CS342 - NEURAL NETWORKS

Philipp Krähenbühl

OVERVIEW

Philipp Krähenbühl
office hours T 11-12
GDC 4.824

TA Dian Chen
office hours M 11-12
GDC 1.302

TA Ankur Garg
office hours M 4-5
GDC 1.302

Try canvas first!

www.philkr.net/cs342/

OVERVIEW

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IN CLASS

- Learn background material
- "Theory"
- Math behind deep learning

SECTION

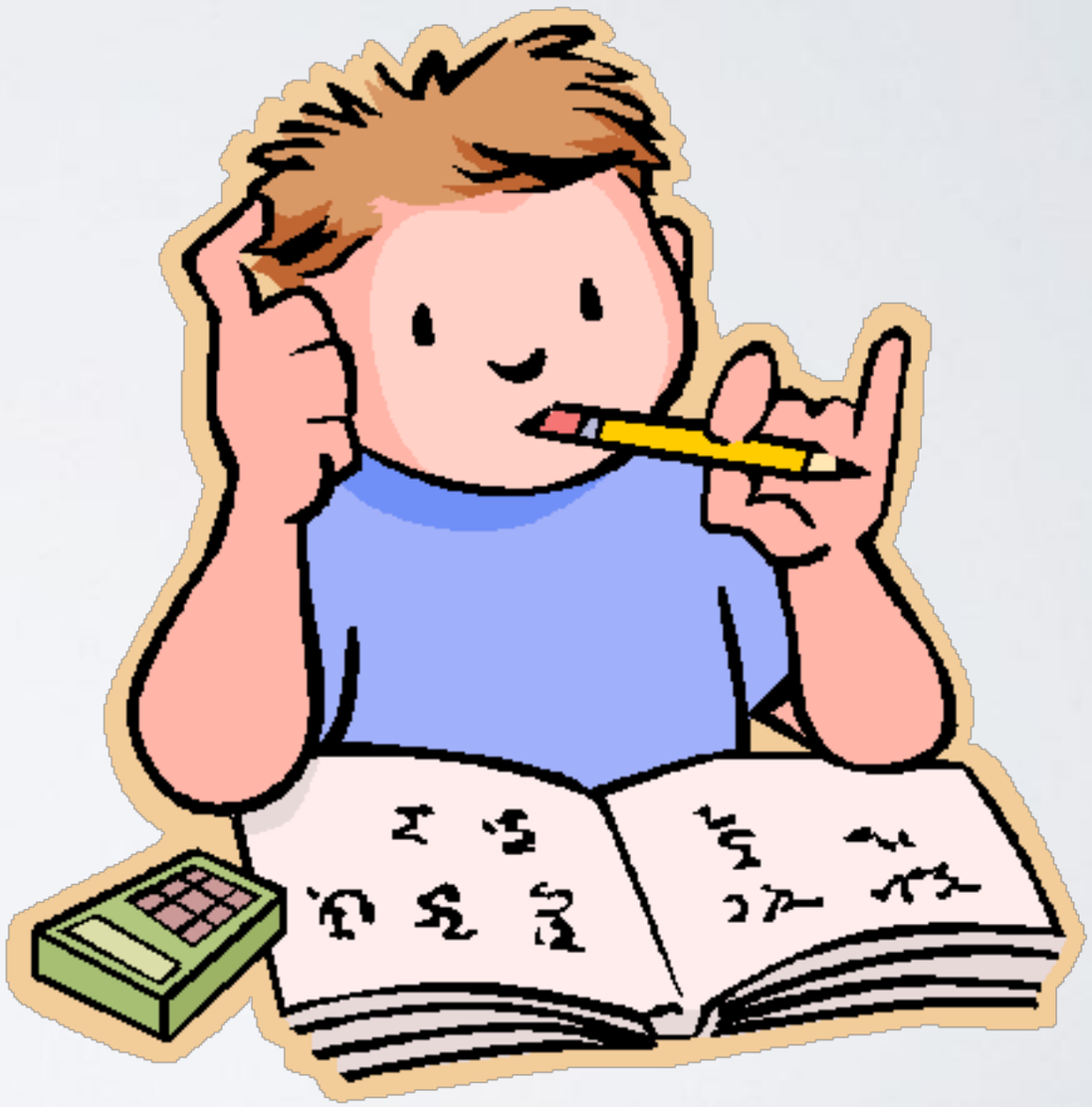
- Coding
  - PyTorch
  - Start homework

IN CLASS QUIZZES

- In average one per week (~13 in total)
- Can work in groups
- Can fail 2, at least 5 required
- Ways to fail
  - Do not show up
  - Hand in an empty quiz
  - Write a purposefully wrong answer

ASSIGNMENTS

- One homework per week
  - Out Thursday night (or Friday morning)
  - due next Th 11:59pm
  - Submit a pytorch module
  - Automatically graded
    - partial grader with assignment



ASSIGNMENTS

FINAL PROJECT

- Learn to race in SuperTuxKart
  - Last 3 weeks
  - open ended strategy
- Competition in class

PREREQUISITES

- 311 or 311H - Discrete math for computer science (or equivalent)
- 343 or 363D - Artificial Intelligence or Statistical Learning and Data Mining
- Proficiency in Python

GOALS

- Implement and train neural networks in pytorch
- Have a basic understanding of the inner workings of neural networks
- Know several types of neural networks, including convolutional and recurrent neural networks

GRADES

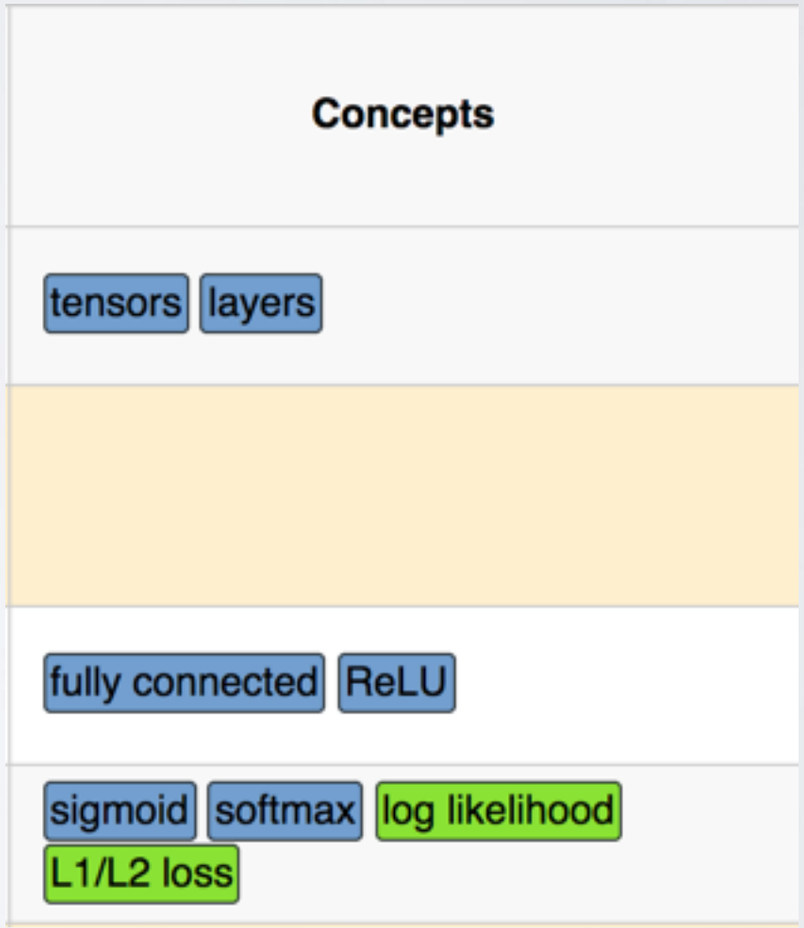
- 10% Quizzes
- 55% homework
- 35% final project
- 1 day late: -25%
- 2 days late: -50%
- 3+ days late: -100%

BOOK

- No official book
- For background reading:
- Deep learning, Goodfellow, Bengio and Courville 2016
- www.deeplearningbook.org

