Artificial Intelligence

at a glance

July 28, 2023

Johanes Suhardjo

History

- Arthur C. Clarke: “Any sufficiently advanced technology is indistinguishable from magic.”
- 1940s-1960s: Turing test, ELIZA, John McCarthty, chess as a litmus test
- 1980s: Expert Systems, only knows what is told, but can’t tell it everything
- 1997: Deep Blue beat world chess champion, but not really “AI”
- From {data,rules} → answers to {data, answers} → rules
- 2000s: Geoffrey Hinton (University of Toronto), Jansen Huang (NVIDIA), Yann LeCun (University of New York), Demis Hassabis (Deep Mind)
- Why AI works now: lots of data (often generated), fast computers, GPUs, economy

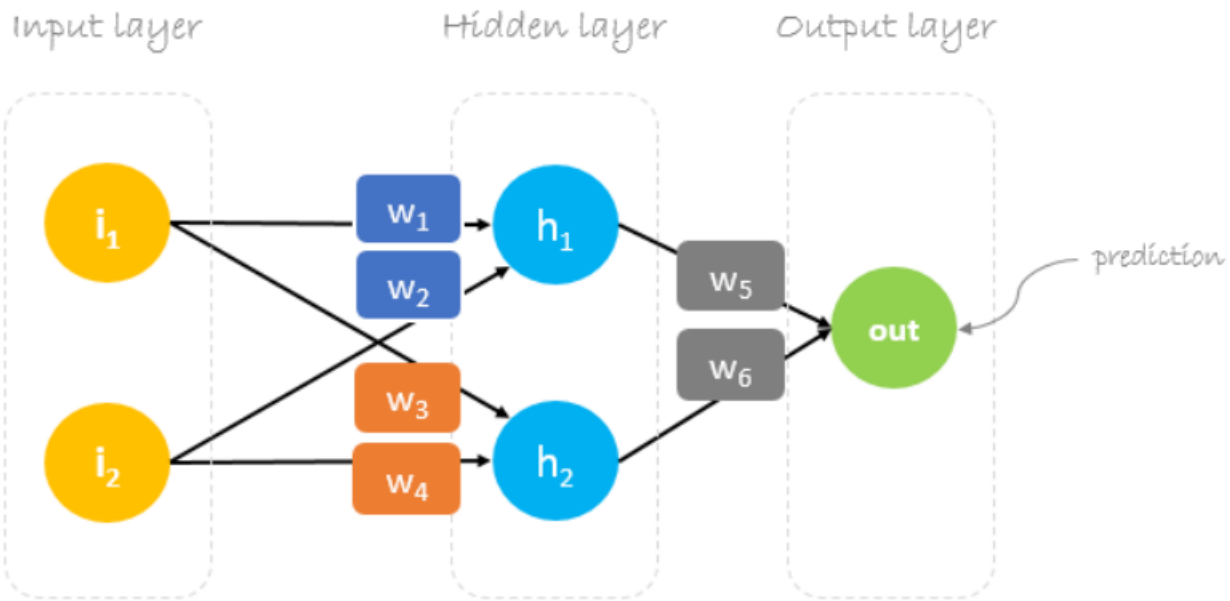
Types of AI

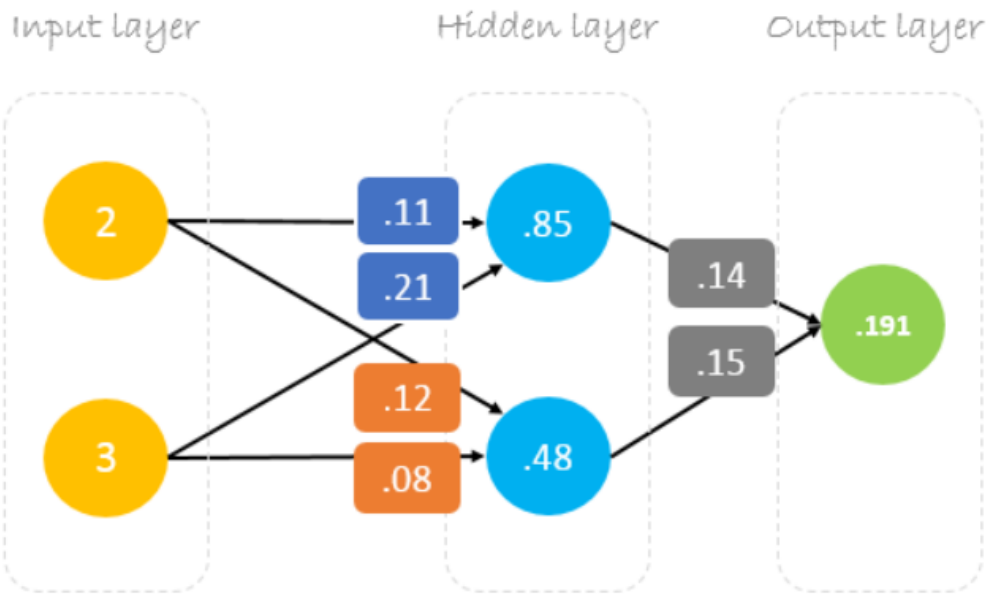
- machine learning, knowledge based expert system, pattern recognition, speech recognition, robotic
- Regression, e.g.: house prices
- Classification e.g.: Modified National Institute of Standards and Technology (MNIST)
- mostly classification

