

Introduction to Deep Learning

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Research in Cluj

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Machine Learning

What is machine learning?

What is machine learning?

To **learn** = algorithmically
find the choice of
parameters that best
explain the data.

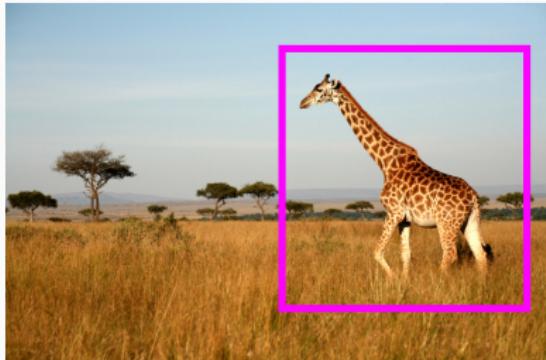
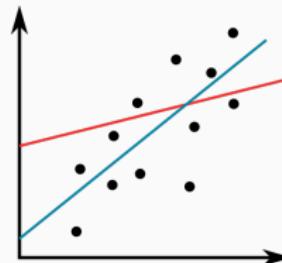
What is machine learning?

Example learning tasks

Find the line that best fits the points.

Find giraffes in pictures.

To **learn** = algorithmically
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Machine learning - Where are we now?

Current uses of ML algorithms in industry:

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- automatic image captioning
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- medical diagnosis
- language understanding and translation

Machine learning - Where do we want to be?

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In the short term:

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In the short term:

- increase robustness

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Machine learning - Where do we want to be?

In the long term:

- algorithms that learn what to learn

In the short term:

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Machine learning - Where do we want to be?

In the long term:

- algorithms that learn what to learn
- general AI?

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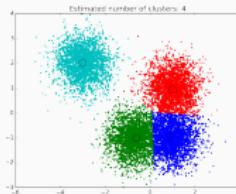
Machine learning - Common algorithms

Commonly used algorithms are:

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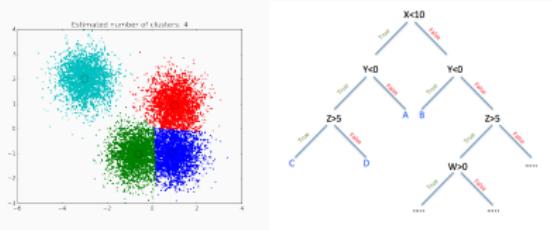
- K-means clustering



Machine learning - Common algorithms

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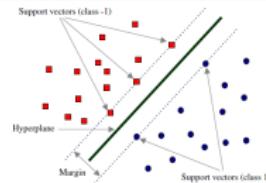
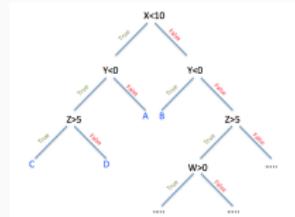
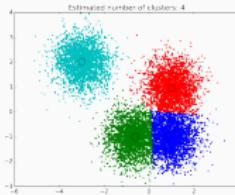
- K-means clustering
- Decision trees



Machine learning - Common algorithms

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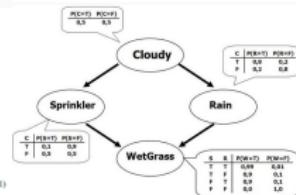
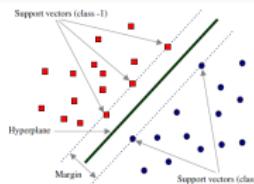
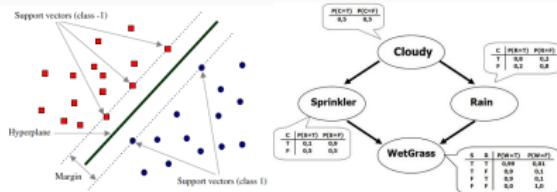
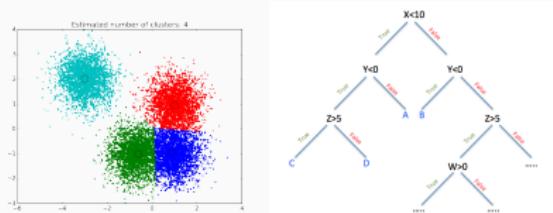
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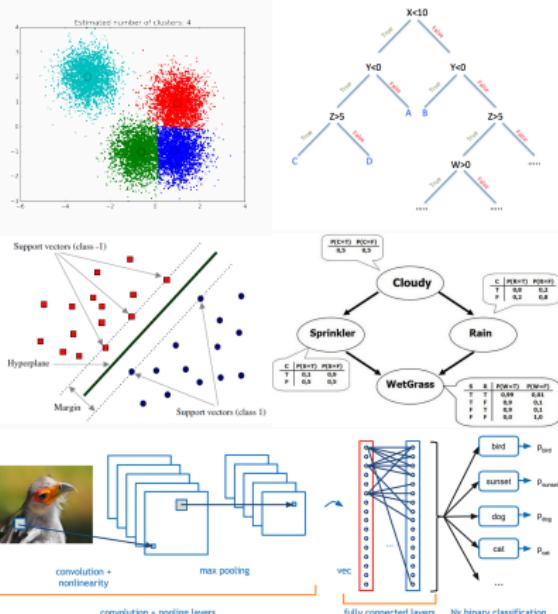
- K-means clustering
- Decision trees
- Support vector machines
- Bayesian networks



Machine learning - Common algorithms

Commonly used algorithms are:

- K-means clustering
- Decision trees
- Support vector machines
- Bayesian networks
- Deep learning / Neural networks



Deep learning

Deep learning - What is it?

