Bartolomeo Ryan 10208
Jeux et Sports

Modélisation de solides déformables

Plan

I. Présentation et première approche
   A. Inspiration
   B. Étude d’un mouvement
   C. Première solution : les systèmes masse-ressort

II. Réalisation
   A. Première méthode d’intégration : Euler
   B. Deuxième Méthode : Runge Kutta
   C. Problème de la réaction du support

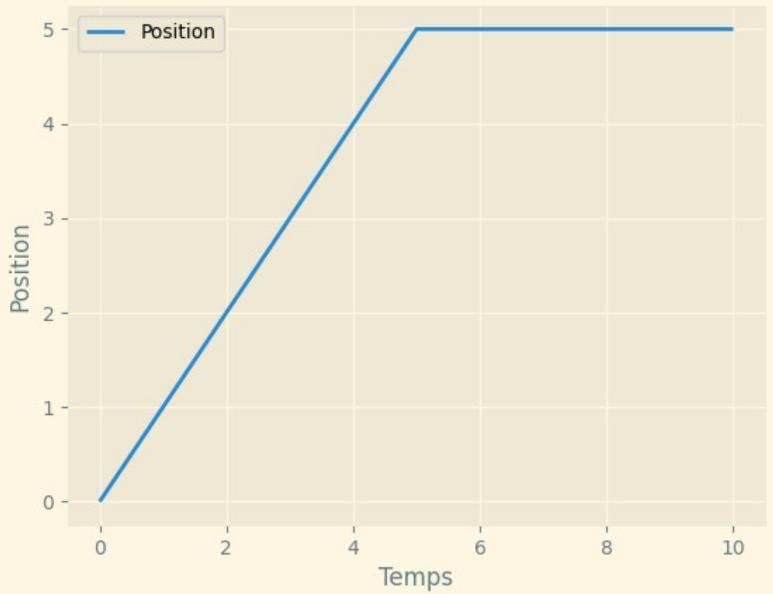
III. Deuxième approche
   A. Modèle du gaz parfait
   B. Confirmation avec expérimentation

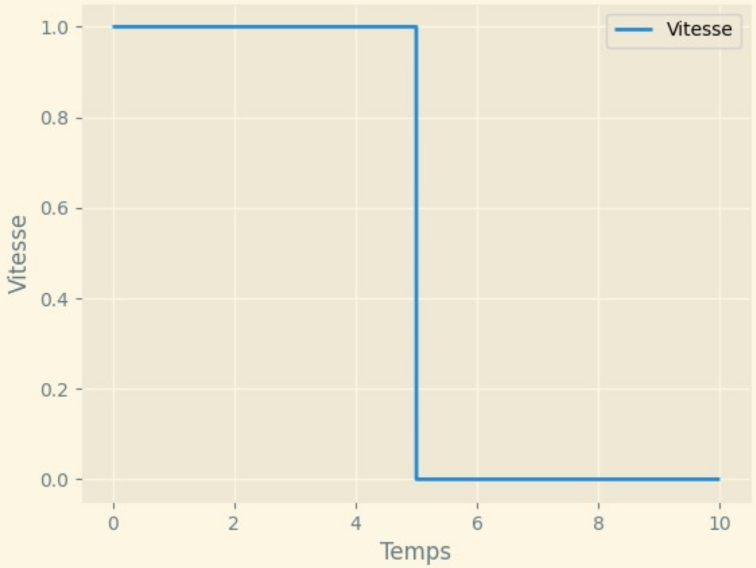
Présentation du problème et première approche

