Optimisation des mouvements de foule lors d'évacuations d'urgence

Numéro d'inscription :

Lien Avec Le Thème :

Ville

Source https://www.algerie-dz.com/forums/international/8567627-irak-au-moins-un-mort-et-60-blesses-suite-a-une-bousculade-dans-un-stade-de-football

Corée du Sud 151 morts et plus de 76 blessés dans une bousculade à Séoul

Source :https://lareleve.ma/69298/

Problématique

-Comment gérer efficacement les mouvements de foule lors d'évacuations d'urgence pour éviter des accidents tragiques ?

Plan

A- 1er Tentative :

B-2nd Tentative :

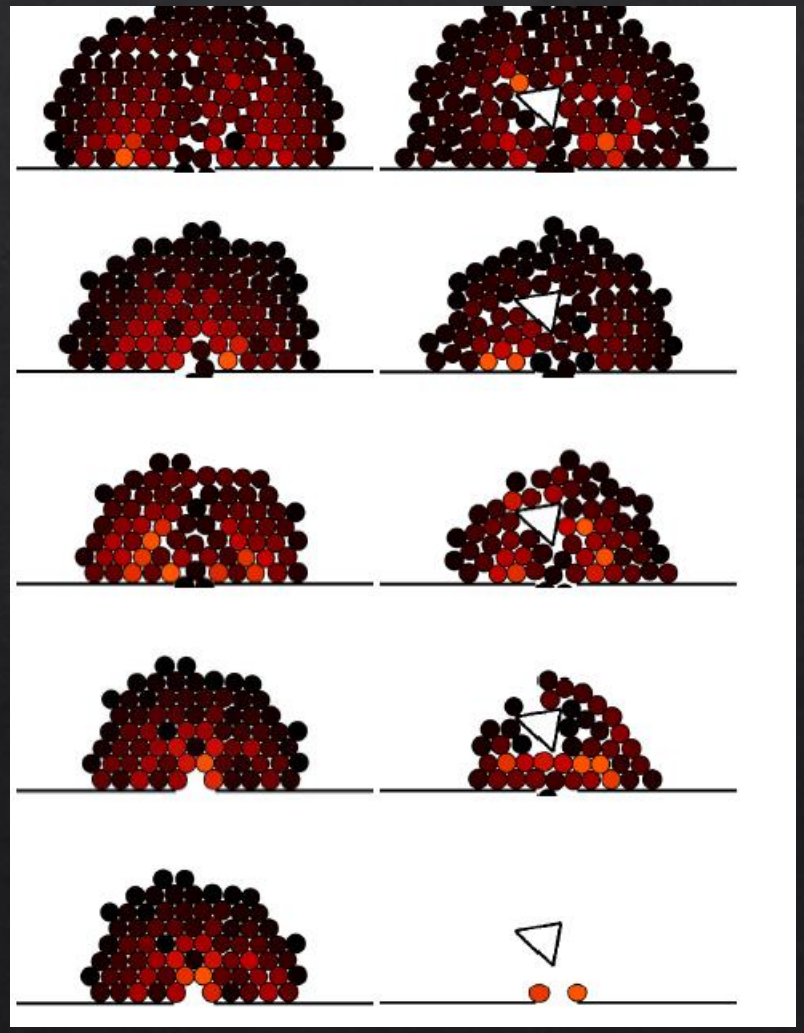
C-Comparaison :

D-Conclusion :

A

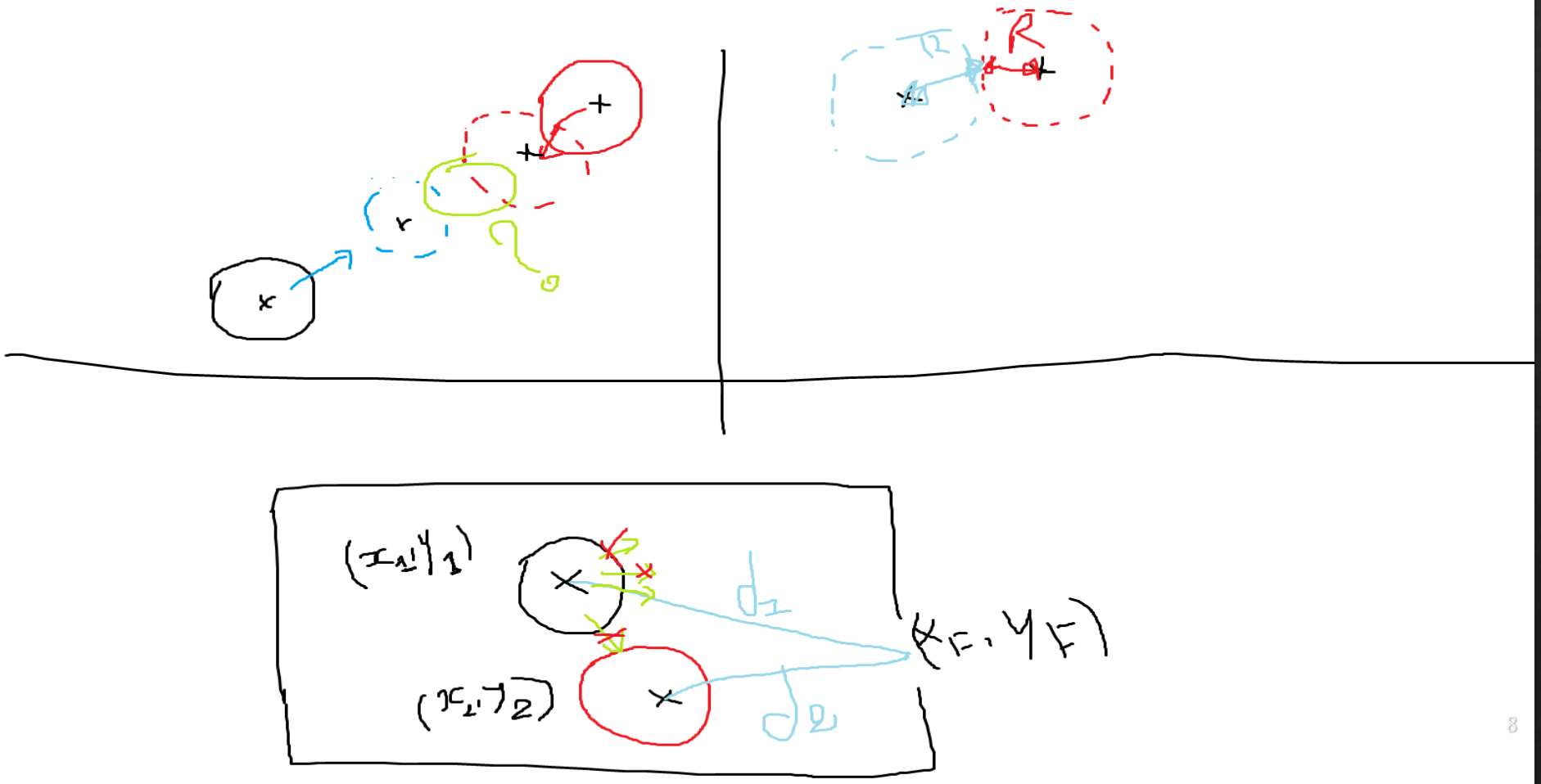
- Tentative 1

Inspiration du modèle granulaire



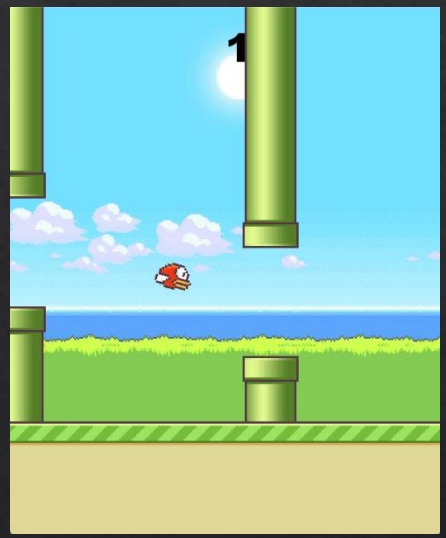
Source : « Crowds In Equations » _ B. Maury & S. Faure page 78

Comment modéliser une foule en 2D ?

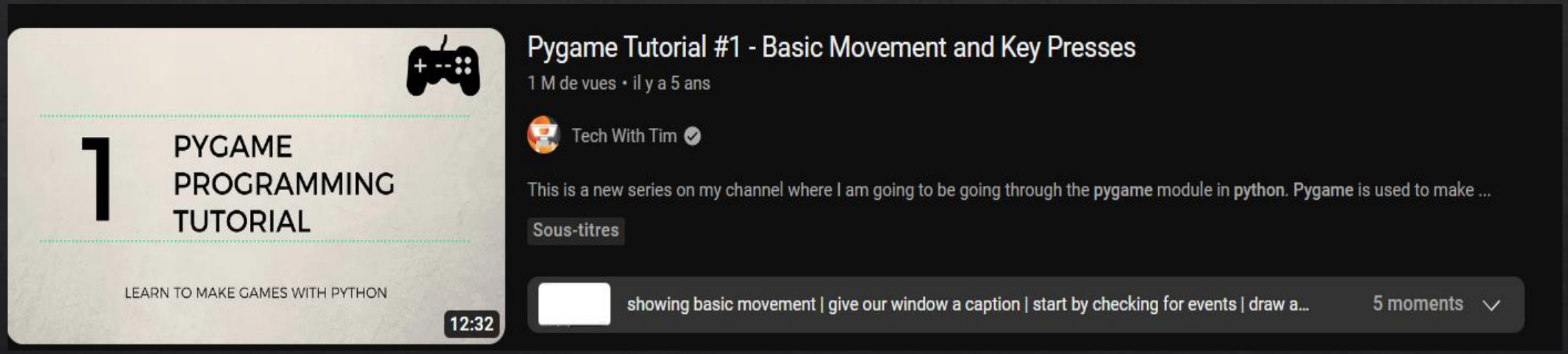


Comment modéliser une foule en 2D ?

Pygame : est une bibliothèque Python permettant de créer des simulations interactives.



Premiers pas Pygame



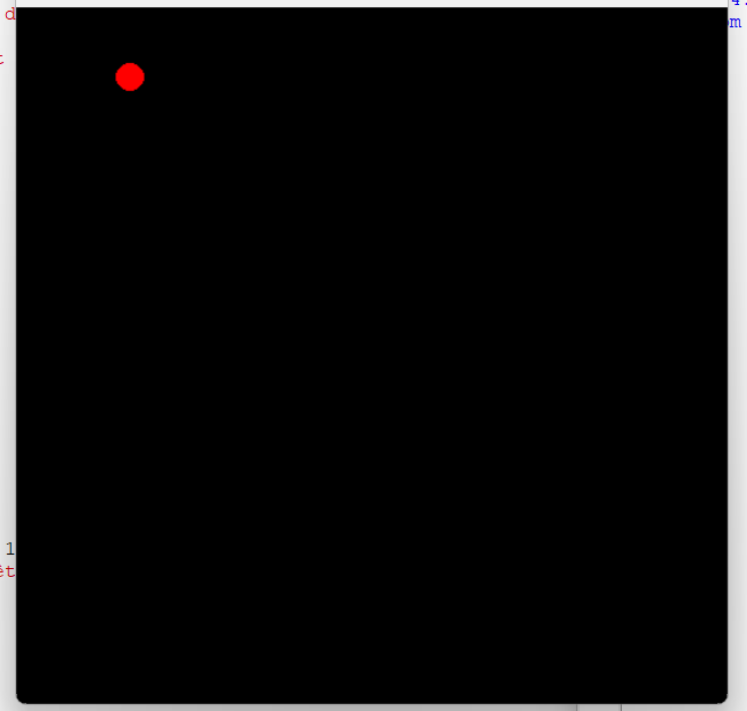
Essai_1.py - C:\Users\rzeig\Desktop\Cours\8.Tipe\2.Atelier\0.Premier_Pas_Python\Essai_1.py (3.11.2)

File Edit Format Run Options Window Help

```
import pygame
pygame.init()
win = pygame.display.set_mode((500, 500))
pygame.display.set_caption("Premier Jeu")
x,y=50,50
run = True
# Boucle principale
while run:
    # "Horloge" pour éviter que les choses ne se d
    pygame.time.delay(50)
    # Événements (tout ce qui se passe de la part
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            run = False
    # Mouvement
    keys = pygame.key.get_pressed()
    # Déplacement horizontal
    if 0 <= x <= 460:
        if keys[pygame.K_LEFT]:
            x -= 10
            if keys[pygame.K_x]:
                x -= 20
        if keys[pygame.K_RIGHT]:
            x += 10
            if keys[pygame.K_x]:
                x += 20
    elif x > 460:
        x = 460
    else:
        x = 0

    win.fill((0, 0, 0))  # Effacer la fenêtre
    pygame.draw.circle(win, (255, 0, 0), (x, y), 1
    pygame.display.update()  # Rafraîchir la fenêt
pygame.quit()
```

Premier Jeu



IDLE Shell 3.11.2

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```
Python 3.11.2 (tags/v3.11.2:878ead1, Feb  7 2023, 16:38:35) [MSC v.1934 64 bit (
AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:\Users\rzeig\Desktop\Cours\8.Tipe\2.Atelier\0.Premier_Pas_Python\Es

