

# Simulations numériques de marches aléatoires : programmes en Python

Pour une bonne compréhension, ces programmes doivent être étudiés successivement. Il est important d'exécuter le code Python et même de tester des petites modifications.

## Génération de nombres aléatoires

### 01\_random.py

```
#!/usr/bin/python
# -*- coding: utf-8 -*-
"""
cf. documentation cf http://docs.python.org/library/random.html
random number generation - génération de nombres aléatoires
functions of interest : choice, randint, seed
"""

from random import *

facepiece = ['pile', 'face']
valeurpiece = [0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1., 2.]

for i in range(1):
    # choice : random choice of an element from a list
    print(choice(facepiece), choice(valeurpiece))
    # randint : return a random integer number between 2 values
    (including limits)
    print(randint(0,10)) # imprime un nombre aléatoire entre 0 et
10
    print(choice(range(0,11,1))) # same function, using choice and
range to create the list

# seed(ANY_DATA) : seeding of the random number generator with any
(constant) data
# in order to generate reproducible random sequences.
# seed() - without data - uses internal clock value to "randomly"
initiate the generator !

for j in range(3):
    #seed('ma chaîne personnelle') # reproducible initialization
    seed() # to randomly initiate the generator
```

```
for i in range(10):
    print(randint(1000,9999))
print(" ")
```

## Histogrammes de nombres aléatoires

### 02\_random\_histogram.py

```
#!/usr/bin/env python
# -*- coding: utf-8 -*-

from random import *      # cf. documentation cf
http://docs.python.org/library/random.html
import numpy as np
import matplotlib.pyplot as plt      #
http://matplotlib.sourceforge.net/api/pyplot_api.html#module-matplotlib
.pyplot
import matplotlib.mlab as mlab      #
http://matplotlib.sourceforge.net/api/mlab_api.html#module-matplotlib.m
lab

#seed('ma chaîne personnelle') # reproducible initialization
seed()

rval = []
for j in range(100000):
    rval.append(randint(0,99)) # append to the list a random
(integer) number between 0 and 99

# print rval # uncomment just to see the list of random numbers

# analysis - histogram - see
http://matplotlib.sourceforge.net/examples/api/histogram_demo.html
# http://fr.wikipedia.org/wiki/Histogramme
xh = np.array(rval) # see http://www.scipy.org/Cookbook/BuildingArrays
transforme une liste en un tableau numérique de Numpy
# print(xh)

fig = plt.figure()
ax = fig.add_subplot(111)

n, bins, patches = ax.hist(xh, 50, facecolor='green', alpha=0.75)
print(n) # les nombres d'occurences par classe
print(bins) # les classes, de largeur identique

# modifier le nombre de nombres générés, les nombres de classes-bins,
```

```
plt.show()
```

## Représenter le déplacement d'un objet

```
<code python 03_tkinter_simple_move.py> #!/usr/bin/python # -*- coding: utf-8 -*-  
  
from tkinter import * import time  
  
window = Tk() sizex = 400 sizey = 200 canvas = Canvas(window, width = sizex, height = sizey)  
canvas.pack() x = 100 # initial left-most edge of first ball y = 30 # initial top-most edge of first ball r  
= 20 # ball diameter depx = 2 # displacement at each move in x direction depy = 1 # displacement  
at each move in y direction  
  
ball=canvas.create_oval(x,y,x+r,y+r,fill="blue")  
  
#moves no_moves = 140 for j in range(no_moves):  
  
    canvas.move(ball, depx, depy)  
    canvas.after(20) # time delay in milliseconds  
    canvas.update()  
  
time.sleep(5) # on attend quelques secondes window.destroy() </codeh>
```