Data Engineering and Data Science

- Data: features and labels
- Should be varied and valid, garbage in garbage out
- Training, validation, and test data should be separated
- A significant effort in machine learning is getting high quality data

- Learning: supervised, unsupervised (with only rules and rewards)
- Statistical methods
- Neural Network: node, layer, weight, activation function, forward pass, error function, back propagation, gradient descent, validation, testing
- Hyperparameters: number of layers, nodes, learning rate, mini batch, epoch, design of the NN
- Overfitting, regularization, dropout


Input layer
Hidden layer
Output layer
i_1
i_2
w_1
w_2
w_3
w_4
h_1
h_2
w_5
w_6
out
prediction



Forward Pass

Matrix multiplication

$$[2 \quad 3] \cdot \begin{bmatrix} 0.11 & 0.12 \\ 0.21 & 0.08 \end{bmatrix} = [0.85 \quad 0.48] \cdot \begin{bmatrix} 0.14 \\ 0.15 \end{bmatrix} = [0.191]$$

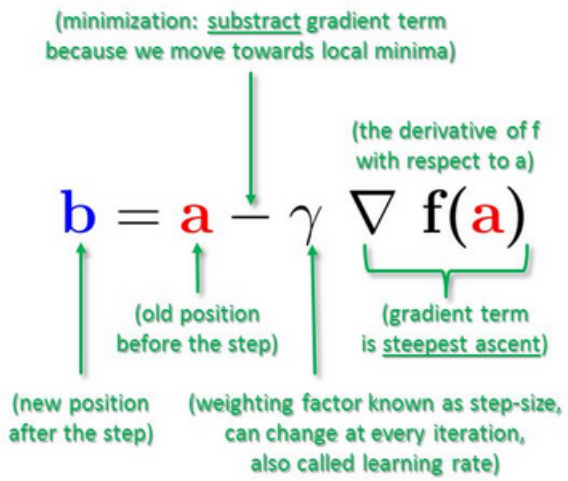
Details

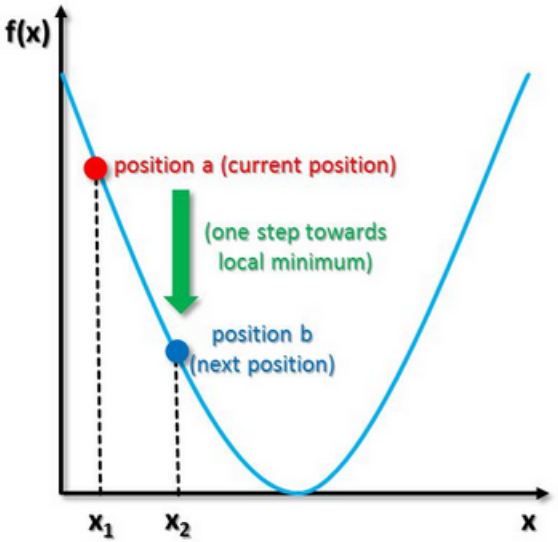
2 x .11 + 3 x .21 = .85

2 x .12 + 3 x .08 = .48

.85 x .14 + .48 x .15 = .191

Gradient Descent





- Example of NN for MNIST database
- CNN and other popular types of neural network.
- Deep Learning: a lot of hidden layers
- AlphaGo to AlphaZero

