LECTURER: Nghia Duong-Trung

ARTIFICIAL INTELLIGENCE

TOPIC OUTLINE

UNIT 3

NEUROSCIENCE AND COGNITIVE SCIENCE

STUDY GOALS

On completion of this unit, you will have learned …

- … how neuroscience describes the anatomical and physiological composition of the brain.
- … how cognitive science unites different scientific disciplines in the search for models of cognitive processes.
- … some of the most salient relations and connections between neuroscience, cognitive science, and artificial intelligence, together with their implications for human and machine intelligence.

EXPLAIN SIMPLY

1. Explain why neuroscience and cognitive science play a major role in the field of artificial intelligence.
2. What is cognitive bias? Can you think of a potential cognitive bias in the context of artificial intelligence?
3. Describe the concept of General Adversarial Networks (GANs).

DEFINITION OF BASIC TERMS

Neuroscience = study of human/animal nervous systems (e.g., anatomy and physiology)

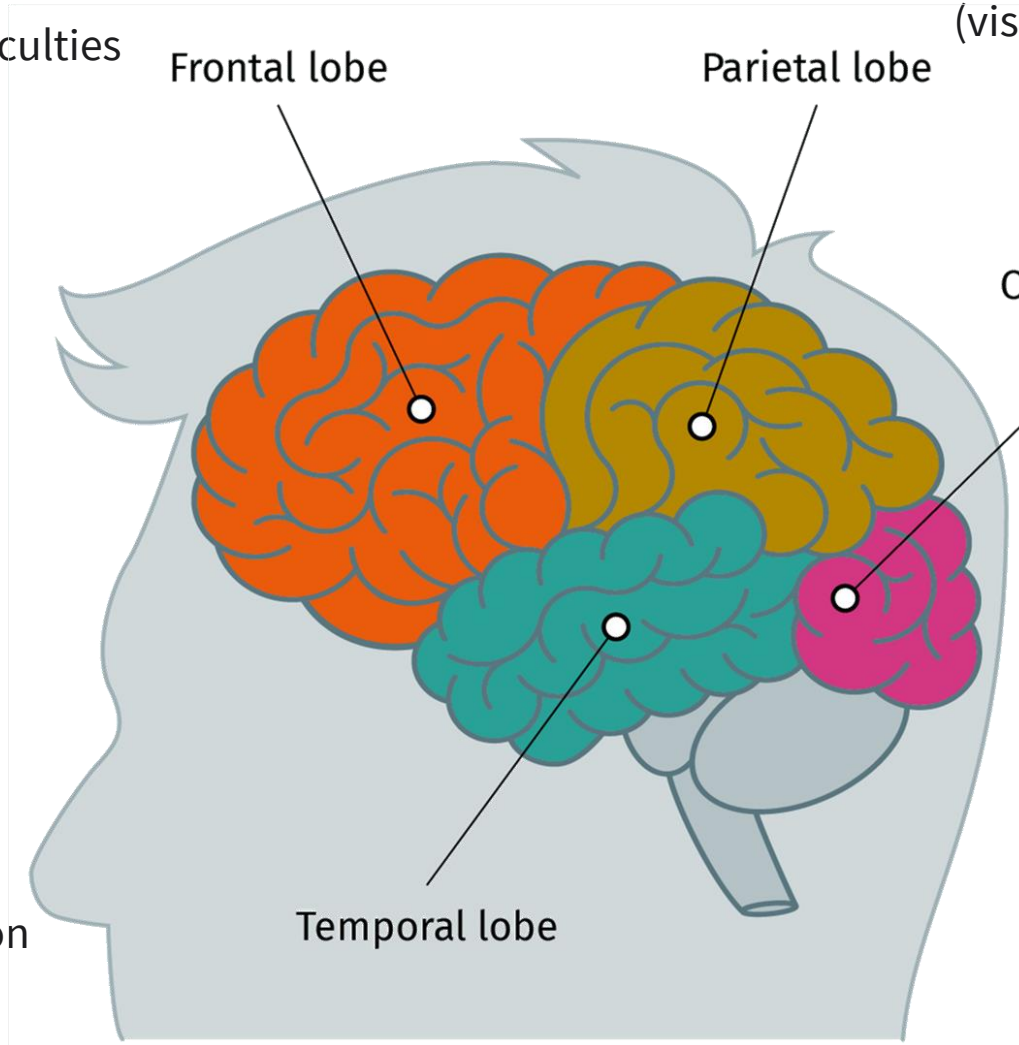
Cognitive science = aiming to model and understand cognitive functions (e.g., behavior, intelligence, memory)

