Neural networks

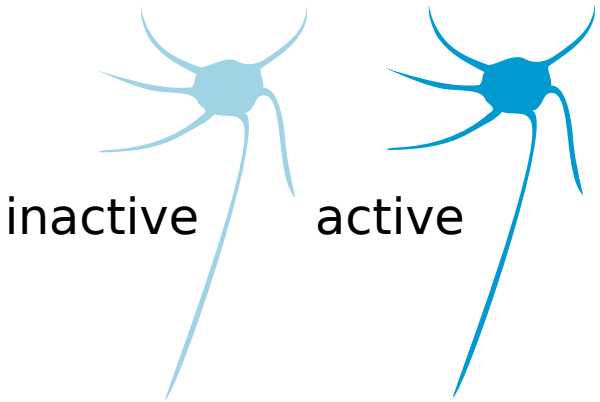
Seminar SoSe2020

AG Soft Matter Theory (Fuchs)

February 12, 2020

Neural networks and statistical mechanics

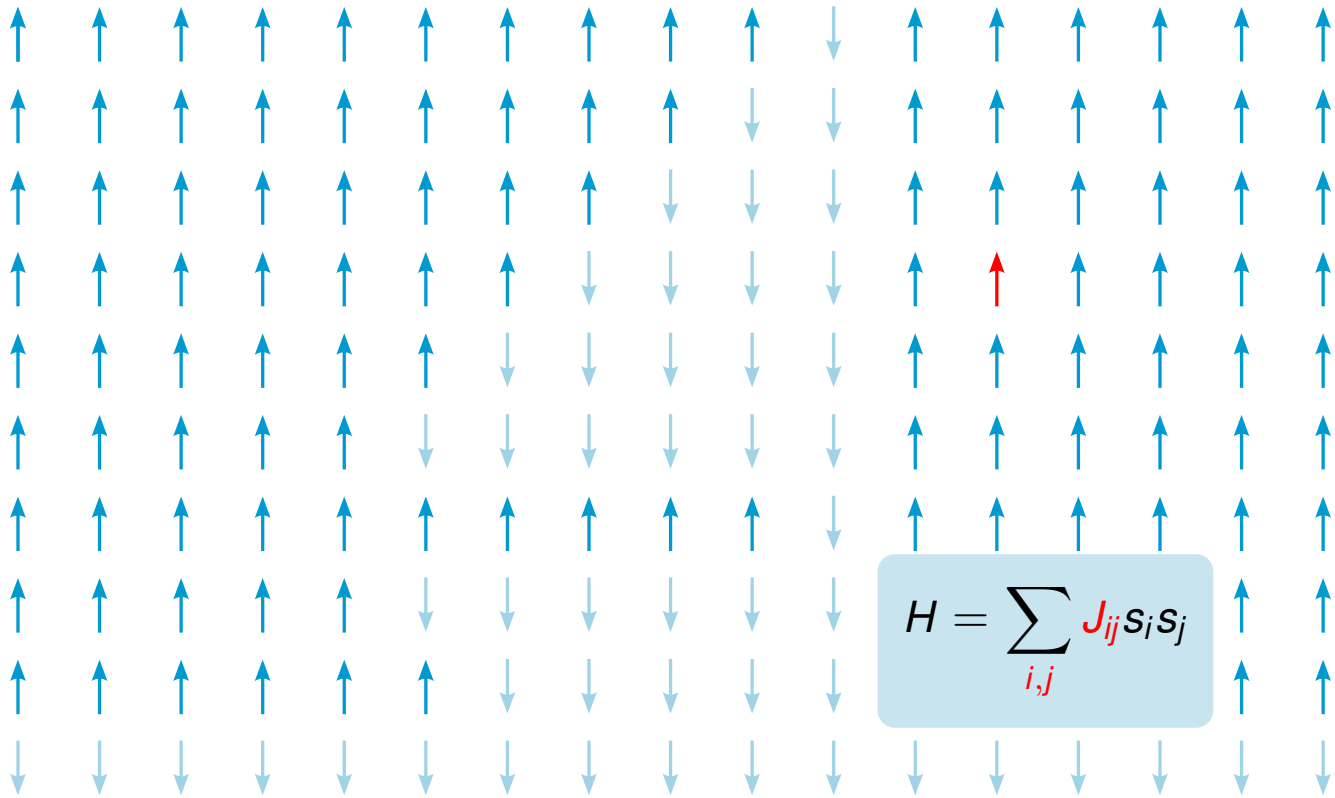
Neurons



Spins

$$H = \sum_{\langle i,j \rangle} J s_i s_j$$

Neural networks and statistical mechanics



