, x2, x3, ... , xn]

Parameters (W, b) = [w1, w2, w3, ... , wn], b

Prediction (y) = sigmoid(w1*x1 + w2*x2 + ... + wn*xn + b)

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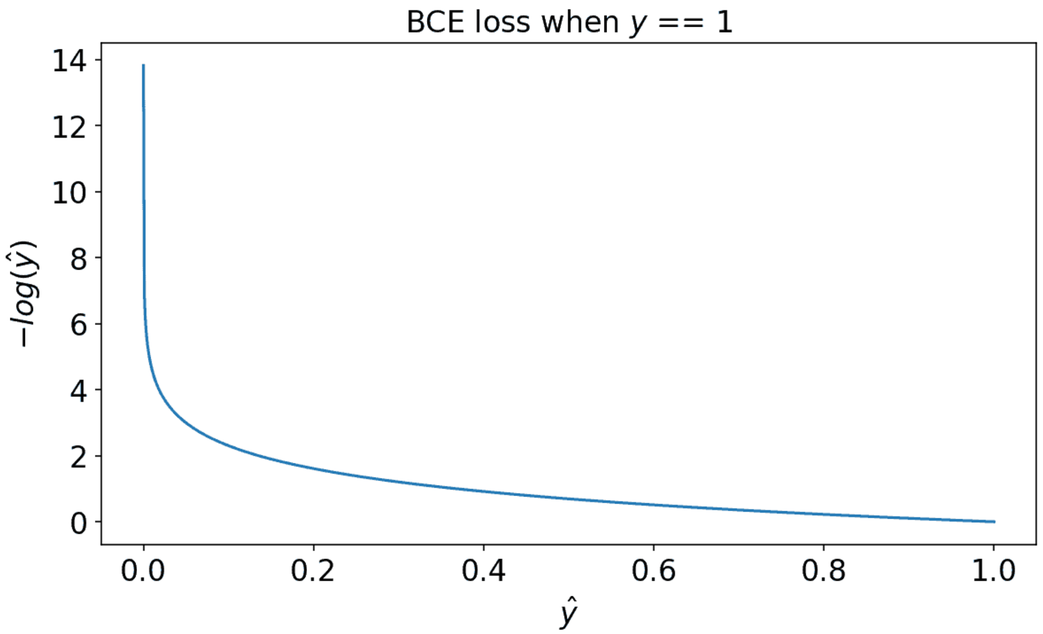
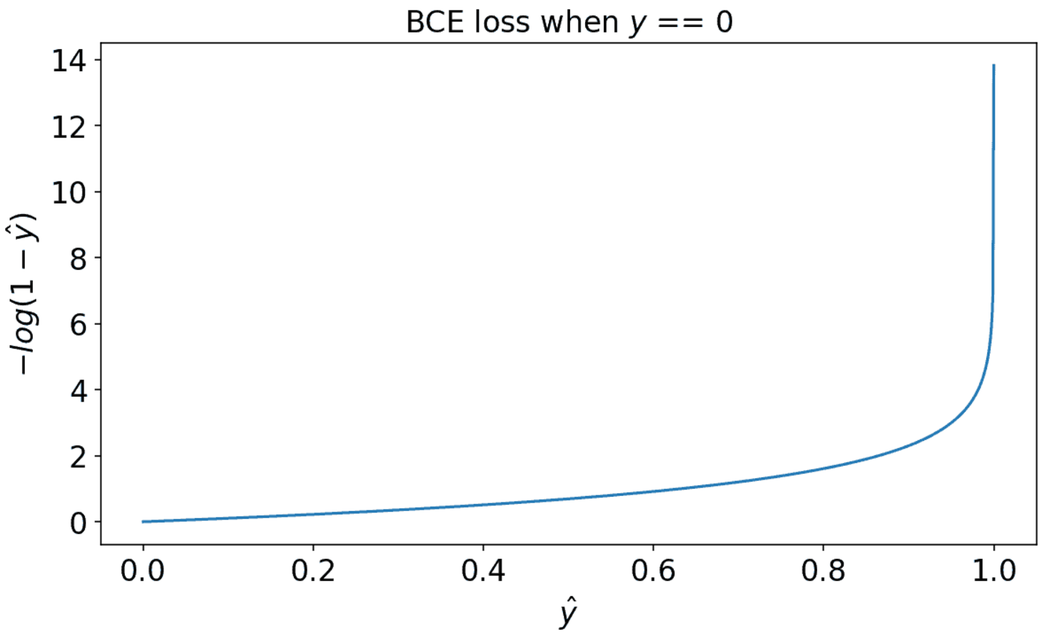
Loss function

$$L_{BCE} = -\frac{1}{n}\sum_{i=1}^{n}(Y_i \cdot \log \hat{Y}_i + (1 - Y_i) \cdot \log (1 - \hat{Y}_i))$$

Loss function

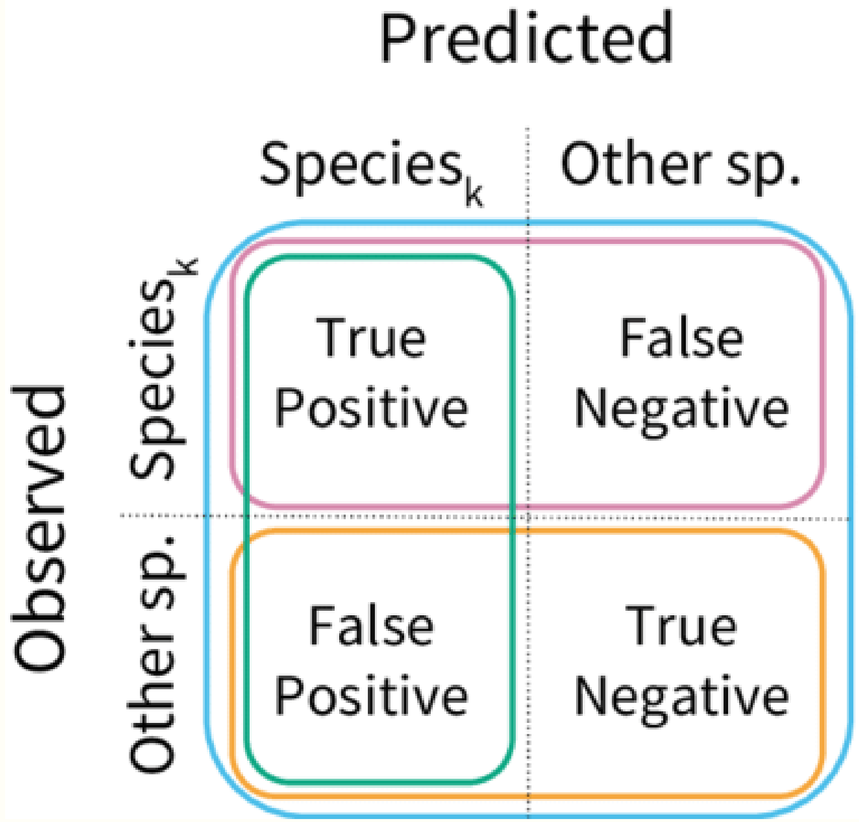




Gradient

$$\frac{\partial L(\boldsymbol{W})}{\partial \boldsymbol{W}} = \frac{\hat{\boldsymbol{y}} - \boldsymbol{y}}{\hat{\boldsymbol{y}}(1-\hat{\boldsymbol{y}})}\hat{\boldsymbol{y}}(1-\hat{\boldsymbol{y}})\boldsymbol{X} = (\hat{\boldsymbol{y}} - \boldsymbol{y})\boldsymbol{X} \qquad (12)$$