4.0 (SDL 2.26.4, Python 3.11.2)
m the pygame community. https://www.pygame.org/contribute.html
```

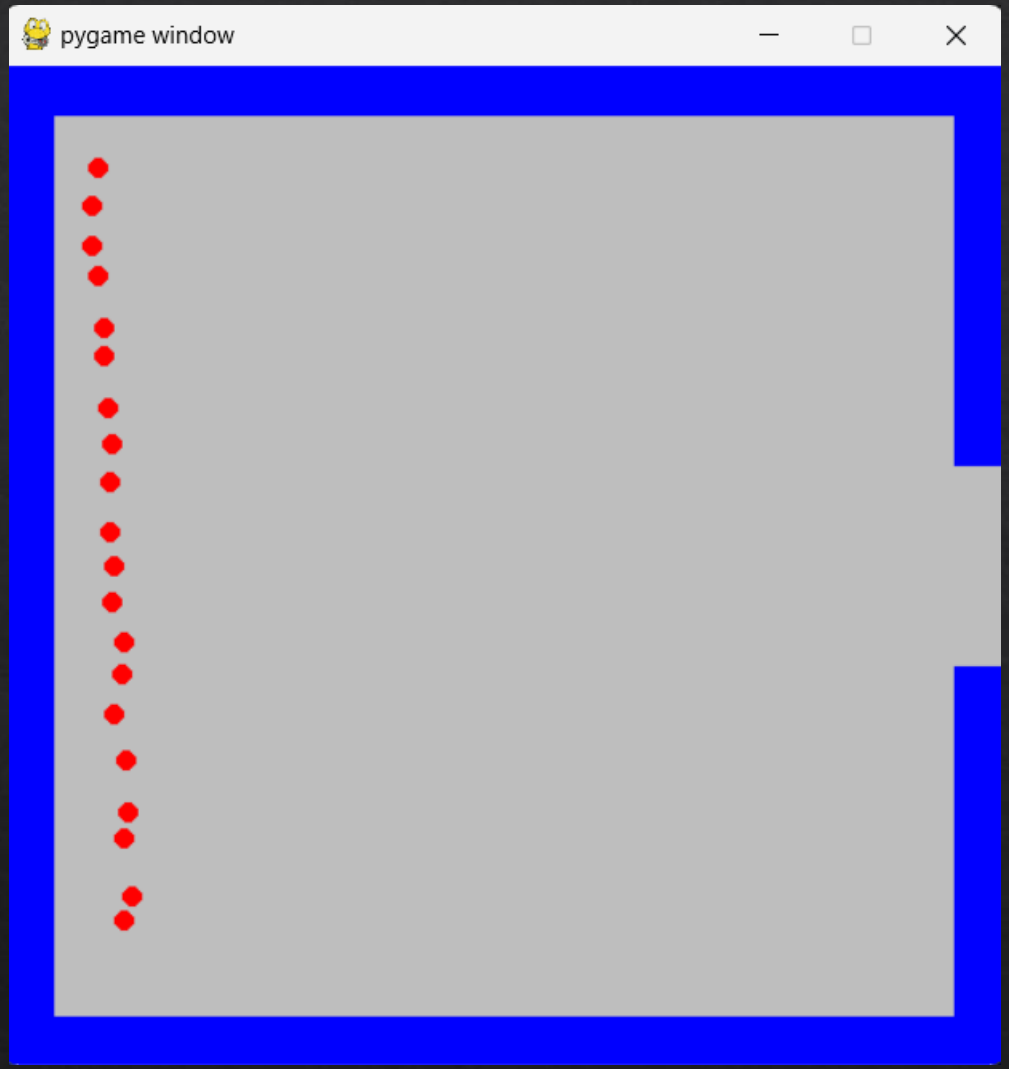
Ln: 7 Col: 0

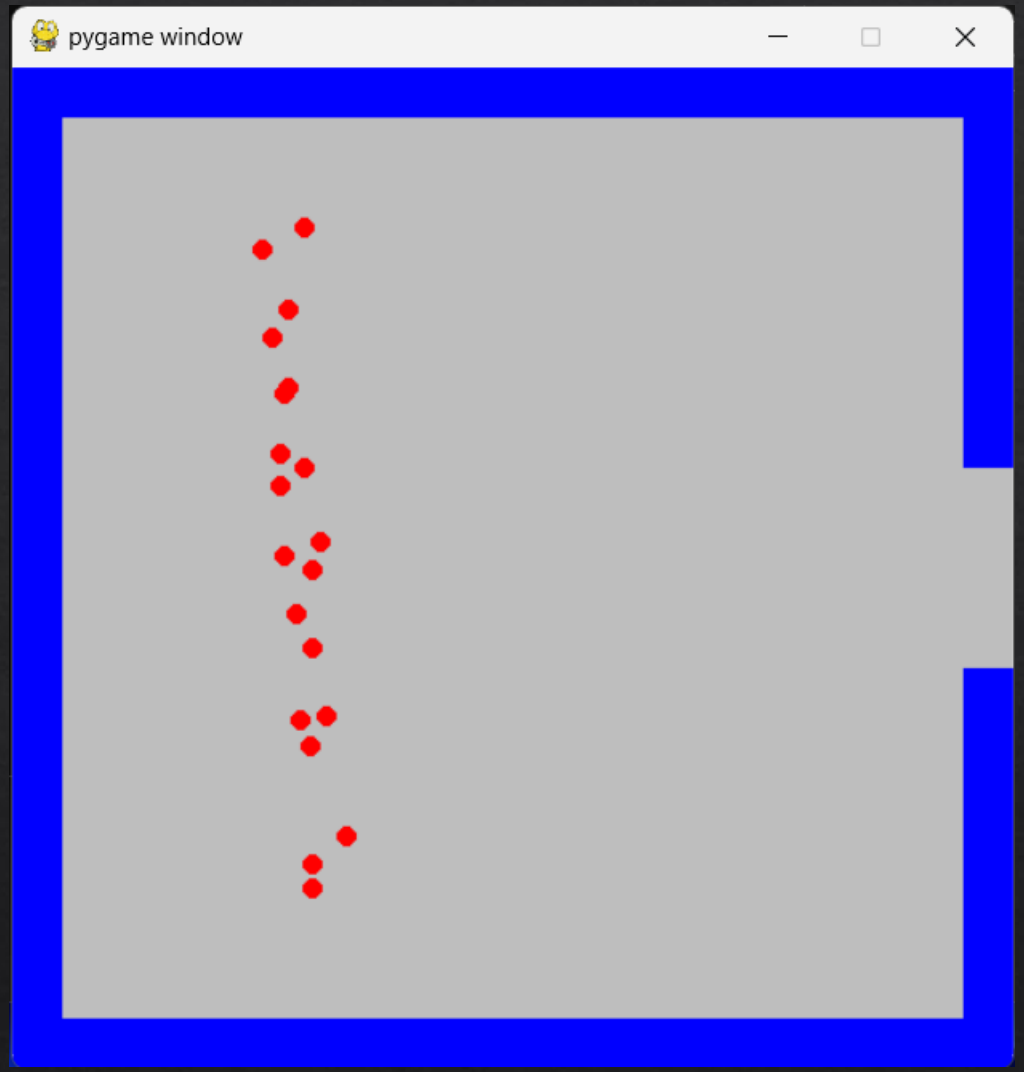
Ln: 31 Col: 0

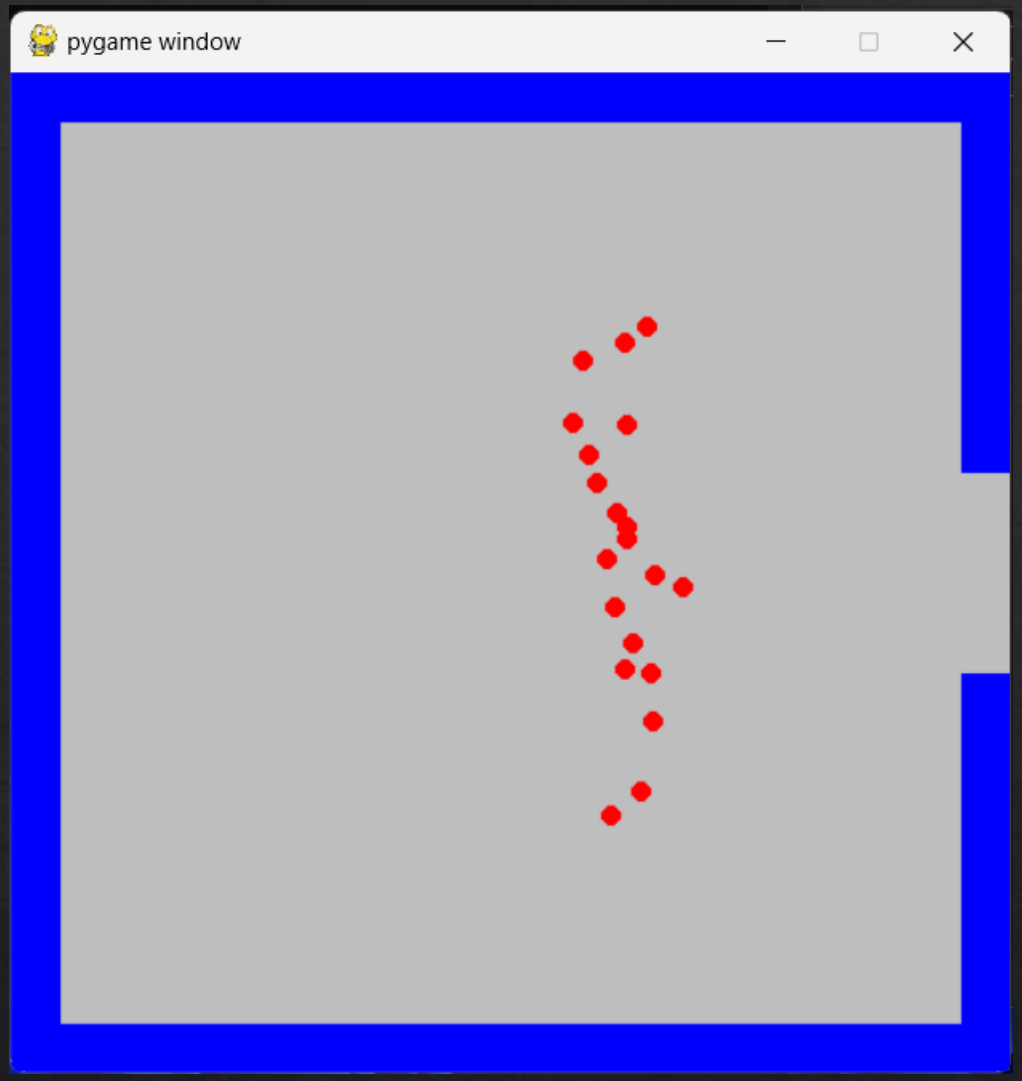
Rechercher FRA 21:55 28/05/2023

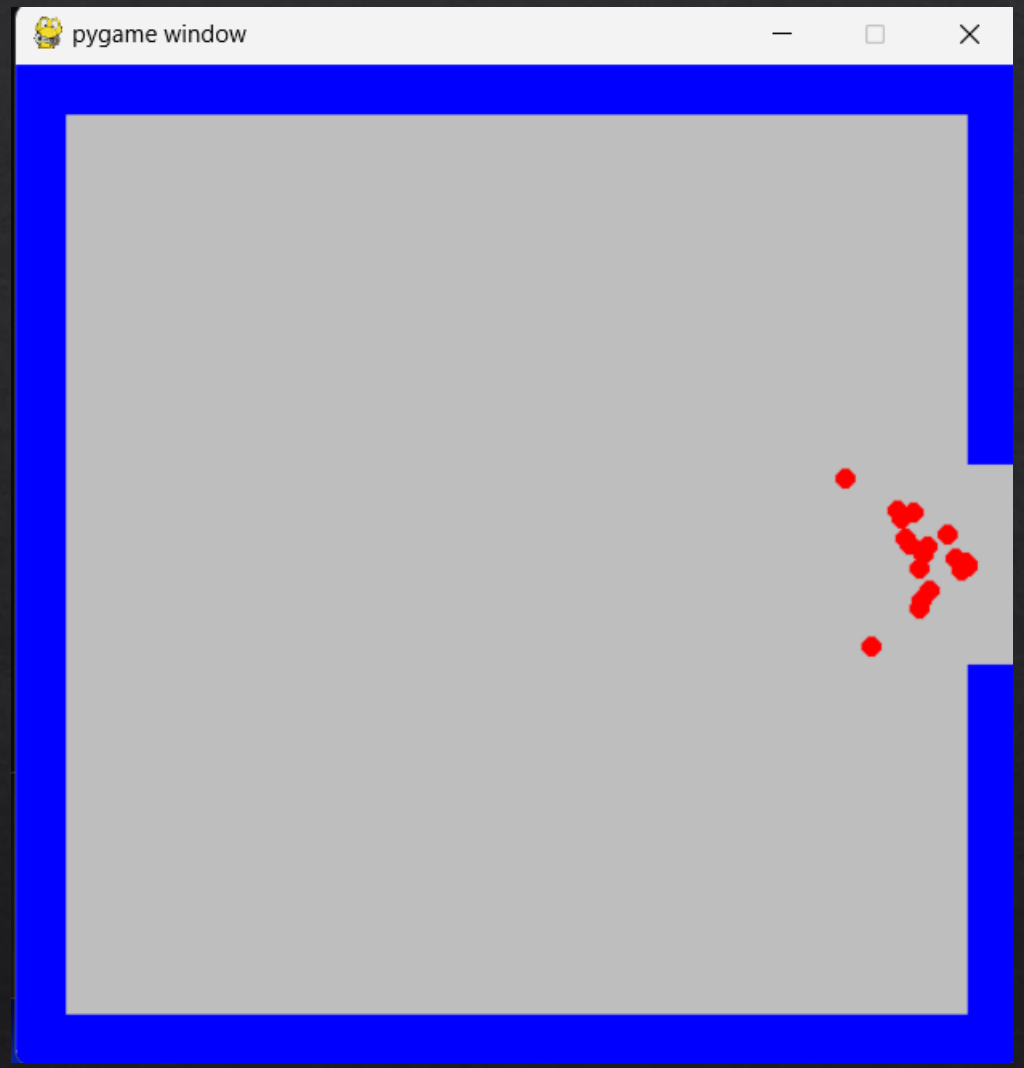
```python
import pygame
pygame.init()
win = pygame.display.set_mode((500, 500))
pygame.display.set_caption("Premier Jeu")
x,y=50,50
run = True
# Boucle principale
while run:
    # "Horloge" pour éviter que les choses ne se déroulent trop rapidement
    pygame.time.delay(50)
    # Événements (tout ce qui se passe de la part de l'utilisateur)
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            run = False
    # Mouvement
    keys = pygame.key.get_pressed()
    # Déplacement horizontal
    if 0 <= x <= 460:
        if keys[pygame.K_LEFT]:
            x -= 10
            if keys[pygame.K_x]:
                x -= 20
        if keys[pygame.K_RIGHT]:
            x += 10
            if keys[pygame.K_x]:
                x += 20
    elif x > 460:
        x = 460
    else:
        x = 0