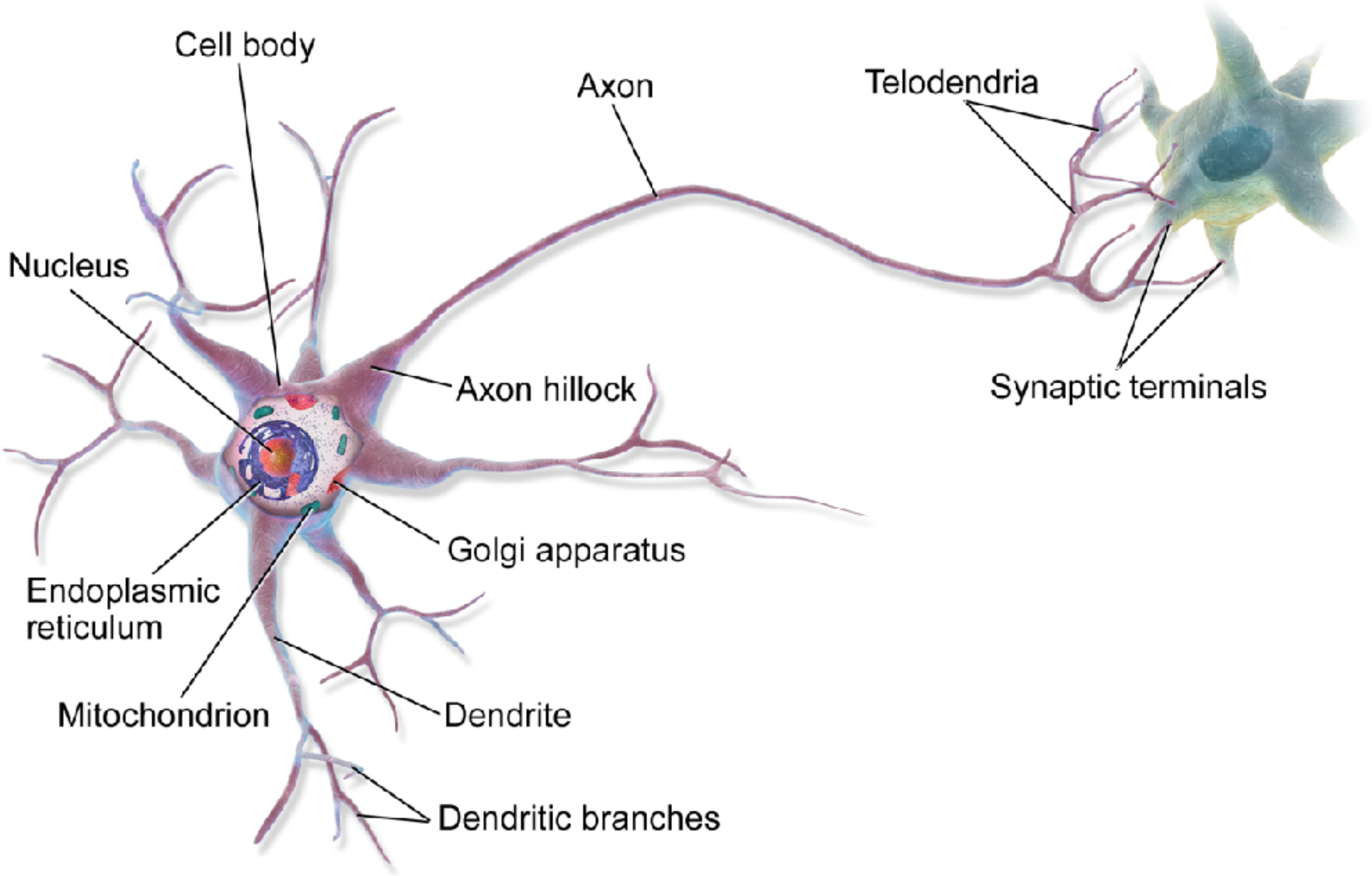
WIKI / DOC

- The webpage as a little writeup for all important concepts you'll learn in class



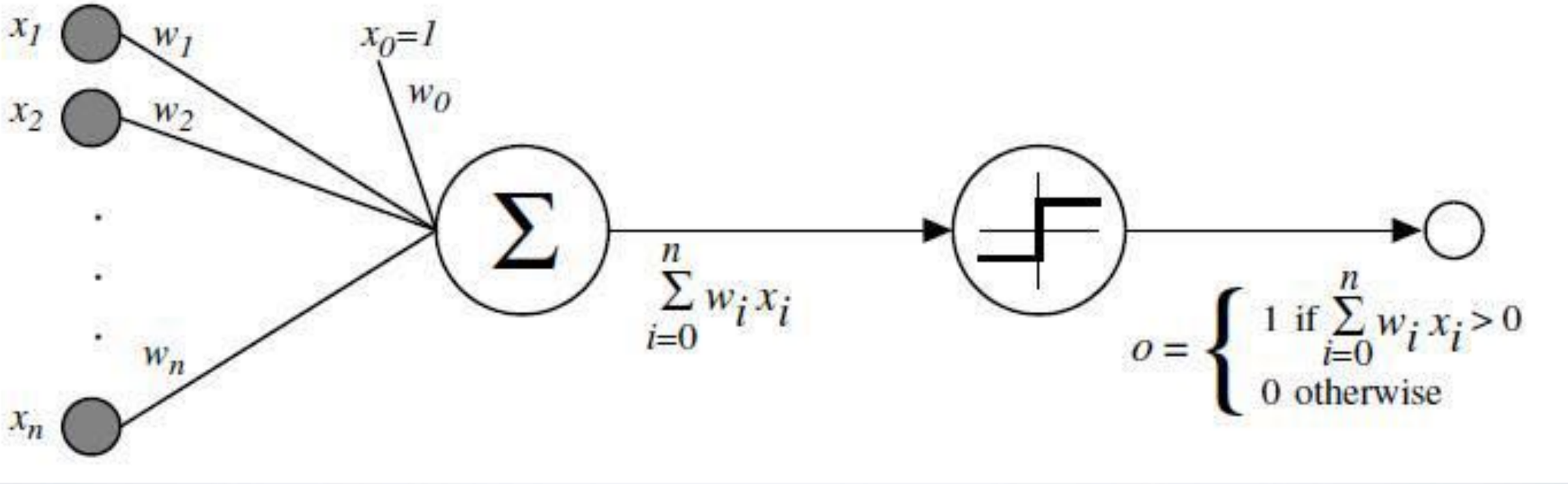
ONCE UPON A TIME

1950s


Cell body
Axon
Telodendria
Nucleus
Axon hillock
Synaptic terminals
Golgi apparatus
Endoplasmic reticulum
Mitochondrion
Dendrite
Dendritic branches

PERCEPTRON

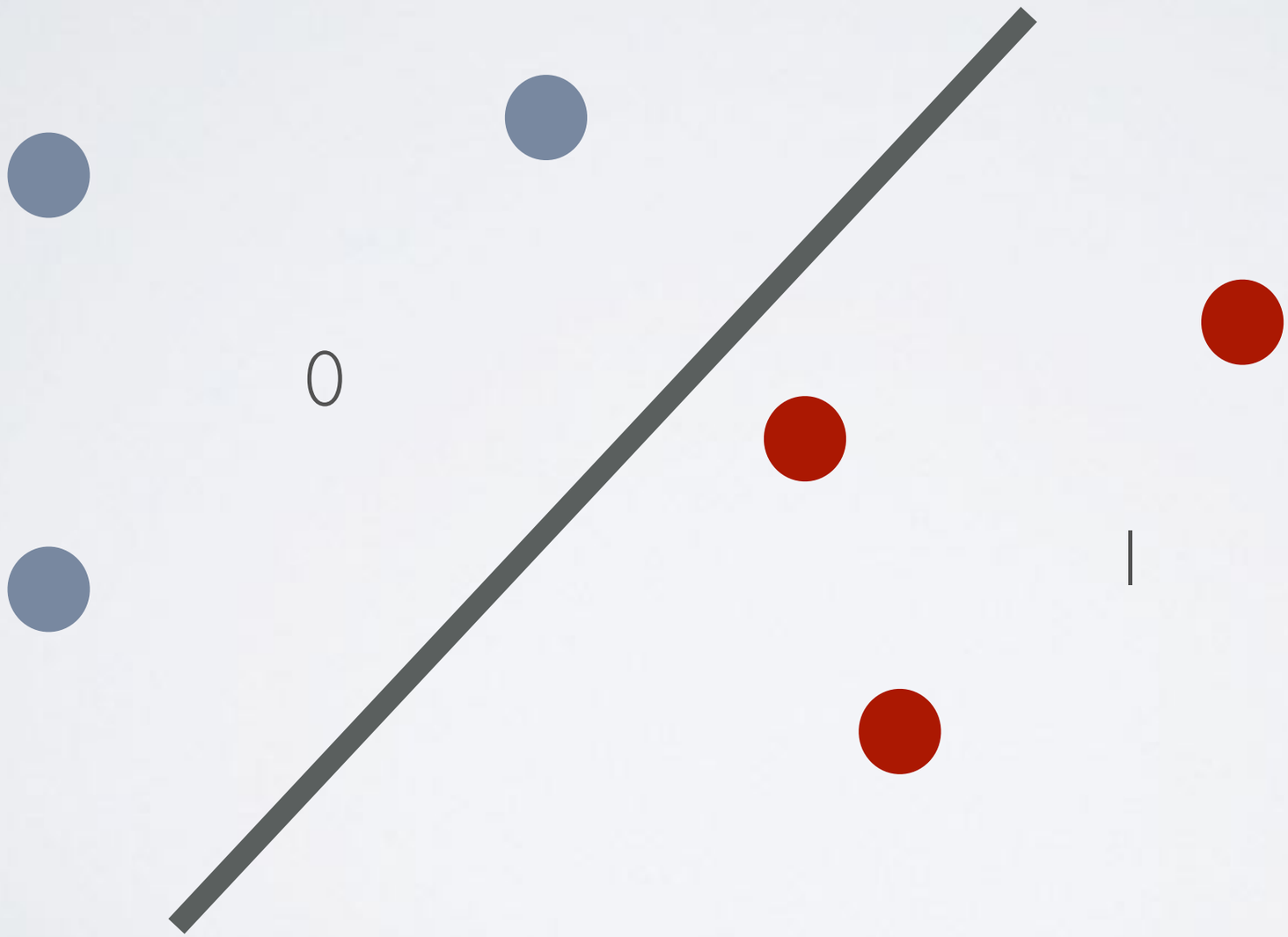
Frank Rosenblatt [1957]



