Jihye Lee Problem 8

(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.**

- In the model without attraction, the agents initially gather in the center and swiftly disperse towards the domain's edges. This behavior is primarily attributed to the repulsion zone, which prompts the agents to veer away from each other upon initialization when they are in close proximity. Subsequently, as they move, the agents gradually align their directions, driven predominantly by the alignment force. This alignment serves as the primary mechanism for the agents to coalesce into a cohesive swarm, as they collectively orient themselves in the same direction. Notably, as the agents encounter the domain's boundaries, they exhibit clustering and alignment, forming distinct flocks as they navigate along the boundary.

Conversely, in the model with attraction, we observe that agents quickly form tight clusters shortly after the simulation commences. These clusters persist and remain intact as the model progresses. An in-depth analysis of the role played by the attraction zone reveals its interaction with the repulsion and alignment zones. The attraction force facilitates the formation of cohesive groups by drawing agents towards each other, counteracting the tendency to disperse caused by the repulsion force. This dynamic interplay between the three zones shapes the collective behavior of the agents, leading to the observed clustering and maintenance of groups over time.

(c) **Change your code from part (b) to have a zone of attraction, as in part (a) Now, using the codes from parts (b) and (c), run representative simulations that investigate whether the presence of a zone of attraction makes it more likely (or less likely) for all agents to form a single swarm. Explain your observations and interpret them.**

- In part (c), the presence of the attraction zone leads to the formation and maintenance of smaller swarms that remain cohesive. Conversely, in part (b), where the attraction zone is absent, the primary force propelling agents towards forming a single swarm is the alignment zone, operating within a range of 1/3 to 1 unit. Consequently, agents in part (b) are more inclined to converge into a unified swarm rather than clustering into smaller, tightly-knit groups as observed in part (c).

(d) **Based on your code from part (a) [i.e., with walls], modify the agent laws so that agents who are within a distance 1 to a wall know about the presence of the wall and adjust their behavior accordingly (i.e., they turn preemptively to avoid the wall). This can be thought of as the birds in the front of the swarm acting as leaders who conduct obstacle avoidance. Describe how this modification affects the emergent swarm behavior relative to the model in part (a)**

- In this modified version of the swarming bird model, agents are equipped with the ability to detect walls within a certain proximity. Specifically, agents monitor their distance to the walls and, when they come within a distance of 1 unit to a wall, they proactively alter their flight path to avoid collision. This adjustment is crucial for maintaining smooth movement patterns and preventing agents from getting trapped against the boundaries.

When an agent detects that it is within the specified distance to a wall, it turns away from the wall to prevent collision. This preemptive action mimics the behavior of leaders within the swarm who act as guides, steering the collective away from obstacles. By incorporating this adjustment, the swarm demonstrates a higher level of adaptability and resilience in navigating complex environments.