Applied Deep Learning

Dr. Philippe Blaettchen
Bayes Business School (formerly Cass)

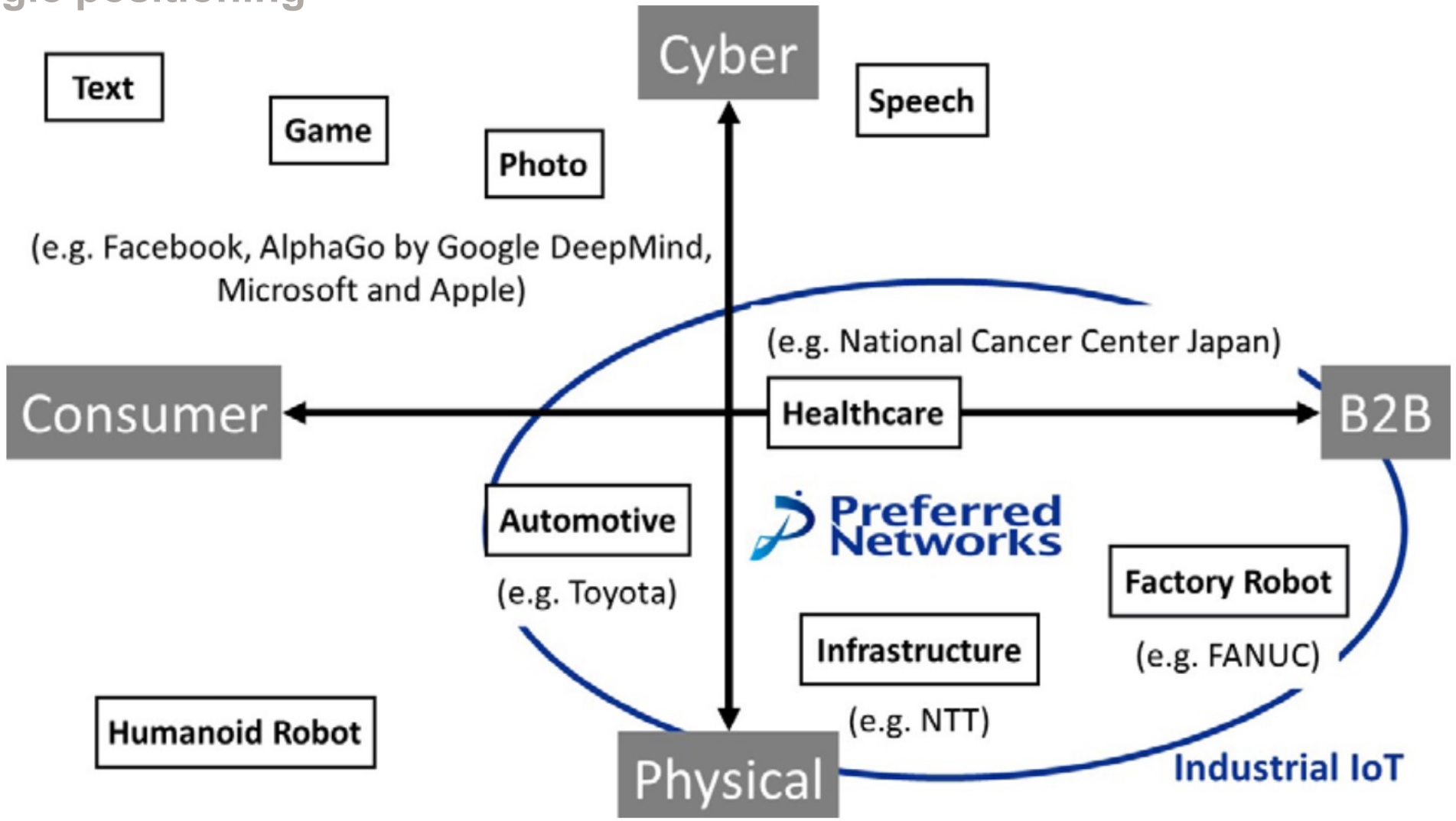
www.bayes.city.ac.uk

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”

- Partnership with Toyota. Safer/autnomous driving
- Fanuc: robotics → learning
- Branch out: healthcare and biotech

Strategic positioning



Source: Company documents.