Formalities

Prerequisites

(I) Physics

- Hamiltonian
- Gibbs-Boltzmann distribution
- Gibbs entropy
- Ising model

(II) Probability theory

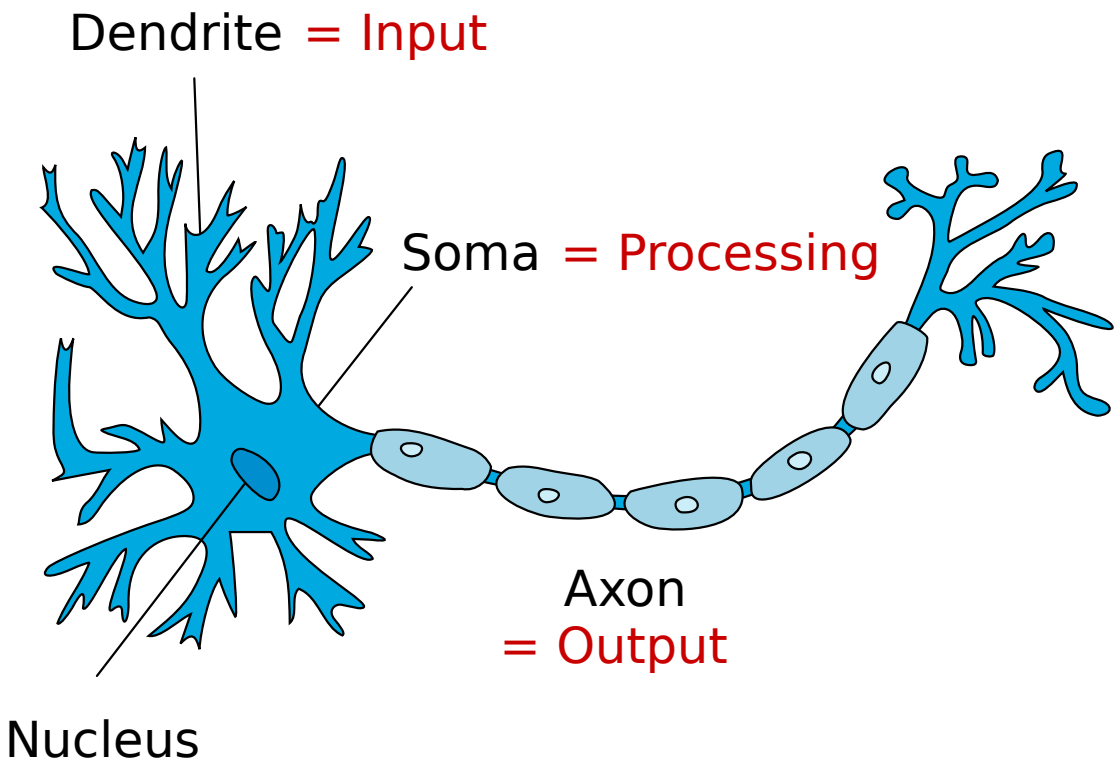
- probability distribution function
- random walk
- central limit theorem
- Markov chain (master equation)

