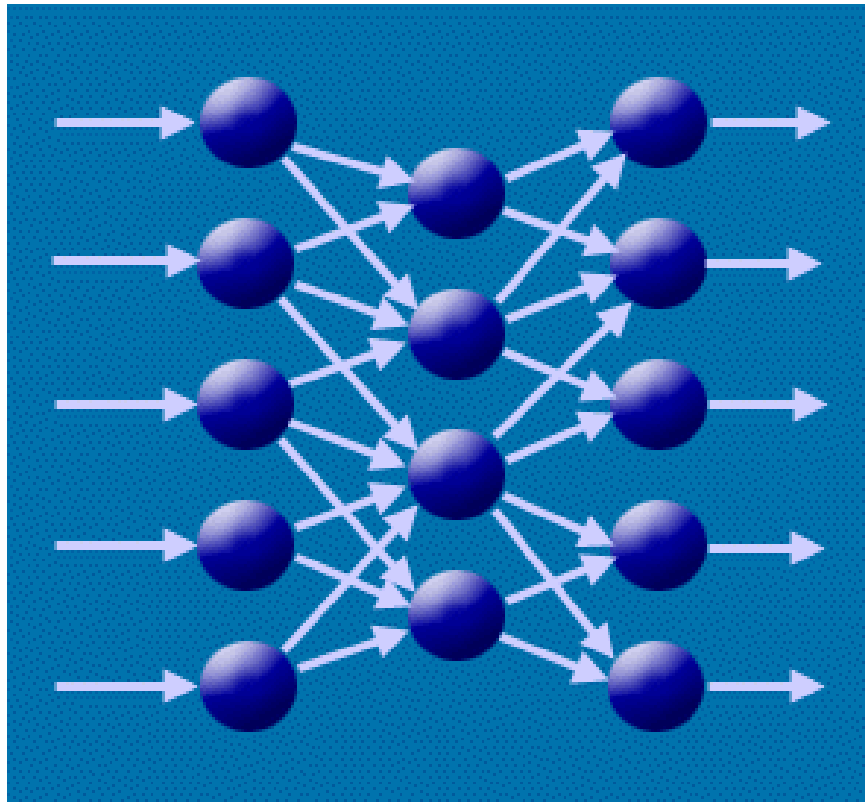


# Neural networks

Reviewing the basics



# Artificial neural networks...

- ... are parallel distributed information processing tools that
  - contain many similar, simple computing units,
  - can learn processing methods based on data samples,
  - can process unknown input after learning.

# Important properties

## Pros:

- ability to model complex problems
- adapting to changing environments
- fault-tolerance

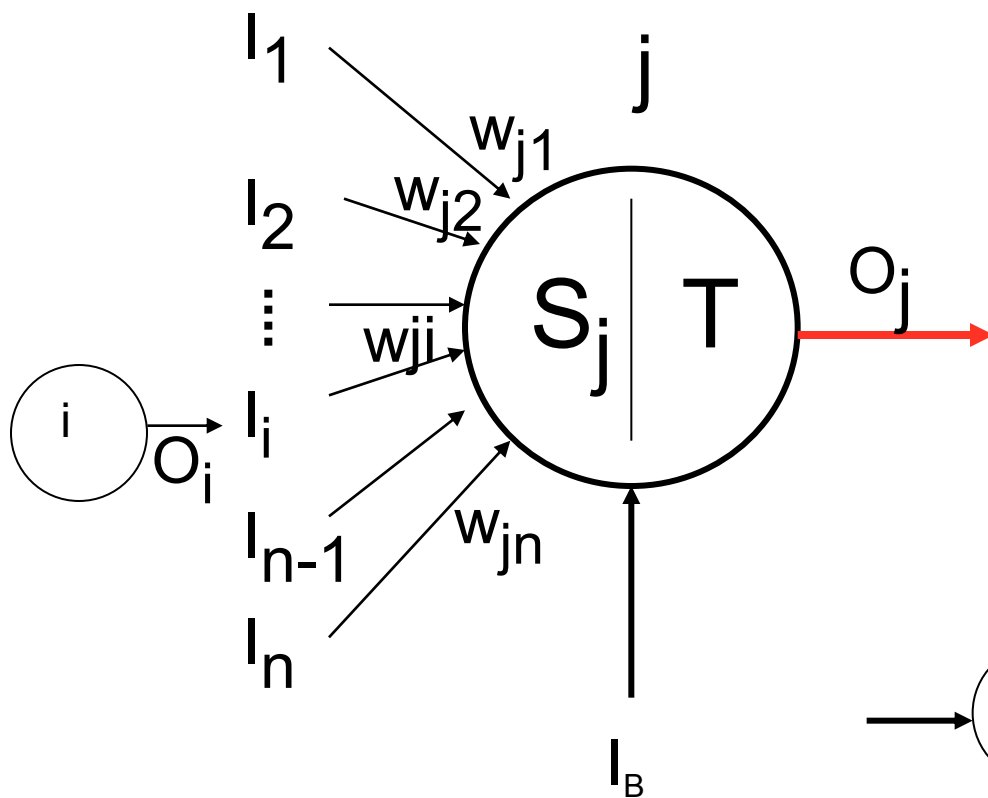
## Cons:

- NOT 100% accurate
- performance depends on quality of the training dataset

# Applications

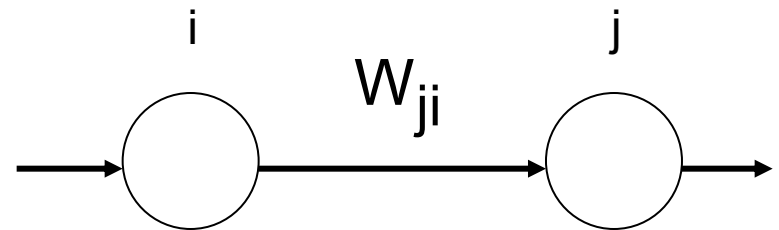
- image processing
- speech recognition
- speech synthesis
- business trend modeling
- control
- risk management
- expert systems
- associative memory
- etc.

# The neuron



$$S_j = \sum_{i=1}^n w_{ji} I_i$$

$$O_j = T(S_j)$$

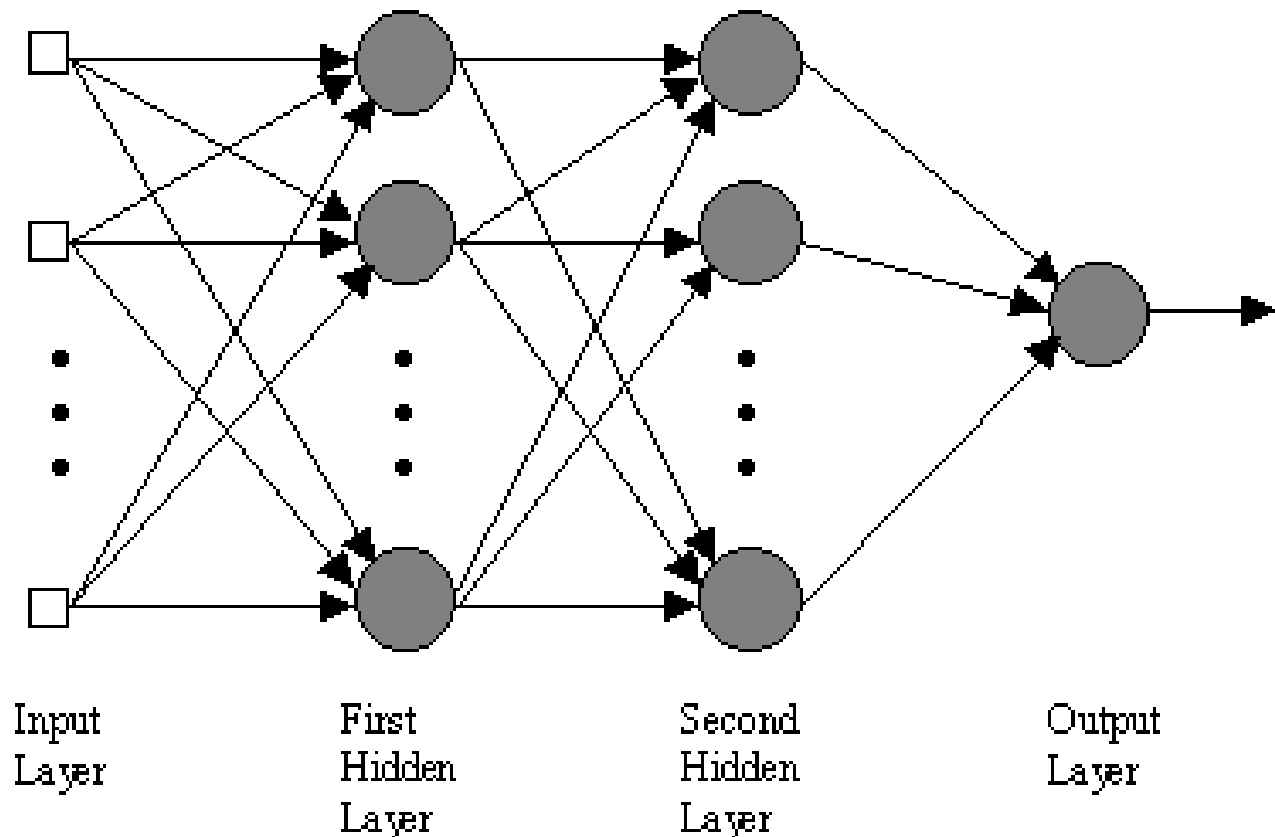


# Transfer functions

- functions with  $[0, 1]$  range
  - step function
  - limited linear function
  - sigmoid (logistic) function
- functions with  $[-1, 1]$  range
  - sign (signum) function
  - hyperbolic tangent function

