

## Codes du TP12

```
import numpy as np
import numpy.random as rd
import numpy.linalg as al
import matplotlib.pyplot as plt
```

### #Premier exemple

```
A=np.array([[8/10,1/10,1/20],[1/10,0,0],[1/10,9/10,19/20]])
U0=np.array([[1],[0],[0]])
```

```
def calcul_U(n):
```

```
    U=U0
```

```
    for k in range(1,n+1):
```

```
        U=np.dot(A,U)
```

```
    return U
```

```
def etats_gustave(n):
```

```
    X=np.zeros(n+1)
```

```
    X[0]=1
```

```
    for k in range(n):
```

```
        if X[k]==1:
```

```
            x=rd.random()
```

```
            if x<8/10:
```

```
                X[k+1]=1
```

```
            elif 8/10< x < 9/10:
```

```
                X[k+1]=2
```

```
            else:
```

```
                X[k+1]=3
```

```
        elif X[k]==2:
```

```
            y=rd.random()
```

```
            if y<1/10:
```

```
                X[k+1]=1
```

```
            else:
```

```
                X[k+1]=3
```

```
        elif X[k]==3:
```

```
            z=rd.random()
```

```
            if z<1/20:
```

```
                X[k+1]=1
```

```
            else:
```

```
                X[k+1]=3
```

```
    return X
```

```

def frequence_gustave(nb):
    D=0
    M=0
    T=0
    for k in range(nb):
        X=etats_gustave(60)
        if X[60]==1:
            D=D+1
        elif X[60]==2:
            M=M+1
        else:
            T=T+1
    return D/nb,M/nb,T/nb

```

```

def etats_gustave_matiere(n):
    X=np.zeros(n+1)
    X[0]=1
    for k in range(n):
        if X[k]==1:
            x=rd.random()
            if x<1/2:
                X[k+1]=1
            else:
                X[k+1]=2
        elif X[k]==2:
            y=rd.random()
            if y<3/4:
                X[k+1]=1
            else:
                X[k+1]=3
        elif X[k]==3:
            z=rd.random()
            if z<1/2:
                X[k+1]=2
            else:
                X[k+1]=3
    return X

```

## #Deuxième exemple

```
B=np.array([[1/2,3/4,0],[1/2,0,1/2],[0,1/4,1/2]])
U0bis=np.array([[0],[1],[0]])
```

```
def calcul_U_matiere(n):
    U=U0bis
    for k in range(1,n+1):
        U=np.dot(B,U)
    return U
```

```
def frequence_gustave_matiere(nb):
    D=0
    M=0
    T=0
    for k in range(nb):
        X=etats_gustave_matiere(10)
        if X[10]==1:
            D=D+1
        elif X[10]==2:
            M=M+1
        else:
            T=T+1
    return D/nb,M/nb,T/nb
```