On Steering Swarms
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1. Abstract
Agents properties:
- Identical and Indistinguishable
- Oblivious (no memory)
- Have limited visibility
- No explicit communication
- No common frame of reference (GPS, compass)

Incentive:
Steering the system via simple global broadcast signals.

2. Gathering Swarms

3. Steering Swarms
Single
\[ p(k+1) = p(k) + c(k)\Delta(k) \]
\[ c(k) = \begin{cases} \mu & \text{o.w.} \\ \frac{1}{\Delta} & \Delta > 0 \end{cases} \]

Multi
\[ p_i(k+1) = p_i(k) + c(k)[-\sigma \sum_{j=1}^{n} (p_i(k) - p_j(k)) + \Delta_i(k)] \]
\[ c(k) = \begin{cases} \mu & \text{o.w.} \\ \frac{1}{\Delta} & \Delta > 0 \end{cases} \]

4. Single Agent Simulation
Single agent, randomly jumps in a unit circle, with and without steering mechanism:
- Infinite visibility and full/Bearing-only sensing. Average number of time steps to reach the target point area: 1,500.
- Finite visibility and Bearing-only sensing. Average number of time steps to reach the target point area: 8,590.

5. Multi Agent Simulation
Systems of 10 agents, target point at a distance 100 units, and \( \mu = 0.01 \):
- Incentive: Steering the system via simple global broadcast signals.

6. Simulation Analysis
Number of time steps (K) to reach the target area vs. number of agents (n), and K/n vs. n.

6. Theory vs. Simulation
Theoretic vs. simulated results, single agent evenly distributed random jump to a unit circle.

Plot of K vs. n, K/n vs. n, and K(\( \delta \), D(0)) vs. \( \delta \) for different initial D(0) values from 10 to 100.