

# ETUDE DES MOUVEMENTS DE FOULE

Malo Briand & Merry Duparc

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# MARATHON CHICAGO - 2016



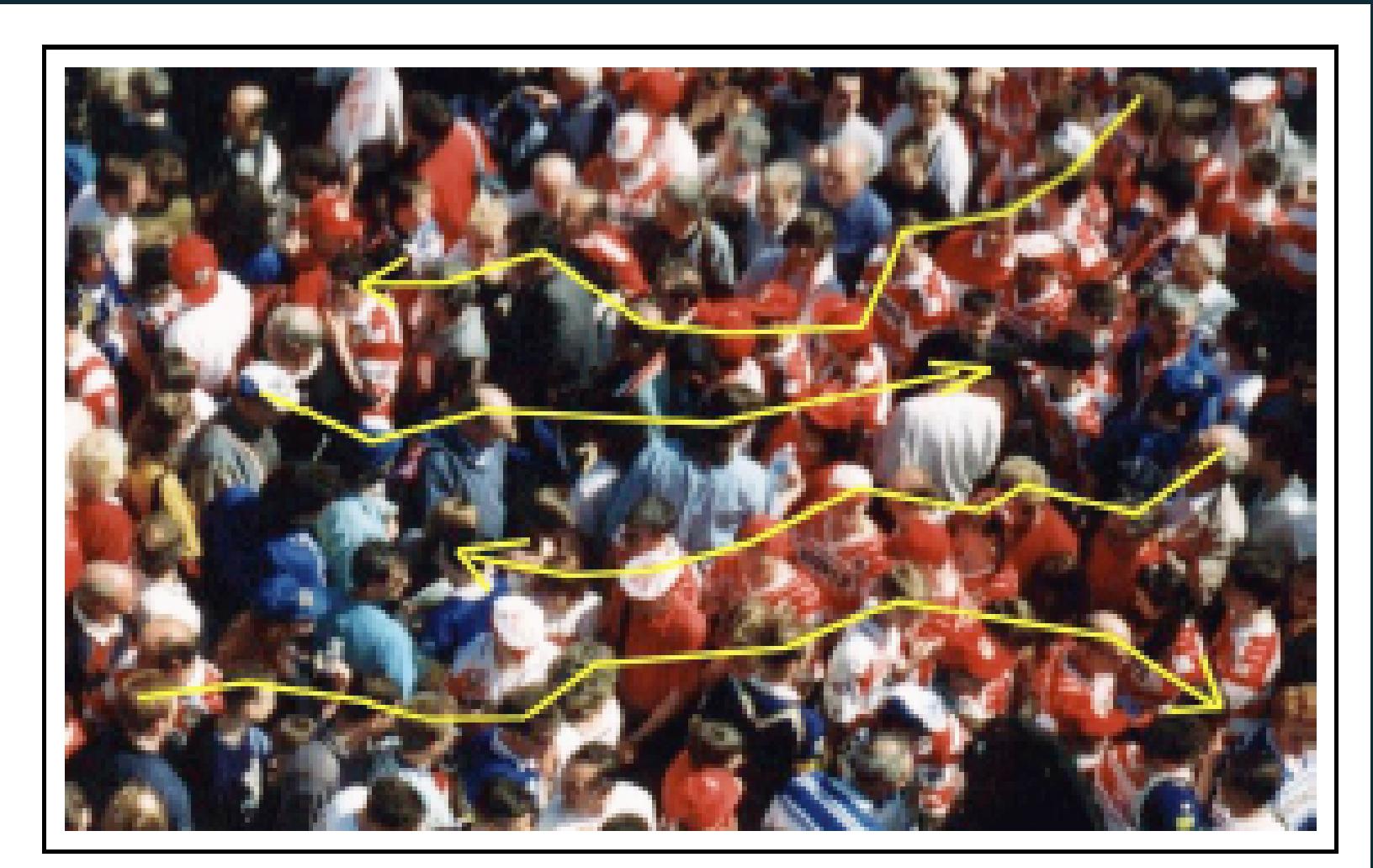
# PREMIERE PARTIE

## COMPORTEMENT DES PIETONS

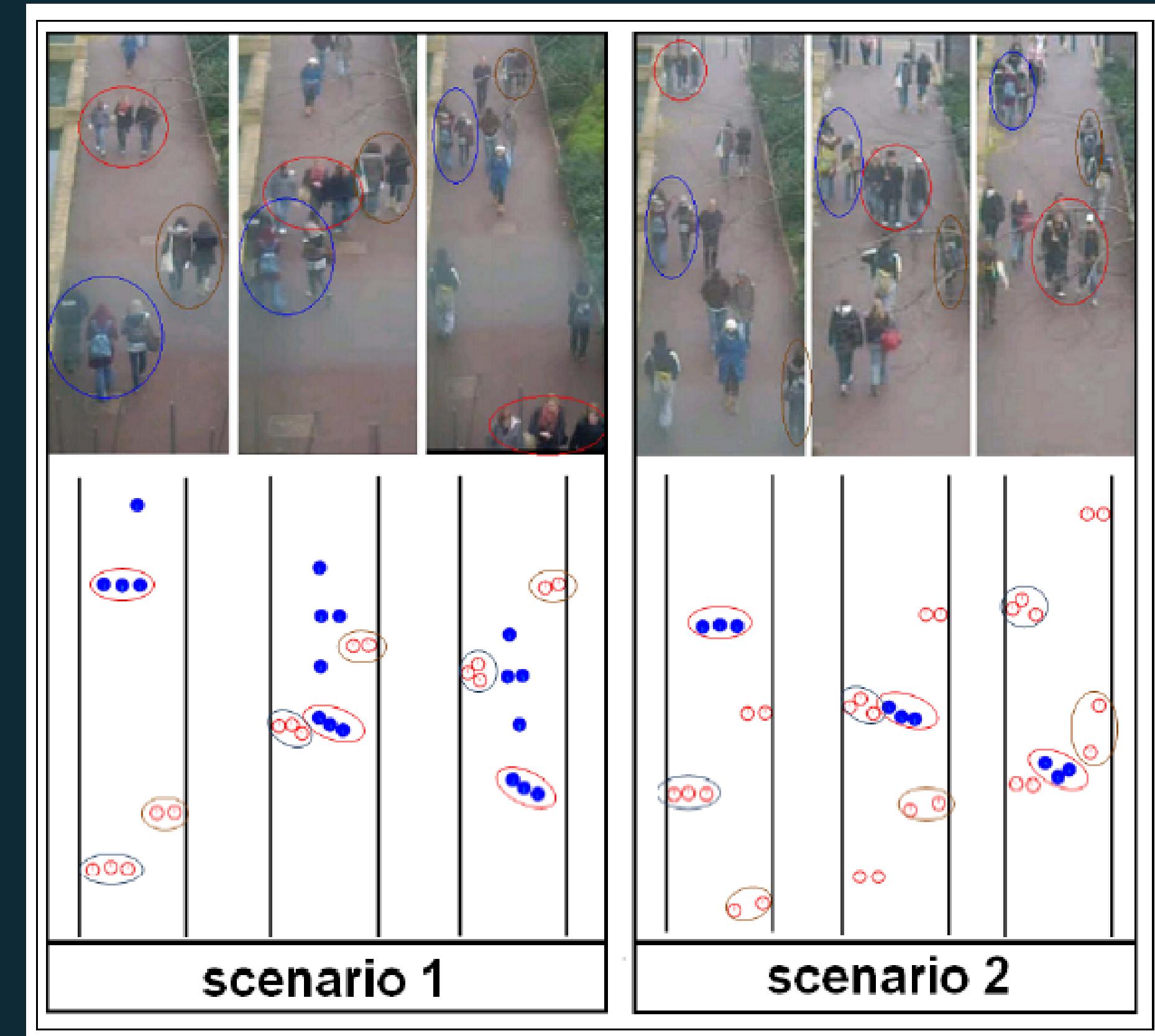
# I. COMPORTEMENT DES PIETONS

$$\langle v_0 \rangle = 1.34 \text{ m.s}^{-1}$$

- Nombreux facteurs qui influent sur le déplacement d'un piéton
- Principe du moindre effort

