

Problem Set 7

(Out Thu 04/03/2025, Due Tue 04/15/2025)

Submissions are to be done by sending an email with subject `MATH 2121: Problem set 7` to the course instructor, containing: all requested Matlab files (called `yourfamilyname_problem7X.m`), plus a single file (PDF preferred), called `yourfamilyname_pset7.pdf`, that contains all requested explanations.

Problem 7

Conduct the following modifications to the Matlab file `temple_abm.swarming_birds.m` from the course website http://faculty.cst.temple.edu/~seibold/teaching/2025_2121/.

(a) Add a zone of attraction to the swarming model, so that there is repulsion for distances less than $1/3$, alignment for distances between $1/3$ and $2/3$, and attraction for a distances between $2/3$ and 1 . Submit your code under the filename `yourfamilyname_problem7a.m`. Compare the modified model (with attraction) to the model without attraction, describe the qualitative differences in the arising flocking behavior, and explain why they happen.

(b) Run an ensemble of simulations with the original code (no attraction zone) and with the modified code from above (with attraction zone) that provides a quantitative answer to the question: does the presence of an attraction zone cause the birds to arrange is fewer sub-swarms than without having an attraction zone? Ideally, you would implement an automated way to define and identify what constitutes a sub-swarm. In that case, submit your code under the filename `yourfamilyname_problem7b.m`. As a simpler (but also more tedious) alternative, you can conduct, say, 15 runs each up to a reasonable final time, and then count the number of sub-swarms by hand. In that case, include plots of the total 30 runs in your document `yourfamilyname_pset7.pdf`.

Modify your code from part (a) so that agents that are within a distance 1 of a wall know about the presence of the wall and adjust their behavior accordingly in a reasonable way. For instance, think of birds turning preemptively to avoid the wall instead of bouncing off the wall. Submit this code under the filename `yourfamilyname_problem7c.m`. Describe how this modification affects the emergent swarm behavior relative to the model in part (a).