Applied Deep Learning

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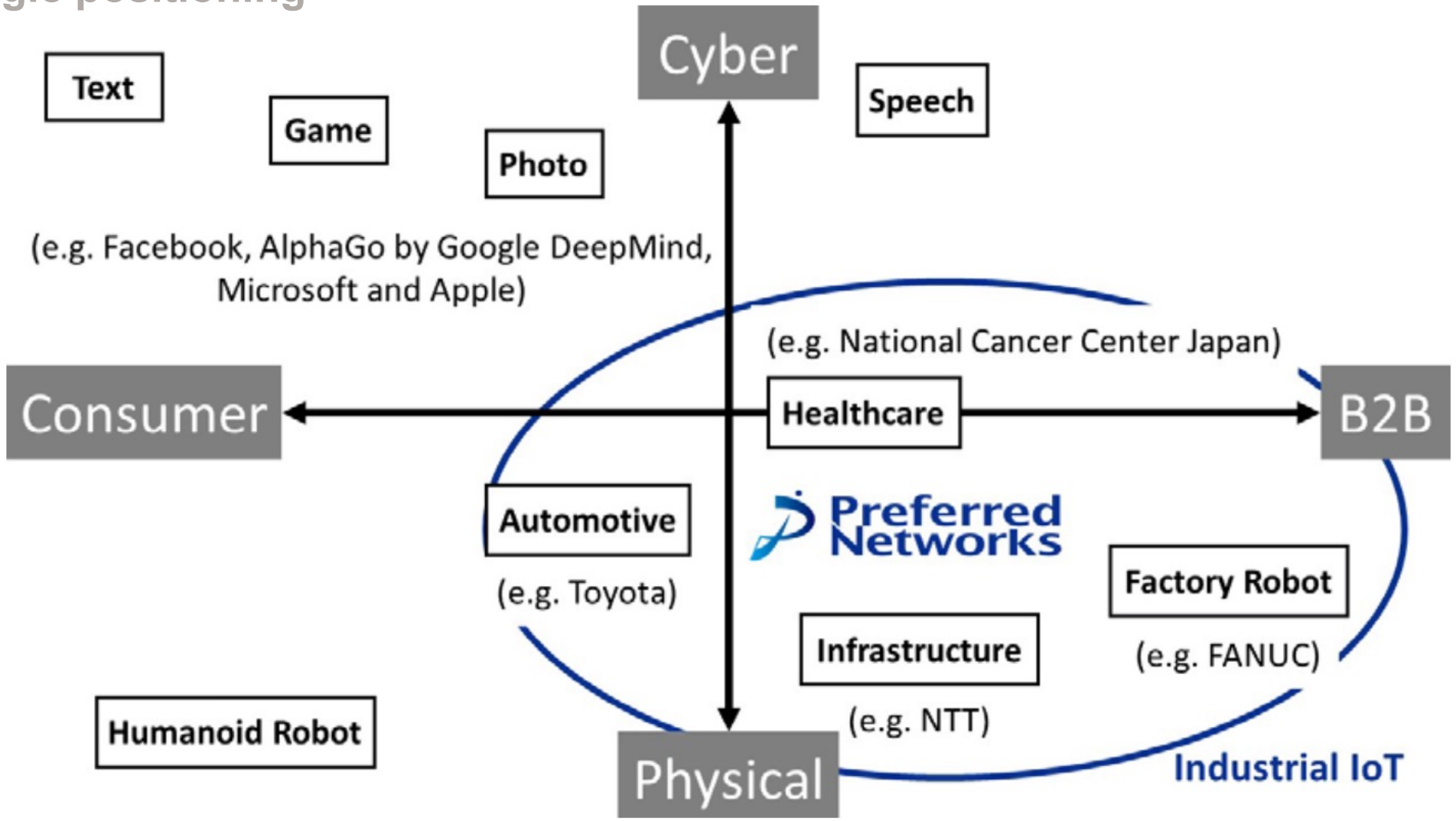
Preferred Networks

- 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”

Strategic positioning



Source: Company documents.