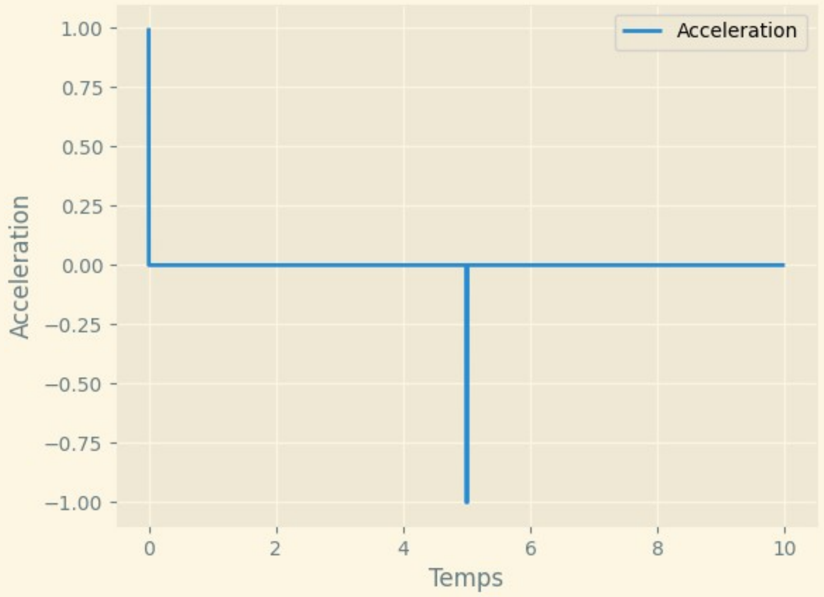
Inspiration

Modélisation réaliste du mouvement

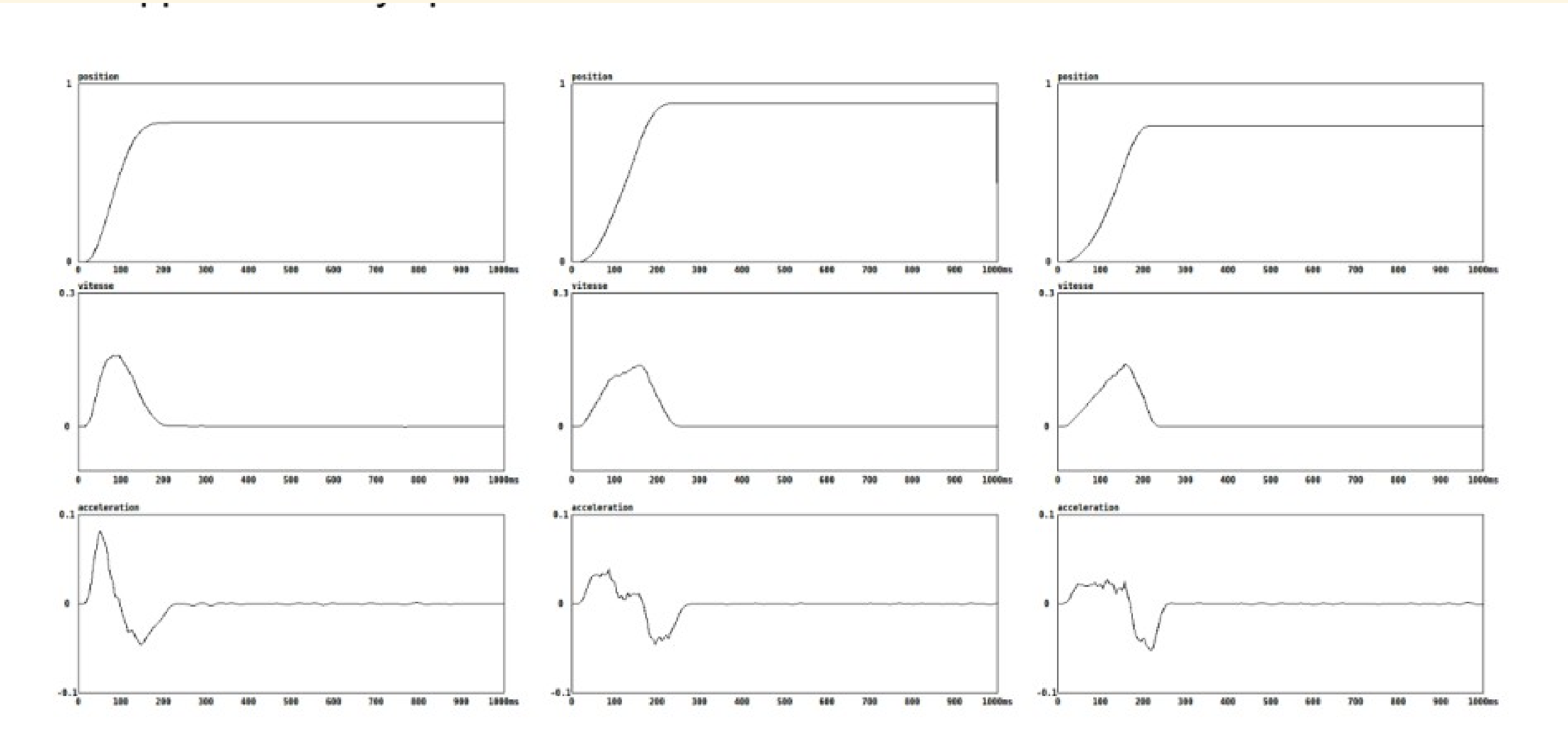
Modèle informatique simple



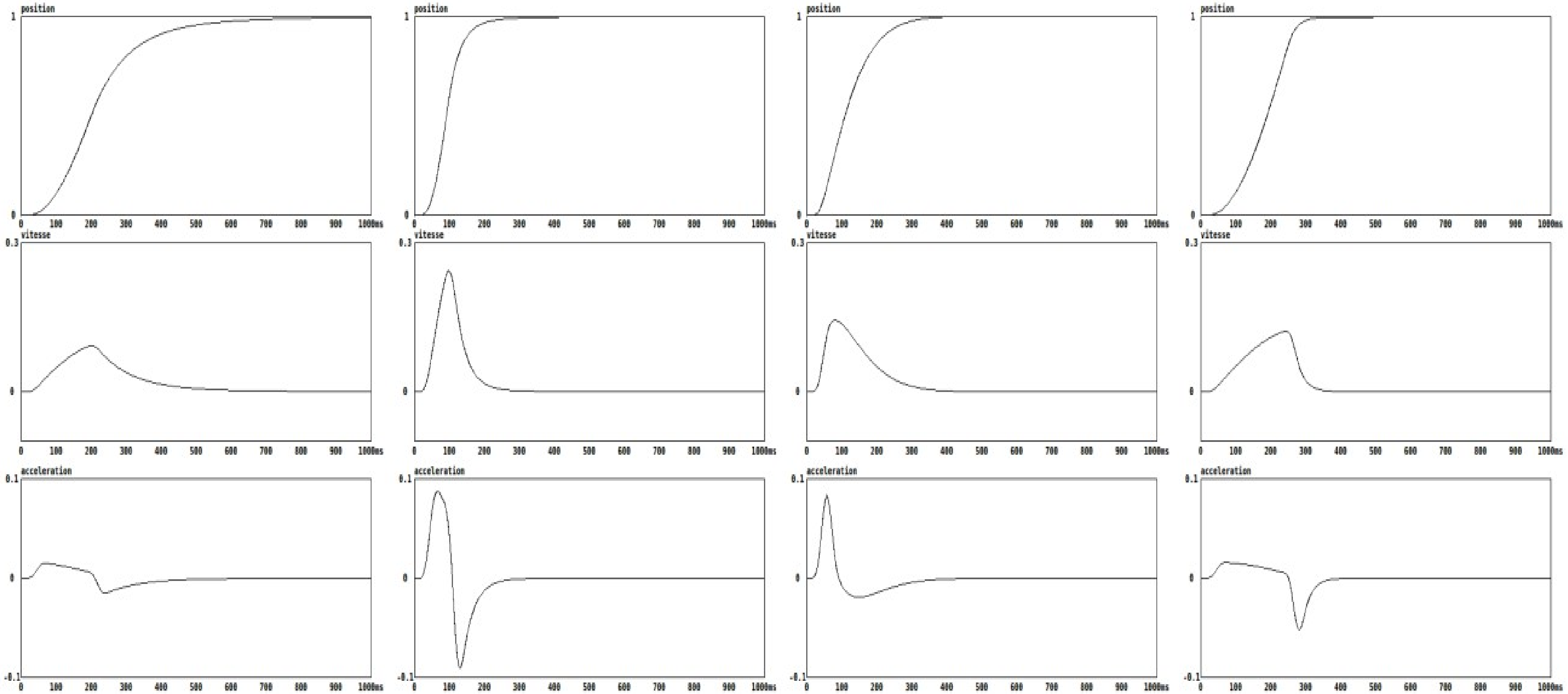




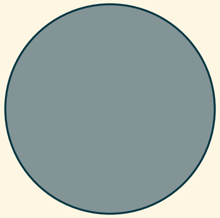
Mouvements naturels



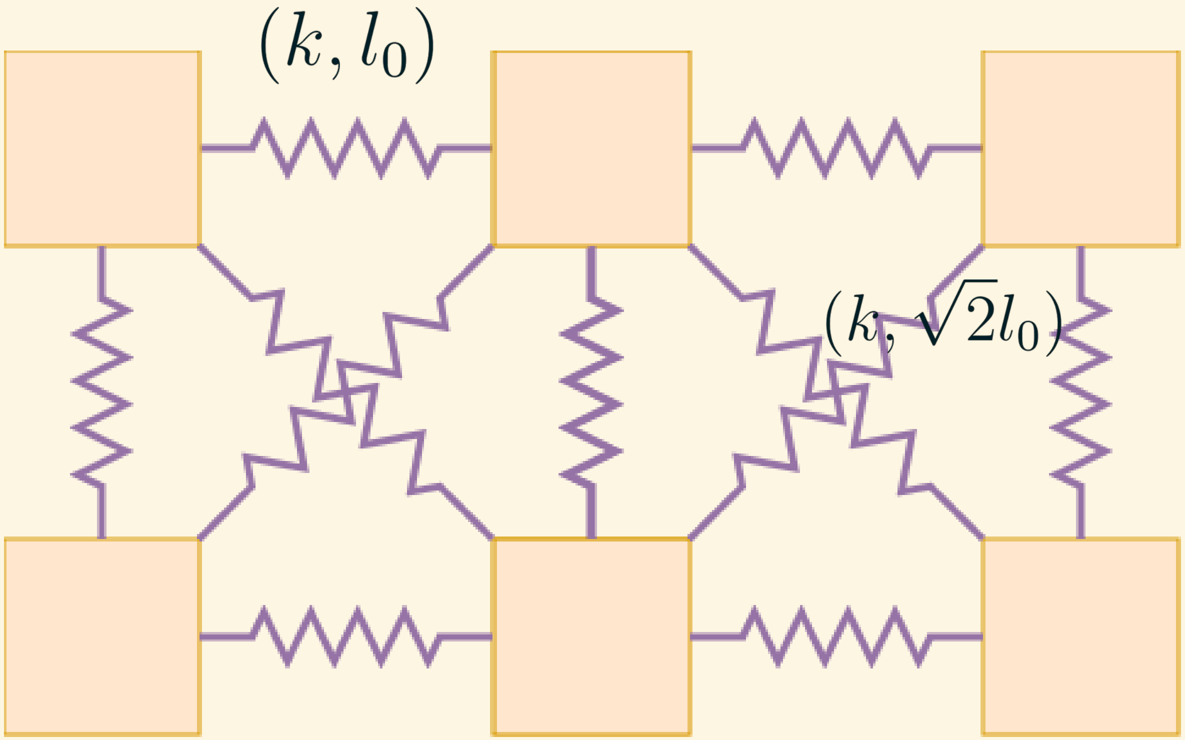
Mouvements type Système masse-ressort



Simplification



