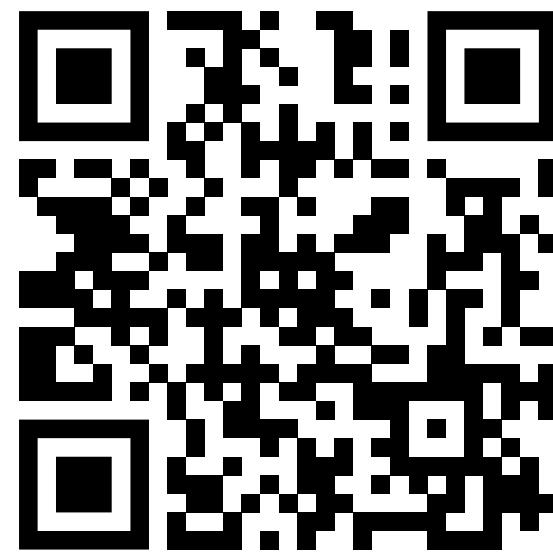


# Nonlinear Dynamics

Final Presentation

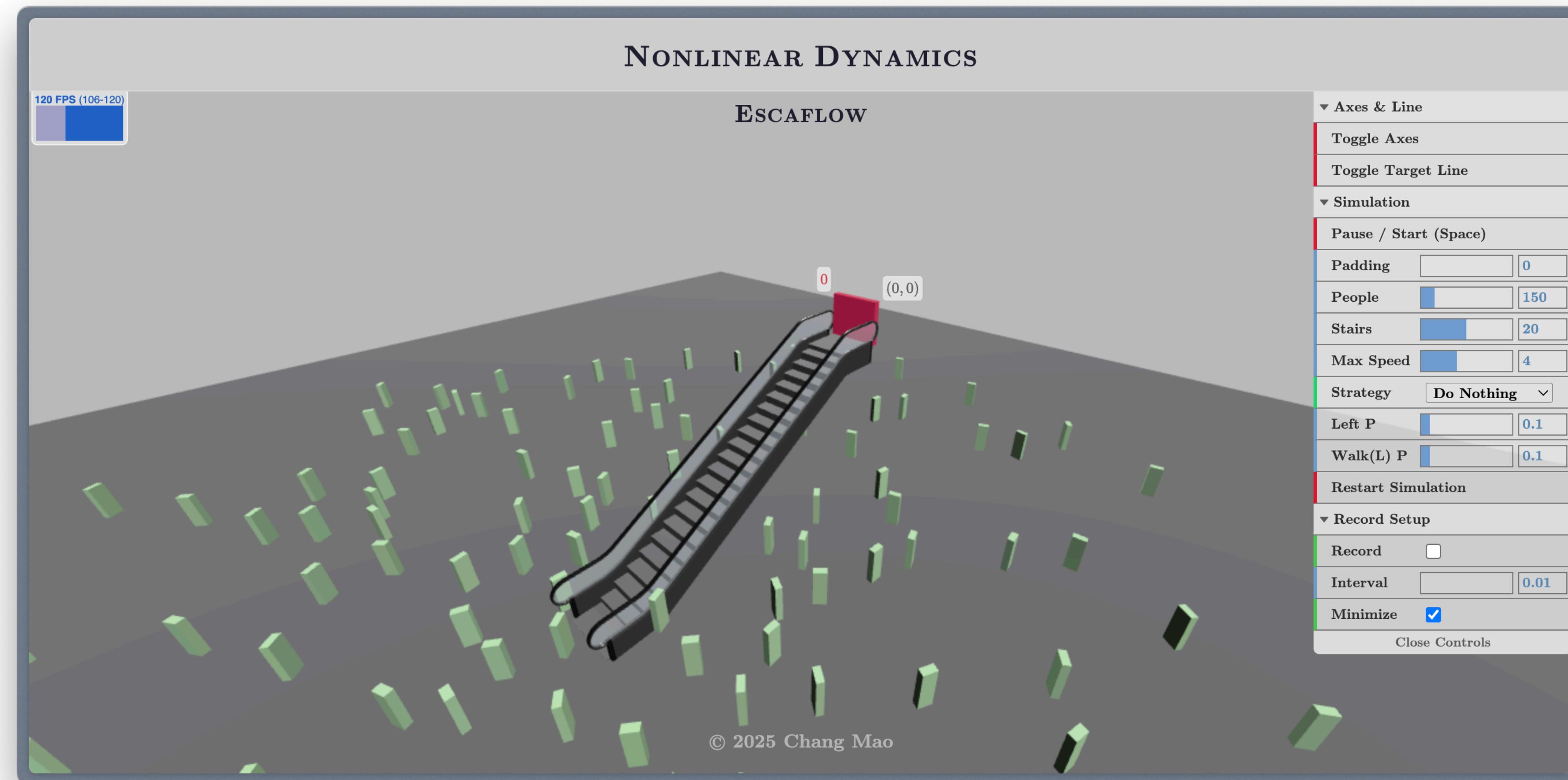
Human Flow on Escalator (EscaFlow)

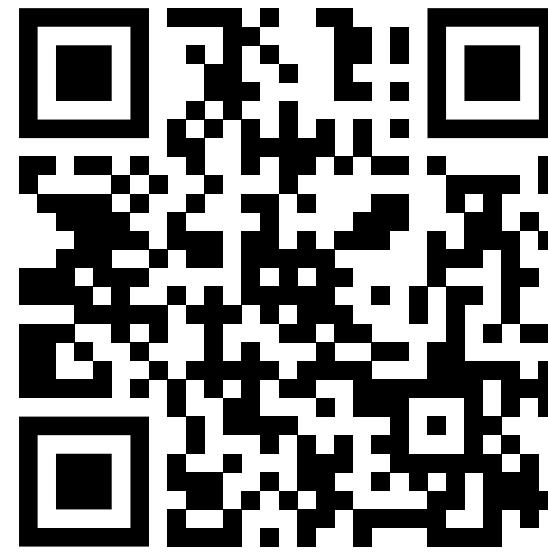
Chang-Mao Yang (楊長茂)