How is the technology operating?

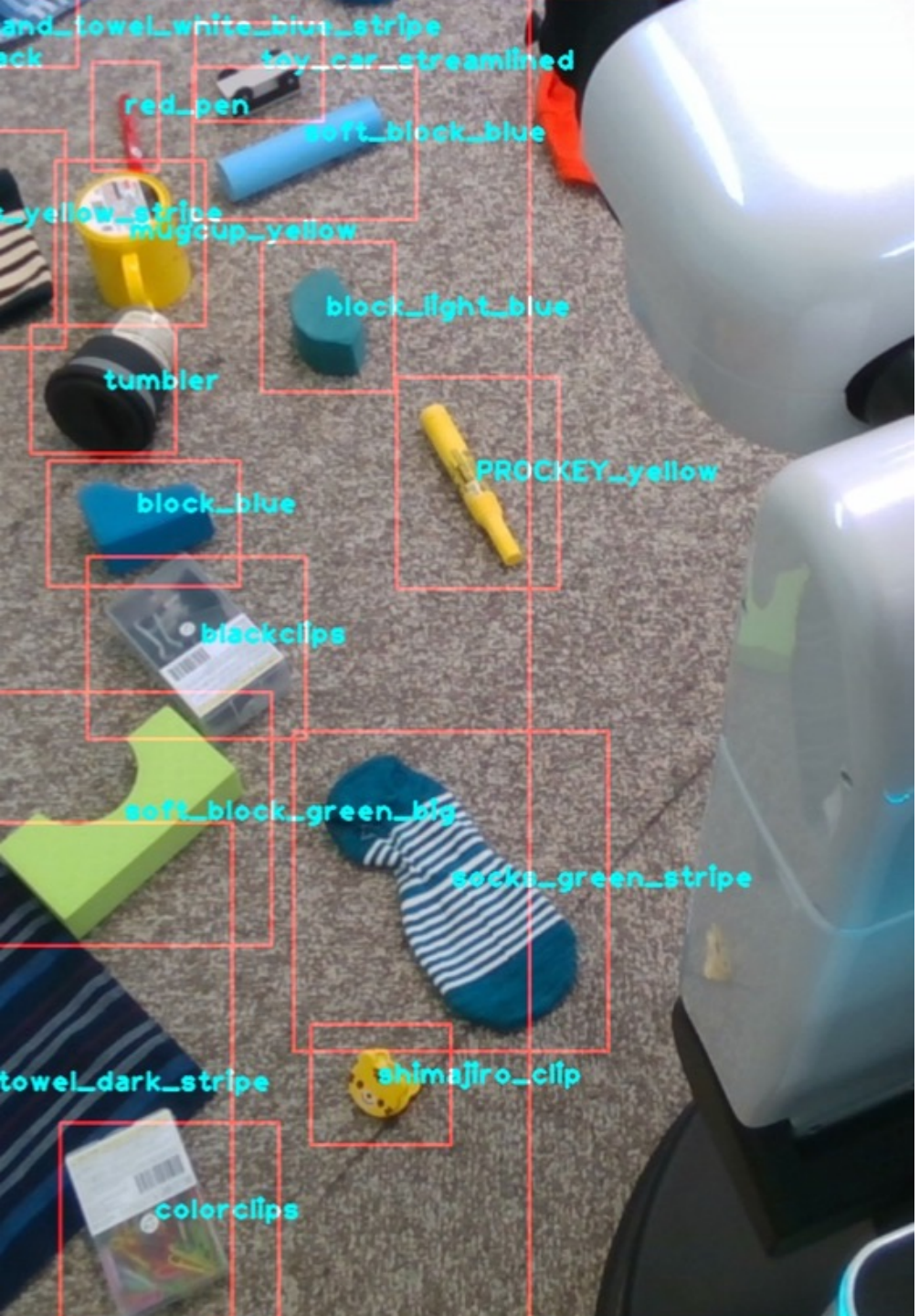
Bin picking: robot picks things and takes images → success or failure
→ Creating our own dataset
→ Learn how to pick