How is the technology operating?

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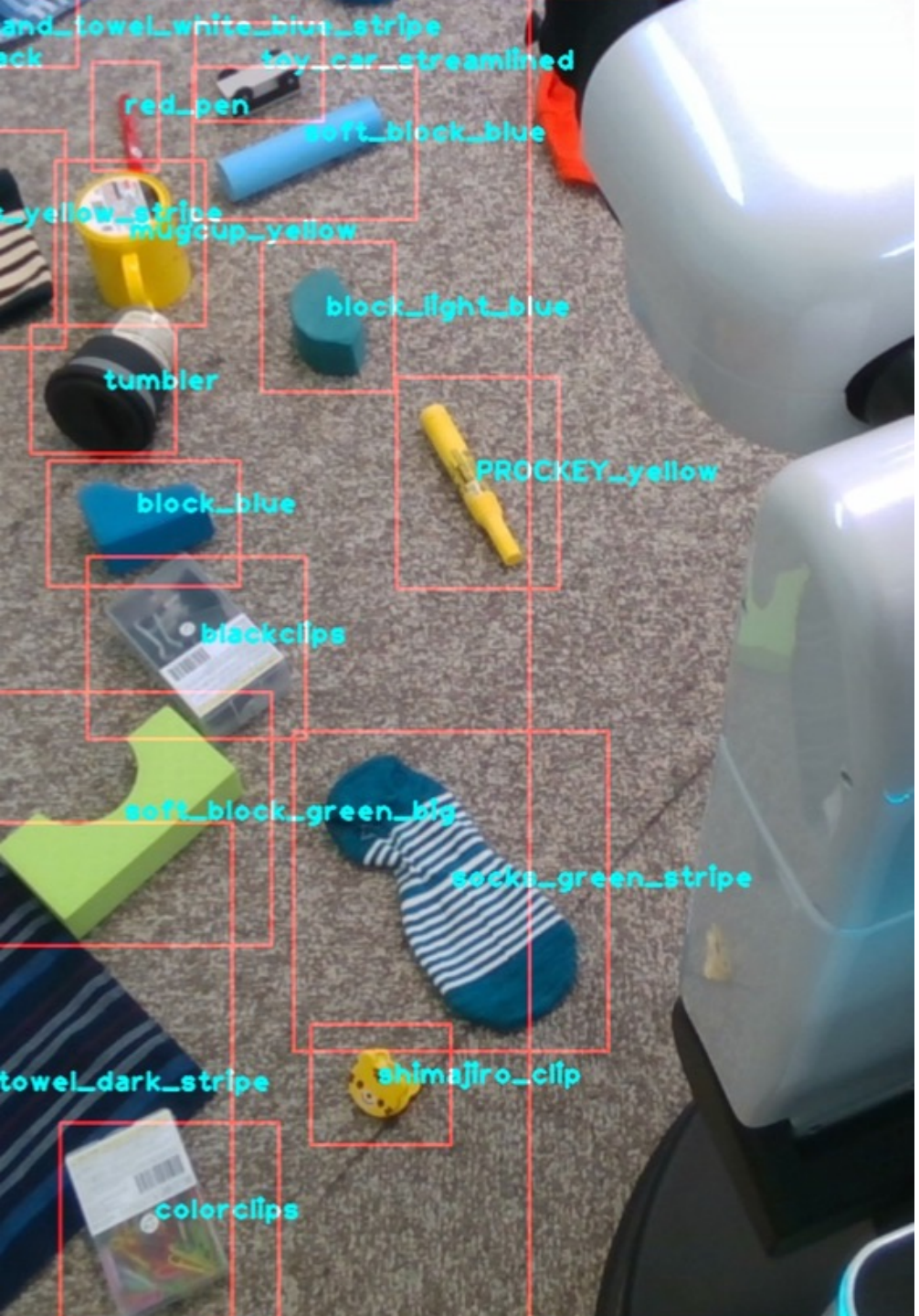
What business model might Preferred Networks use?



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?

