
# Applied Deep Learning

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# Preferred Networks

- Founded in 2006 by Daisuke Okanohara and Toru Nishikawa as ”Preferred Infrastructure”
- Original focus: search engines and natural-language processing
- Key strength: image analysis → attention from Sony
- Pivot in 2014 to “Preferred Networks”

Toyota investment → crowded → robotics

Fanuc

Bioscience / healthcare } DL!

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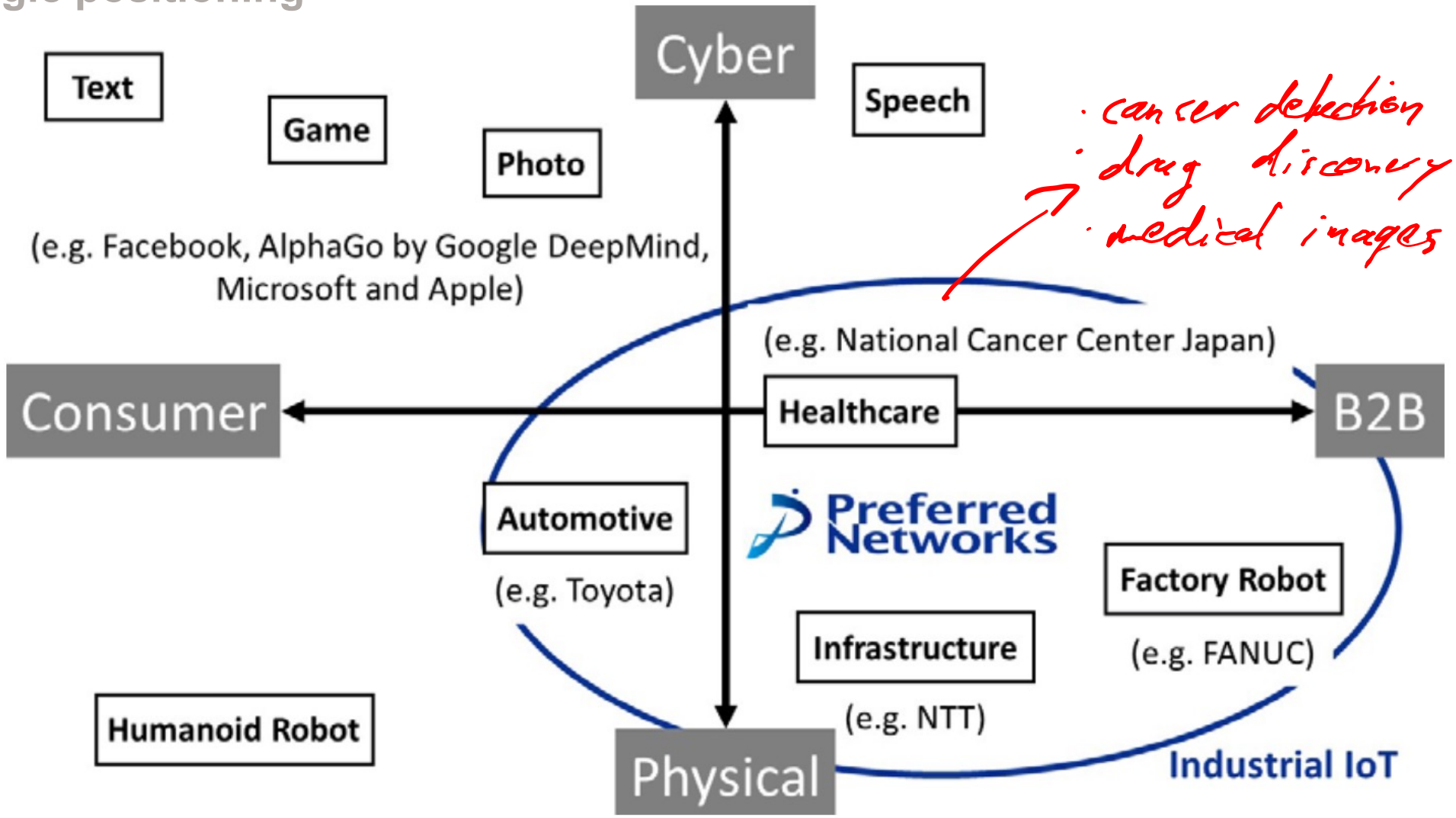
# Strategic positioning




Source: Company documents.