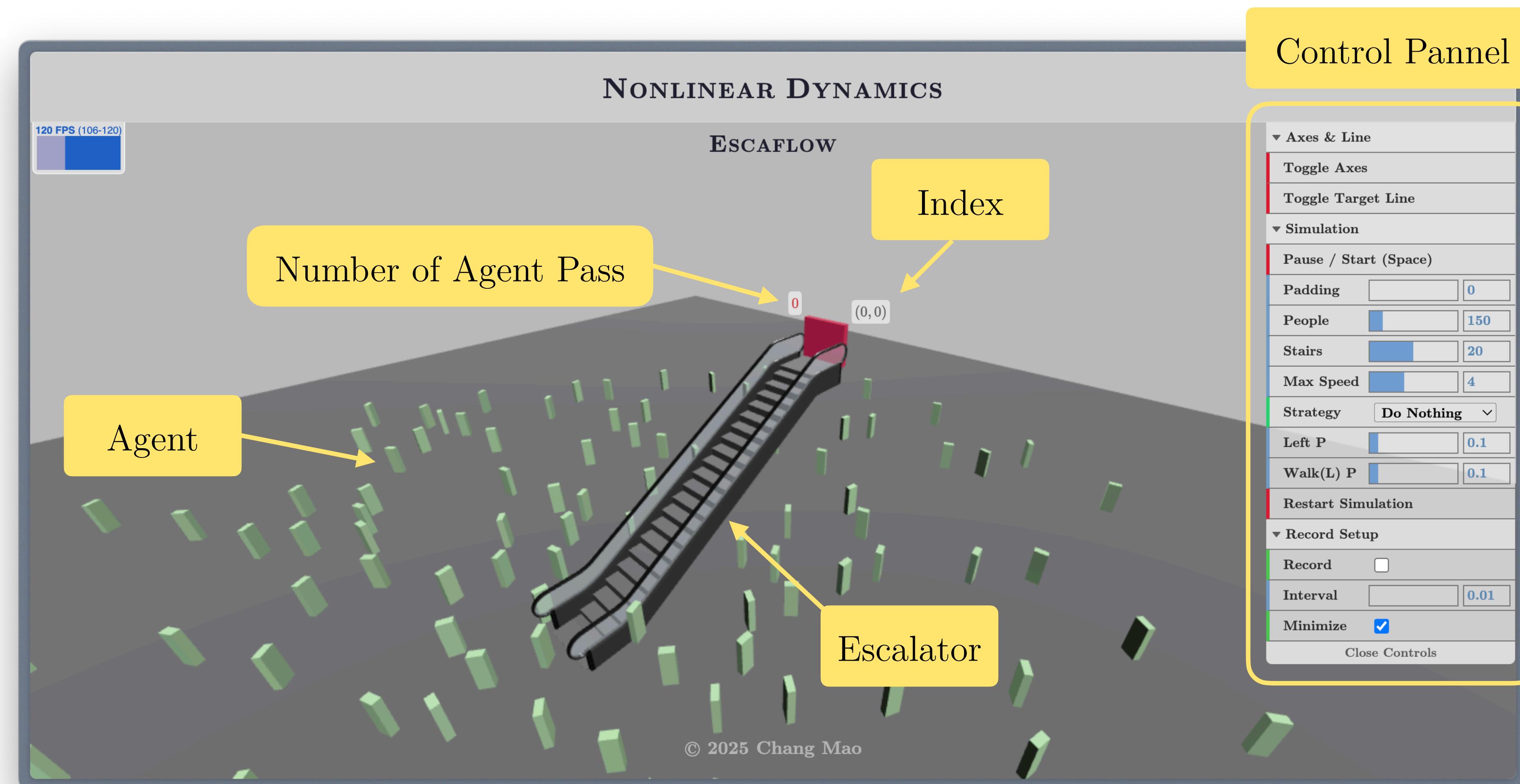
# 1. Introduction

<https://changmao.app/escaflow>

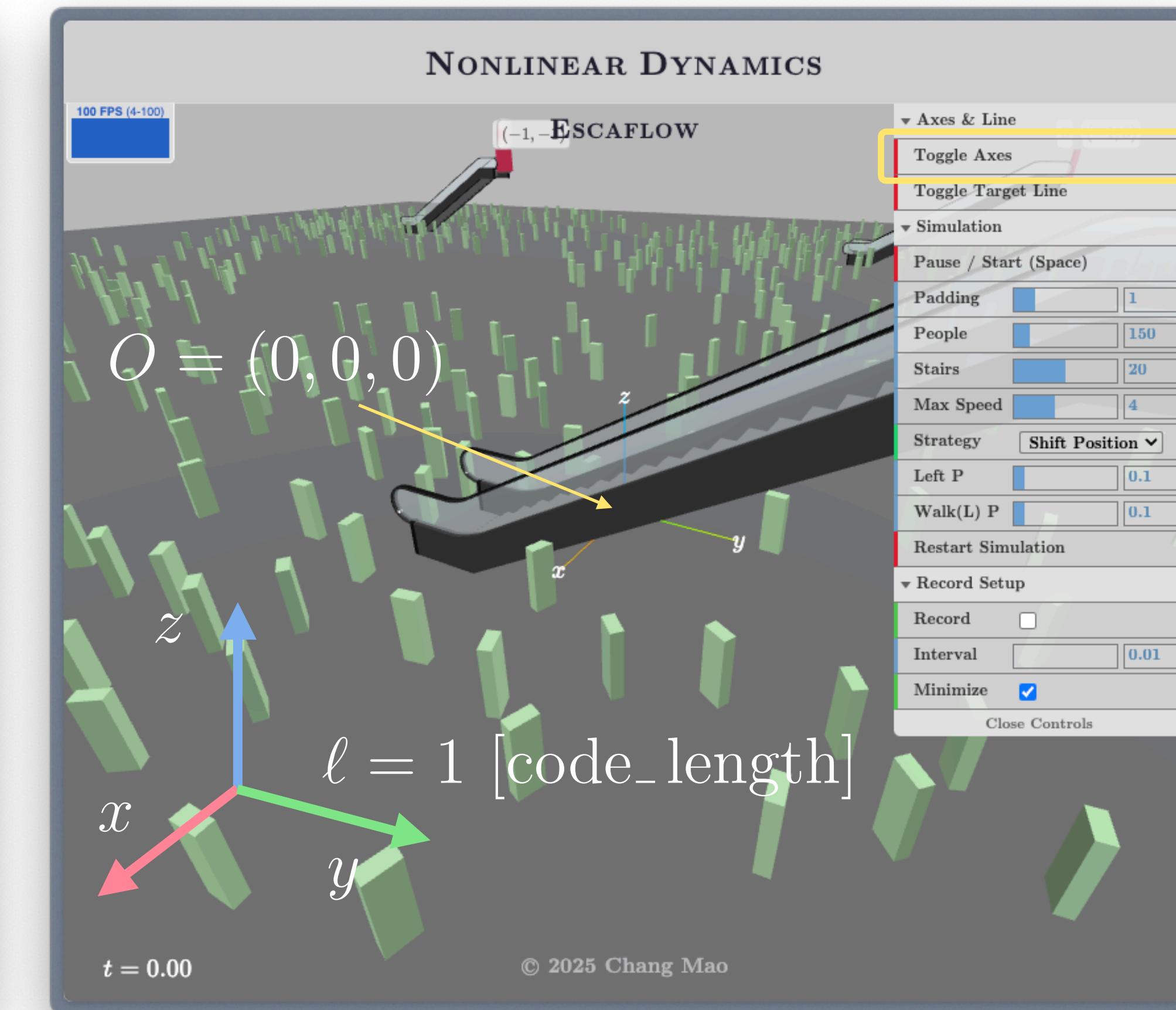
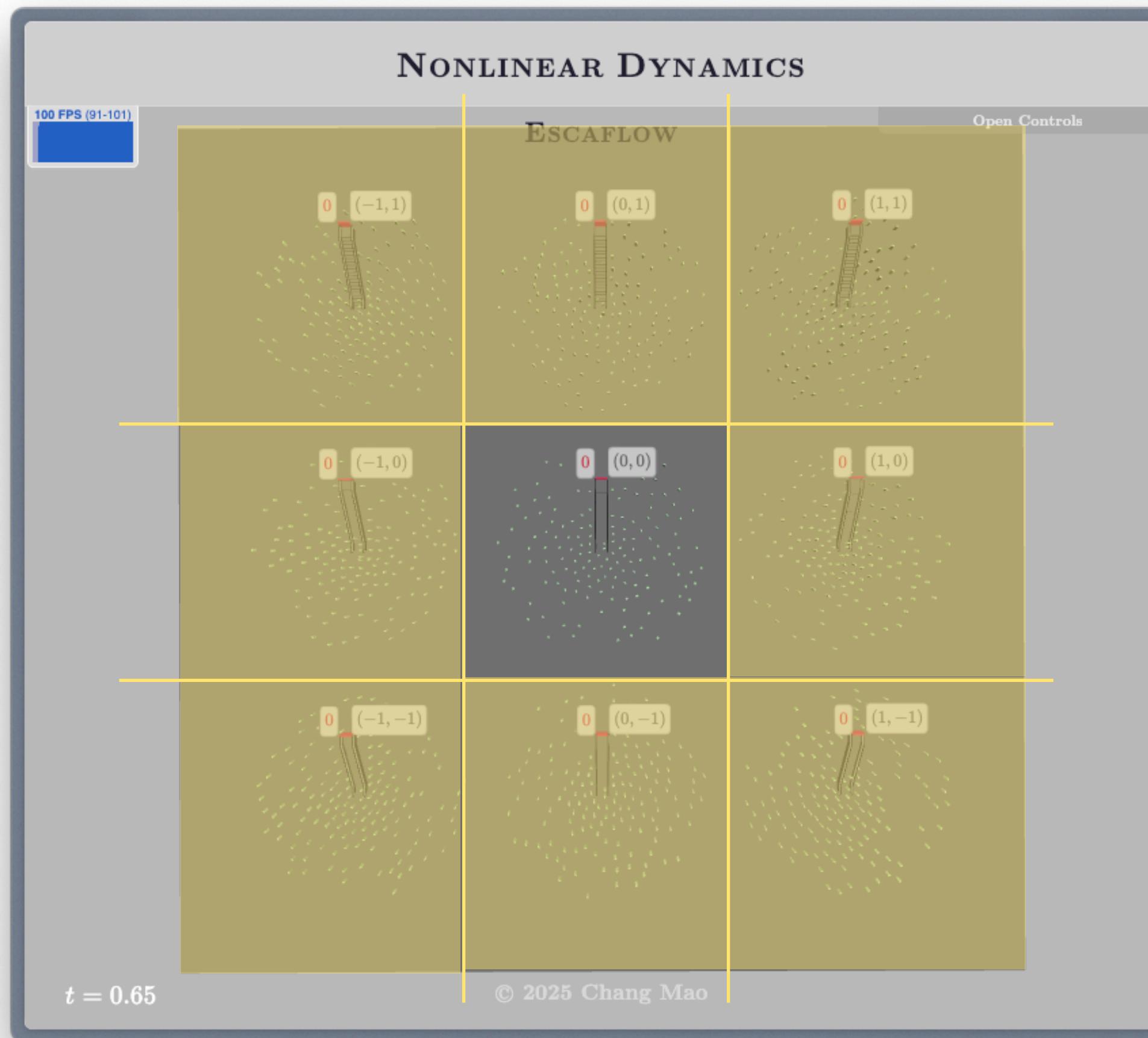




