Homework 3
Colorado CSCI 5314

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Simulation of Flocks

Note: All code and simulation GIFs can be found here. Simulation GIFs were unable to be attached to this document, thus must be viewed in a repository.

(1)

Note: The naming of the GIF files relevant to this part of the problem take the form of "cx_y_z", where "cx" is the scaling factor in question (c1, c2, c3, c4) and "y_z" is the value for said scaling factor with the decimal point replaced with an underscore (to stay standard with file naming conventions). For example, "c4_0_5.gif" is the simulation where scaling factor c4 is set to 0.5 (and all other scaling factors are left at their default values). The simulation run with all default scaling values is named accordingly ("control_simulation.gif").

From the simulations run, it seems that the scaling factors effect the simulations in the following ways:

- c1 (Attraction)
  - The higher the value of this scaling factor, the more the agents strive to be close to one another. With smaller values (that are still greater than the default value), we see the agents flock together at a fair pace. When the value increases, we see the agents flock together more quickly, becoming almost instant as we increase the value further. With the highest value tested (c1=0.025), we see the agents get so close together so quickly that they are subsequently repelled, then flock back together, then repelled, so on and so forth (they are exhibit a sort of cyclic behavior of attraction and repulsion due to their strong desire to stick together - it seems they get TOO close to one another).

- c2 (Repulsion)
  - The higher the value of this scaling factor, the more the agents strive to be apart from one another. With smaller values, we see the agents spread apart at a fairly slow pace, with the pace increasing as the scaling factor does. After some time, the agents can be seen to be evenly (or nearly evenly) spaced out, looking to reach a sort of equilibrium state (with minor fluctuations as the agents drift toward one another and are repelled).
- c3 (Heading)
  - With value of one or greater for this scaling factor, the agents look to keep the same heading as one another. With lower values, their headings "wobble" a bit, and devolve into a bit of chaos as the value gets low enough (as the agents do not have a strong desire to stay on the same heading as one another).
- c4 (Randomness)
  - With reasonably small values for this scaling factor (that are still greater than the default value), we see the agents exhibit a similar "wobbling" behavior as mentioned in the above description. With these values we still see the agents maintain generally the same course (their velocities are generally matched, but their headings wobble). With larger values, we see the agents devolve once again into chaos, not keeping the same velocity or heading, seeming to move around with a high degree of randomness.

(2)

Note: The naming of the GIF files relevant to this part of the problem are structured the same way as in the previous part.

As expected (and as described in the assignment), a lower attraction scaling factor leads to the non-static agents splitting into two groups to get around a static repulsive agent, while a higher attraction scaling factor leads to the non-static agents staying grouped as one, even turning around to avoid the obstacle if necessary (the agents want to stick together so much so that they'd rather turn around entirely to avoid the obstacle than split into two groups to get around it). This behavior is about what was expected, but fascinating nonetheless.

Paper Review

Main Contribution

This paper is centered around the study of the herding of flocking animals. Specifically, the authors formulate an automated approach to sheep-sheepdog herding processes with the goal of simulating actual herding processes with a reasonable degree of accuracy/realism (and thus gain an understanding of how the herding agents go about effectively herding their respective groups of flocking animals).

Essential Principle Being Exploited

The authors use an attraction/repulsion model (similar to the problem presented in the coding portion of this assignment) with position, velocity, and heading alignment (along with a randomness factor). There is some set of movement rules for the flocking agents, and another for the herding agent. The flocking agents each have some degree of attraction toward the center of mass of the entirety of the flock (or in other cases, toward the local center of mass, only taking into account some amount of nearest neighbors).

Major Strength

It seems that the authors were able to fairly accurately formulate an automated approach to herding, in that their mechanism performs quite similarly to the sampled real-life herding events. They also do a great job of proposing various future work directions to readers, prompting those with interest in the topic to delve deeper into research of this kind.

Weakness

The one main issue I have with this work is that the main issue encountered in creating this model (the herding agent getting stuck between multiple groups of flocking agents) is not remedied. It is mentioned that instructions/rules could be given to the herding agent if this were to occur, but I think it's quite relevant to this subject matter to see how such a remedy would perform. It simply seems odd to me that the main issue is addressed in ideation, but not applied (especially when it seems that this model has few flaws otherwise).

Future Work Direction

As mentioned above, I need to see how the "instructions" given to the herding agent would perform. Beyond that, I would like to see how broader applications of the ideas addressed in this paper would pan out. Cleaning up environments (i.e. trash cleanup from bodies of water) would be fascinating, as it brings in other outside factors such as current movement, water temperature, and how those could interact with various waste substances. It could also be interesting to vary the amount of information each flocking agent has, and how that affects the group dynamic.