# How is the technology operating?

Bin picking: create dataset → learn how to pick (DL!)

Speech robot: image recognition (DL) → select item & target

language processing

Cars: Image → Action → Reward (arrow ↑, crash ↓)

↳ incr. reward (reinforc. learning)

State → Action

DL

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# What business model might Preferred Networks use?

Partnerships

e.g. Toyota, Fanuc

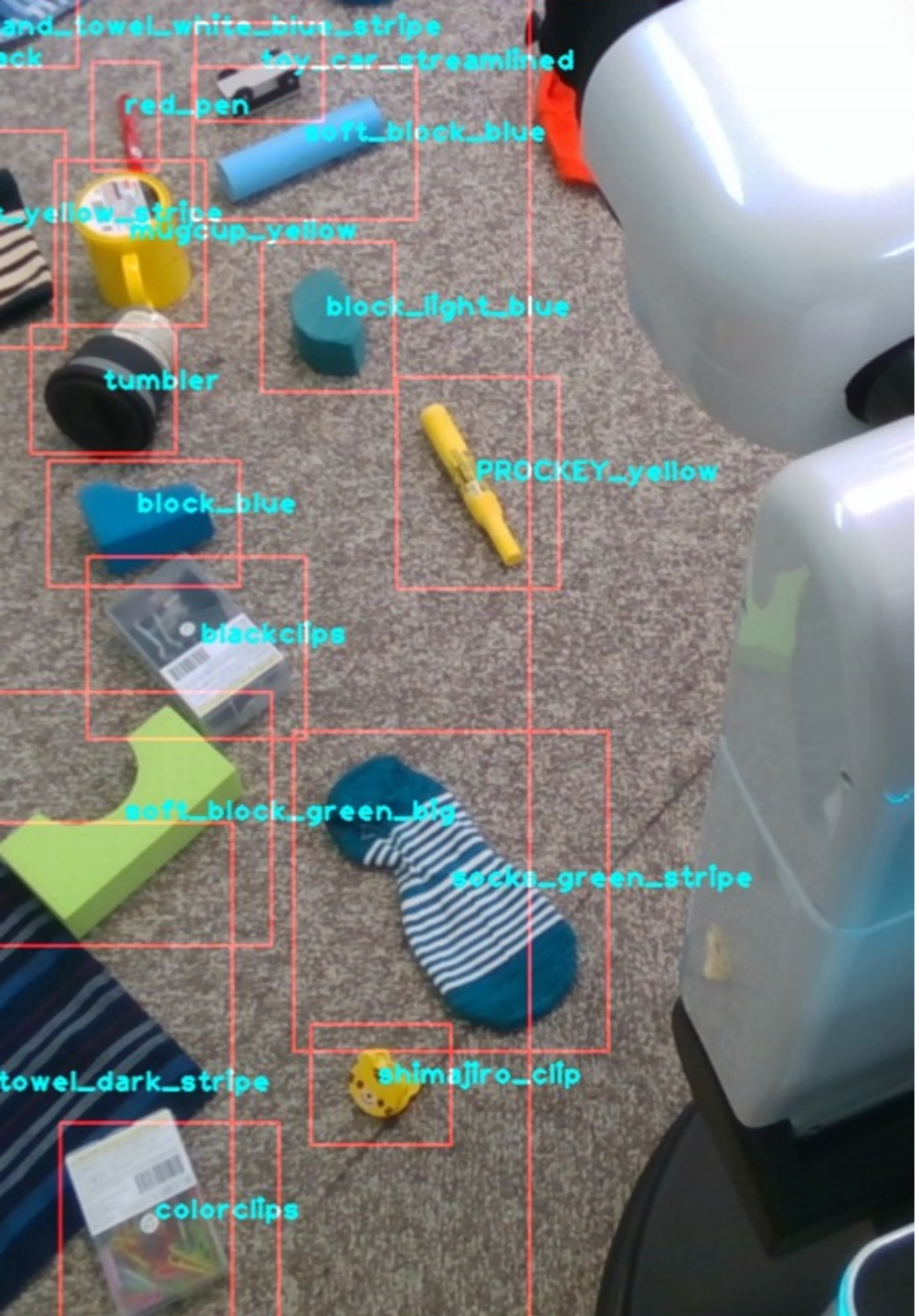
Product Dev

"Windows of personal robots"

Profit sharing

Healthcare

Sell




In groups of 4-6, choose one business model for Preferred Networks and prepare arguments to defend your choice.