Artifical intelligence = mechanical reproduction of intelligent behavior

BRAIN ANATOMY AND PHYSIOLOGY

Higher mental faculties (judgement)

Interpretation of sensory input (vision, touch signals)



Visual processing

Understanding and formation (recognition of objects)

Source of the graphic: Course Book DLMAIAI01, p.41

MAIN APPROACHES IN COGNITIVE SCIENCE

BRAIN IMAGING

TRACING OF NEURAL ACTIVITY

BEHAVIORAL EXPERIMENTS

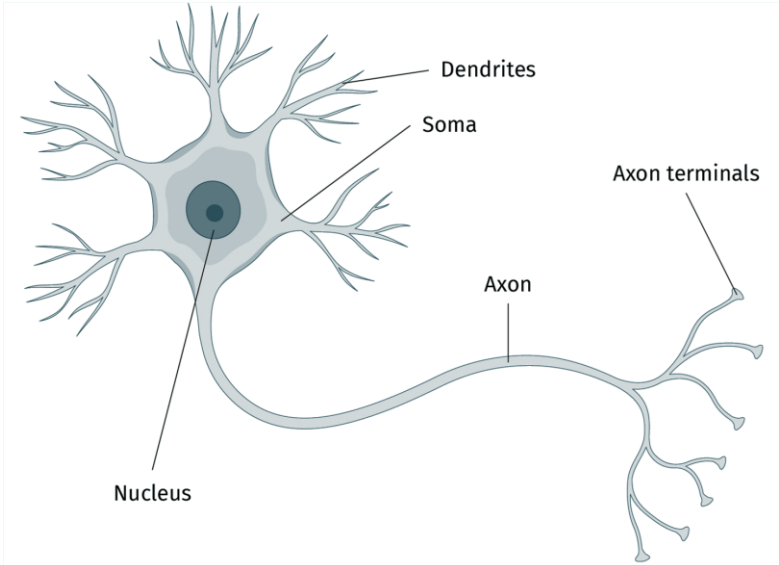
DRAW CONCLUSIONS ABOUT THE PROCESSING OF STIMULI

SIMULATION VIA COMPUTATIONAL MODELING

VERIFY THEORETICAL IDEAS BY COMPARING OUTCOMES WITH REAL-WORLD BEHAVIORAL DATA

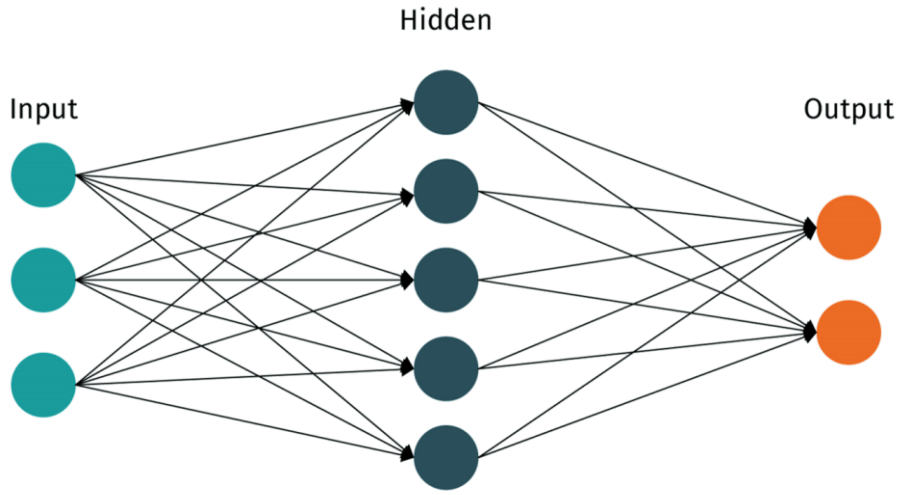
BRAIN NEURONS AND PERCEPTION

The human brain is composed of 86 billion neurons responsible for information processing.



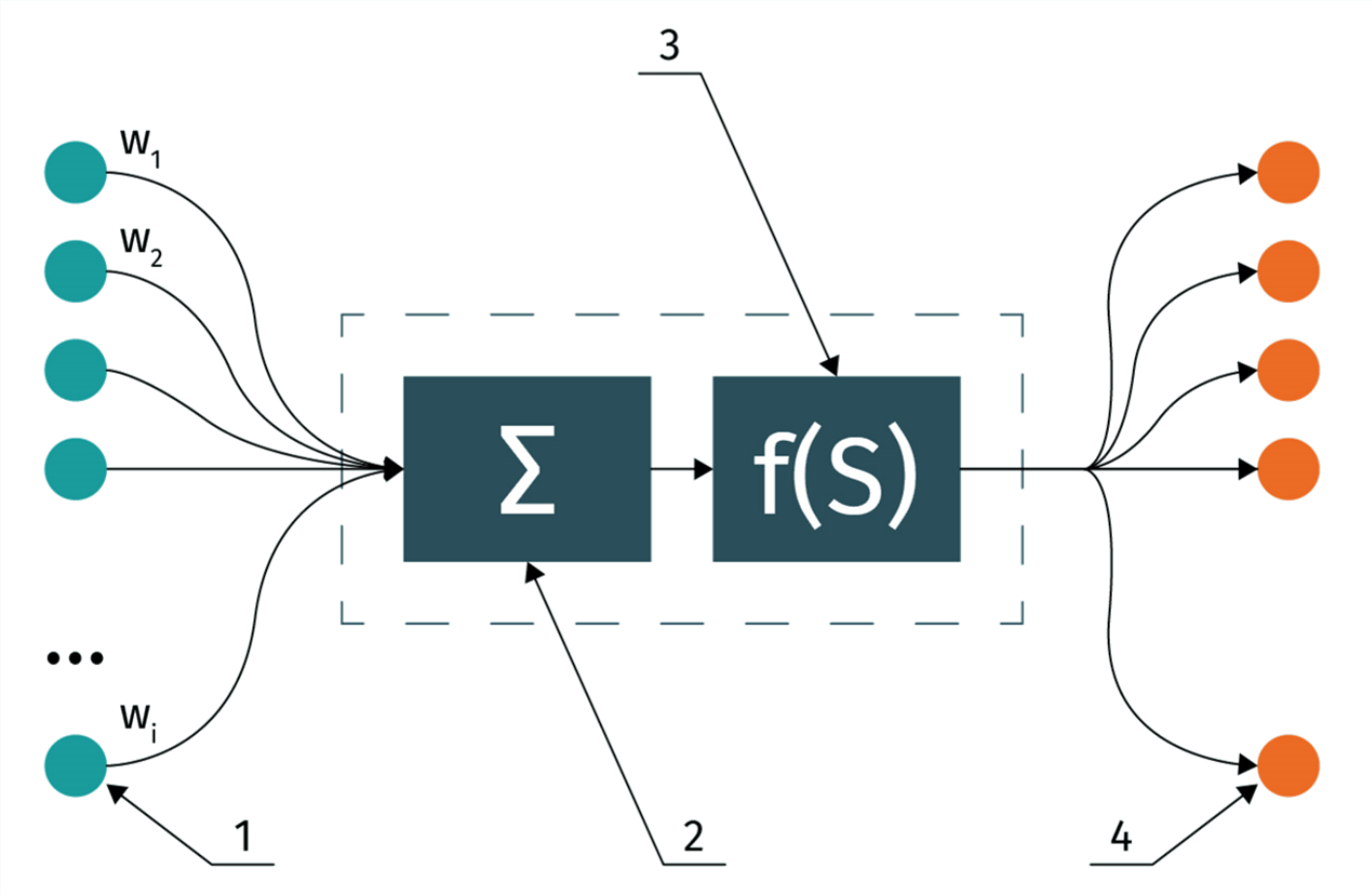
Perception of inputs and cognition process

