Main functions

1. Mathematics

Classical operations

- `a + b`, `a - b`, `a * b` classic operations
- `a / b` "real" division (returns a floating point number)
- `a // b` Euclidean division quotient (returns an integer)
- `a % b` remainder of the Euclidean division, called a modulo b
- `abs(x)` absolute value
- `x ** n` power x^n
- `4.56e12` for 4.56×10^{12}

Module "math"

The use of other mathematical functions requires the module `math` which is called by the command:

```
from math import *
```

- `sqrt(x)` square root $\sqrt{x}$
- `cos(x)`, `sin(x)`, `tan(x)` trigonometric functions $\cos x$, $\sin x$, $\tan x$ in radians
- `pi` approximate value of $\pi = 3.14159265\ldots$
- `floor(x)` integer just below x
- `ceil(x)` integer just above x
- `gcd(a,b)` gcd of a and b

Module "random"

The `random` module generates numbers in a pseudo-random way. It is called by the command:

```
from random import *
```

- `random()` on each call, returns a floating number x at random satisfying $0 \leqslant x < 1$.
- `randint(a,b)` for each call, returns an integer n at random satisfying $a \leqslant n \leqslant b$.
- `choice(mylist)` on each call, randomly draws an item from the list.
- `mylist.shuffle()` mixes the list (the list is modified).

Binary notation

- `bin(n)` returns the binary notation of the integer n as a string. Example: `bin(17)` returns `'0b10001'`.
- To write a number directly in binary notation, simply write the number starting with `0b` (without quotation marks). For example `0b11011` is equal to 27.

2. Booleans

A boolean is a data that takes either the value `True` or the value `False`.

Comparisons
The following comparison tests return a boolean.

- `a == b` equality test
- `a < b` strict lower test
- `a <= b` large lower test
- `a > b` or `a >= b` higher test
- `a != b` non-equality test

Do not confuse "`a = b`" (assignment) and "`a == b`" (equality test).

Boolean operations

- `P and Q` logical "and"
- `P or Q` logical "or"
- `not P` negation

3. Strings I

Chains

- `"A"` or `'A'` one character
- `"Python"` or `'Python'` a string
- `len(string)` the string length. Example: `len("Python")` returns 6.
- `string1 + string2` concatenation.
  Example: `"I love" + "Python"` returns `"I lovePython"`.
- `string[i]` returns the *i*-th character of `string` (numbering starts at 0).
  Example with `string = "Python"`, `string[1]` is equal to `"y"`. See the table below.

Letter	**P**	**y**	**t**	**h**	**o**	**n**
Rank	0	1	2	3	4	5

Number/string conversion

- **Chain.** `str(number)` converts a number (integer or floating point number) into a string. Examples: `str(7)` returns the string `"7"`; `str(1.234)` returns the string `"1.234"`.
- **Integer.** `int(string)` returns the integer corresponding to the string. Example: `int("45")` returns the integer `45`.
- **Floating point number.** `float(string)` returns the floating point number corresponding to the string. Example: `float("3.14")` returns the number `3.14`.

Substrings

- `string[i:j]` returns the substring of characters with a rank of i to $j-1$ from `string`.
  Example: with `string = "This is a string"`, `string[2:7]` returns `"is is"`.
- `string[i:]` returns characters with a rank of i until the end of `string`.
  Example : `string[5:]` returns `"is a string"`.
- `string[:j]` returns characters from the beginning to the rank $j-1$ of `string`. Example: `string[:4]` returns `"This"`.

Format

The `format()` method allows you to format text or numbers. This function returns a string.