Structure du système

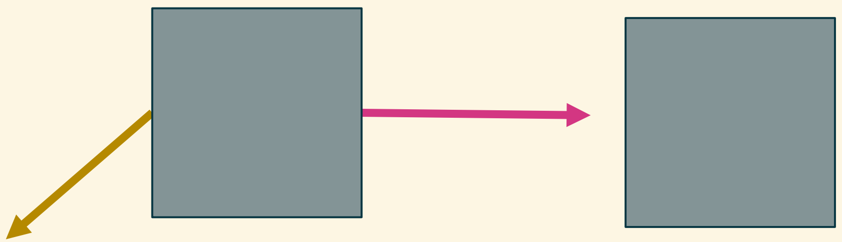


II. Réalisation

Méthode d'Euler

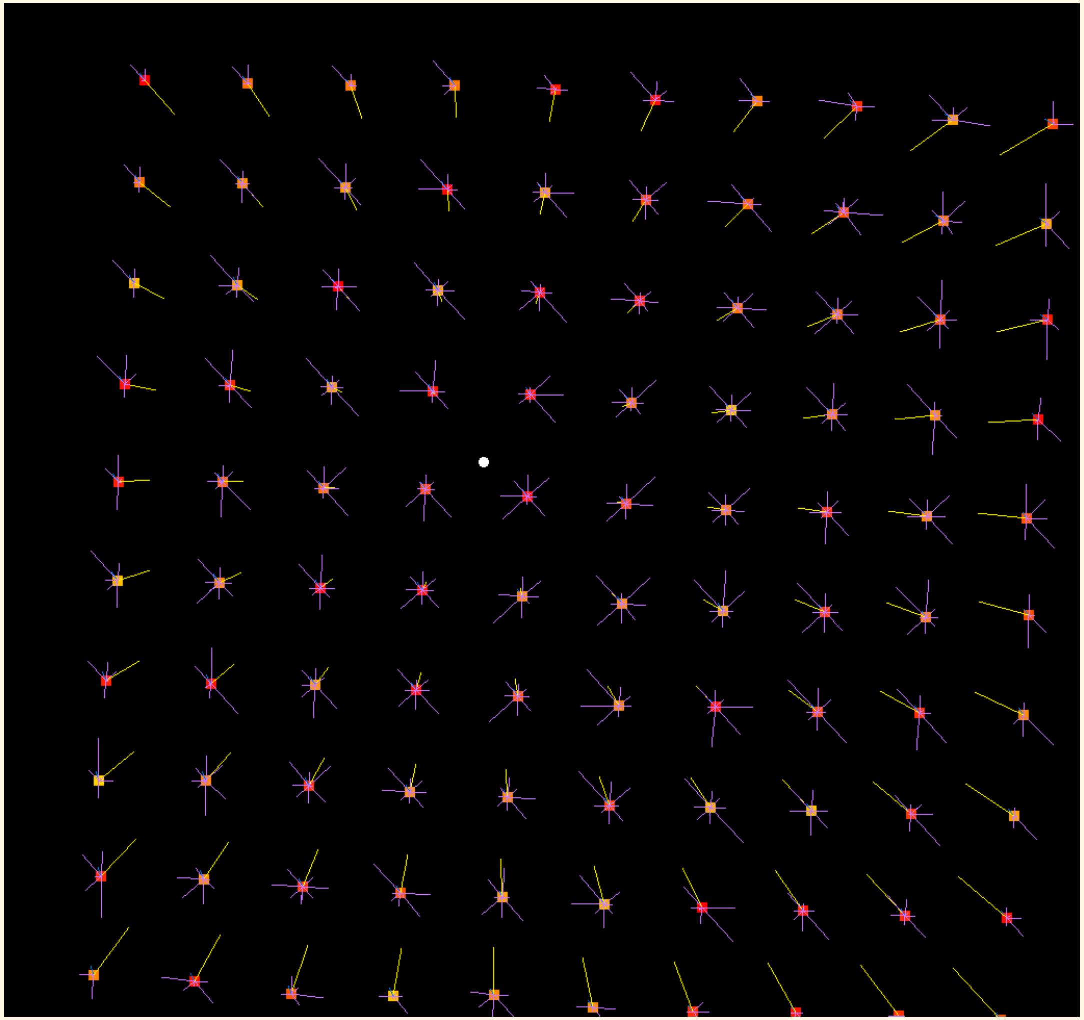
$$\vec{R} = k * (l - l_0)\vec{e_x}$$

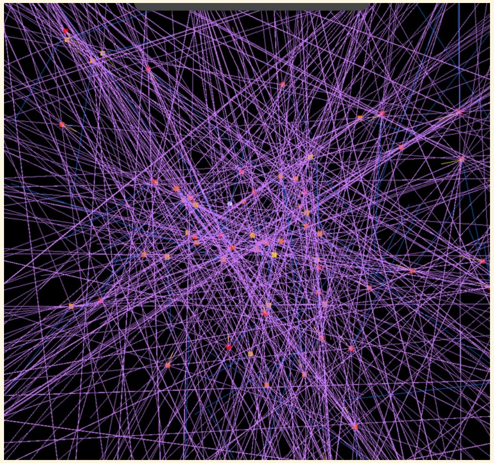
$$\vec{f} = -\alpha\vec{v}$$

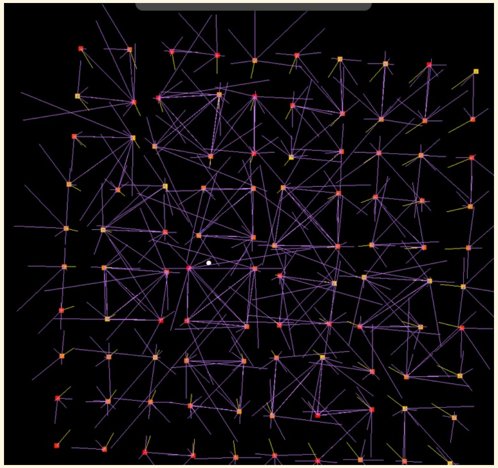


```
x[t + 1] = x[t] + v[t] * dt
v[t + 1] = v[t] + acceleration(t) * dt
```