credit: Andrey Kurenkov

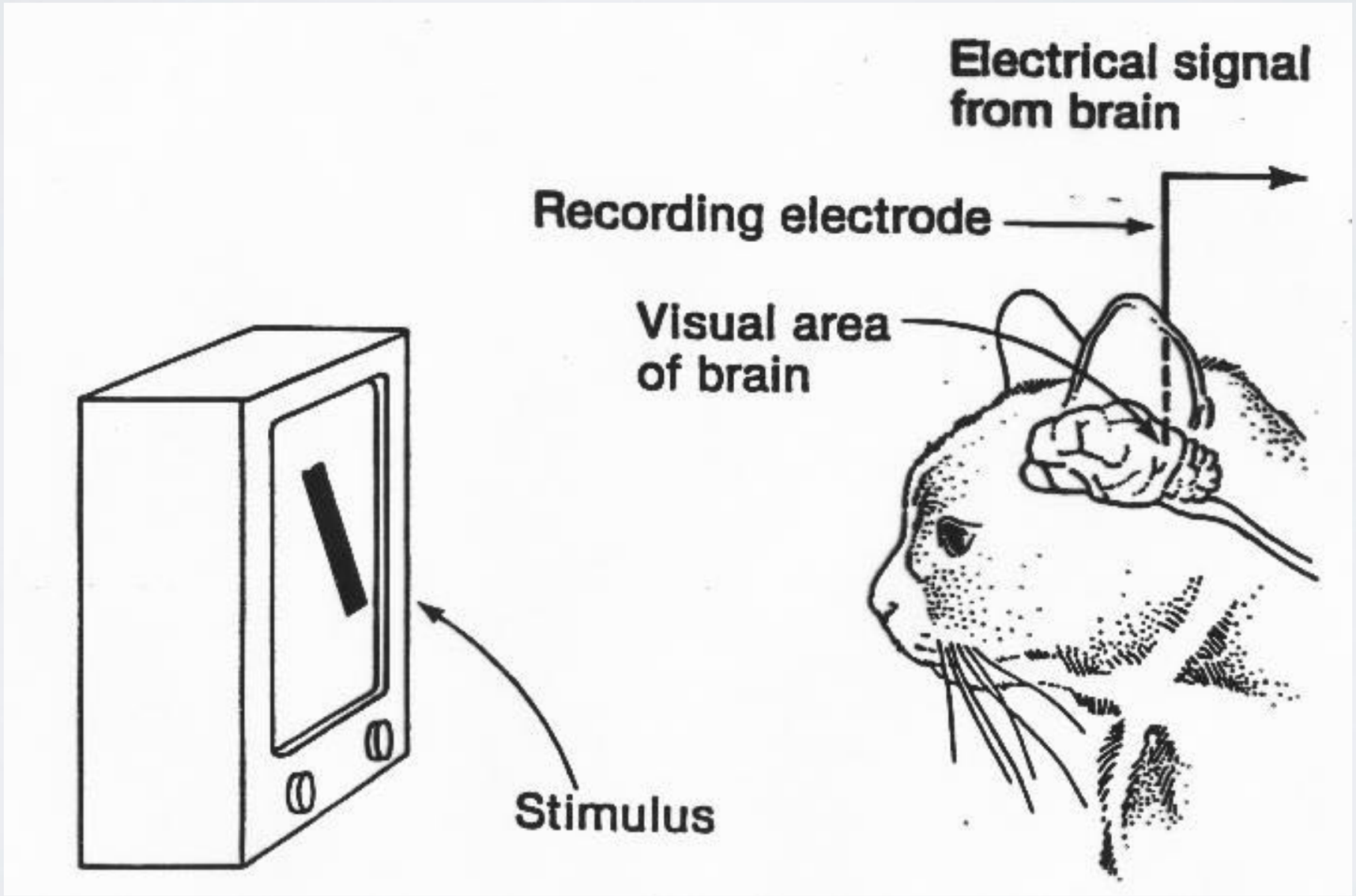
PERCEPTRON

$$f(x) = \begin{cases} 1 \text{ if } w*x > 0 \\ 0 \text{ otherwise} \end{cases}$$

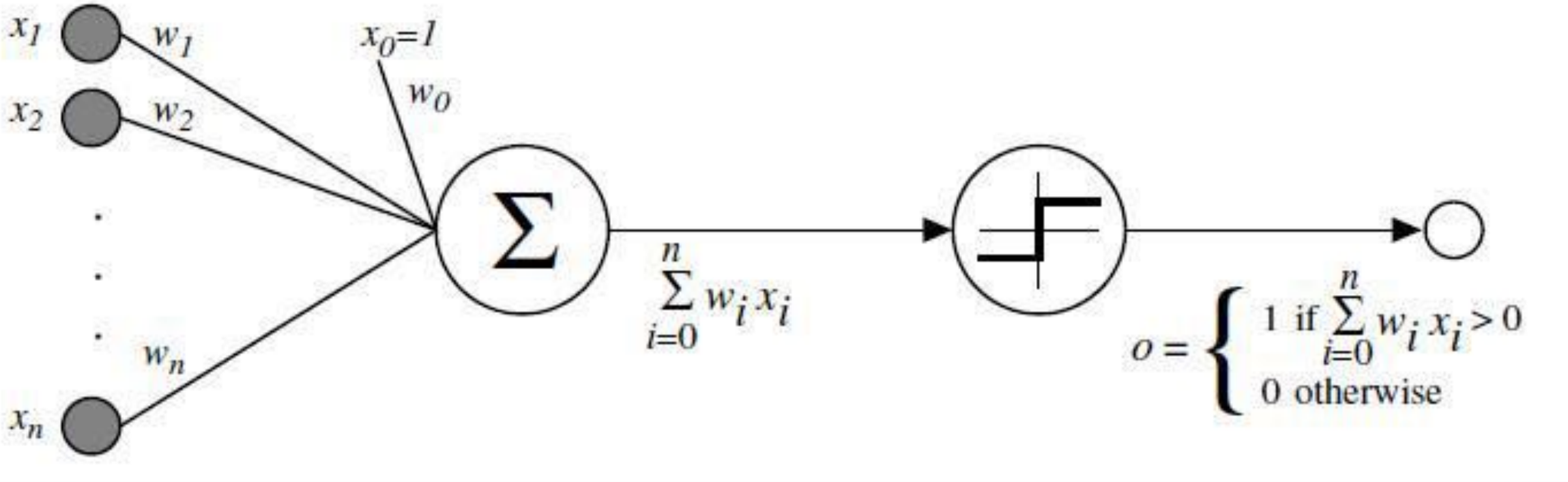


HISTORY OF DEEP LEARNING

Hubel & Wiesel [early 1950s]



MULTI-LAYER PERCEPTRON



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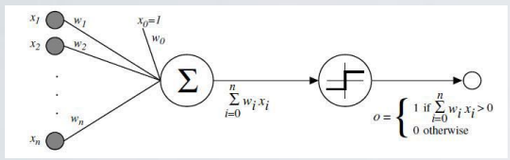

