

# Artificial repulsive pheromone approach for the exploration of ocean dynamics

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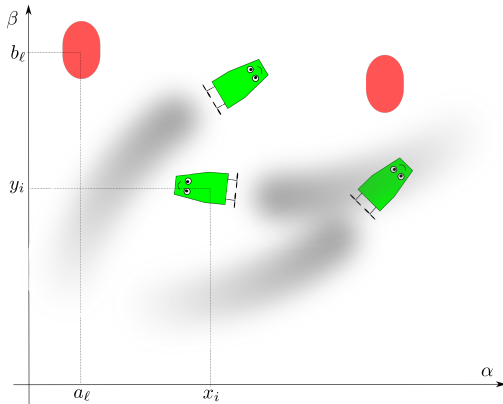


# Artificial pheromones

$$\mathcal{R}_i : \begin{cases} \dot{x}_i &= \cos \psi_i \\ \dot{y}_i &= \sin \psi_i \\ \dot{\psi}_i &= u_i \end{cases}$$

Artificial pheromone function has an evolution which is influenced by two factors: the evaporation and the visit:

$$\frac{\partial \phi}{\partial t}(\alpha, \beta) = \underbrace{-p_1 \phi(\alpha, \beta)}_{\text{evaporation}} + \underbrace{\sum_i e^{-\frac{(\alpha - (x_j - \cos \psi_j))^2 + (\beta - (y_j - \sin \psi_j))^2}{p_2}}}_{\text{visit}}$$



Each robot sows behind it some repulsive artificial pheromones

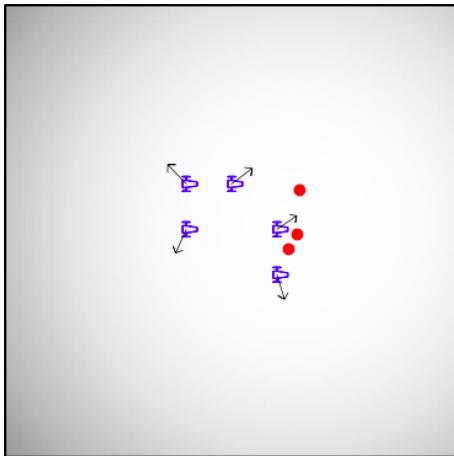
## Artificial force

$$\mathbf{f}_i = \underbrace{-\text{grad}\phi}_{\text{repulsive pheromones}} - \underbrace{\sum_{j \neq i} \frac{\mathbf{r}_{ij}}{\|\mathbf{r}_{ij}\|^3}}_{\text{repulsion between robots}} + \underbrace{\sum_{\ell} \begin{pmatrix} a_{\ell} - x_i \\ b_{\ell} - y_i \end{pmatrix}}_{\text{attraction by the buoys}}$$

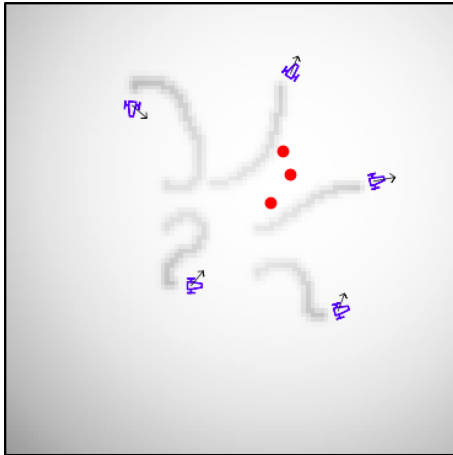
where

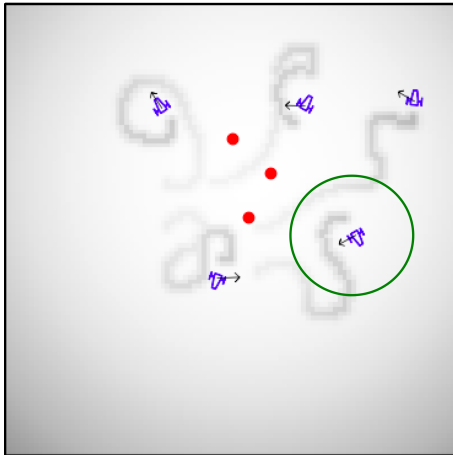
$$\mathbf{r}_{ij} = \begin{pmatrix} x_j - x_i \\ y_j - y_i \end{pmatrix}$$