Image recognition → target specific item → bin picking
Speech recognition → find item

Autonomous car: camera/image recognition → Action → Reward (crash: negative, follow the arrow: positive) (reinforcement learning)

What business model might Preferred Networks use?

Toyota, Fanuc, Hitachi (Integrator/Partner)
Biotech/Healthcare (Profit Sharing)
Personal robots (Product Development)
DeepMind (Sell IP)



In groups, 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?

Integrator:
+ Have some data through partner
+ Resources
- Push to cut costs
- Lack of scaling

Profit sharing:
+ Some data through customers
- Ensure sufficient usage

Product development:
- Lack access to data
- Infrastructure lack

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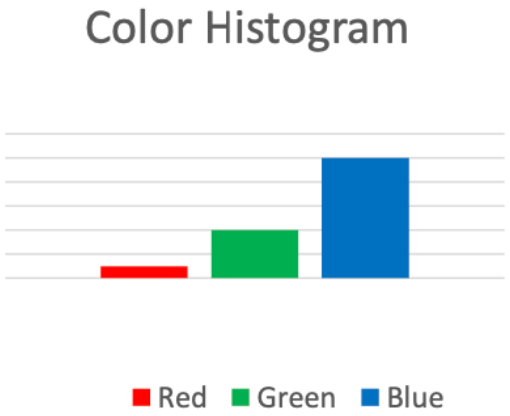
What is deep learning?