Artificial Neural Network



Source of the graphics: Course Book DLMAIAI01, p.42

1. Receive input
2. Weighted sums are computed
3. Activation function is applied to sum
4. Distributed to output neurons

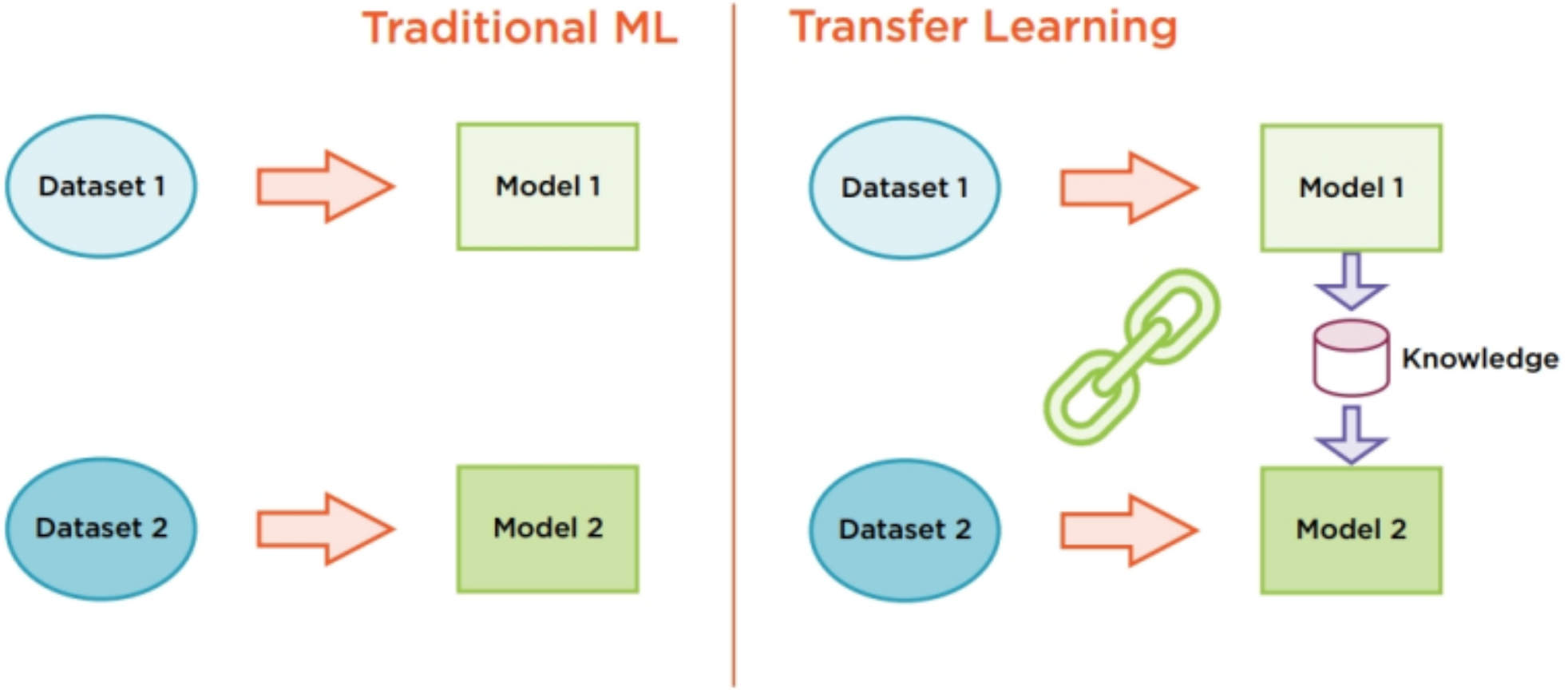