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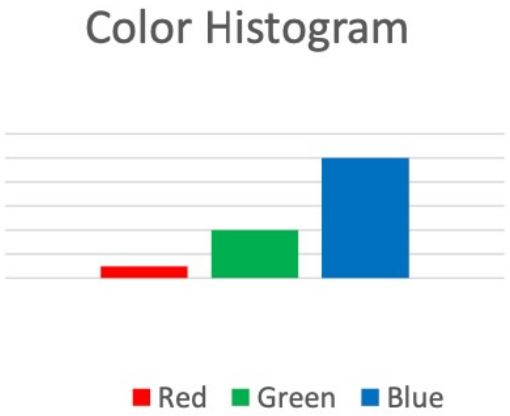
What is deep learning?

Deep learning according to the case

The traditional way of extracting features: pre-defined representations

x

Extract features



build hypothesis

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

Source: Liang

Representation learning: learning the features to extract

x

Learn $\phi(x)$

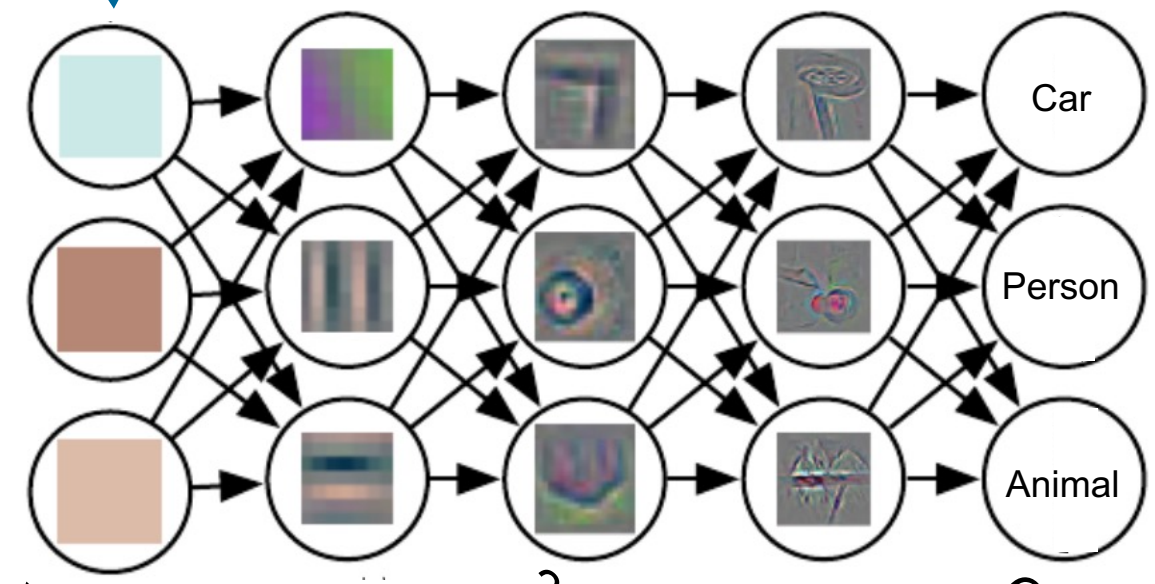
$\phi(x)$

Learn w

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

Source: Liang

So what is the magic behind deep learning?



Visible layer (input pixels)

1st hidden layer (edges)

2nd hidden later (corners, contours)

3rd hidden layer (object parts)

Output layer (object identity)

Source: Goodfellow et al.