- **Text**

  `Test␣␣␣␣␣␣` `␣␣␣␣␣␣Test` `␣␣␣Test␣␣␣`

  - `'{:10}'.format('Test')` left aligned (on 10 characters)
  - `'{:>10}'.format('Test')` right alignment
  - `'{:^10}'.format('Test')` centered

- **Integer**

  `456` `␣␣␣456` `000456`

  - `'{:d}'.format(456)` integer
  - `'{:6d}'.format(456)` right aligned (on 6 characters)
  - `'{:06d}'.format(456)` adding leading zeros (on 6 characters)

- **Floating point number**

  `3.141593` `3.14159265` `␣␣3.1416` `003.1416`

  - `'{:f}'.format(3.141592653589793)` floating point number
  - `'{:.8f}'.format(3.141592653589793)` 8 decimal places
  - `'{:8.4f}'.format(3.141592653589793)` on 8 characters with 4 numbers after the decimal point
  - `'{:08.4f}'.format(3.141592653589793)` adding leading zeros

4. Strings II

Encoding

- `chr(n)` returns the character associated with the ASCII/unicode code number *n*. Example: `chr(65)` returns `"A"`; `chr(97)` returns `"a"`.
- `ord(c)` returns the ASCII/unicode code number associated with the character *c*. Example: `ord("A")` returns `65`; `ord("a")` returns `97`.

The beginning of the ASCII/unicode table is given below.

33	!	43	+	53	5	63	?	73	I	83	S	93	]	103	g	113	q	123	{
34	"	44	,	54	6	64	@	74	J	84	T	94	^	104	h	114	r	124	|
35	#	45	-	55	7	65	A	75	K	85	U	95	_	105	i	115	s	125	}
36	$	46	.	56	8	66	B	76	L	86	V	96	‘	106	j	116	t	126	~
37	%	47	/	57	9	67	C	77	M	87	W	97	a	107	k	117	u	127	-
38	&	48	0	58	:	68	D	78	N	88	X	98	b	108	l	118	v		
39	’	49	1	59	;	69	E	79	O	89	Y	99	c	109	m	119	w		
40	(	50	2	60	<	70	F	80	P	90	Z	100	d	110	n	120	x		
41	)	51	3	61	=	71	G	81	Q	91	[	101	e	111	o	121	y		
42	*	52	4	62	>	72	H	82	R	92	\	102	f	112	p	122	z		

Upper/lower-case

- `string.upper()` returns a string in upper case.
- `string.lower()` returns a string in lowercase.

Search/replace

- `substring in string` returns “true” or “false” depending on if `substring` appears in `string`.
  Example : `"NOT" in "TO BE OR NOT TO BE"` returns `True`.
- `string.find(substring)` returns the rank at which the substring was found (and -1 otherwise).
  Example: with `string = "ABCDE"`, `string.find("CD")` returns 2.
- `string.replace(substring,new_substring)` replaces each occurrence of the substring by the new substring.
  Example: with `string = "ABCDE"`, `string.replace("CD","XY")` returns `"ABXYE"`.

Split/join

- `string.split(separator)` separates the string into a list of substrings (by default the separator is the space).
  Examples:
  - `"To be or not to be.".split()` returns `['To', 'be', 'or', 'not', 'to', 'be.']`
  - `"12.5;17.5;18".split(";")` returns `['12.5', '17.5', '18']`
- `separator.join(mylist)` groups the substrings into a single string by adding the separator between each.
  Examples:
  - `"".join(["To", "be", "or", "not", "to", "be."])` returns `'Tobeornottobe.'` Spaces are missing.
  - `" ".join(["To", "be", "or", "not", "to", "be."])` returns `'To be or not to be.'` It’s better when the separator is a space.
  - `"--".join(["To", "be", "or", "not", "to", "be."])` returns `'To--be--or--not--to--be.'`

5. Lists I

Construction of a list

Examples:

- `mylist1 = [5,4,3,2,1]` a list of integers 5.
- `mylist2 = ["Friday","Saturday","Sunday"]` a list of 3 strings.
- `mylist3 = []` the empty list.
- `list(range(n))` list of integers from 0 to $n-1$.
- `list(range(a,b))` list of integers from a to $b-1$.
- `list(range(a,b,step))` list of integers from a to $b-1$, with a step given by the integer `step`.

Get an item

- `mylist[i]` returns the element of rank i. Be careful, the rank starts at 0.
  Example: `mylist = ["A","B","C","D","E","F"]` then `mylist[2]` returns `"C"`.

Letter	"A"	"B"	"C"	"D"	"E"	"F"
Rank	0	1	2	3	4	5

- `mylist[-1]` returns the last element, `mylist[-2]` returns the second last element...
- `mylist.pop()` removes the last item from the list and returns it.

