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 personnielle')  # reproducible initialization
    seed()   # to randomly initiate the generator
```

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

Histogrammes de nombres aléatoires

<sxh python; title : 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.mlab

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

rval=[] for j in range(10000):

```
  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, 10, 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() </sxh>

Représenter le déplacement d'un objet

<sxh python; title : 03_tkinter_simple_move.py> #!/usr/bin/python # -*- coding: utf-8 -*-

from Tkinter import * import time

window = Tk() sizex=400 sizey=100 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

ball=canvas.create_oval(x,y,x+r,y+r,fill=“blue”)

#moves no_moves=10 for j in range(no_moves):

```
  canvas.move(ball, depx, depy)
  canvas.after(10)         # time delay in milliseconds
  canvas.update()
```

time.sleep(5) # on attend quelques secondes window.destroy()

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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()

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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>