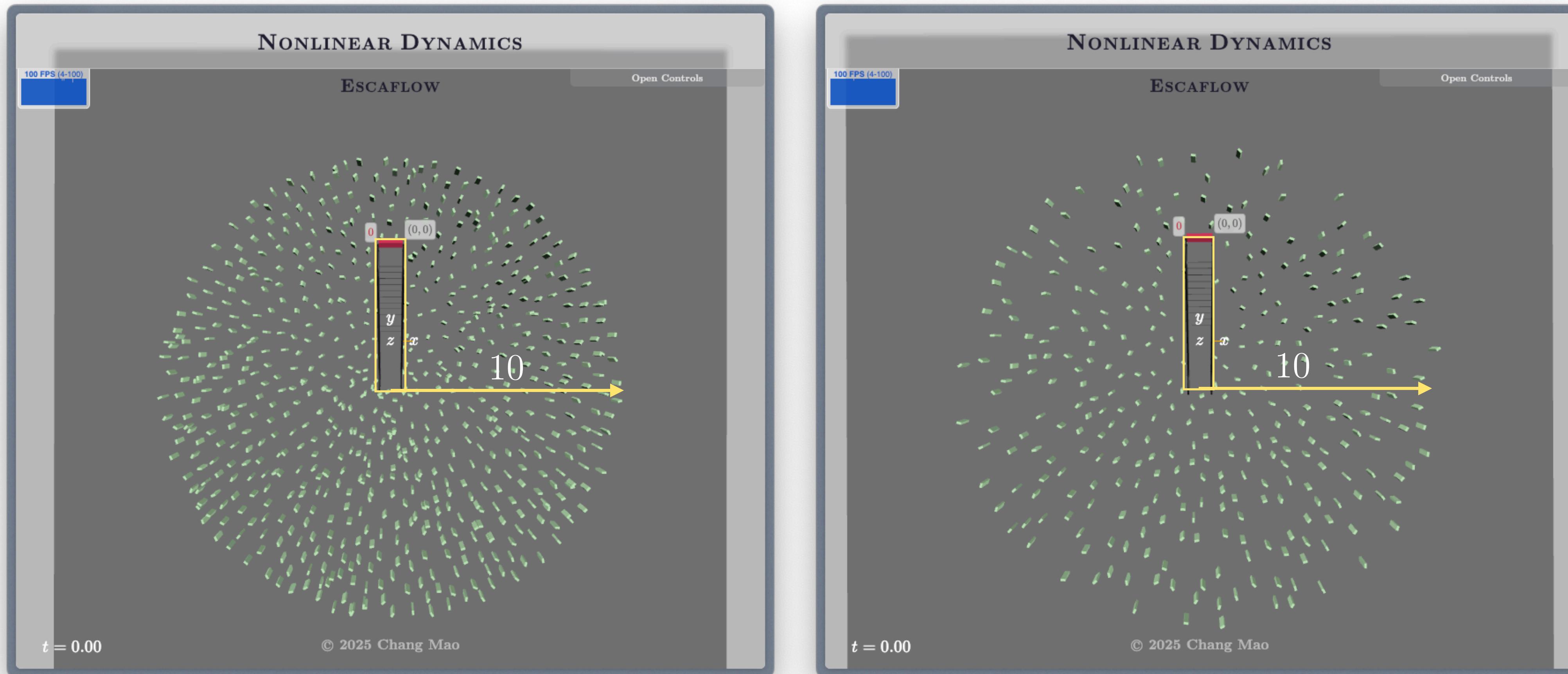
# 1. Introduction



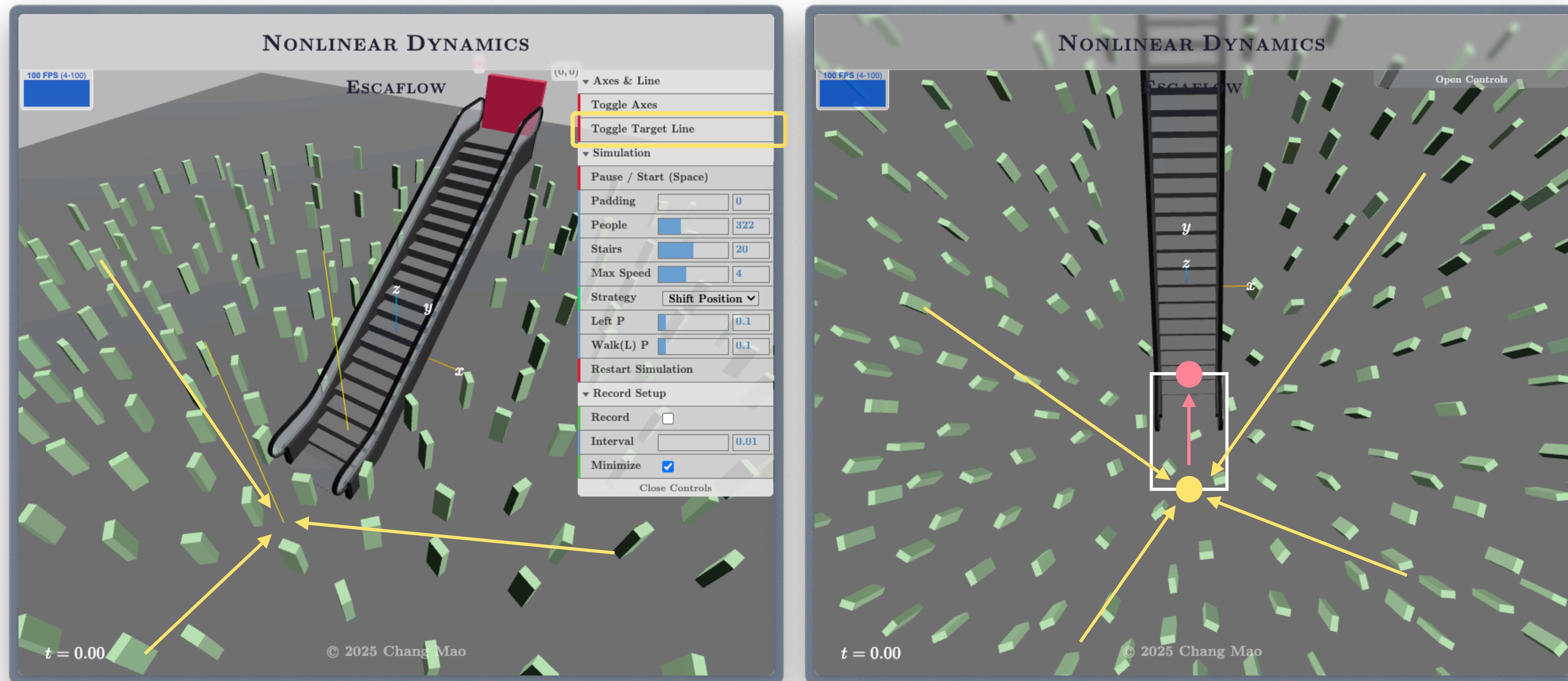
## 2. Method



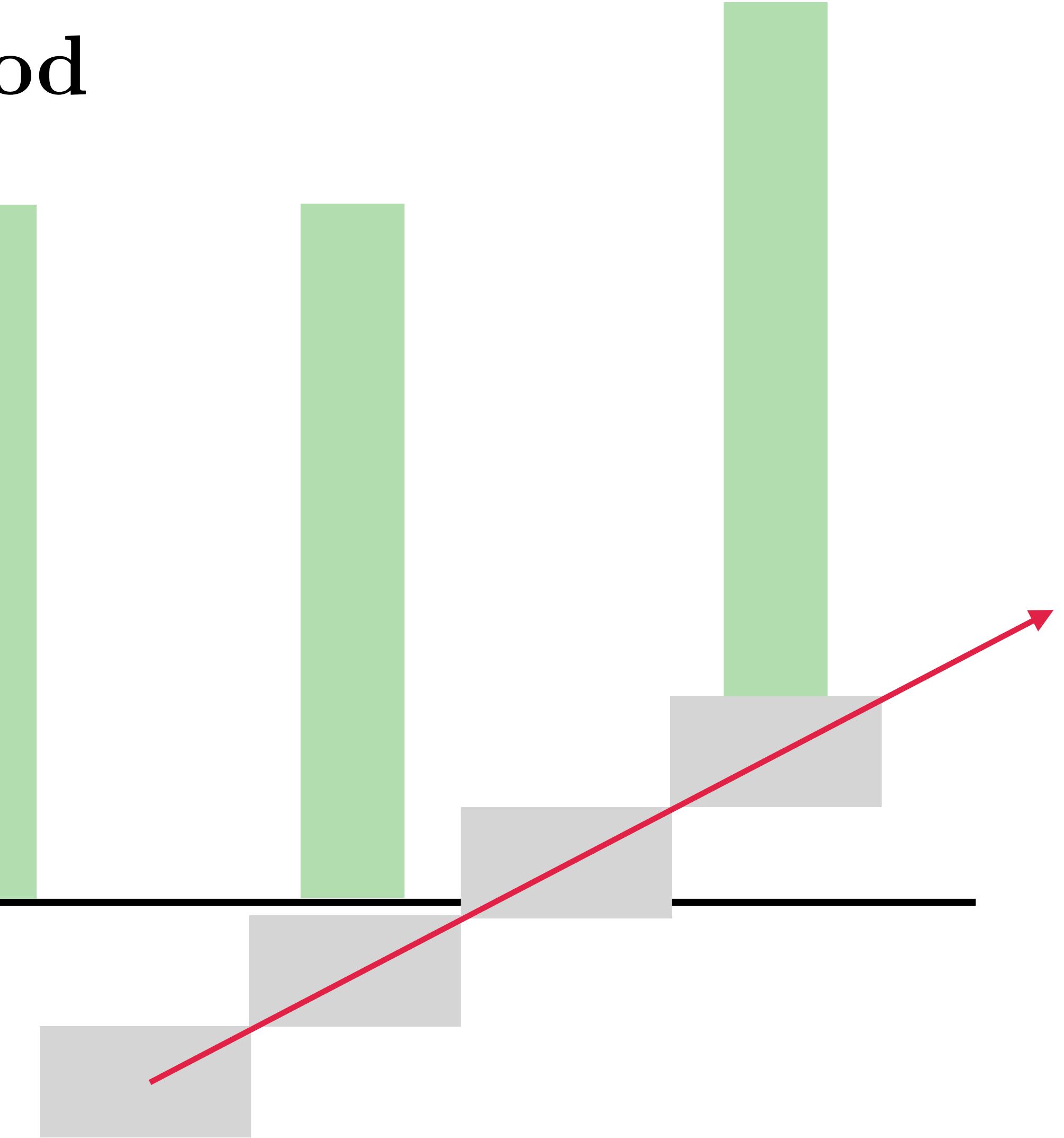