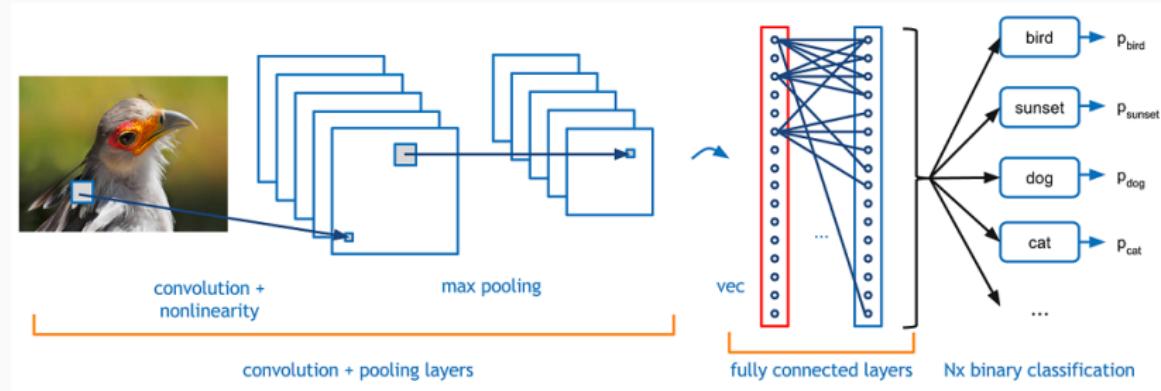
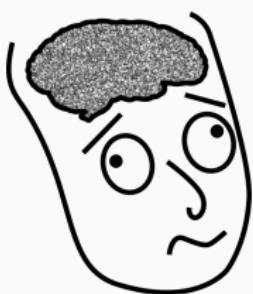


Figure 2: Arguably complicated figure that you won't understand.

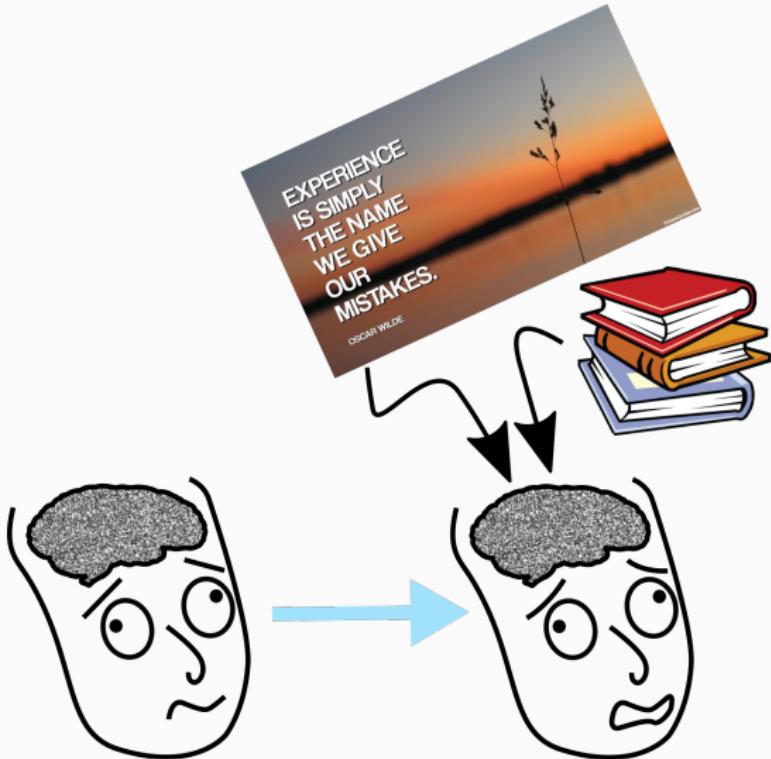
Deep learning:

- A particular **subset** of ML algorithms a.k.a. “enhanced neural networks”
- The closest to an **ideal learning agent**

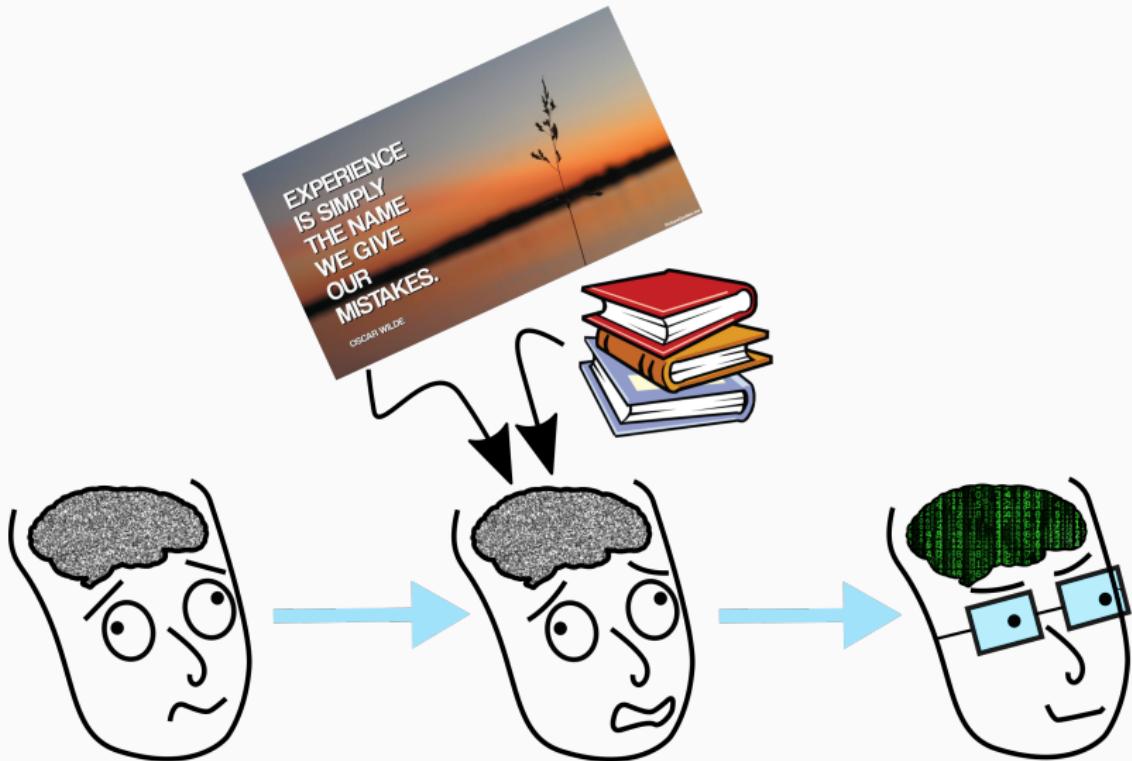
Ideal learning agent



Ideal learning agent



Ideal learning agent



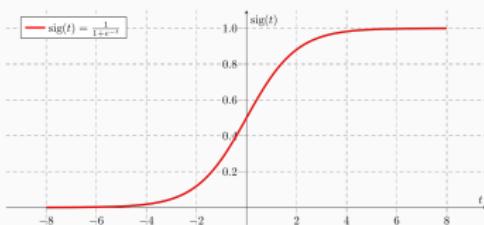
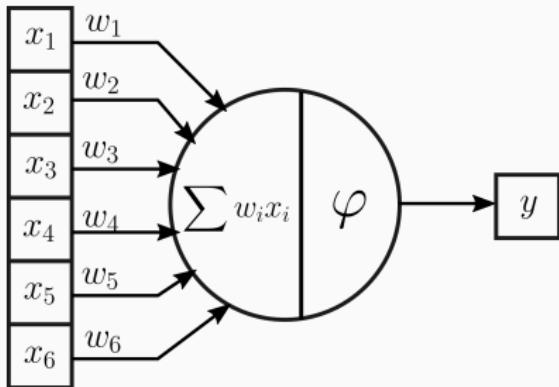
Enhanced neural networks

Enhanced neural networks

“Deep learning” can be translated to: “enhanced neural networks”.