Source: https://projects.preferred.jp/tidying-up-robot/

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# What are the pros and cons of each business model for a company like Preferred Networks?

## Partnership

⊕
- resources
- established network
- investment
- less risk

⊖
- dependency
- data access
- shares ↓
- freedom ↓

## Profit Sharing

- flow of funds
- share risk
- share objective
- using existing market regulatory experience

- risk of low sales measure

## Product Dev

- first-mover
- freedom / autonomy
- customers

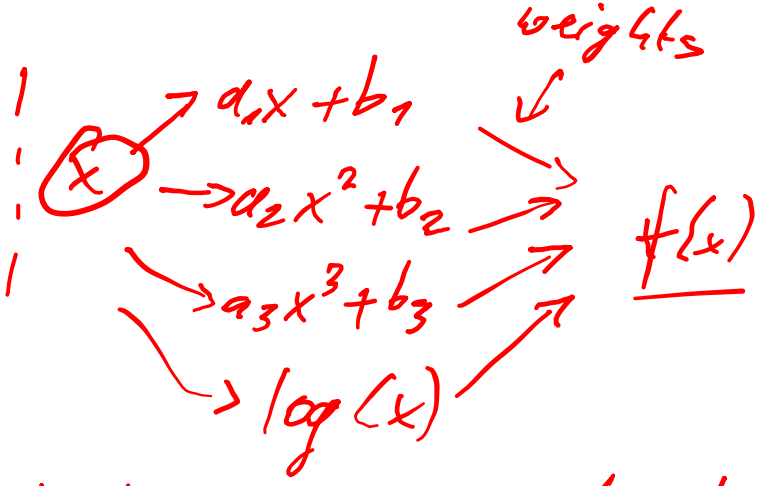
- (competitive)
- resources / funding
- marketing