Add one element (or more)

- `mylist.append(element)` adds the item at the end of the list. Example: if `mylist = [5,6,7,8]` then `mylist.append(9)` adds 9 to the list, `mylist` is now `[5,6,7,8,9]`.
- `new_mylist = mylist + [element]` provides a new list with an extra element at the end. Example: `[1,2,3,4] + [5]` is `[1,2,3,4,5]`.
- `[element] + mylist` returns a list where the item is added at the beginning. Example: `[5] + [1,2,3,4]` is `[5,1,2,3,4]`.
- `mylist1 + mylist2` concatenates the two lists. Example: with `mylist1 = [4,5,6]` and `mylist2 = [7,8,9]` then `mylist1 + mylist2` is `[4,5,6,7,8,9]`.

Example of construction. Here is how to build the list that contains the first squares:

```
list_squares = []                # We start from an empty list
for i in range(10):
    list_squares.append(i**2)     # We add squares one by one
```

At the end `list_squares` is:

```
[0, 1, 4, 9, 16, 25, 36, 49, 64, 81]
```

Browse a list

- `len(mylist)` returns the length of the list. Example: `len([5,4,3,2,1])` returns 5.
- Just browse a list (and here display each item):

```
for element in mylist:
    print(element)
```

- Browse a list using the rank.

```
n = len(mylist)
for i in range(n):
    print(i,mylist[i])
```

6. Lists II

Mathematics

- `max(mylist)` returns the largest element. Example: `max([10,16,13,14])` returns `16`.
- `min(mylist)` returns the smallest element. Example: `min([10,16,13,14])` returns `10`.
- `sum(mylist)` returns the sum of all elements. Example: `sum([10,16,13,14])` returns `53`.

Slicing lists

- `mylist[a:b]` returns the sublist of elements from the rank a to the rank $b-1$.
- `mylist[a:]` returns the list of elements of rank a until the end.
- `mylist[:b]` returns the list of items from the beginning to the rank $b-1$.

Letter	"A"	"B"	"C"	"D"	"E"	"F"	"G"
Rank	0	1	2	3	4	5	6

For example if `mylist = ["A","B","C","D","E","F","G"]` then:

- `mylist[1:4]` returns `["B","C","D"]`.
- `mylist[:2]` is like `mylist[0:2]` and returns `["A","B"]`.
- `mylist[4:]` returns `["E","F","G"]`. It's the same thing than `mylist[4:n]` where `n = len(mylist)`.

Find the rank of an element

- `mylist.index(element)` returns the first position at which the item was found. Example: with `mylist = [12, 30, 5, 9, 5, 21]`, `mylist.index(5)` returns 2.
- If you just want to know if an item belongs to a list, then the statement :

  `element in mylist`

  returns `True` or `False`. Example: with `mylist = [12, 30, 5, 9, 5, 21]`, "`9 in mylist`" is true, while "`8 in mylist`" is false.

Order

- `sorted(mylist)` returns the ordered list of items.
  Example: `sorted([13,11,7,4,6,8,12,6])` returns the list `[4,6,6,7,8,11,12,13]`.
- `mylist.sort()` does not return anything but the list `mylist` is now ordered.

Invert a list

Here are three methods:

- `mylist.reverse()` modifies the list in place;
- `list(reversed(mylist))` returns a new list;
- `mylist[::-1]` returns a new list.

Delete an item

Three methods.

- `mylist.remove(element)` deletes the first occurrence found.
  Example: `mylist = [2,5,3,8,5]`, the instruction `mylist.remove(5)` modifies the list which is now `[2,3,8,5]` (the first 5 has disappeared).
- `del mylist[i]` deletes element at rank i (the list is modified).
- `element = mylist.pop()` removes the last item from the list and returns it.