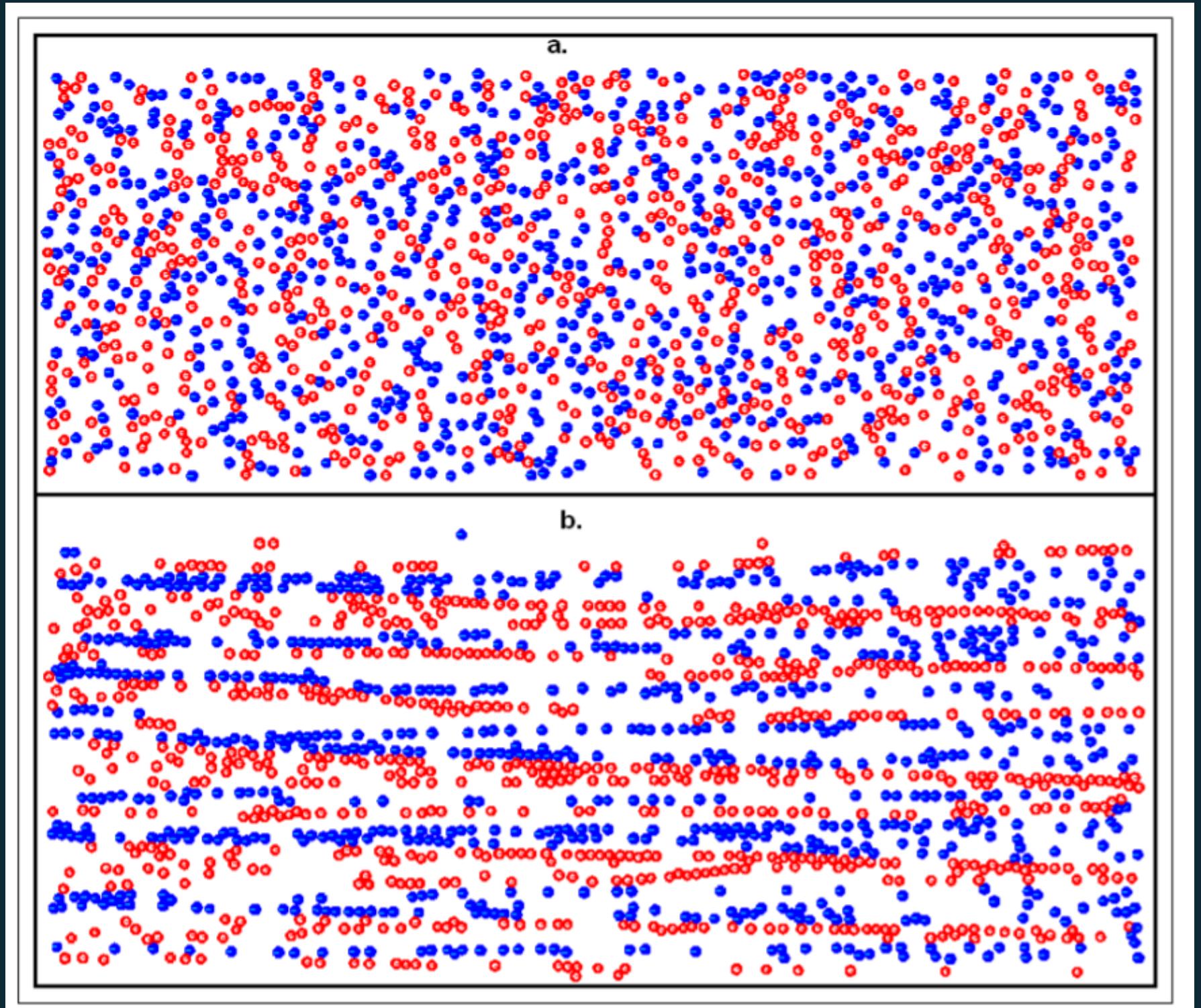


# I. COMPORTEMENT DES PIETONS



# I. COMPORTEMENT DES PIETONS

- 1500 individus allant pour la moitié à gauche et l'autre à droite.
- Positionnés aléatoirement à  $t=0$
- A  $t=40s$  des lignes de courant se forment

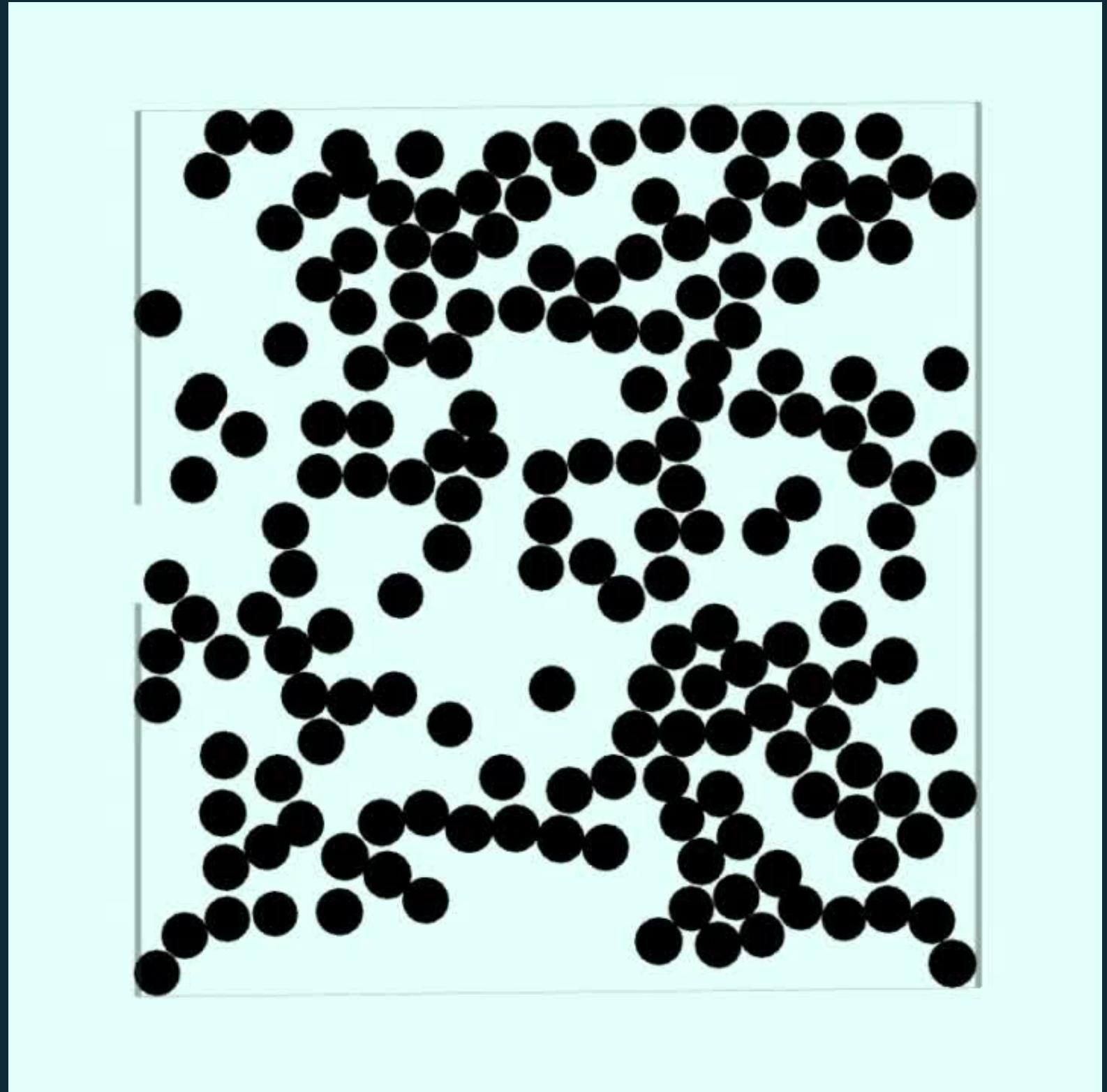
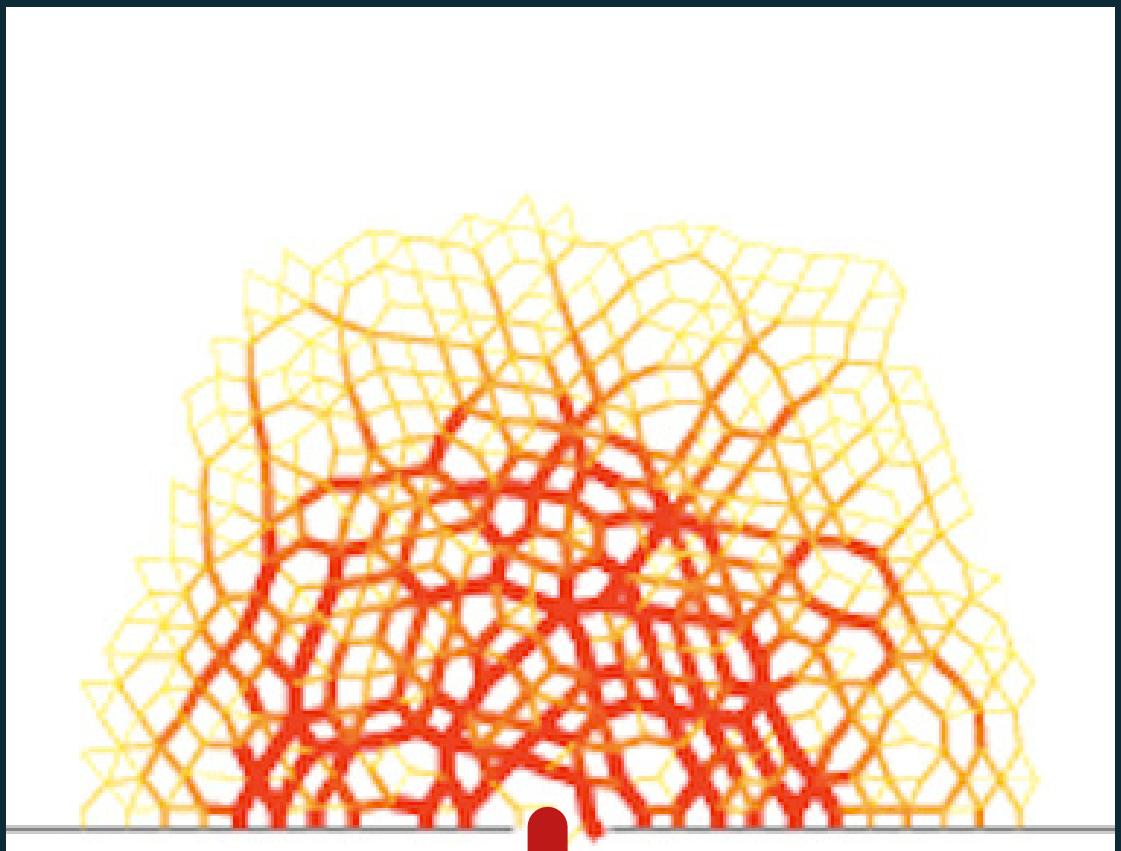