Time and Requirements

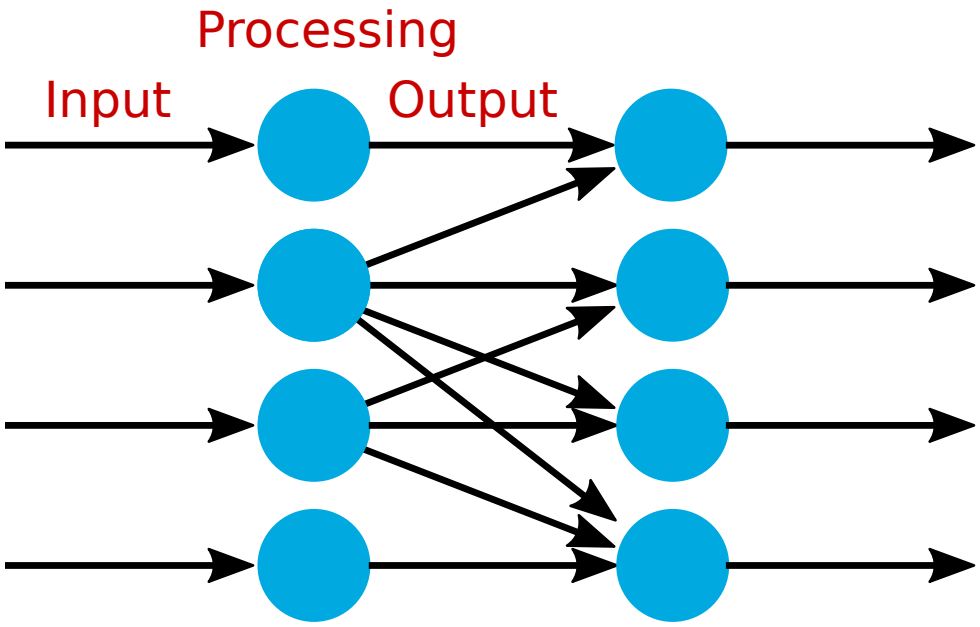
Seminar time: Thursdays, 15:15 (planned)

- seminar talk with some interactive part (demonstration using Jupyter notebook, blackboard proof, . . .)
- written report
- active participation in the seminar

Neurons

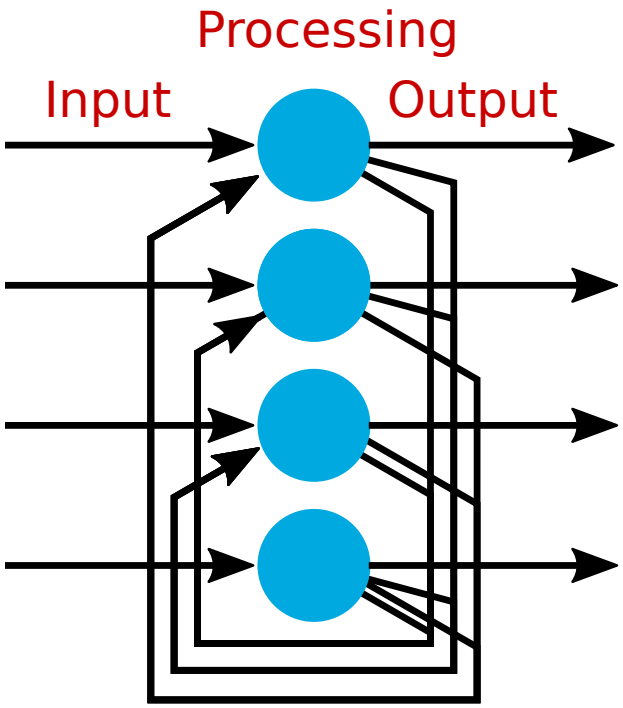


Neurons



feedforward neuronal network

Neurons



recurrent neuronal network

1. Introduction to neural networks
2. Learning and minimization
3. Single-layer-networks – the perceptron
4. Deep and convolutional neural networks
5. Hopfield model and memory
6. Generative models and Boltzmann machines

Literature

[CKS05] A. C. C. Coolen, R. Kühn, and P. Sollich, *Theory of neural information processing systems*. Oxford: Oxford University Press, (2005), ISBN: 978-0-19-853023-7.

[Mac03] D. J. MacKay, *Information theory, inference and learning algorithms*. Cambridge university press, (2003).

[MBW+19] P. Mehta *et al.*, "A high-bias, low-variance introduction to machine learning for physicists", *Physics Reports*, (Mar. 14, 2019). DOI: 10.1016/j.physrep.2019.03.001.