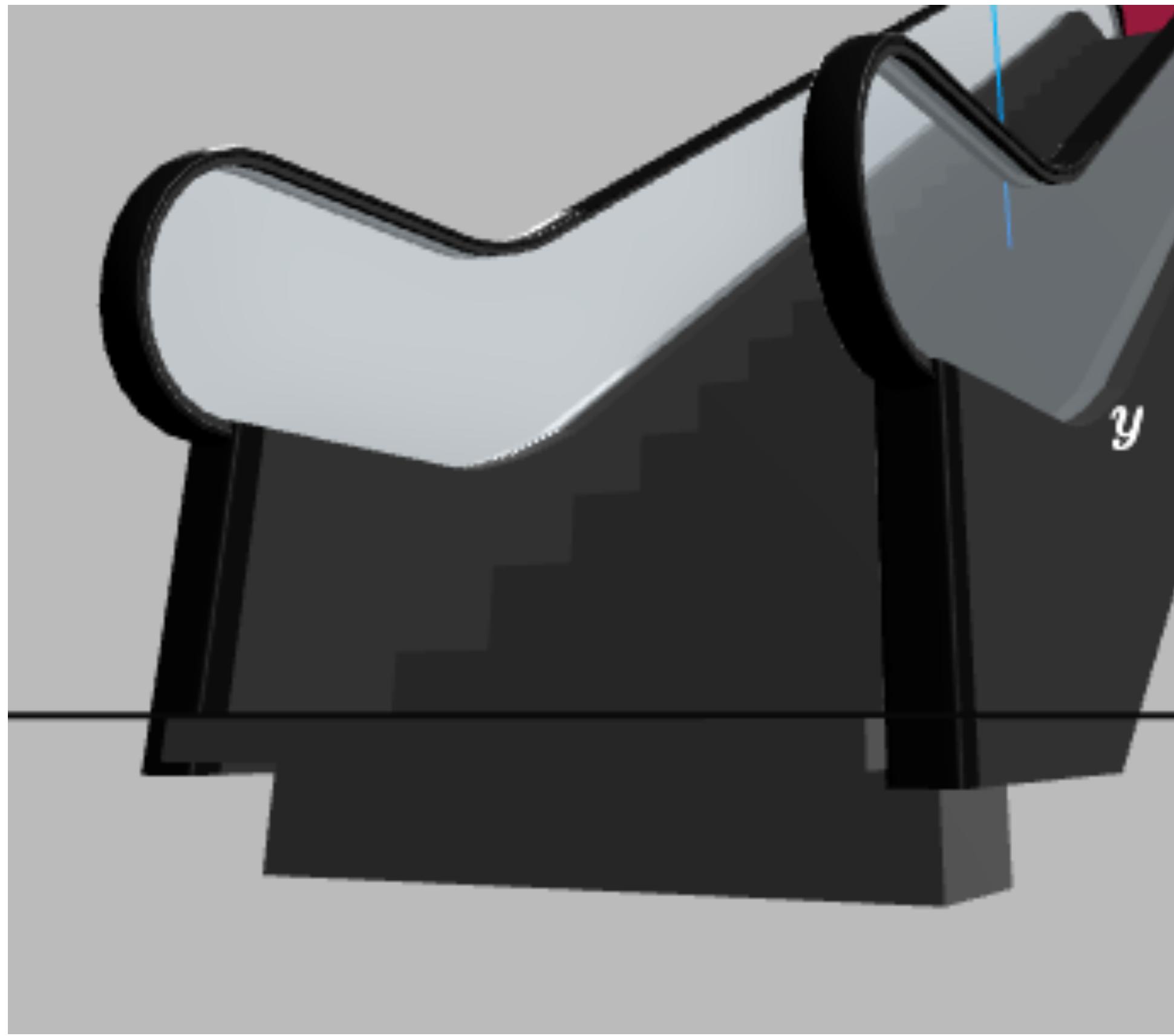
## 2. Method



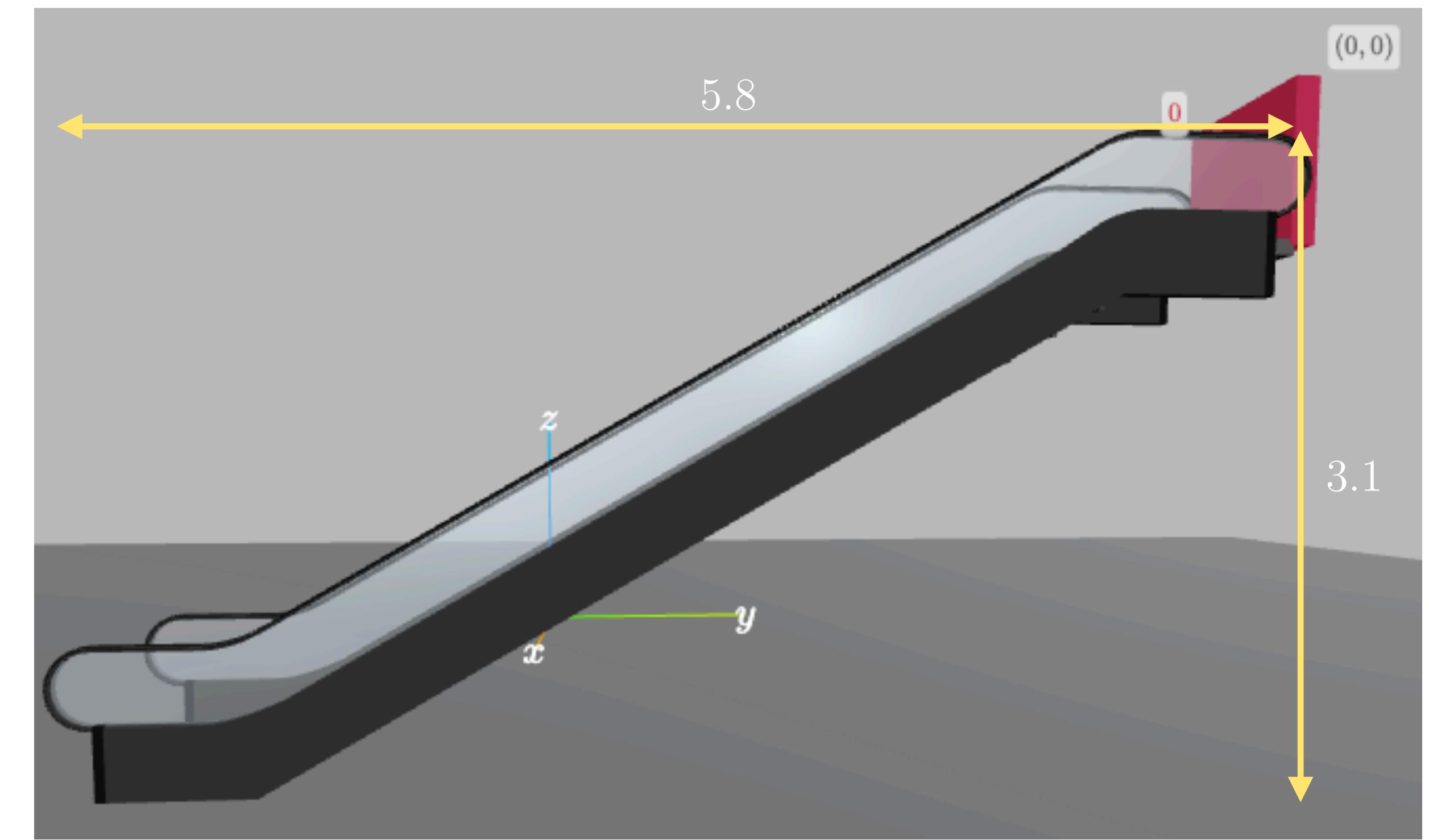
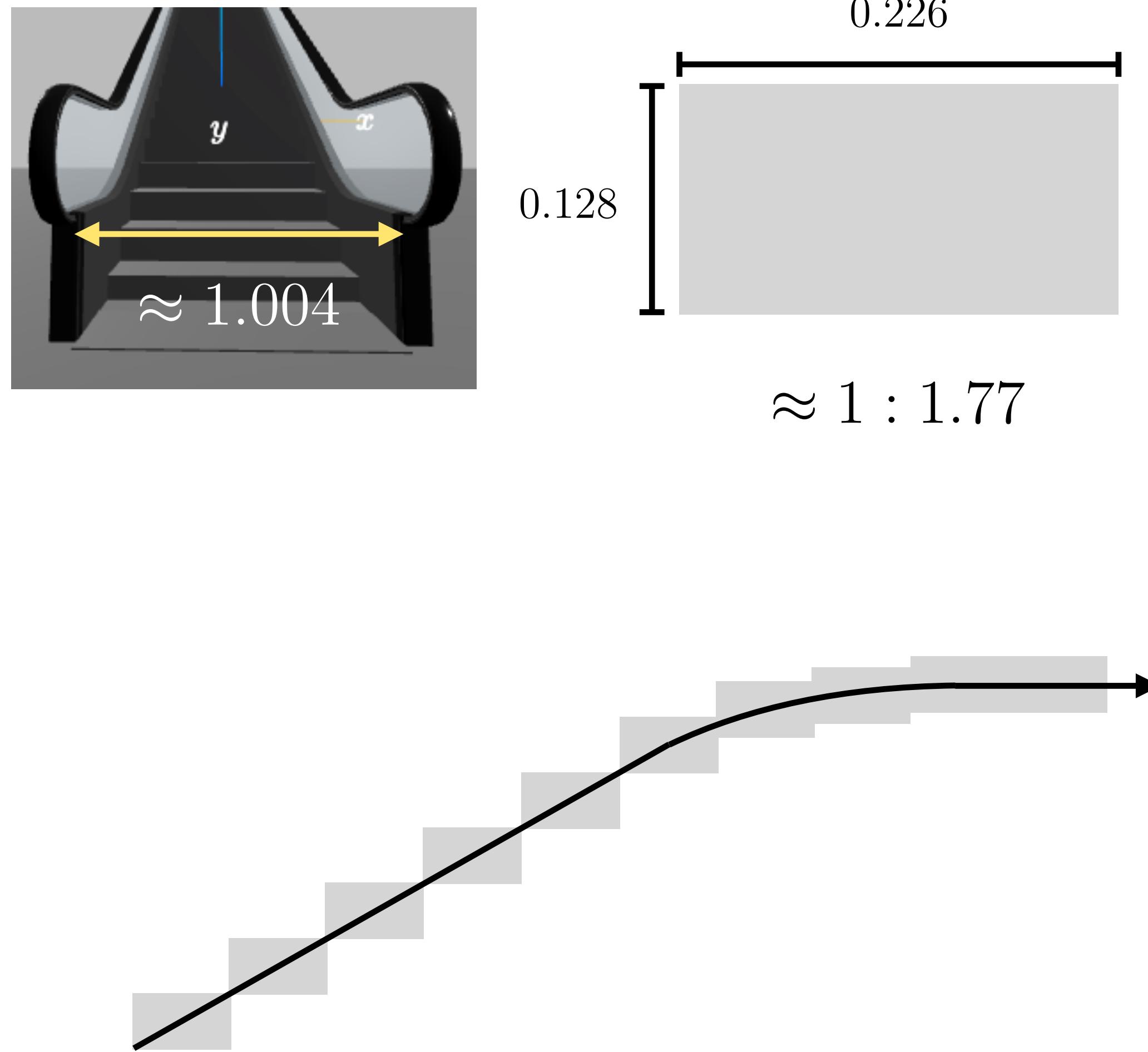
## 2. Method