List comprehension

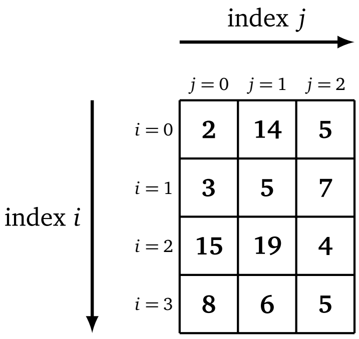
- Let's start from a list, for example `mylist = [1,2,3,4,5,6,7,6,5,4,3,2,1]`.
- `list_doubles = [ 2*x for x in mylist ]` returns a list that contains the doubles of the items of `mylist`. So this is the list `[2,4,6,8,...]`.
- `liste_squares = [ x**2 for x in mylist ]` returns the list of squares of the items in the list `mylist`. So this is the list `[1,4,9,16,...]`.
- `partial_list = [ x for x in mylist if x > 2 ]` extracts from the list only the elements greater than 2. So this is the list `[3,4,5,6,7,6,5,4,3]`.

List of lists

Example:

```
array = [ [2,14,5], [3,5,7], [15,19,4], [8,6,5] ]
```

corresponds to the table:



	$j=0$	$j=1$	$j=2$
$i=0$	2	14	5
$i=1$	3	5	7
$i=2$	15	19	4
$i=3$	8	6	5

Then `array[i]` returns the sublist of rank i, and `array[i][j]` returns the element located in the sublist number i, at rank j of this sublist. For example:

- `array[0]` returns the sublist `[2,14,5]`.
- `array[1]` returns the sublist `[3,5,7]`.
- `array[0][0]` returns the integer 2.
- `array[0][1]` returns the integer 14.
- `array[2][1]` returns the integer 19.

A table of n rows and p columns.

- `array = [[0 for j in range(p)] for i in range(n)]` initializes an array and fills it with 0.
- `array[i][j] = 1` modifies a value in the table (the one at the location (i, j)).

7. Input/output

Display

- `print(string1,string2,string3,...)` displays strings or objects. Example: `print("Value =",14)` displays `Value = 14`. Example: `print("Line 1 \n Line 2")` displays on two lines.
- **Separator.** `print(...,sep="...")` changes the separator (by default the separator is the space character). Example: `print("Bob",17,13,16,sep="; ")` displays `Bob; 17; 13; 16`.
- **End of line.** `print(...,end="...")` changes the character placed at the end (by default it is the line break `\n`). Example `print(17,end="")` then `print(76)` displays `1776` on a single line.

Keyboard entry

`input()` pauses the program and waits for the user to send a message on the keyboard (end by pressing the “Enter” key). The message is a string.

Here is a small program that asks for the user’s first name and age and displays a message like “Hello Kevin” then “You are a minor/adult” according to age.

```
first_name = input ("What's your name? ")
print("Hello",first_name)

age_str = input("How old are you? ")
age = int(age_str)

if age >= 18:
    print("You're an adult!")
else:
    print("You're a minor!")
```

8. Files

Order

- `fi = open("my_file.txt","r")` opening in reading (`"r"` = *read*).
- `fi = open("my_file.txt","w")` opening in writing (`"w"` = *write*). The file is created if it does not exist, if it existed the previous content is first deleted.
- `fi = open("my_file.txt","a")` opening for writing, the data will be written at the end of the current data (`"a"` = *append*).
- `fi.write("one line")` write to the file.
- `fi.read()` reads the whole file (see below for another method).
- `fi.readlines()` reads all the lines (see below for another method).
- `fi.close()` file closing.

Write lines to a file

```
fi = open("my_file.txt","w")

fi.write("Hello world!\n")

line = "Hi there.\n"
fi.write(line)
fi.close()
```

Read lines from a file

```
fi = open("my_file.txt","r")

for line in fi:
    print(line)

fi.close()
```

Read a file (official method)

```
with open("my_file.txt","r") as fi:
    for line in fi:
        print(line)
```