# DEUXIÈME PARTIE

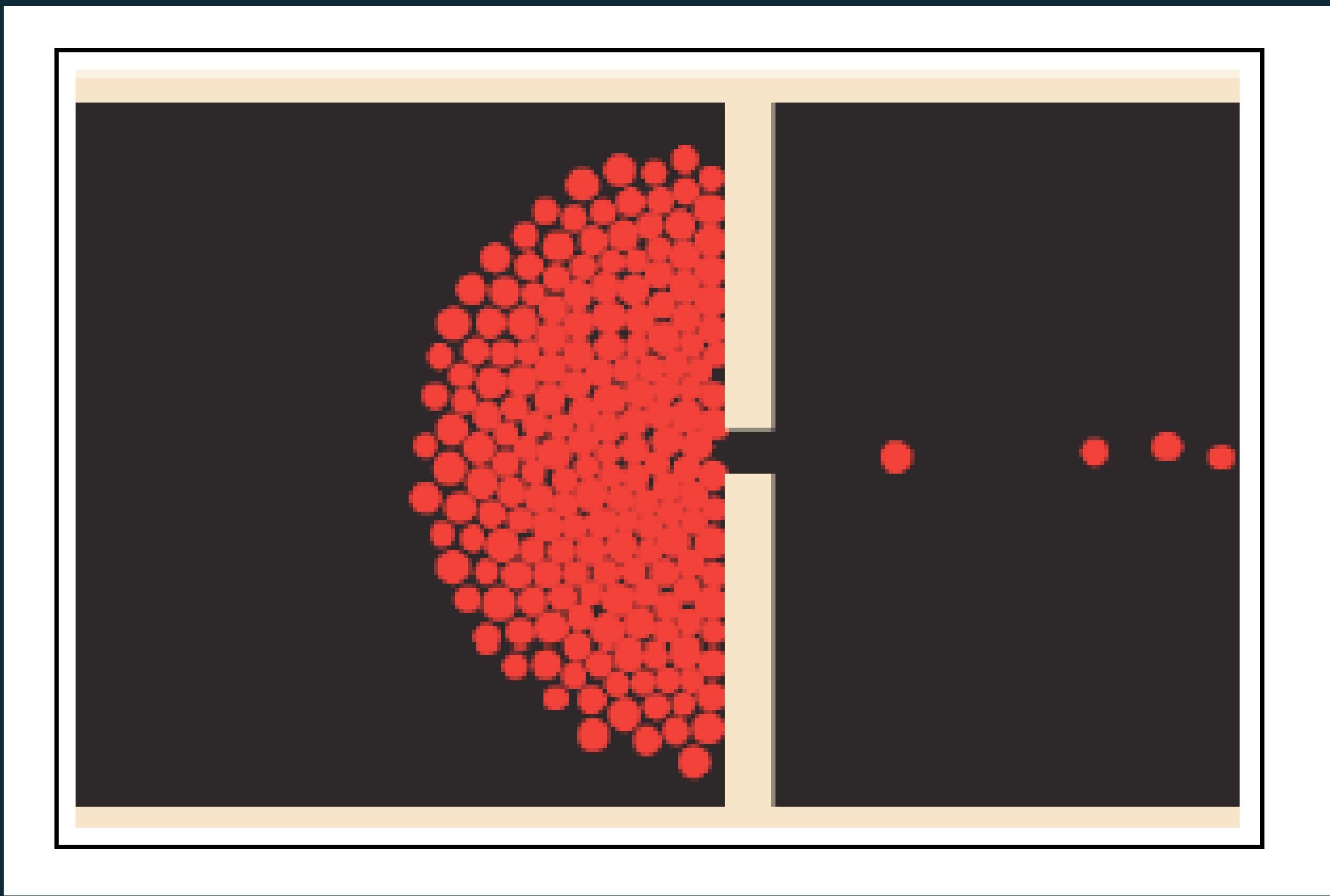
## EXPERIENCE DE SORTIE D'URGENCE

## II. EXPERIENCE DE SORTIE D'URGENCE

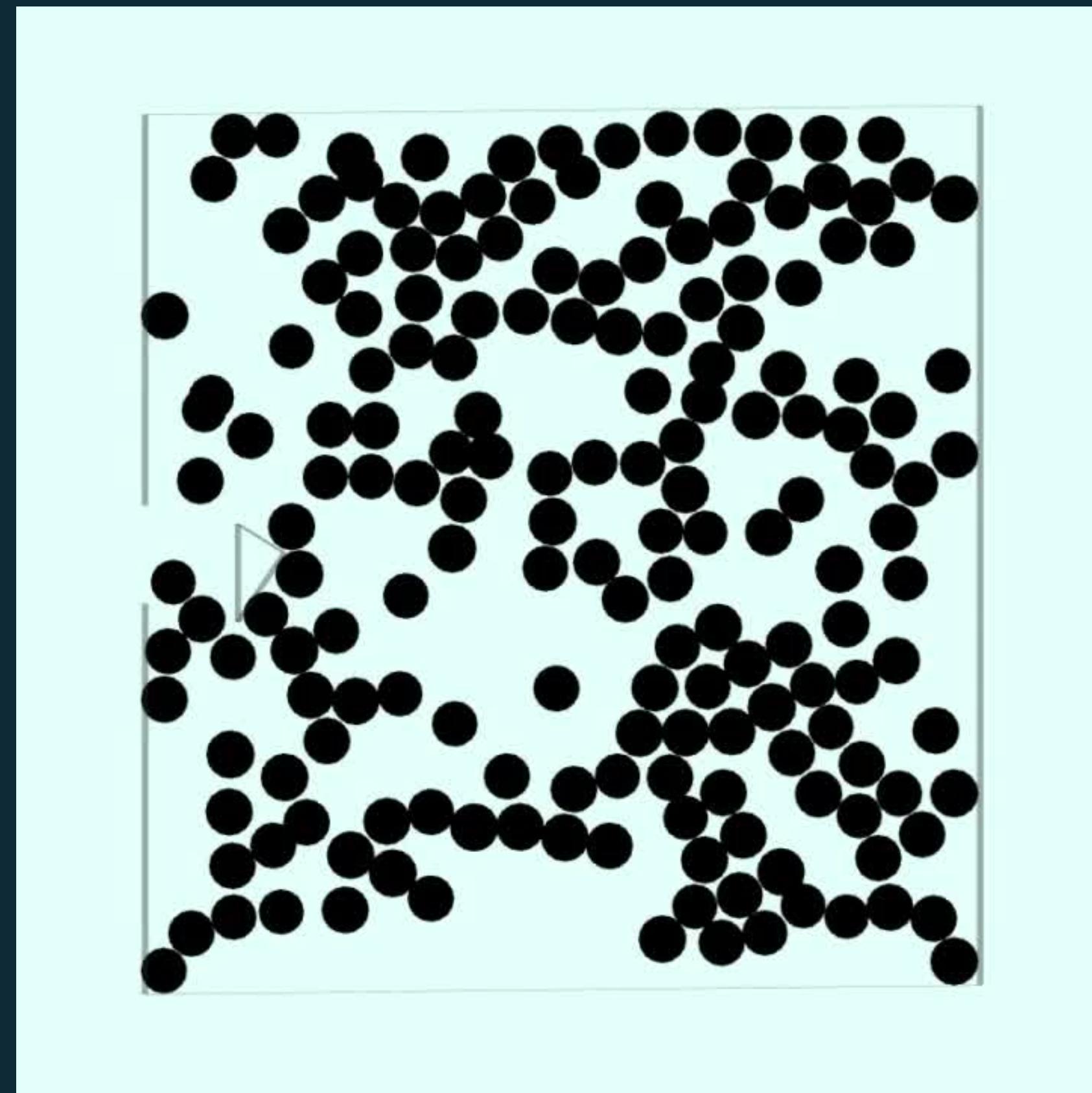
- Création d'une zone de tension autour de la sortie
- Formation d'une voûte