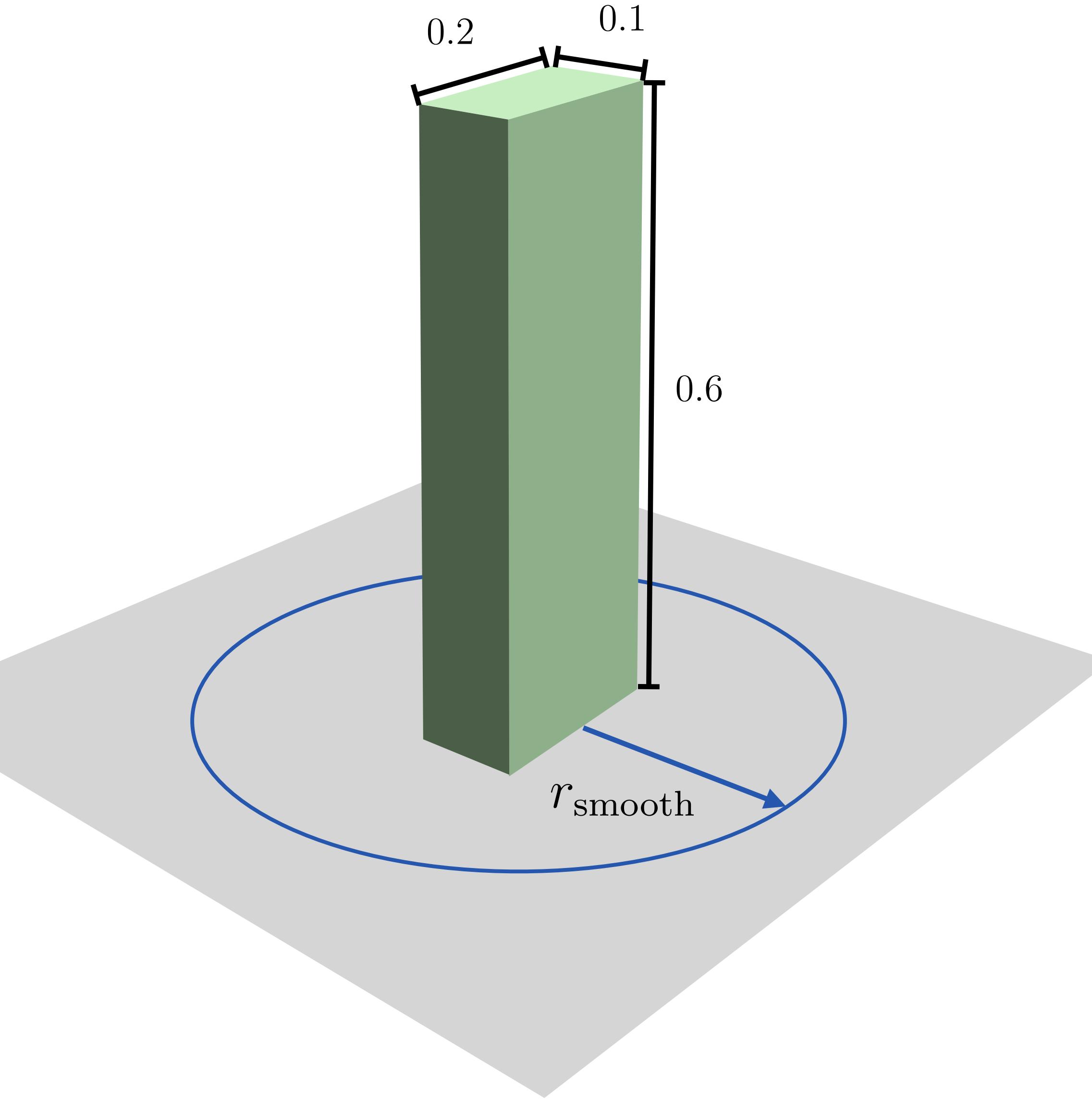
## 2. Method



## 2. Method

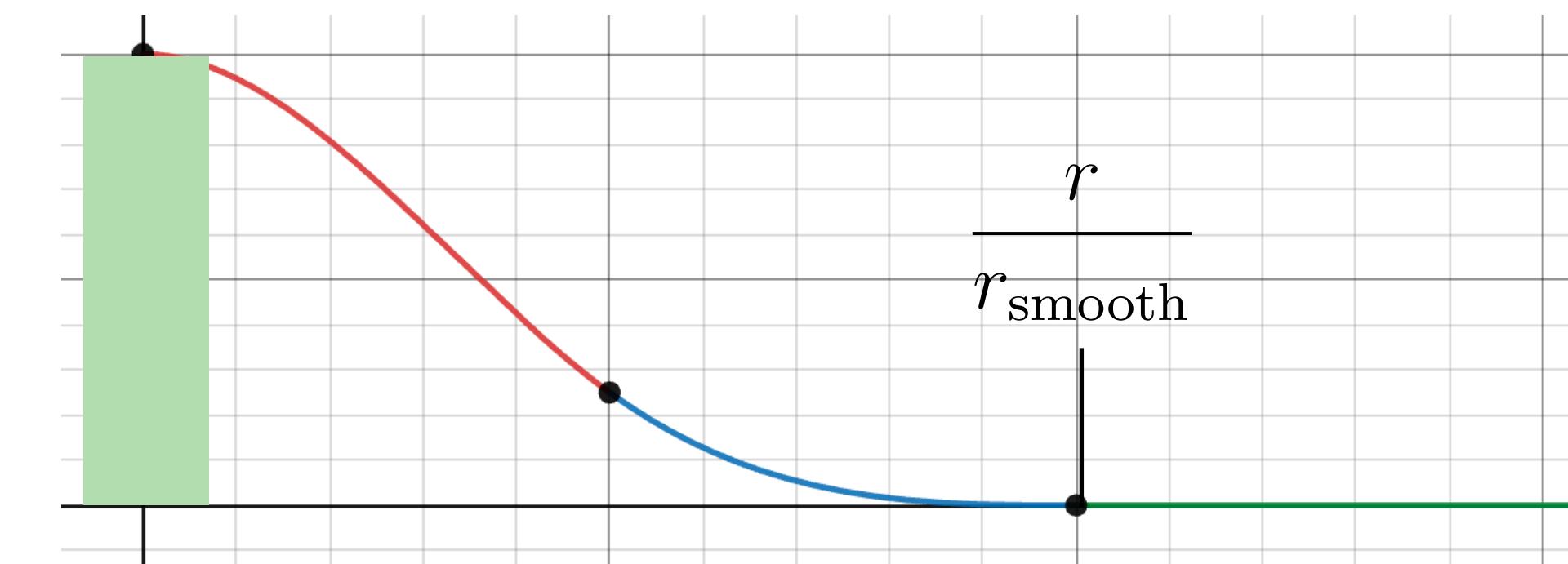


## 2. Method

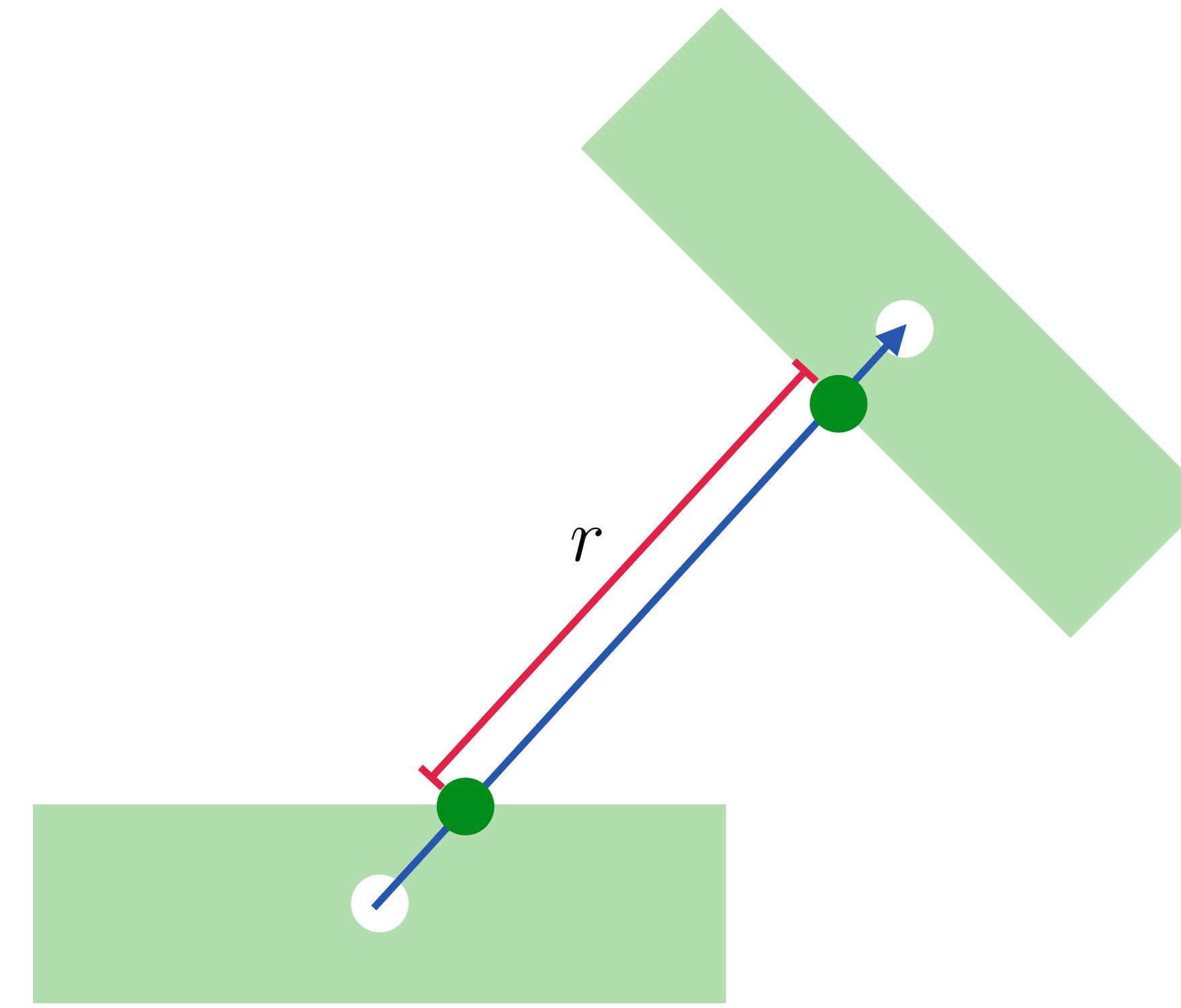
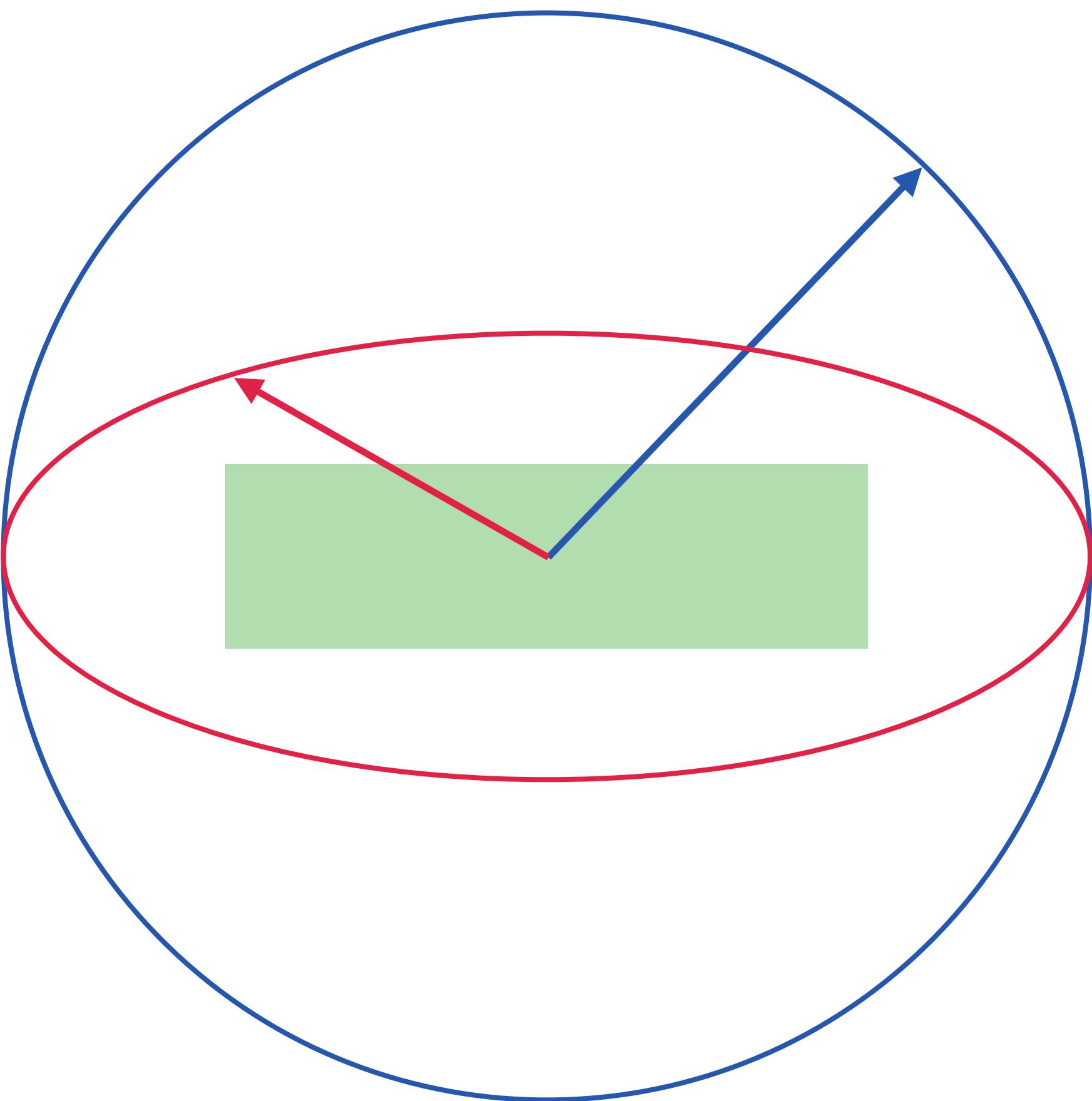


- Position  $(x, y, z)$
- Velocity  $(v_x, v_y, v_z)$
- Smooth Radius  $r_{\text{smooth}} = 9 \times \max(0.1, 0.2)$

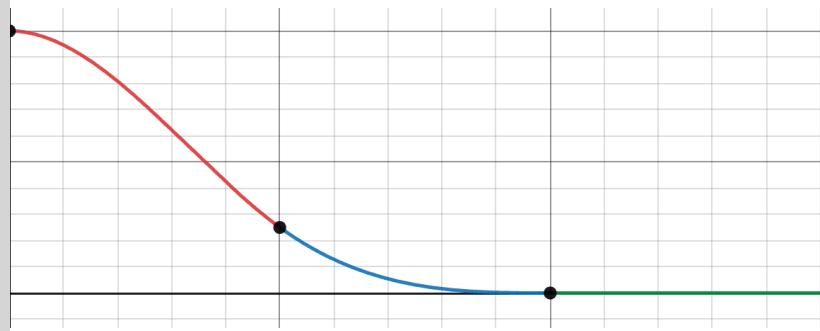
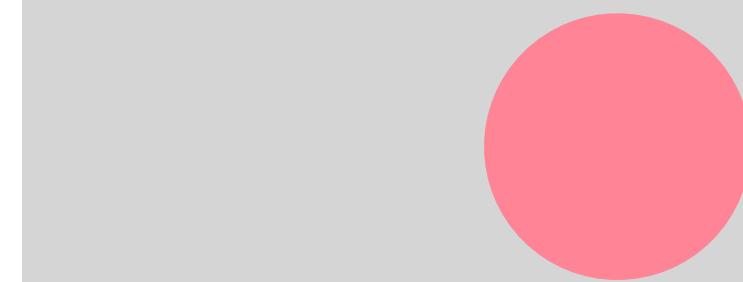
$$W(r) = \begin{cases} 1 - 6 \left(\frac{r}{r_{\text{smooth}}}\right)^2 + 6 \left(\frac{r}{r_{\text{smooth}}}\right)^3, & 0 \leq \frac{r}{r_{\text{smooth}}} \leq \frac{1}{2}, \\ 2 \left(1 - \frac{r}{r_{\text{smooth}}}\right)^3, & \frac{1}{2} < \frac{r}{r_{\text{smooth}}} \leq 1, \\ 0, & \frac{r}{r_{\text{smooth}}} > 1. \end{cases}$$



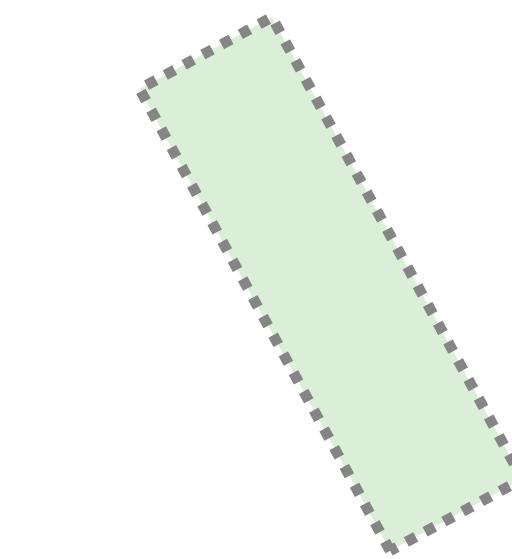
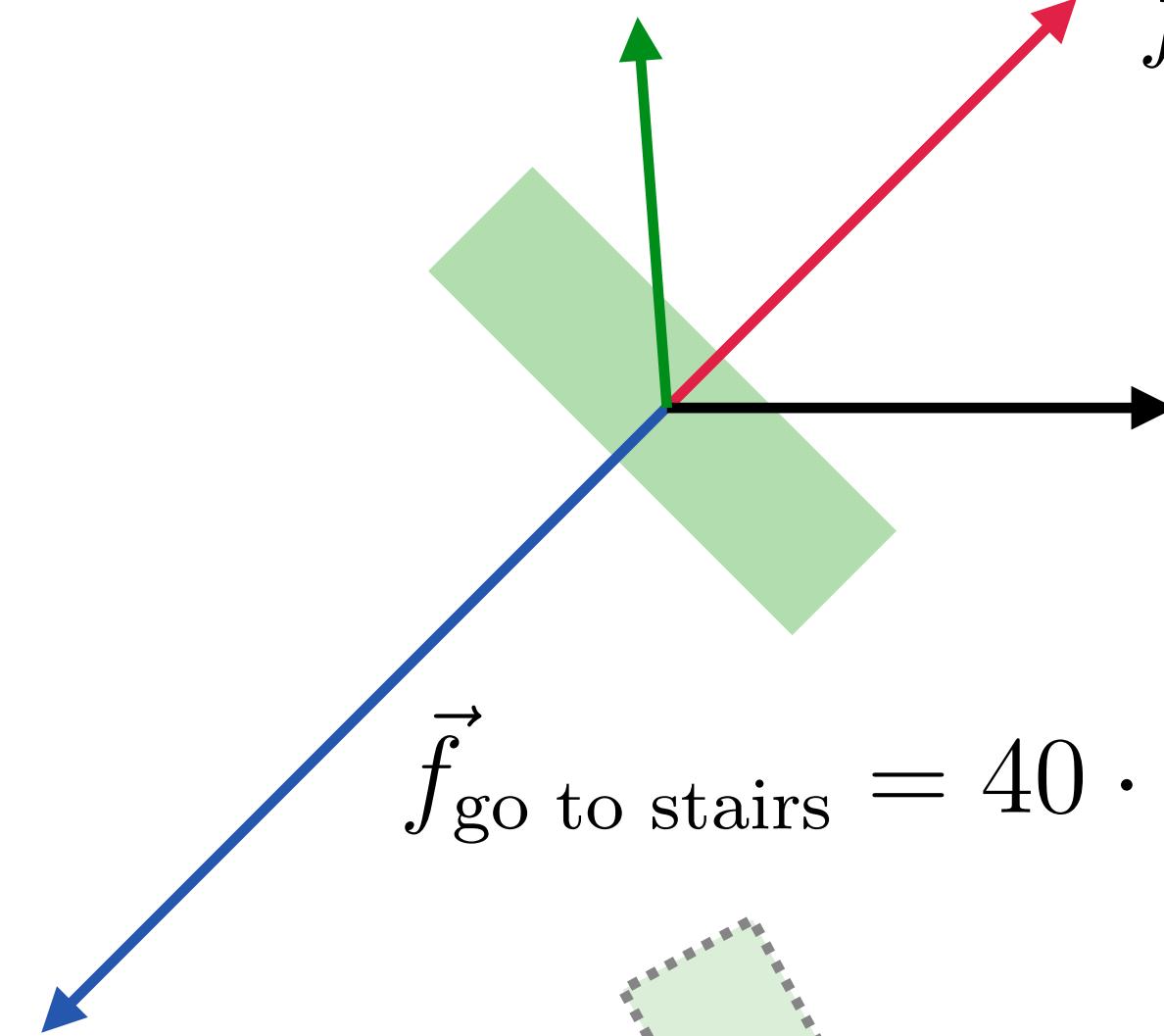
## 2. Method