9. Turtle

The `turtle` module is called by the command:

```
from turtle import *
```

Main commands

- `forward(length)` advances a number of steps
- `backward(length)` goes backwards
- `right(angle)` turns to the right (without advancing) at a given angle in degrees
- `left(angle)` turns left
- `setheading(direction)` points in one direction ($0 =$ right, $90 =$ top, $-90 =$ bottom, $180 =$ left)
- `goto(x,y)` moves to the point (x, y)
- `setx(newx)` changes the value of the abscissa
- `sety(newy)` changes the value of the ordinate
- `down()` sets the pen down
- `up()` sets the pen up
- `width(size)` changes the thickness of the line
- `color(col)` changes the color: `"red"`, `"green"`, `"blue"`, `"orange"`, `"purple"`...
- `position()` returns the (x, y) position of the turtle
- `heading()` returns the direction `angle` to which the turtle is pointing
- `towards(x,y)` returns the angle between the horizontal and the segment starting at the turtle and ending at the point (x, y)
- `speed("fastest")` maximum travel speed
- `exitonclick()` ends the program as soon as you click

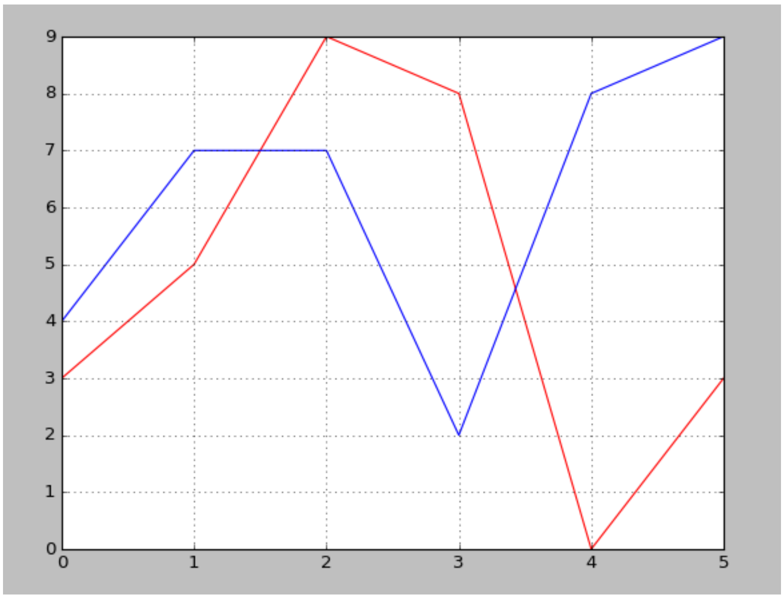
Several turtles

Here is an example of a program with two turtles.

```
turtle1 = Turtle()   # with capital 'T'!
turtle2 = Turtle()

turtle1.color('red')
turtle2.color('blue')

turtle1.forward(100)
turtle2.left(90)
turtle2.forward(100)
```

10. Matplotlib

With the `matplotlib` module it is very easy to draw a list. Here is an example.



```
import matplotlib.pyplot as plt

mylist1 = [3,5,9,8,0,3]
mylist2 = [4,7,7,2,8,9]

plt.plot(mylist1,color="red")
plt.plot(mylist2,color="blue")
plt.grid()
plt.show()
```

Main functions.

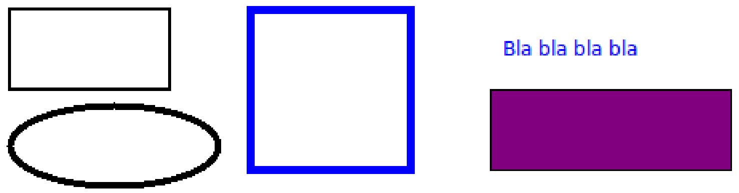
- `plt.plot(mylist)` traces the points of a list (in the form (i,ℓ_i)) that are linked by segments.
- `plt.plot(list_x,list_y)` traces the points of a list (in the form of (x_i, y_i) where x_i browses the first list and y_i the second).
- `plt.scatter(x,y,color='red',s=100)` displays a point in (x, y) (of a size `s`).
- `plt.grid()` draws a grid.
- `plt.show()` displays everything.
- `plt.close()` exits the display.

- `plt.xlim(xmin,xmax)` defines the interval for the x.
- `plt.ylim(ymin,ymax)` defines the interval for the y.
- `plt.axis('equal')` imposes an orthonormal basis.