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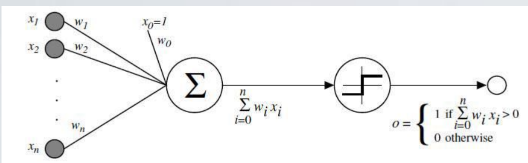
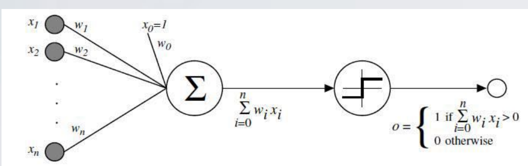
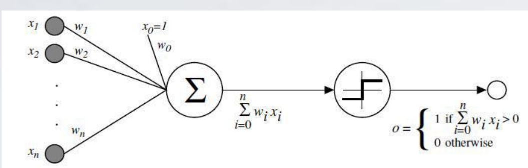
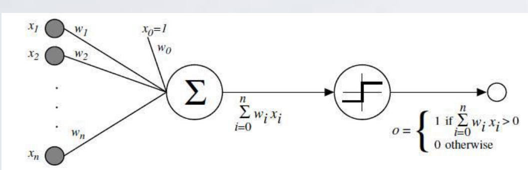
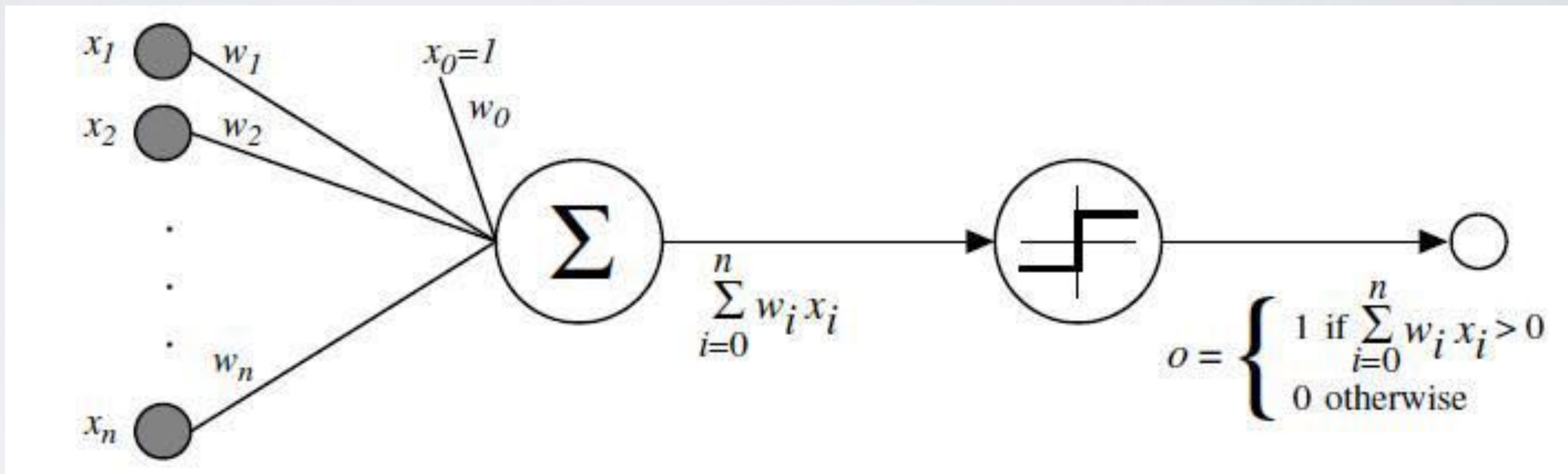


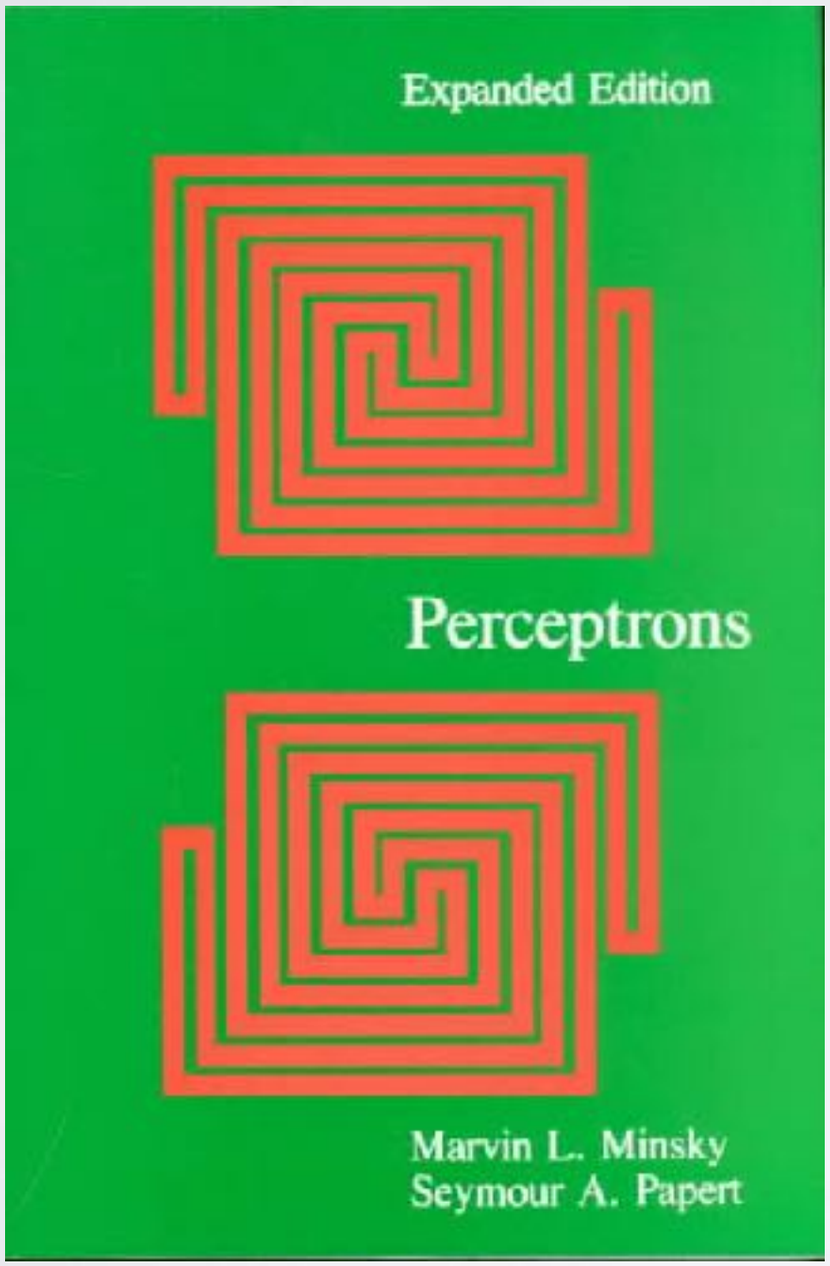








MARVIN MINSKY [1968]



symbolic AI
rule based systems

AI winter [1970s]

BACK-PROPAGATION [1988]

=

MACHINE LEARNING + OPTIMIZATION

[1990 - 2005]