– Paul Drăgan, some minutes ago

Artificial neuron



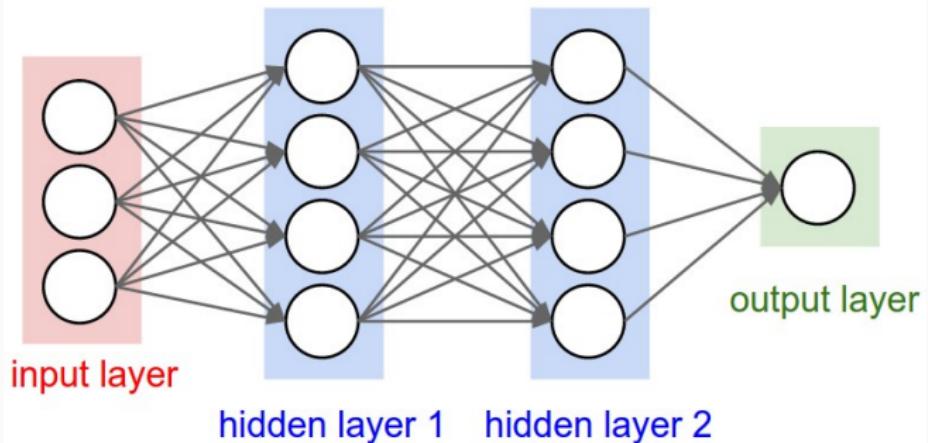
The sigmoid activation function φ .

Where:

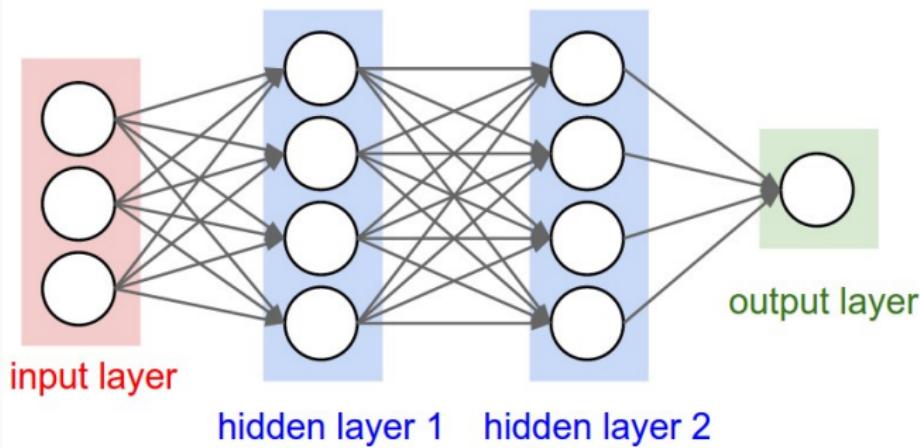
- x_i are the inputs
- w_i are the weights
- φ is the activation function
- y is the output

The weights w_i are **free parameters** -> they can be trained / learned.

Neural networks



Neural networks



Neural networks are theoretically guaranteed to be **universal function approximators**.

Universal function approximators

Universal function approximators

Simple mathematical functions:

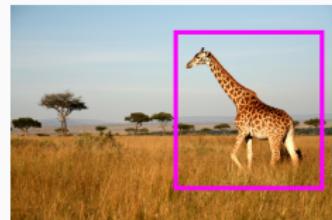
$$x \mapsto y \quad f(x) = x^2 + 1 = y$$

Universal function approximators

Simple mathematical functions:

$$x \mapsto y \quad f(x) = x^2 + 1 = y$$

Giraffe detection:

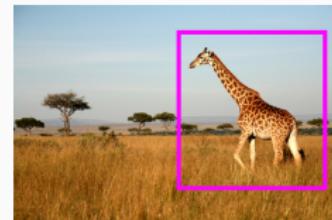


Universal function approximators

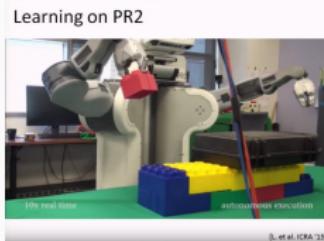
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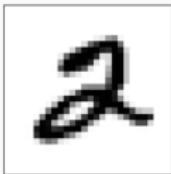
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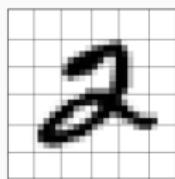
Robot trajectories:



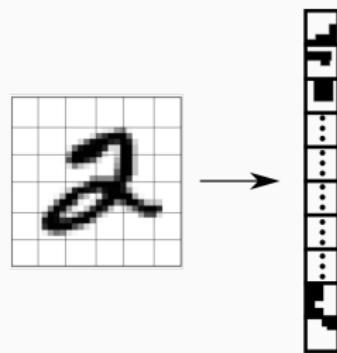
Training neural networks



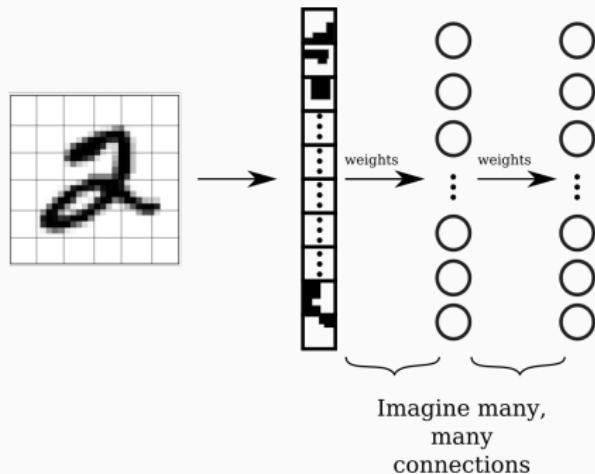
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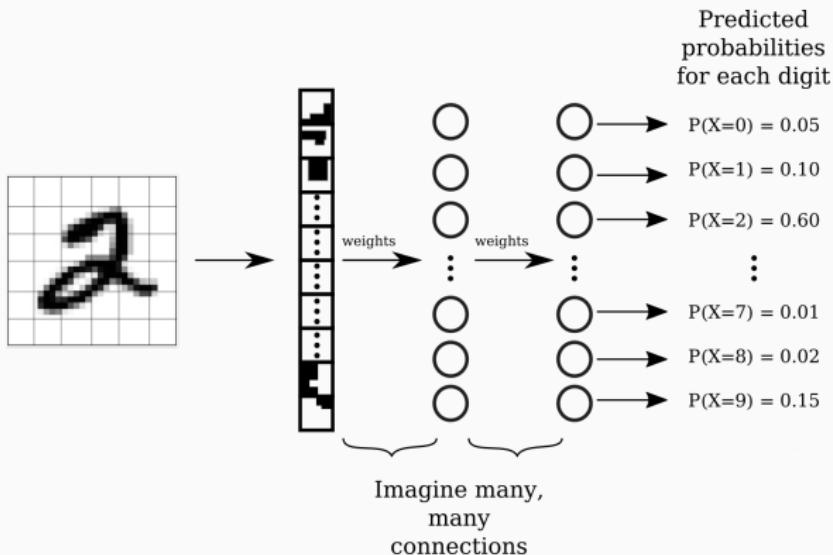
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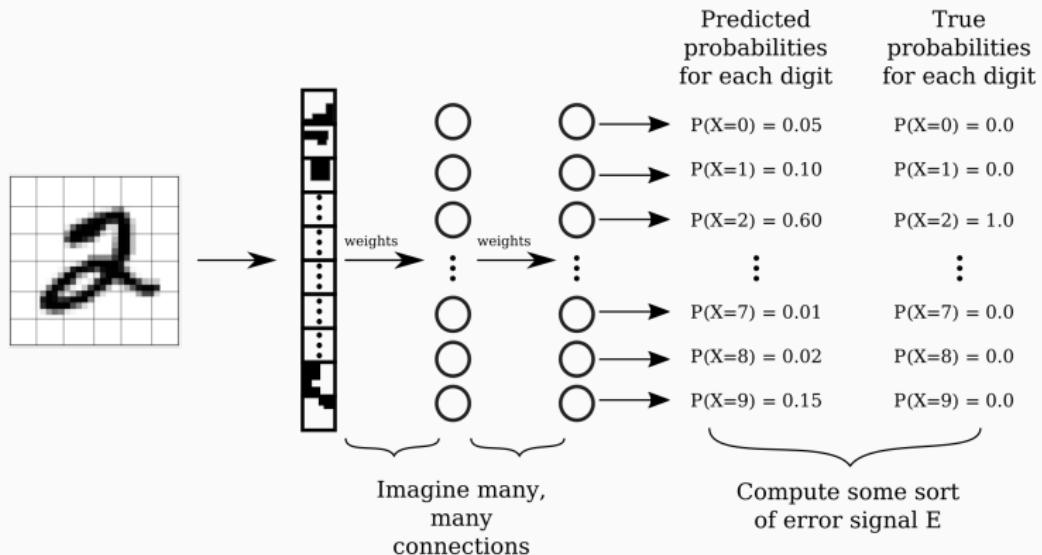
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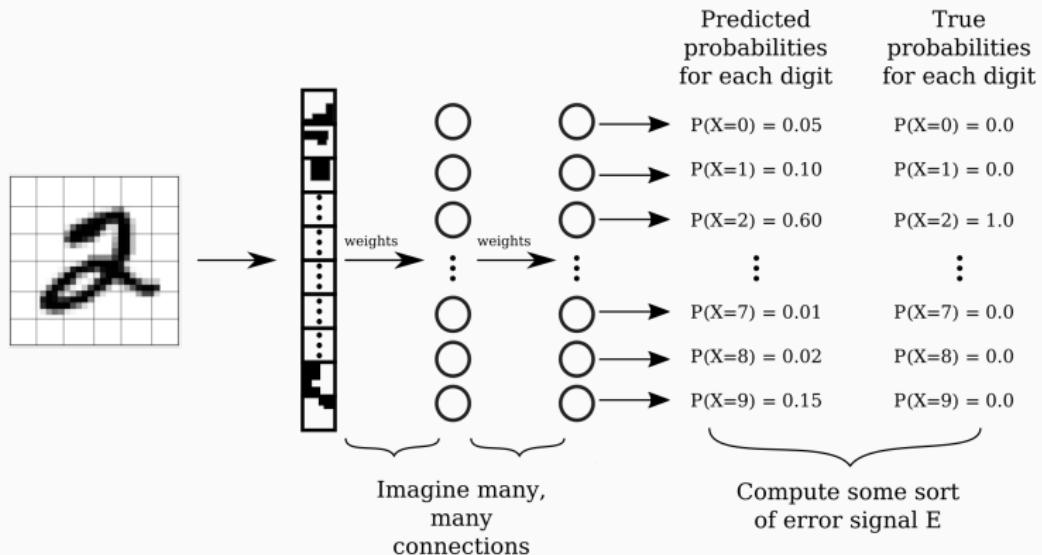
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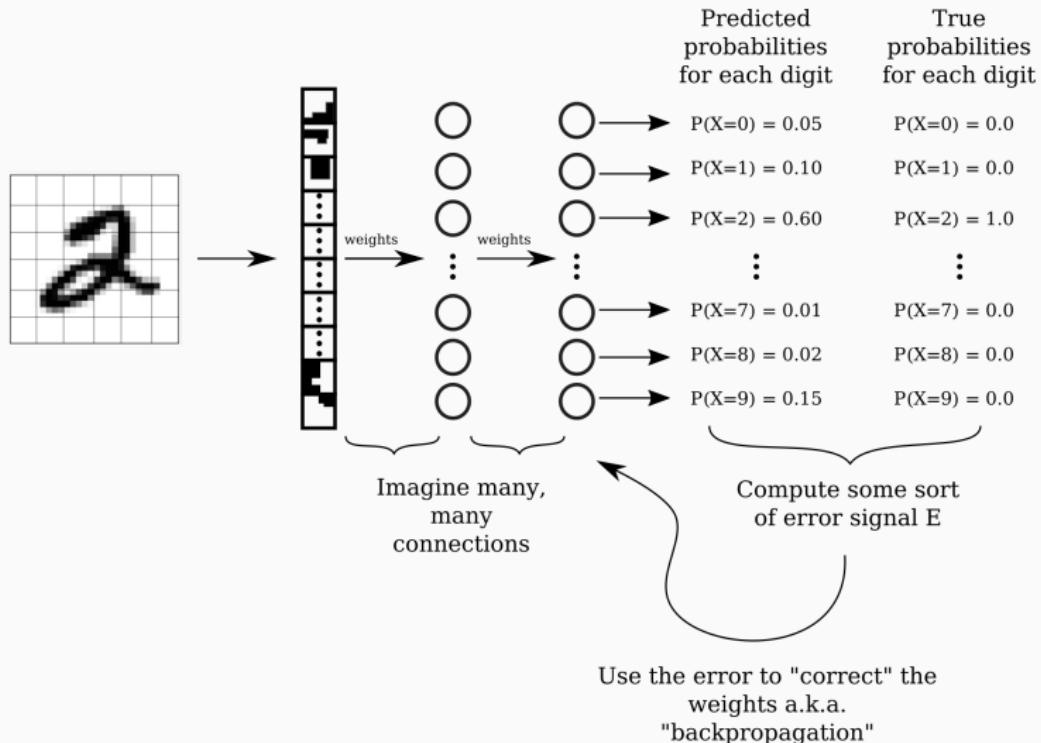
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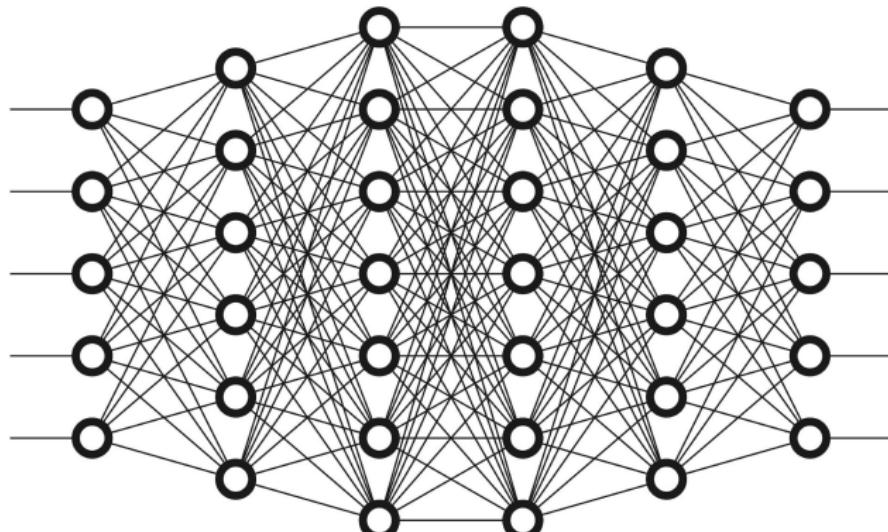