## 2. Method

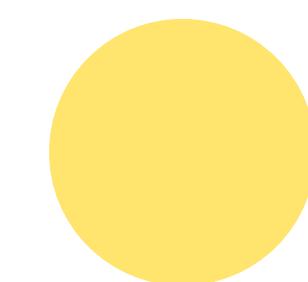
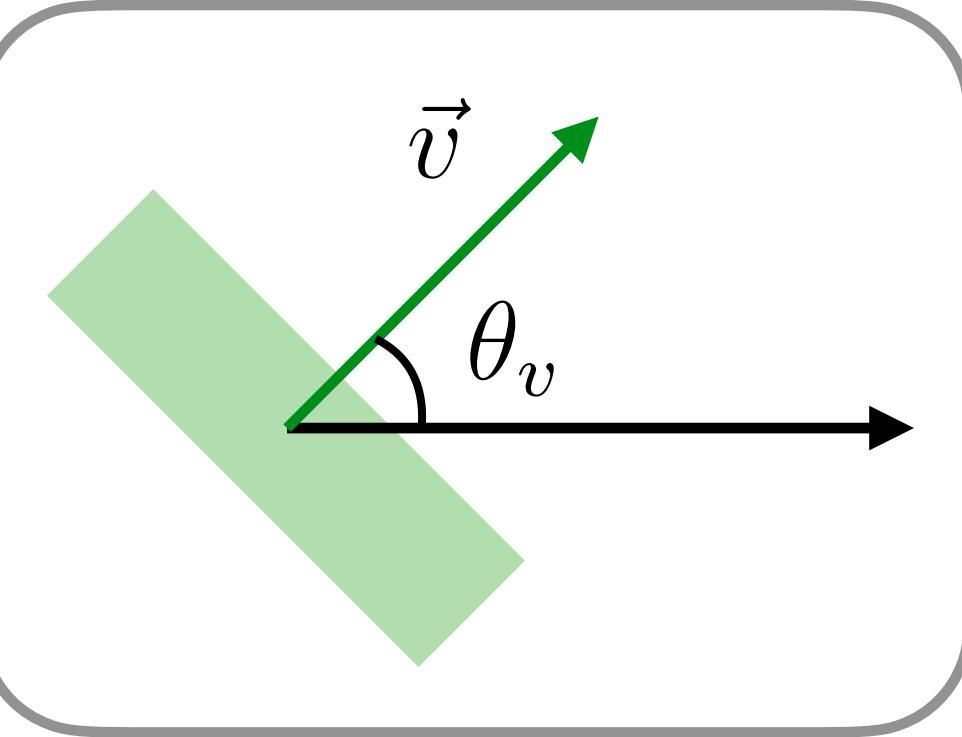


$$\vec{f}_{\text{others}} = 400 \cdot W \cdot \hat{r}_{j \rightarrow i} \quad \vec{f}_{\text{friction}} = -10 \cdot \vec{v}$$



$$\vec{f}_{\text{wall}} = 1000 \cdot W \cdot \hat{n}$$

$$\vec{v}(t + dt) = \max(v(t), v_{\max}) \cdot \hat{v}(t)$$

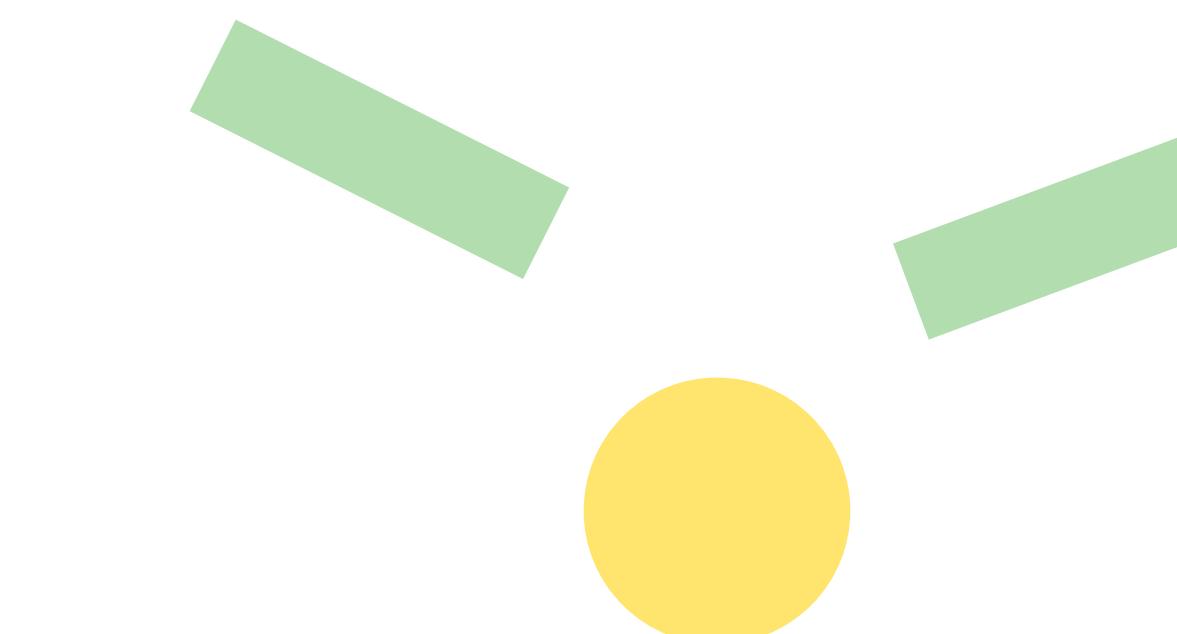
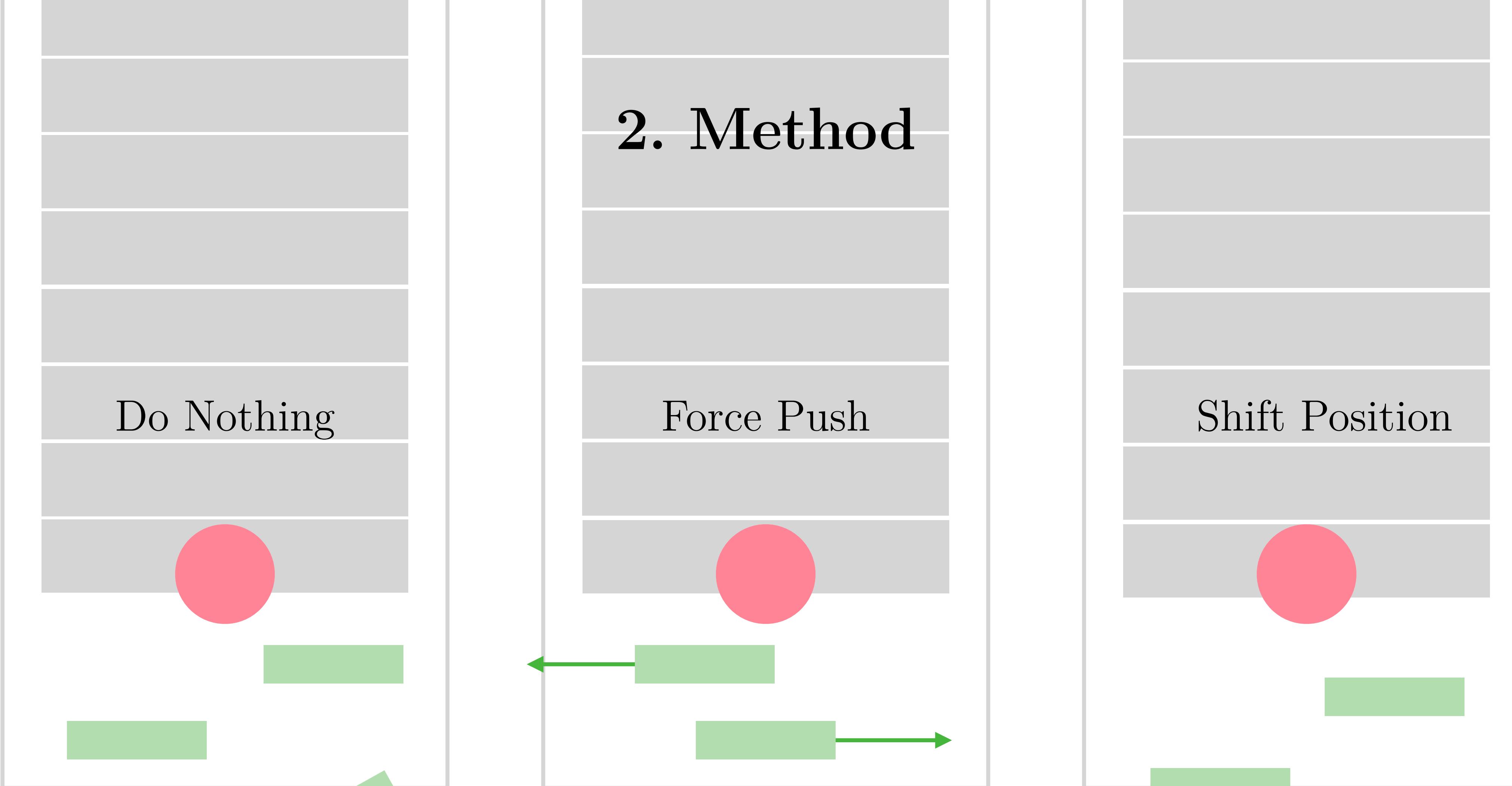


## 2. Method

Do Nothing

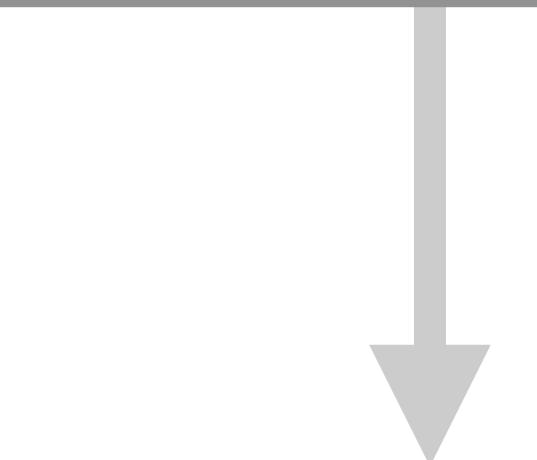
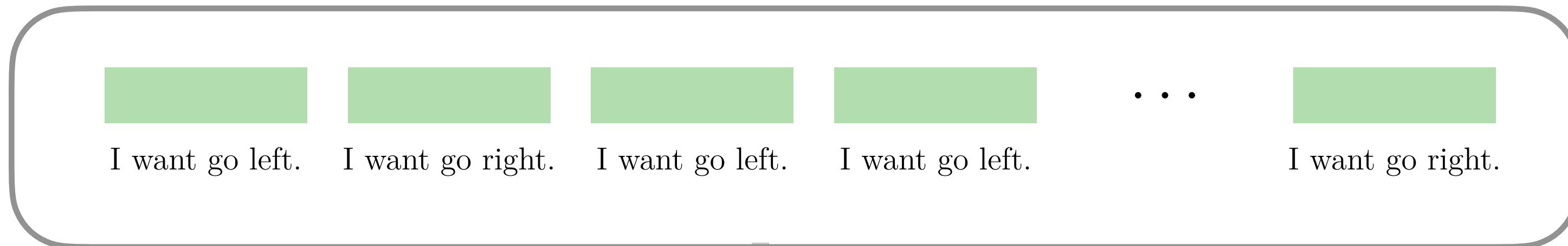
Force Push

Shift Position



## 2. Method

- $P_L$  : probability to go left,
- $P_{LW}$  : probability to walk if on left.



