NE593

Course themes (so far) & exam notes

Scientific computing

Good programming habits.

Write readable, testable, inspectable code.

Don’t repeat yourself (or others).

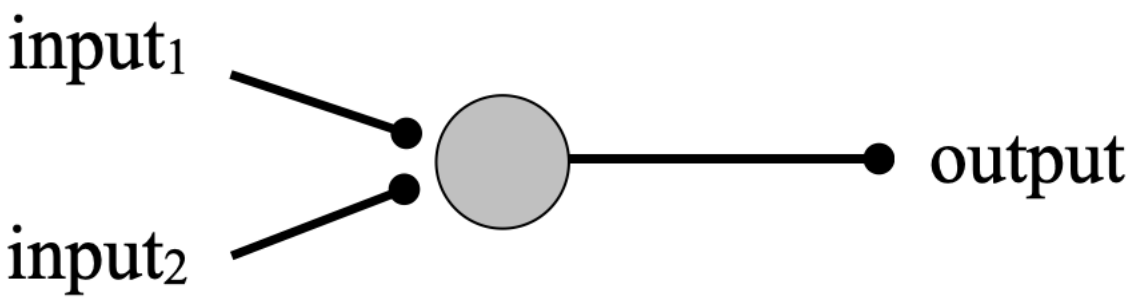
How? **Make the computer repeat tasks**

Who writes programs anymore?

Abstraction (AI) → biology

Abstract neurons and simplified network models

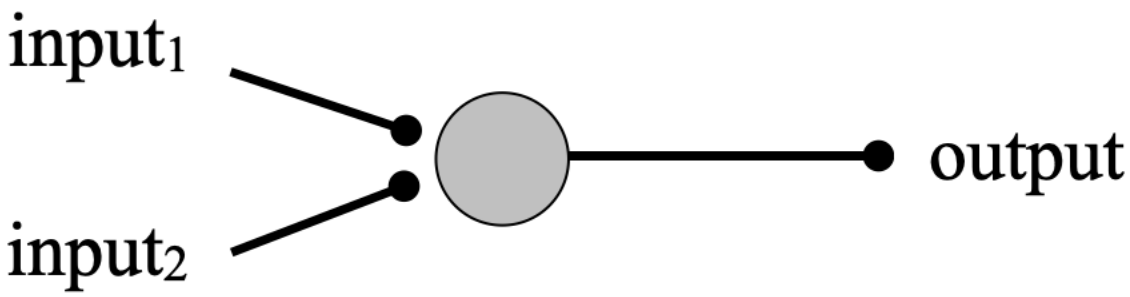
- Perceptron
- Networks of Perceptrons



Later → more biophysical neurons (rhythms?)

Neural computations in simple models

Perceptron (the simplest model)



Inputs

- weighted
- summed
- passed through an activation function → output.

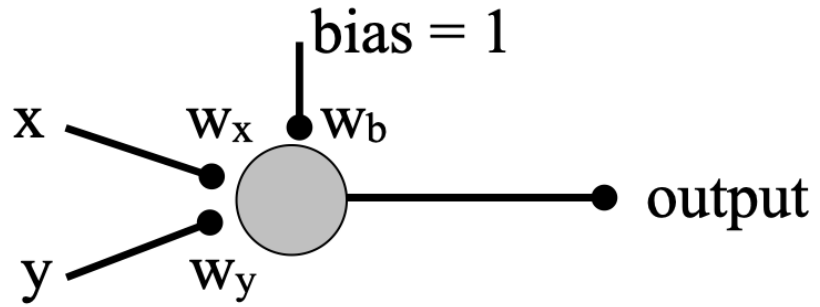
Act as simple information processors and classifiers.