Training neural networks



How to deep learn? The naive approach

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Just stacking more simple layers will result in a **inefficient** and **difficult to train** network.

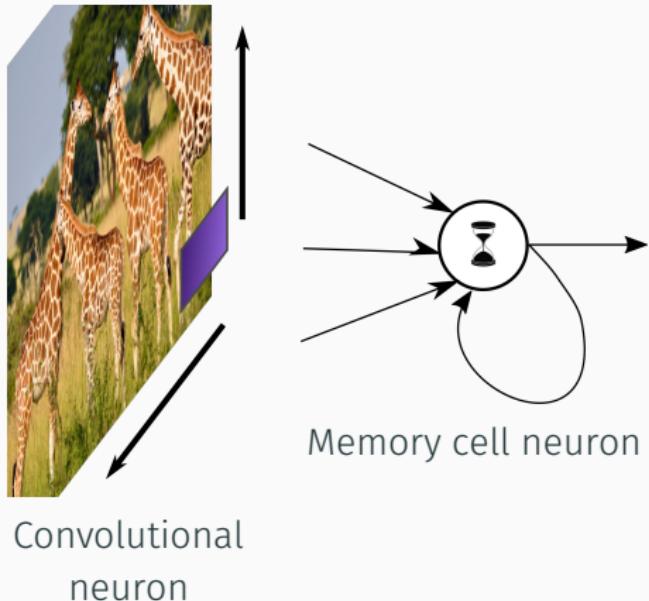
Some of the new things

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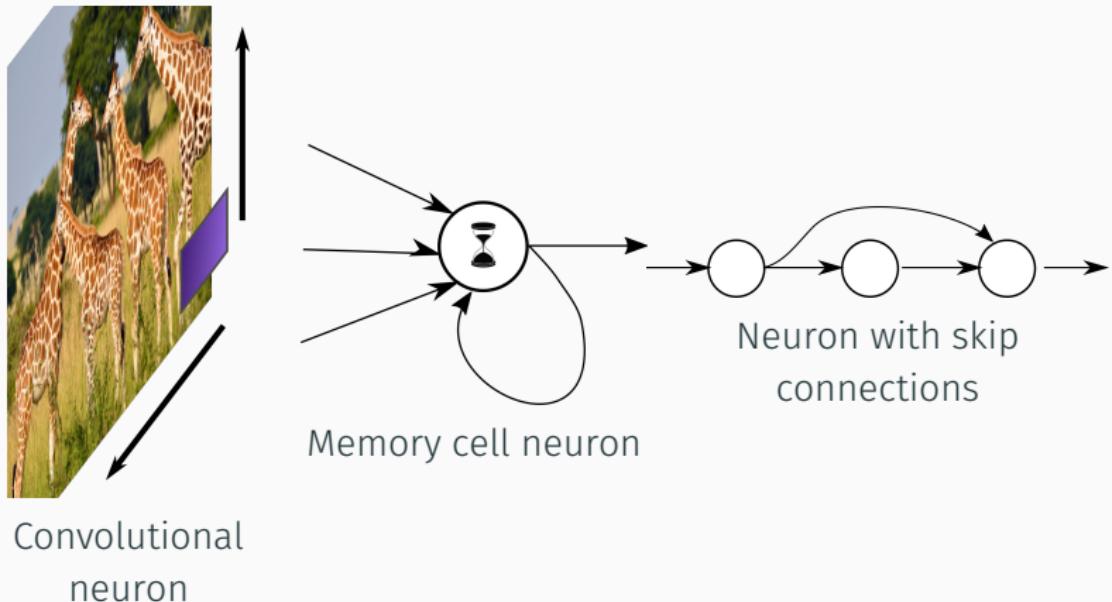