Simulation Start

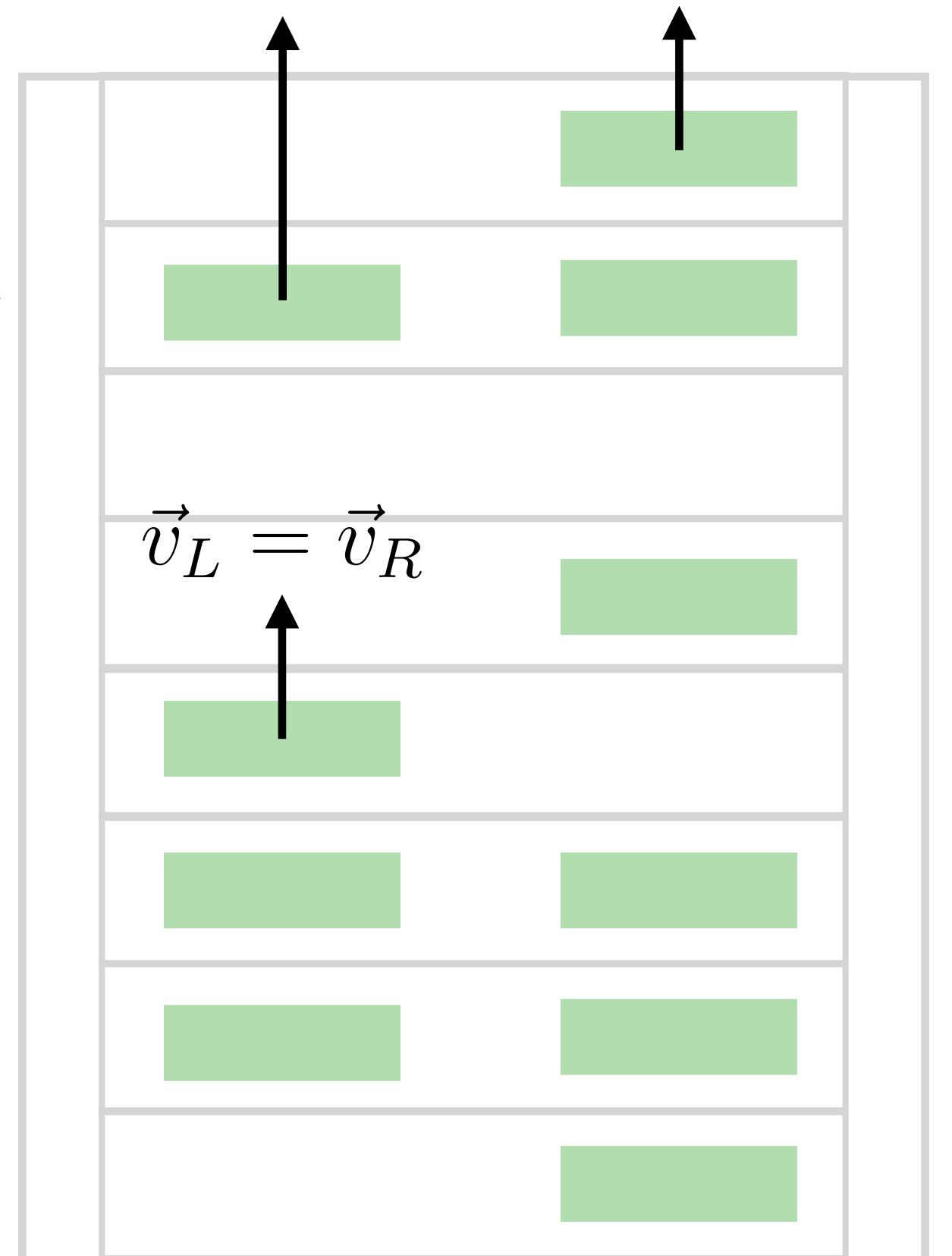
$$\vec{v}_L^{(W)} = \vec{v}_R + 1.0 \cdot \hat{v}_R \quad \vec{v}_R = (0, \delta y, \delta z)$$

$$P_{LW}$$

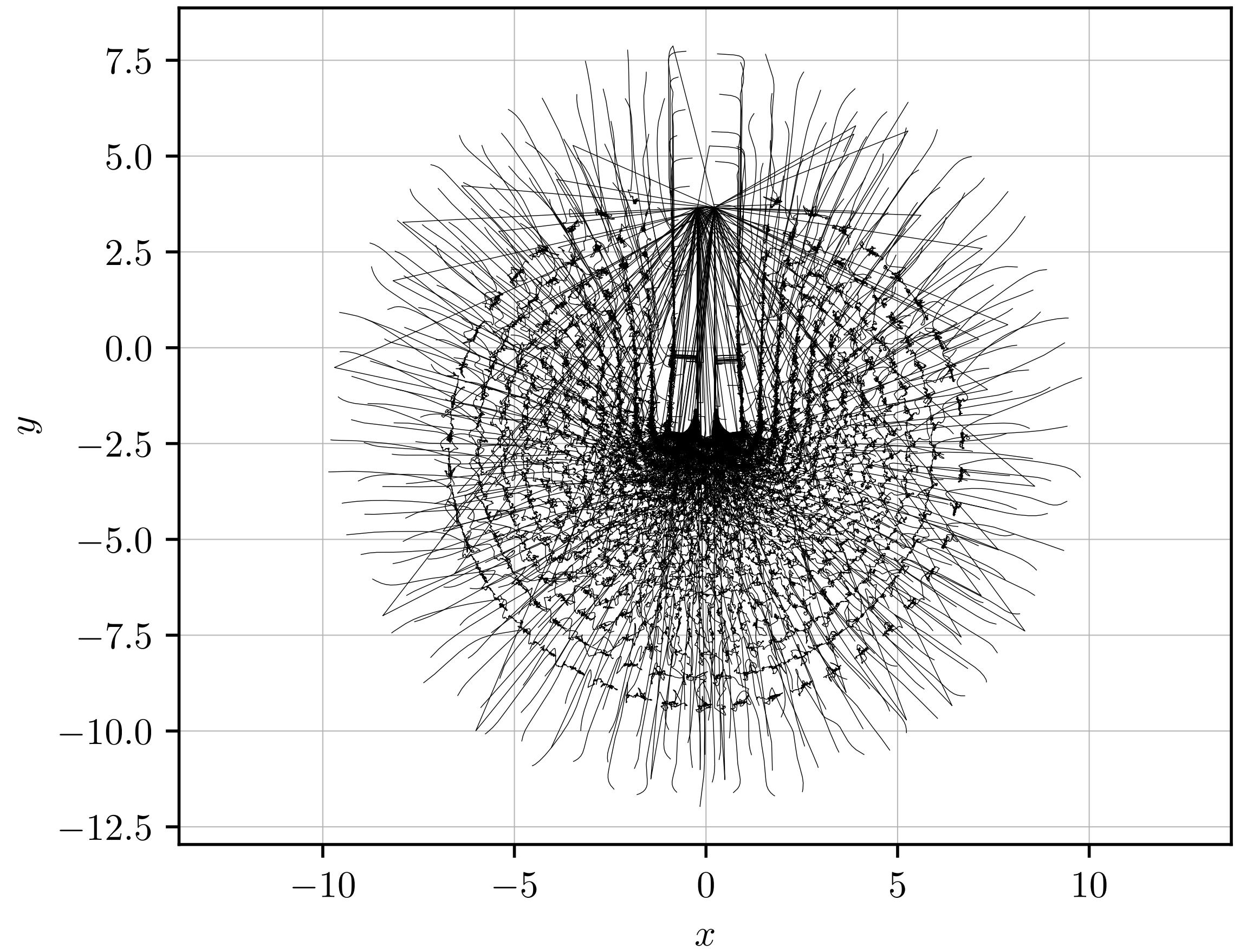
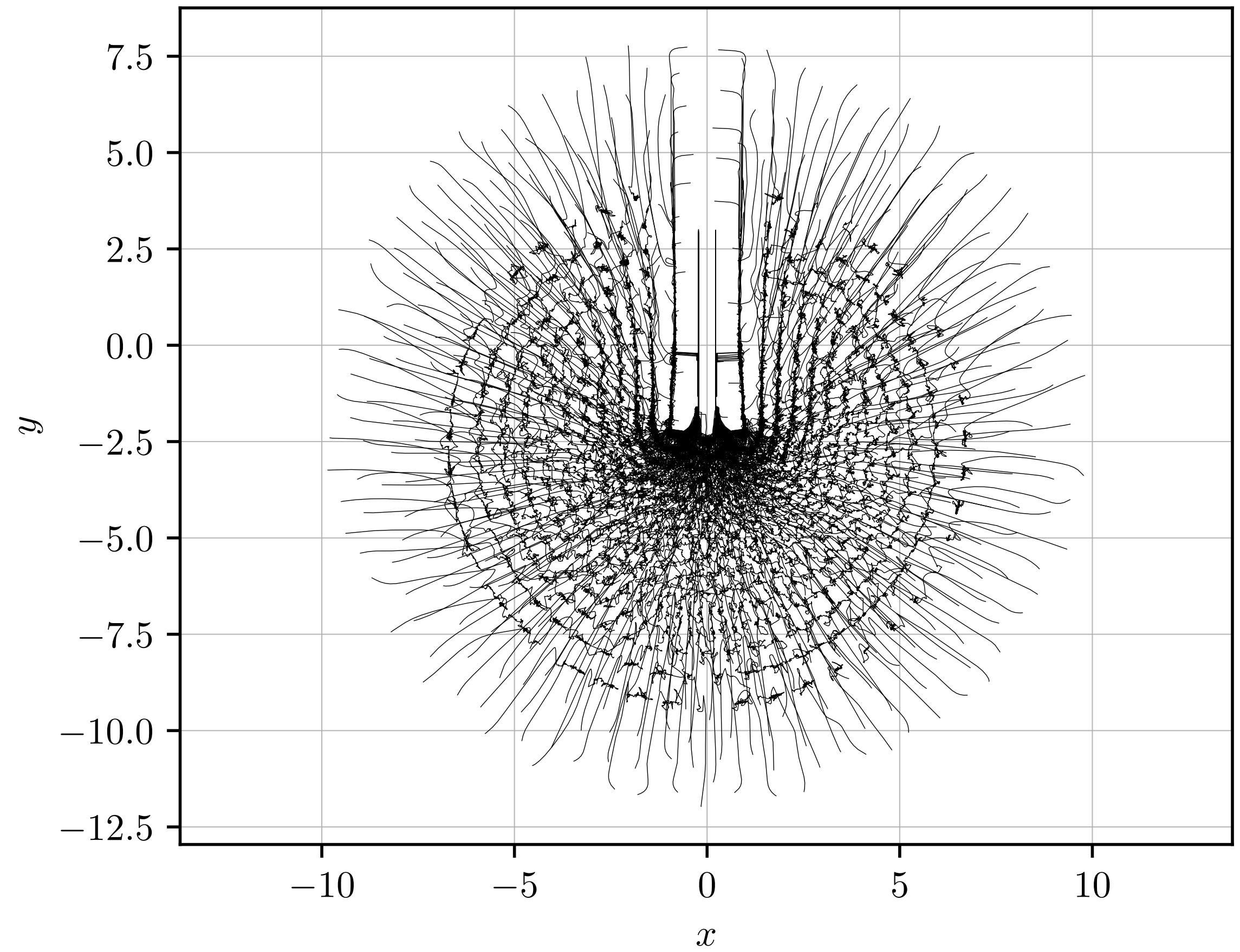
$$\vec{v}_L = \vec{v}_R$$