Random Forests

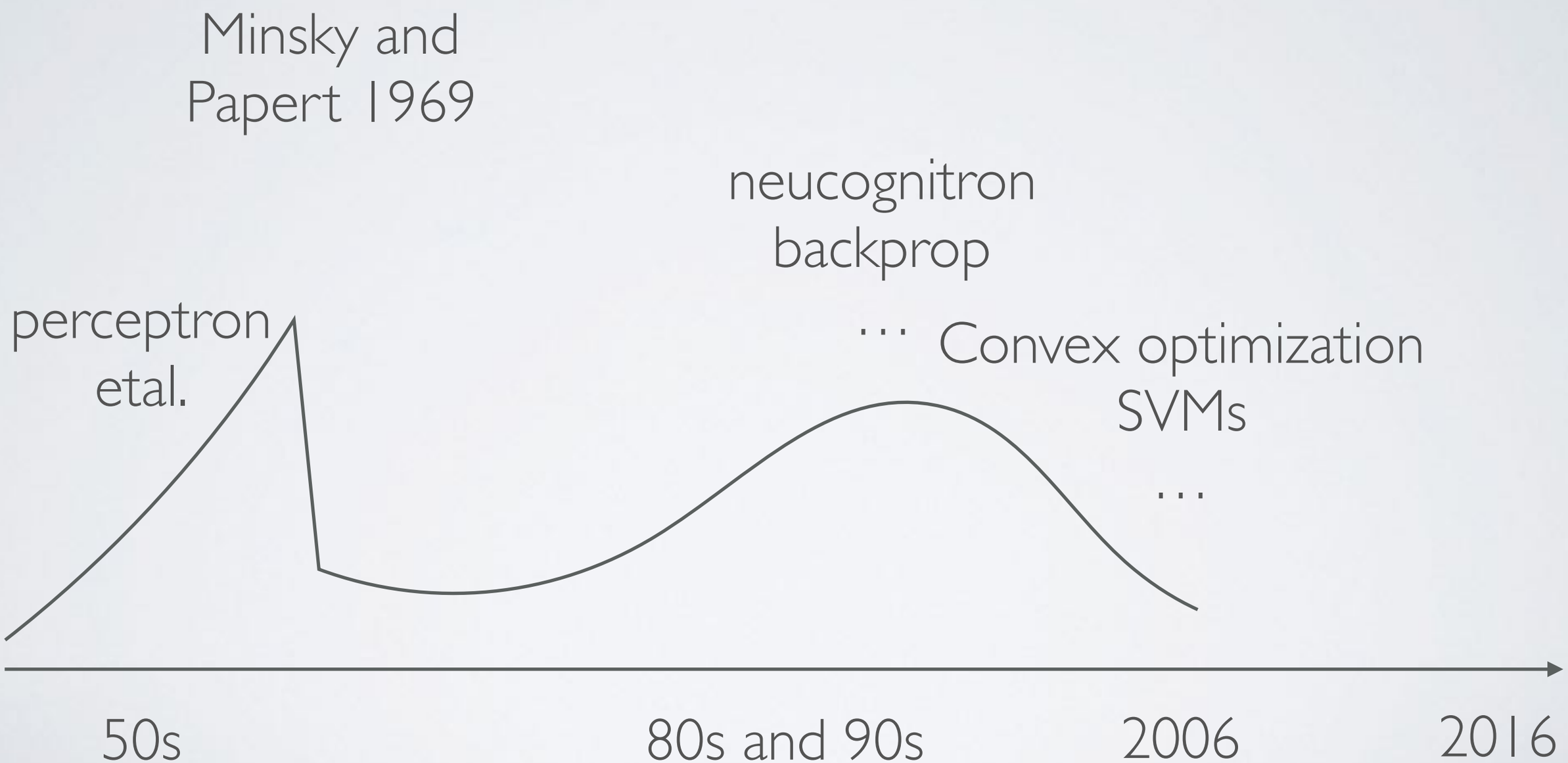
Suport Vector Machines

Boosting

Hand engineering

Computer Vision: Geometry

THE DEEP LEARNING CONSPIRACY



THE DEEP LEARNING CONSPIRACY

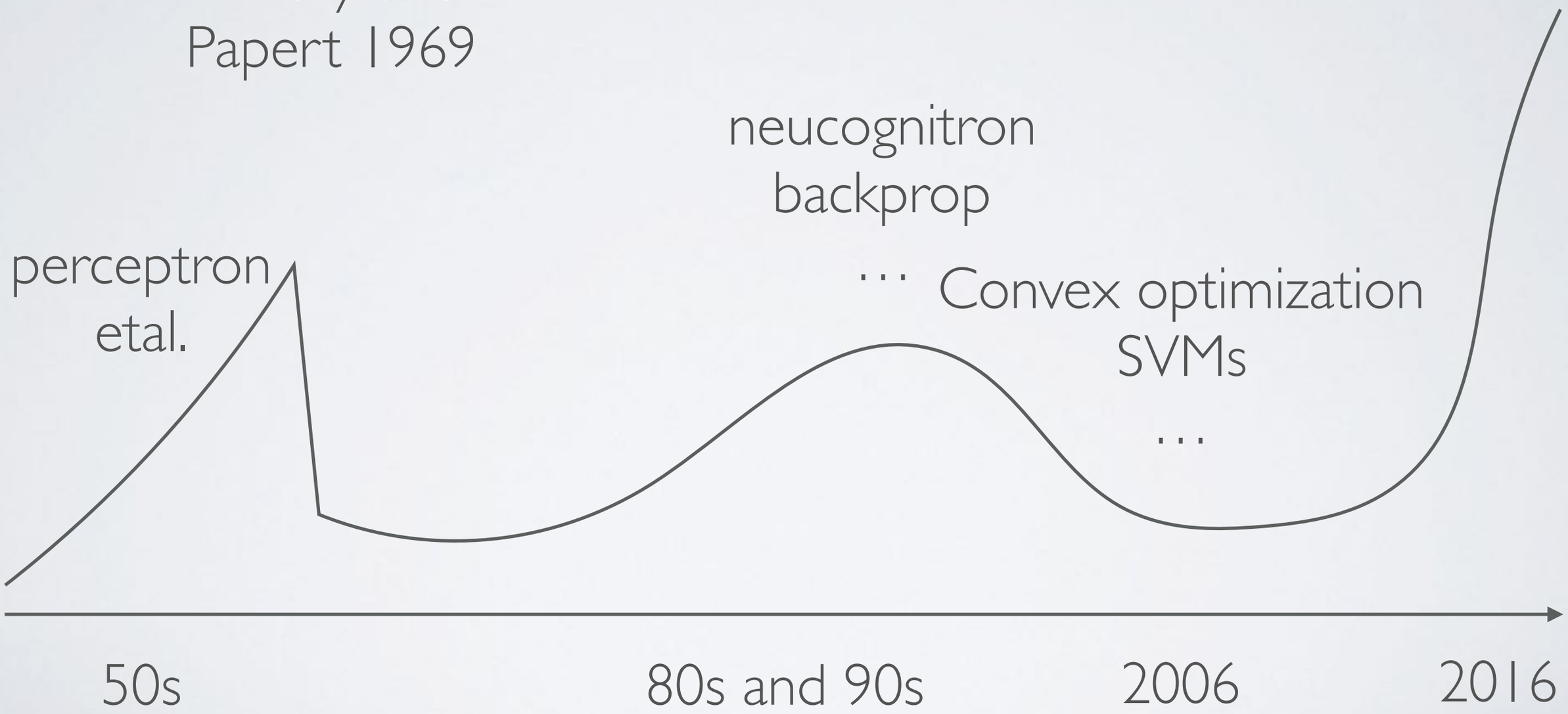
REVIEW

doi:10.1038/nature14539

Deep learning

Yann LeCun[1,2], Yoshua Bengio[3] & Geoffrey Hinton[4,5]