    win.fill((0, 0, 0))  # Effacer la fenêtre
    pygame.draw.circle(win, (255, 0, 0), (x, y), 10)  # Dessiner le cercle
    pygame.display.update()  # Rafraîchir la fenêtre
pygame.quit()
```


pygame window


pygame window


pygame window


pygame window

Sketch_Principal.py - C:\Users\rzeig\Desktop\Cours\8.Tipe\2.Atelier\1.Principal\Sketch_Principal.py (3.11.2)

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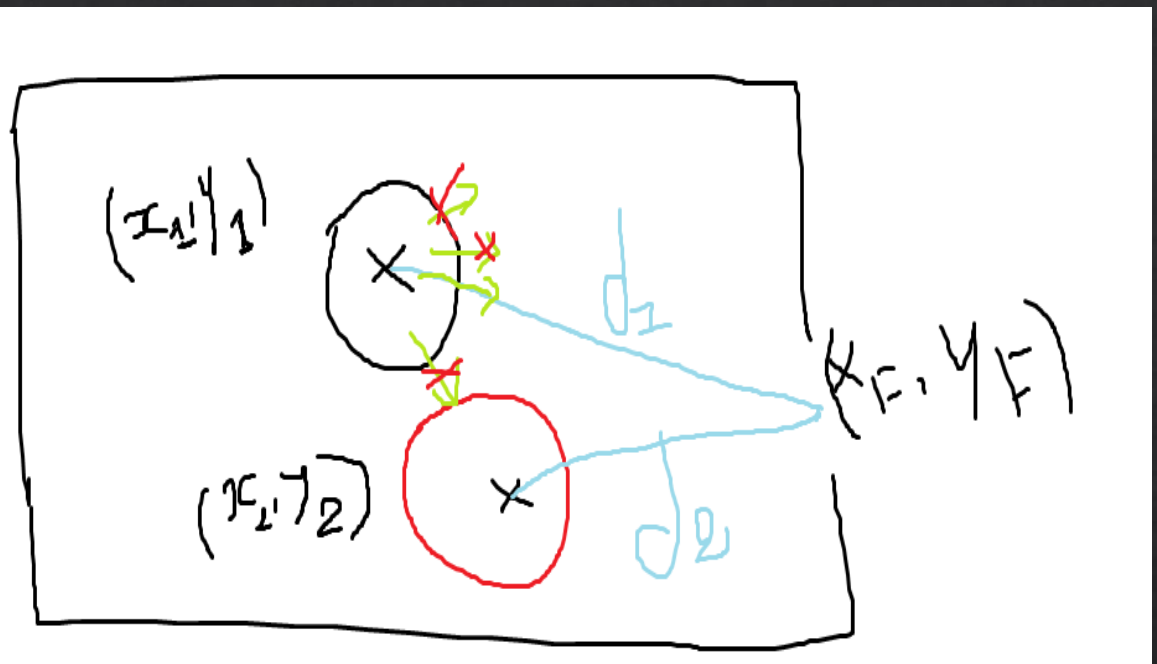
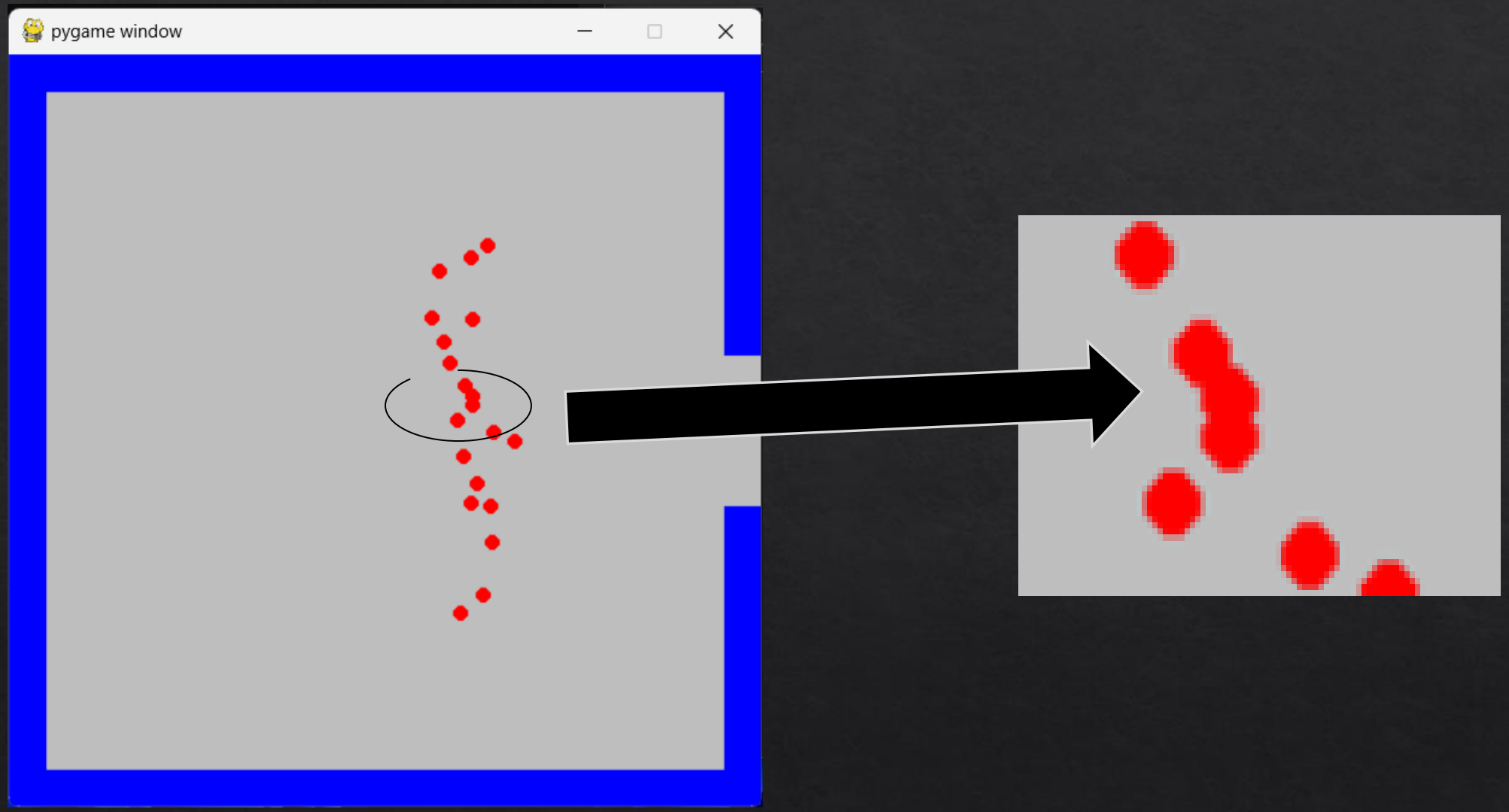
```
import pygame , random , time
from Boids import *
from Bords import *

screen = pygame.display.set_mode((500,500))

l=[ i for i in range(50,451,20)]
p=[ i  for i in range(50,451,20)]

##m=np.zeros((450,450))
##for i in range(450):
##    for j in range(450):
#        m[i,j]=

Birds=[]
for i in range(20):
    Birds.append(Boid(i+40,p[i],1,1,255,0,0))
    #Birds.append(Boid(250-i*10.5,250,1,1,255,0,0))
##a=Boid(200,200,1,1,1,255,1)
##b=Boid(300,300,5,5,255,0,0)

bord1=Bord(25)

run=True

while run:
    pygame.time.delay(50)
    #win.fill((0,0,0))
    screen.fill("Grey")

    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            run = False
    bord1.dessiner_bords()
    for i in range(20):
        Birds[i].move()

##    Birds[0].move()
##    Birds[10].move()
    #print('Birds[{}](x),Birds[{}](y)'.format(0,0),Birds[0].x,Birds[0].y)
    pygame.display.update()
    #time.sleep(0.01)


pygame.quit()
```

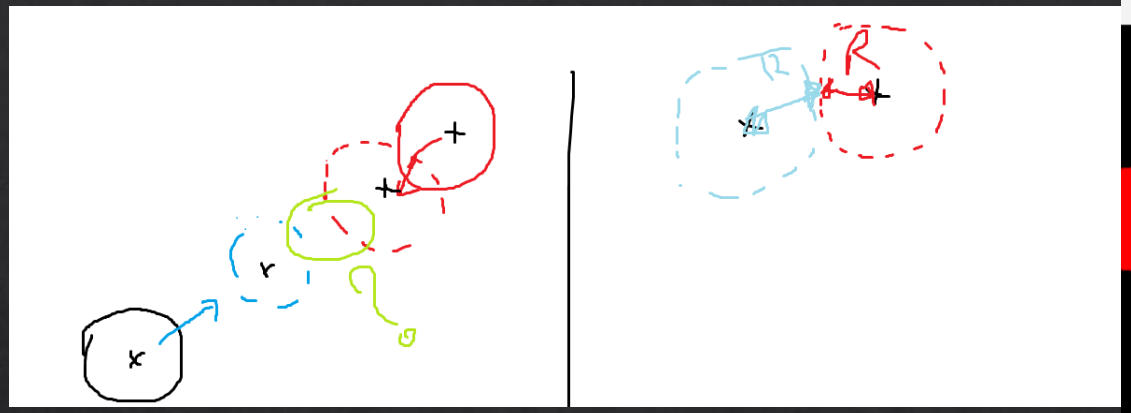
```
bord1.dessiner_bords()
for i in range(20):
    Birds[i].move()
```

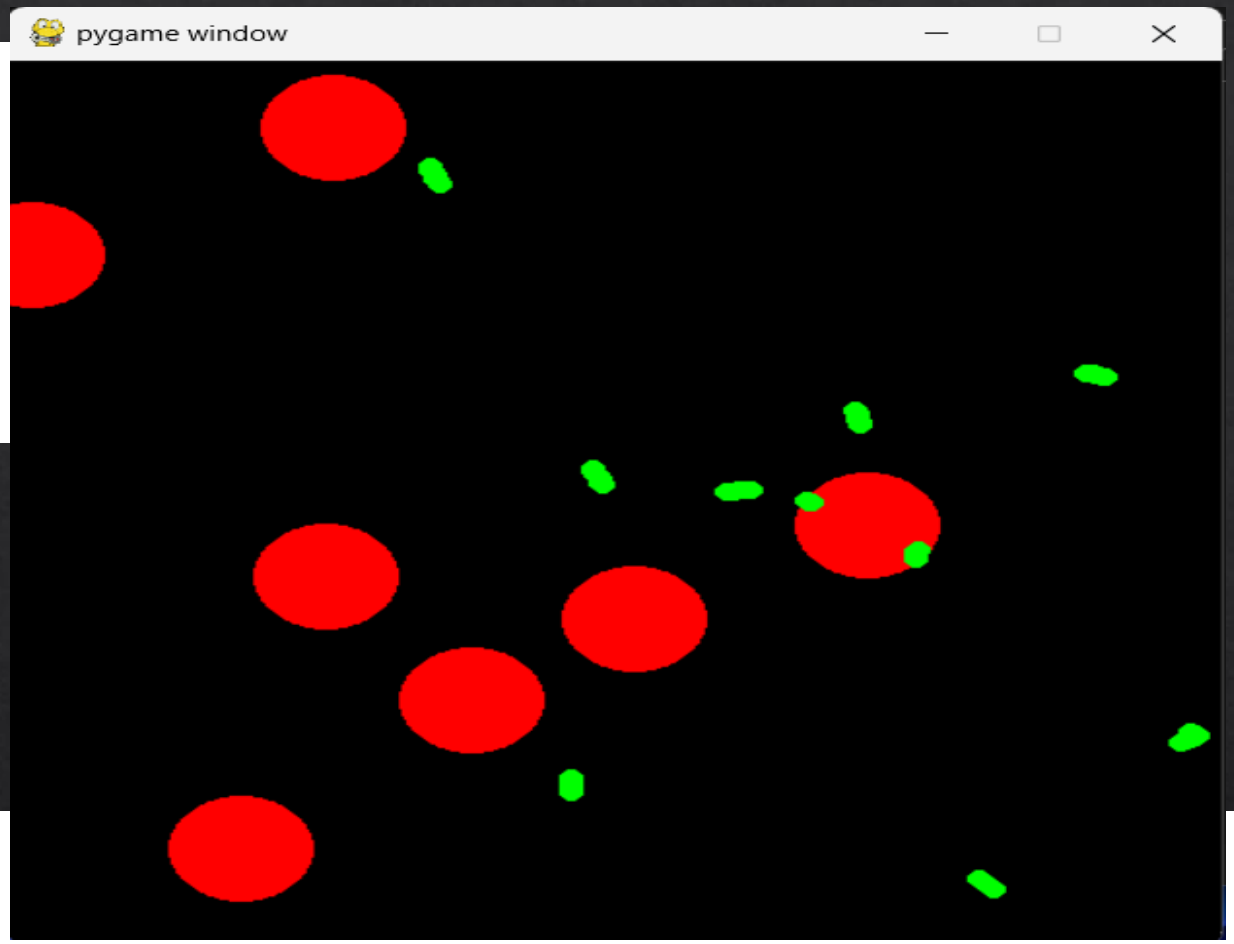
Ln: 1 Col: 0

```
def Distance_Existnce(self,c,d):
    a=(Exist_x-c)**2
    b=(Exist_y-d)**2
    return math.sqrt(a+b)
def update_position(self):
    self.dx=random.uniform(-3.5,3.5)
    self.dy=random.uniform(-3.5,3.5)
    return(self.dx,self.dy)
def move(self):
    d1=self.Distance_Existnce(self.x,self.y)
    Run=(self.x,self.y)==(Exist_x,Exist_y)
    while not(Run):
        dx,dy=self.update_position()
        c=self.x+dx
        d=self.y+dy
        d2=self.Distance_Existnce(c,d)
        if d2<d1:
            #print("d1={},d2={}".format(d1,d2))
            self.x+=dx
            self.y+=dy
            break
```




pygame window

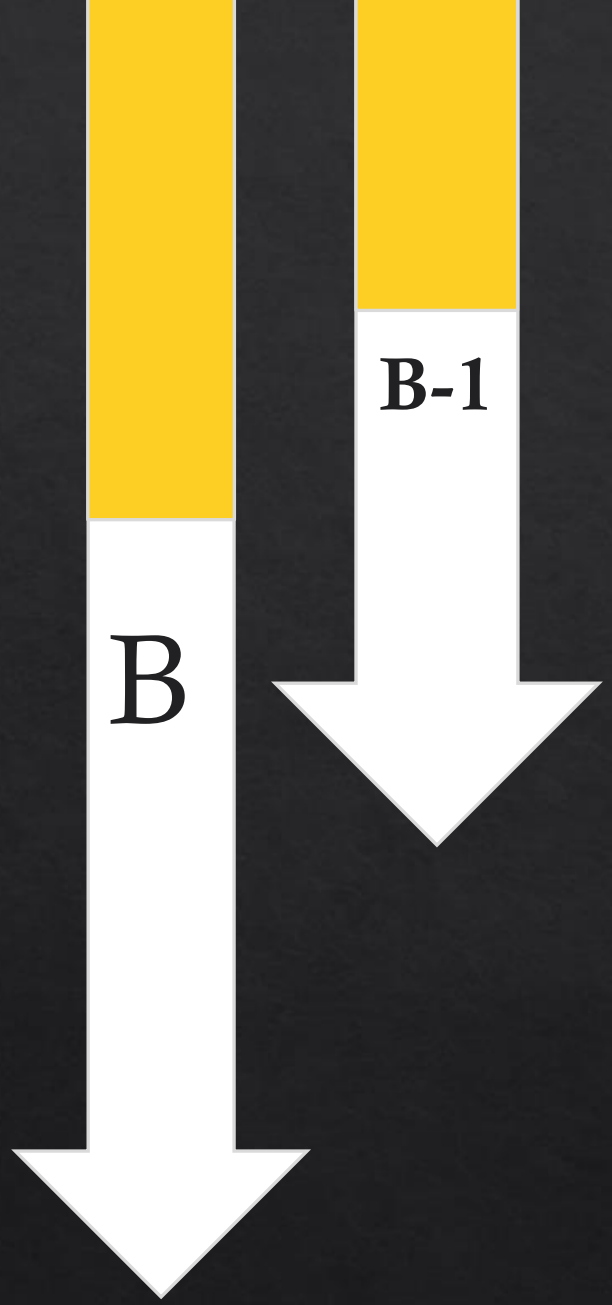