Classification Evaluation



$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{Specificity} = \frac{TN}{TN + FP}$$

$$\text{Precision} = \frac{TP}{TP + FP}$$

$$\text{Recall} = \frac{TP}{TP + FN}$$

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Deep Learning

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Deep Learning

Problems can become harder implying complex data patterns

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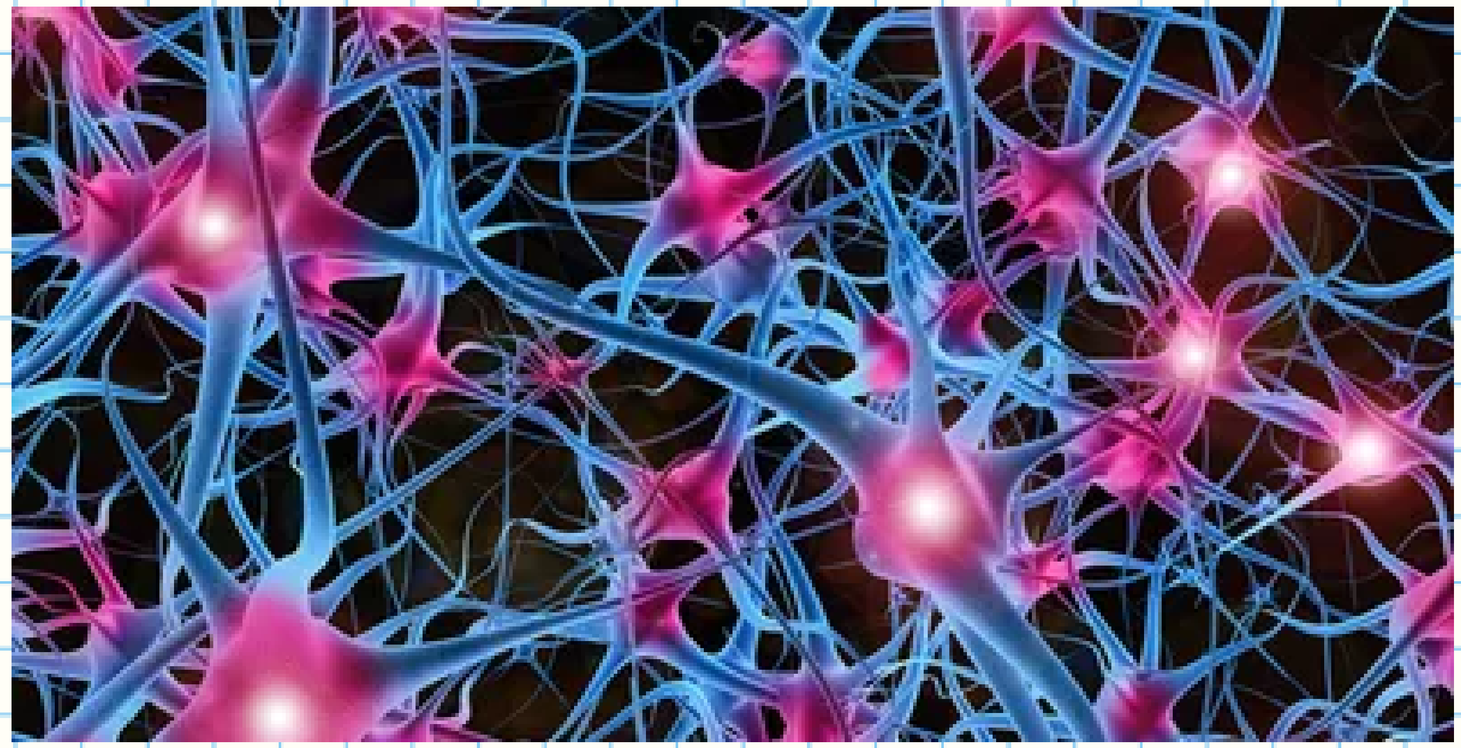
Biology ?!



