
Programming

A scholar in social sciences has to have good skills in **mathematics, statistics and econometrics**

With the diffusion of computer simulation, the same is true about **programming knowledge**

Using what kind of tools? High level ones, as most important packages for calculus, statistics, econometrics, simulation ..., but having also a close look to the modern foundations of programming, via an object oriented language

Programming methodologies

- imperative programming http://en.wikipedia.org/wiki/Imperative_programming
 - sequences of orders to be executed in a formal way
 - with the object-oriented paradigm, we use objects and methods as a metaphors of the actual world
- declarative programming http://en.wikipedia.org/wiki/Declarative_programming
 - definitions and “engines” to use them
- *soft computing*
 - neural networks http://en.wikipedia.org/wiki/Neural_network
 - genetic algorithms http://en.wikipedia.org/wiki/Genetic_algorithms
 - classifier systems http://en.wikipedia.org/wiki/Learning_classifier_system ,
<http://eco83.econ.unito.it/golem/>



Imperative programming, calculating a factorial (in Python)

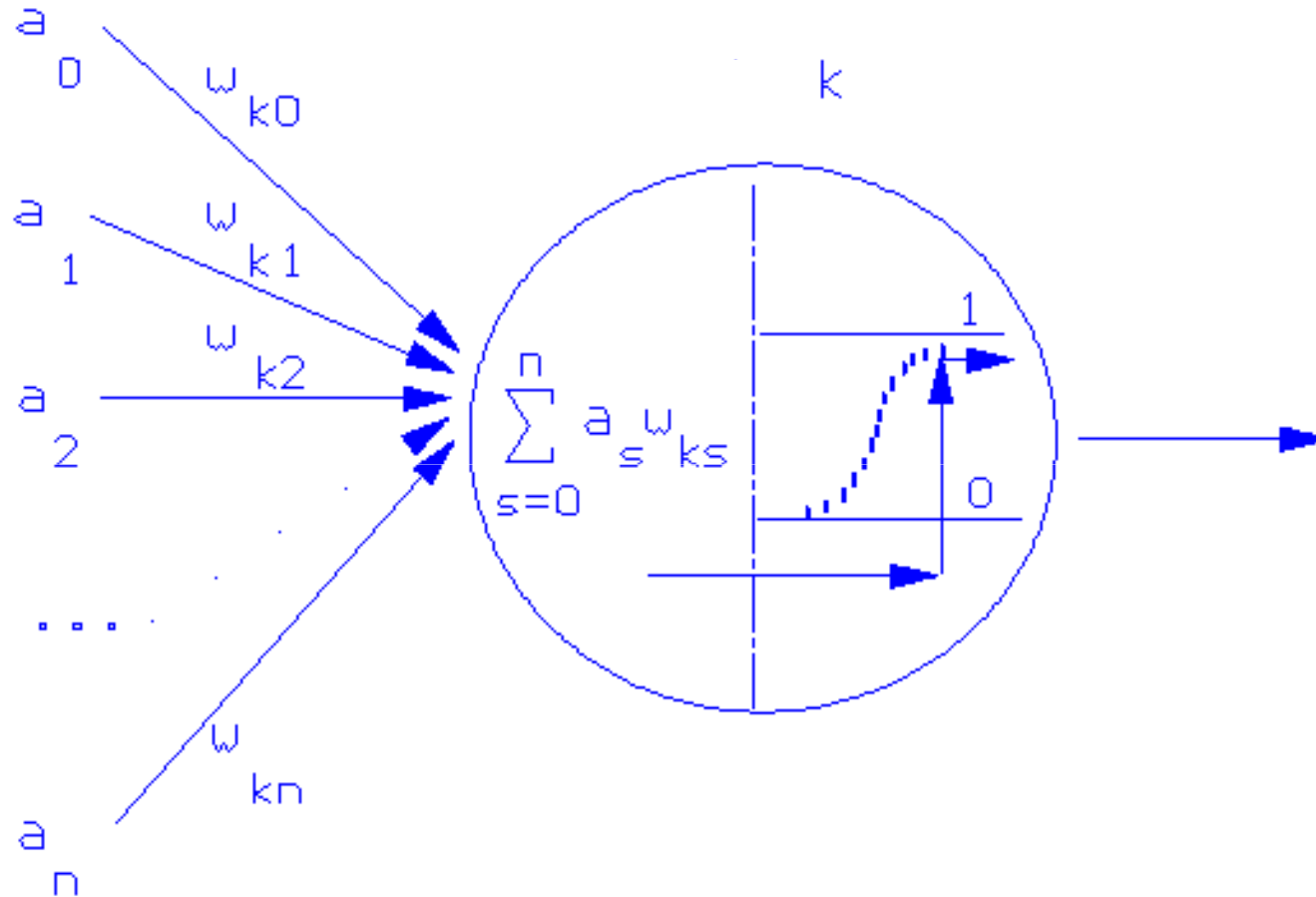
```
n=5
f=1.
for i in range(1, 6):
    f=f*i
print f
```