# What is deep learning?

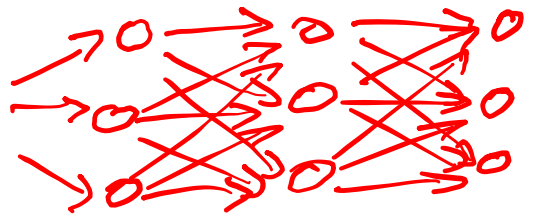
# Deep learning according to the case

Shallow learning: $x \rightarrow ax+b \rightarrow f(x)$

$f(x) = y$




in theory: any function

Deep learning $x$  ... $\Rightarrow f(x)$

in practice

# The traditional way of extracting features: pre-defined representations


Source: Liang

# Representation learning: learning the features to extract

$x$

Learn $\phi(x)$

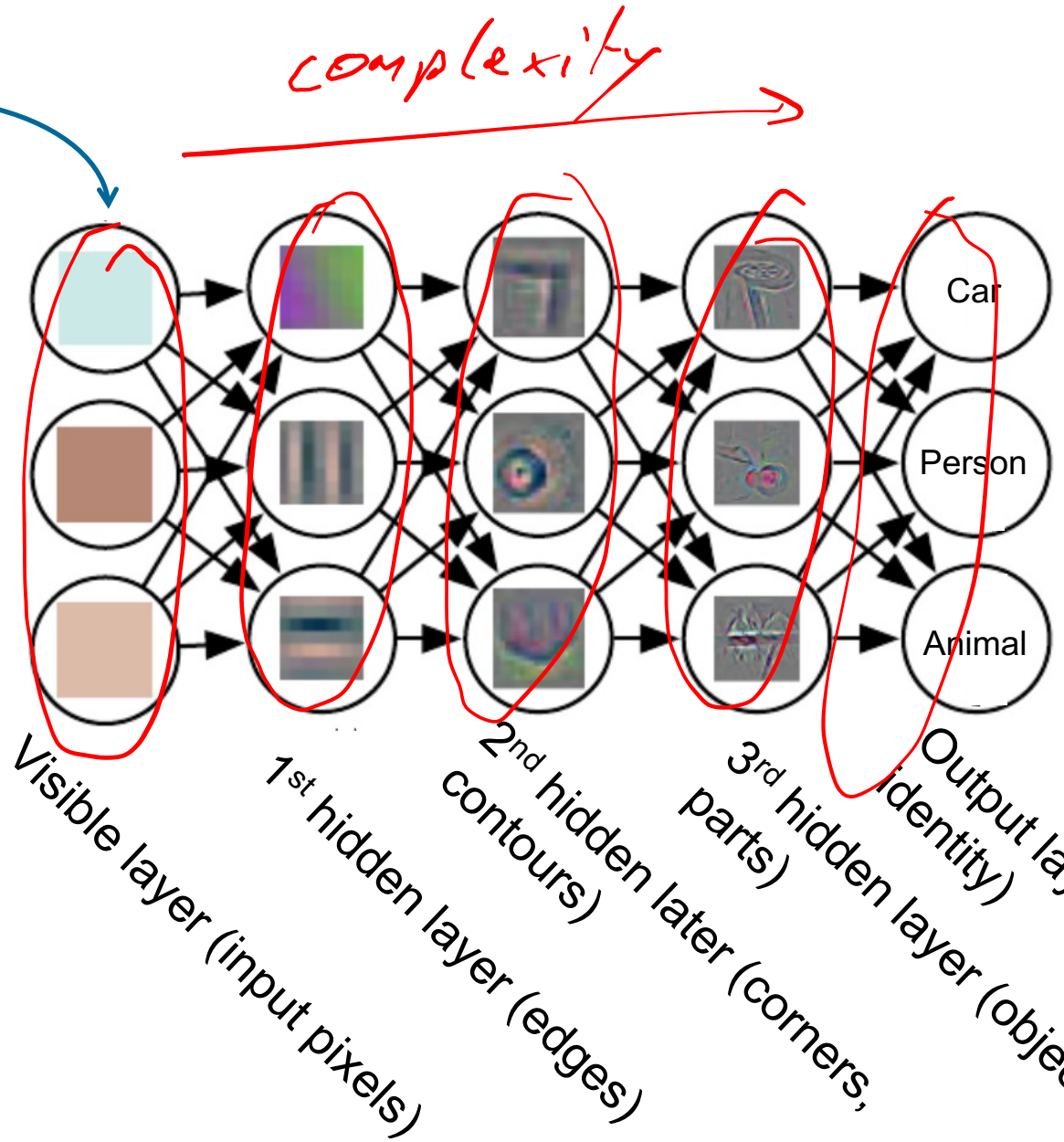
$\phi(x)$

Learn $w$

$$y = w^T \phi(x)$$

Source: Liang

# So what is the magic behind deep learning?




Source: Goodfellow et al.