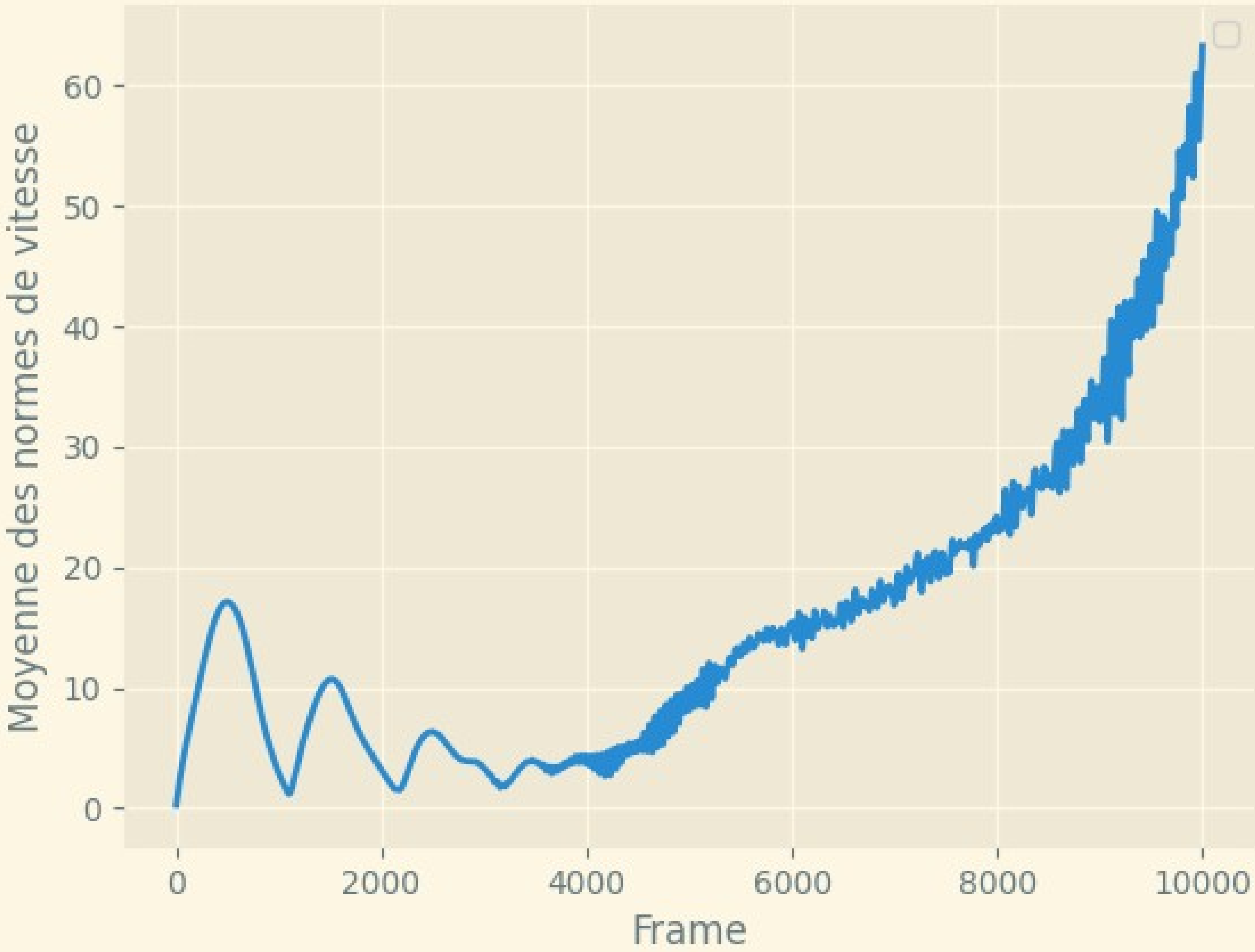
Premier algorithme





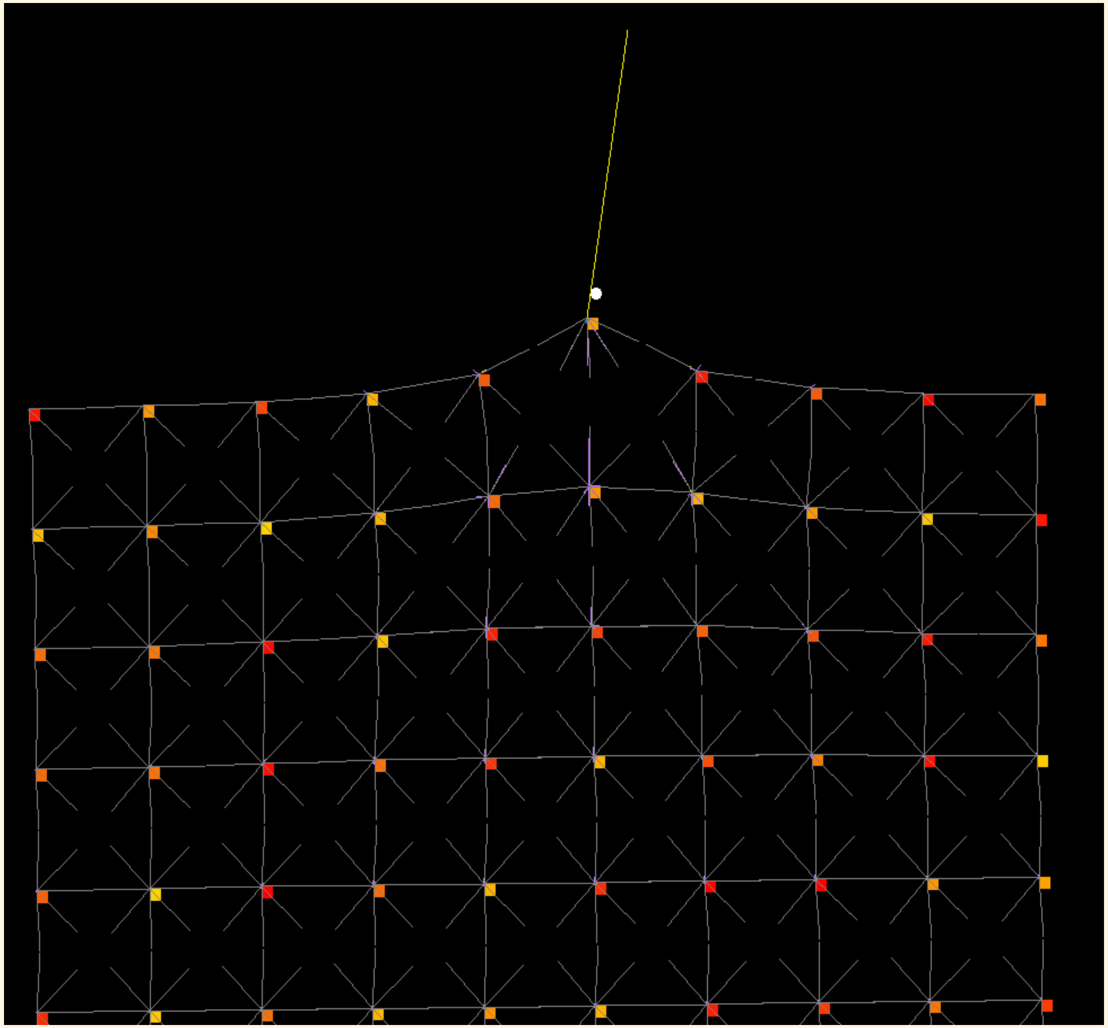


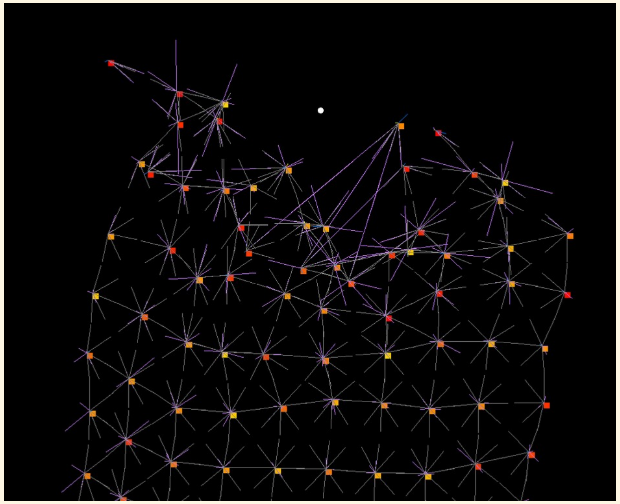
Premier résultat

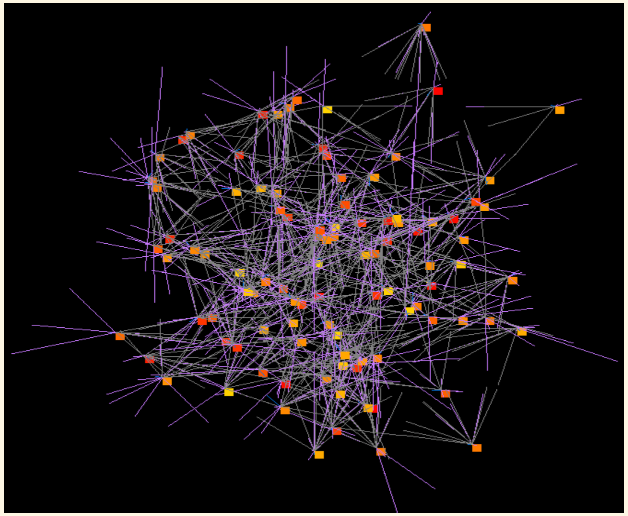


Méthode de Runge-Kutta

Expérimentation





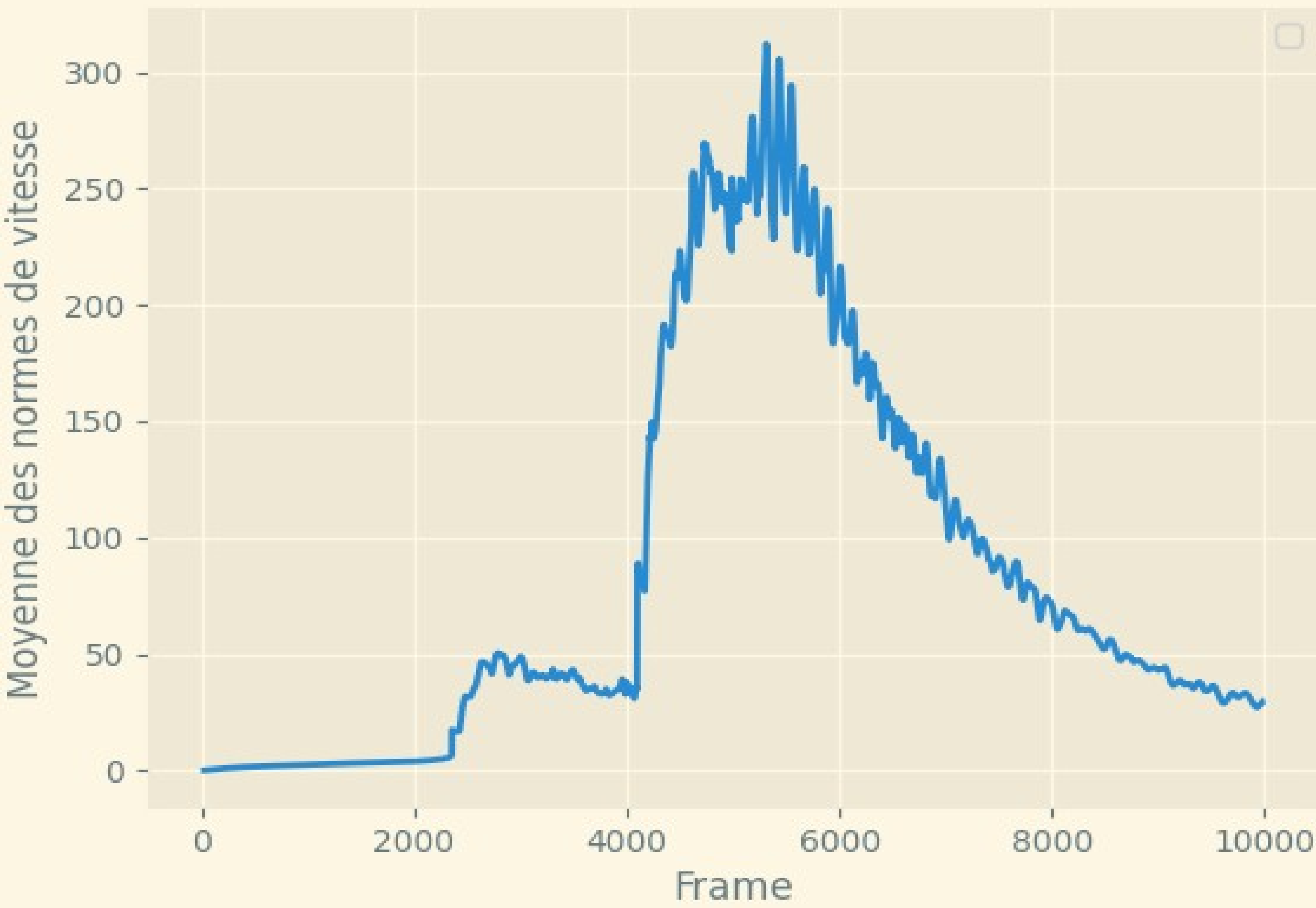


$$\begin{cases} y' = z \\ z' = f(t, y, z) \end{cases}$$