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Neural Networks

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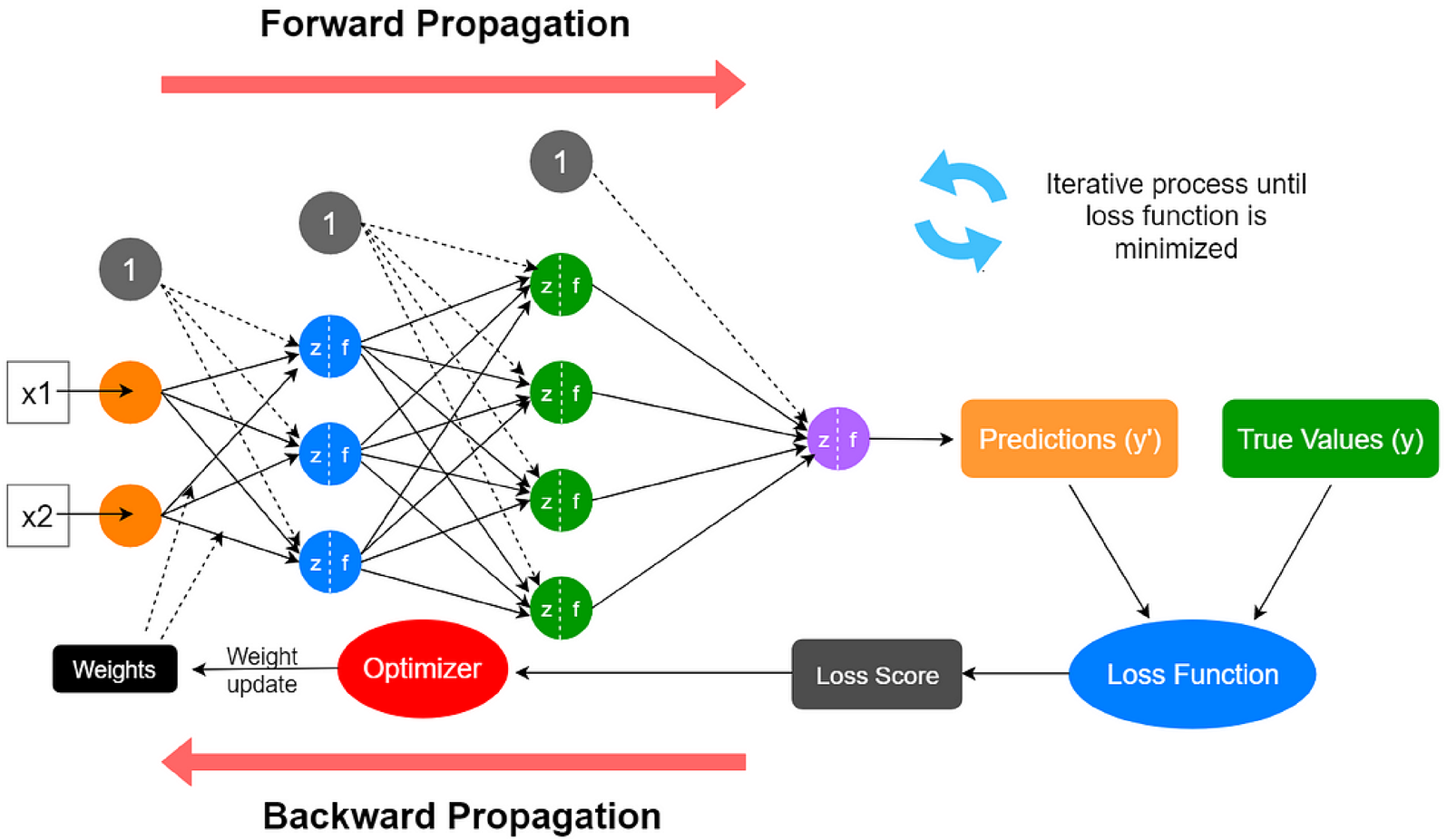
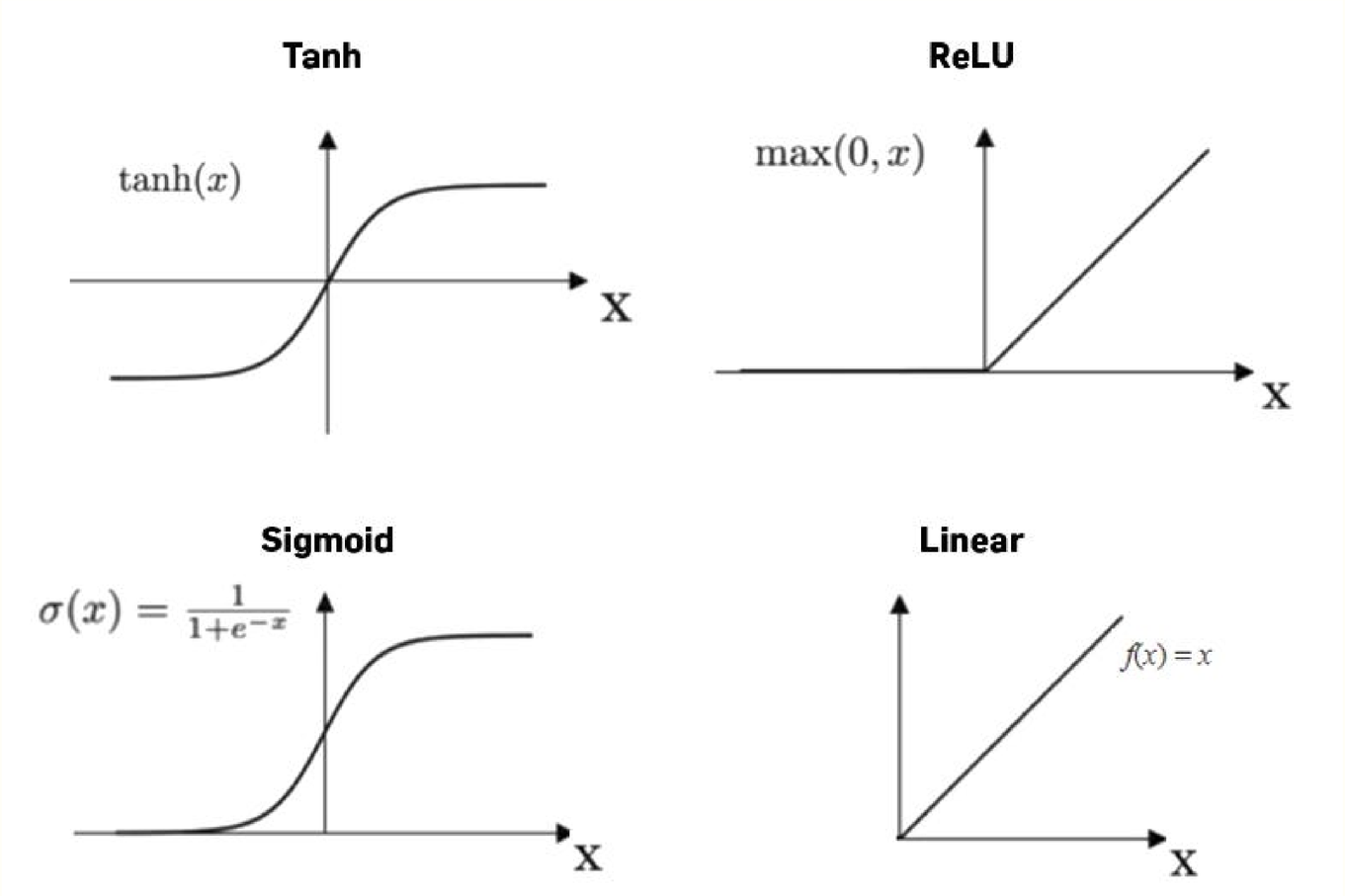
Neural Networks



Activation functions



Chain rule

$$\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$$

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Intuition

With deeper networks, computers can model very complex functions. Hence, they can understand the world!

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Computer Vision

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Computer Vision

Computers can now see!