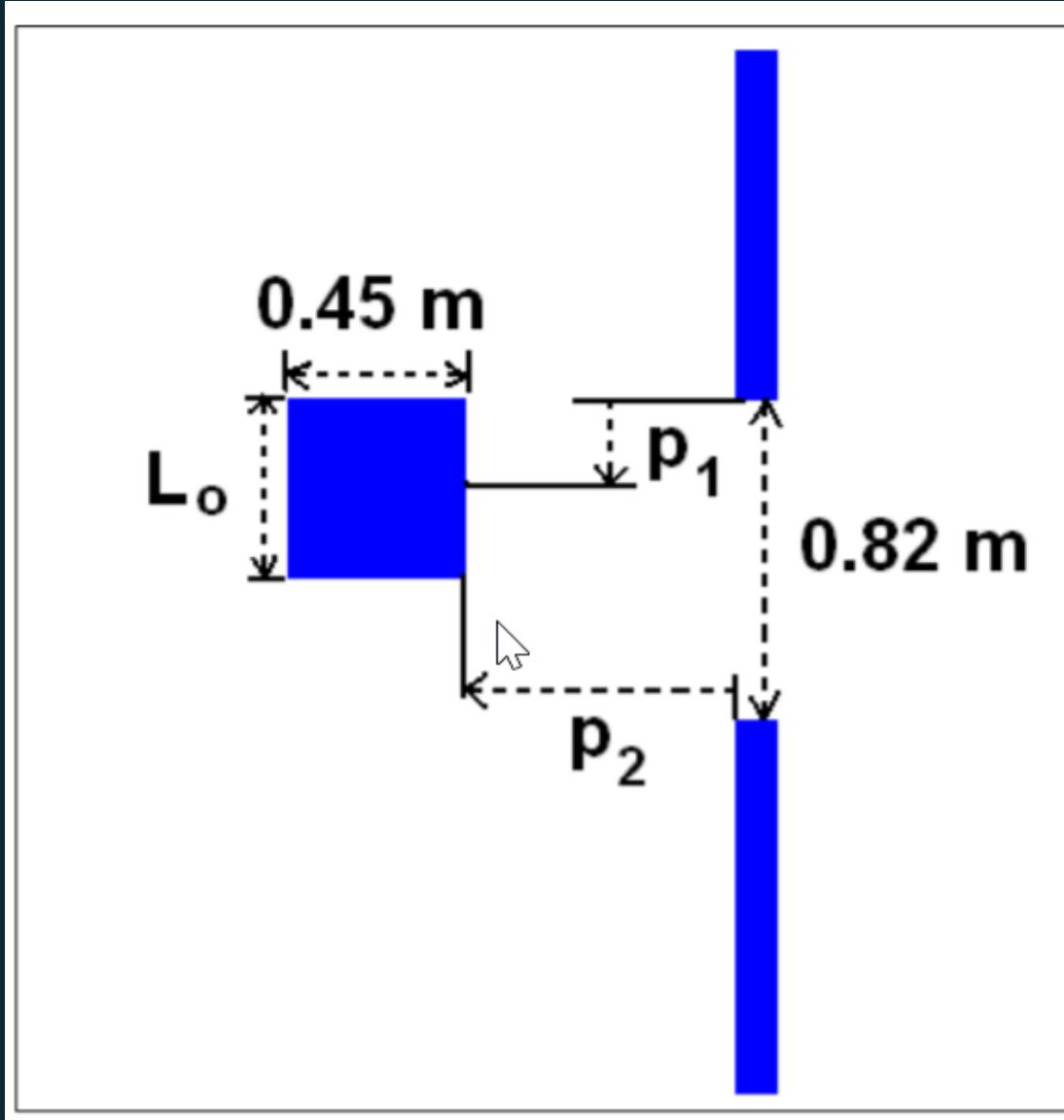
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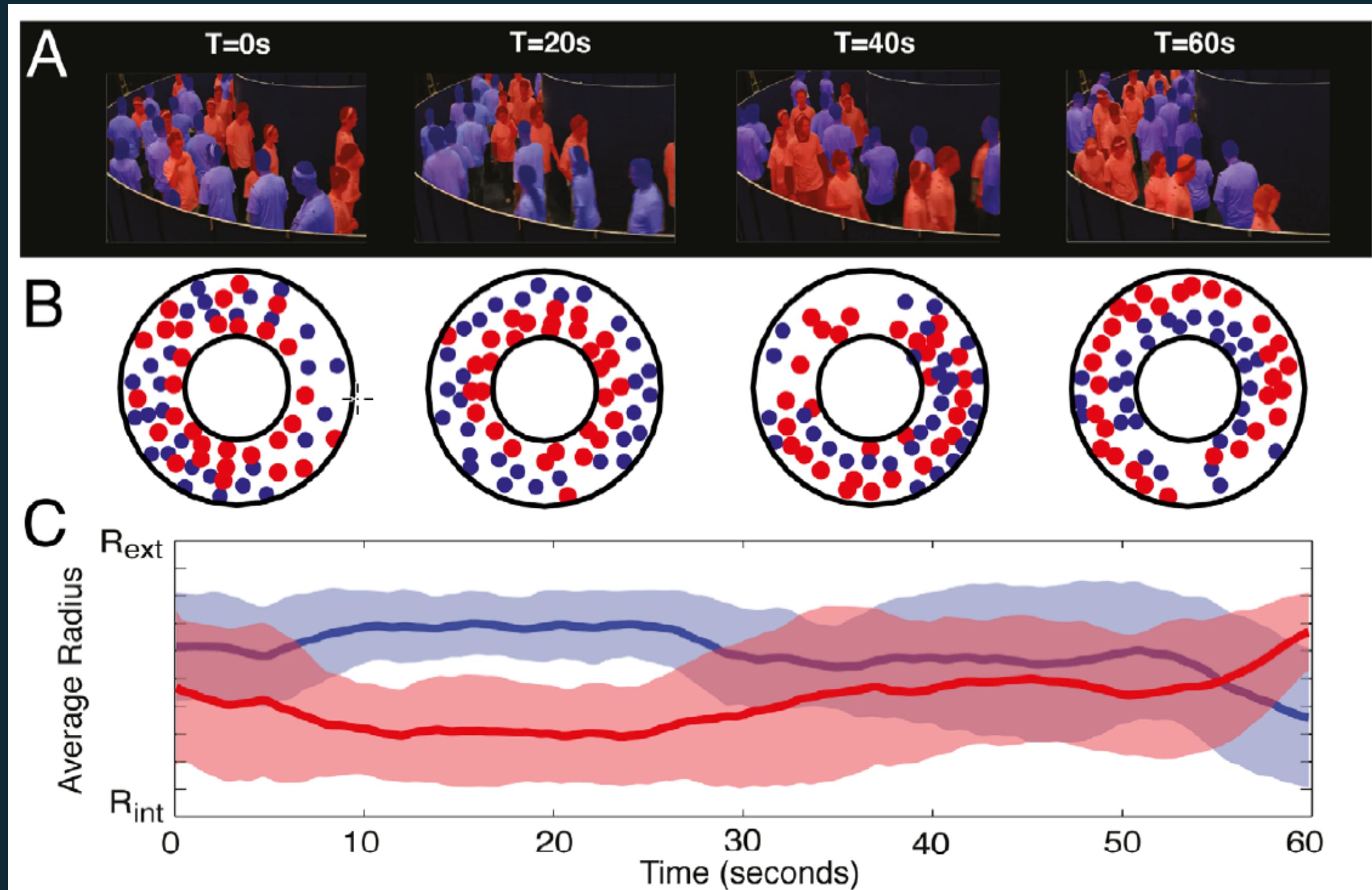


		$\tau$	0.1 s		0.5 s		
		$p_1$	0.41 m	0 m	0.41 m	0 m	
		$p_2$	0.7 m	0.9 m	0.7 m	0.9 m	0.7 m
$Q$ (peds/min)	rectangulaire $L_o$	pas d'obstacle	230	230	230	116	116
		0.45 m	231	213	212	115	115
		0.636 m	247	217	206	109	116
		0.8 m	251	223	203	102	116
	circulaire $D_o$	1 m	264	222	200	101	112
		0.45 m	202	222	222	112	114
		0.636 m	238	207	208	122	107
							112