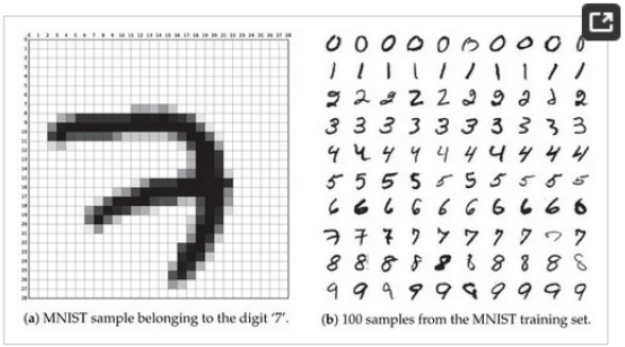
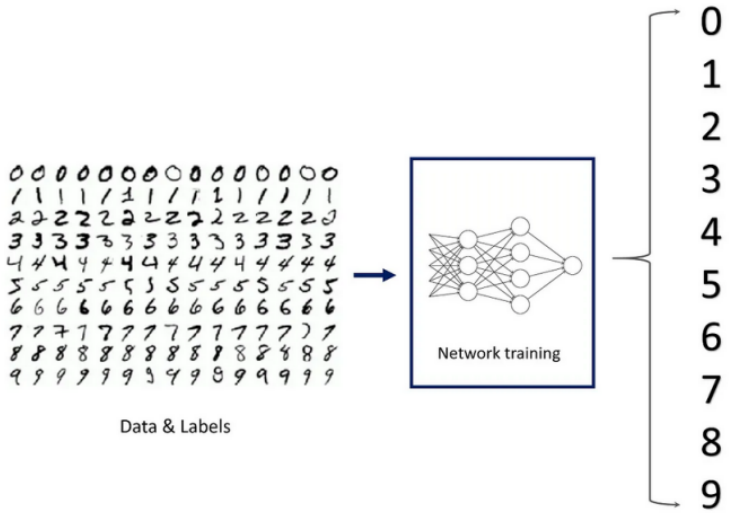
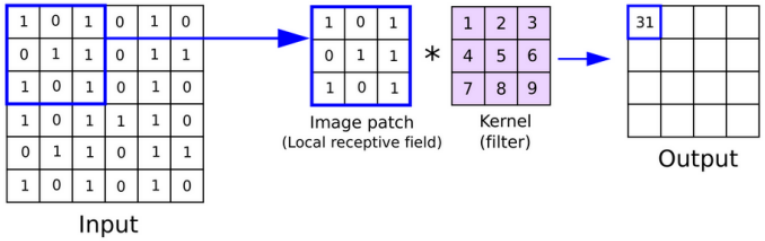
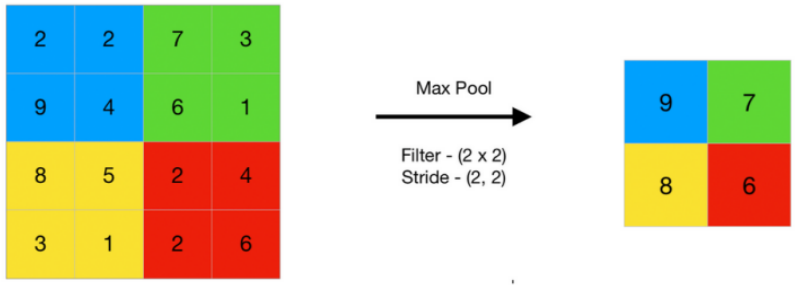


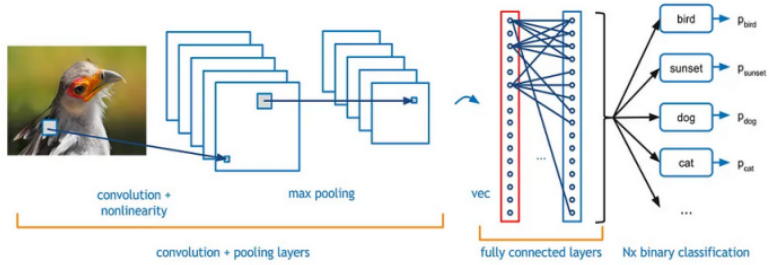
Figure 1. Example of the MNIST database.



