Introduction to Artificial Neural Networks (ANN) and System Identification

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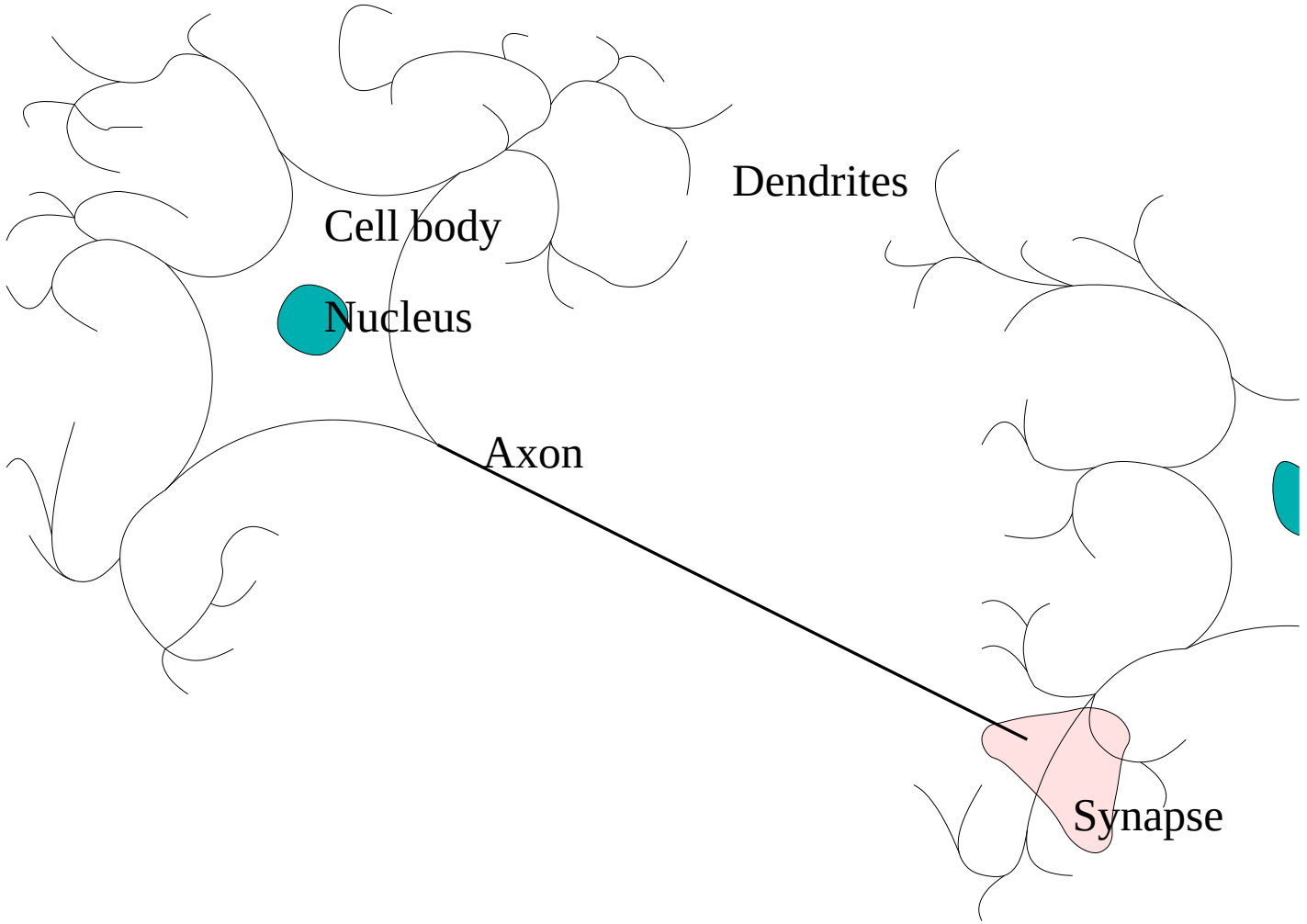
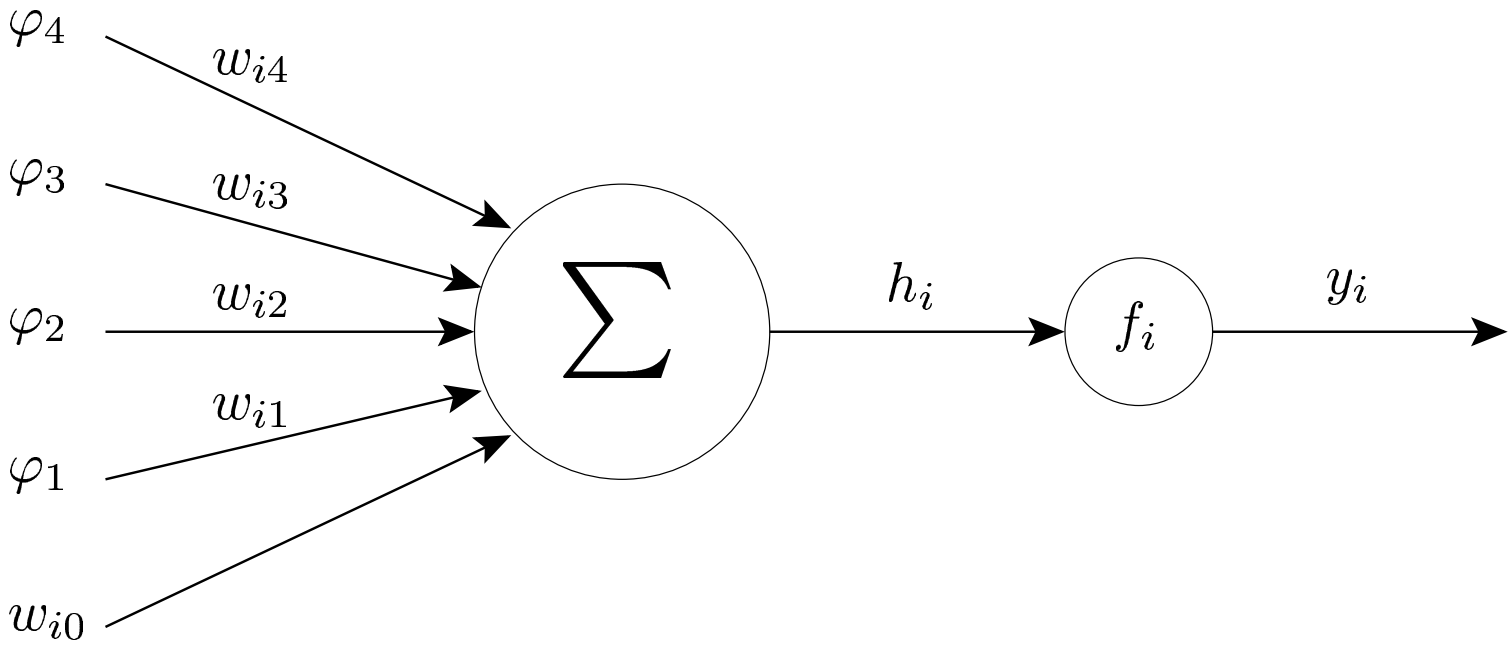
ANN - Background



