An LGCA model of density-independent polar alignment

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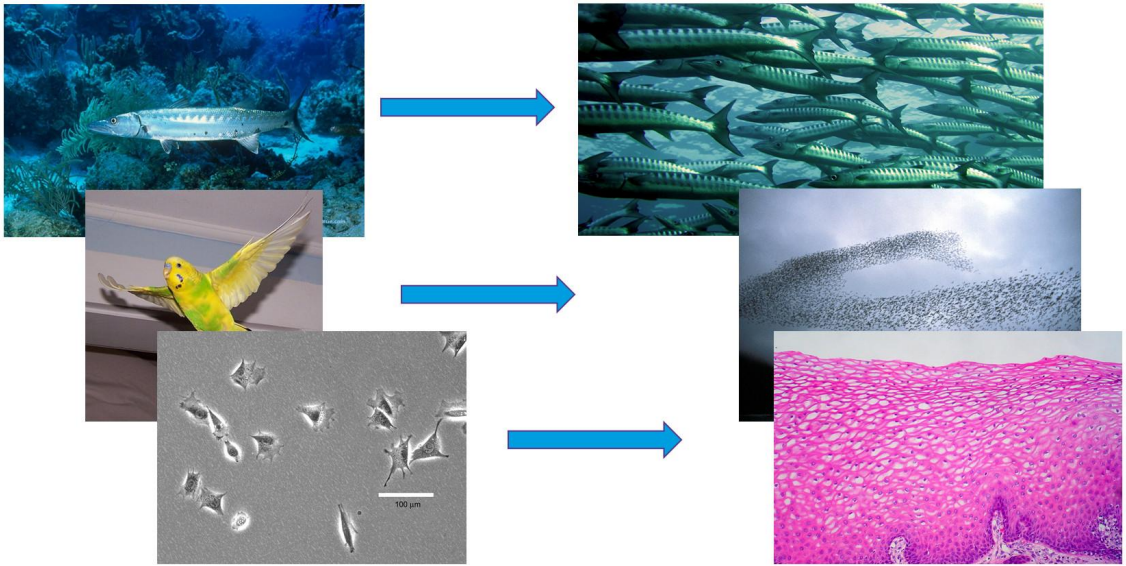
Swarm formation in nature



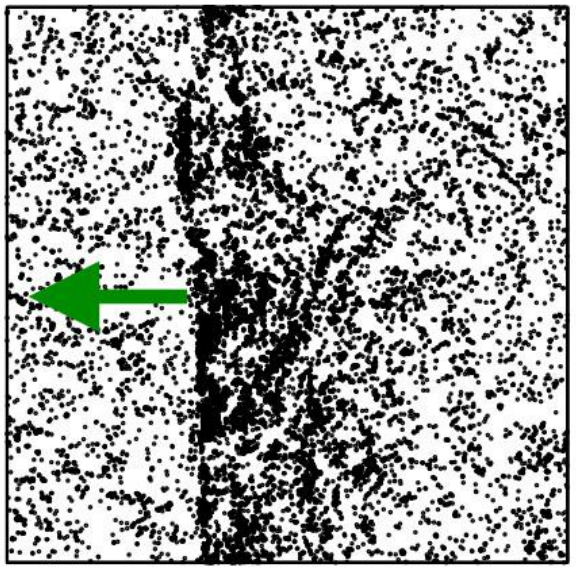
Vicsek model

In the classic off-lattice model, given that the particle velocity is given by

$$\vec{v}\left(\theta\right) = \left(\cos\theta, \sin\theta\right)$$

Then, the angle changes each time step as

$$\theta_n\left(t + \delta t\right) = \bar{\theta}_{\text{neigh}} + \xi(t)$$



Classic LGCA model

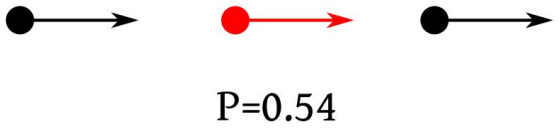
Single particle transition probabilities:

$$P_i = \frac{1}{Z} \exp\left(\beta \vec{P}\, \vec{c}_i\right)$$

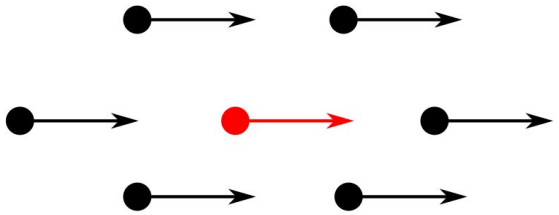
where the neighborhood momentum is

$$\vec{P} = \sum_{j=1}^{b} \sum_{k=1}^{b} \vec{c}_j s_j \left(\vec{r} + \vec{c}_k\right)$$

neu benennen! (vec) P ist bei mir was anderes!