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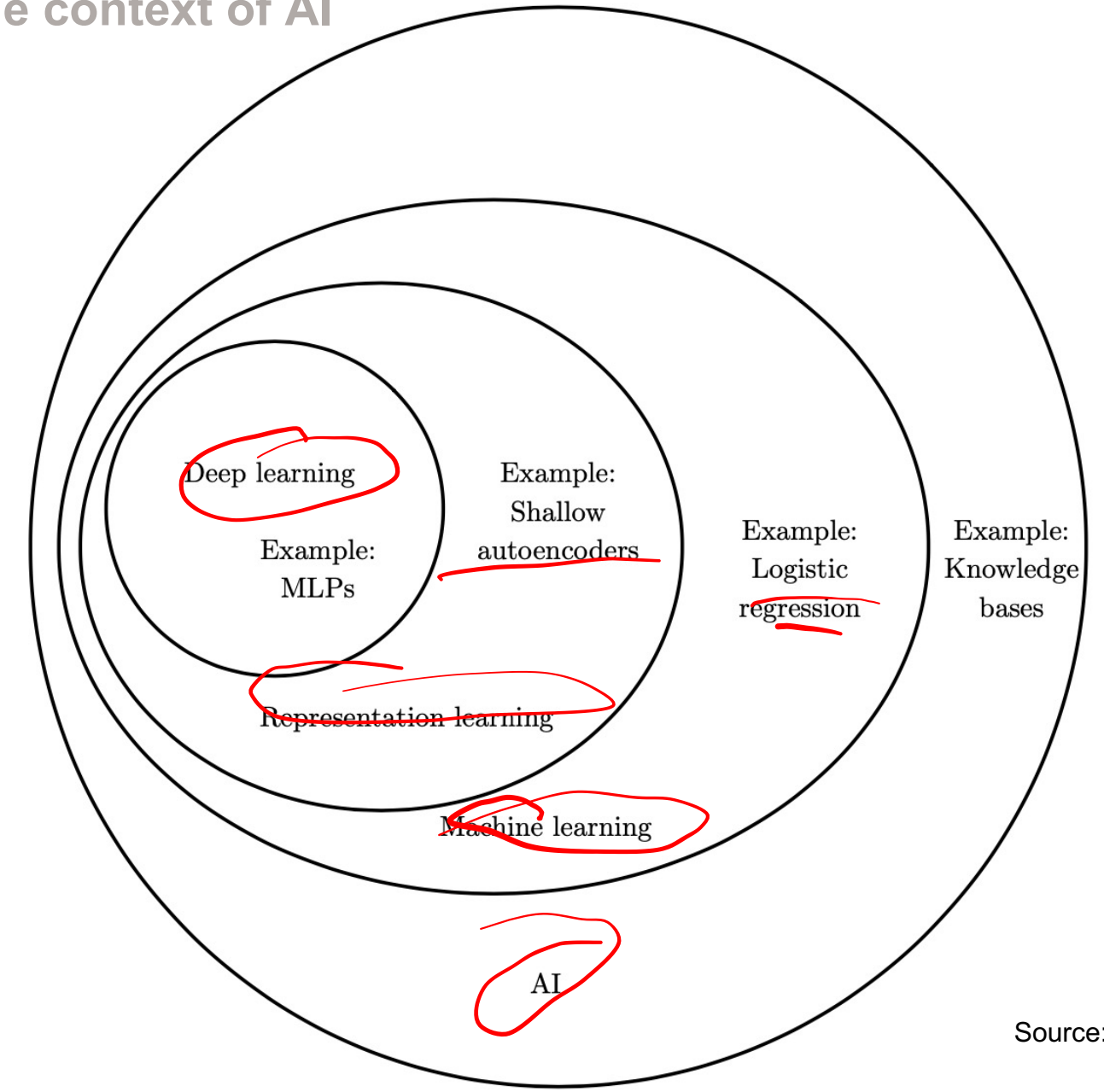