11. Tkinter

11.1. Graphics

To display this:



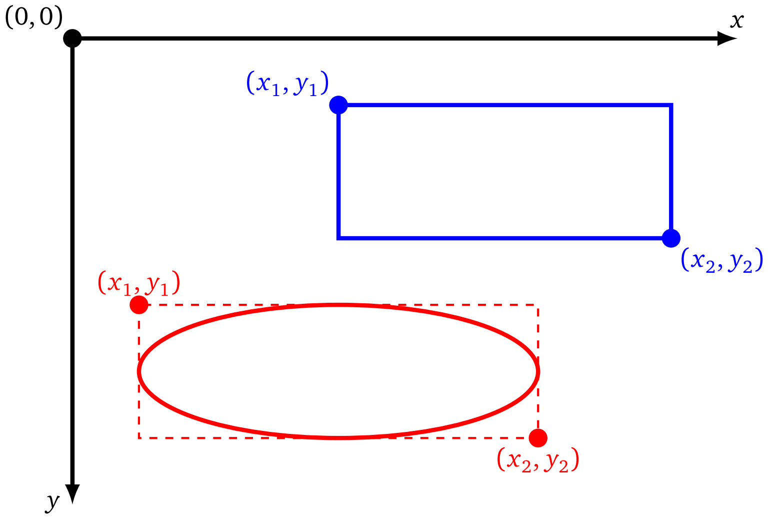
The code is:

```
# tkinter window
root = Tk()

canvas = Canvas(root, width=800, height=600, background="white")
canvas.pack(fill="both", expand=True)

# A rectangle
canvas.create_rectangle(50,50,150,100,width=2)

# A rectangle with thick blue edges
canvas.create_rectangle(200,50,300,150,width=5,outline="blue")

# A rectangle filled with purple
canvas.create_rectangle(350,100,500,150,fill="purple")

# An ellipse
canvas.create_oval(50,110,180,160,width=4)

# Some text
canvas.create_text(400,75,text="Bla bla bla bla",fill="blue")

# Launch of the window
root.mainloop()
```

Some explanations:

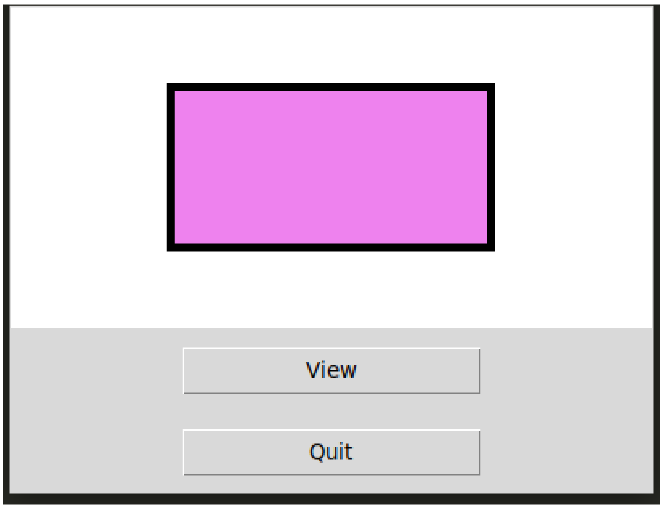
- The `tkinter` module allows us to define variables `root` and `canvas` that determine a graphic window (here width 800 and height 600 pixels). Then describe everything you want to add to the window. And finally the window is displayed by the command `root.mainloop()` (at the very end).

- Attention! The window's graphic marker has its y-axis pointing downwards. The origin $(0,0)$ is the top left corner (see figure below).
- Command to draw a rectangle: `create_rectangle(x1,y1,x2,y2)`; just specify the coordinates (x_1,y_1), (x_2,y_2) of two opposite vertices. The option `width` adjusts the thickness of the line, `outline` defines the color of this line, `fill` defines the filling color.
- An ellipse is traced by the command `create_oval(x1,y1,x2,y2)`, where (x_1,y_1), (x_2,y_2) are the coordinates of two opposite vertices of a rectangle framing the desired ellipse (see figure). A circle is obtained when the corresponding rectangle is a square!
- Text is displayed by the command `canvas.create_text(x,y,text="My text")` specifying the coordinates (x,y) of the point from which you want to display the text.