```
def DetectColli(self):
    if distance(self.persx,self.persy,self.obsx,self.obsy)<(self.persradius+self.obsradius)-2:
        return(True)
```

B

- Tentative 2



Recherche de modèle

Des Modèles qui existaient Déjà

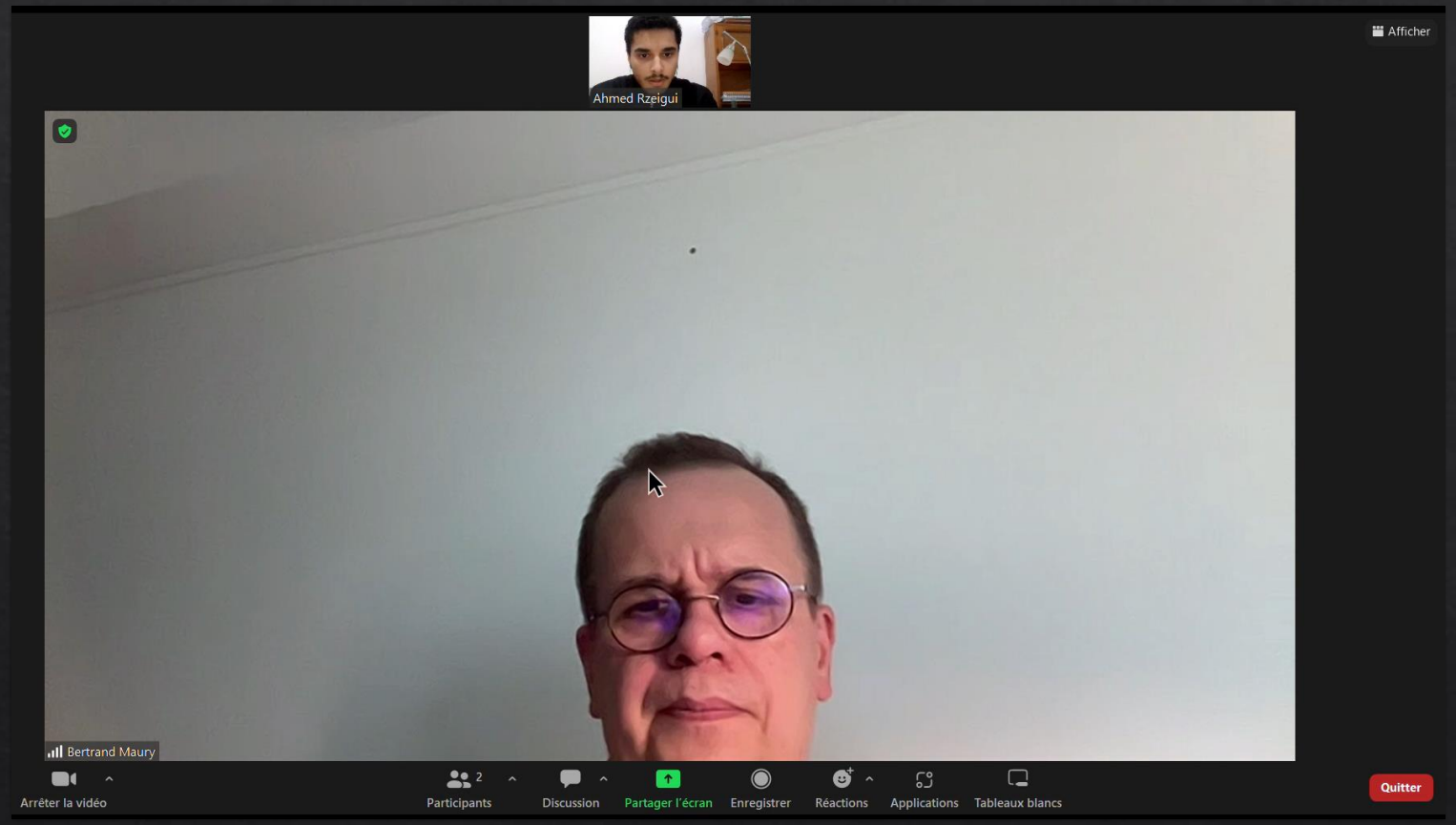
- Des Modèles Macroscopiques:

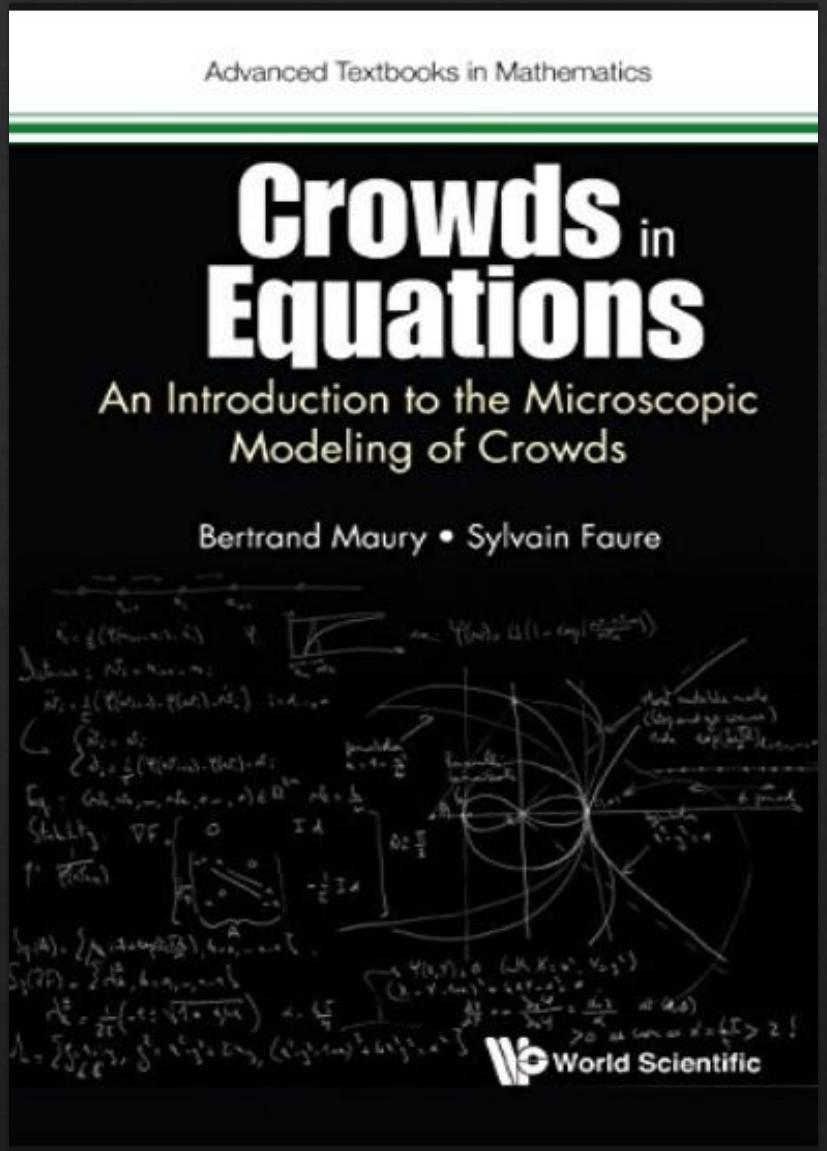
1. modèle de régression
2. modèle dynamique de fluide ou gaz

- Des Modèles Microscopiques :

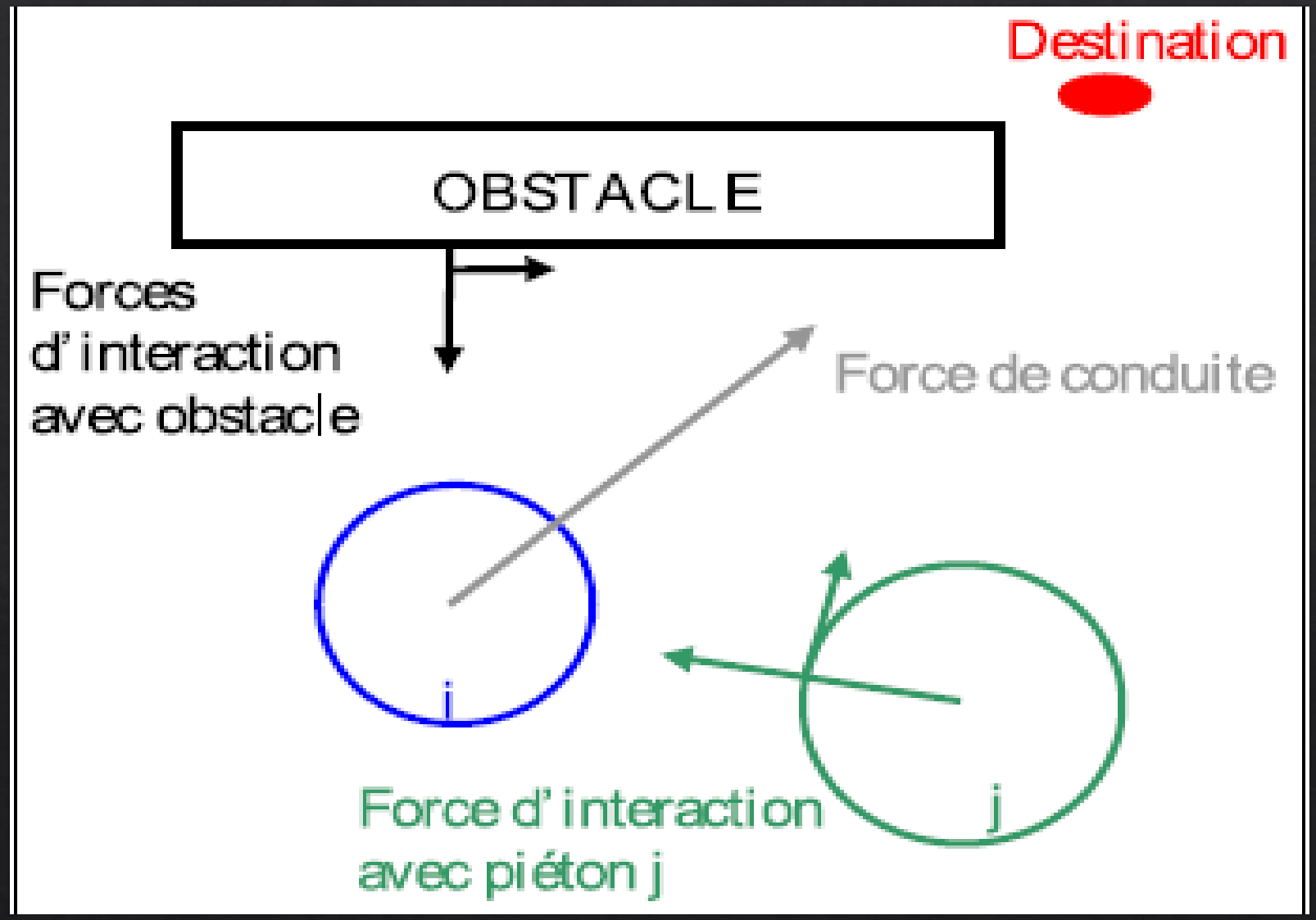
1. Modèle à base de règles (Boids ,Introduits par Reynolds)
2. Modèle de forces sociales
3. modèle d'automates cellulaires
4. Modèle mathématique de Venel

UN conatact Avec M.Bertrand Maury




Advanced Textbooks in Mathematics
Crowds in Equations
An Introduction to the Microscopic Modeling of Crowds
Bertrand Maury • Sylvain Faure
World Scientific

Modèle de Force Sociale



Equation du Mouvement

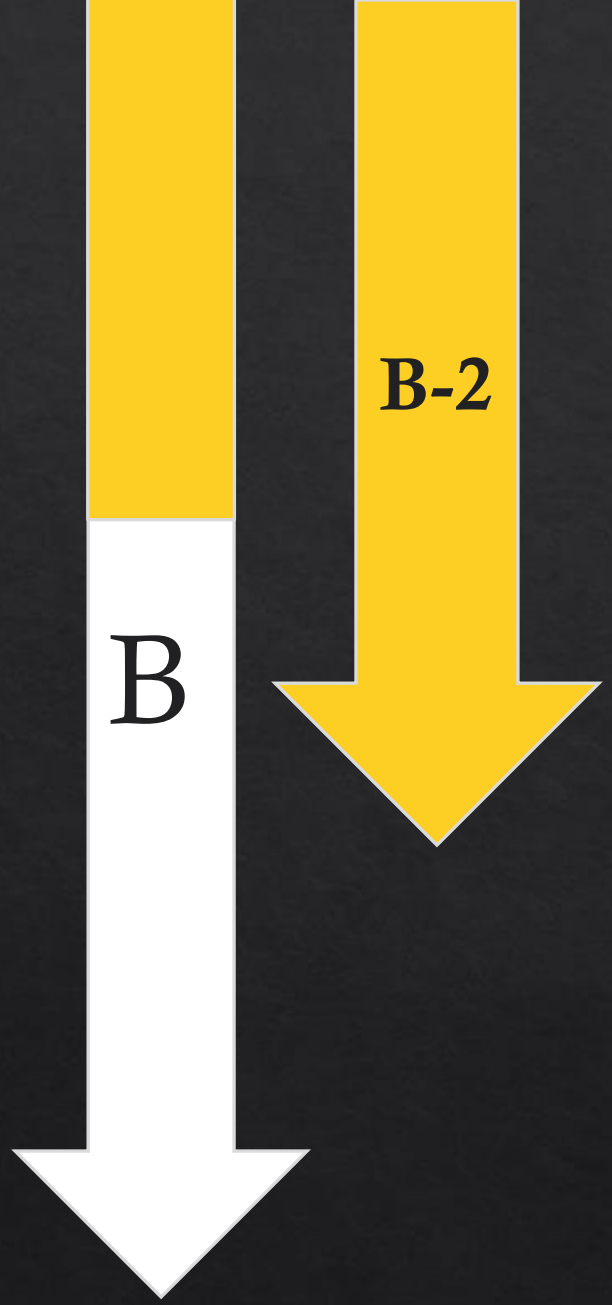
$(x_i \in \mathbb{R}^2)$

$$\underbrace{\frac{dx_i}{dt}}_{?} = \underbrace{U_i}_{?} + \sum_{i \neq j} \underbrace{w_{ij}}_{?}$$

$$\frac{dx}{\mathrm{d}t} = -\nabla\psi(x) \longrightarrow U_i = -\nabla\left(\sum_i v_i(x_i)\right)$$

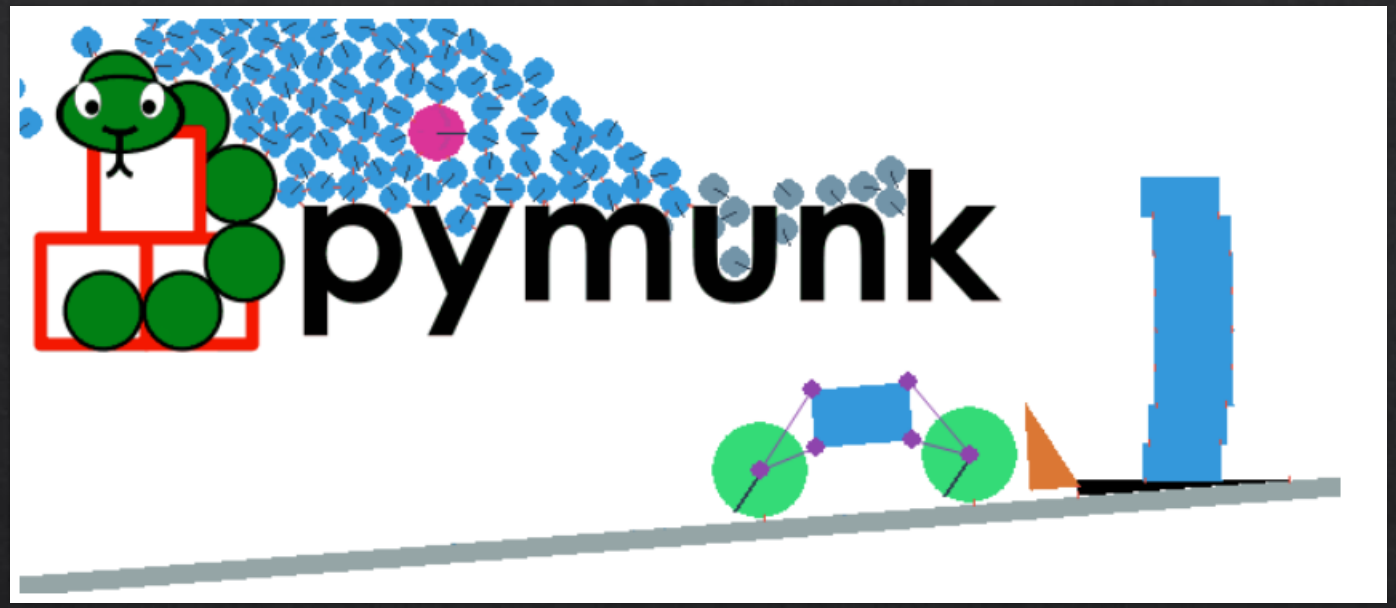
$$v_i(x_i) = UD(x_i)$$

$$W_{ij} = -U \exp\left(-\frac{D\mathrm{i}j}{\delta}\right) e_{ij}$$

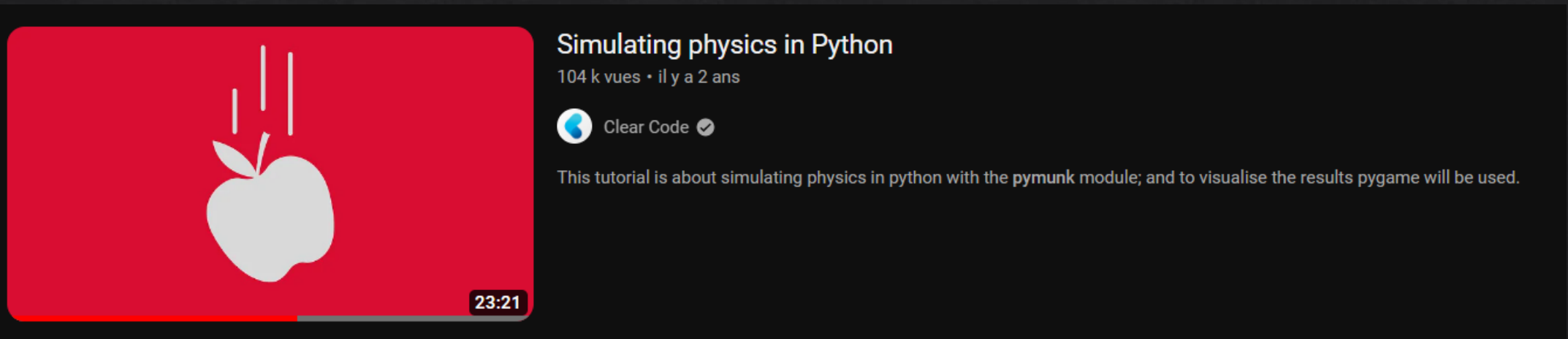


Implémentation du modèle

Comment améliorer le Code ?



Son Avantage
Manipuler les Forces , Les Vitesses , les Collisions PLUS FACILEMENT

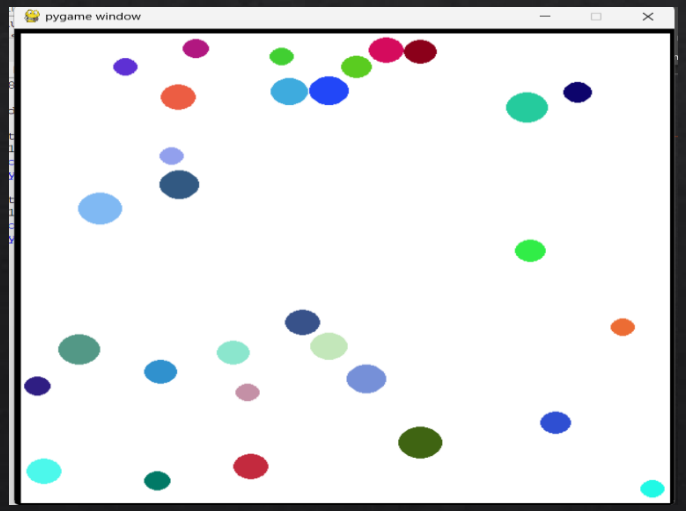


En effet :

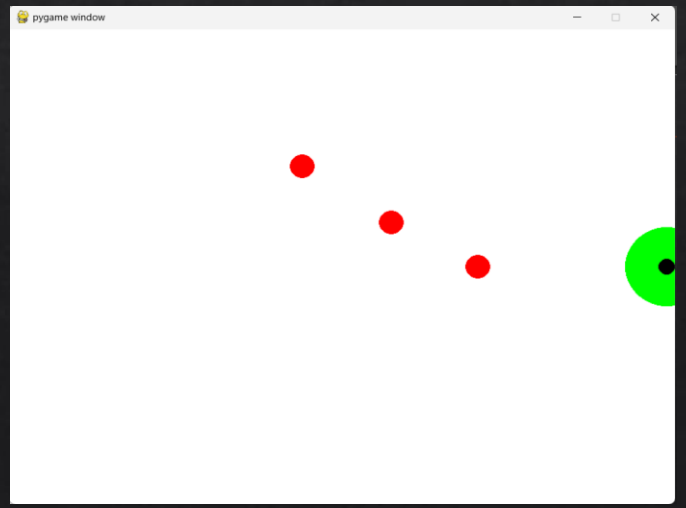
```
# Classe Personne
class Personne:
    def __init__(self, position,radius):
        self.radius = radius
        self.position = position
        self.velocity = (0, 0)