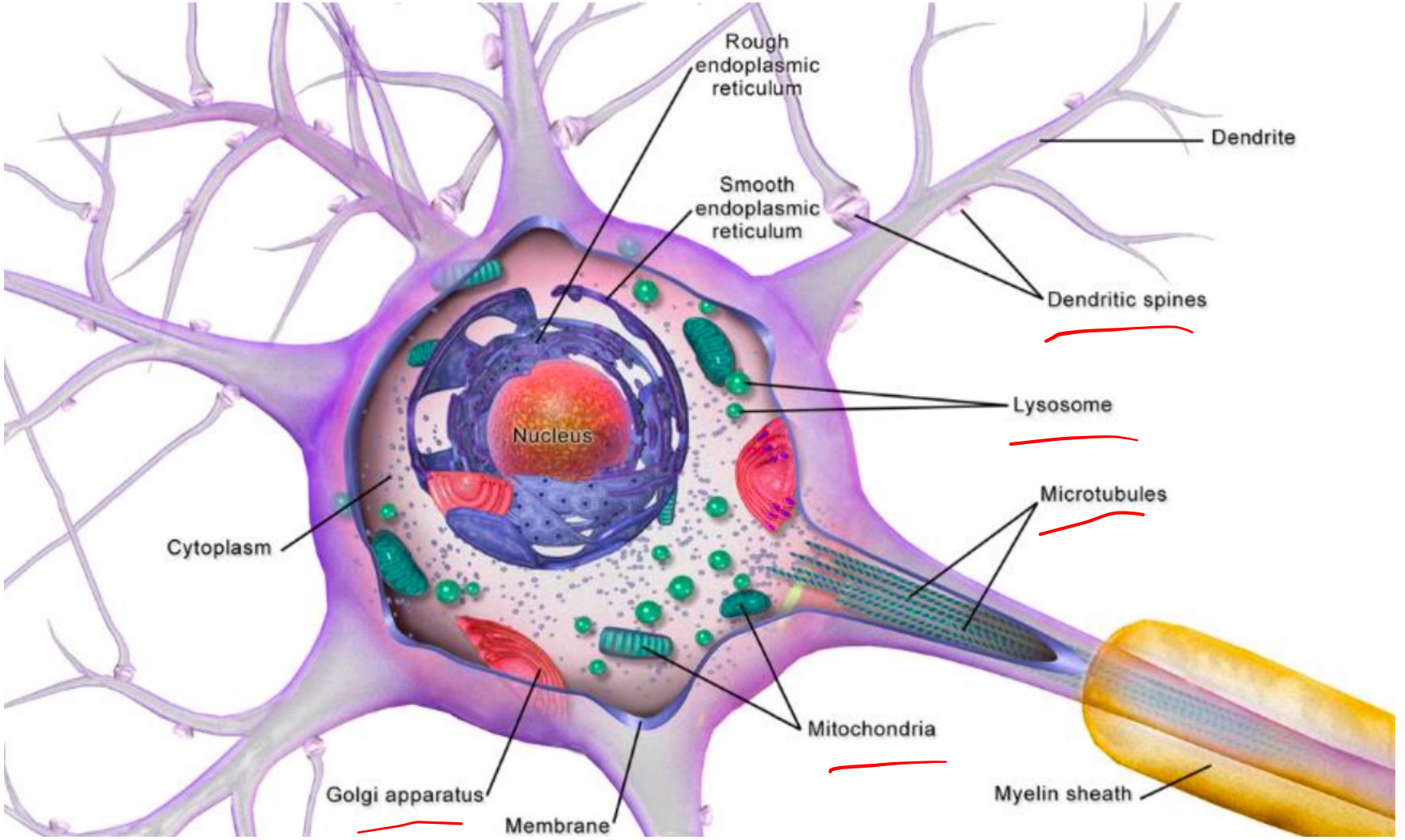
# Deep learning in the context of AI