Source of the graphic Course Book DLMAIAI01, p. 48

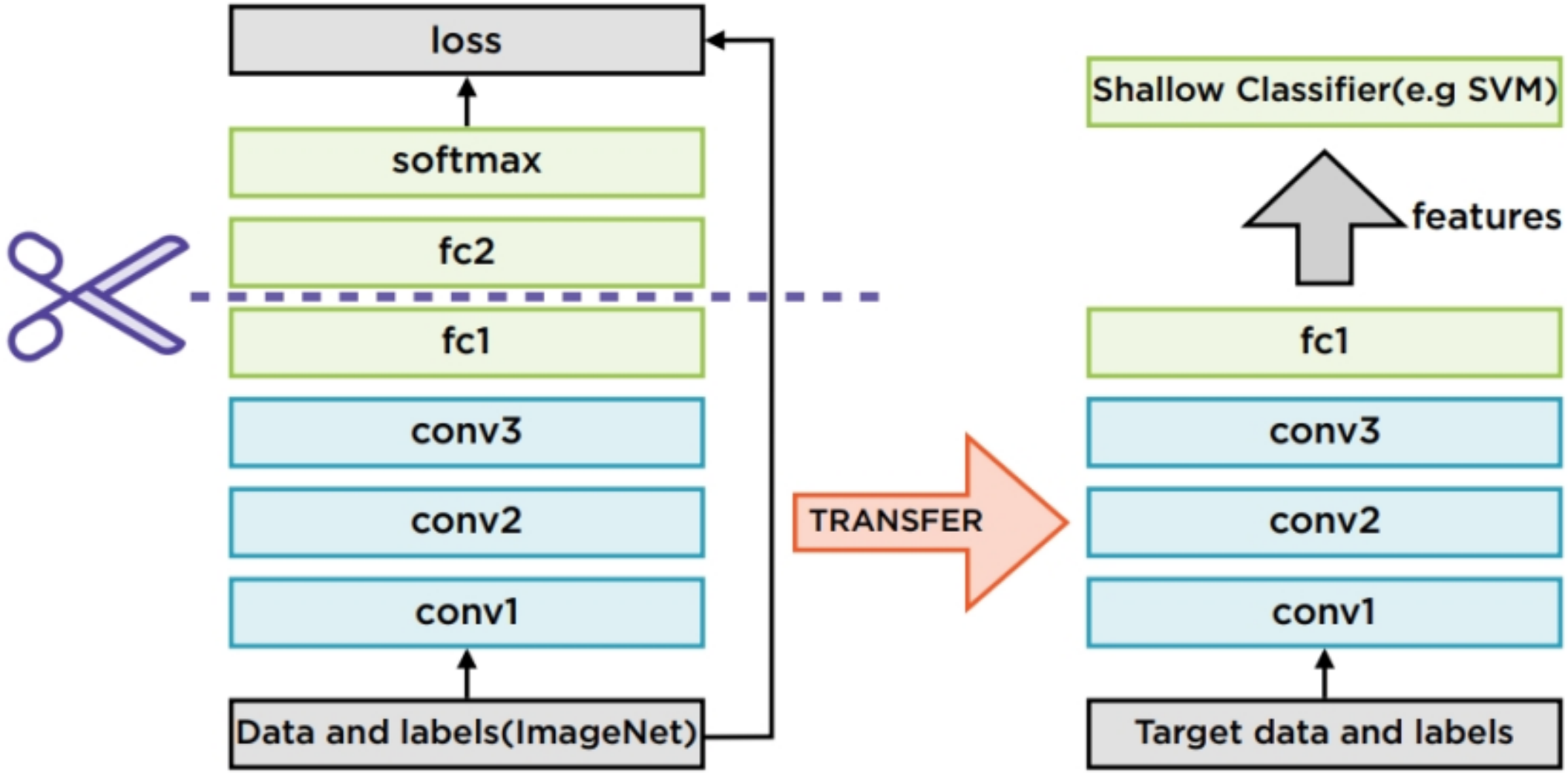
Transfer learning (TF) is the practice of re-using a trained model that solves a similar problem, usually leaving the model architecture unchanged and re-using some of or all the model weights.