$$P_L$$

$$1 - P_L$$



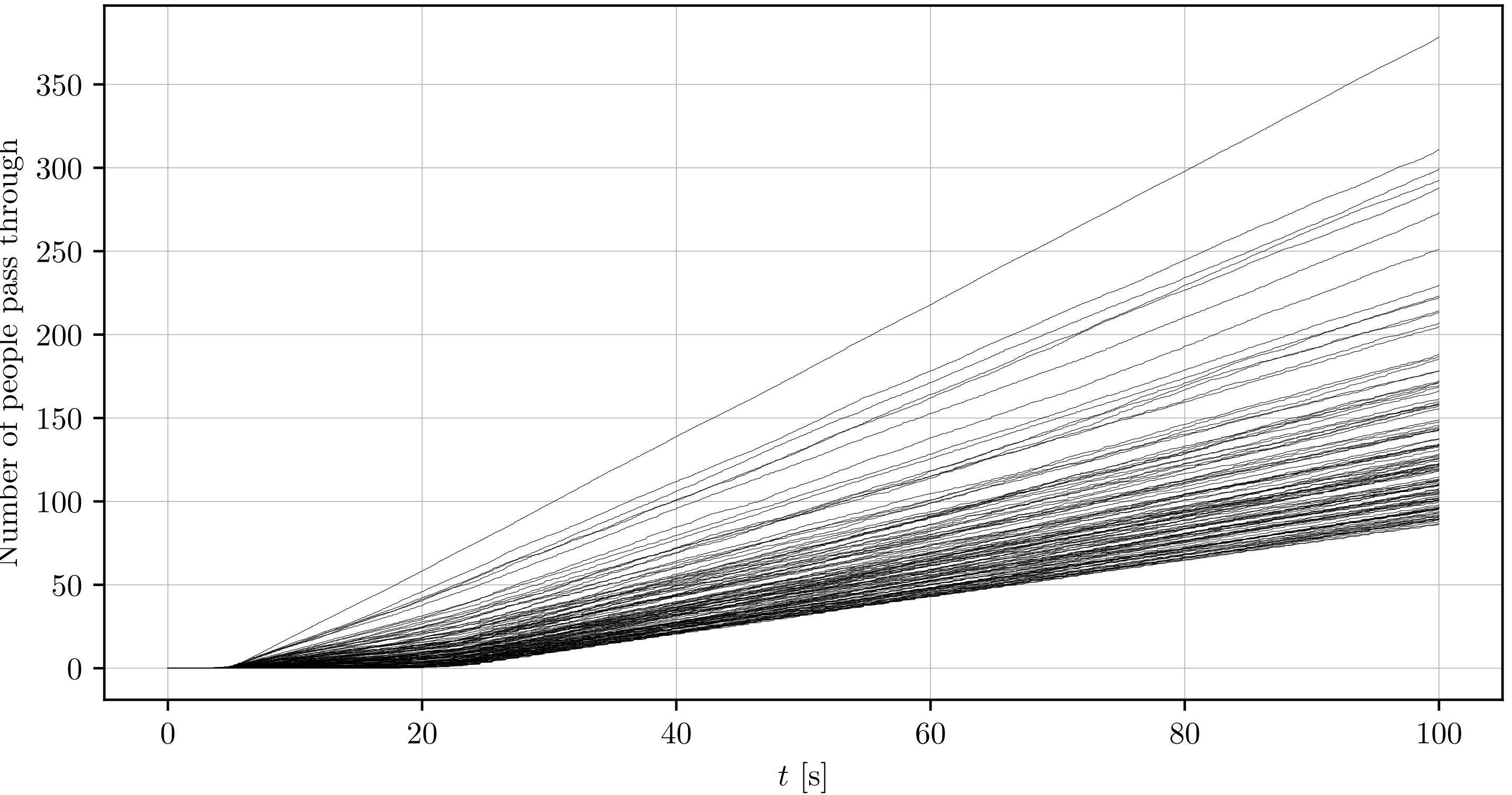
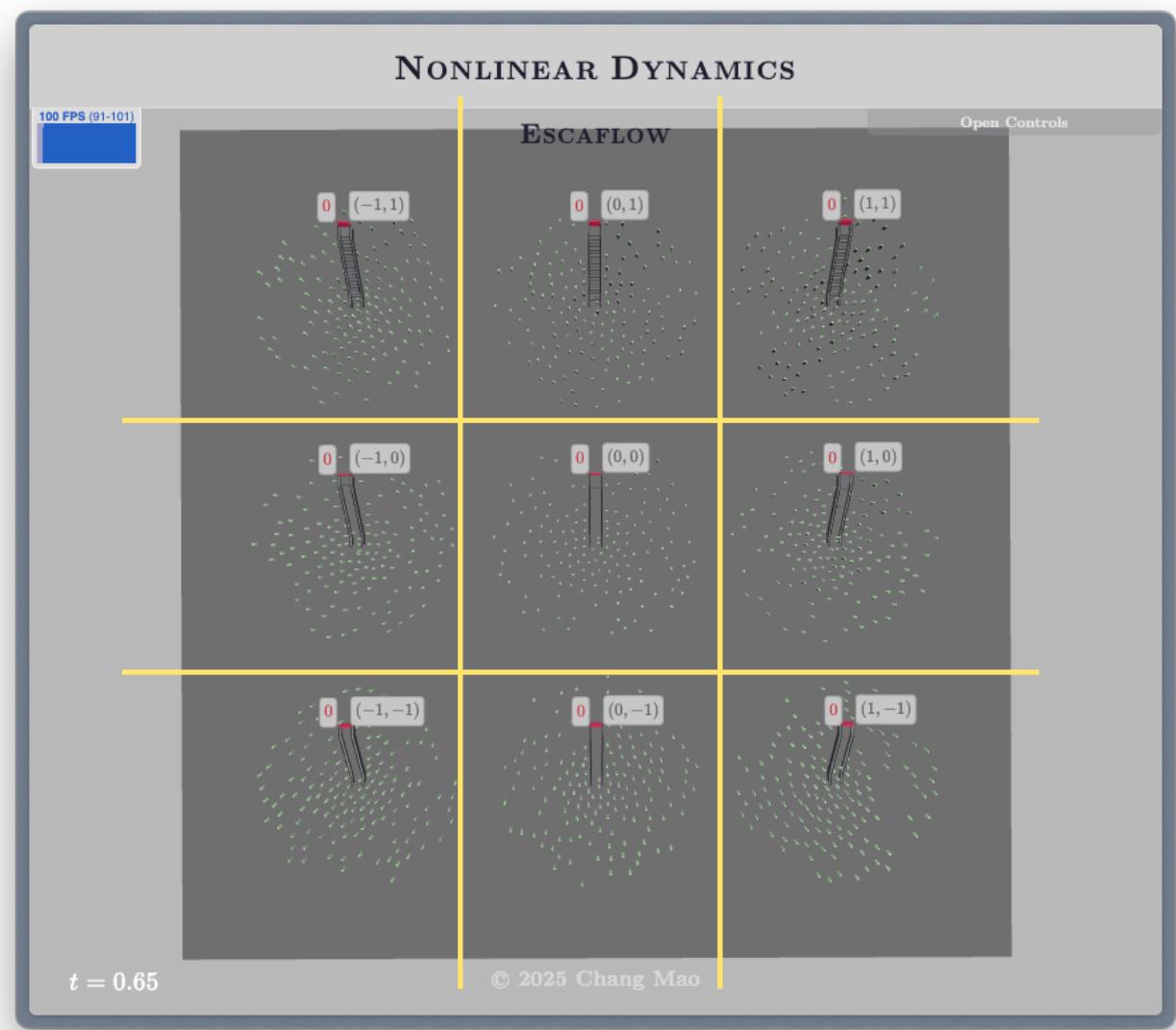
### 3. Dynamics



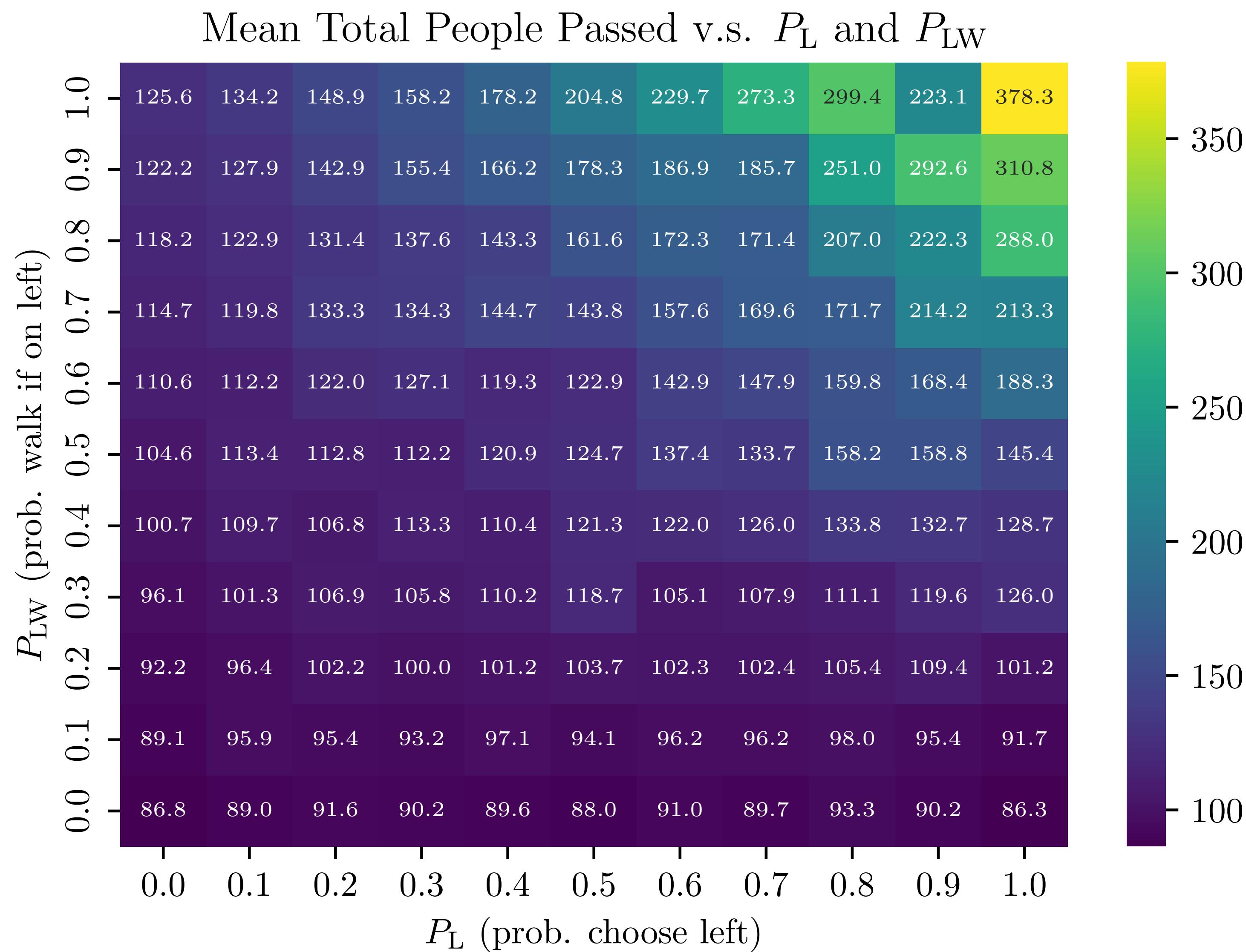
### 3. Opacity

- $P_L$  : probability to go left,
- $P_{LW}$  : probability to walk if on left.

$$P \in [0.0, 0.1, \dots, 1.0]$$



### 3. Opacity



### 3. Opacity