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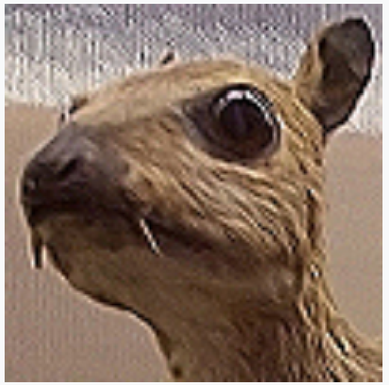
Image filters

Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	

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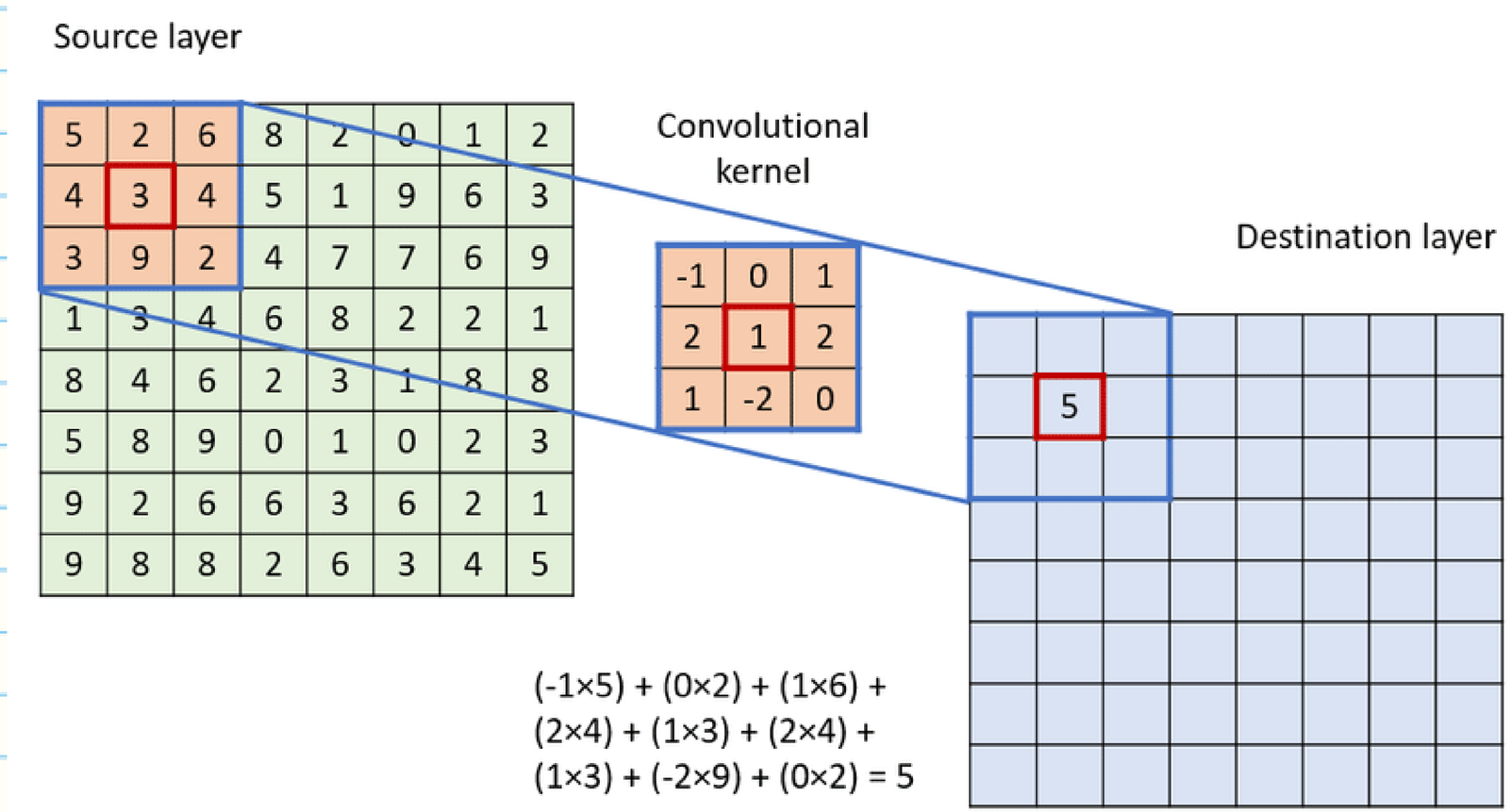
Convolution Operation



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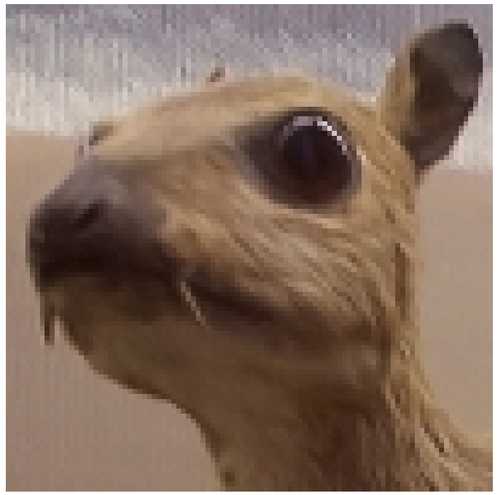
Convolution kernels

Input image



Convolution Kernel

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

Feature map

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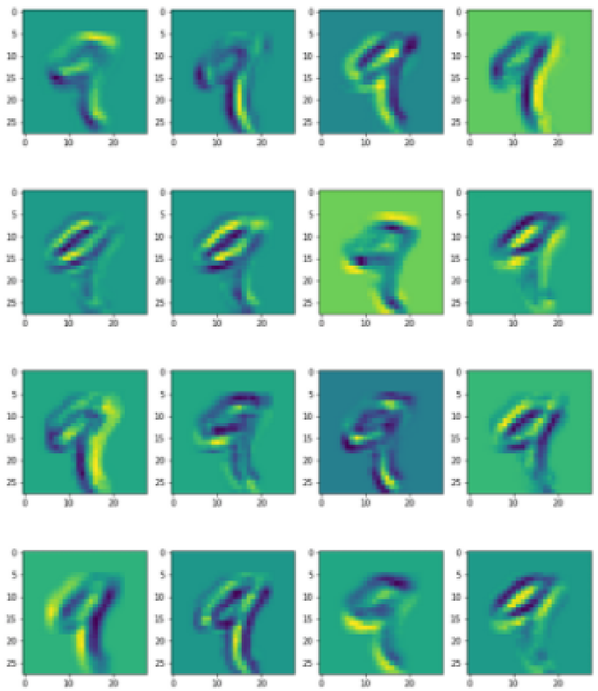
Convolutional Layers

