UNIVERSIDADE DE AVEIRO
DEPARTAMENTO DE ELECTRÓNICA, TELECOMUNICAÇÕES E INFORMÁTICA

Programming Elements (2023/24)

Lab work nº 1 — Due: 30 Oct 2023

Part I

1. Implement a C program, `print_bit`, that reads an integer, i, from the keyboard and a bit position, p, and prints the corresponding value of that bit in the binary representation of i. Note: consider that $p = 0$ corresponds to the position of the least significant bit.

2. Implement a C program, `print_bits`, that reads an integer, i, from the keyboard and prints i in binary format, from the most to the least significant bit.

3. Implement a C program, `bits_to_int`, that reads a string of binary digits (i.e., composed of zeros and ones) and prints the corresponding integer in decimal format.

4. Join `print_bits` and `bits_to_int` into a single program, `bits`. In this case, the needed inputs must be passed as command-line arguments.

Part II

5. Develop a C module, denoted `nn_base`, to:

   - Construct a data structure for holding a neural network with `I` inputs, a layer of `H` hidden units, and `O` outputs. The units of the neural network should implement a linear function (this will be changed later).
   - Construct a data structure for holding the values of the connections (weights) between the neural network units. Assume a fully connected network, with all weights initialized to zero.
   - Load the weights from a file (according to the format specified below), such that, for example, "`1:1 2:3 1.124`" means that the connection from unit number one of the input layer to unit number three of the hidden layer has value 1.124.

```
I H O
int:int int:int float
int:int int:int float
...
int:int int:int float
```

Example:

```
2 3 1
1:1 2:1 0.234
1:1 2:2 -0.3456
1:1 2:3 1.124
1:2 3:1 0.098
1:2 2:2 -1.9877
```

- Implement a function to propagate an array of `I` input values, from the input layer to the output layer.
- Implement a function to write to a file the parameters of a neural network existing in memory, according to the format described above.

Part III

6. Elaborate a small report, where you describe all the relevant steps and decisions taken in all the items of the work. This report should also contain the user manual of each program and of the `nn_base` module interface.