        # Création du corps physique
        mass = 1.0
        inertia = pymunk.moment_for_circle(mass, 0, self.radius)
        self.body = pymunk.Body(mass, inertia)
        self.body.position = self.position
        self.shape = pymunk.Circle(self.body, self.radius*1.43)
        space.add(self.body, self.shape)
```

Simplification des Taches

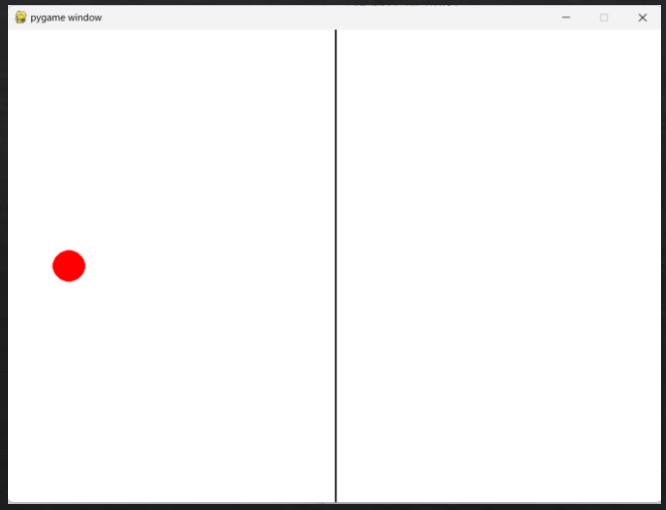
0.Boules en mouvement aléatoires sans collision



1.Boules en mouvement vers un Target Point



2.Comment_Calculer_Termps



Retour sur L'équation : $\frac{dx_i}{dt} = U_i + \sum_{i \neq j} w_{ij}$

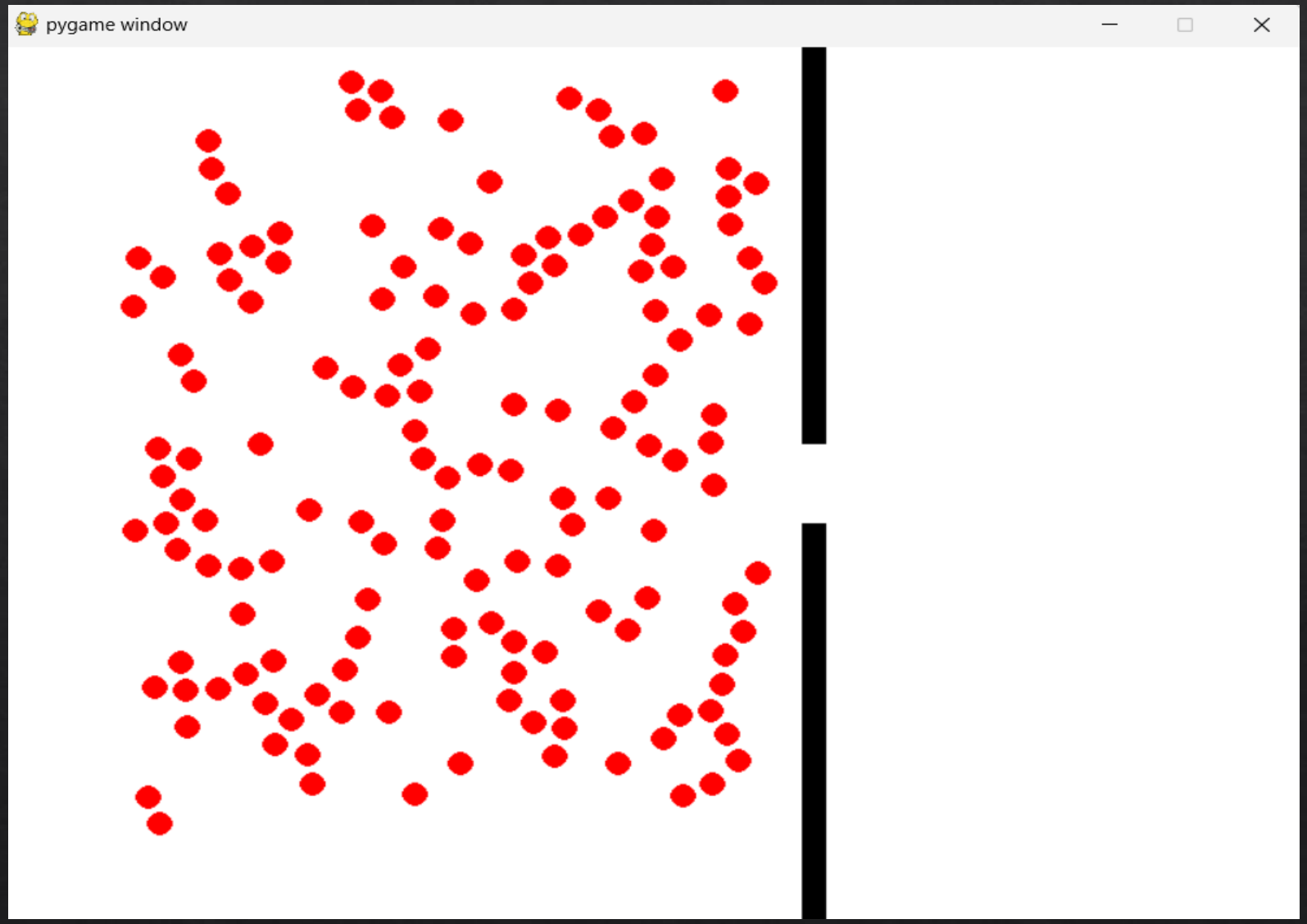
```python
def calculate_desired_velocity(self, target_point):
    # Calculer le gradient de la fonction de potentiel
    diff_x = target_point[0] - self.position[0]
    diff_y = target_point[1] - self.position[1]
    distance = math.sqrt(diff_x**2 + diff_y**2)
    gradient_x = diff_x / distance
    gradient_y = diff_y / distance

    # Calculer la vitesse désirée
    desired_velocity_x = U * gradient_x
    desired_velocity_y = U * gradient_y

    return (desired_velocity_x, desired_velocity_y)
```

```python
def calculate_correction_velocity(self, balls):
    correction_velocity = (0, 0)

    for ball in balls:
        if ball != self:
            diff_x = ball.position[0] - self.position[0]
            diff_y = ball.position[1] - self.position[1]
            distance = math.sqrt(diff_x**2 + diff_y**2)
            direction_x = diff_x / distance
            direction_y = diff_y / distance
            direction = [diff_x, diff_y]
            # Calculer la correction de vitesse
            correction = [-U * math.exp(-distance/delta) * d for d in direction]
            correction_velocity = (correction_velocity[0] + correction[0], correction_velocity[1] + correction[1])

