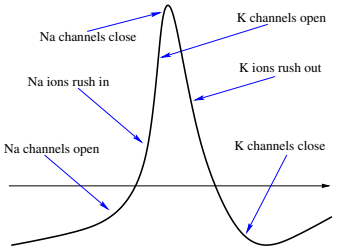
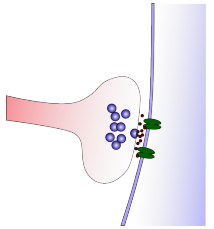
Flashback Course Summary

Neurophysiology

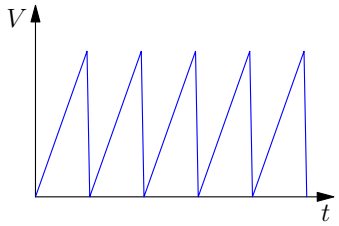
- Hodkin-Huxley Models
  - Membrane potential
  - Ion currents (Na^+, K^+)
  - Action potentials (spikes)
- Synaptic Interaction
  - Transmittor substances
  - Excitation / inhibition
- Compartment Models

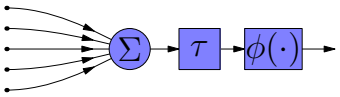


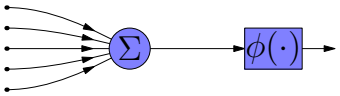


Abstract Neurons

- Integrate-and-fire models
- Leaky integrators
- Threshold logic units

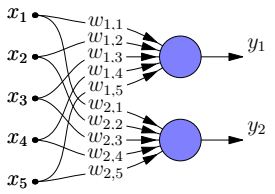


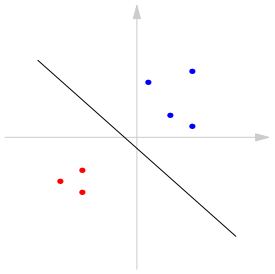




Feed-forward Networks

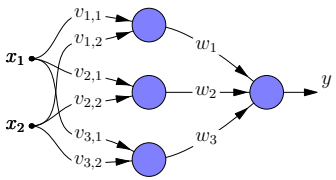
- Single Layer Networks
- Linear Separation
- Error driven learning
  - Perceptron learning
  - Error minimization

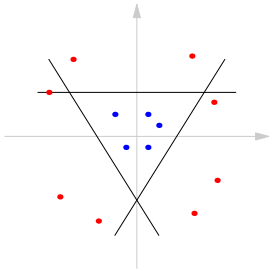




Feed-forward Networks

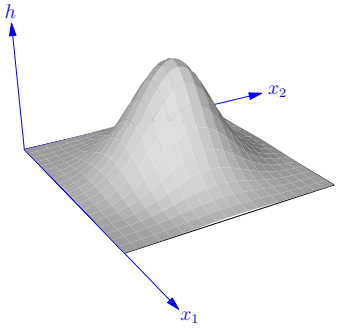
- Multi Layer Networks
  - General Classifier
  - Function Approximator
- Back-propagation Learning
  - Differentiable threshold functions
  - Convergence properties

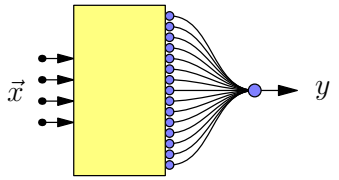




Radial-Basis Functions

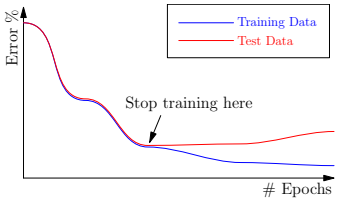
- Local activation in first layer
- Better function approximator





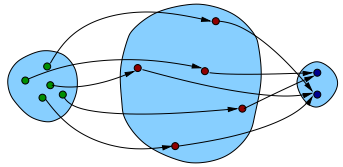
Overfitting

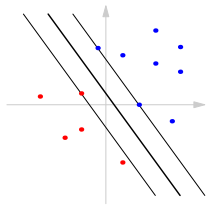
- Reduced ability to generalize
- Too powerful learner
- Cures
  - Early stopping
  - Pruning
  - Regularization



Support-Vector Machines

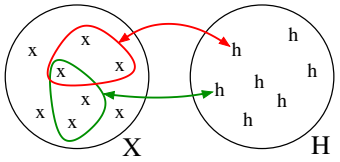
- Linear separation in high-dimensional space
- Maximization of margins
- Optimal generalization
- Kernels for efficient computation