$$\text{Y' = F(t,Y), avec Y(t)} = \begin{pmatrix} y(t) \\ z(t) \end{pmatrix}, \text{ Y(t}_0\text{)} = \begin{pmatrix} y_0 \\ y'_0 \end{pmatrix}$$

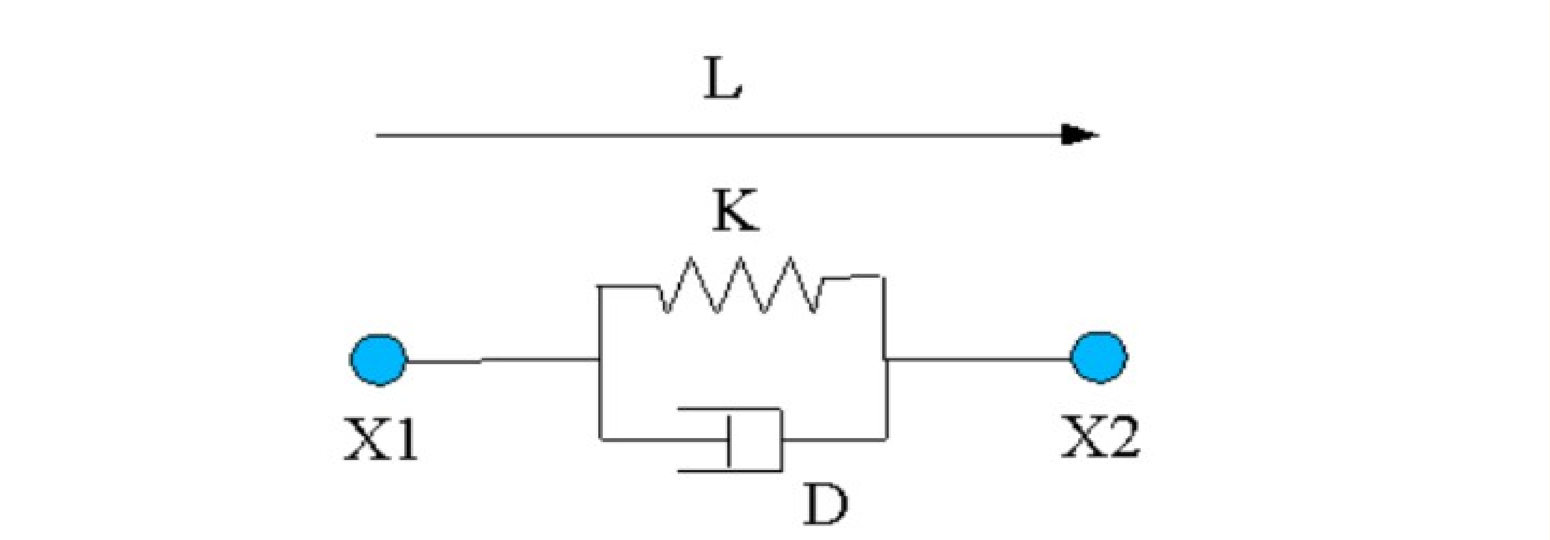
$$y'' = f(t, y, y'), \tag{1}$$

$$y(t_0) = y_0, \quad y'(t_0) = y'_0 \tag{2}$$

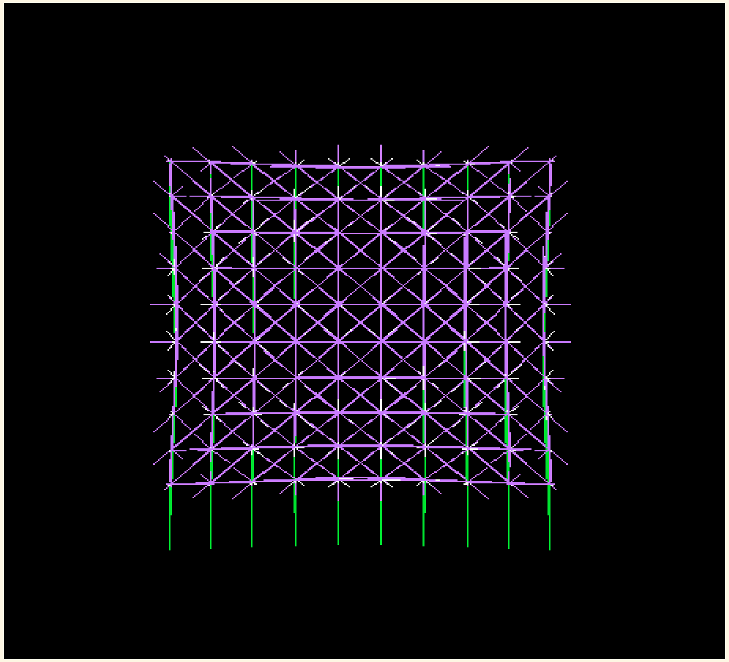


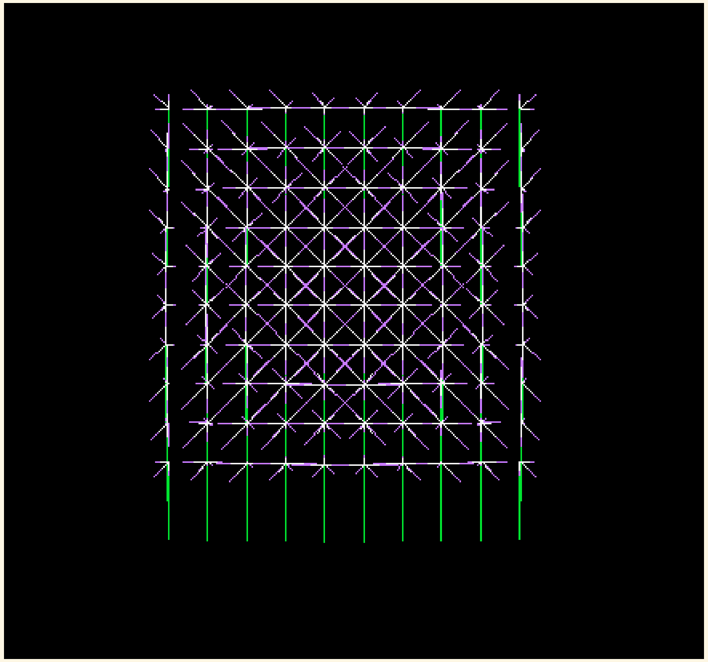
Moyenne des normes de vitesse
300
250
200
150
100
50
0
0
2000
4000
6000
8000
10000
Frame