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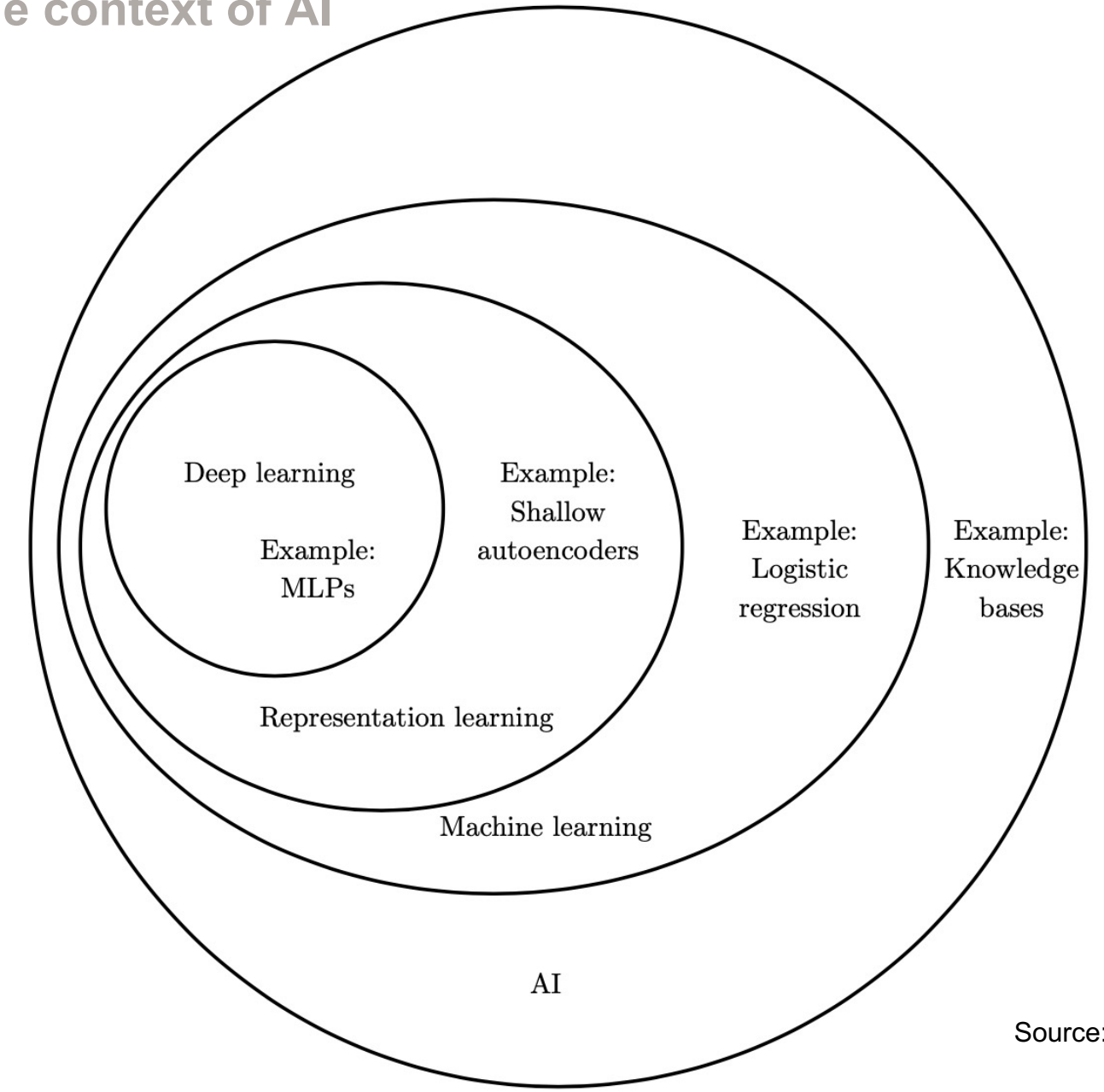
Deep learning in the context of AI



Source: Goodfellow et al.