    return correction_velocity
```

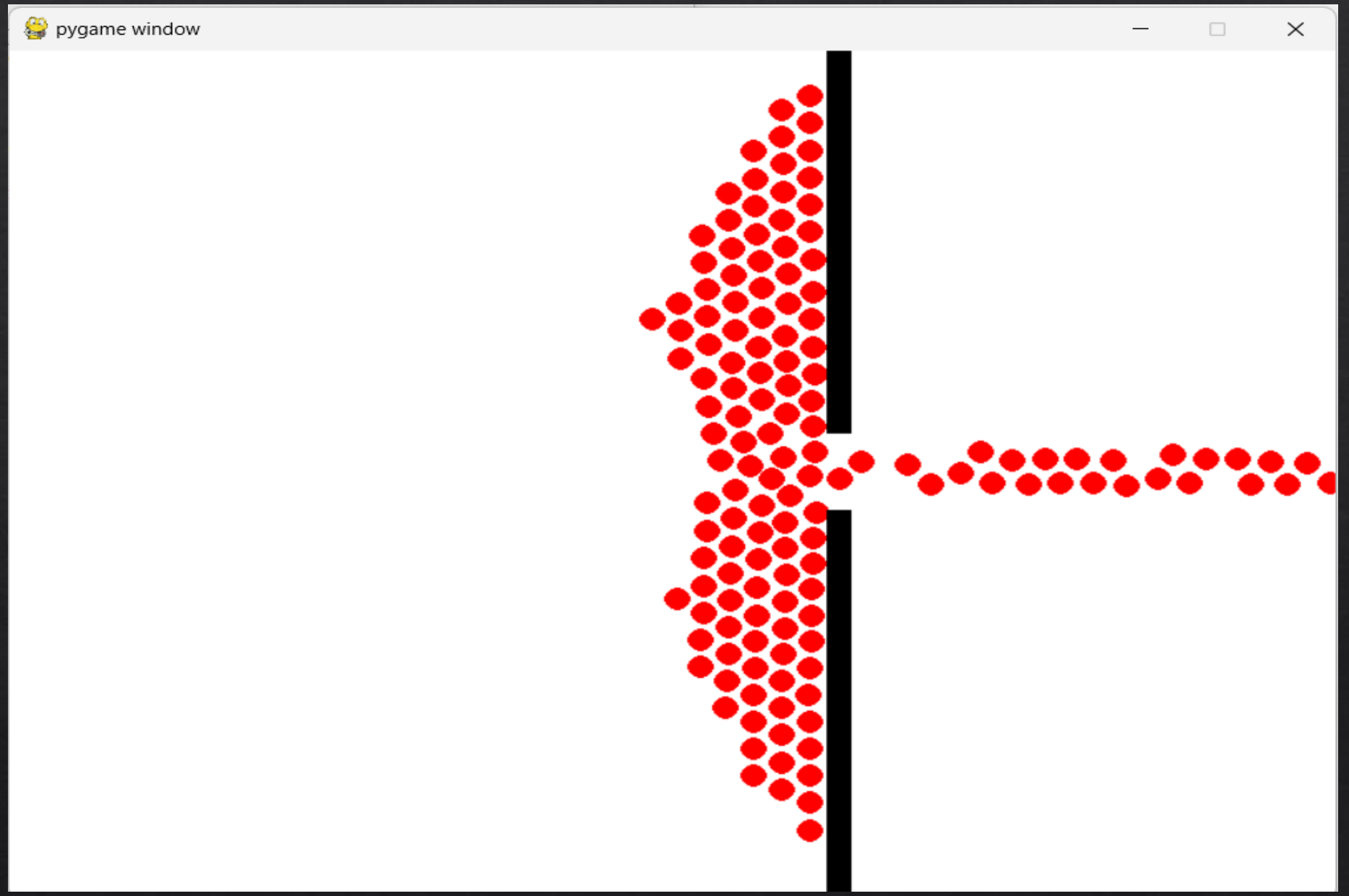
Résultat Obtenu :

U=50.0 , δ=0.08, Nombre de personne = 150

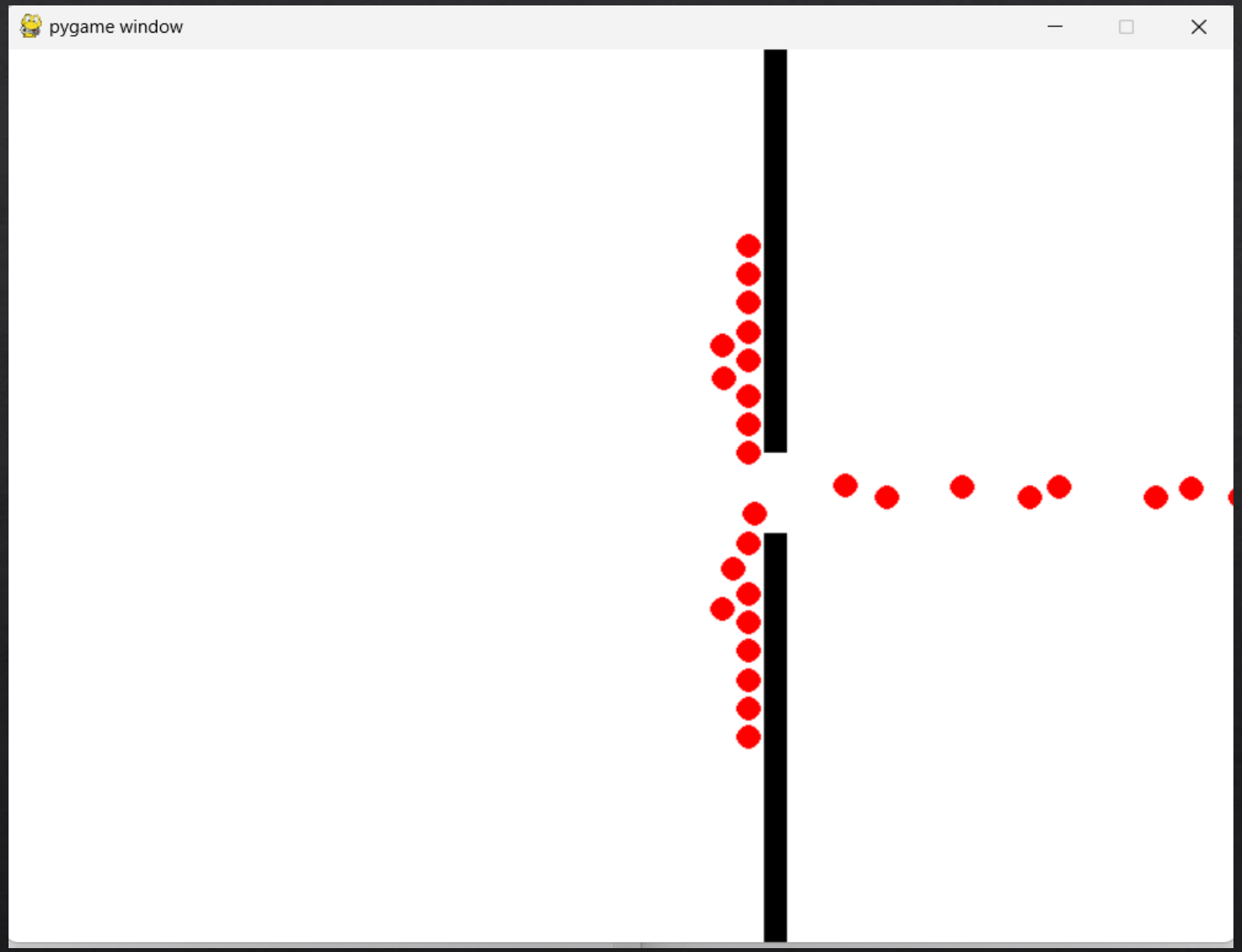
T = 0,05 s



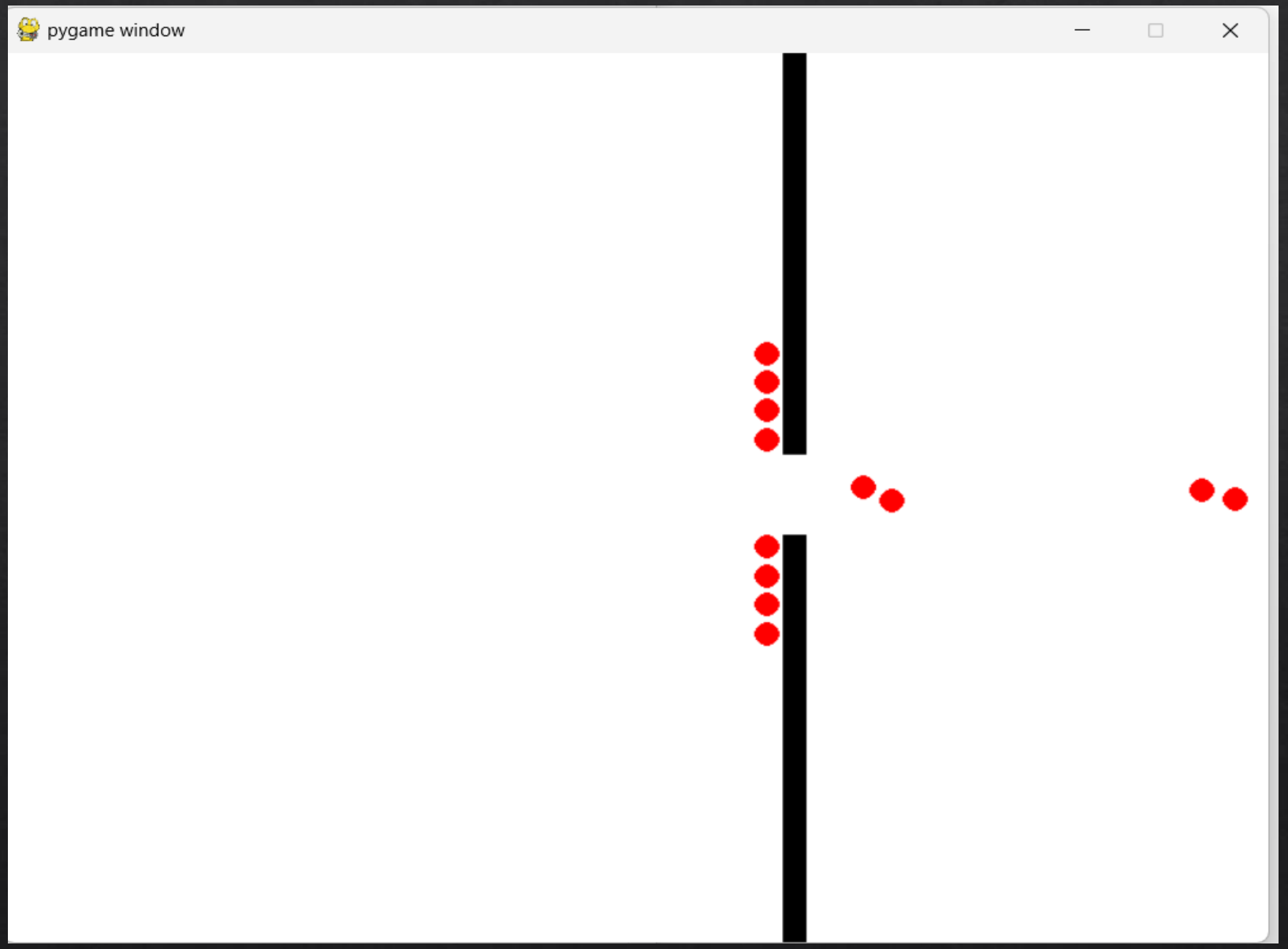
T =30 s



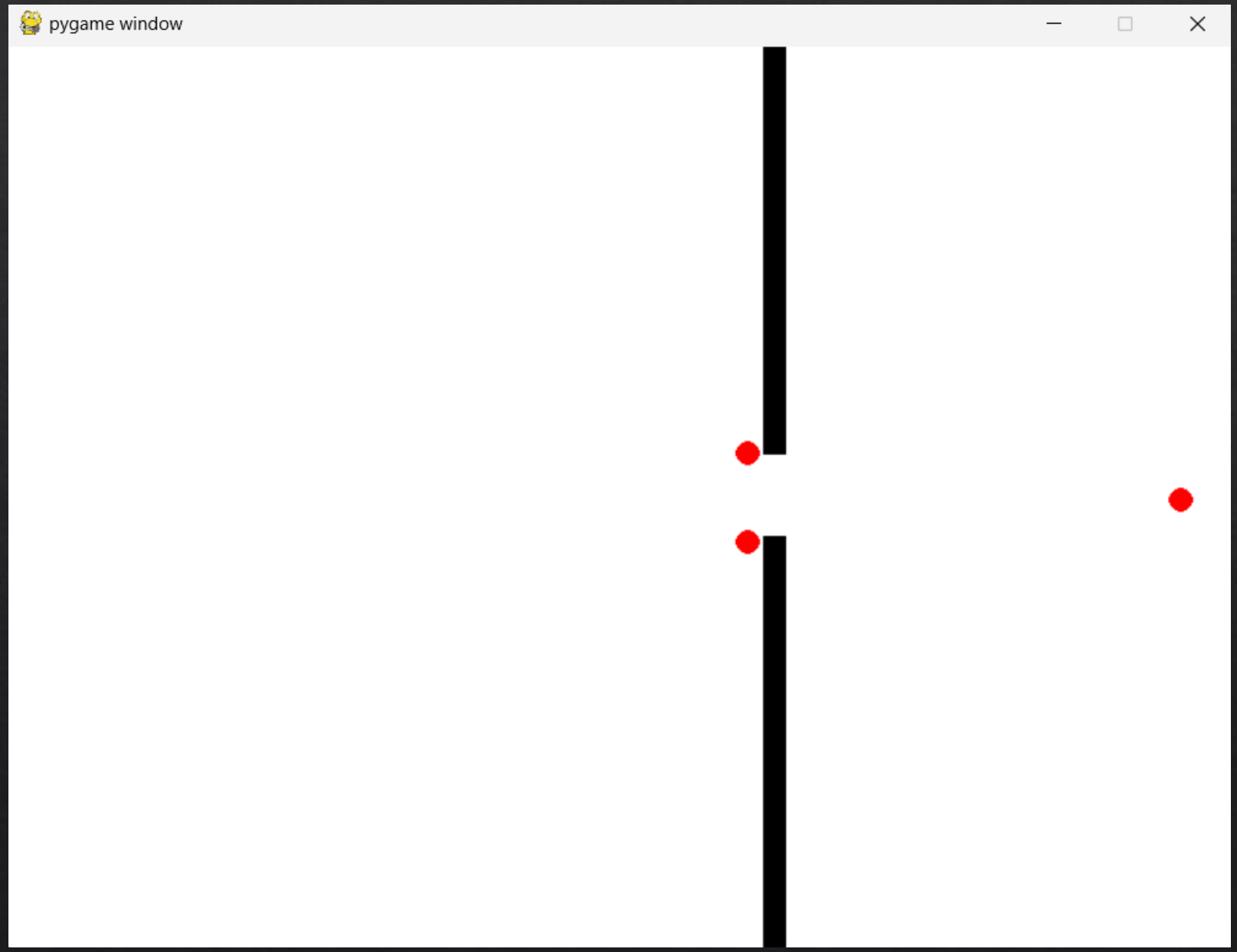
T =2 min



T =2 min 41 s

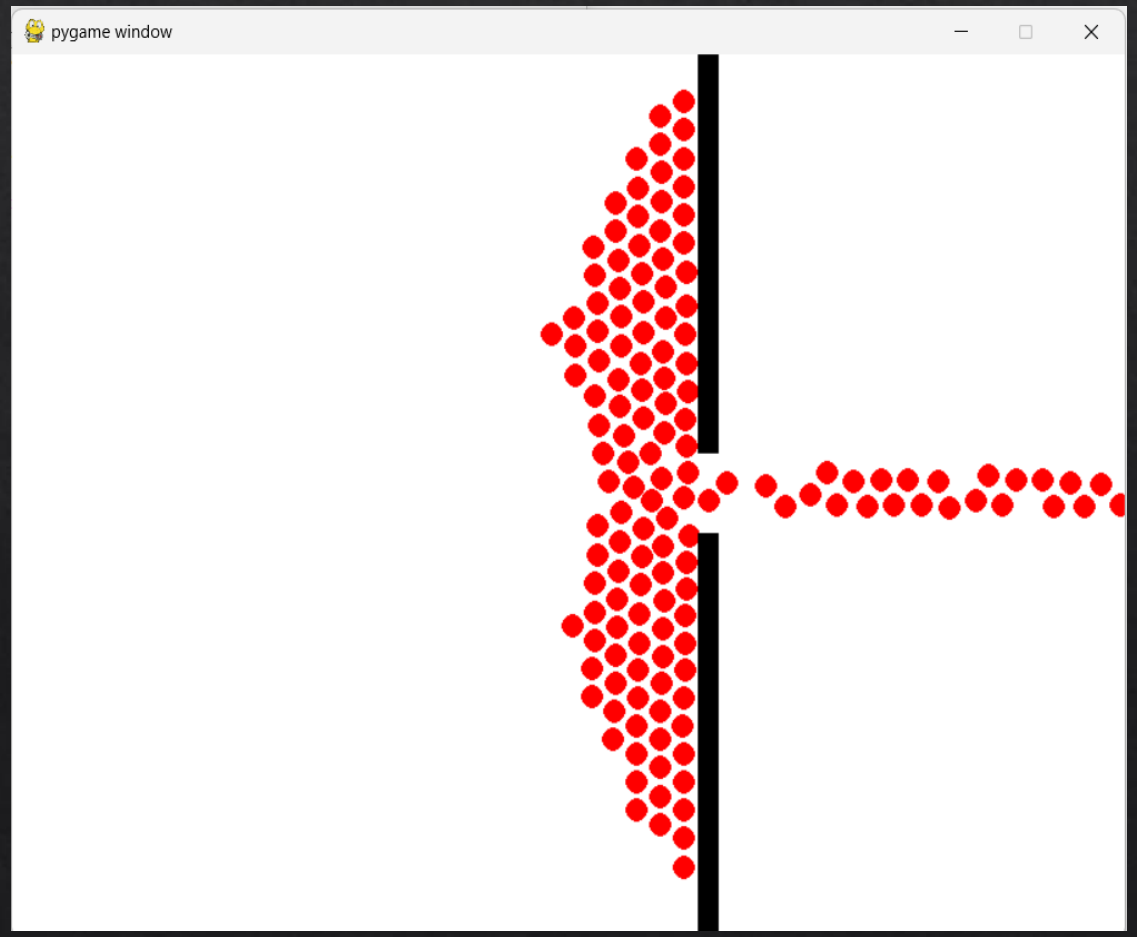


T =4 min



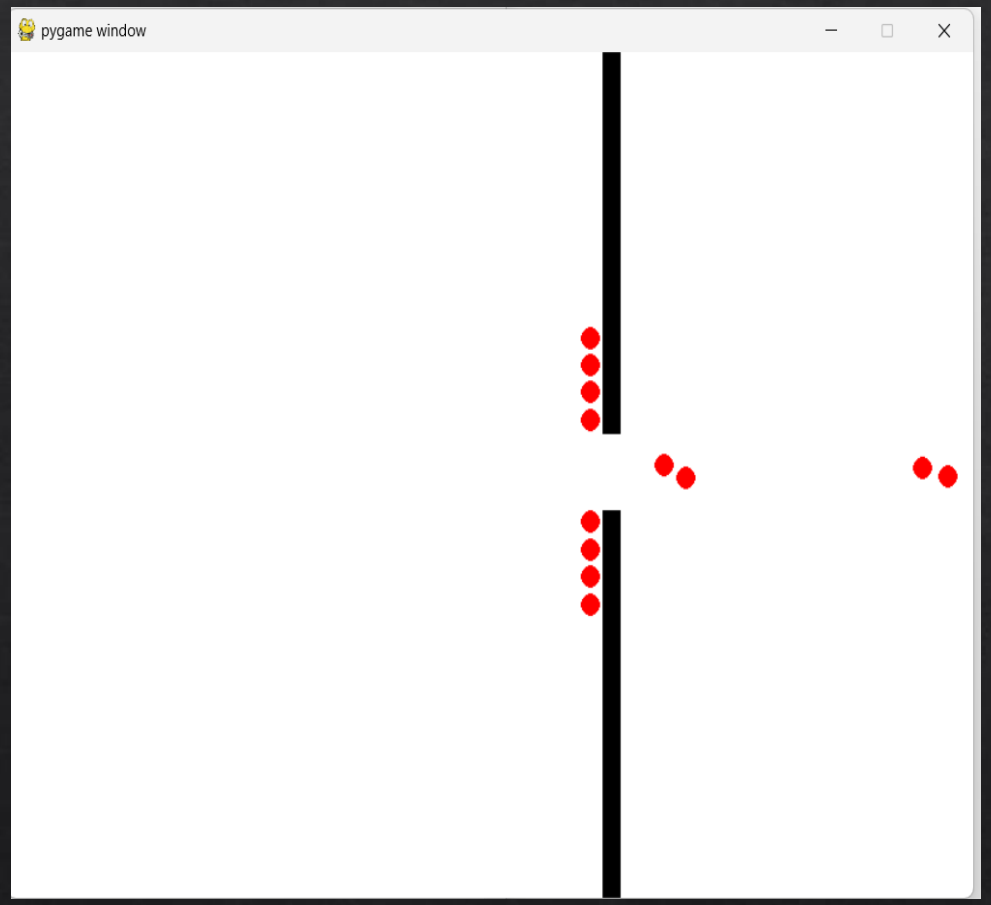
Vérification de Phénomènes d'auto-organisation observés :

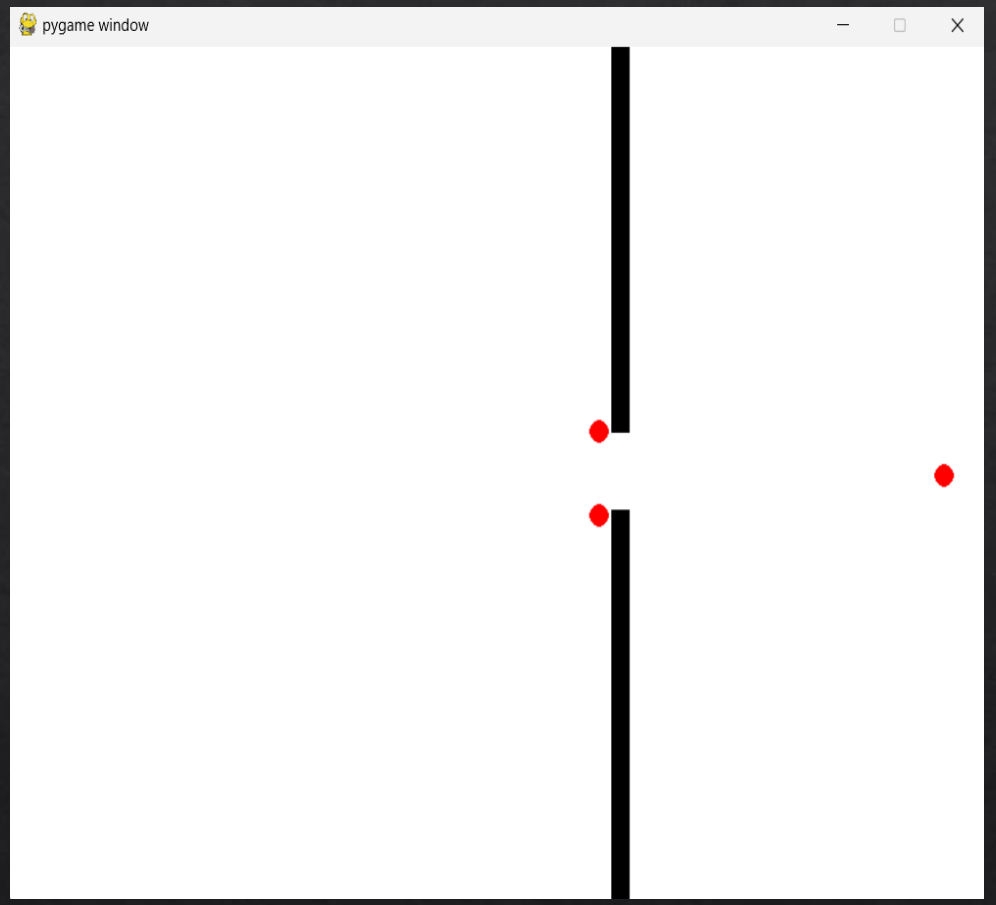
- l'embouteillage
- le blocage et le phénomène d'arche



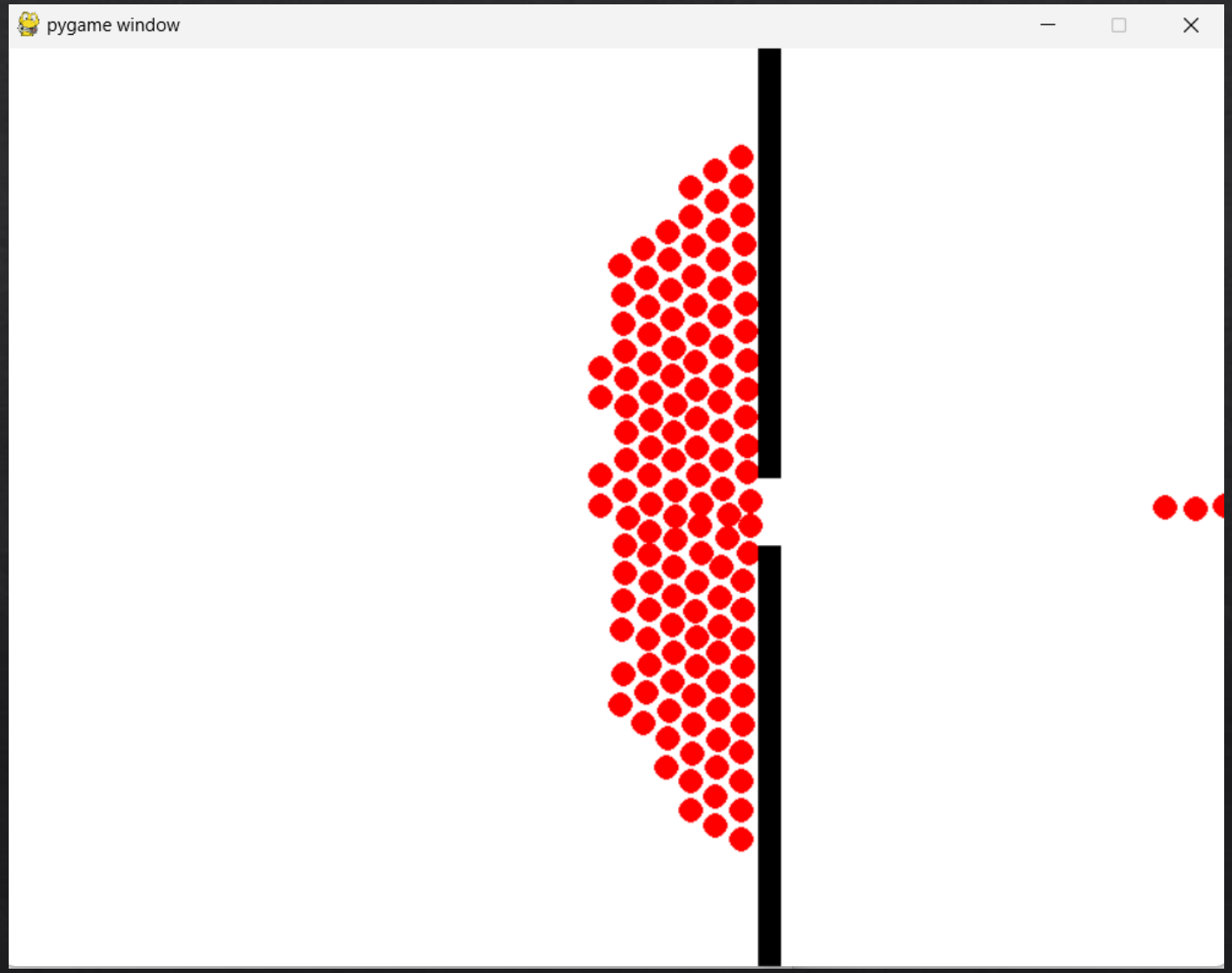
Limites de la simulation :

- La vitesse diminue considérablement pour les dernières boules en effet :





- La largeur du Porte (Ici Fente) peut Bloquer Entièrement le mouvement même si elle supérieur au diamètre d'une boule en effet :



C

- Comparaison

Simulation d'une évacuation d'une Salle PROPOS2 PAR