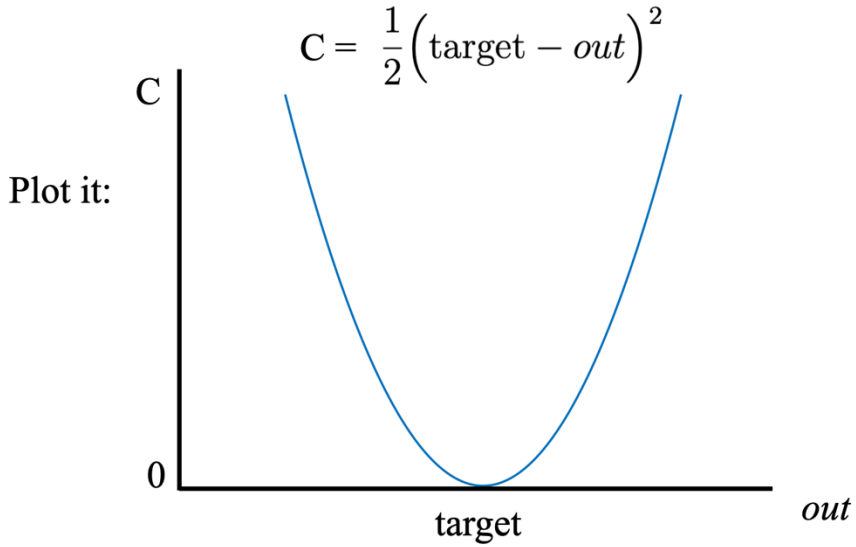
Learning = changing weights

learning → adjust weights to reduce error

Two examples

- perceptron-style supervised learning
- gradient-based approach





Backpropagation

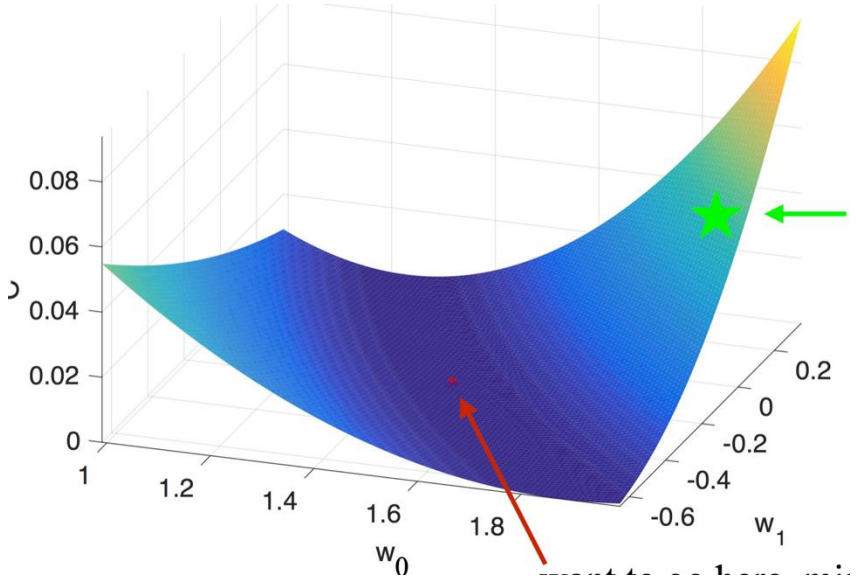
calculus (chain rule)

$$\frac{\mathrm{d}\, out}{\mathrm{d}\, w_1} = \frac{\mathrm{d}\, out}{\mathrm{d}\, s_2} \frac{\mathrm{d}\, s_2}{\mathrm{d}\, x_2} \frac{\mathrm{d}\, x_2}{\mathrm{d}\, w_1}$$

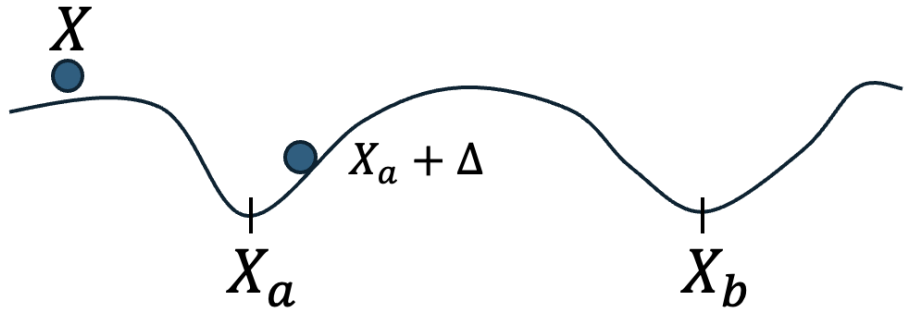
cost function

gradient descent

- update weights in the negative gradient direction (“move downhill”)
- minimize error



