# Natural Language
Practical Classes

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# P0

**Basics**: Python and Feedforward Neural Networks (*optional class*)

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- **Summary**:
  - Python – basics
  - Neural Networks – essentials
- **Operational objectives**:
  - Learn (or remember) the basics of programming in Python
  - Understand the computational principles behind simple Feedforward Neural Networks
- **This class needs**: paper, a pen/pencil and a computer
- **Class material**: jupyter notebooks and few slides on neural processing

# 1 Python

Go to Colab – `https://colab.research.google.com` – and upload the notebook "P0_basic_python.ipynb" (slightly adapted by Luisa Coheur from a notebook created by Fernando Batista and Ricardo Ribeiro from ISCTE. Thanks!). Rui Henriques added more information. Run it and carefully check the syntax and results.

# 2 Feedforward Neural Networks

1. Spend a few minutes reading the slides P0_presentation_perceptron_FFNN.pdf. Your challenges:

   (a) Consider a neuron with 3 input weights, $\mathbf{w} = [0.2, 2.0, 0.01]$, a bias of 1, and the ReLU activation function[1].

      i. Given the input $\mathbf{x} = [0.5, 0.003, 0.1]$, what is the approximate neuron's output?

      ii. Given the same input, what is the output when you replace ReLU activation by the sigmoid function[2]?

      iii. Given the model estimates $\hat{y} = [0.9, 0.7, 0.3]$ and true outcomes $y = [0.8, 0.6, 0.5]$, compute the mean squared error ($l_2$ loss).

   (b) [*Optional*] Consider a feedforward network with 2 inputs, a hidden layer of 3 neurons, 1 output, and ReLU activations. Let the weights between input and hidden nodes be $W_1$, weights between hidden and output nodes be $W_2$, and all biases be 0,

   $$W_1 = \begin{pmatrix} -1 & 0.1 \\ 1 & 1 \\ 0.5 & 1 \end{pmatrix}, \quad W_2 = \begin{pmatrix} 1 & 1 & -0.5 \end{pmatrix}.$$

   What is the network output for the input $\mathbf{x} = [0.4, 2.0]$?

2. Go again to Colab and upload the notebook "P0_basic_NN.ipynb". Your challenges:

   (a) Play with the provided perceptron. Note that the perceptron is currently working as a regressor (if you don't know what a regressor is, search for it) and a learning task is considered (increment 1).

   (b) Assess the impact of the following changes:

      i. learning rate $\eta \in \{0.001, 0.01, 0.1, 1\}$ and epochs $n \in \{1, 2, 5, 10, 100\}$

      ii. varying number of training observations ($|D_{train}| \in \{5, 10, 20, 100, 500\}$).

[1] $\text{ReLU}(x) = \max(0, x)$

[2] $\sigma(x) = \frac{1}{1+e^{-x}}$