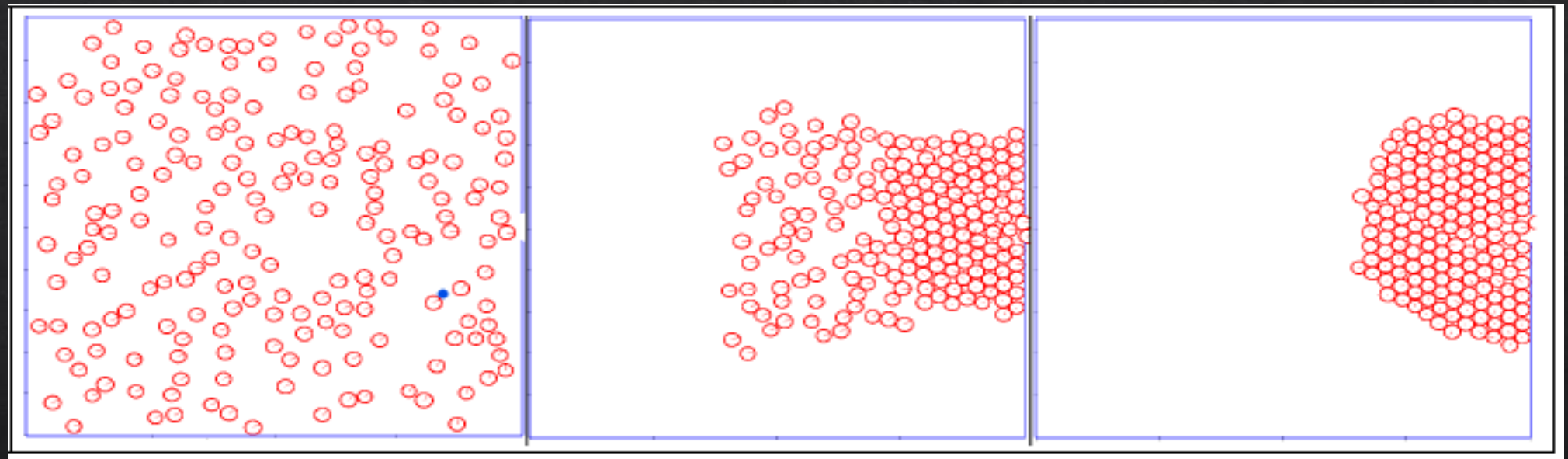


FIGURE 6.3 – Simulation d'une évacuation de salle - Formation d'arche - a. $t = 0\ s$, 200 piétons veulent évacuer ; b. $t = 6\ s$, 187 piétons restent à évacuer ; c. $t = 12\ s$, 166 piétons restent à évacuer.

En utilisant la méthode NSM 2 il a pu obtenu :

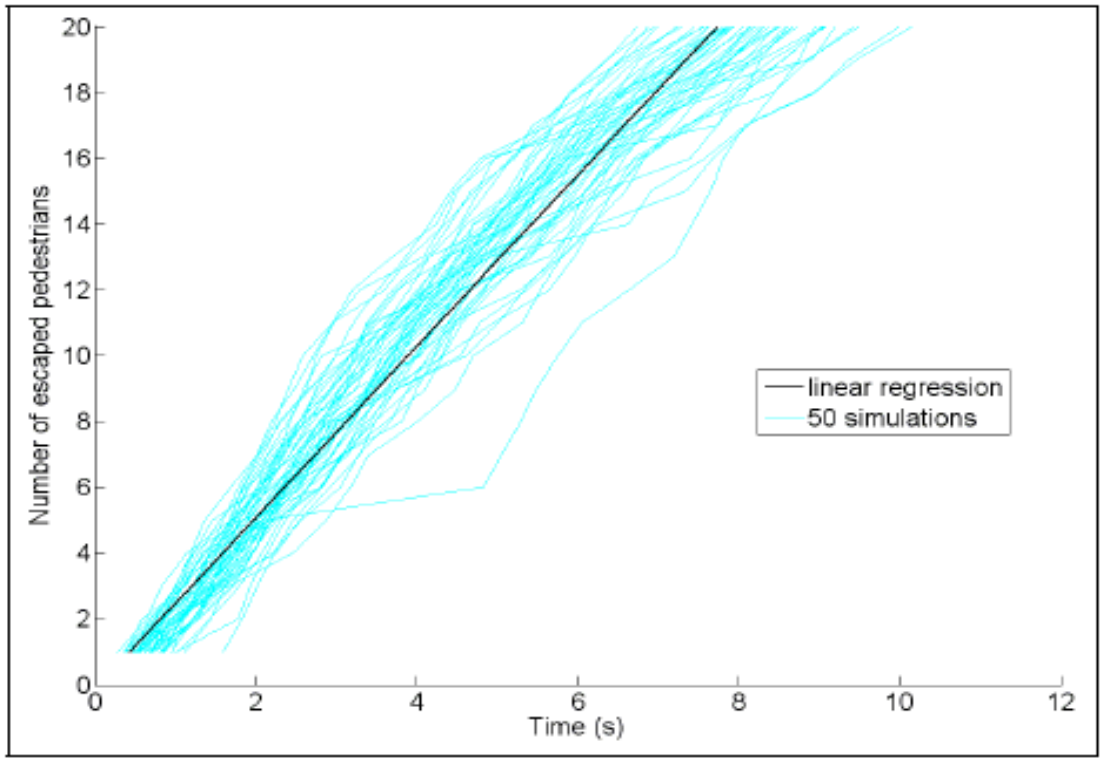
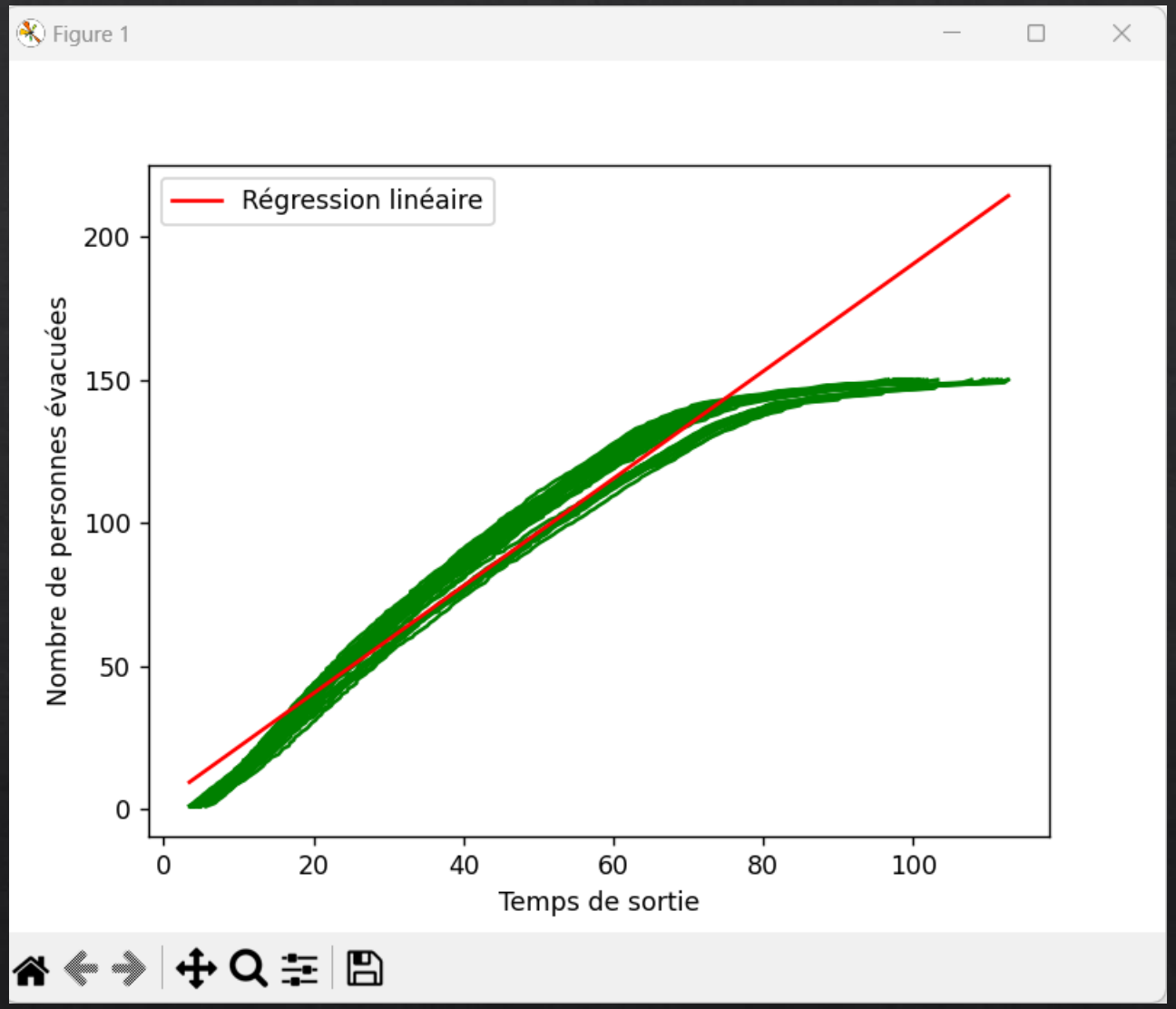


FIGURE 6.4 – Evacuation de salle - Courbes d'évacuation pour NSM2, avec $h = 10^{-2}$ s. Les courbes de couleur cyan résultent des 50 simulations. La régression linéaire des 50 simulations (droite noire) permet d'obtenir le débit moyen de piétons traversant la porte.

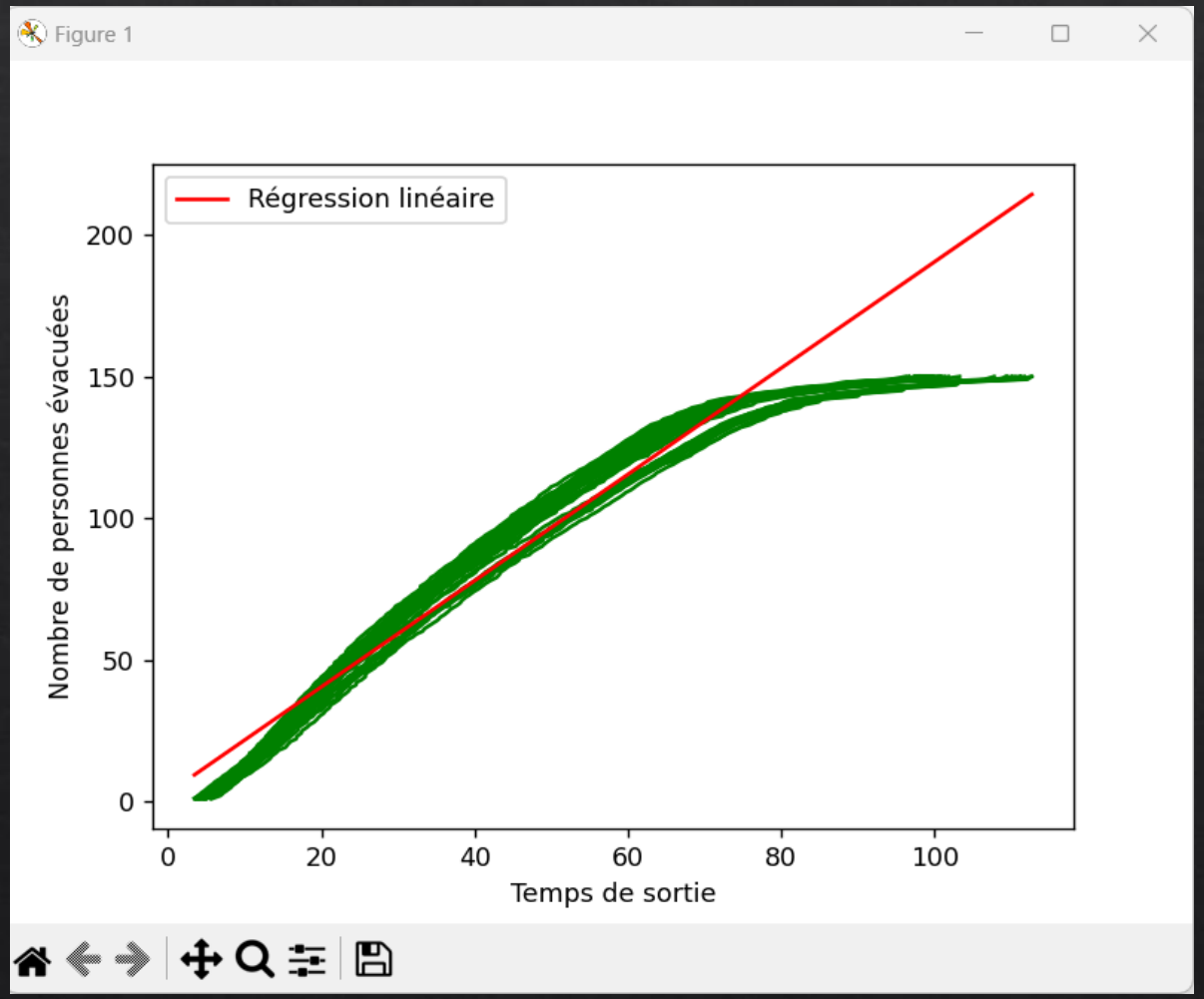
Implémentation de la Régression Linéaire

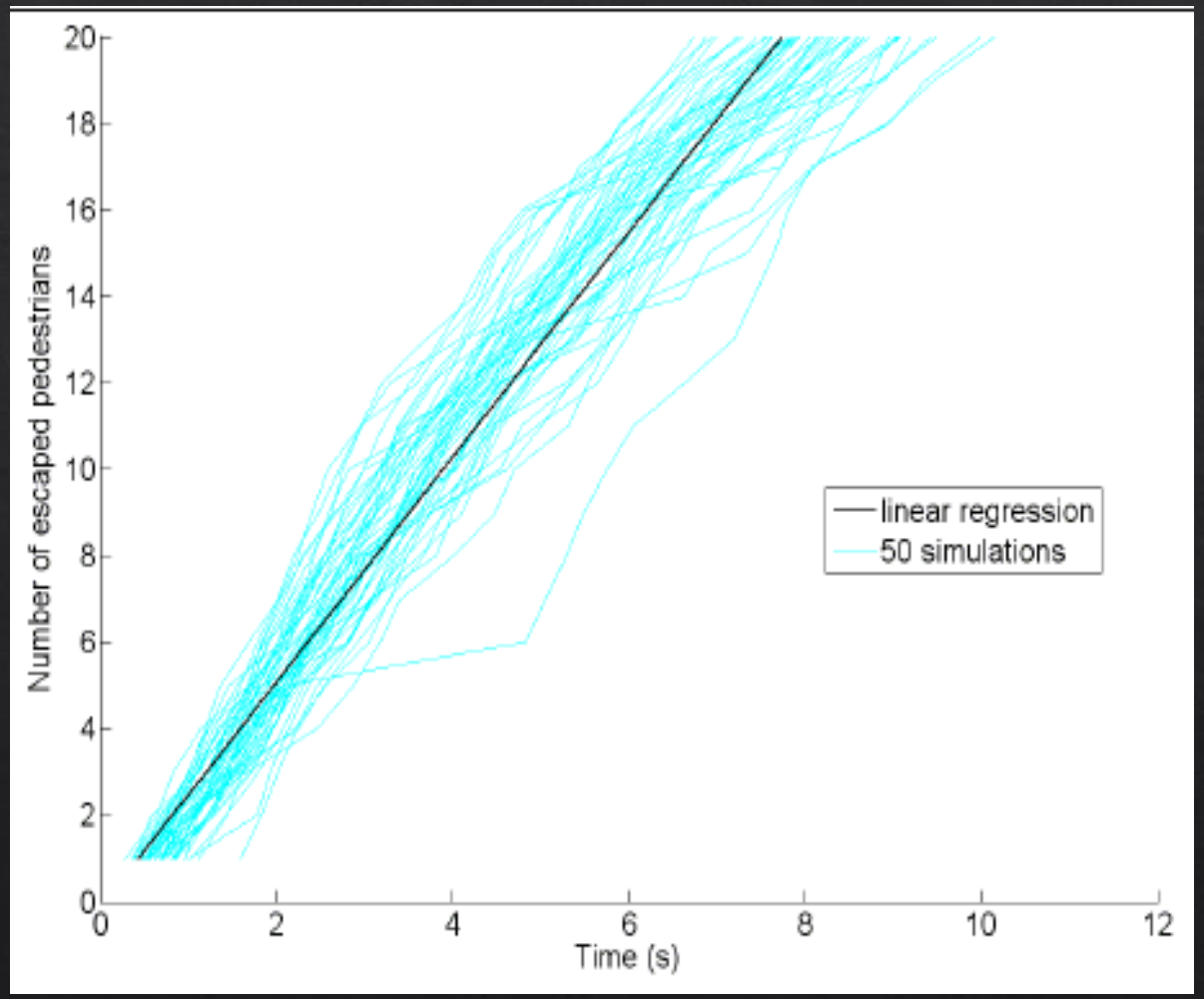
```
def tracage(nombre_ball,nombre_simulation):
    import numpy as np
    import matplotlib.pyplot as plt
    from sklearn.linear_model import LinearRegression