Convolutional
neuron

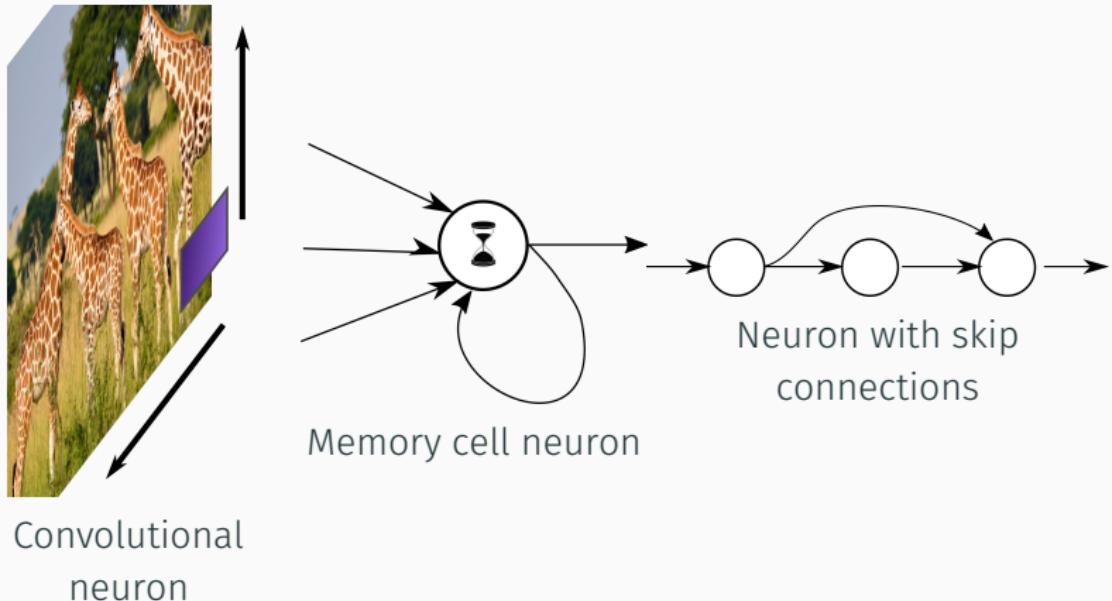
Some of the new things



Some of the new things



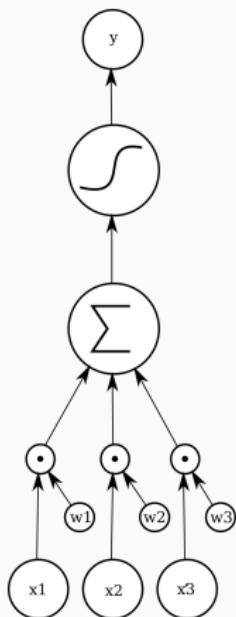
Some of the new things



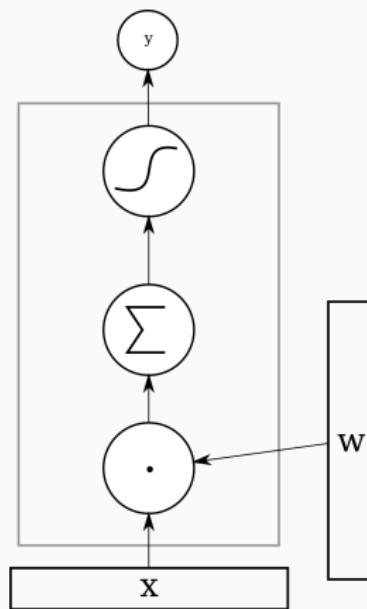
Any kind of **differentiable** function can be a neuron!