Source: Goodfellow et al.

# The biological inspiration for “neural networks”




Source: Wikipedia

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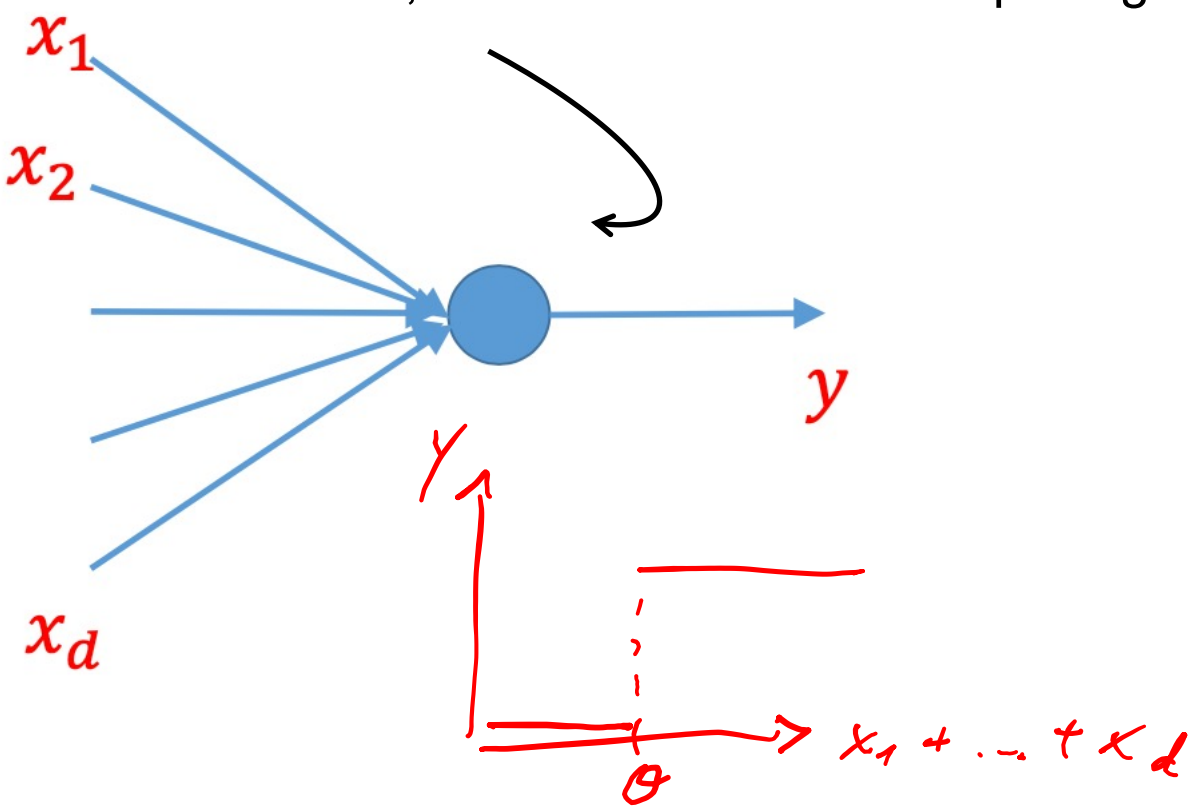
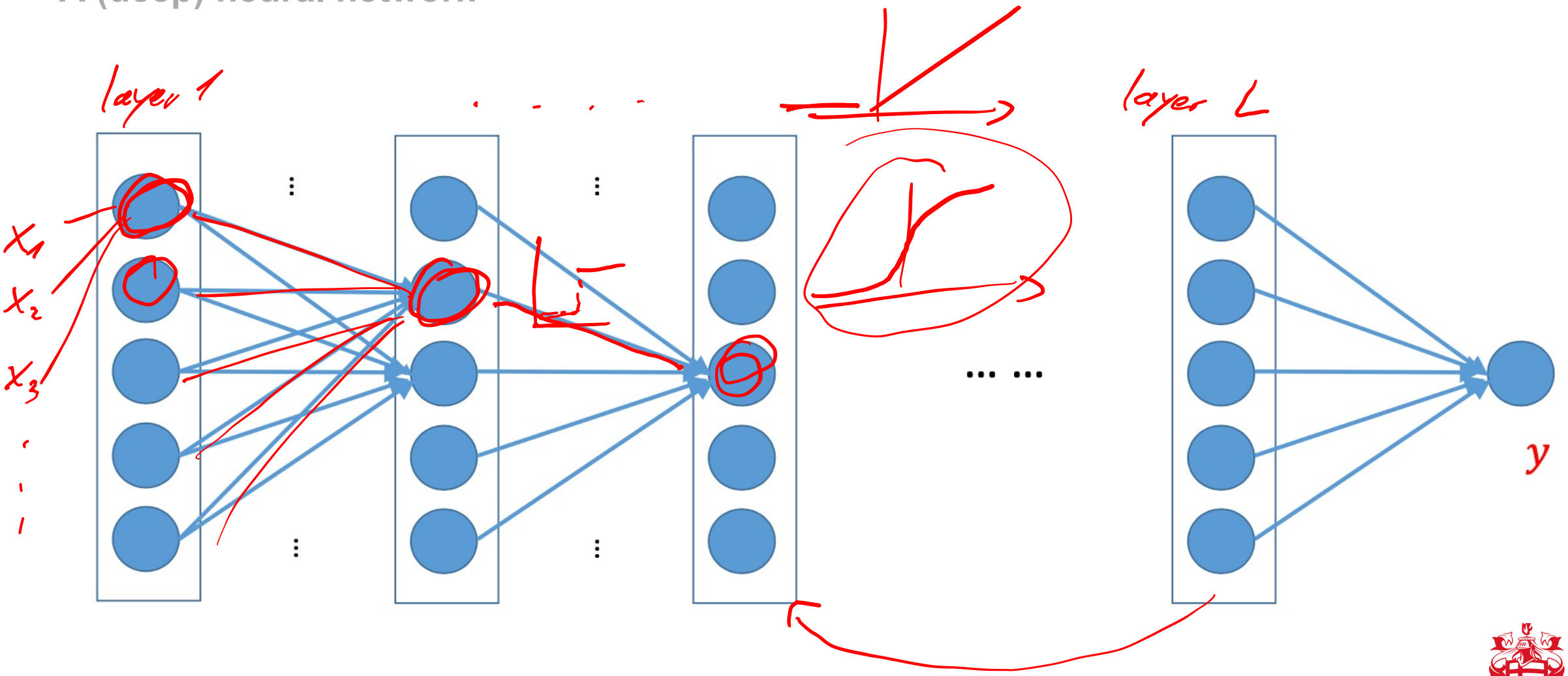
# An abstract model of a neuron

When the combined input signals reach a certain threshold, the neuron emits an output signal




So where are the input signals coming from?