THE DEEP LEARNING CONSPIRACY



THE DEEP LEARNING CONSPIRACY

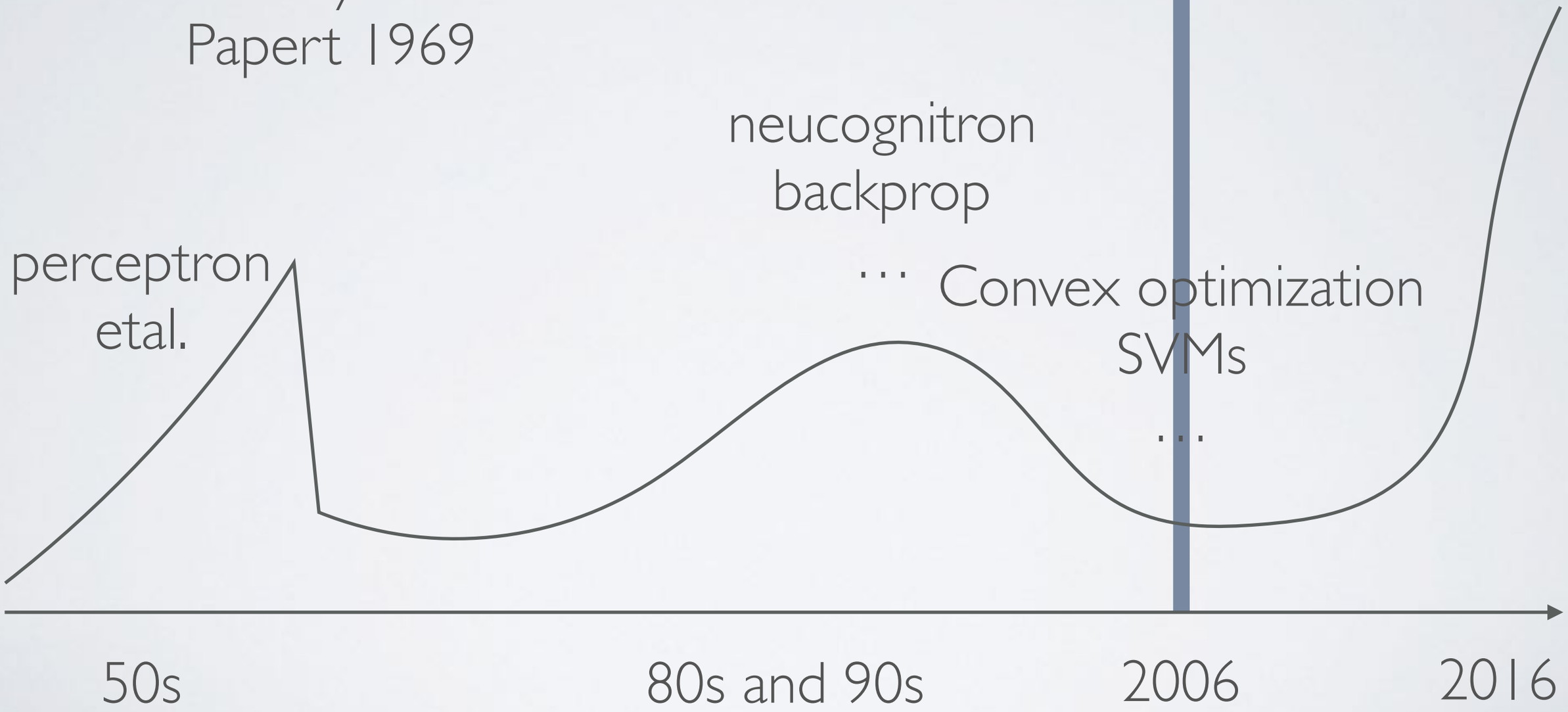
Minsky and Papert 1969

neural networks

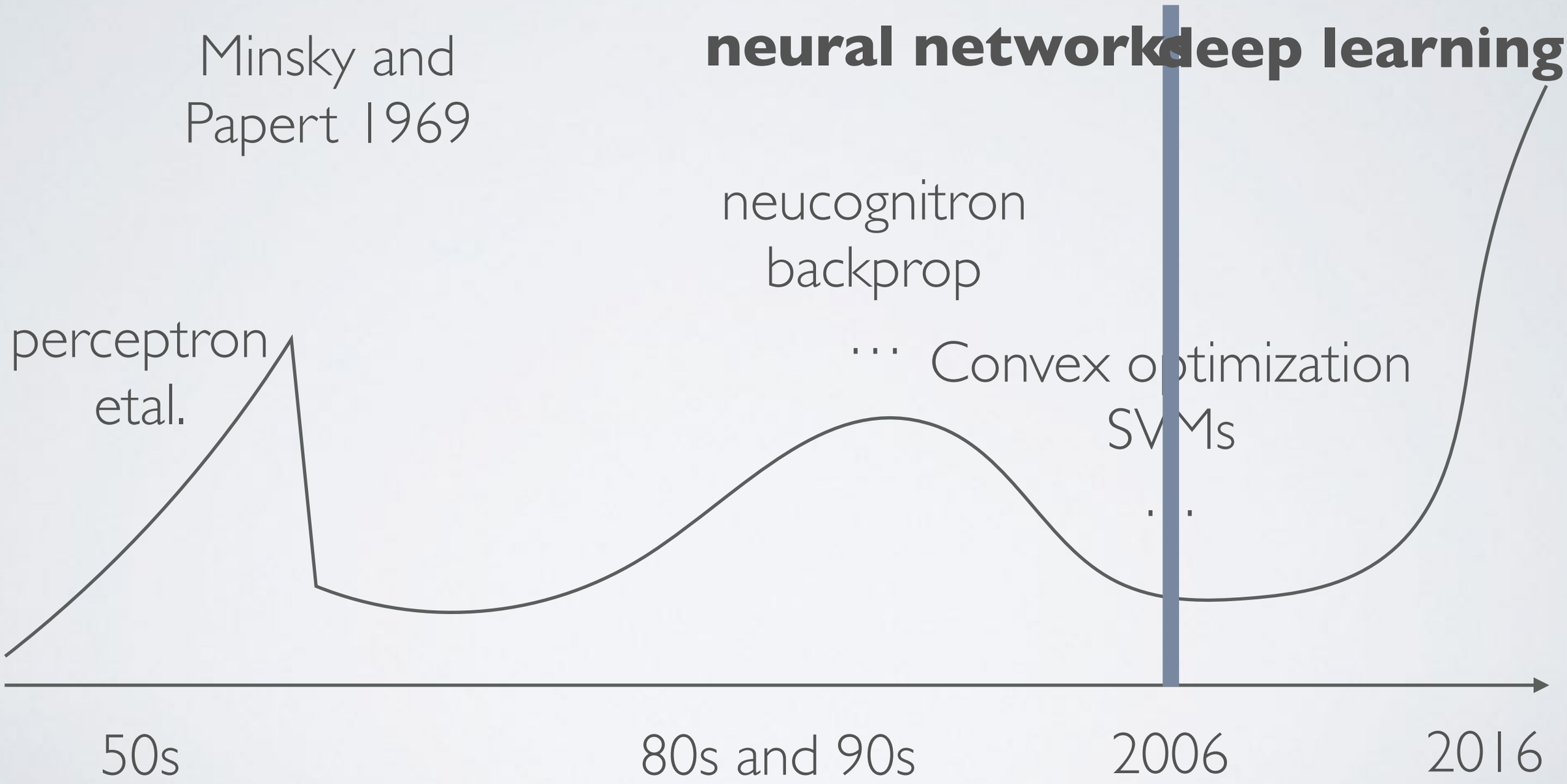
neucognitron
backprop
…

perceptron etal.

