CSCI 4314: Dynamic Models In Biology

Homework Set 3

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Simulation of Flocks

**Original Conditions: *c1:*** 0.00001 ***c2:*** 0.00001 ***c3:*** 1 ***c4:*** 0.001

**Chart, scatter chart

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|  |  |  |
| --- | --- | --- |
| **C1:** Attraction | | |
| **-0.00001** | **-0.000005** | **0** |
| **Chart, scatter chart  Description automatically generated** | **Chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** |
| **0.000025** | **0.000005** | **Analysis** |
| **Chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** | From the varied C1 values of attraction amongst to flock, it can be seen that **0** attraction amongst the agents places them evenly within the flock spread. The attraction of the flock also influences the direction of the flock and velocity of each individual agent. With negative attraction values, the flock fly’s in the opposite direction. An increase attraction from the original value brings them closer together. A smaller attraction adjusts the direction and spreads the flock out. |

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| --- | --- | --- |
| **C2:** Repulsion | | |
| **0.05** | **0.0005** | **0** |
| **Chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** |
| **1** | **0.0000025** | **Analysis** |
| **Chart, scatter chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** | The varied C2, representing repulsion between agents, shows some interesting trends. When the replsion between agents is 0, the flock moves in the opposite direction. With a repulsion factor closer to 1, the flock seems to fly into itself, therefore not being a plausible repulsion factor. With a repulsion factor closer to 0, the flock adjusts direction. With a larger repulsion factor than the original, the flocks spread becomes a little more consistent. With a smaller factor, the flock spread becomes a bit larger than the original but the direction of movement changes more significantly. |

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| **C3:** Velocity | | |
| **-1** | **-0.5** | **0** |
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| **0.5** | **1** | **Analysis** |
| **Chart  Description automatically generated** | **Chart  Description automatically generated** | Looking at various flock velocities, it can be seen that a smaller velocity near 0 causes the flock to ‘implode’ therefore not being realistic. A velocity of -1 shifts the flock direction northeast and a velocity of 1 shifts it futher east. A velocity of -0.5 acts similarly to a velocity of 1. But a velocity of 0.5 acts opposite to -1. |

|  |  |  |
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| **C4:** Randomness | | |
| **-0.001** | **0.01** | **0** |
| **Chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** |
| **0.00005** | **1** | **Analysis** |
| **Chart, scatter chart  Description automatically generated** | **Chart, scatter chart  Description automatically generated** | A randomness of 0 shows a flock with equal spread and velocities as the original flying southwest. A randomness of 1 shows a flock flying into each other, therefore being unrealistic. Values larger than the original randomness of 0.001 showed the flock flying in the opposite direction. Values smaller than 0.001 Show pretty similar spread and velocity to the original but with a shift northeast in direction. |

**C5 = 0.001 Chart

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Paper Review

1. **Main Contribution**

Strömbom mentions that most research relating to shepherding and herding follows a theoretical approach. This past research effectively models the interactions of agents based on factors such as attraction, repulsion and alignment. Strömbom aims to contribute to research in this field with a more realistic and real-life approach that can benefit in applications outside of herding. Strömbom finds that sheepdogs can herd groups double the side of a normal large group of sheep. Using an emergent method of switching between driving and collecting sheep, the dogs show an effective method of herding sheep. By collecting the sheep into one large group, and then directing them to their destination, the sheepdog can focus on keeping the herd cohesive and on route. With these findings, Strömbom hopes to use sheep-dog interactions to design robots that can aid in influence movement of other agents.

1. **Essential Principle**

The essential principle that Strömbom focuses on is the use of shepherding dogs herding autonomous interacting agents, sheep, towards a target destination. Based on the adaptive switching shown in the research and data analysis, a side-to-side motion of the shepherd emerges that shows improved efficiency in herding. This follows the two principles, (i) to reduce the probability of the herd splitting and (ii) to keep the herd moving towards their destination. Strömbom focuses on this emergent trend in herding strategies and finds it to be useful in understanding group movement.

1. **Major Strength**

Strömbom heavily discusses the plausibility of the data used in their research. The data analysis is defended with real world examples of similar trends and phenomena. Sheep-dog interactions repeatedly show similar emergent movement in herding dogs that aid in efficiently moving a flock to their destination.

1. **Weakness**

The paper lacks discussion of future work and applications outside of shepherding flocks. Though there is slight mention of possible applications, including citations to other sources, there is no discussion of how the conducted research and analysis can also be applied further. There is not discussion of how past data or research can or has been applied to outside applications, and therefore, the paper begs for a discussion of how their data and research goes further to prove outside application.

1. **Future Work**

There is clear evidence that research in sheep-dog interaction and behaviors has applications in crowd control. In current society, it is common for riot or other quickly forming crowds to need quick, non-violent crowd control or dispersal. This is commonly the responsibility of police officers and other officials. Using the methods found from the research and data analysis in this paper and others similar to it could greatly help these officials in non-violent crown control. Herding research has great applications even further at large scale concert venues or weekend long events. Overall, the paper failed to really dive into the many uses of their research, and did not fully support why it has great value.

Strömbom D, Mann RP, Wilson AM, Hailes S, Morton AJ, Sumpter DJT, King AJ. 2014 Solving the shepherding problem: heuristics for herding autonomous, interacting agents. J. R. Soc. Interface

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