    Personne_evacuee = np.arange(1, nombre_ball+1)
    Temps_Sortie_Personne = []

    # Effectuer les 10 simulations
    for i in range(nombre_simulation):
        temps_simulation = simulate(nombre_ball)  # Remplacez cette ligne par votre fonction simulate
        Temps_Sortie_Personne.append(temps_simulation)

    # Convertir les listes en tableaux numpy
    Personne_evacuee = np.array(Personne_evacuee)
    Temps_Sortie_Personne = np.array(Temps_Sortie_Personne)

    # Tracer les courbes
    plt.figure()
    for i in range(nombre_simulation):
        plt.plot(Temps_Sortie_Personne[i], Personne_evacuee, color='green')

    # Effectuer la régression linéaire
    reg = LinearRegression()
    reg.fit(Temps_Sortie_Personne.mean(axis=0).reshape(-1, 1), Personne_evacuee.reshape(-1, 1))

    # Obtenir les prédictions de la régression linéaire
    x_pred = np.linspace(Temps_Sortie_Personne.min(), Temps_Sortie_Personne.max(), 100)
    y_pred = reg.predict(x_pred.reshape(-1, 1))

    # Tracer la ligne de régression linéaire
    plt.plot(x_pred, y_pred, color='red', label='Régression linéaire')

    plt.xlabel('Temps de sortie')
    plt.ylabel('Nombre de personnes évacuées')
    plt.legend()
    plt.show()
```

Courbe Obtenu pour : Nombre_Ball =150 , Nombre Simulation = 50



Comparons les Résultats





D

- Conclusion