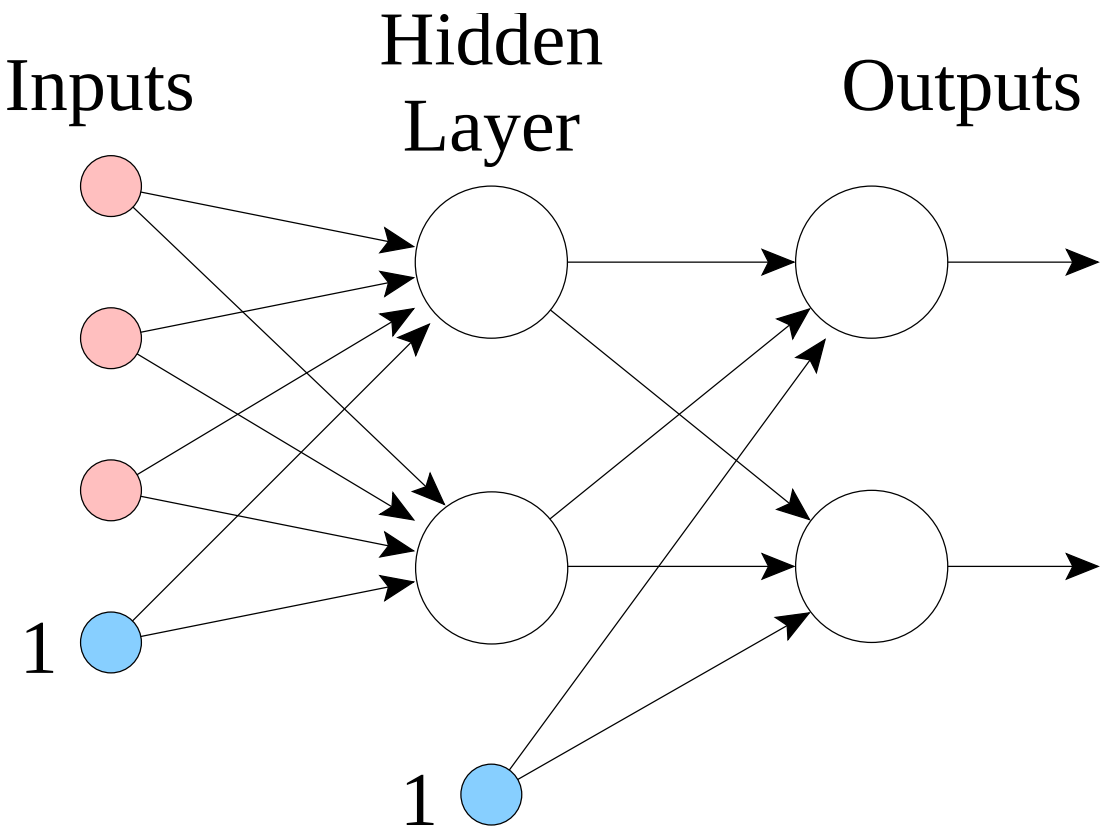
ANN - A neuron



A neuron $y_i = f_i(h_i) = f_i(\sum_{j=1}^{n} w_{i,j} + w_{i,0})$

ANN - Example

A fully connected two layer feedforward network with three inputs, two hidden units and two outputs.



ANN - Why and when?