## Représenter le déplacement de nombreux points

```
<sxh python; title : 04_tkinter_many_moves.py> #!/usr/bin/python # -*- coding: utf-8 -*-  
  
from Tkinter import * import time  
  
window = Tk() sizex=400 sizey=600 canvas = Canvas(window, width = sizex, height = sizey)  
canvas.pack() x = 100 # initial left-most edge of first ball y = 30 # initial top-most edge of first ball  
r=20 # ball diameter depx=2 # displacement at each move in x direction depy=0 # displacement at  
each move in y direction  
  
# create balls: no_particles= 20 dy = (sizey-2.)/(no_particles+1) # y initial separation between balls  
print dy ball_list=[] for i in range(no_particles):  
  
    ball=canvas.create_oval(x,y,x+r,y+r,fill="blue")  
    y = y+dy  
    ball_list.append(ball)  
  
#moves no_moves=100 for j in range(no_moves):  
  
    for ball in ball_list:  
        canvas.move(ball, depx, depy)  
        canvas.after(10)
```

```
canvas.update()
```

```
time.sleep(5) # on attend quelques secondes window.destroy() </sxh>
```

## Marche aléatoire d'un petit nombre de pas

```
<sxh python; title : 05_tkinter_random_walk_few_steps_1D.py> #!/usr/bin/env python # -*- coding: utf-8 -*-
```

```
from Tkinter import * from random import choice # http://docs.python.org/library/random.html import numpy as np import matplotlib.pyplot as plt # http://matplotlib.sourceforge.net/api/pyplot\_api.html#module-matplotlib.pyplot import matplotlib.mlab as mlab # http://matplotlib.sourceforge.net/api/mlab\_api.html#module-matplotlib.mlab
```

```
window = Tk() sizex=200 sizey=600 canvas = Canvas(window, width = sizex, height = sizey) canvas.pack() x = 100 # initial left-most edge of first ball y = 1 # initial top-most edge of first ball r=4 # ball diameter depx=10 # displacement at each move in x direction depy=0
```

```
# create balls: no_particles= 100 dy = (sizey-2.)/(no_particles+1) # y initial separation between balls print dy ball_list=[] for i in range(no_particles):
```

```
    ball=canvas.create_oval(x,y,x+r,y+r,fill="red")
    y = y+dy
    ball_list.append(ball)
```

```
#moves no_moves=4 # number of moves for j in range(no_moves):
```

```
    for ball in ball_list:
        canvas.move(ball, choice([-1,1])*depx, depy)
    canvas.after(1)
    canvas.update()
```

```
#analysis - histogram # see http://matplotlib.sourceforge.net/examples/api/histogram\_demo.html
xpos=[] for ball in ball_list:
```

```
    posi=canvas.coords(ball)
    xpos.append(((no_moves+1.)/no_moves)*(posi[0]-x)/depx)
    # le facteur (no_moves+1.)/no_moves permet de gérer la largeur des barres
    de l'histogramme
```

```
xh=np.array(xpos) # see http://www.scipy.org/Cookbook/BuildingArrays #print xh
```

```
fig = plt.figure() ax = fig.add_subplot(111) n, bins, patches = ax.hist(xh, (no_moves)+1, facecolor='green', alpha=0.75) print n,bins, patches
```

```
plt.show()
```

```
#window.mainloop()
```

```
</sxh>
```

## Marche aléatoire d'un grand nombre de pas

```
<sxh python; title : 06_tkinter_random_walk_many_steps_1D.py> #!/usr/bin/env python # -*- coding: utf-8 -*-
```

```
from Tkinter import * from random import choice # http://docs.python.org/library/random.html import
numpy as np import matplotlib.pyplot as plt #
http://matplotlib.sourceforge.net/api/pyplot\_api.html#module-matplotlib.pyplot import
matplotlib.mlab as mlab #
http://matplotlib.sourceforge.net/api/mlab\_api.html#module-matplotlib.mlab
```

```
window = Tk() sizex=400 sizey=400 canvas = Canvas(window, width = sizex, height = sizey)
canvas.pack() x = 200 # initial left-most edge of first ball y = 1 # initial top-most edge of first ball
r=4 # ball diameter depx=1 # displacement at each move in x direction depy=0
```

```
# create balls: no_particles= 2000 dy = (sizey-2.)/(no_particles+1) # y initial separation between
balls print dy ball_list=[] for i in range(no_particles):
```

```
    ball=canvas.create_oval(x,y,x+r,y+r,fill="blue")
    y = y+dy
    ball_list.append(ball)
```

```
#moves no_moves=1000 for j in range(no_moves):
```

```
    for ball in ball_list:
        canvas.move(ball, choice([-1,1])*depx, depy)
    canvas.after(1)
    canvas.update()
```

```
#analysis - histogram # see http://matplotlib.sourceforge.net/examples/api/histogram\_demo.html
xpos=[] for ball in ball_list:
```

```
    posi=canvas.coords(ball)
    xpos.append((posi[0]-x)/depx)
```

```
xh=np.array(xpos) # see http://www.scipy.org/Cookbook/BuildingArrays # compute the mean mu and
sigma from xh (and/or theoretical value from random walk result) mu=np.mean(xh) sigma=np.std(xh)
fig = plt.figure() ax = fig.add_subplot(111) # print xh n, bins, patches = ax.hist(xh, 10,
facecolor='green', alpha=0.75) print n,bins, patches # hist uses np.histogram to create 'n' and 'bins'.
cf. http://docs.scipy.org/doc/numpy/reference/generated/numpy.histogram.html
```

```
ax.set_xlabel('X positions') ax.set_ylabel('Occurences')
```

```
ax.grid(True)
```

```
plt.show()
```

```
#window.mainloop() </sxh>
```