Nouvelle description du système



Effet de respiration





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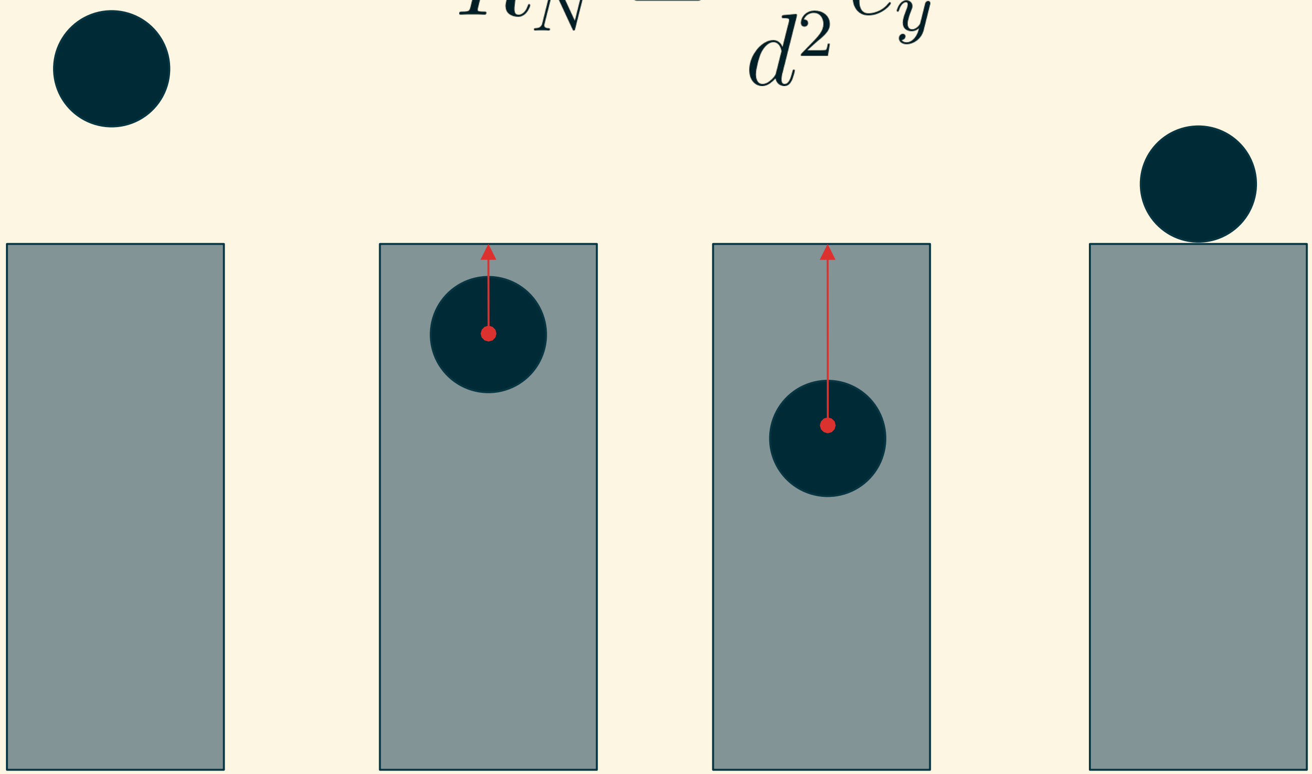
frottement du ressort

force de ressort élastique

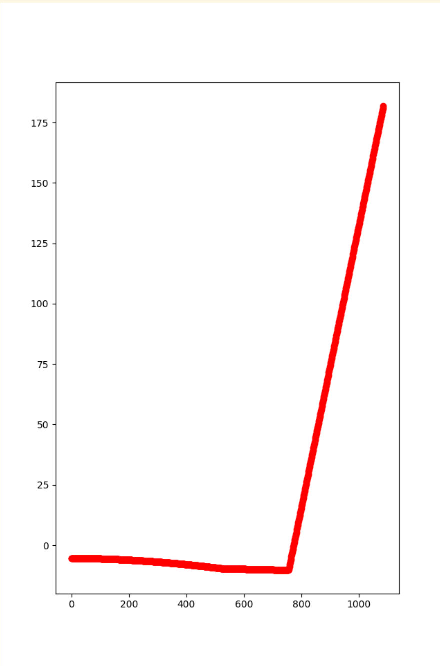
Collisions

Collision “magnétique”