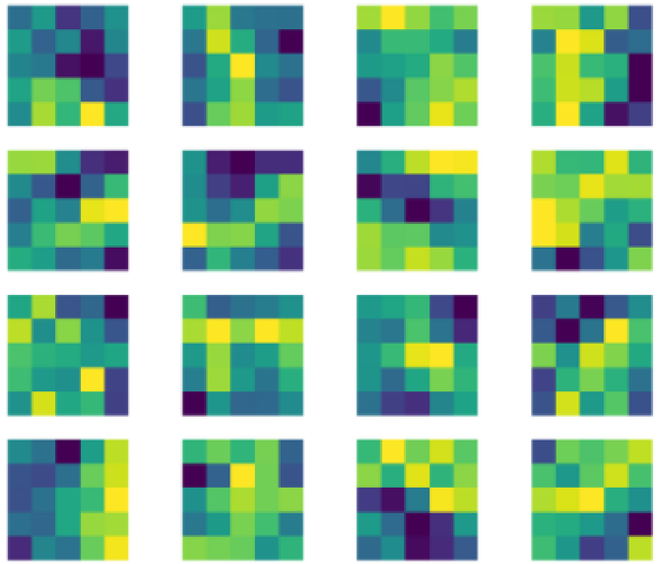
GDG Algiers

Convolutional layers

Feature map



Filters



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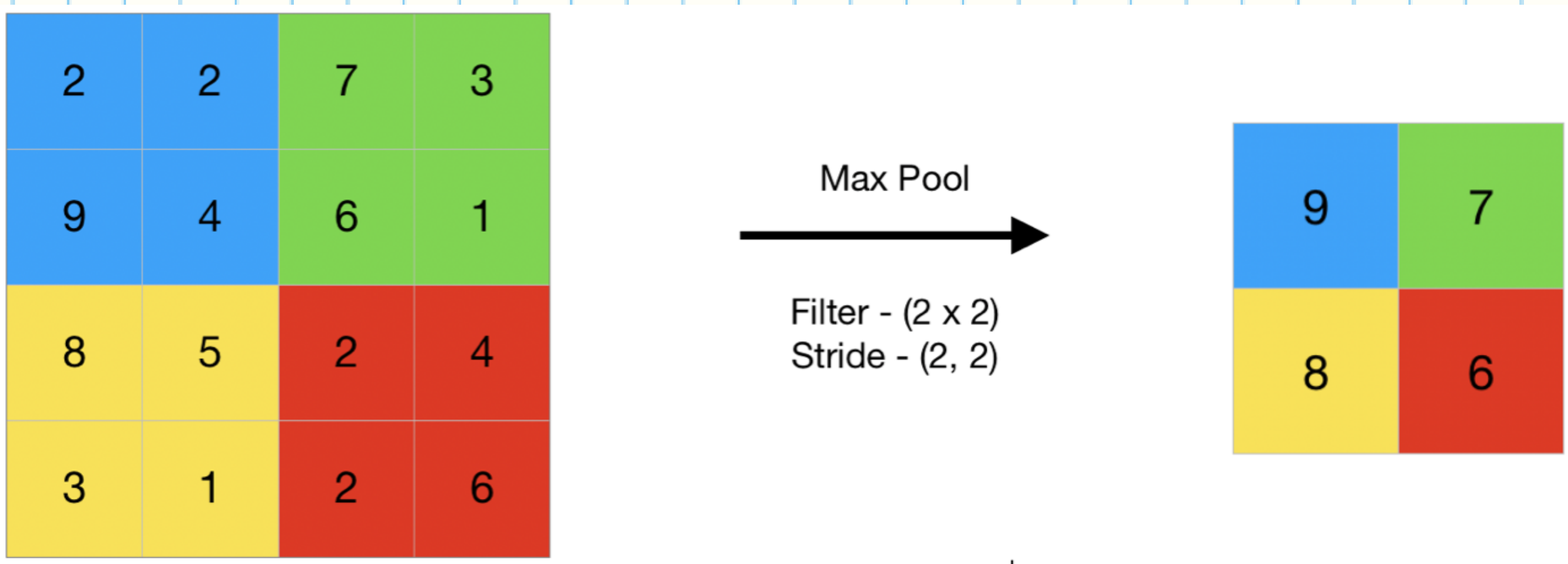
Pooling layers



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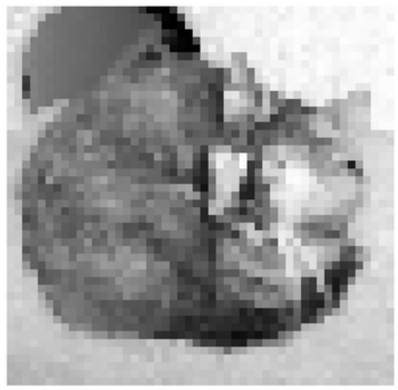
Pooling layers

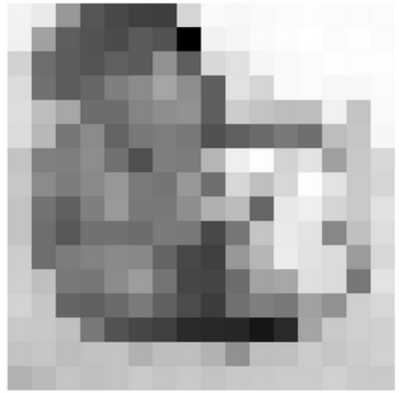
(446, 450)

(148, 150)

(49, 50)



(16, 16)