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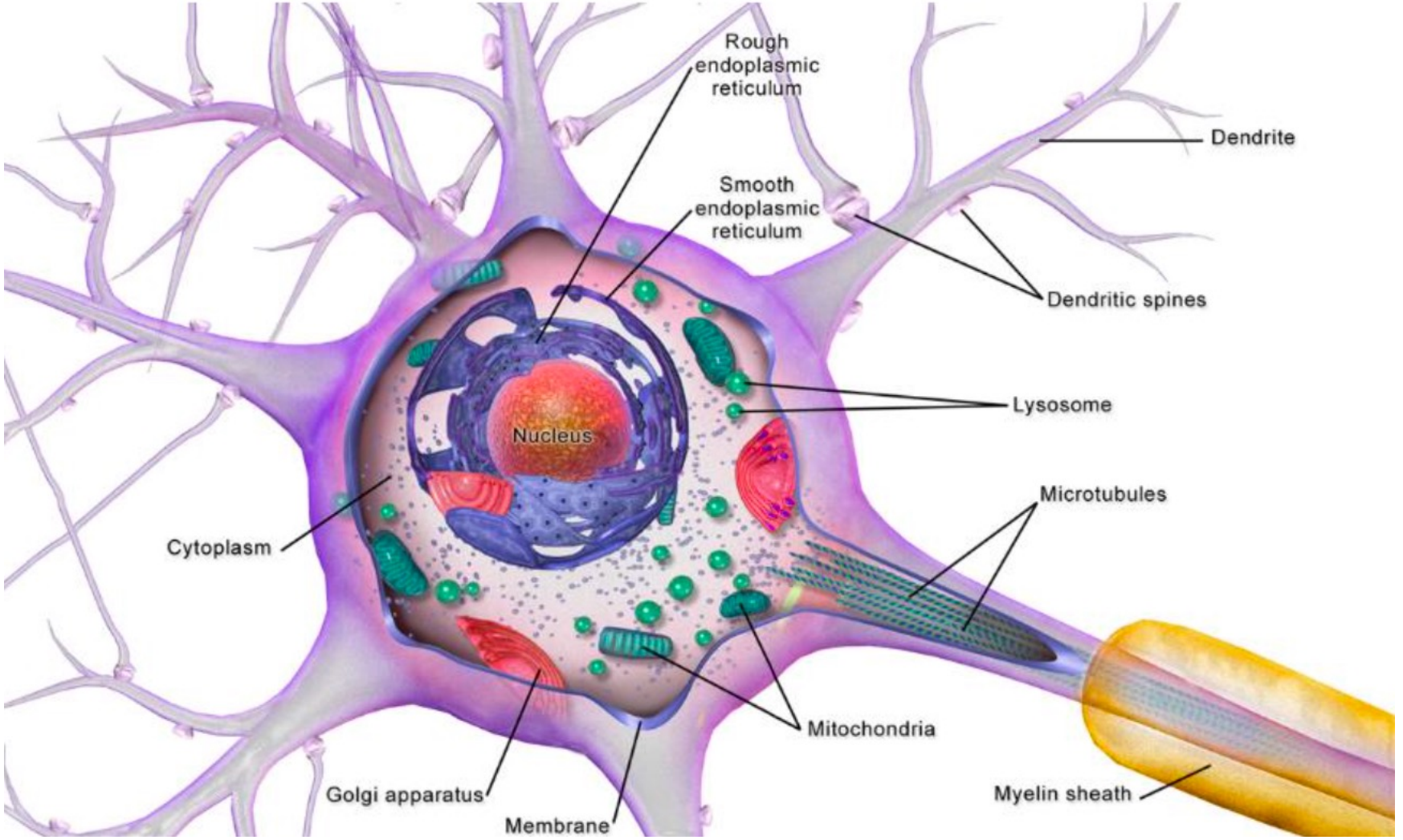
The biological inspiration for “neural networks”



