Data Science Course
Understading swarm behaviour

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Presentation Overview

- All models: sim300.py
- Paper 1: Effective leadership and decision-making in animal groups on the move (Couzin et al)
- Paper 2: Double milling in self-probelled swarms from kinetic theory (Carrillo et al)
- Quantification

All models: sim300.py

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 Models available:
'Simple speed coupling.....................smpl'
'Couzin model..............................czn'
'Viscek model..............................vsck'
'Couzin-2 model............................czn2'
'Mill model................................mill'
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Paper 1: Effective leadership and decision-making in animal groups on the move (Couzin et al): `czn2`

same as Couzin 1 model but without orientation phase

Paper 2: Double milling in self-probelled swarms from kinetic theory (Carrillo et al): `mill`

A kinetic theory based approach for swarming systems of self-propelled discrete particles.
Individuals driven by self-propelling forces and pairwise attractive and repulsive interactions lead to various morphologies, e.f. flocks, rotating mills, rings and clumps.
We can
- average in direction or velocity
- consider different zones of interaction and averaging (see Couzin et al)

Paper 2: Double milling in self-probelled swarms from kinetic theory (Carrillo et al): `mill`

But: As N=particles grows, it becomes increasingly difficult to follows the dynamics of each individual agent. Therefore, we choose a continuous approach where particles are represented by a density field.
Consider N interacting, self-propelled particles governed by the following equations of motion

$$\begin{aligned} \dot{x}_i &= v_i \\ \dot{v}_i &= (\alpha - \beta|v_i|^2)v_i - \nabla_{x_i} \sum_{j \neq i} U(|x_i - x_j|) \end{aligned} \tag{1}$$

where U is a pairwise interaction potential and $\alpha, \beta > 0$ are values for propulsion and friction forces.

Paper 2: Double milling in self-probelled swarms from kinetic theory (Carrillo et al): `mill`

For U we choose the Morse potential which is a common choice for interacting swarming systems

$$U(r) = \underbrace{-C_a e^{-r/l_a}}_{\text{attraction}} + \underbrace{C_r e^{-r/l_r}}_{\text{repulsion}} \tag{2}$$

where C_a, C_r denote attractive and repulsive strengths and l_a, l_r their respective length scales.

Quantification