Some notes on Machine Learning

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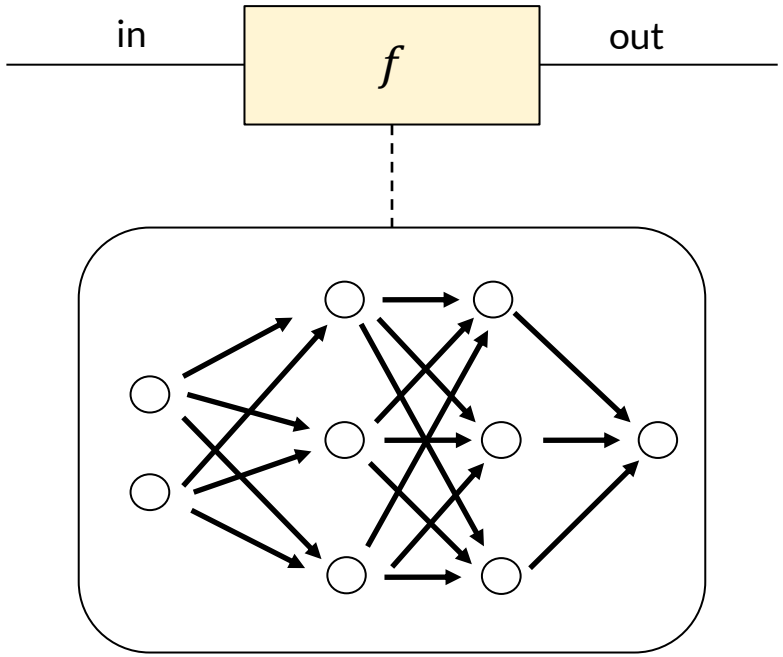
Machine learning and neural networks

- In machine learning, training data is used to learn a function (or a relationship).
- Input example: humidity, wind speed, pressure
- Output example: temperature
- For f we often use neural network. These are *function approximators* that can in principle mimic any function.
- Put differently, the network can describe many, many different functions and we need to find the right one (or a good one).



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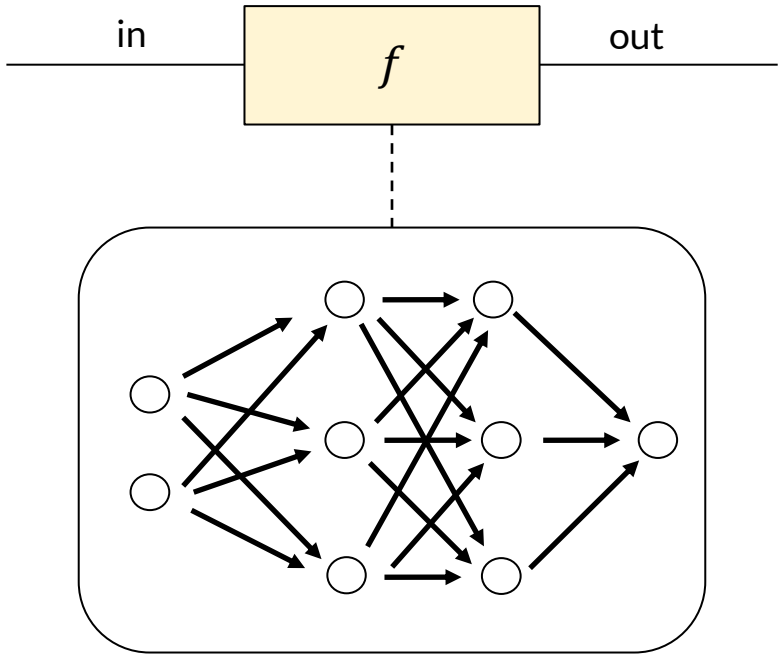
Machine learning and neural networks

- The model depends on a number of adjustable parameters. The parameter values determine which function the model describes.
- It is these parameters that are adjusted during the model training.
- Neural networks are built as compositions of simpler parts in a network. Each layer is a linear (or affine) function together with a so-called activation function.
- Data commonly comes in (input, output) pairs.
- The network is supposed to learn from the training data examples and be able to generalize to new data.
- We often split in training and testing data so that the model is tested on data not used for training.