- Avoid designing a model from scratch
- Make sense for common, widely studied use-cases in which basic problem structure stays same, but details vary
- TF scenario: use entirely as-is, fine-tune model weights, re-train from scratch

TRANSFER LEARNING

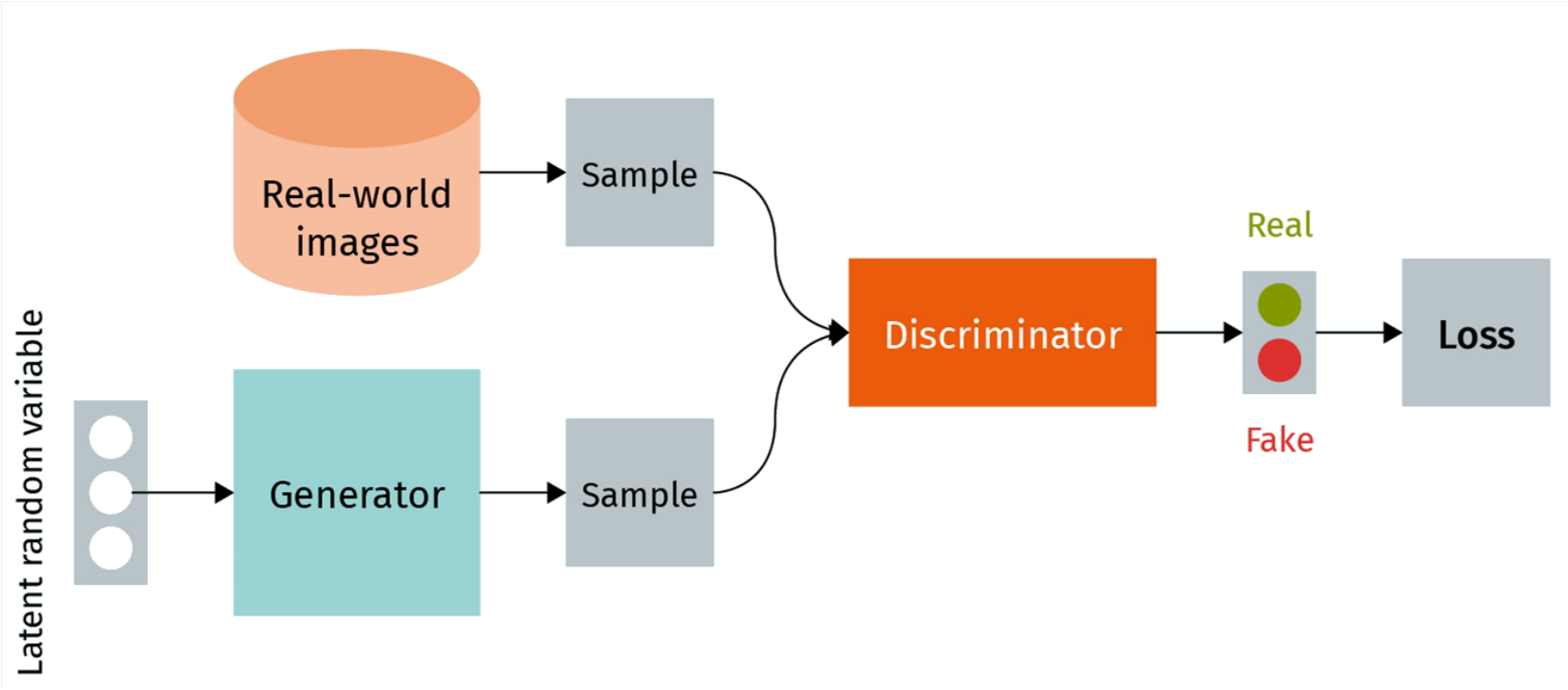


TRANSFER LEARNING



Transfer learning: take trained model and adjust it to new use case with small dataset