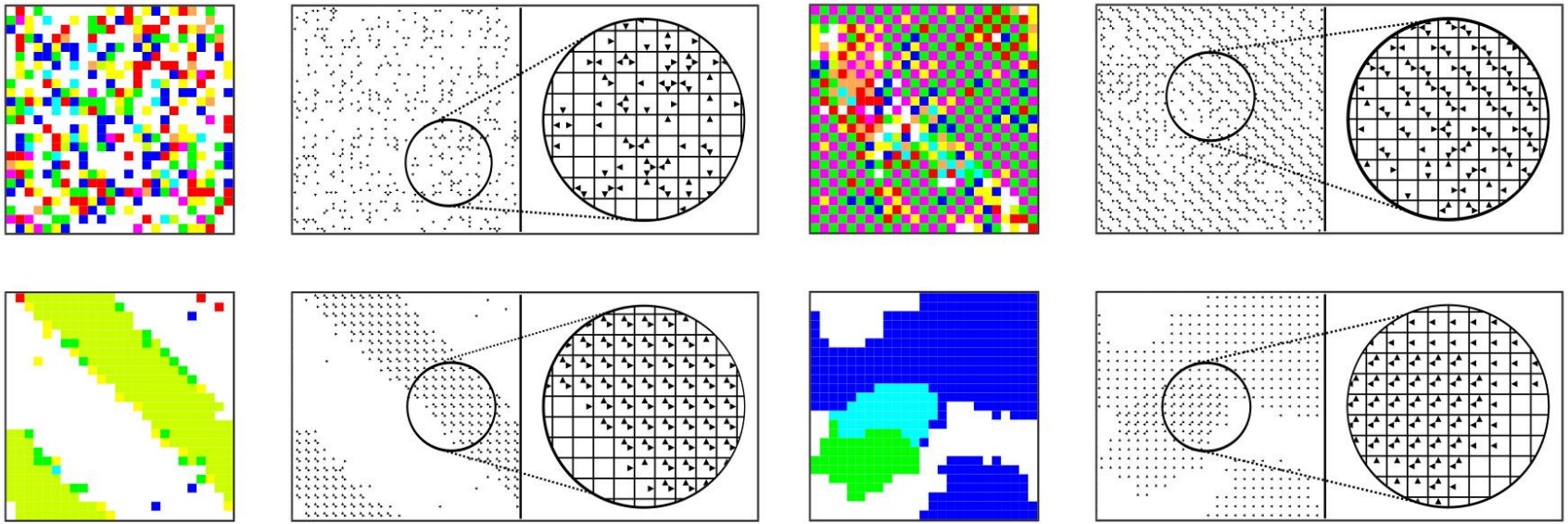


P=0.54



P=0.91

Patterns



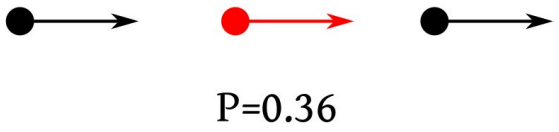
New LGCA model

Single particle transition probabilities:

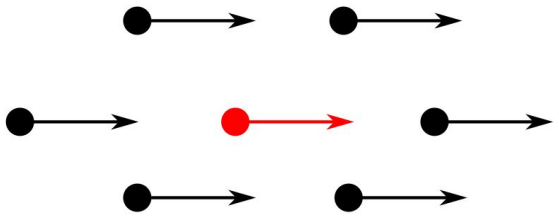
$$P_i = \frac{1}{Z} \exp\left(\beta \left\langle \vec{v} \right\rangle \cdot \vec{c}_i\right)$$

where the mean neighborhood velocity is

$$\left\langle \vec{v} \right\rangle = \frac{\sum_{j=1}^{b} \sum_{k=1}^{b} \vec{c}_j s_j \left(\vec{r} + \vec{c}_k\right)}{\sum_{j=1}^{b} \sum_{k=1}^{b} s_j \left(\vec{r} + \vec{c}_k\right)}$$



P=0.36



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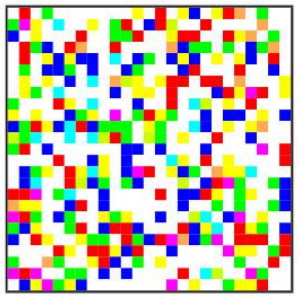
Patterns?

Sensitivity β



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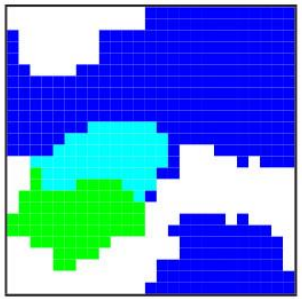

$\beta \approx 0$

$\beta \gg 1$