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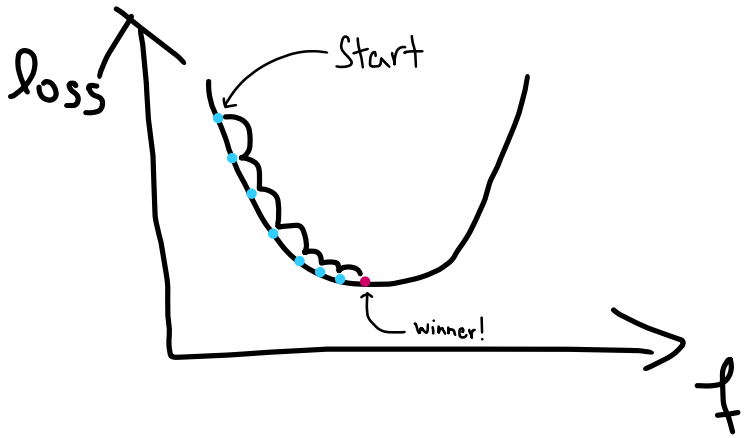
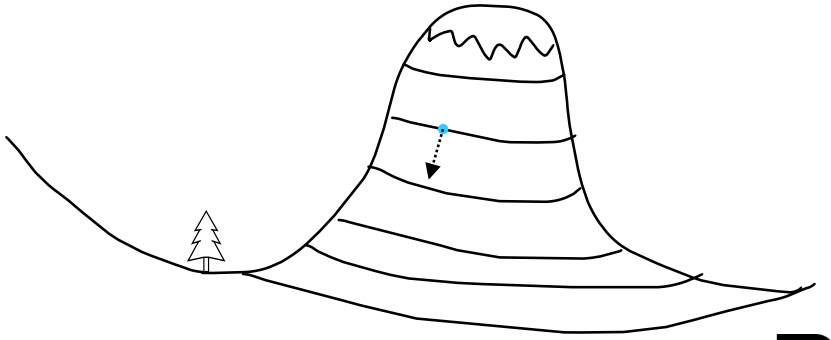
Machine learning and neural networks

- How well the networks predictions are is measured with the loss function. Example: mean squared error.
- The task is to minimize the loss function.
- The learning procedure often goes something like this:
  - Start with some random guess of parameter values.
  - Repeat the following:
  1. Measure how good the network predictions are: evaluate the loss function.
  2. Modify the parameters incrementally to make a small improvement in the loss.
- Step 2 is gradient descent on the loss function: compute the derivate of the loss and take a step in the direction where it decreases the most.





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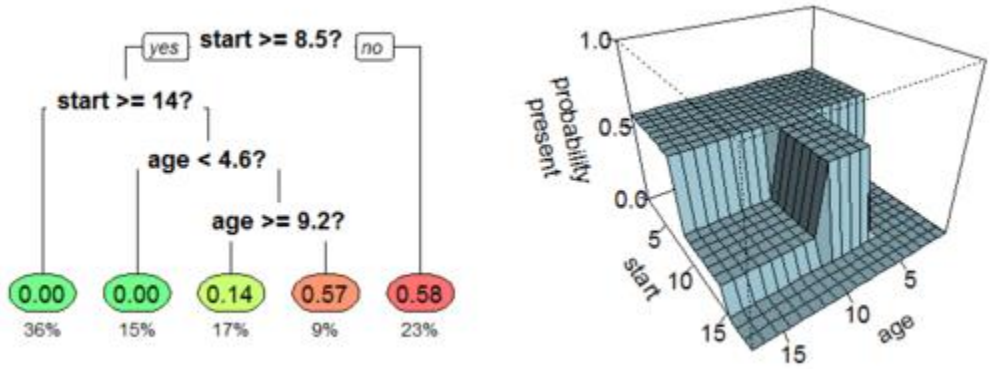
Decision trees and random forests

- **Decision Tree Regression**: piece wise constant function used as model. The input space is partitioned into boxes where the model function has constant value.
- A greedy optimization algorithm is used to define the boxes (decide splitting variables and threshold values) and the model output on each box.
- **Random forests**: average the result of many decision trees trained on different parts of the data.



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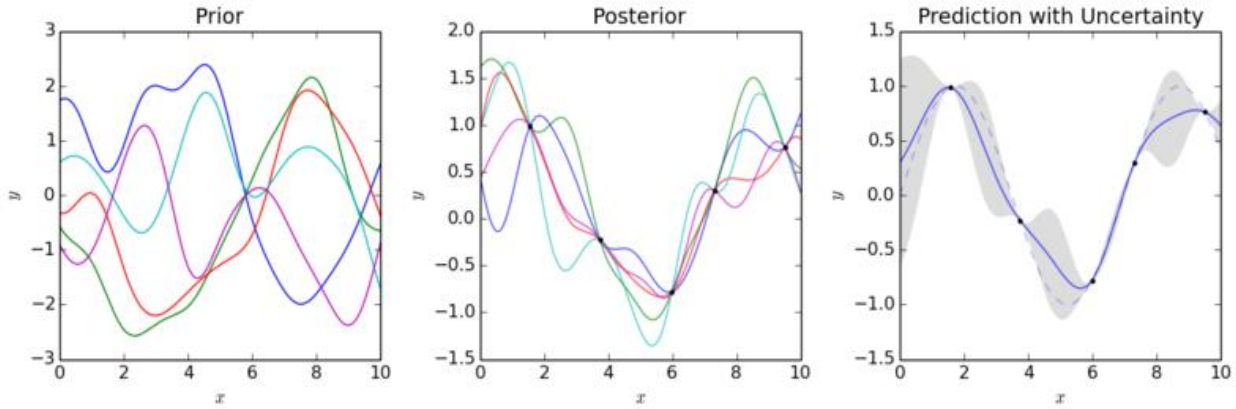
Gaussian processes

- **Gaussian Process Regressors**: Stochastic processes (random functions) are used for regression.
- Incorporates Bayesian viewpoint.
- Includes confidence intervals (uncertainty of prediction) in the model.



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