Generative Adversarial Networks: (GANs) generate new data with same statistics



Source of the graphic: Course Book DLMAIAI01, p. 52

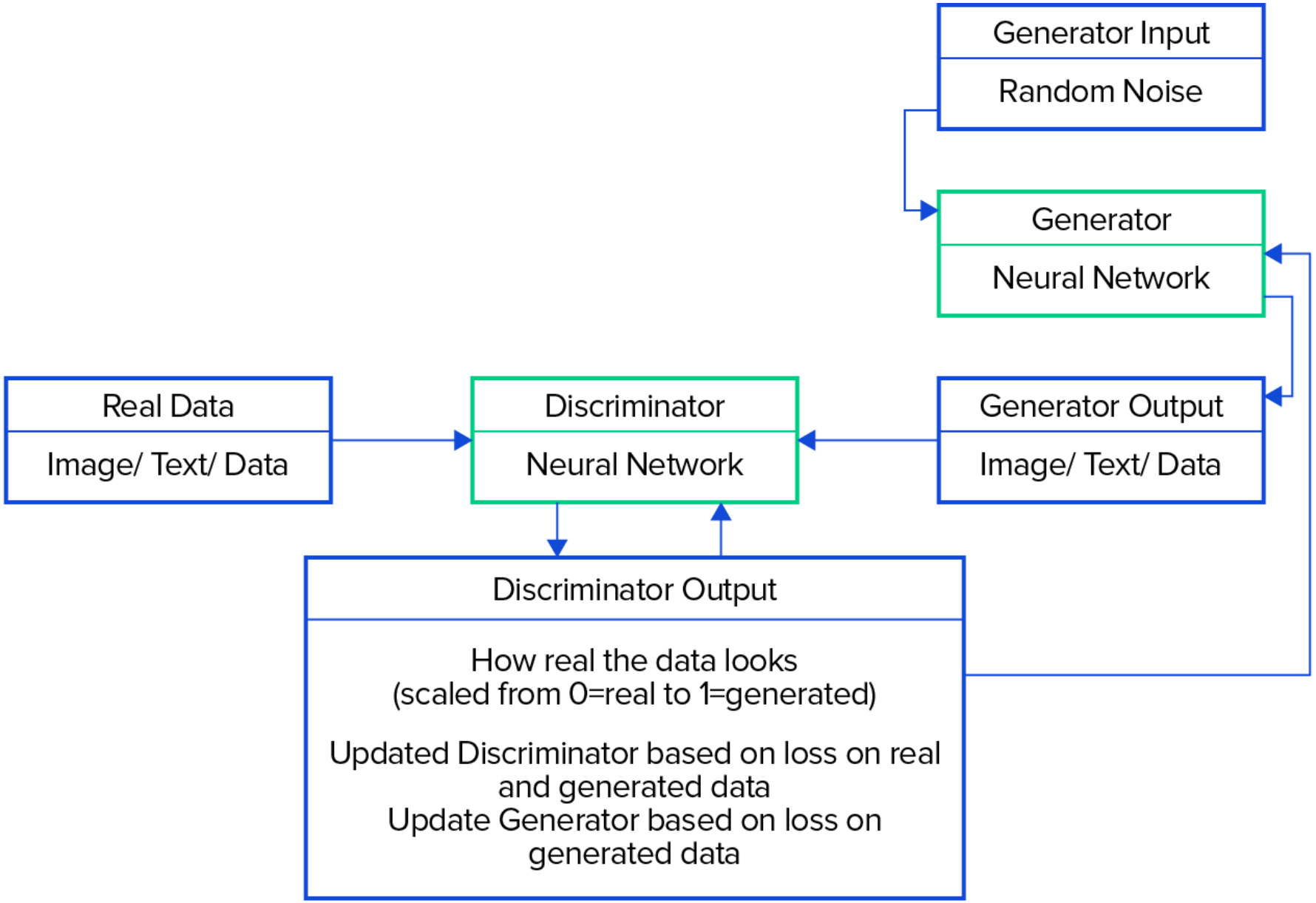
HISTORY OF GANS

In 2014, a paper on generative adversarial networks (GANs) was published by Ian Goodfellow and his colleagues. This research paper proposed a new framework for unsupervised learning, in which two neural networks are trained to compete against each other.

Since then, GANs have become one of the most popular and widely-used types of neural networks for generative modeling. In recent years, GAN have also provided to be useful for data augmentation, reinforcement learning, and semi-supervised learning techniques.

https://arxiv.org/abs/1406.2661

GANS


Generator Input
Random Noise
Generator
Neural Network
Real Data
Image/ Text/ Data
Discriminator
Neural Network
Generator Output
Image/ Text/ Data
Discriminator Output
How real the data looks
(scaled from 0=real to 1=generated)
Updated Discriminator based on loss on real and generated data
Update Generator based on loss on generated data

GANS APPLICATIONS

- Generate Examples for Image Datasets
- Generate Photographs of Human Faces
- Generate Realistic Photographs
- Generate Cartoon Characters
- Image-to-Image Translation
- Text-to-Image Translation
- Semantic-Image-to-Photo Translation
- Face Frontal View Generation
- Generate New Human Poses
- Photos to Emojis
- Photograph Editing
- Face Aging
- Photo Blending
- Super Resolution
- Photo Inpainting
- Clothing Translation
- Video Prediction
- 3D Object Generation

USEFUL LINKS

https://poloclub.github.io/ganlab/

http://3dgan.csail.mit.edu/

https://github.com/junyanz/CycleGAN

https://github.com/chuanli11/MGANs