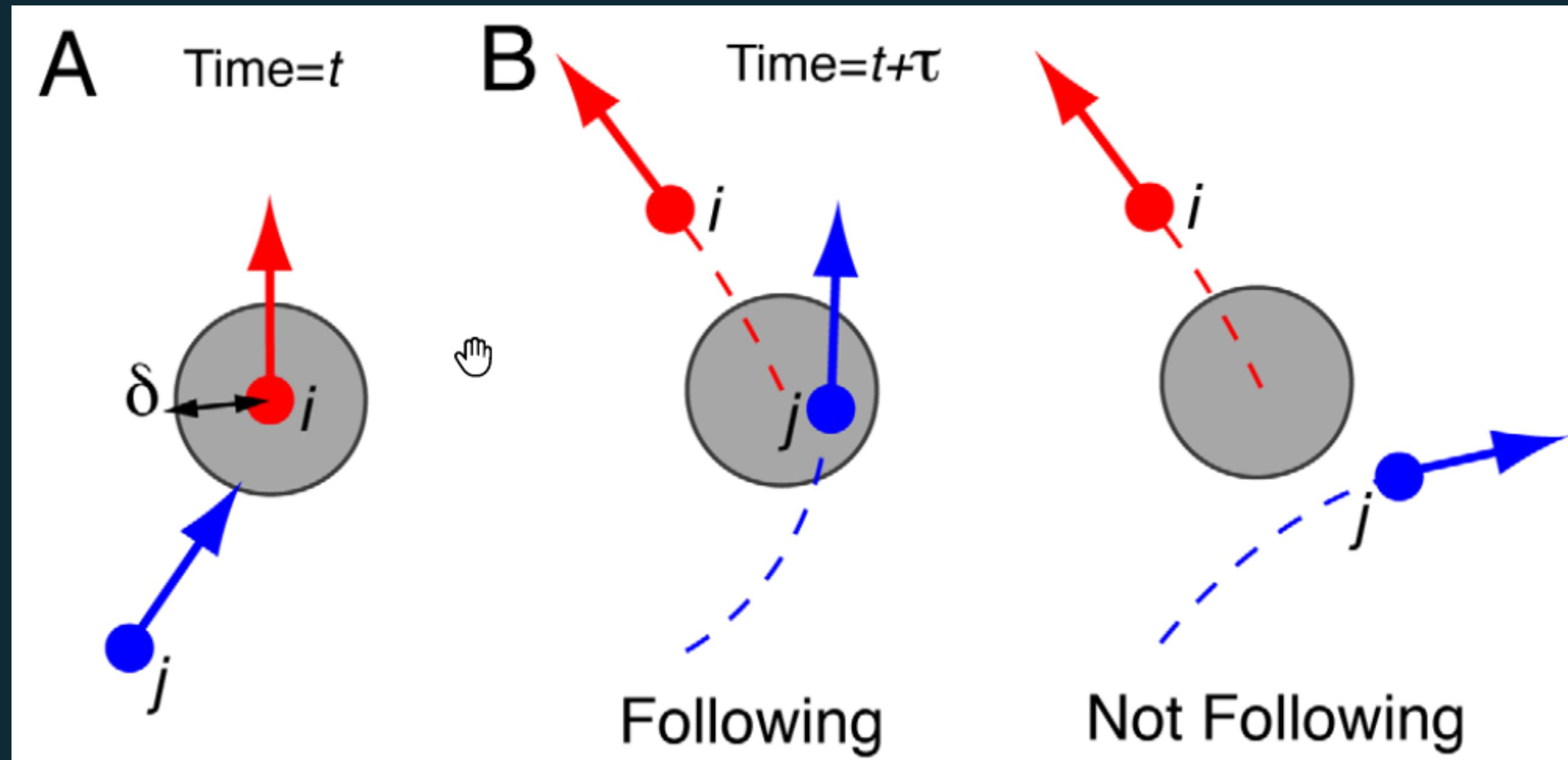
# TROISIÈME PARTIE

## AUTO-ORGANISATION DES INDIVIDUS

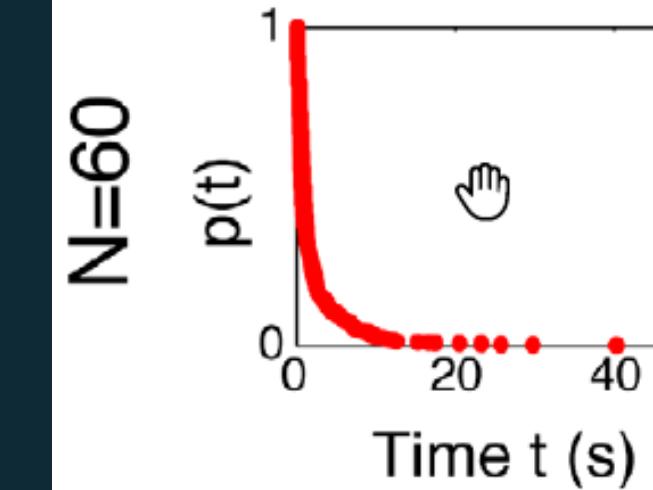
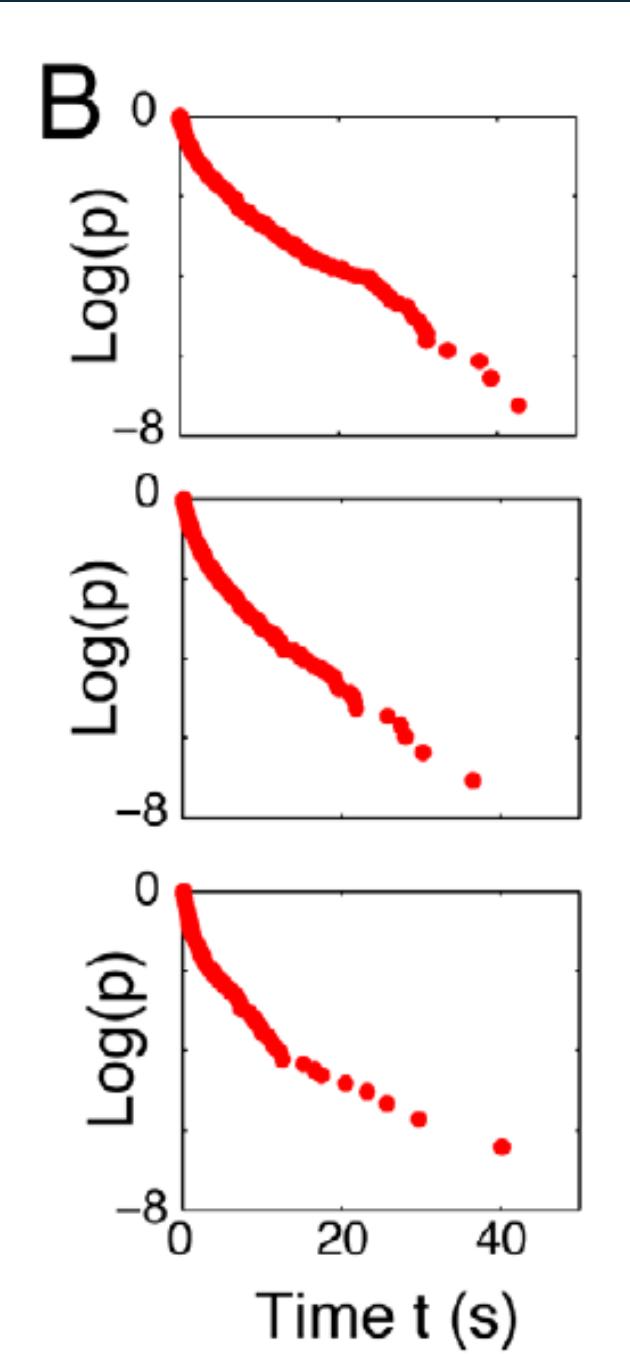
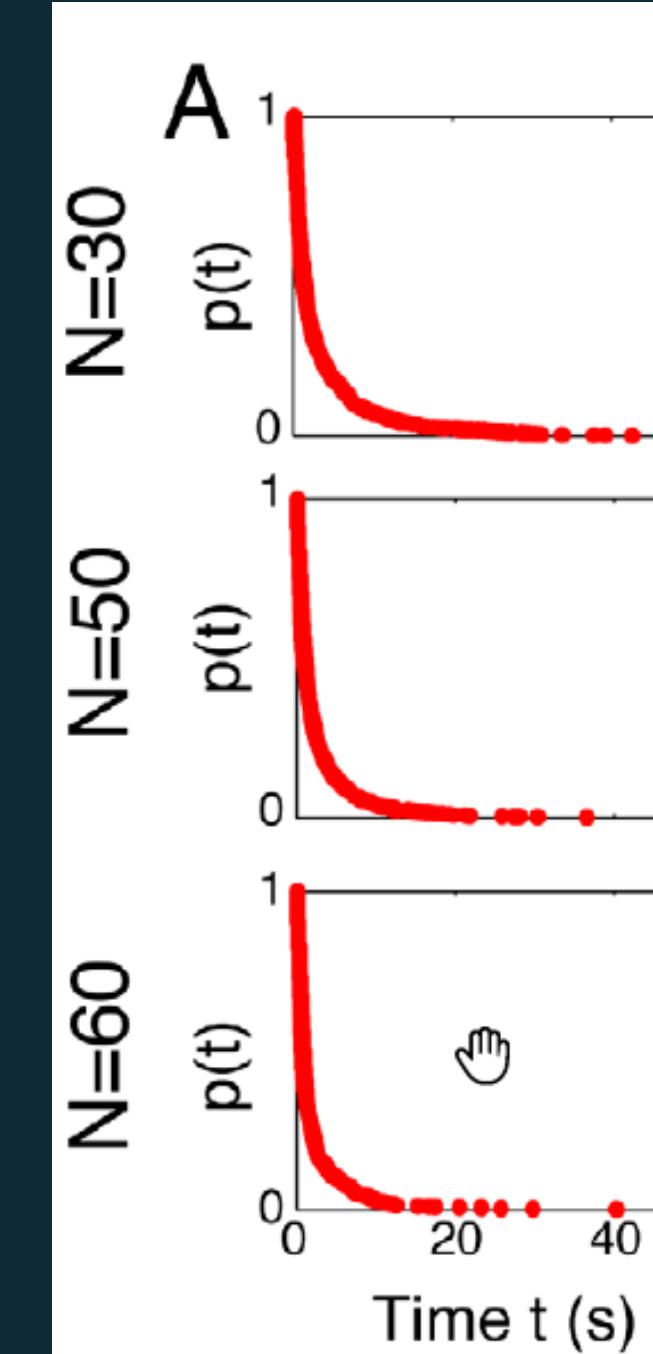
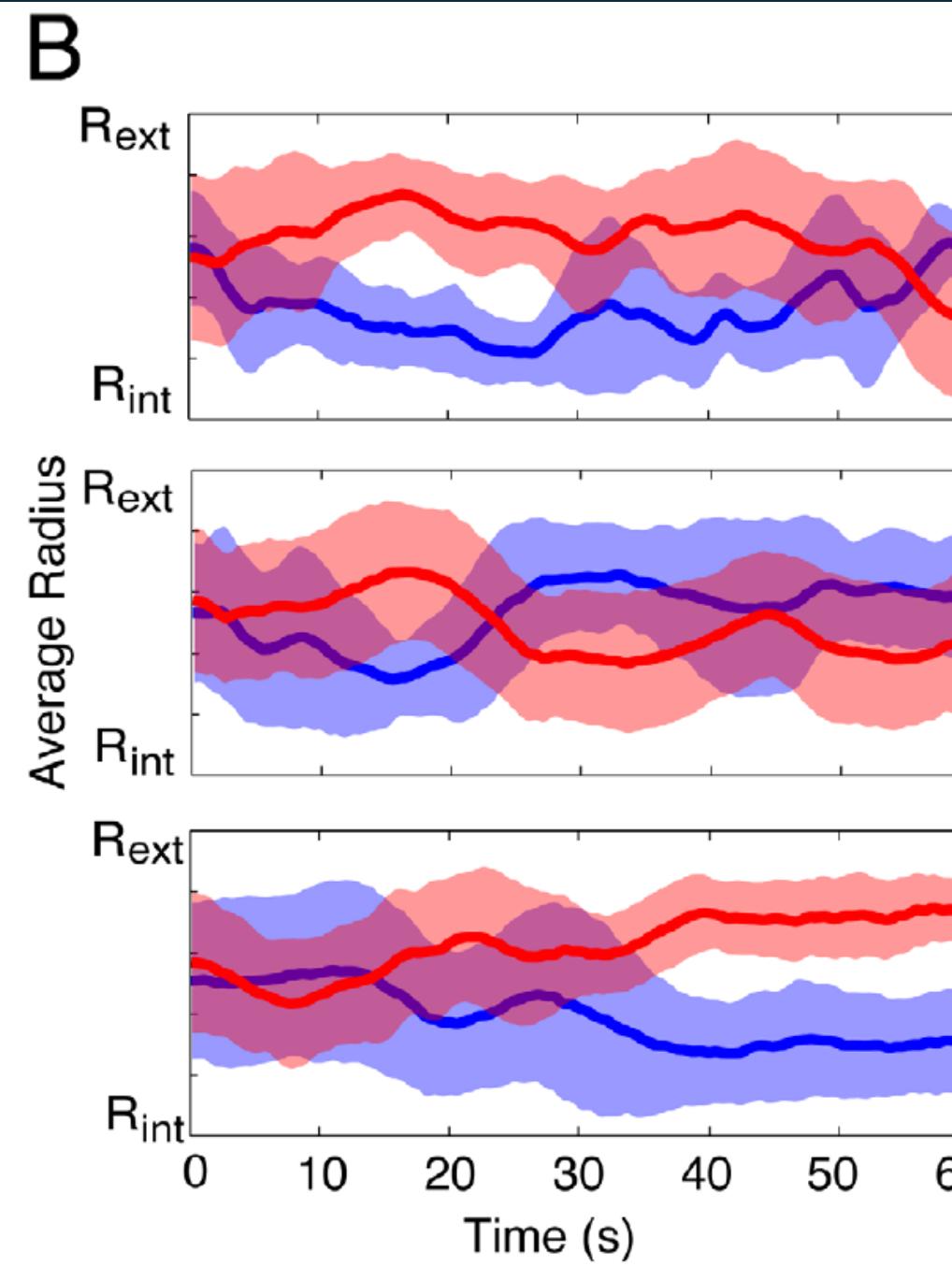
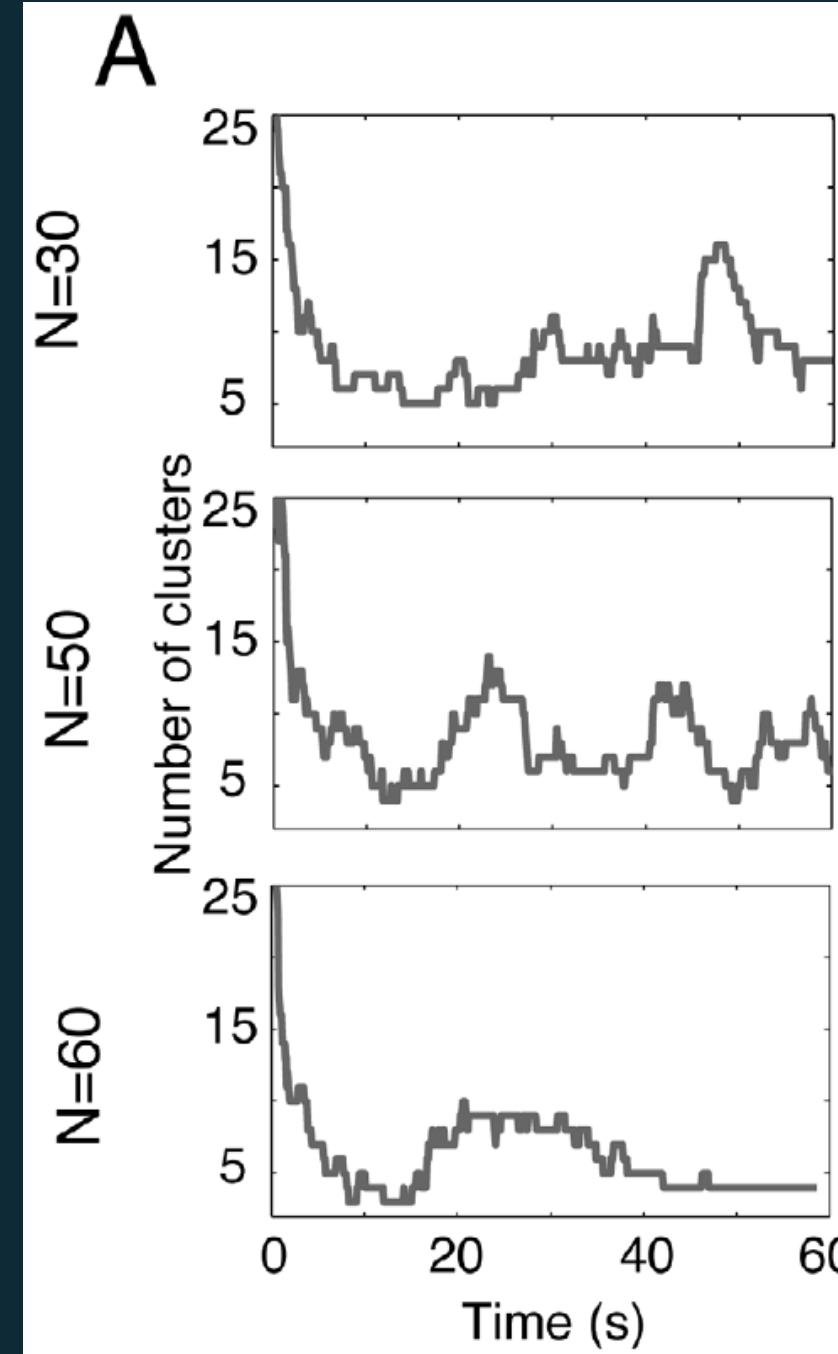
### III. AUTO-ORGANISATION DES INDIVIDUS