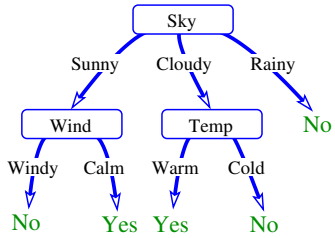
Concept Learning

- Hypotheses space
- Relations between hypotheses



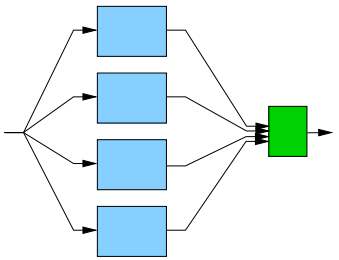
Decision Trees

- Entropy — unpredictability
- Information Gain



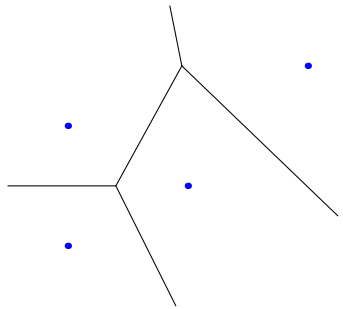
Boosting

- Weak learners → strong learner
- Multiple learners
- Different training sample sets
- Weighted voting
- AdaBoost



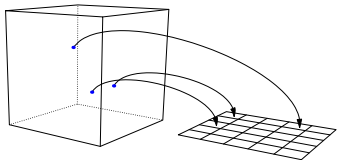
Competitive Learning

- Only winning node is updated
- Local specialists
- Cluster detection
- Quantization of high-dimensional data



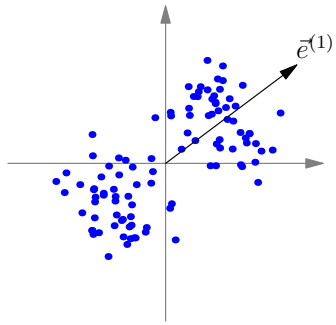
Topology Preserving Maps

- Winner with neighborhood
- Self-organizing feature maps
- One or two dimensional map



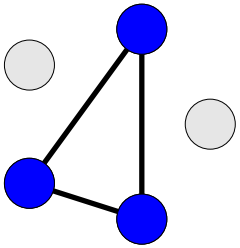
Principal Component Analysis

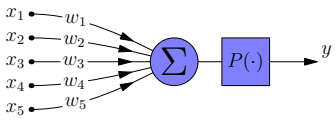
- Reduction of dimensionality
- Subspace with maximal variance
- Linear combinations



Attractor Models

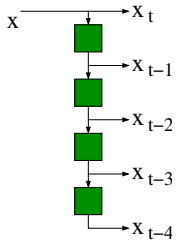
- Hopfield networks
  - Fixpoint attractors
  - Energy minimization
- Boltzmann machines
  - Stochastic neurons
  - Constrained optimization

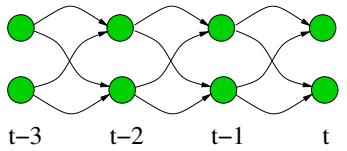




Time Sequences

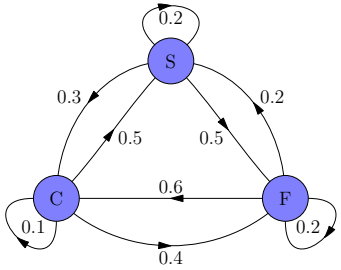
- Tapped delay line
- History unfolding
- Back-propagation through time





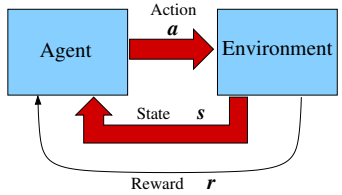
Markov Models

- Hidden Markov models
- Viterbi algorithm
  - Find most likely hidden state sequence
- Baum-Welch algorithm
  - Find model parameters from examples



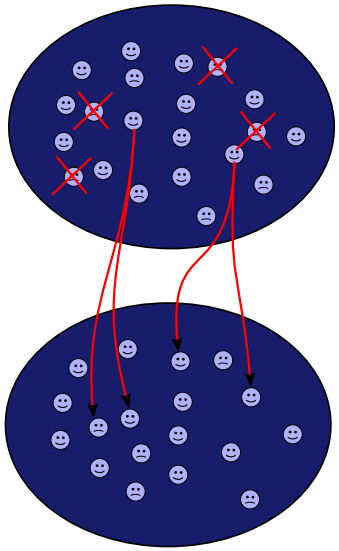
Reinforcement Learning

- Delayed reward
- Temporal credit assignment
- Value function
- Policy
- Temporal difference techniques
- *Q*-learning
- Sarsa-learning



Genetic Algorithms

- Optimization
- Fitness function
- Parallel stochastic gradient following
- Crossover — Sharing partial solutions
- Coding
- Genetic programming



Methods we have not talked about

- Bayesian classification
- Bayesian networks
- Learning theory
- Rule based learning