Memory as dynamics



attractors

- memory → dynamics flow to locally stable states

Hopfield model

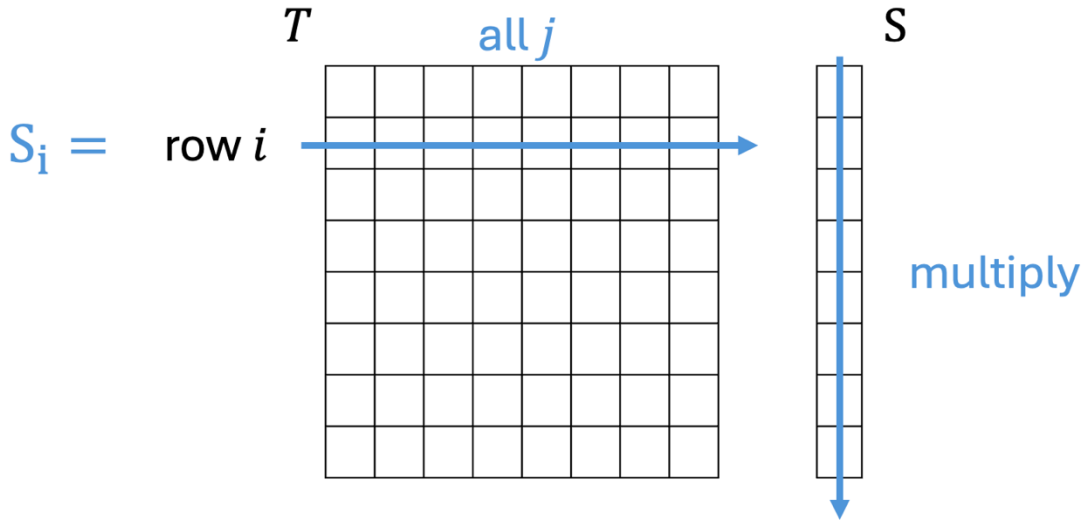
- store memories ξ in $T_{ij} = \xi_i \xi_j$
- states S can follow the dynamics to memories

$$S_i = \text{sign}\left\{\sum_{\text{j} \neq \text{i}} T_{ij} S_j\right\}$$

So, $S_i \rightarrow \xi_i$ State S moving towards the stable, stored state ξ

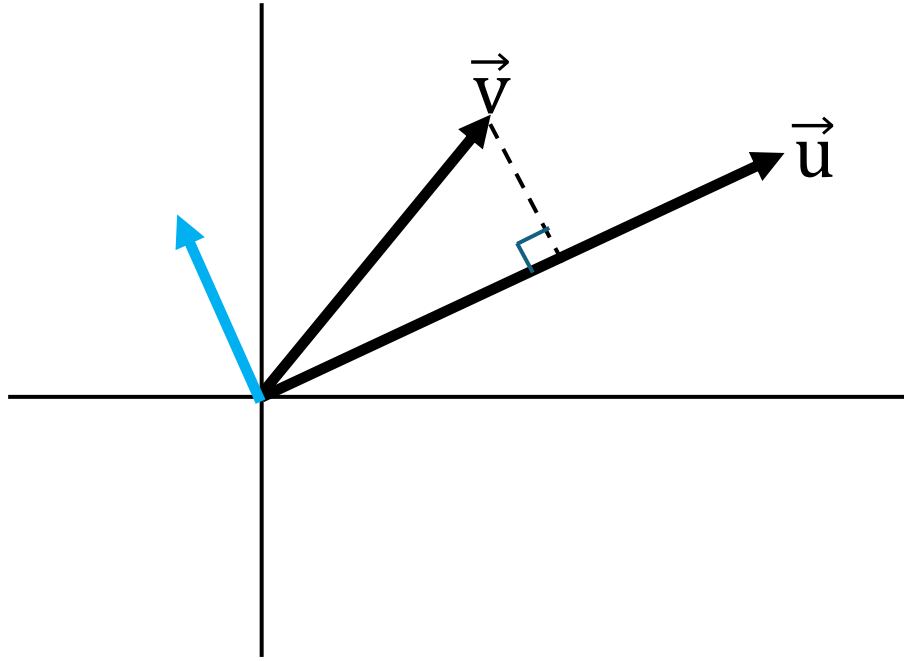
This works and $S_i \rightarrow \xi_i$ as long as $\sum_{\text{j} \neq \text{i}} \xi_j S_j > 0$

Linear algebra



The language of neural networks

- Vectors
- Matrices
- Dot product (projection & orthogonality)
- Matrix vector multiplication



Exam notes

- 13 questions (7 from practice exam)
- 100 points (question are either 5 or 10 points)
- Short answer & calculations & calculus
- No RNNs
- Paper based
- Bring: 1 piece of paper with notes & pencil/pen
- Practice exam on Blackboard