… Convex optimization
SVMs
…



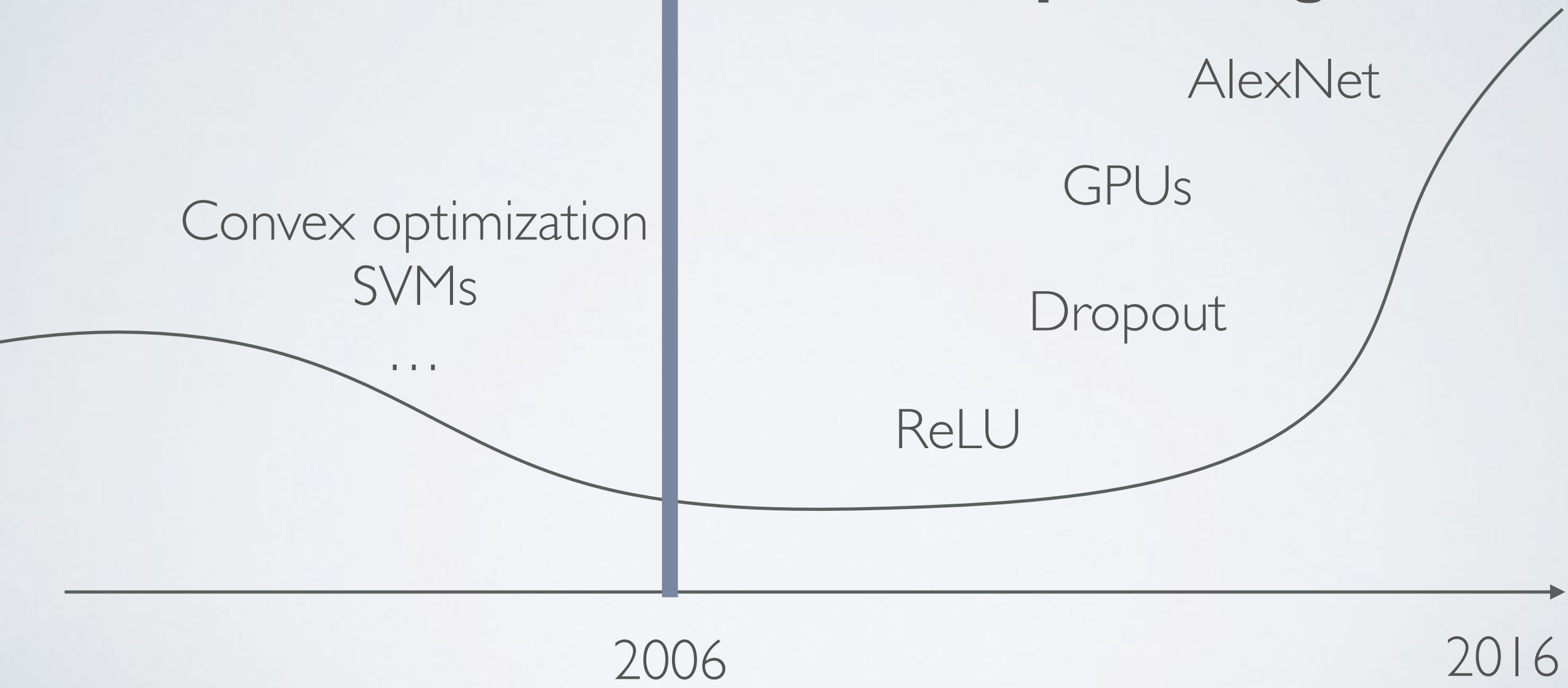
THE DEEP LEARNING CONSPIRACY



THE DEEP LEARNING CONSPIRACY

neural networks

deep learning



THE DEEP LEARNING CONSPIRACY

30 days of = x days of

THE DEEP LEARNING CONSPIRACY

30 c ars of

THE DEEP LEARNING CONSPIRACY

30 days of = x years of

THE DEEP LEARNING CONSPIRACY

30 days of = 26 years of

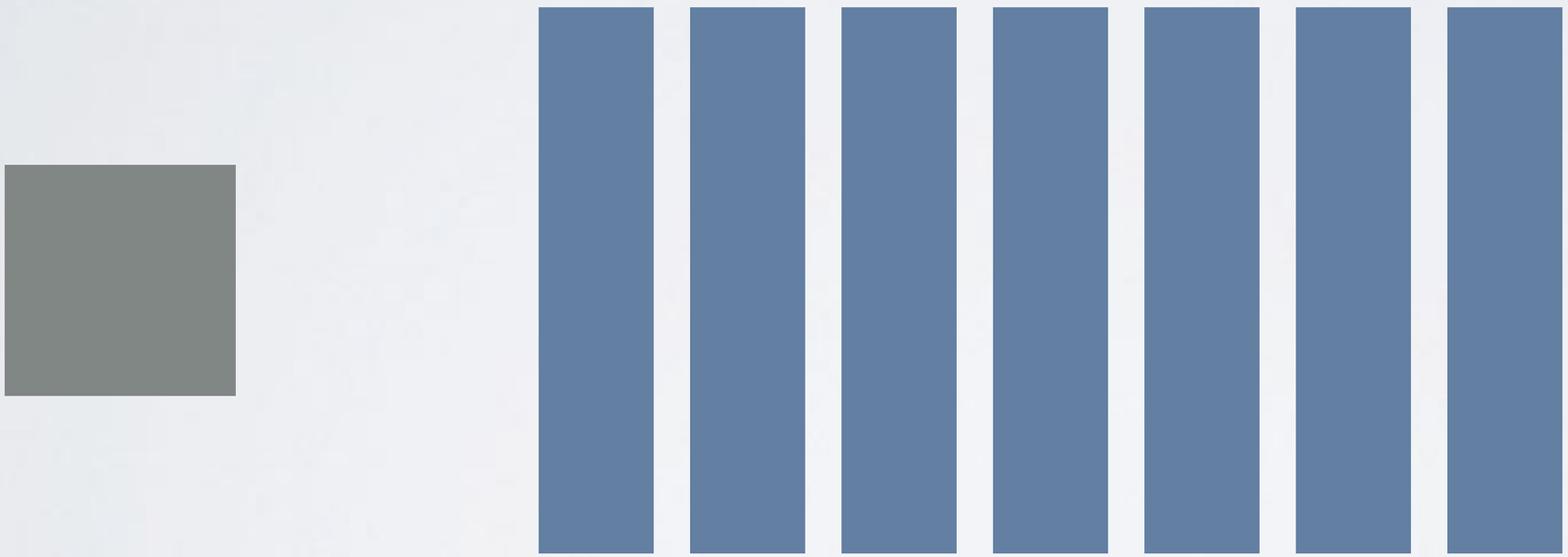
THE N-WORD

- Neural
  - Deep Learning
  - try to keep Neuroscience out of this class
  - try to motivate through optimization and ML
    - instead of biology

HISTORY LESSON OVER

WHAT IS A DEEP NETWORK?

A "differentiable" function
composed out of multiple layers
of computation

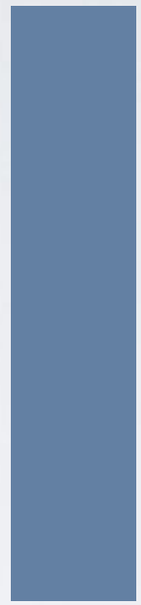


TENSORS

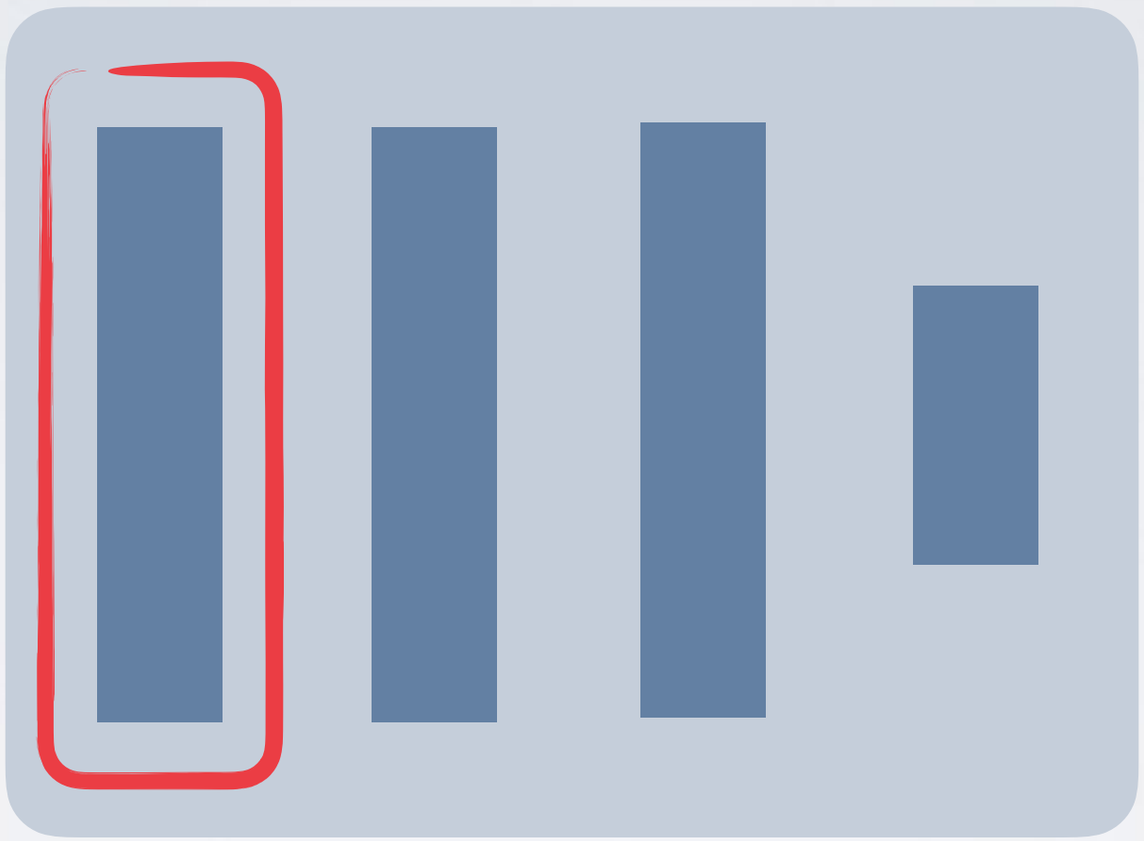
- A tensor is a d-dimensional array
  - A 1-d tensor is a vector
  - A 2-d tensor is a matrix
  - …
- Tensors are inputs and outputs of layers, as well as their parameters

LAYER

- Basic unit of computation
- Simple function
  - With parameters



WHY DO DEEP NETWORKS WORK SO WELL IN PRACTICE?



prairie chicken

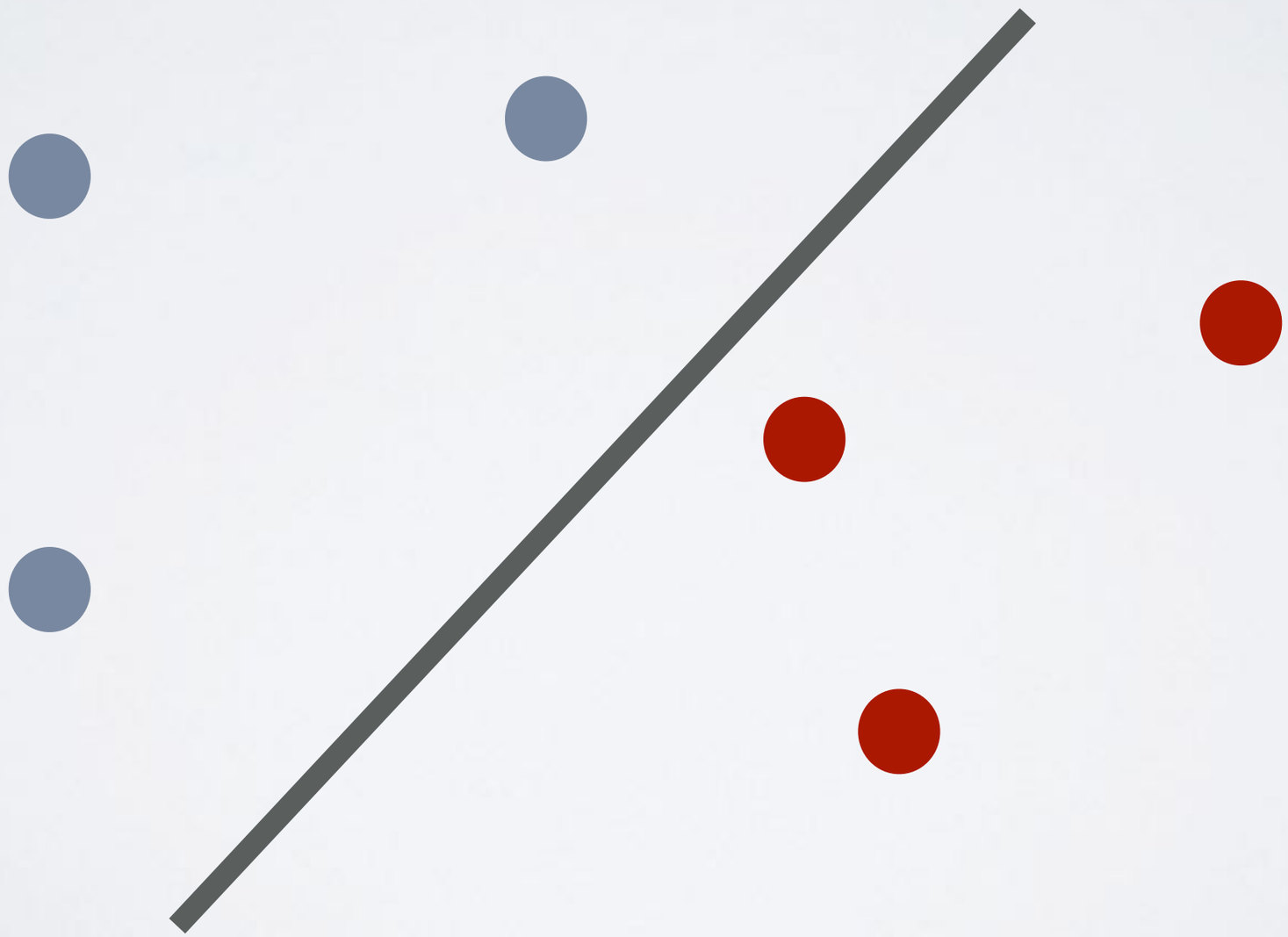
THINGS TO KNOW BEFORE YOU TAKE THE CLASS