Deep learning networks as computational graphs

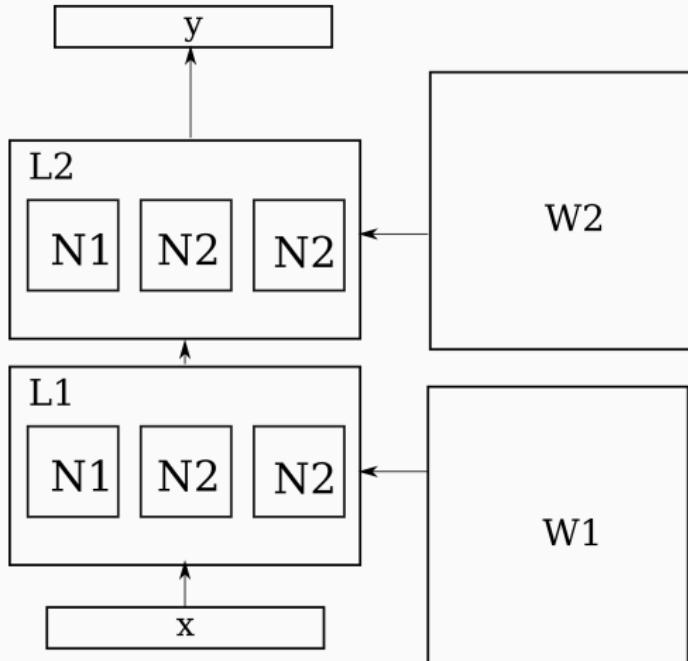
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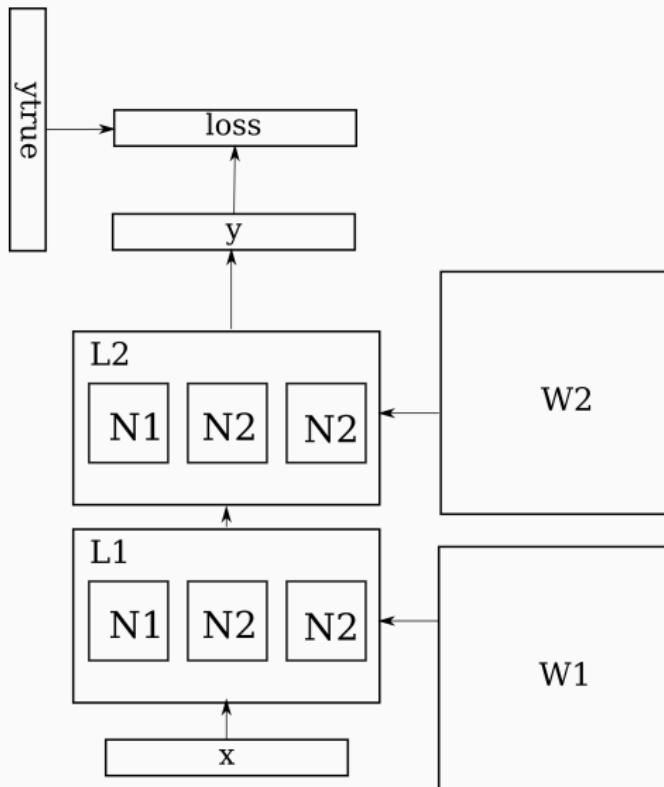
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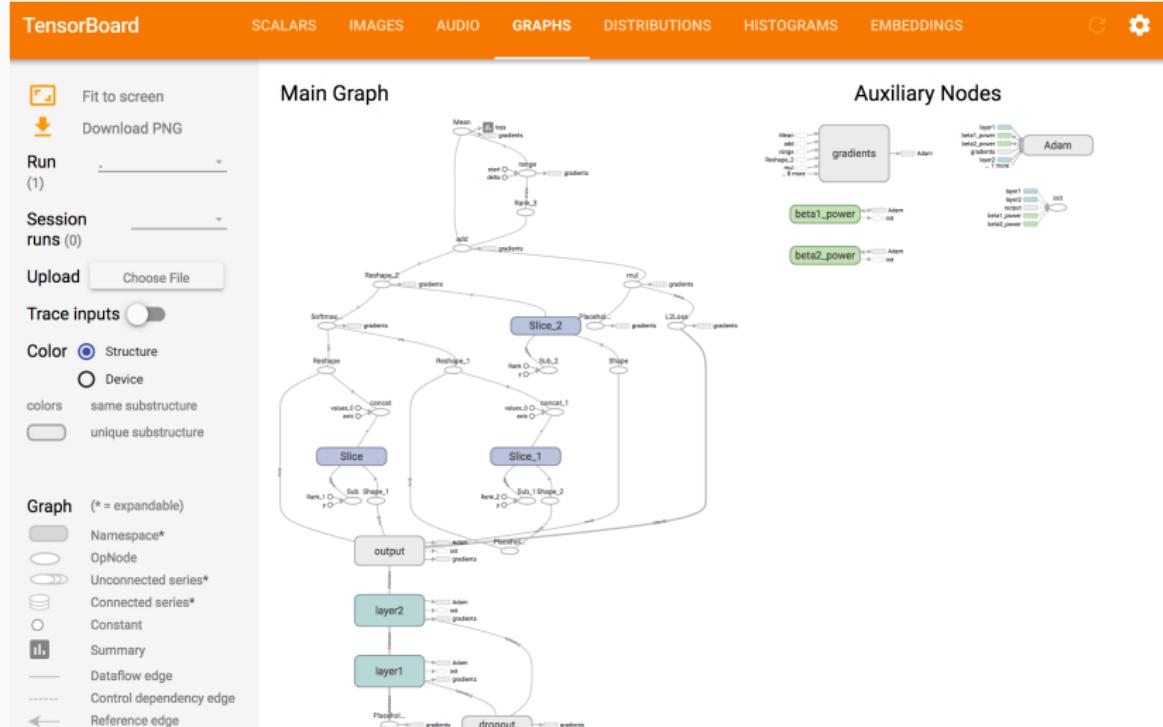
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Deep learning networks as computational graphs



A classification network

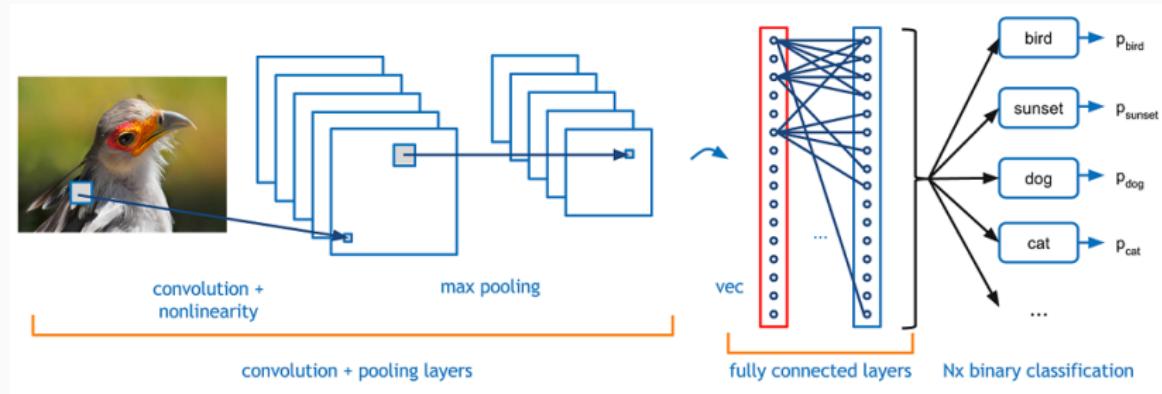


Figure 6: A deep classification network using convolutional neurons.