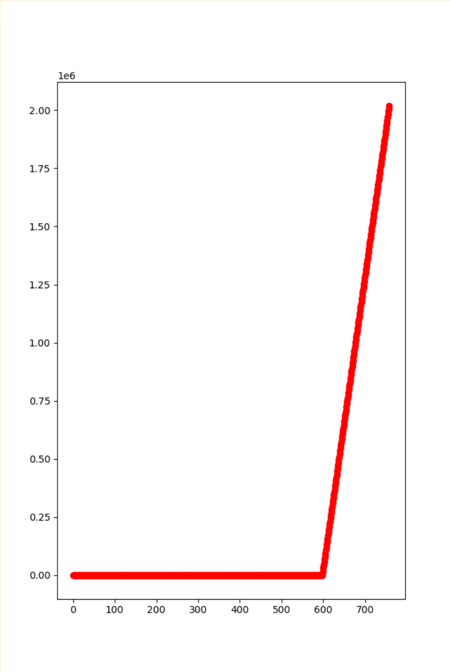
$$\vec{R_N} = \frac{K}{d^2}\vec{e_y}$$



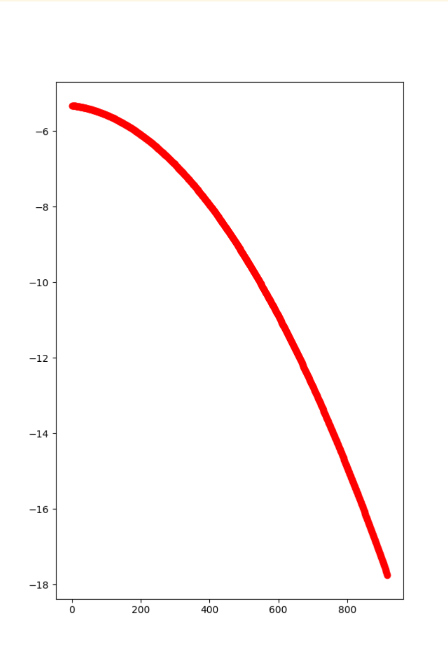
Résultats pour différentes valeurs de K



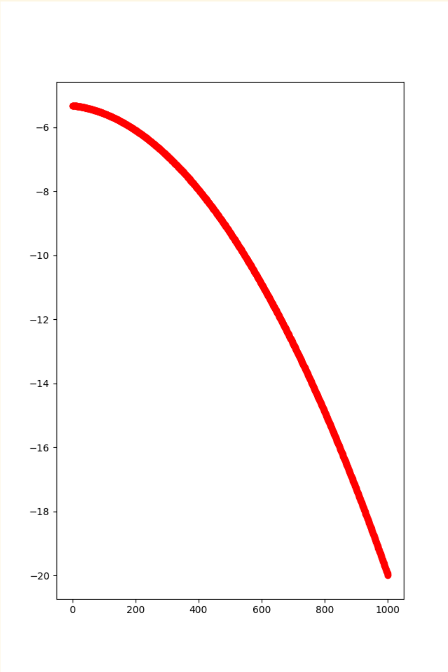
$K = 1.0$



$K = 1.0e - 1$



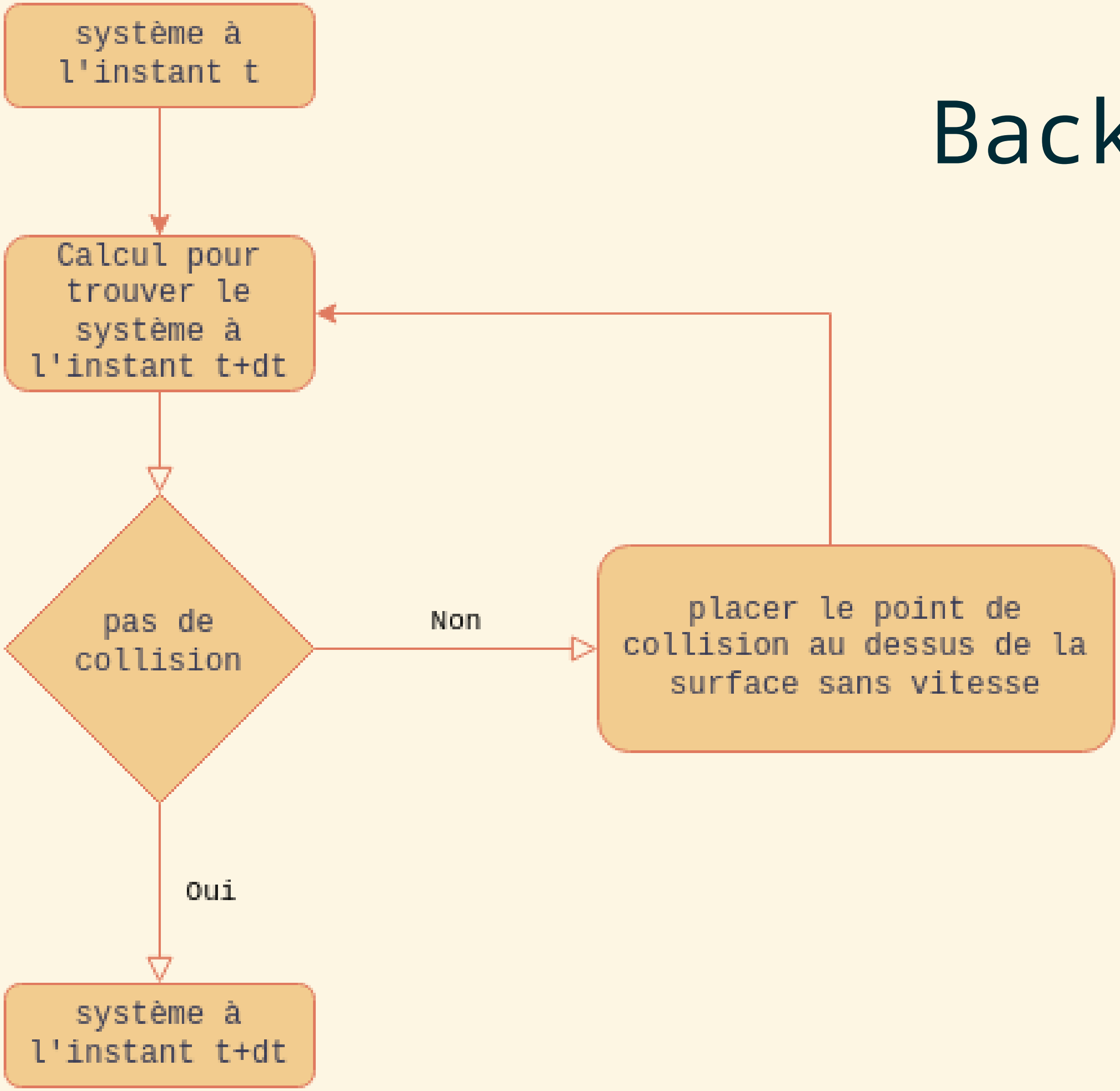
$K = 1.0e - 2$



$K = 1.0e - 4$

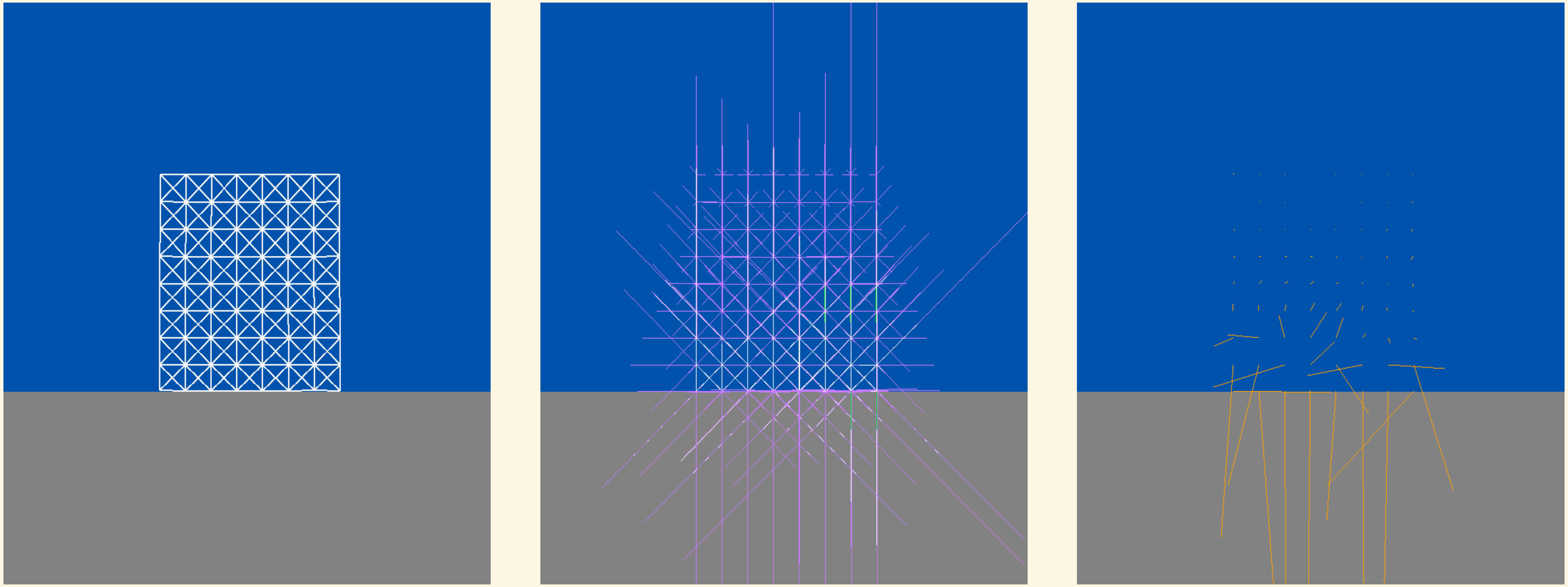
Position moyenne verticale en fonction du temps

Backtracking



forces

accélération



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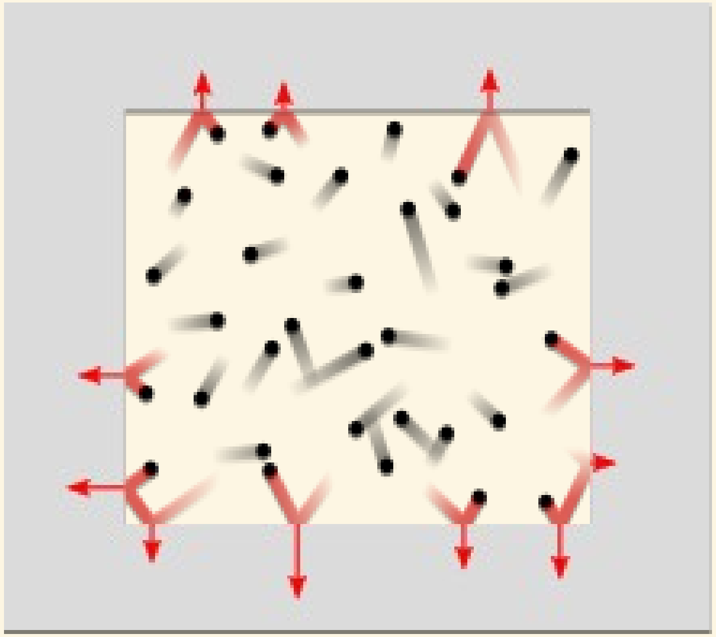
frottement du ressort

force de ressort élastique

Problèmes :
Nombreux calculs de replacement
Imprécision sur les points à la surface