training set

test set

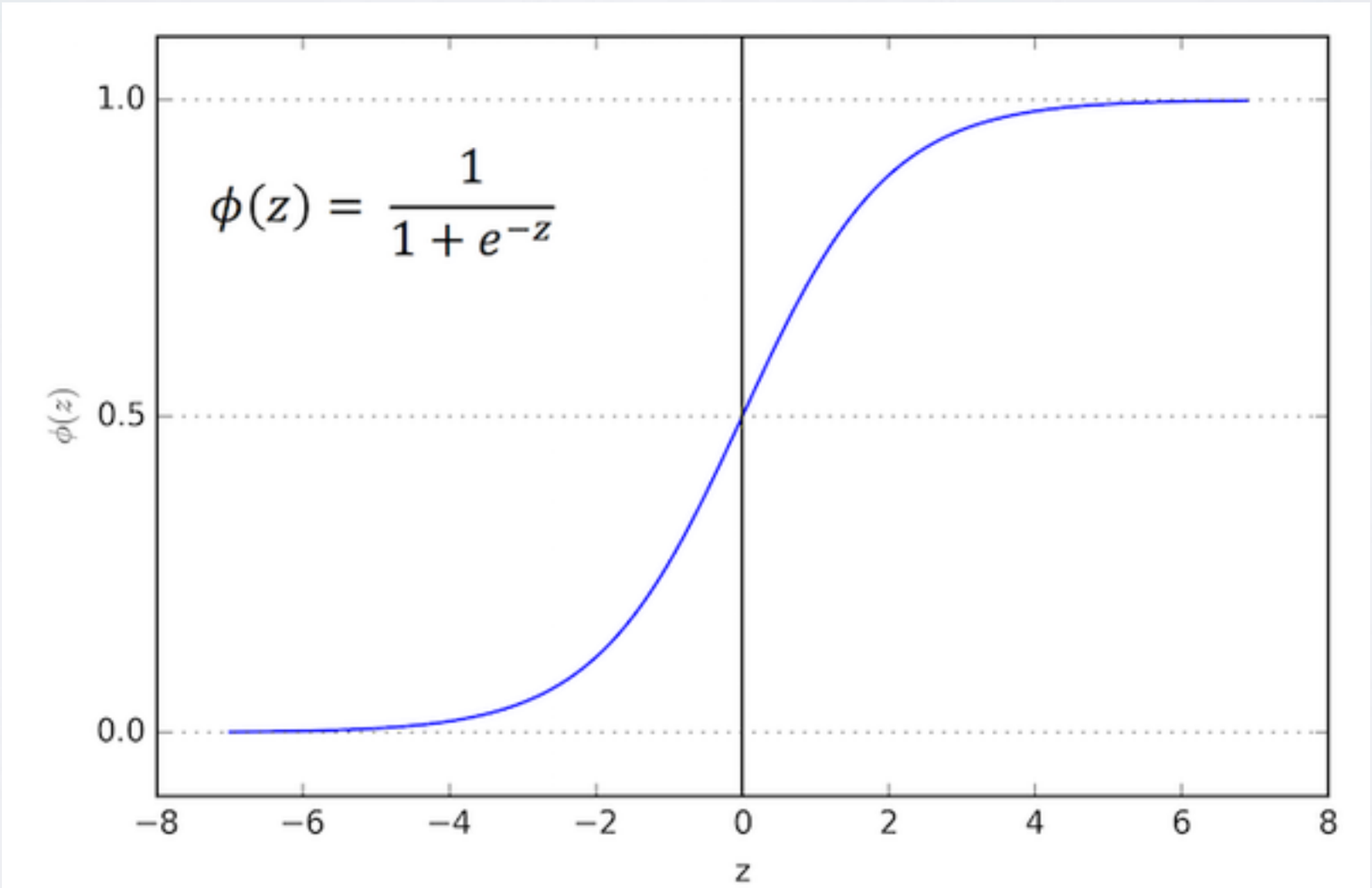
THINGS TO KNOW BEFORE YOU TAKE THE CLASS

linear classifier



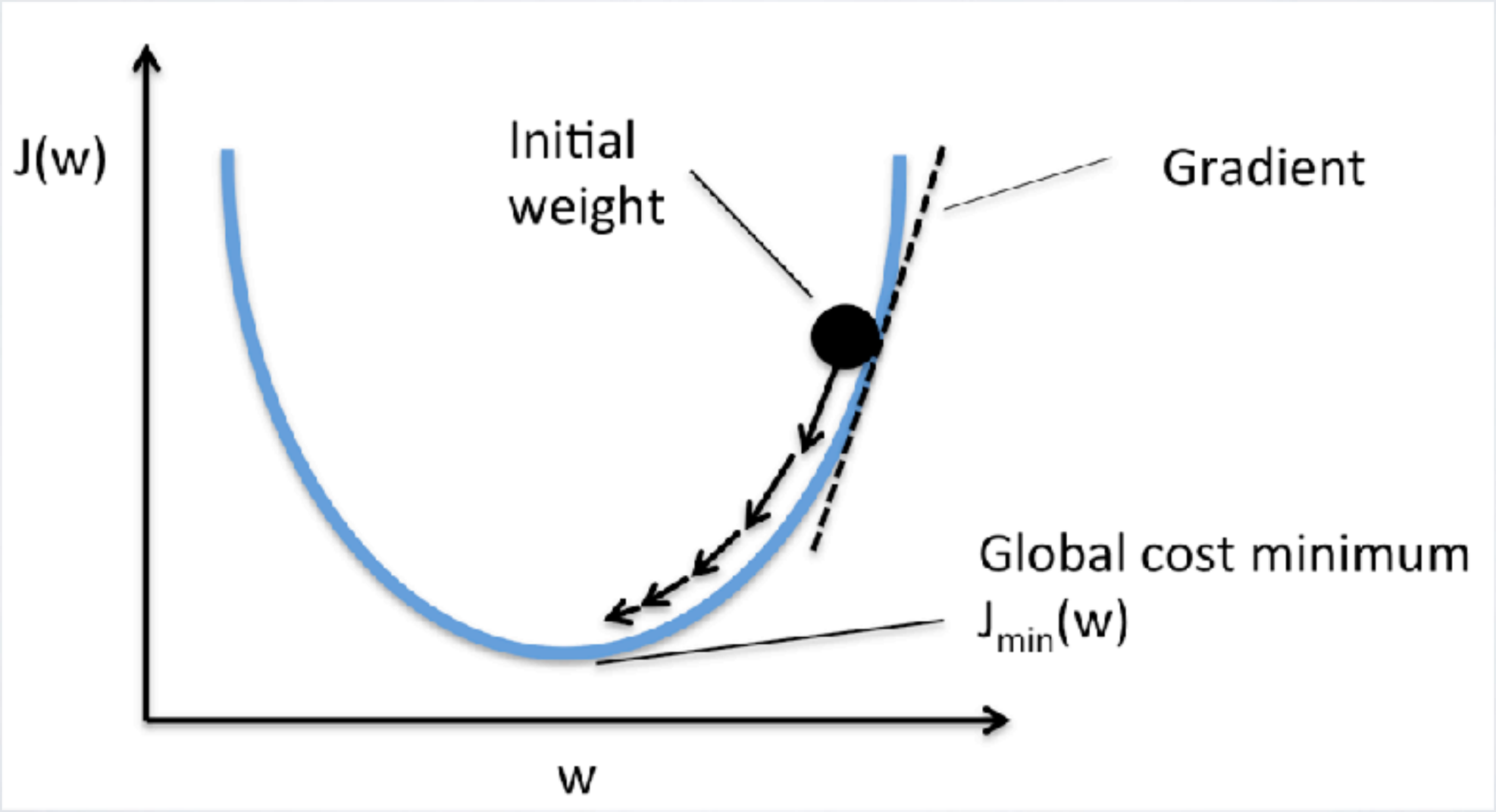
THINGS TO KNOW BEFORE YOU TAKE THE CLASS

logistic regression



THINGS TO KNOW BEFORE YOU TAKE THE CLASS

training logistic regression



PREPARATION FOR SECTION

- Windows 10
  - install bash (ubuntu within windows)
- Install python3, pip
- Install pytorch, torchvision
- Bring your laptop to section!