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 $\phi(x)$

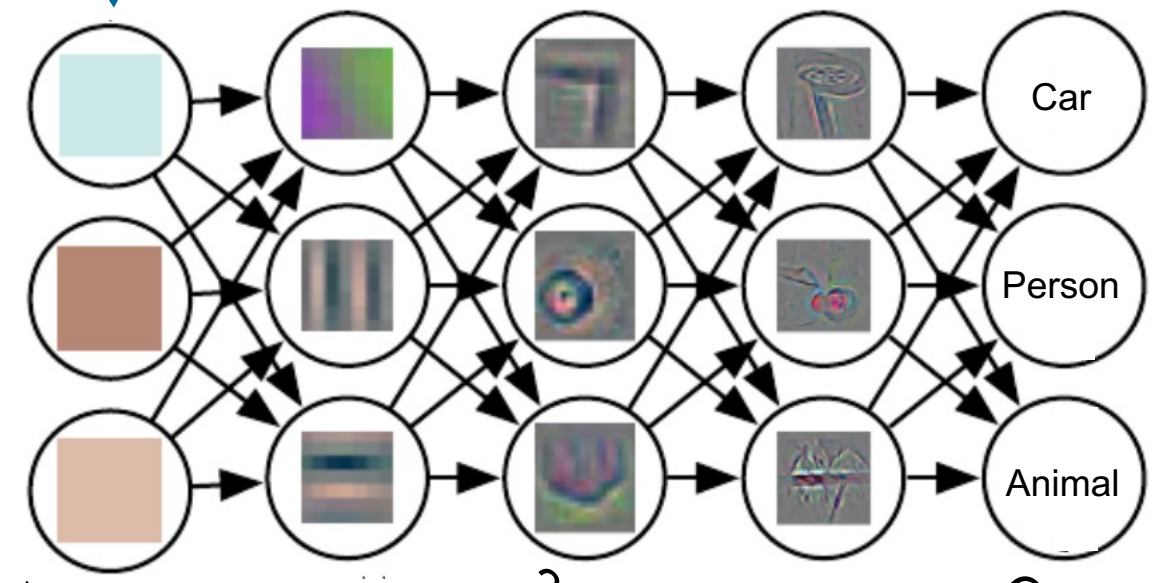
$\phi(x)$

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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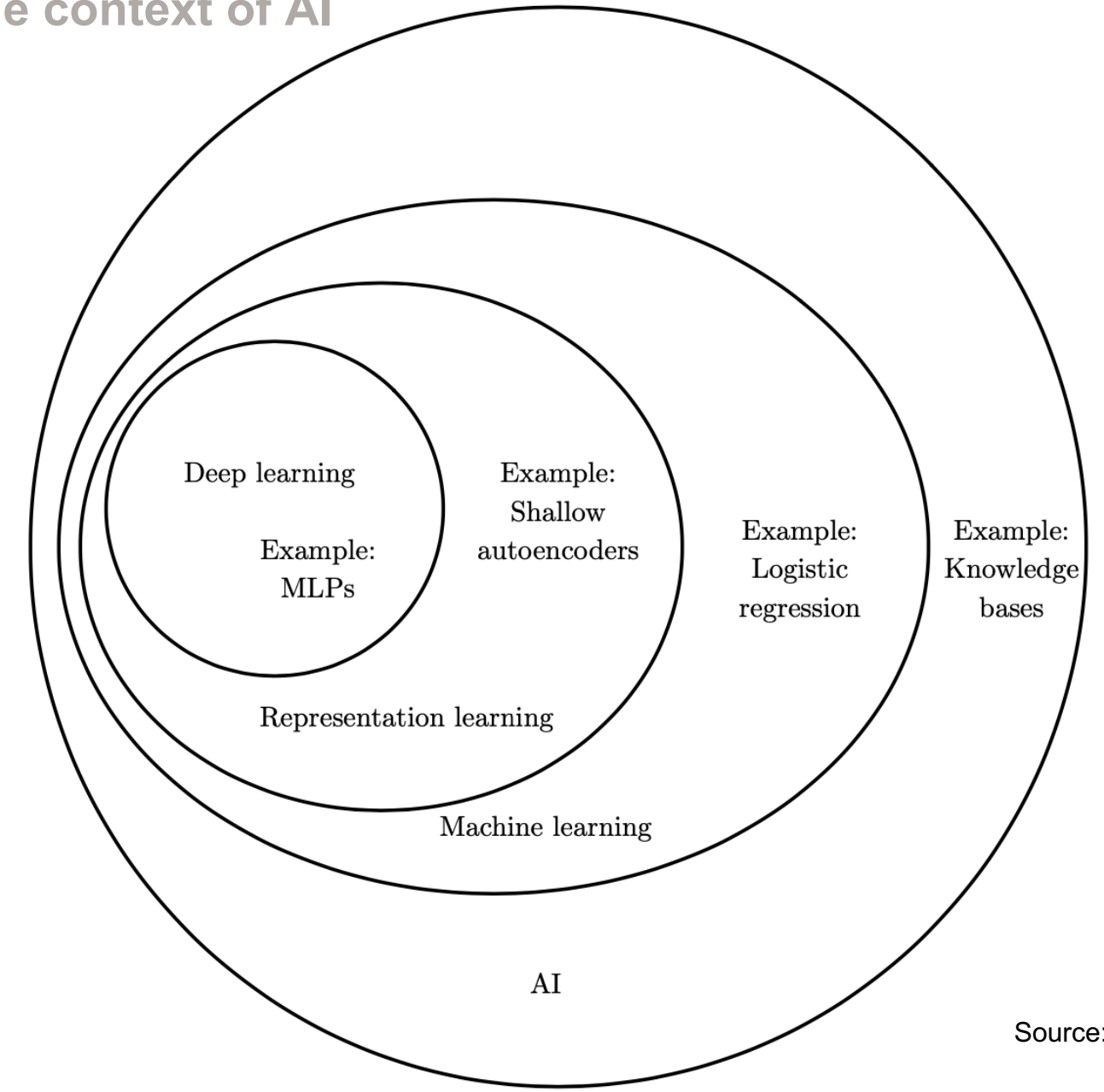
Deep learning in the context of AI



Source: Goodfellow et al.