III. Deuxième approche

Modèle du gaz parfait



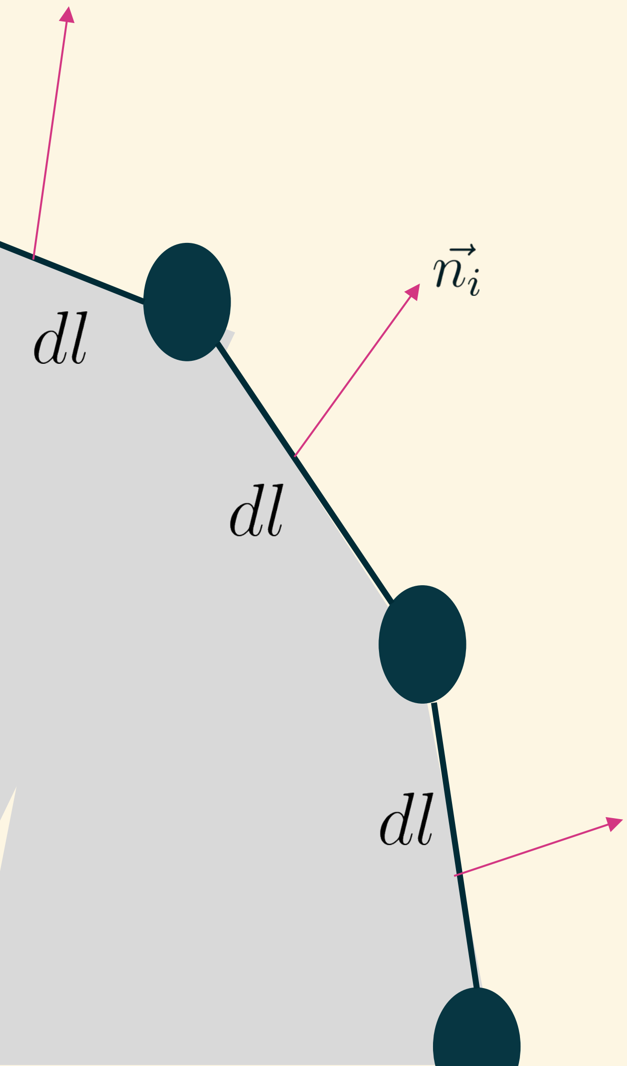
$$\vec{F} = P d\vec{S}$$

$$P = \frac{nRT}{V}$$

$$\vec{F} = K_{nRT} \frac{1}{V} d\vec{S}$$

Calcul du volume

Théorème de Stokes :



$$\boxed{\iint_S \mathrm{div}\vec{F}\cdot d\vec{S} = \oint_C \vec{F}\cdot\vec{dl}}$$

$$\vec{F} = x\vec{e_x}$$

$$\mathrm{div}\vec{F} = 1$$

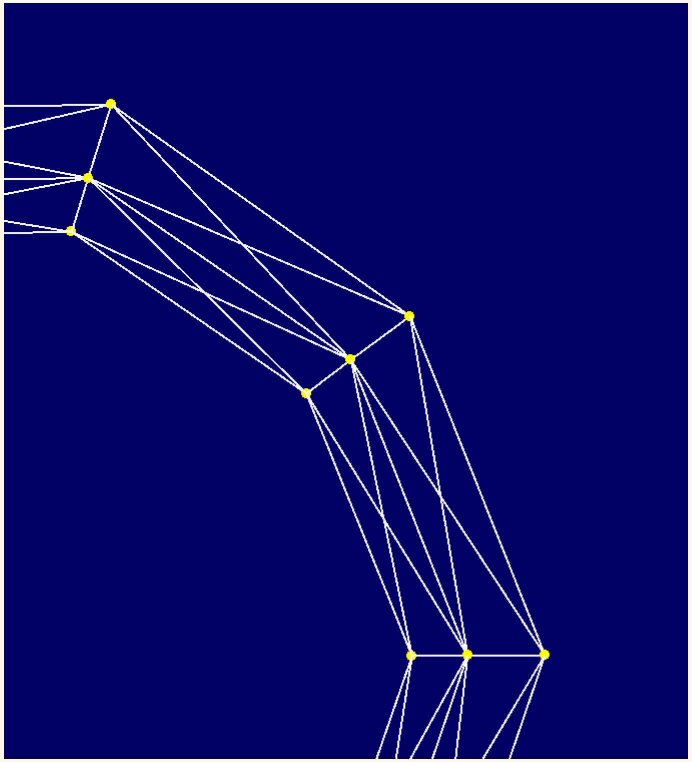
$$\vec{F}\cdot\vec{dl}$$

$$= \vec{F}\cdot\vec{n}dl$$

$$= x \cdot n_x \cdot dl$$

$$S \approx \sum x_i \cdot n_i \cdot dl$$

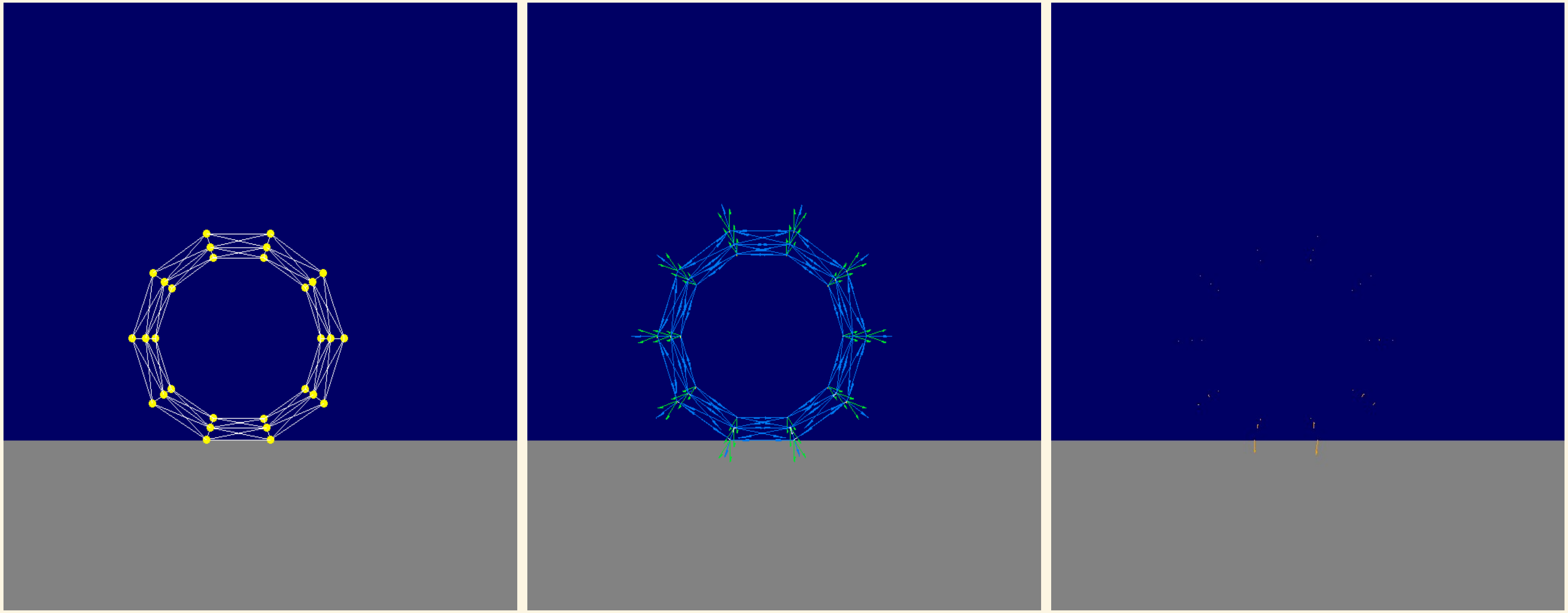
Compromis ressort/gaz



Résultat

forces

accélération



gaz

gravité

force de ressort élastique

Améliorations possibles