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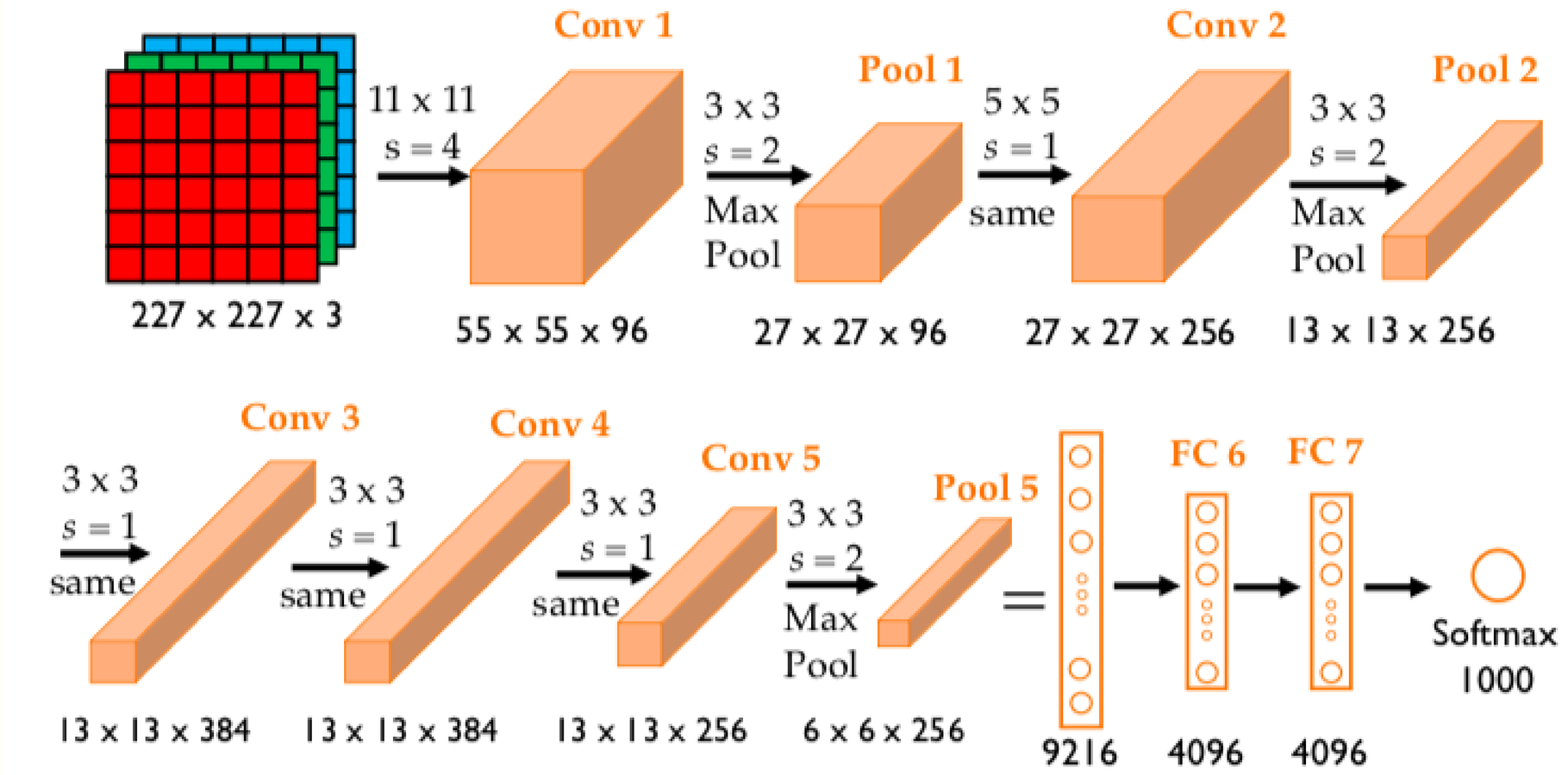
Convolutional Networks



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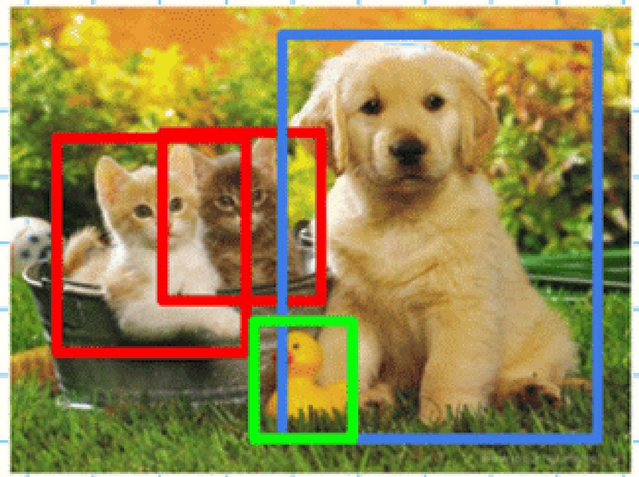
Use cases

Classification

CAT

Object Detection



CAT, DOG, DUCK

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Natural Language Processing

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Natural Language Processing

Computers can now understand and talk with us!

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Language

This is an Artificial Intelligence workshop!

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Language

Tokens	Characters
7	44

This is an Artificial Intelligence workshop!

TEXT TOKEN IDS

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Meaning

How to make meaning out of language?

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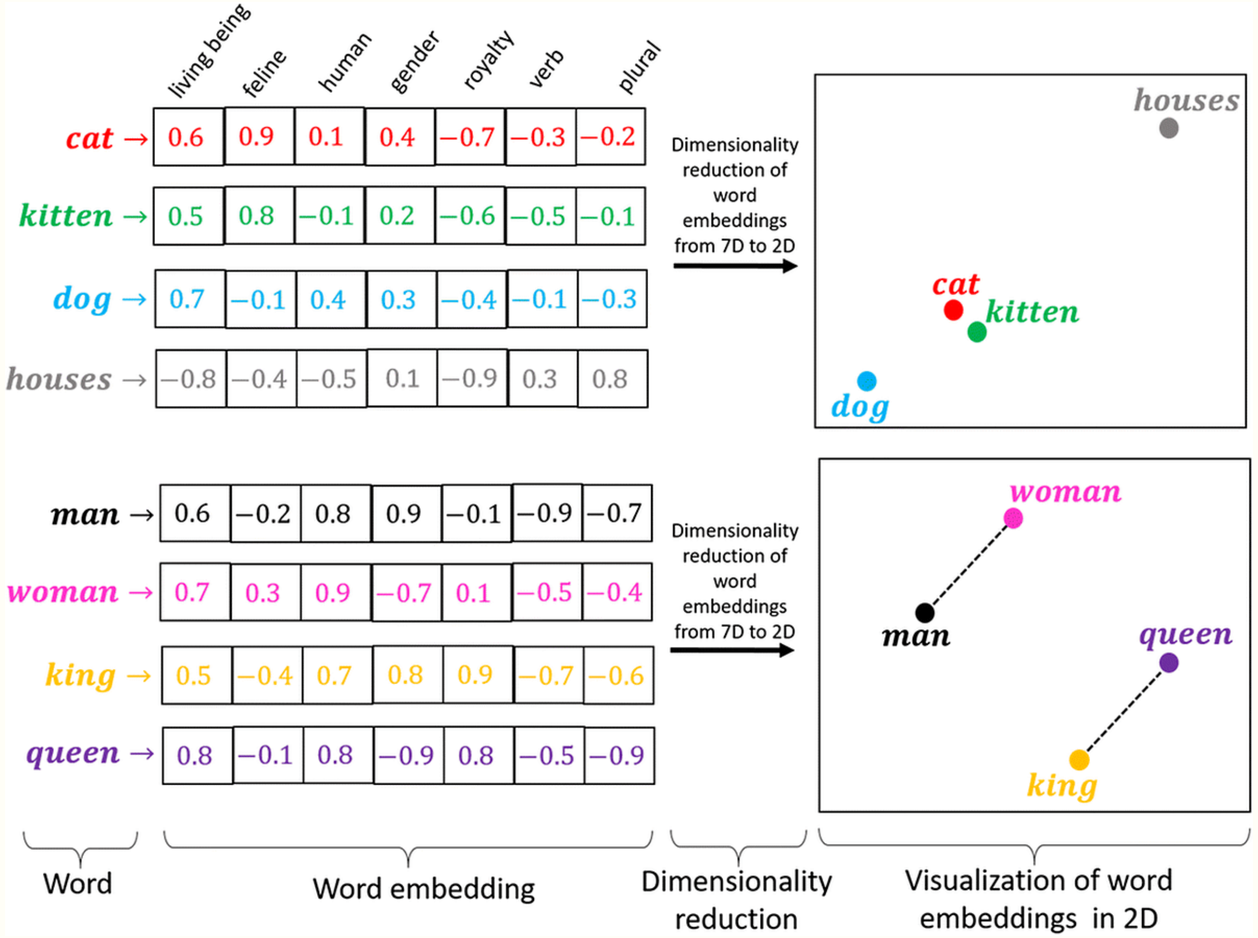
Word Embedding