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# QUATRIEME PARTIE

MODELISATION PAR LA FORCE SOCIALE

## VI. MODELISATION PAR LA FORCE SOCIALE

$$\vec{F}_\alpha^0(\vec{v}_\alpha, v_\alpha^0 \vec{e}_\alpha) = \frac{1}{\tau_\alpha} (v_\alpha^0 \vec{e}_\alpha - \vec{v}_\alpha)$$

## VI. MODELISATION PAR LA FORCE SOCIALE

$$\vec{f}_{\alpha\beta}(\vec{r}_{\alpha\beta}) = -\vec{\nabla}_{\vec{r}_{\alpha\beta}} V_{\alpha\beta}[b(\vec{r}_{\alpha\beta})]$$

## VI. MODELISATION PAR LA FORCE SOCIALE

$$\vec{F}_{\alpha B}(\vec{r}_{\alpha B}) = -\vec{\nabla}_{\vec{r}_{\alpha B}} U_{\alpha B}(\|\vec{r}_{\alpha B}\|)$$

## VI. MODELISATION PAR LA FORCE SOCIALE

$$\vec{f}_{\alpha i}(\|\vec{r}_{\alpha i}\|, t) = -\vec{\nabla}_{\vec{r}_{\alpha i}} W_{\alpha i}(\|\vec{r}_{\alpha i}\|, t)$$

## VI. MODELISATION PAR LA FORCE SOCIALE

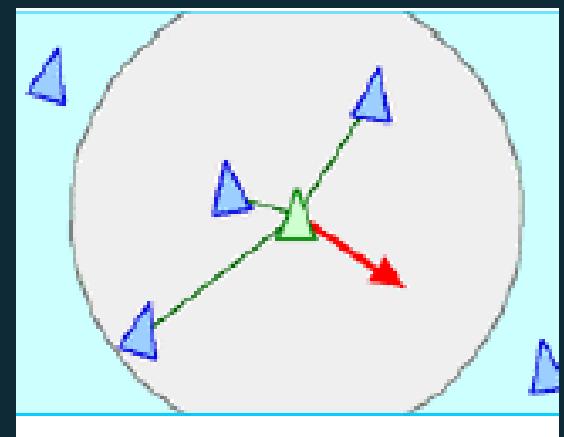
$$\vec{F}_{\alpha\beta}(\vec{e}_\alpha, \vec{r}_\alpha - \vec{r}_\beta) = w(\vec{e}_\alpha, -\vec{f}_{\alpha\beta}) \vec{f}_{\alpha\beta}(\vec{r}_\alpha - \vec{r}_\beta)$$

$$\vec{F}_{\alpha i}(\vec{e}_\alpha, \vec{r}_\alpha - \vec{r}_i, t) = w(\vec{e}_\alpha, \vec{f}_{\alpha i}) \vec{f}_{\alpha i}(\vec{r}_\alpha - \vec{r}_i, t)$$

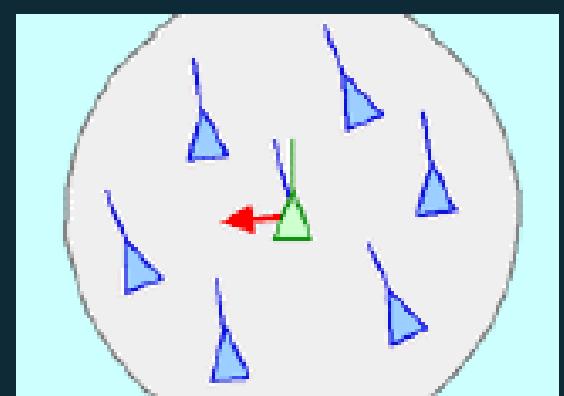
$$\begin{aligned} \vec{F}_\alpha(t) &= \vec{F}_\alpha^0(\vec{v}_\alpha, v_\alpha^0 \vec{e}_\alpha) + \sum_\beta \vec{F}_{\alpha\beta}(\vec{e}_\alpha, \vec{r}_\alpha - \vec{r}_\beta) + \\ &\quad \sum_B \vec{F}_{\alpha B}(\vec{e}_\alpha, \vec{r}_\alpha - \vec{r}_B^\alpha) + \sum_i \vec{F}_{\alpha i}(\vec{e}_\alpha, \vec{r}_\alpha - \vec{r}_i, t) \end{aligned}$$

$$\frac{d\vec{w}_\alpha}{dt} = \vec{F}_\alpha(t)$$

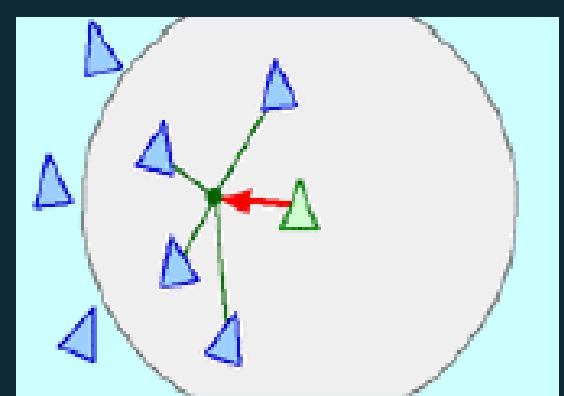
## VI. MODELISATION PAR LA FORCE SOCIALE