Source: Wikipedia

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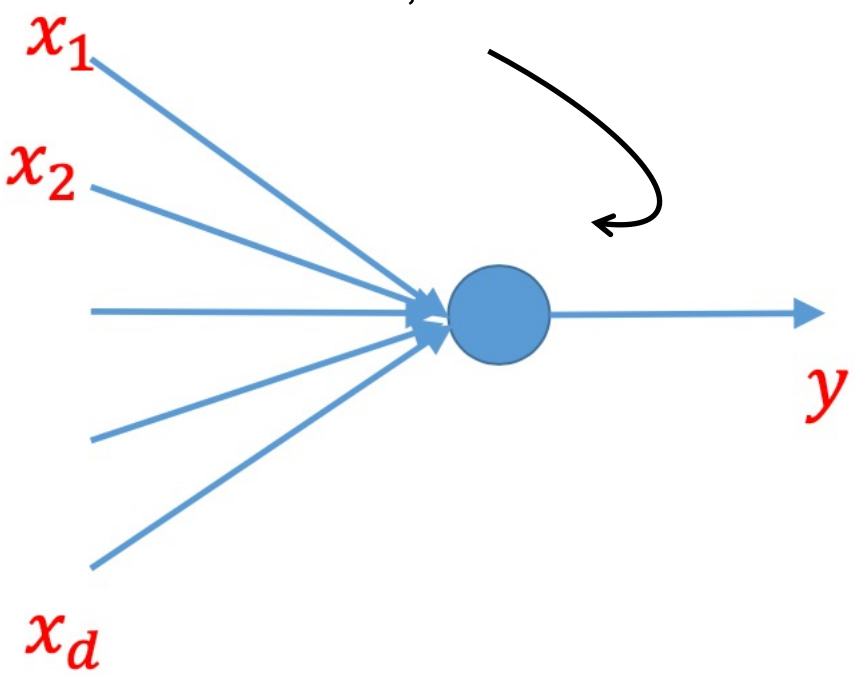
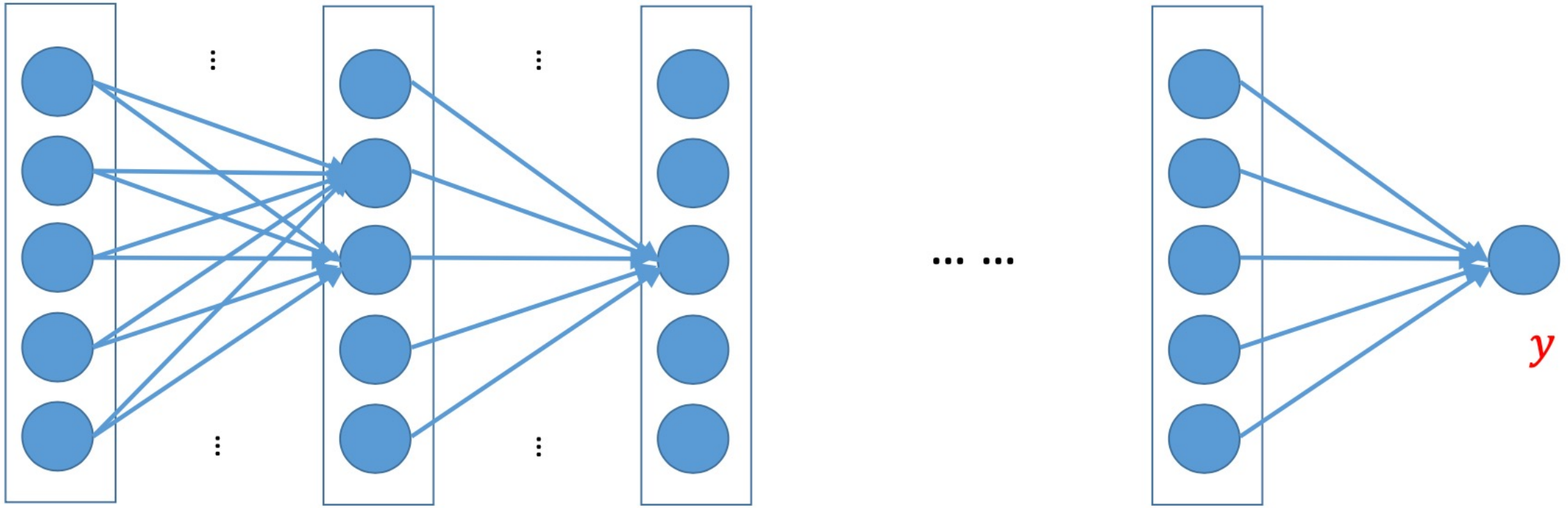
An abstract model of a neuron

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

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)

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