MNIST Dataset and Number Classification by Katakoda


Input
Image patch
(Local receptive field)
Kernel
(filter)
Output


Max Pool
Filter - (2 x 2)
Stride - (2, 2)


convolution + nonlinearity
max pooling
vec
bird
sunset
dog
cat
convolution + pooling layers
fully connected layers
Nx binary classification

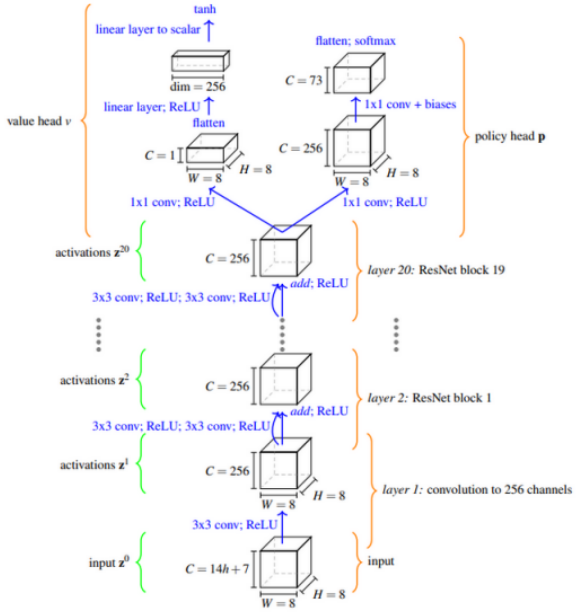
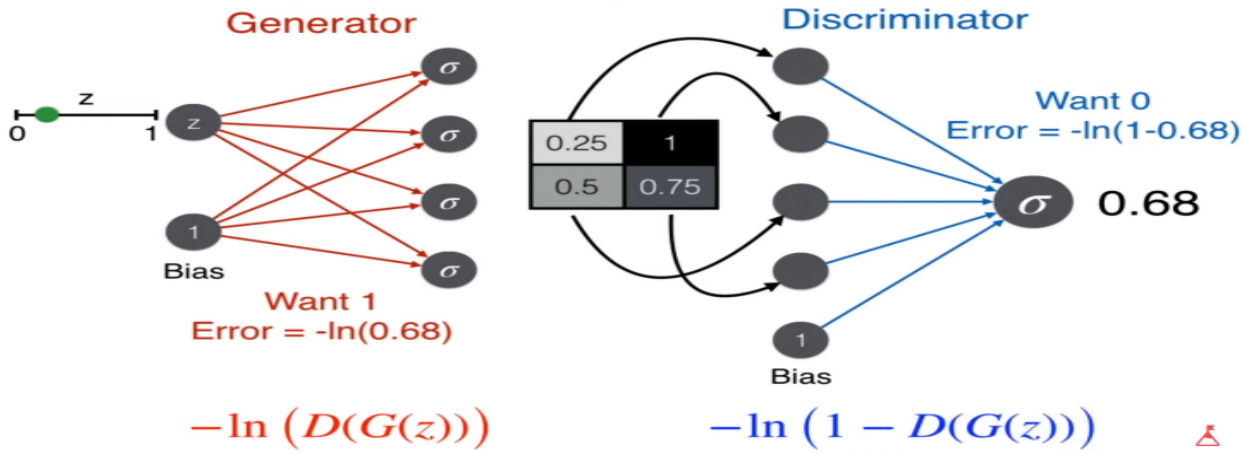


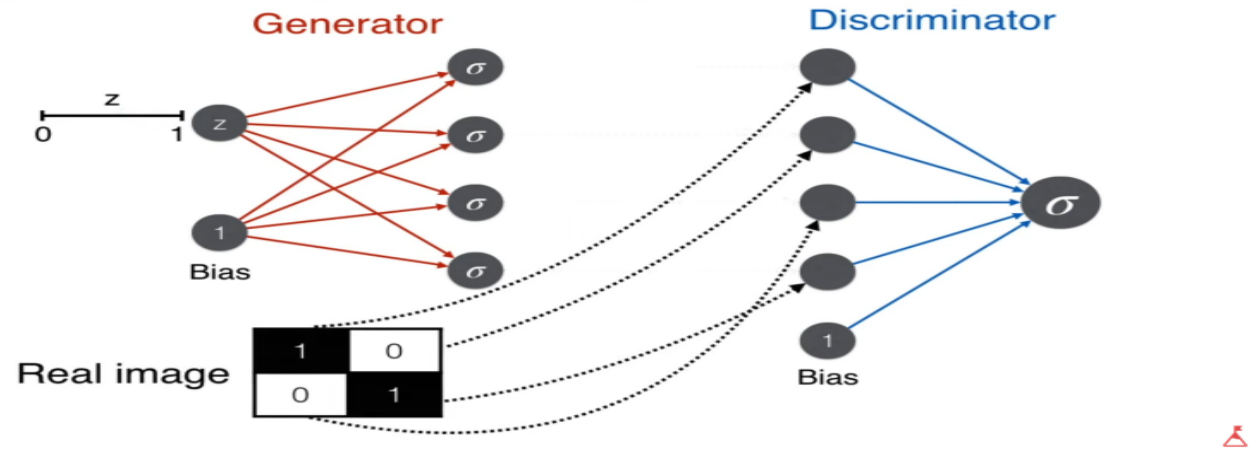
Figure 1. The AlphaZero network. Each 3×3 convolution indicates the application of 256 filters of kernel size 3×3 with stride 1. A ResNet block contains two rectified batch-normalized convolutional layers with a skip connection. In the input $\mathbf{z}^0$, a history length of $h = 8$ plies is used, encoding the current board position and those of the seven preceding plies. The input is a $8 \times 8 \times 119$-dimensional tensor.