# A (deep) neural network




Source: Liang

## Some challenges of deep learning

- Interpretation
- computational power
- hyperparameters
- lots of data (e.g. drug trial(s)) → simulations
- best if future ≈ past → physical
- best if input ≈ training
- no guarantees

# Learning objectives and modalities

# General modalities

**Lectures:**

- Video and exercise material to study **before** class (broken up into digestible bits), mostly to introduce new concepts and tools. I will release videos before the live class on Moodle and update you by email
- Two hours of face-to-face lecture every week during the term. This will be **very interactive**, and you will get plenty of chance to practice your coding and learn-by-doing

**Tutorials:**

- Three tutorials throughout the term, two hours each
- Focused on repeating difficult parts of the previous lecture(s) and going into more depth

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# Hybrid class norms

Please arrive on time – or even a couple of mins ahead of schedule

Please make sure to wear a mask at all times to protect yourselves and others

Please only use your computers for the task at hand: no social media, no browsing

Camera on please on Zoom. Use chat for raising clarification questions.

Come prepared to class: lecture learnt, homework done

# Learning objectives of the module

**Goals:** Provide you with the knowledge to

- feel comfortable with the key concepts relevant to deep learning
- be aware of the most important deep learning architectures
- know how to use TensorFlow to easily create neural networks in Python
- apply deep learning tools to solve relevant business problems

**How will we do this?**

- Some theory to understand the most fundamental concepts underlying neural networks
- Hands-on approach to programming neural networks
- Guided use of state-of-the-art frameworks and architectures

# A rough outline of the contents

- Introduction
- The necessary background: linear algebra and calculus
- Elements of neural networks
- Learning with neural networks (forward- and backward-propagation)
- Using programming frameworks, especially Keras and TensorFlow
- Advanced methods for programming neural networks: gradient descent improvements, regularization, hyperparameter tuning
- Convolutional neural networks: concepts
- Convolutional neural networks: content detection, facial recognition, and avoiding bias
- Recurrent neural networks: concepts
- Recurrent neural networks: recommender systems
- Recurrent neural networks: stock market price predictions

# Assessment

**Group assignment (50%):**
- Mid-term project

**Individual assignment (50%)**
- Final project

**Homeworks (ungraded)**
- From time to time

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# Communication and office hours

- Questions about assignments and homework will only be answered on the Q&A forum or during office hours

- Office hours:
  - Process: you know the drill
  - Time: Tuesday, 11 am – 12 pm, Link on Moodle (changes possible in some weeks, so take a look at the Moodle page first)

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# Time permitting: a first neural network

# Using a neural network to predict outcomes

Open https://playground.tensorflow.org/

1. A simple case of binary classification:
   - Change to the pattern on the lower left
   - Set the level of “Noise” to 50
   - Set “Ratio of training to test data” to 50%
   - Set up the neural network: 1 hidden layer, 1 neuron, then press play
   - Answer the following questions:
     - Did the training eventually find a model that seems to capture the pattern in the data?
     - How would you describe the pattern the model captured?
     - Record the “Training loss” and “Test loss”
   - How do your answers change when you select the bottom at the top right? What about setting the noise to 0?

# Using a neural network to predict outcomes

2. A shallow neural network:
   - Stick with the pattern at the top right, a noise of 0 and a ratio of 50%
   - Now use 3 neurons for your hidden layer
   - Answer the following questions:
     - Did the training eventually find a model that seems to capture the pattern in the data?
     - How would you describe the pattern the model captured?
     - Record the “Training loss” and “Test loss”
   - How do your answers change when you use 6 neurons instead?

3. A deep neural network:
   - Use a second hidden layer, with three neurons each (and the other setups from 2.)
   - Answer the following questions:
     - Did the training eventually find a model that seems to capture the pattern in the data?
     - How would you describe the pattern the model captured?
     - Record the “Training loss” and “Test loss”


See you next week!

# Sources


- Goodfellow, Bengio, Courville, 2016, The Deep Learning Book: http://www.deeplearningbook.org
- Kireyev, Evgenious, Brandwein, 2019, Preferred Networks: A Deep-Learning Startup Powers the Internet of Things
- Liang, 2016, Introduction to Deep Learning: https://www.cs.princeton.edu/courses/archive/spring16/cos495/
- Wikipedia, n.d., Neuron: https://en.wikipedia.org/wiki/Neuron