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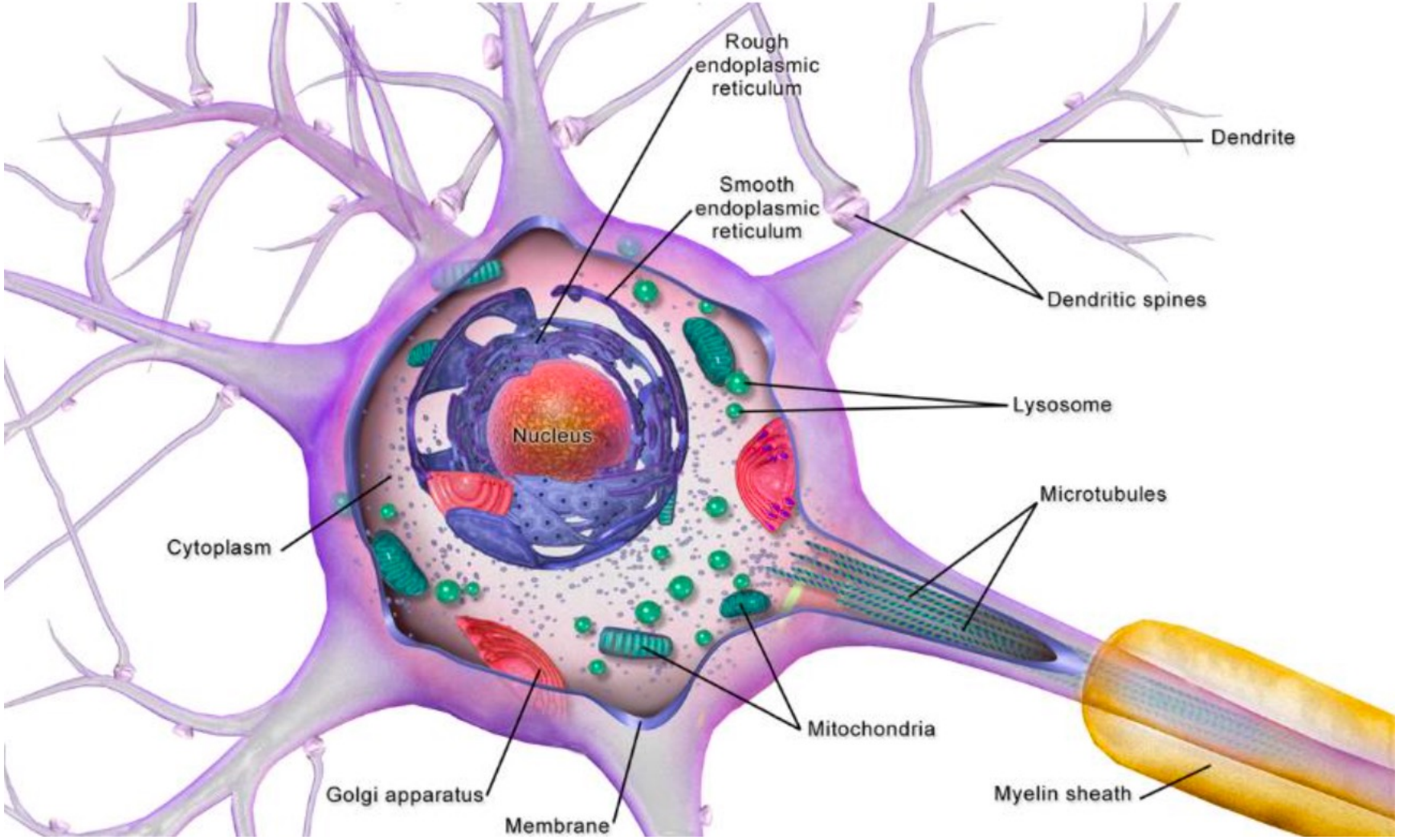
The biological inspiration for “neural networks”