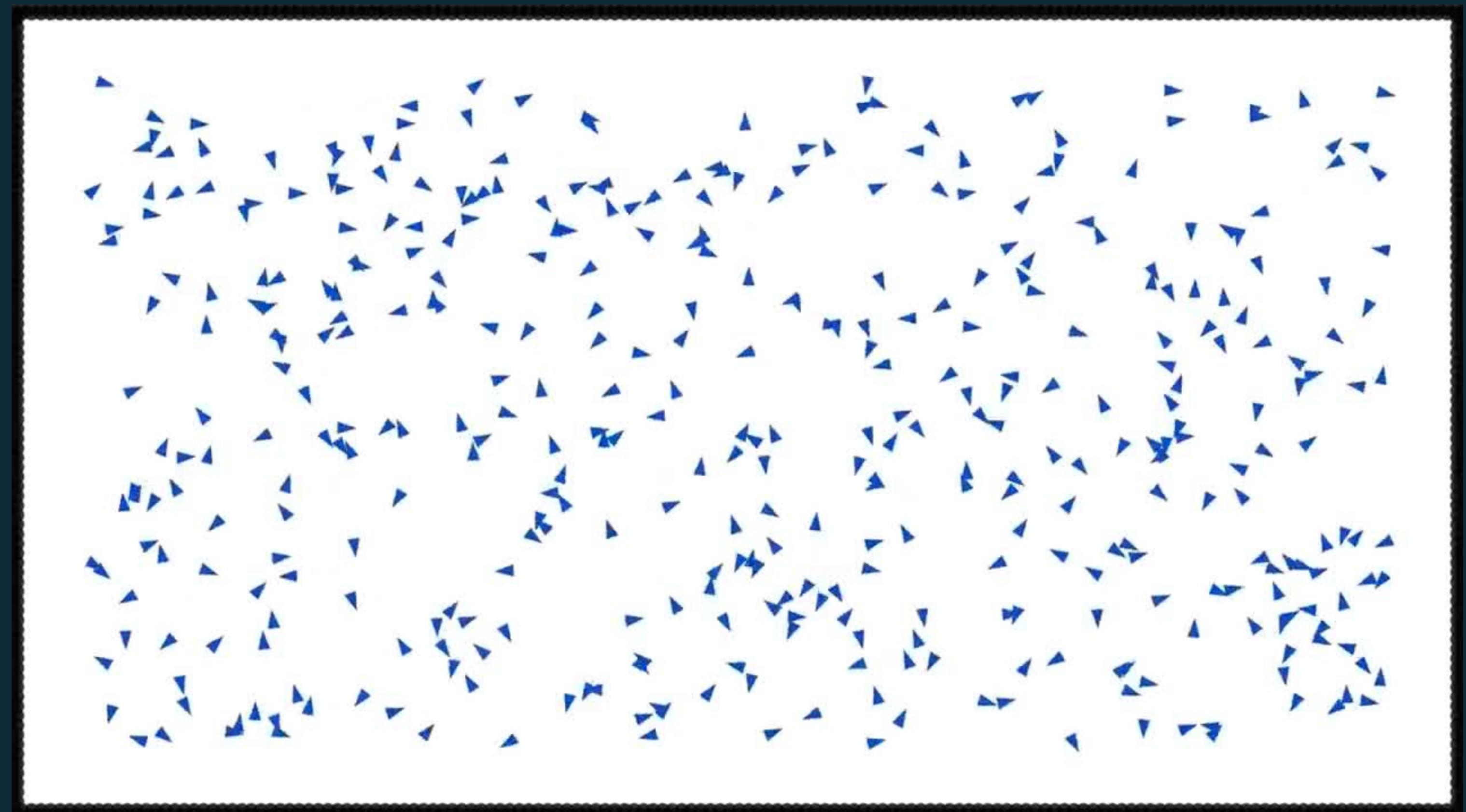
1. Séparation



2. Alignement

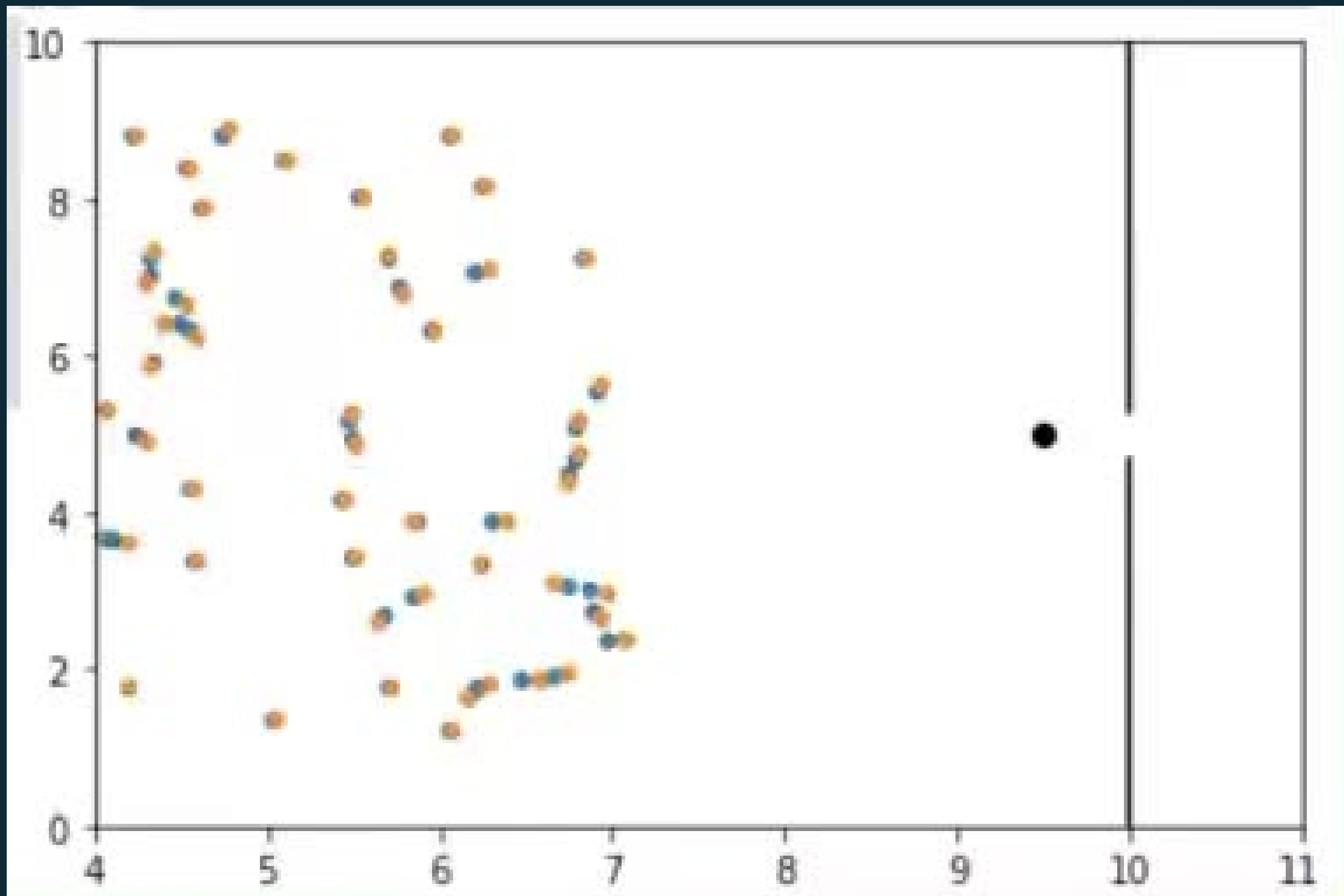


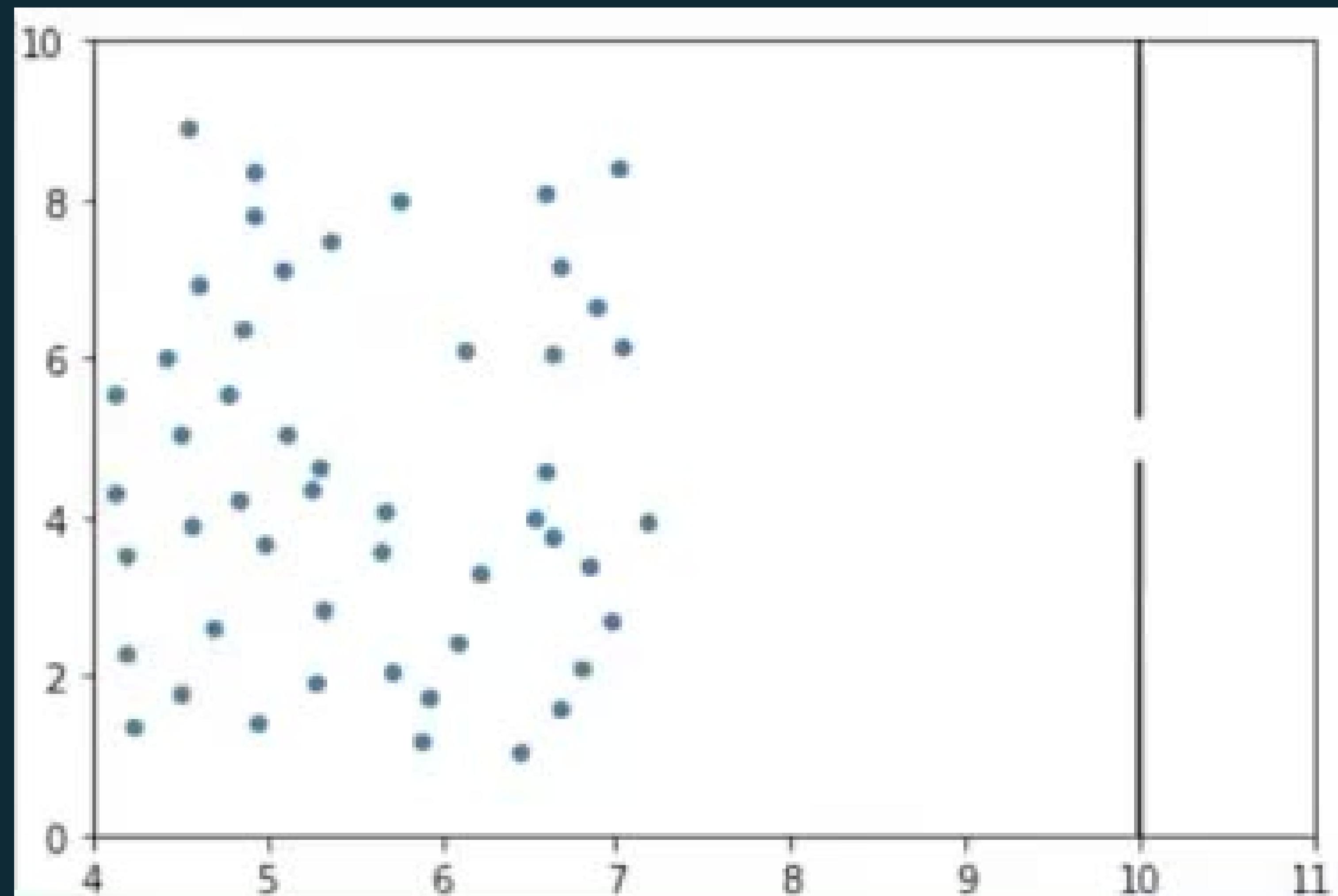
3. Cohésion

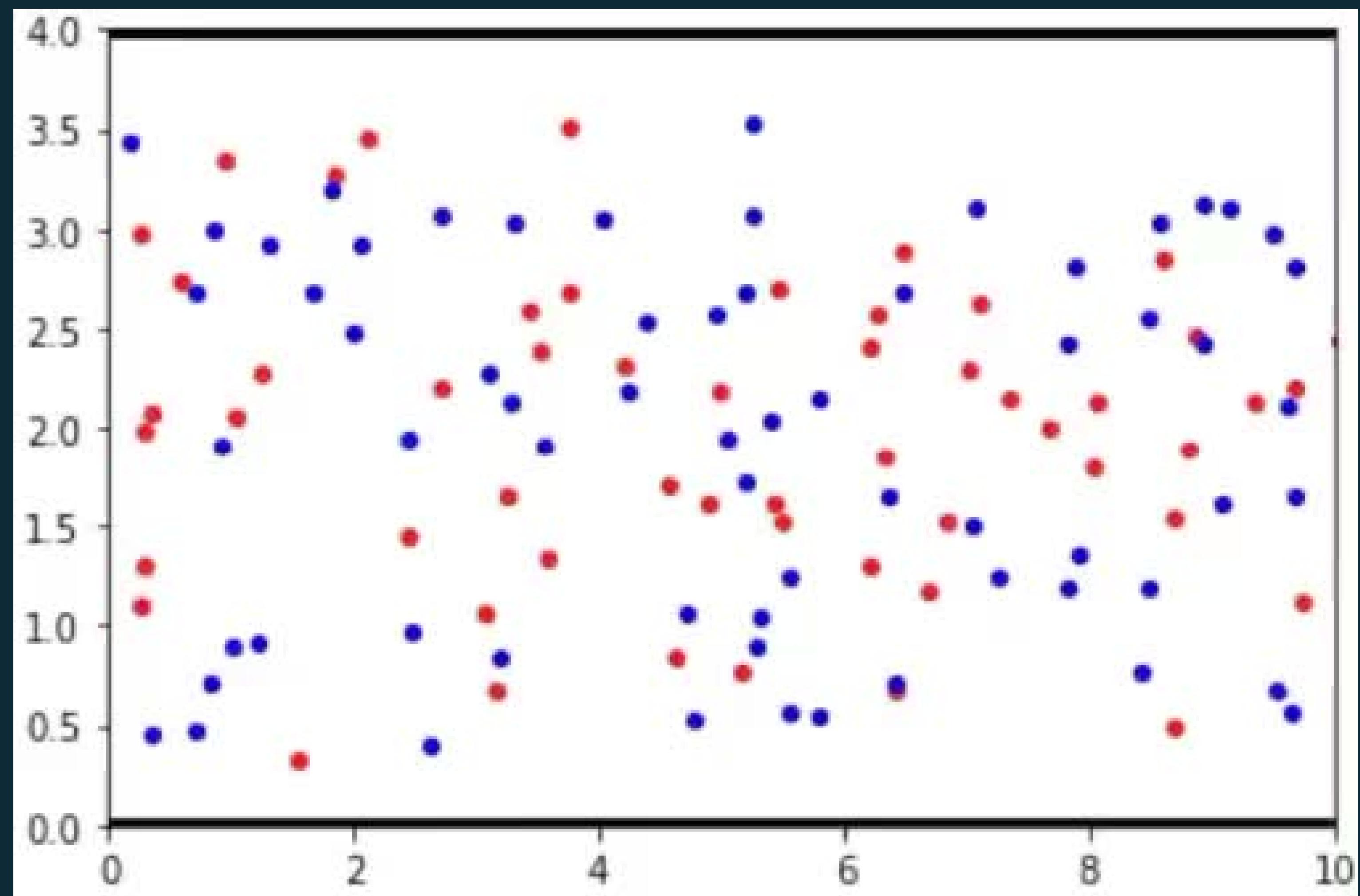


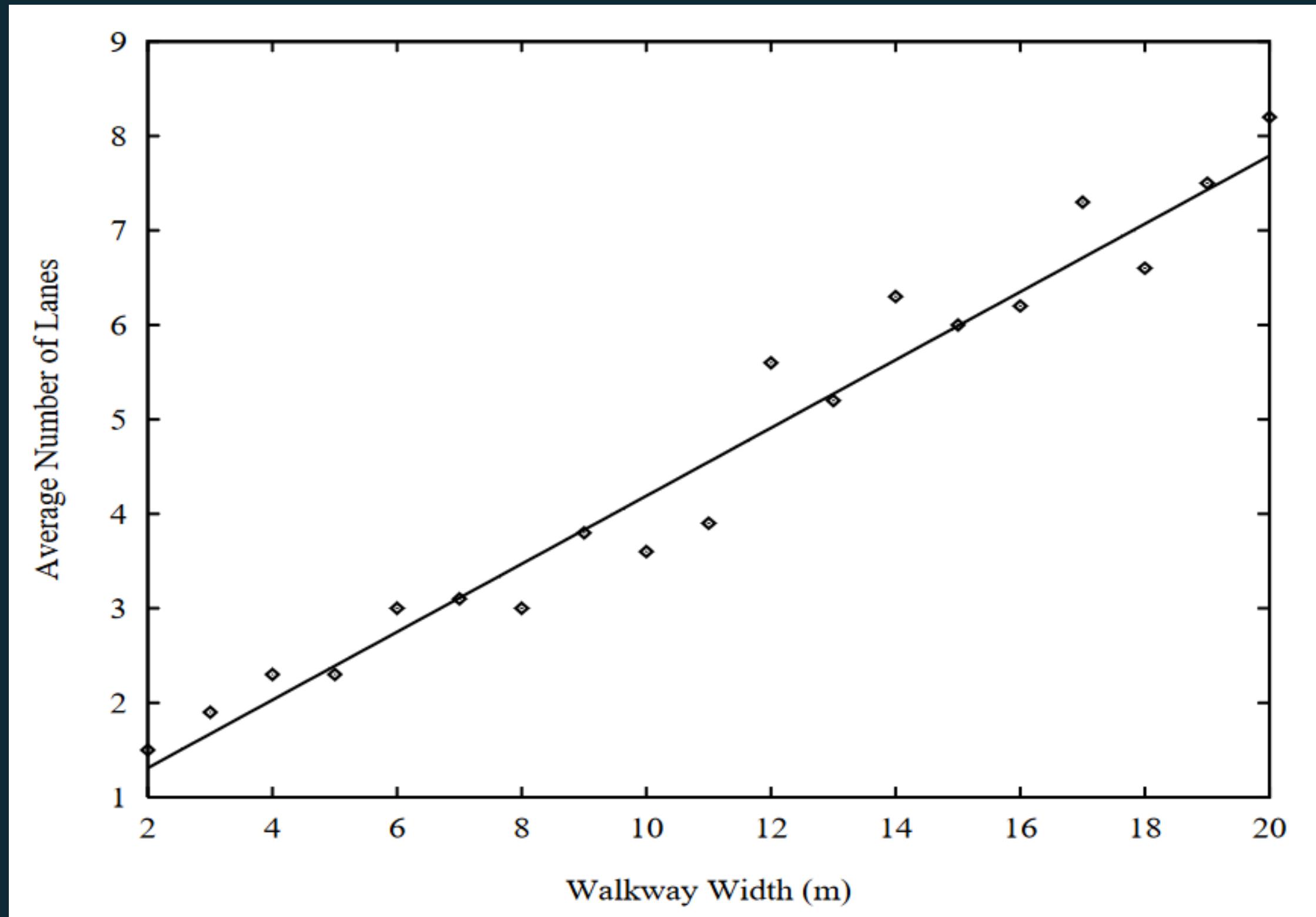
# CINQUIEME PARTIE

## APPLICATIONS











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*M. Moussaïd* : **Étude expérimentale et modélisation des déplacements collectifs de piétons**

*M. Mousaïd* : **Traffic Instabilities in Self-Organized Pedestrian Crowds**

*D. Helbing* : **Social Force Model for Pedestrian Dynamics**

*D. Helbing, P. Molnàr* : **Social force model for pedestrian dynamics**