

Models and Simulations in Shepherding Work (Public)

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1 Models

At the k th step, the i th sheep has forces from the j th sheep neighbor, the d th shepherd and the goal g . The d th shepherd has forces from the i th sheep, the j th shepherd neighbor and the goal g .

Models are introduced in the tables below. The last table has been deprecated.

When the Euclidean distance between shepherd and sheep is less than one and it is at the position of the dominator of the formula, we approximately think of the value as one.

(Formulas are deleted for protection.)

2 Discussion

The limit distance can be omitted due to our unique strategies, like the method of choosing target sheep and repulsive forces between shepherds.

Through decreasing and balancing the parameters, as well as adjusting the models, we have made the movement of shepherds more fluent and natural.

We have not considered whether there are insensitive sheep inside the flock at present.

3 Simulation

We did simulations by the Zeus server in the research lab. The shepherd number varies from 1 to 10 while the sheep number varies from 1 to 50, which means that each process has 500 iterations in total. The whole process costs less than 10 minutes.

Speaking of target selecting strategy, under selection with fraction, shepherding may fail when the total shepherd number is 2 or 3 because shepherds tend to drive one sheep member away from the flock. Under selection with subtraction, the shepherding usually succeeds.

Table 1: Model of Sheep

Force	Parameter
Separation in flock K_{s_1}	100.0
Alignment in flock K_{s_2}	0.5
Cohesion in flock K_{s_3}	2.0
Repulsion from shepherds K_{s_4}	100.0

Table 2: Model of Shepherd

Force	Parameter
Attract from target sheep K_{d_1}	4.0
Repulsion from sheep K_{d_2}	400.0
Repulsion from goal K_{d_3}	
Repulsion from other shepherds K_{d_4}	0.8

Table 3: Target Selection Strategies

Element	Parameter
Selection with fraction	$k_1 = 0.8$
Selection with subtraction	$k_2 = 0.5$

Table 4: Other Strategies

Element	Attribute
Limited distance d_{min}	
Limit velocity when $\min(\ x_d(k) - x_i(k)\) < d_{min}$	

If the shepherding succeeds, the process will cost about 200 steps under both strategies. With the increase of shepherd number, while, the costs will maintain in general.

4 Summary

In this week, we have removed the limit distance, balanced the parameters and redcribed the model formulas and have some preliminary simulation results.

Under this framework of formulas, I will continue to make simulations to compare the shepherding performances in different parameters or under varied physical conditions.

5 Appendix

Fore more graphs, please check the attached files.

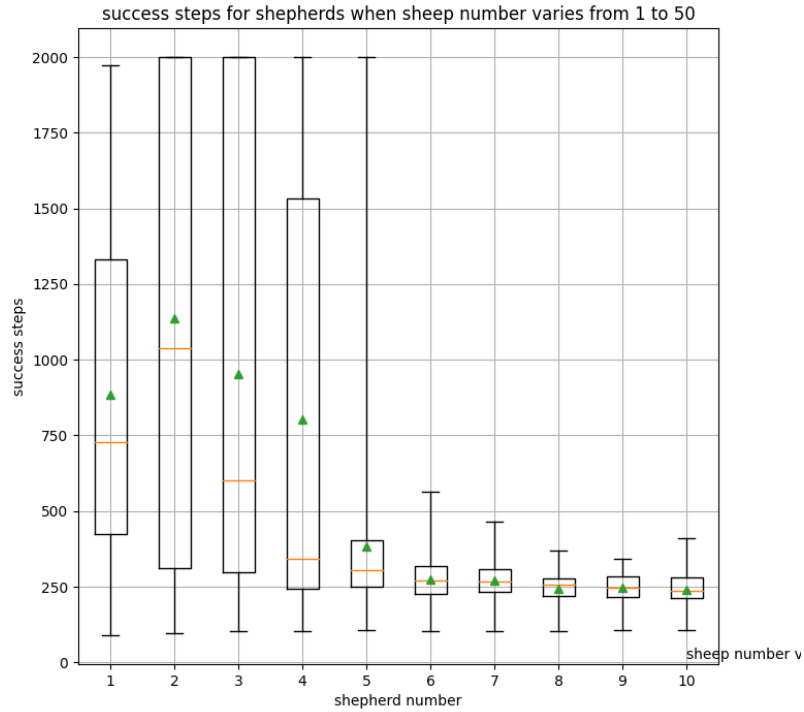


Figure 1: Selection with fraction

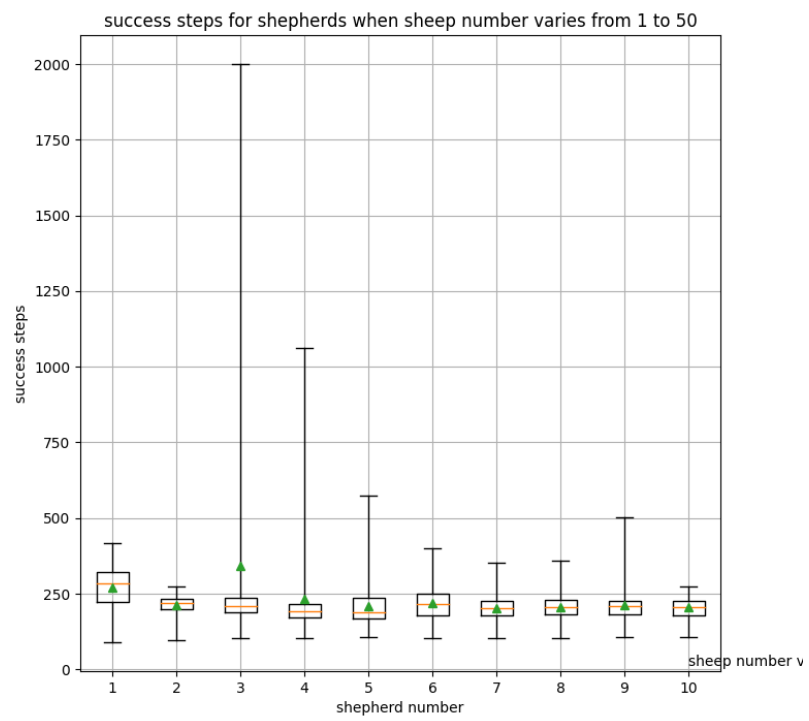


Figure 2: Selection with subtraction