Source: https://arxiv.org/pdf/2111.09259.pdf

Generative AI

- https://thispersondoesnotexist.com/
- How it works
- A very simple example from Luis Serrano https://www.youtube.com/watch?v=8L11aMN5KY8&t=58s


Generator
Discriminator
z
0
1
Bias
Want 1
Error = -ln(0.68)
0.25
1
0.5
0.75
Want 0
Error = -ln(1-0.68)
0.68
$-\ln\left(D(G(z))\right)$
$-\ln\left(1-D(G(z))\right)$

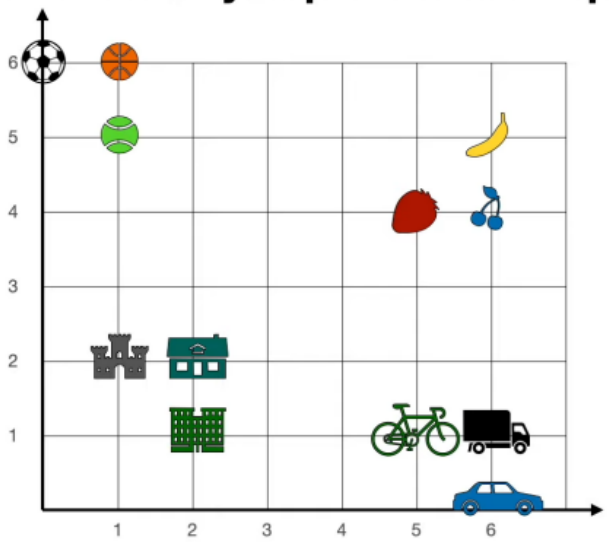

Generator
Discriminator
z
0
1
Bias
Real image
1
0
0
1
Bias

Large Language Model (LLM)

- Sequence processing, RNN, LSTM
- Embeddings, Attention is All You Need, Transformer
- ChatGPT made AI very popular
- https://chat.openai.com, often busy
- bard.google.com experimental, Google PaLM not free
- LLM biases and made up answers (hallucinations)

Embeddings Quiz 1

Where would you put the word apple?



Serrano.Academy Serrano.Academy

Word	Numbers	
Apple	?	?
Banana	6	5
Strawberry	5	4
Cherry	6	4
Soccer	0	6
Basketball	1	6
Tennis	1	5
Castle	1	2
House	2	2
Building	2	1
Bicycle	5	1
Truck	6	1
Car	6	0

Benefits of AI

- Healthcare, faster medicine development; as tools, shortage of medical professionals
- AlphaFold, https://www.youtube.com/watch?v=1KQc6zHOmtU
- Farming, e.g. “weeding”
- Manufacturing, robots
- Self driving cars, safer than the drunk/sleepy drivers
- Civil and Structural Engineering
  https://www.youtube.com/watch?v=t6RLpST1cys
  https://www.youtube.com/watch?v=ZHAIJHS5yRo

Implications of AI

- Changes our lives like industrial revolution, electricity, and computers
- Job displacement, mostly educated white collar jobs
- Opens up new jobs
- If you can't beat them, join them
- Need to adjust education, prompting skills

The future of AI

- Full of promise, but it also comes with challenges.
- Can be used for crime but also for detecting criminals.
- We have to be careful moving forward, regulations, xAI.
- It is a tool. Any tool is only as good or bad as the people who use it.
- AGI, Technological Singularity, Sci-Fi stuff
- First, worry about human, e.g. misinformation, weaponization of AI.

Further Readings

- https://www.youtube.com/watch?v=kgCUn4fQTsc
- https://www.youtube.com/watch?v=OU9cKjWsvH0
- https://www.youtube.com/watch?v=Y6Sgp7y178k&t=925s
- Luis Serrano YouTube videos
- Deep Learning with Python – Francois Chollet
- Stanford CS229 YouTube videos
- https://forums.developer.nvidia.com/