Source: Wikipedia

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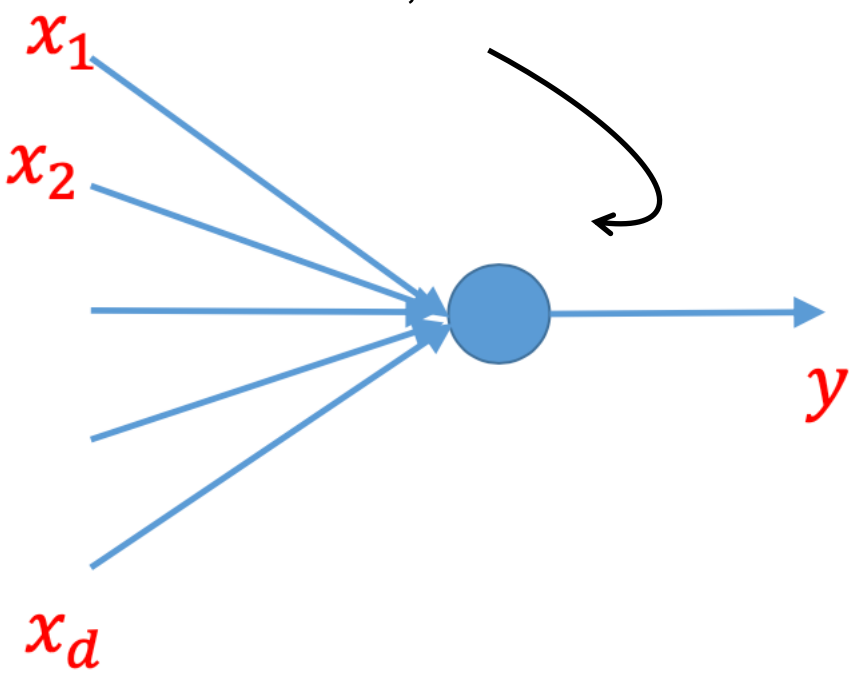
An abstract model of a neuron