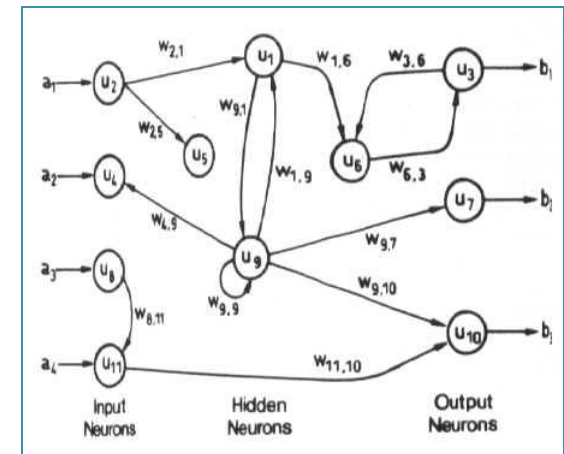
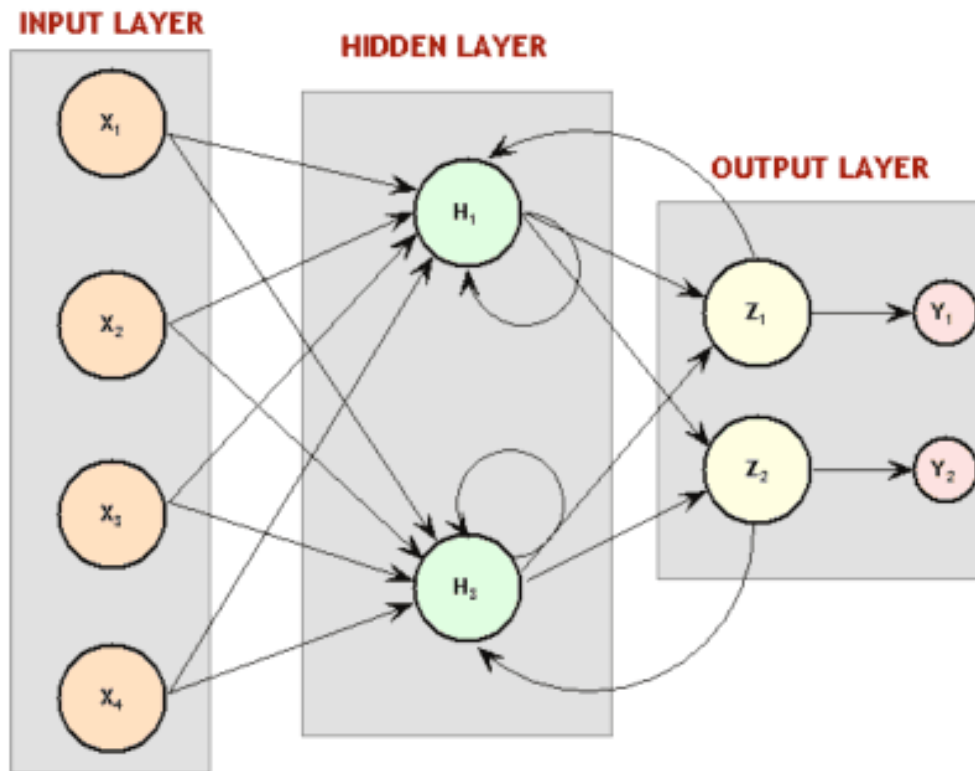
# Topology

- Feedforward network



# Topology

- Feedback network





# Training

- Supervised learning
  - training data set: inputs+expected outputs
  - adjusting weights according to difference of expected and actual output

Delta rule:

$$w_{ji}(t+1) = w_{ji}(t) + \alpha * O_i * (C_j - O_j)$$

- measuring error:
  - eg.  $E = \sum_k (C_k - O_k)^2$
  - or something similar...

# Training

- *Backpropagation*
  - weights are initialized to random
  - weights are adjusted proportional to the partial derivative of the error function
  - training stops when predetermined error threshold (performance target) is reached

# Training

- Reinforcement learning
  - no target values given, only measure of quality of the output (good answers reinforced)
- Unsupervised learning
  - no target values given
  - error is **not** defined as deviance from target; another function has to be chosen

# Applying neural networks

- Collecting **representative** training data (input and expected output)
- Choosing
  - neural network paradigm
  - network parameters
  - performance target
  - testing method
- Training and testing

# Resources

- <http://www.ai-junkie.com/>
- Stergiou, C., Siganos, D.: Neural networks  
[http://www.doc.ic.ac.uk/~nd/surprise\\_96/journal/vol4/cs11/report.html](http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4/cs11/report.html)
- Dr. Kutor's slides  
<http://uni-obuda.hu/users/kutor/IS%202016/Is%2016-5.pdf>