Why: ANN can learn complex relations with different properties

Why: Efficient computation with parallelism

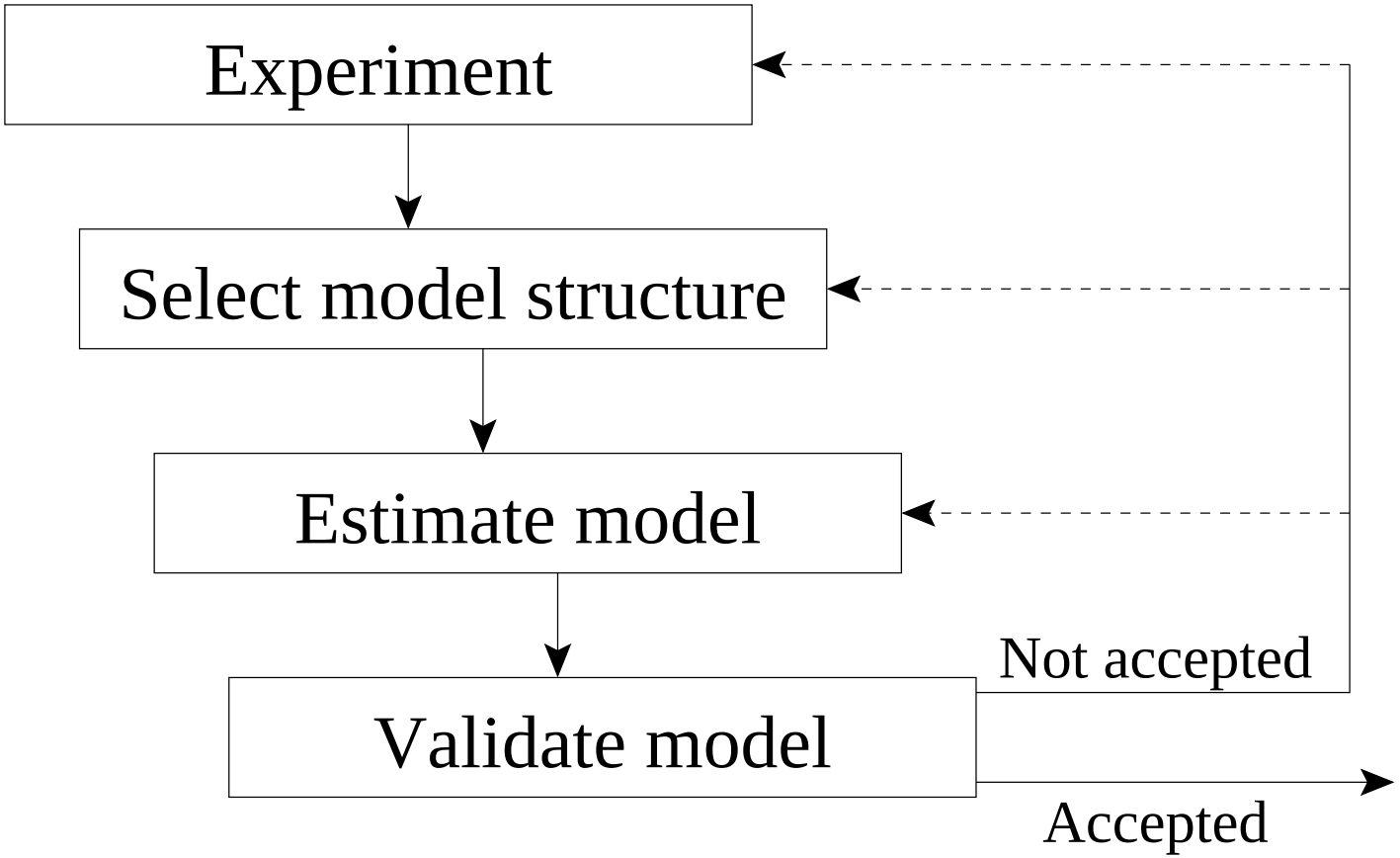
When: Traditional way (i.e. designing and algorithm) is troublesome

(When:) You have data but not the know-how

ANN - Issues

- Data, does it
  - have structure?
  - represent the system properly?
- The design of the ANN
  - Inputs
  - Hidden layers
  - Nodes
  - Connections
  - Activation functions
- In general, is it possible to use ANN successfully?

System Identification - The procedure



Example - Predicting course popularity

The objective of the system would be to predict the number of students partcipating in a particular course in advance, so that the course staff could plan the course more easily.

Example - Step 1: Experiment

What do we know?

- Course statistics from previous years
  - When the course was organized and the participants
- Something about the students who participated/didn't participate
  - Department, major, minors
  - Credits, courses, study schedule

Example - Step 2: Select model structure

What to use? An ANN?

No, its easier to derive the predictions by other means.

Yes, the data seems to have some structure, which – however – seems not to be trivial. Time to make an *educated guess*$^{\text{TM}}$ about the

- proper inputs
- structure of the ANN
- size of the ANN

Example - Steps 3 & 4: Estimation and validation

Divide the data for training set and test set, and check if the predictions given by the (seemingly best) ANN are sufficiently accurate with the test set.

If not, iterate...