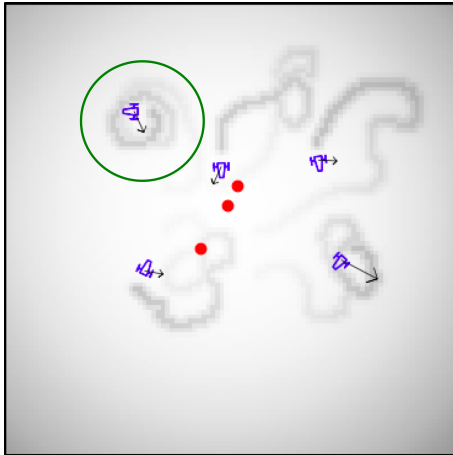
# Simulation

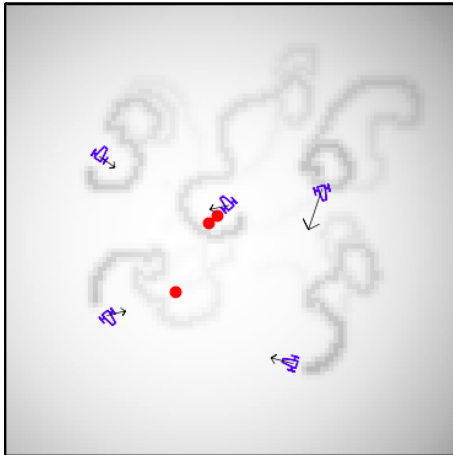


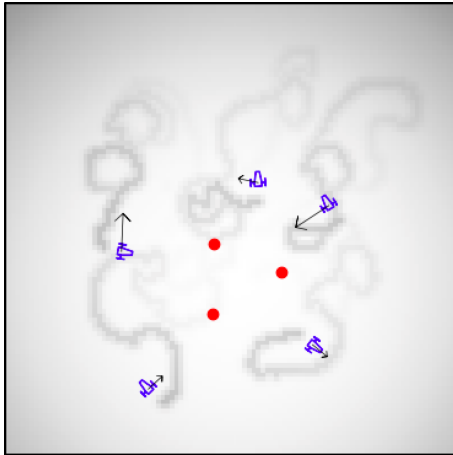


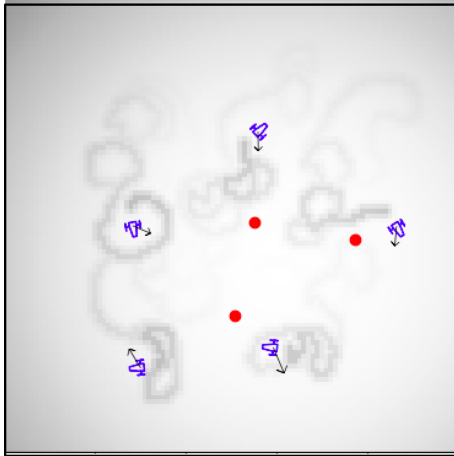


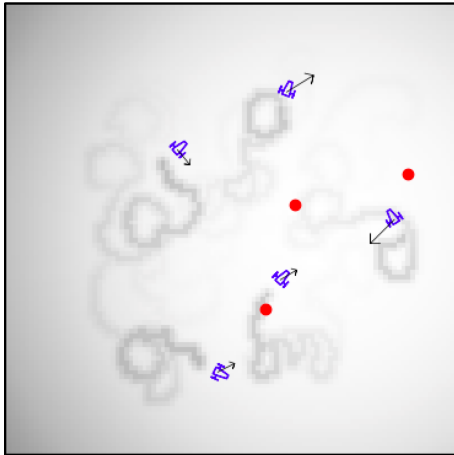






















# Experiment in the lac of la Maine





Mobesens : the autonomous Kayak in Angers, 2022, June 22

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<https://www.ensta-bretagne.fr/jaulin/pheromone.html>