Declarative programming, calculating a factorial (in Mathematica)

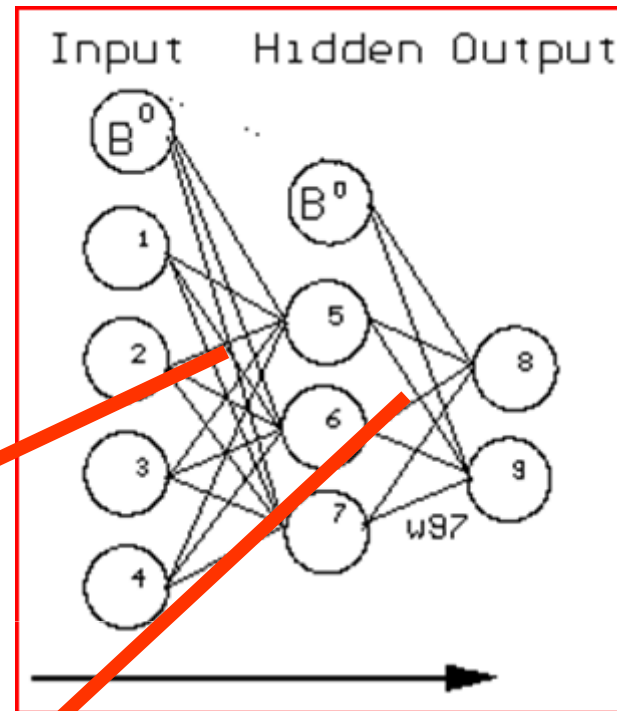
```
fact[n_] := n fact[n-1]
fact[0]=1
```

Artificial neural networks

A neuron or knot of the network



The network




$$A = \begin{array}{|c|c|c|} \hline w50 & w60 & w70 \\ \hline w51 & w61 & w71 \\ \hline w52 & w62 & w72 \\ \hline w53 & w63 & w73 \\ \hline w54 & w64 & w74 \\ \hline \end{array}$$

$$B = \begin{array}{|c|c|} \hline w80 & w90 \\ \hline w85 & w95 \\ \hline w86 & w96 \\ \hline w87 & w97 \\ \hline \end{array}$$

With $f(x) = 1/(1 + e^{-x})$ we can write:
 $y = f(B [1, f(A [1, x])])$

where $y = [y8 \ y9]'$ is the output vector and

$x = [x1 \ x2 \ x3 \ x4]'$ is the input vector; the constant 1 is added as first element of the vector as input values for the so called bias knots or neurons

$$y = f(B f(A x))$$


Considering the error $E = \sum (t_k - y_k)^2$ we can
calculate the correction
of each w_{ij} parameter
following a set of (x,y) statistics

To read more about Artificial Neural Networks, from my home page:

P.Terna (2000a), Economic Experiments with Swarm: a Neural Network Approach to the Self-Development of Consistency in Agents' Behavior, in F. Luna and B. Stefansson (eds.), *Economic Simulations in Swarm: Agent-Based Modelling and Object Oriented Programming*. Dordrecht and London, Kluwer Academic.

<http://web.econ.unito.it/terna/deposito/bpct.html>

Beltratti, A., Margarita S., Terna P. (1996a), *Neural Networks for Economic and Financial Modelling*, ITCP, London. [Ch. 4 \(CTs\)](#)

http://web.econ.unito.it/terna/deposito/ct_1996.pdf