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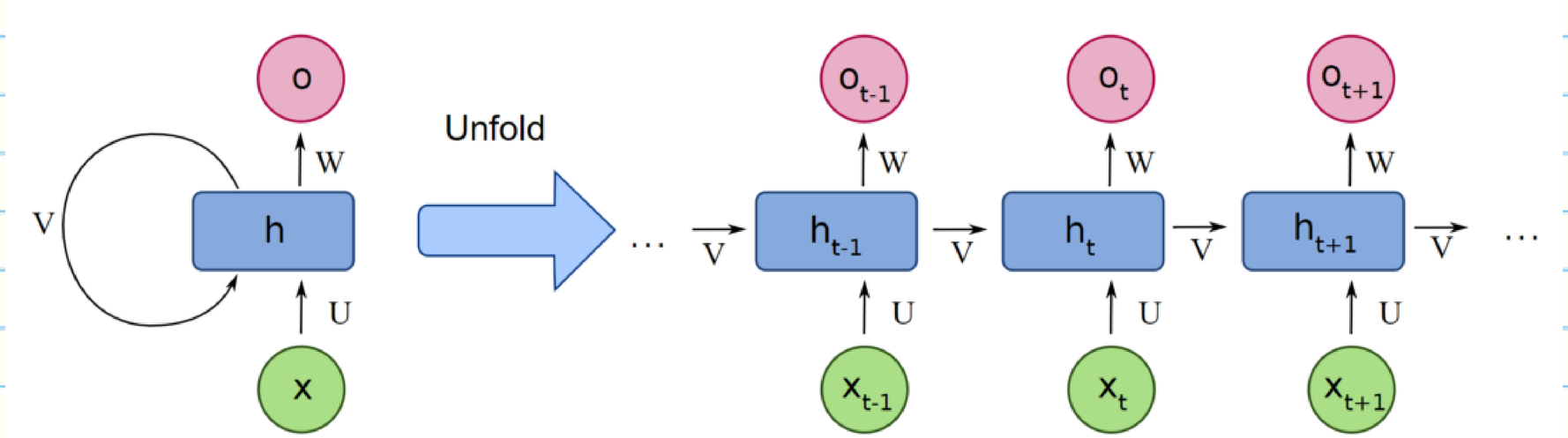
Recurrent Layers



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LLMs

Every AI revolution starts with a paper

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Attention

Every AI revolution starts with a paper

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Attention Is All You Need

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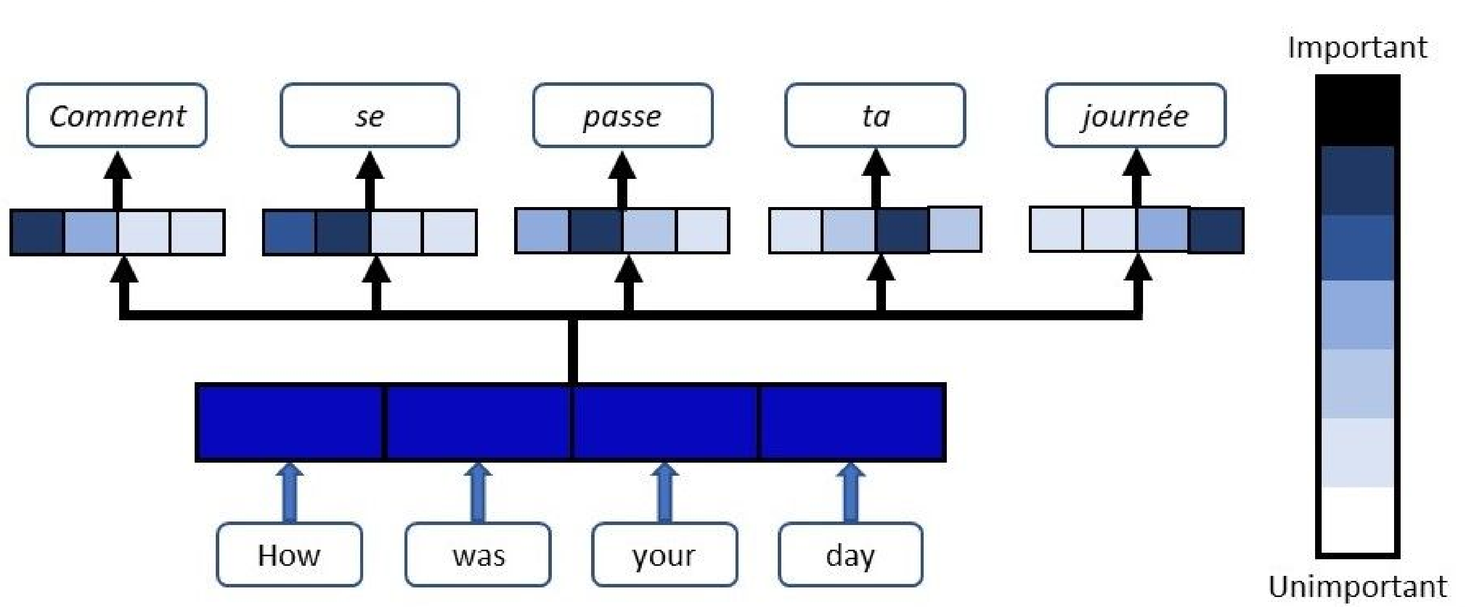
Attention Mechanism



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pov: your lunch break

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Tensorflow

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Tensorflow

TensorFlow is an open-source machine learning framework developed by Google that facilitates the creation and deployment of deep learning models.

TensorFlow

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Labs

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Reinforcement Learning

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Reinforcement Learning

Computers can now play games beyond human level!

