

### Python assignment 1

Consider the following two-dimensional list, MAT, with dimensions 6×6

```
MAT = [[7, 0, 0, 0, 0, 0],  
        [0, 0, 0, 0, 0, 0],  
        [0, 0, -3, 0, 9, 0],  
        [0, 0, 0, 0, 0, 0],  
        [0, 0, -1, 0, 0, 0],  
        [0, -6, 0, 0, -5, 1]]
```

A two-dimensional list in which most of the elements are zero is called a sparse matrix. A sparse matrix can be compressed by storing only non-zero elements using three one-dimensional lists.

The first list, VALUES, stores all non-zero elements taken from the sparse matrix in row-major order (left-to-right then top-to-bottom order).

The length of the list VALUES is equal to the number of non-zero elements in the sparse matrix. For the sparse matrix above, MAT, the list VALUES is:

```
[7, -3, 9, -1, -6, -5, 1]
```

a) Construct the code that stores non-zero elements of MAT in VALUES.

The second list is ROWC. ROWC[i] stores the number of non-zero elements, from row 0 to row i of the sparse matrix, inclusive. The length of ROWC is equal to the number of rows in the sparse matrix. For MAT the list ROWC is:

```
[1, 1, 3, 3, 4, 7]
```

For example, ROWC[2] stores 3 because in MAT there are three non-zero elements from row 0 to row 2, inclusive.

b) Construct the code that builds the ROWC list.

The third list, COL, stores the column index for each non-zero element in the sparse matrix. COL[i] stores the sparse matrix column index for the non-zero element stored in VALUES[i]. For MAT the list COL is:

```
[0, 2, 4, 2, 1, 4, 5]
```

c) Construct the code that builds the COLlist.

HINT: the three lists (VALUES, ROWC and COL) can be built simultaneously.

## Python assignment 2

There are many different ways of placing the numbers 1 to  $N^2$  into an  $N \times N$  two-dimensional list. The following two-dimensional list, with dimensions  $5 \times 5$  has been filled in a circular (spiral) pattern with numbers 1 to  $5^2$ .


```
[1, 2, 3, 4, 5]
[16, 17, 18, 19, 6]
[15, 24, 25, 20, 7]
[14, 23, 22, 21, 8]
[13, 12, 11, 10, 9]
```

The general process of filling an  $N \times N$  two-dimensional list, in a circular (spiral) pattern, with numbers from 1 to  $N^2$  could be described as follows:

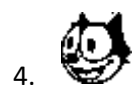
1. initialize  $Z=1$ ,
2. initialize TOP, BOTTOM, LEFT and RIGHT,
3. iterate until the whole list is filled,
4. each time  $Z$  is placed correctly increase the value of  $Z$  by 1,
5. fill the elements of the TOP row starting from LEFT to RIGHT,
6. increase TOP by 1 before filling the elements of the RIGHT column,
7. fill the elements of the RIGHT column starting from TOP to BOTTOM,
8. decrease RIGHT by 1 before filling the elements of the BOTTOM row,
9. and continue filling the BOTTOM row and LEFT column in a similar way
10. adjusting TOP, RIGHT, BOTTOM and LEFT accordingly

a) Construct the code of an algorithm to fill a  $5 \times 5$  two-dimensional list, in a circular (spiral) pattern, with numbers from 1 to 25 as described above.

### Python assignment 3

The file `felix_the_cat.py` displays the following image: 

Construct the code such that the image is displayed as follows:



#### Python assignment 4

1. Compute in Python, or state “not defined” (use a try except)

a.  $\begin{pmatrix} 3 & 1 \\ -4 & 2 \end{pmatrix} \begin{pmatrix} 0 & 5 \\ 0 & 0.5 \end{pmatrix}$

b.  $\begin{pmatrix} 1 & 1 & -1 \\ 4 & 0 & 3 \end{pmatrix} \begin{pmatrix} 2 & -1 & -1 \\ 3 & 1 & 1 \\ 3 & 1 & 1 \end{pmatrix}$

c.  $\begin{pmatrix} 2 & -7 \\ 7 & 4 \end{pmatrix} \begin{pmatrix} 1 & 0 & 5 \\ -1 & 1 & 1 \\ 3 & 8 & 4 \end{pmatrix}$

d.  $\begin{pmatrix} 5 & 2 \\ 3 & 1 \end{pmatrix} \begin{pmatrix} -1 & 2 \\ 3 & -5 \end{pmatrix}$