## Avec analyse de la distribution :

```
<sxh python; title : 07_tkinter_random_walk_many_steps_1D-analysis.py> #!/usr/bin/env python # -*- coding: utf-8 -*-
```

```
from Tkinter import * from random import choice # http://docs.python.org/library/random.html import numpy as np import matplotlib.pyplot as plt # http://matplotlib.sourceforge.net/api/pyplot\_api.html#module-matplotlib.pyplot import matplotlib.mlab as mlab # http://matplotlib.sourceforge.net/api/mlab\_api.html#module-matplotlib.mlab
```

```
window = Tk() sizex=400 sizey=400 canvas = Canvas(window, width = sizex, height = sizey) canvas.pack() x = 200 # initial left-most edge of first ball y = 1 # initial top-most edge of first ball r=4 # ball diameter depx=1 # displacement at each move in x direction depy=0
```

```
# create balls: no_particles= 1000 dy = (sizey-2.)/(no_particles+1) # y initial separation between balls #print dy ball_list=[] for i in range(no_particles):
```

```
    ball=canvas.create_oval(x,y,x+r,y+r,fill="blue")
    y = y+dy
    ball_list.append(ball)
```

```
#moves no_moves=900 for j in range(no_moves):
```

```
    for ball in ball_list:
        canvas.move(ball, choice([-1,-1,-1,-1,-1,1,1,1,1,1])*depx, depy)
    canvas.after(1)
    canvas.update()
```

```
#analysis - histogram # see http://matplotlib.sourceforge.net/examples/api/histogram\_demo.html
xpos=[] for ball in ball_list:
```

```
    posi=canvas.coords(ball)
    xpos.append(posi[0]-x)
```

```
xh=np.array(xpos) # see http://www.scipy.org/Cookbook/BuildingArrays # compute the mean mu and sigma from xh (and/or theoretical value from random walk result) mu=np.mean(xh) sigma=np.std(xh)
fig = plt.figure() ax = fig.add_subplot(111) # print xh n, bins, patches = ax.hist(xh, 20, facecolor='green', alpha=0.75) print mu, sigma print n,bins, patches # hist uses np.histogram to create 'n' and 'bins'. # np.histogram returns the bin edges, so there will be ii probability # density values in n, ii+1 bin edges in bins and ii patches. To get # everything lined up, we'll compute the bin centers bincenters = 0.5*(bins[1:]+bins[:-1]) # add a 'best fit' line for the normal PDF yh = (bins[1]-bins[0])*no_particles*mlab.normpdf( bincenters, mu, sigma) # http://matplotlib.sourceforge.net/api/mlab\_api.html#matplotlib.mlab.normpdf l = ax.plot(bincenters, yh, 'r-', linewidth=1) #print n ax.set_xlabel('X positions') ax.set_ylabel('Occurences')
```

```
ax.grid(True)
```

```
plt.show()
```

```
#window.mainloop() </sxh>
```

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