11.2. Buttons

It is more ergonomic to display windows where actions are performed by clicking on buttons. Here is the window of a small program with two buttons. The first button changes the color of the rectangle, the second button ends the program.



The code is:

```
from tkinter import *
from random import *
```

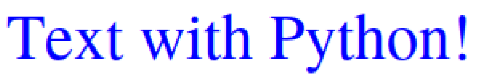
```
root = Tk()
canvas = Canvas(root, width=400, height=200, background="white")
canvas.pack(fill="both", expand=True)

def action_button():
    canvas.delete("all")       # Clear all
    colors = ["red","orange","yellow","green","cyan","blue","violet","purple"]
    col = choice(colors)       # Random color
    canvas.create_rectangle(100,50,300,150,width=5,fill=col)
    return

button_color = Button(root,text="View", width=20, command=action_button)
button_color.pack(pady=10)

button_quit = Button(root,text="Quit", width=20, command=root.quit)
button_quit.pack(side=BOTTOM, pady=10)

root.mainloop()
```

Some explanations:

- A button is created by the command `Button`. The `text` option customizes the text displayed on the button. The button created is added to the window by the method `pack`.
- The most important thing is the action associated with the button! It is the option `command` that receives the name of the function to be executed when the button is clicked. For our example `command=action_button`, associate the click on the button with a change of color.
- Attention! You have to give the name of the function without brackets: `commande=my_function` and not `command=my_function()`.
- To associate the button with “Quit” and close the window, the argument is `command=root.quit`.
- The instruction `canvas.delete("all")` deletes all drawings from our graphic window.

11.3. Text

Here’s how to display text with `Python` and the graphics window module `tkinter`.



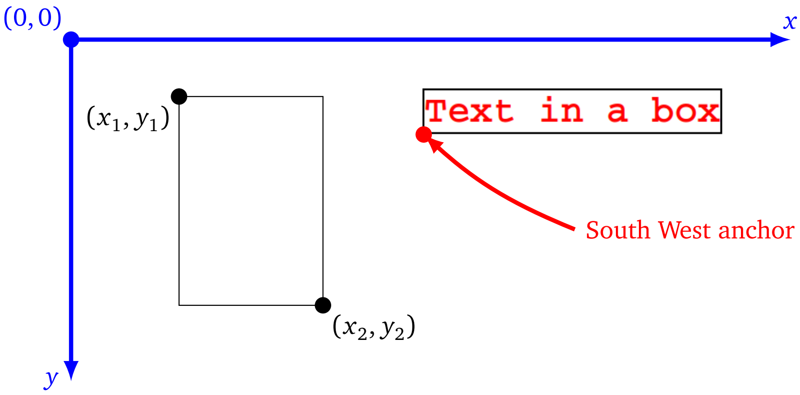
Text with Python!

The code is:

```
from tkinter import *
from tkinter.font import Font
# tkinter window
root = Tk()
canvas = Canvas(root, width=800, height=600, background="white")
canvas.pack(fill="both", expand=True)
# Font
myfont = Font(family="Times", size=30)
# Some text
canvas.create_text(100,100, text="Text with Python!",
anchor=SW, font=myfont, fill="blue")
# Launch the window
root.mainloop()
```

Some explanations:

- `root` and `canvas` are the variables that define a graphic window (here of width 800 and height 600 pixels). This window is launched by the last command: `root.mainloop()`.
- We remind you that for the graphic coordinates, the y-axis is directed downwards. To define a rectangle, simply specify the coordinates (x_1, y_1) and (x_2, y_2) from two opposite vertices (see figure below).
- The text is displayed by the command `canvas.create_text()`. It is necessary to specify the coordinates (x, y) of the point from which you want to display the text.
- The `text` option allows you to pass the string to display.
- The `anchor` option allows you to specify the text anchor point, `anchor=SW` means that the text box is anchored to the Southwest point (SW) (see figure below).
- The `fill` option allows you to specify the text color.
- The option `font` allows you to define the font (i.e. the style and size of the characters). Here are some examples of fonts, it's up to you to test them:
  - `Font(family="Times", size=20)`
  - `Font(family="Courier", size=16, weight="bold")` in **bold**
  - `Font(family="Helvetica", size=16, slant="italic")` in *italic*