A classification network

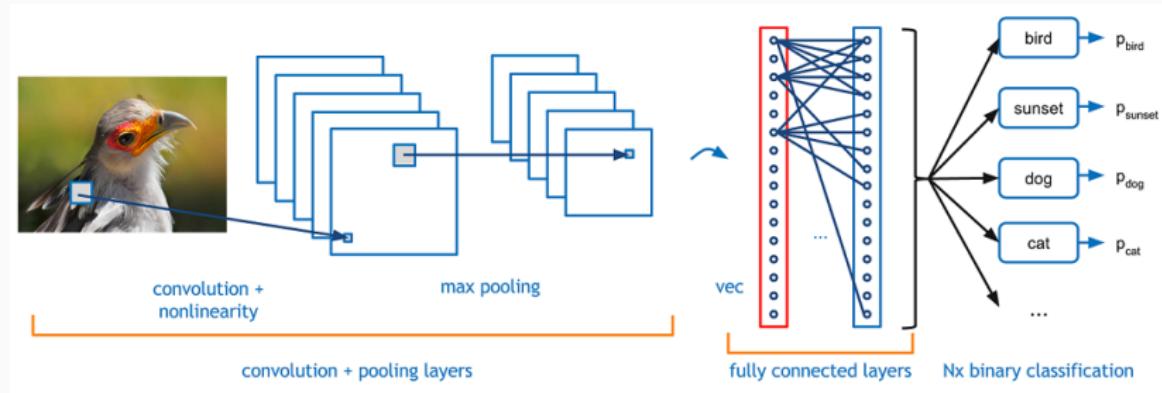


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Super powers of deep learning:

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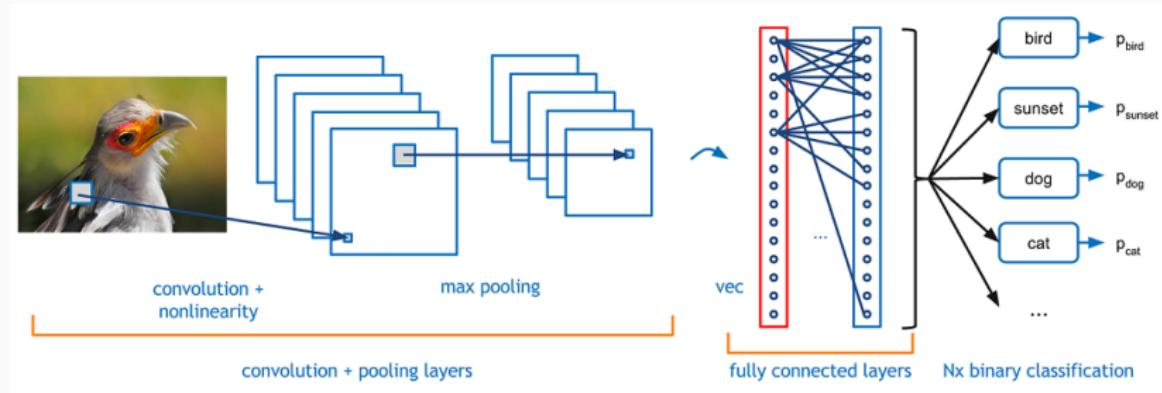


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Super powers of deep learning:

- general framework

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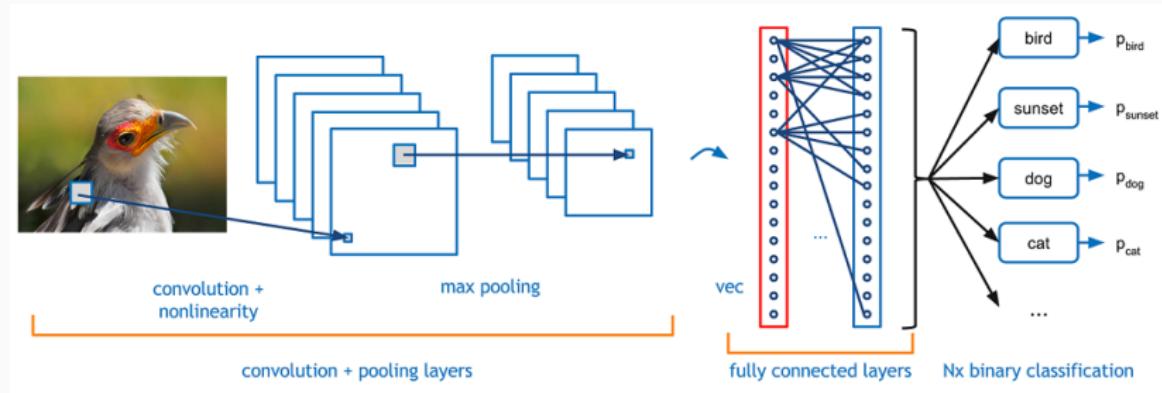


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Super powers of deep learning:

- general framework
- efficient structure

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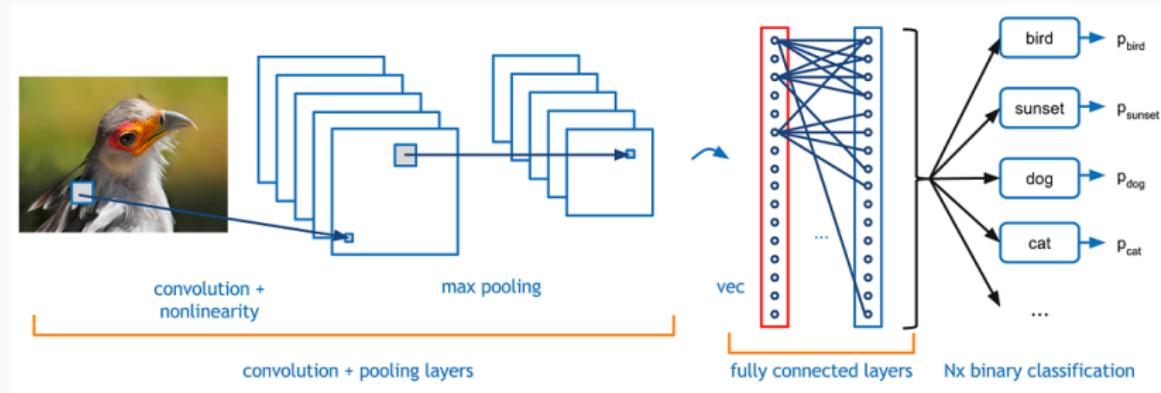


Figure 6: A deep classification network using convolutional neurons.

Super powers of deep learning:

- general framework
- efficient structure
- well performing given the right circumstances

Do they really use it?

Applications of deep learning

Applications of deep learning

Image processing:

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- image classification

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Applications of deep learning

Control related (reinforcement learning):

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Applications of deep learning

Medicine, biology and chemistry:

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Is deep learning right for you?

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- you have access to quite large amounts of data

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- the problem is reasonably complex, high dimensional space

Is deep learning right for you?

You should consider deep learning if:

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- the problem is reasonably complex, high dimensional space
- no hard constraints or hard logic

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(usually require **GPUs**):

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- more at **this** link

Thank you for your attention!

Questions?

Slides can be found at www.github.com/pauldragan.