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



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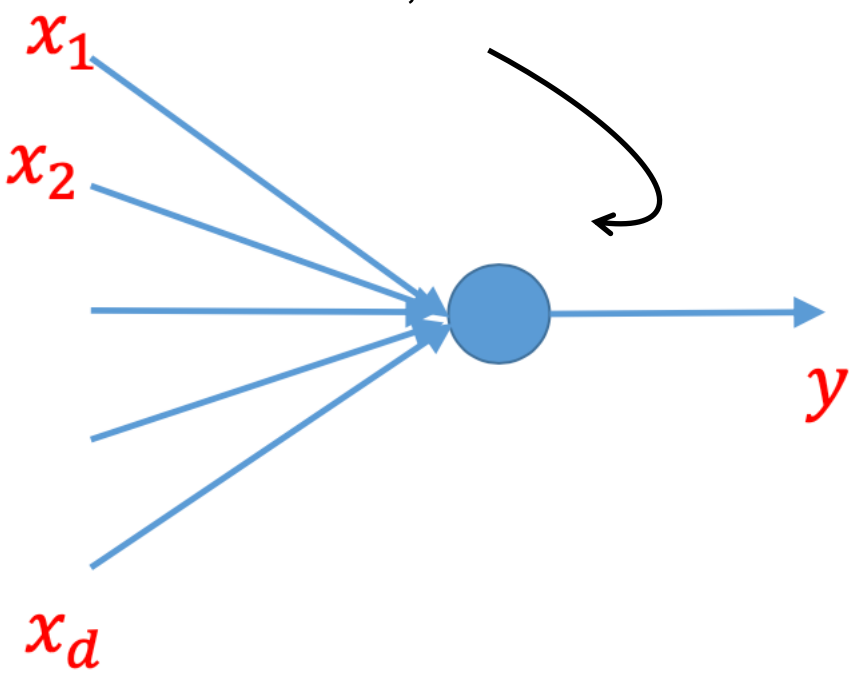
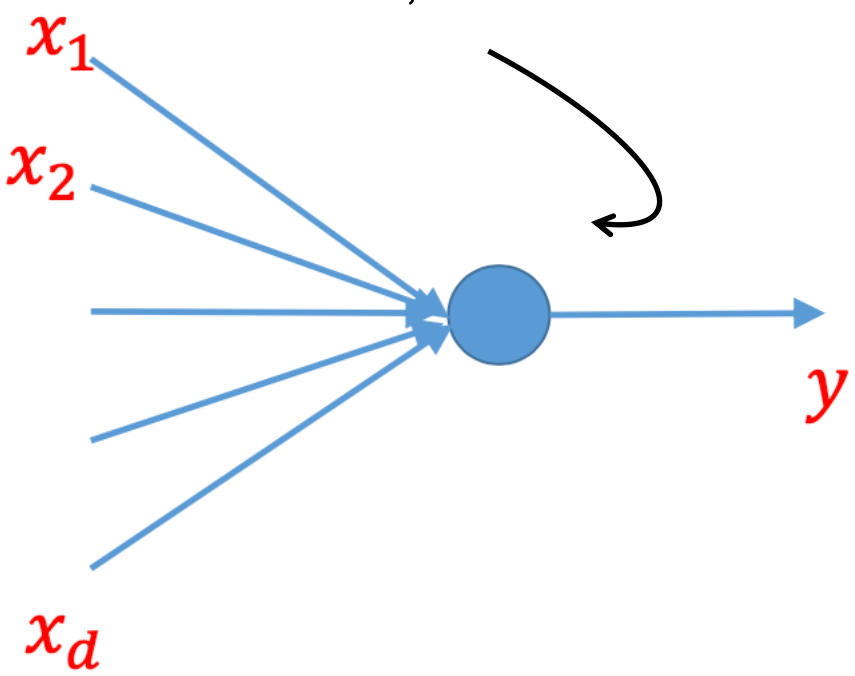
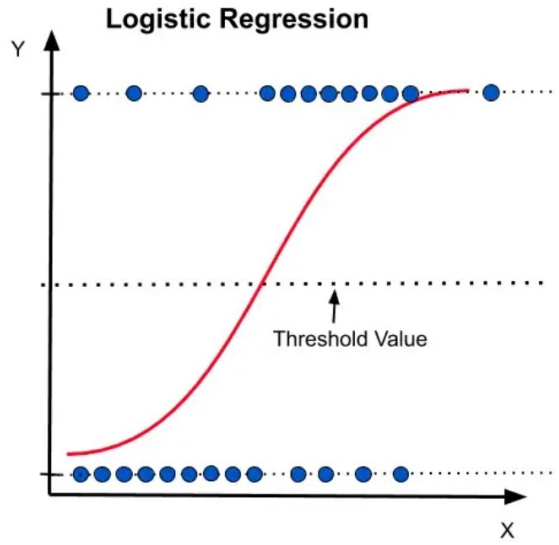


So where are the input signals coming from?

An abstract model of a neuron

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





Congratulations! You've created a logistic regression!