11.4. Mouse click

Here is a small program that displays a graphic window. Each time the user clicks (with the left mouse button) the program displays a small square (on the window) and displays "Click at $x = \ldots$, $y = \ldots$" (on the console).

```
from tkinter import *

# Window
root = Tk()
canvas = Canvas(root, width=800, height=600, background="white")
canvas.pack(side=LEFT, padx=5, pady=5)

# Catch mouse click
def action_mouse_click(event):
    canvas.focus_set()
    x = event.x
    y = event.y
    canvas.create_rectangle(x,y,x+10,y+10,fill="red")
    print("Click at x =",x,", y =",y)
    return

# Association click/action
canvas.bind("<Button-1>", action_mouse_click)

# Launch
root.mainloop()
```

Here are some explanations:

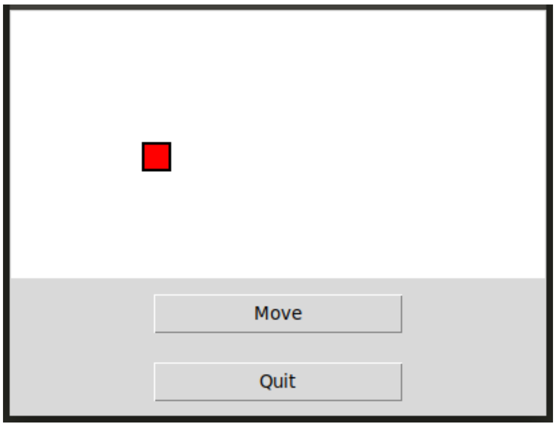
- The creation of the window is usual. The program ends with the launch by the command `mainloop()`.
- The first key point is to associate a mouse click to an action, that's what the line does:

  `canvas.bind("<Button-1>", action_mouse_click)`

  Each time the left mouse button is clicked, `Python` executes the function `action_mouse_click`. (Note that there are no brackets for the call to the function.)
- Second key point: the `action_mouse_click` function retrieves the click coordinates and then does two things here: it displays a small rectangle at the click location and displays the (x, y) coordinates in the terminal window.
- The coordinates x and y are expressed in pixels; $(0,0)$ refers to the upper left corner of the window (the area delimited by `canvas`).

11.5. Movement

Here is a program that moves a small square and bounces it off the edges of the window.



Here are the main points:

- An object `rect` is defined, it is a global variable, as well as its coordinates `x0`, `y0`.
- This object is (a little bit) moved by the function `mymove()` which shifts the rectangle by `(dx,dy)`.
- The key point is that this function will be executed again after a short period of time. The command:

  `canvas.after(50,mymove)`

  requests a new execution of the function `mymove()` after a short delay (here 50 milliseconds).
- The repetition of small shifts simulates movement.

```
from tkinter import *
```

```
the_width = 400
the_height = 200

root = Tk()
canvas = Canvas(root, width=the_width, height=the_height, background="white")
canvas.pack(fill="both", expand=True)

# Coordinates and speed
x0, y0 = 100,100
dx = +5  # Horizontal speed
dy = +2  # Vertical speed

# The rectangle to move
rect = canvas.create_rectangle(x0,y0,x0+20,y0+20,width=2,fill="red")

# Main function
def mymove():
    global x0, y0, dx, dy

    x0 = x0 + dx  # New abscissa
    y0 = y0 + dy  # New ordinate

    canvas.coords(rect,x0,y0,x0+20,y0+20)  # Move

    if x0 < 0 or x0 > the_width:
        dx = -dx  # Change of horizontal direction
    if y0 < 0 or y0 > the_height:
        dy = -dy  # Change of vertical direction

    canvas.after(50,mymove)  # Call after 50 milliseconds

    return

# Function for the button
def action_move():
    mymove()
    return

# Buttons
button_move = Button(root,text="Move", width=20, command=action_move)
button_move.pack(pady=10)

button_quit = Button(root,text="Quit", width=20, command=root.quit)
button_quit.pack(side=BOTTOM, pady=10)

root.mainloop()
```