https://github.com/luanfujun/deep-photo-styletransfer

https://github.com/pathak22/context-encoder

https://reiinakano.com/gan-playground/

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SESSION 3

TRANSFER TASK

TRANSFER TASK

Discuss the concept of transfer learning.

Can you think of potential advantages for businesses and scientists?

TRANSFER TASK
PRESENTATION OF THE RESULTS

Please present your results.

The results will be discussed in plenary.

TRANSFER TASKS

https://beta.dreamstudio.ai/dream
https://app.runwayml.com/
https://openai.com/dall-e-2/
https://deepdreamgenerator.com/
https://bulletproof.charisma.ai/
https://www.synthesia.io/
https://www.craiyon.com/
https://www.myheritage.de/
https://lrpserver.hhi.fraunhofer.de/handwriting-classification
https://teachablemachine.withgoogle.com/
https://app.runwayml.com/login
https://quickdraw.withgoogle.com/
https://www.nvidia.com/en-us/research/ai-playground/

1. What is the purpose of the activation function of the neuron?

   a) It always passes on a signal.
   b) It sends a signal down the axon if a threshold on the inputs is met.
   c) It always blocks a signal.
   d) It never modifies a signal strength.

2. In brain anatomy, the notion of lobes refers to…

a) large-scale compartmentalizations of the brain.
b) the hemisphere split of the brain.
c) anatomic details of dendrites.
d) parts of the peripheral nervous system.

3. Current neural network models as used in artificial intelligence are…

   a) an exact replication of biological neural networks.
   b) not related to biological neural networks at all.
   c) a mostly accurate analogue of biological neural networks.
   d) a coarse analogue to biological neural networks.