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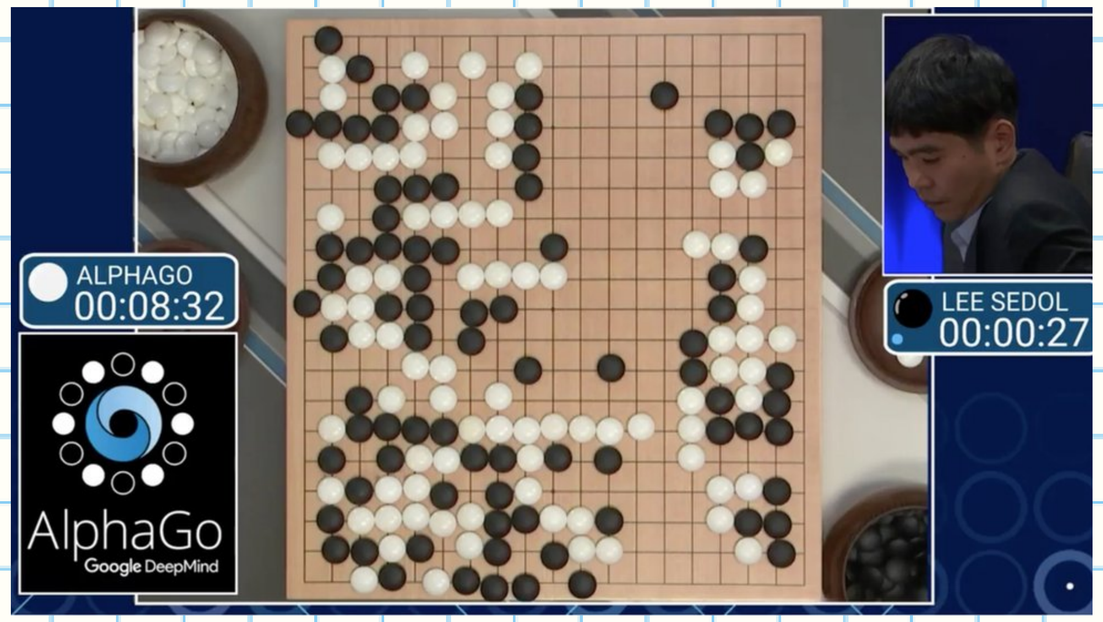
Reinforcement Learning



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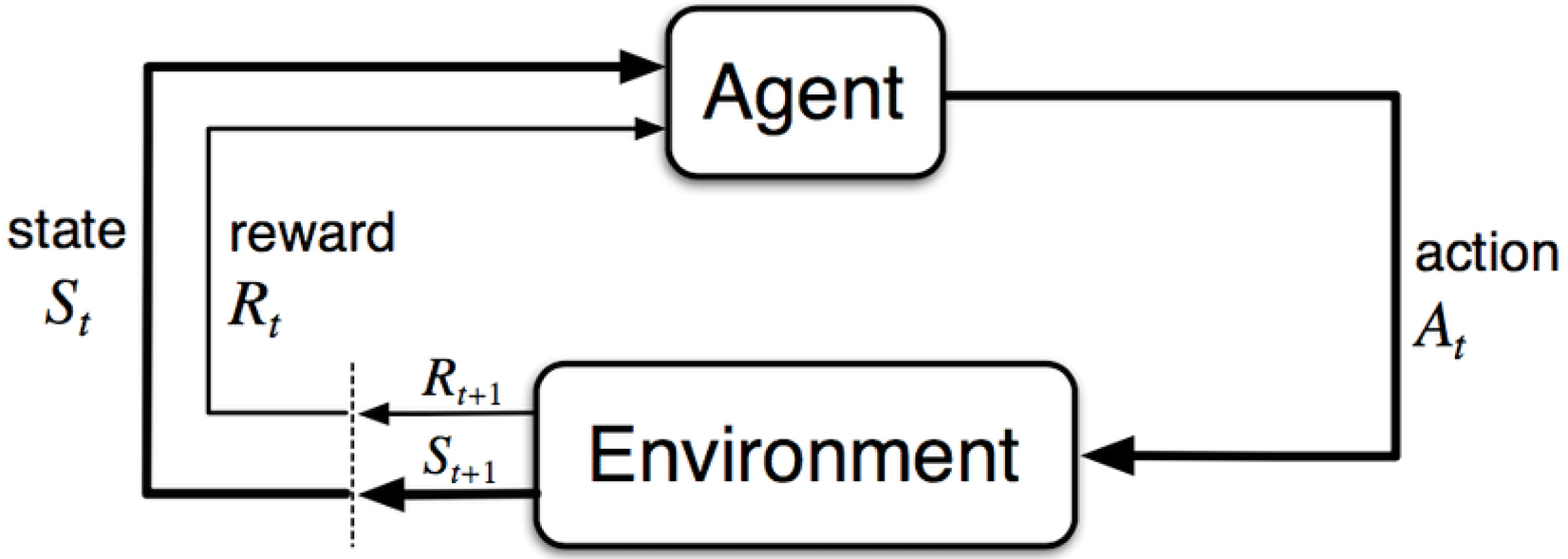
RL Framework



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RL Framework

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Reward Hypothesis

Every goal can be described as the maximization of an expected cumulative reward.

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Return: Cumulative Reward

$$R(\tau) = r_{t+1} + \gamma r_{t+2} + \gamma^2 r_{t+3} + \gamma^3 r_{t+4} + \dots$$

Return: cumulative reward

Gamma: discount rate

Trajectory (read Tau)
Sequence of states and actions

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Value Based Solution: Q-Learning

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State-Action Value

$$Q^{\pi}(s,a) = \mathbb{E}_{\pi}\left[\sum_{k=0}^{\infty} \gamma^{k} r_{t+k+1} \middle| s_t = s, a_t = a\right]$$

(math-ignore)

How good is it to be in state (St) and take action (At)

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Getting Smart

$$Q(S_t, A_t) \leftarrow Q(S_t, A_t) + \alpha[R_{t+1} + \gamma max_a Q(S_{t+1}, a) - Q(S_t, A_t)]$$

New Q-value estimation

Former Q-value estimation

Learning Rate

Immediate Reward

Discounted Estimate optimal Q-value of next state

Former Q-value estimation

TD Target

TD Error

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Q-Learning

- epsilon, learning_rate
- For every episode:
  - While St in not terminal:
    - Observe state St
    - Take action At (e-greedy)
    - Observe St+1, Rt+1
    - Correct Q(St, At)

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Discussion

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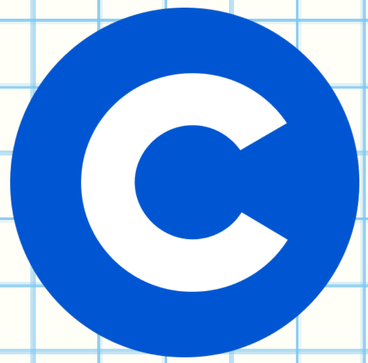
Ressources



kaggle

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Q/A

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Thank you!

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