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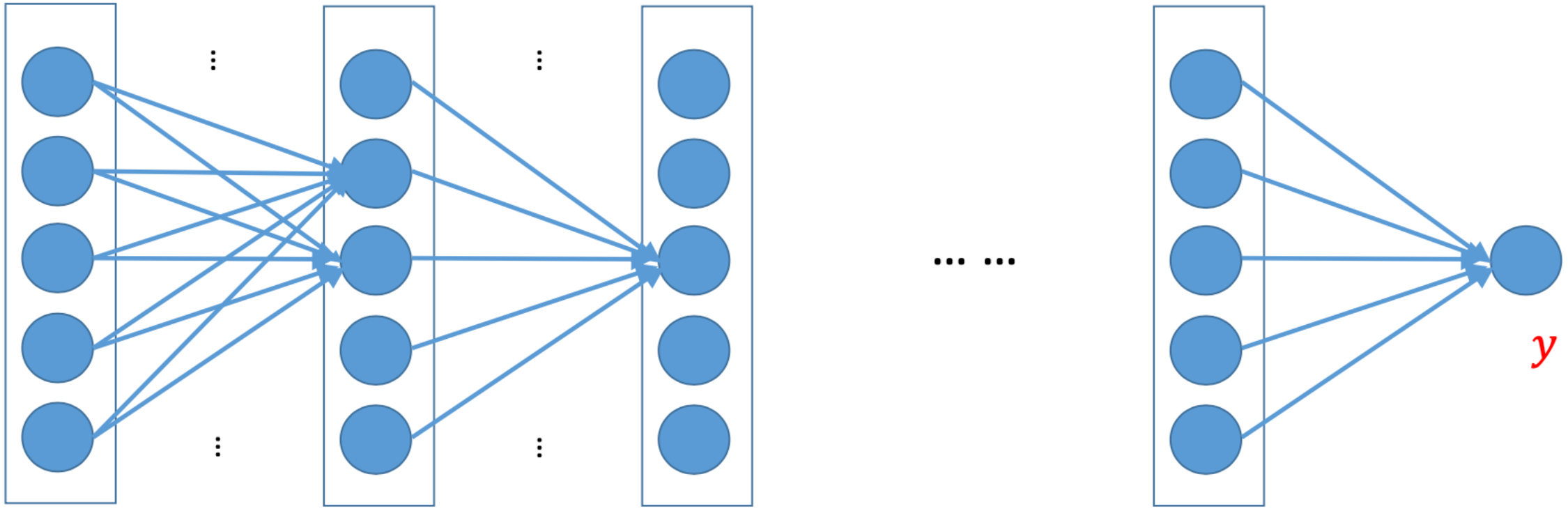
A (deep) neural network



Source: Liang

Some challenges of deep learning

Computational power
Data availability
Right algorithm
Difficult to interpret what comes out / Black box
Input should be roughly like the past
Rare situations
No guarantees

Application areas

Structured problems

- Most of the examples so far in the programme
- Shallow learning good enough
- Key tool today: Gradient Boosting

Perceptual problems

- Things that humans are good at intuitively, but that are hard to teach to computers
- Shallow learning insufficient
- Key tool today: Neural Networks

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- Image recognition and generation
- Speech recognition and generation
- Translation

→ Let's see it in action!

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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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Assessment

Group assignment (50%):

- Mid-term project

Individual assignment (50%)

- Final project
- Individual means individual. You have to create your **own solution**. That includes the code you use.
  - If you use code blocks from outside the course materials, make sure you cite it appropriately

Homeworks

- In some weeks. Make sure to complete it in order to follow the content – we will move fast!
- In two or three weeks, you can submit your answer to receive a bonus point.

Class norms

Come **prepared** to class: **lectures** learnt, **homework** done, **pre-class materials** completed, **notebooks** downloaded

Please arrive on time – or even a couple of mins ahead of schedule (I know, it's not easy at 9 am)

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

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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 back-propagation)
- Using programming frameworks, especially Keras and TensorFlow
- Advanced methods for programming neural networks: gradient descent improvements, regularization, hyperparameter tuning
- Convolutional neural networks: concepts, medical diagnosis
- Convolutional neural networks: content detection, facial recognition, and avoiding bias
- Recurrent neural networks: concepts
- Recurrent neural networks: natural language processing
- Transformers: concepts and natural language processing

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: Monday, 5pm-6pm, Link on Moodle (changes possible in some weeks, so take a look at the Moodle page first)

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See you next week!

Sources

- Chollet, 2021, Deep Learning with Python (2nd edition)
- 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