Multi-scale swarm dynamics

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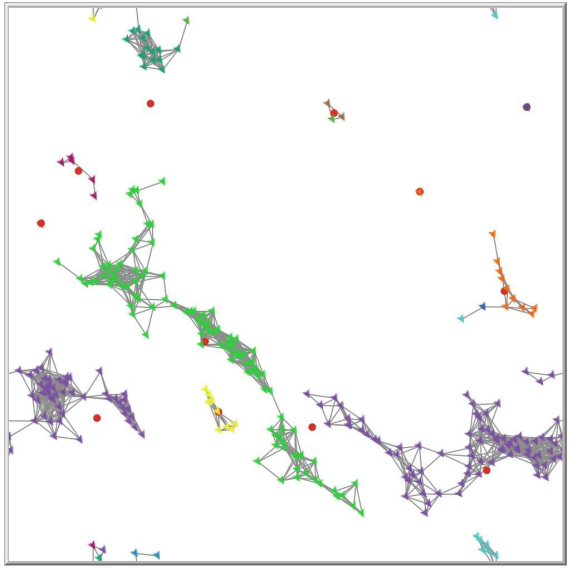
Outline

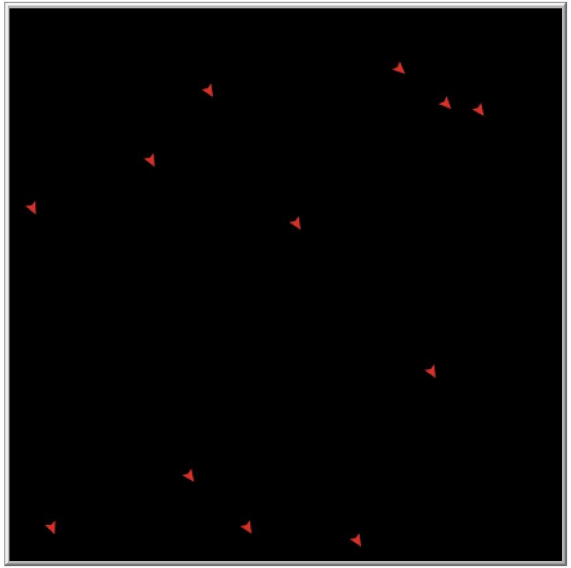
- ❑ Introduction
- ❑ Swarm Dynamics : Basics
- ❑ Tuning the model
- ❑ Multi-Scale
- ❑ Experiments
- ❑ Conclusion

Introduction

Idea



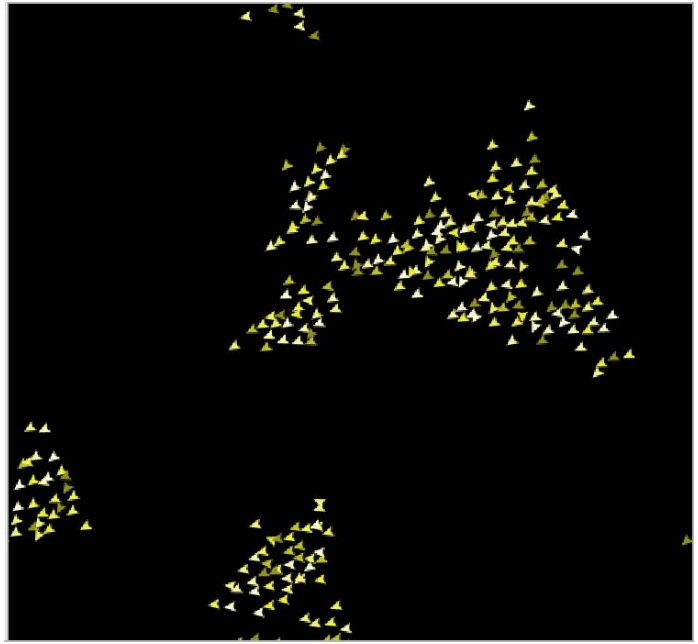
Bottom level of bird swarms



Top level of swarms of bird swarms

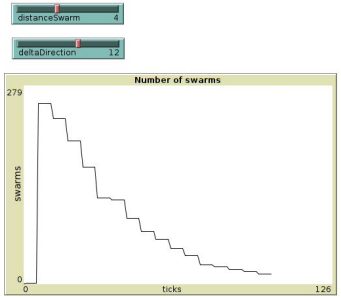
Swarm Dynamics

FLOCKING (NetLogo Example)



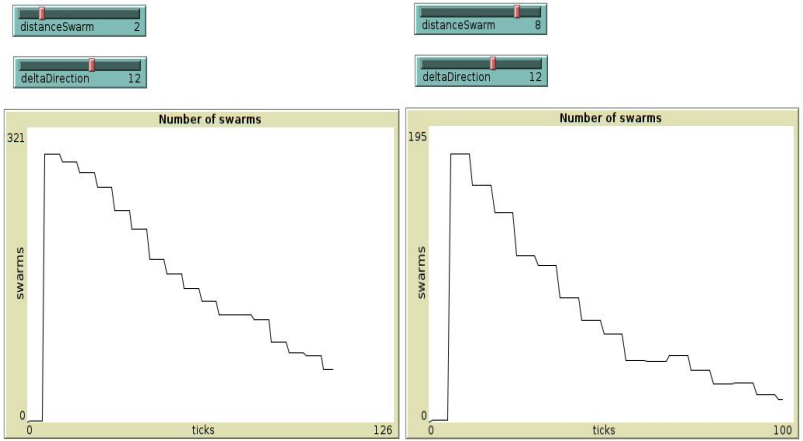
- separate
- cohere
- align

Tuning

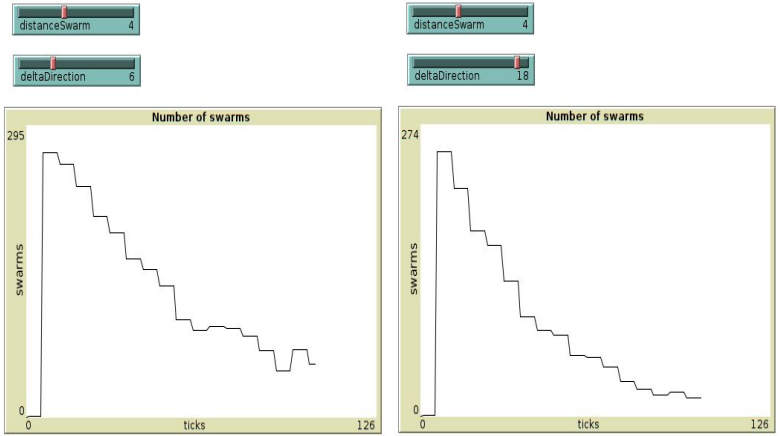


Swarm detection

Distance between two agents



Delta between two agents' headings



Centroid computation

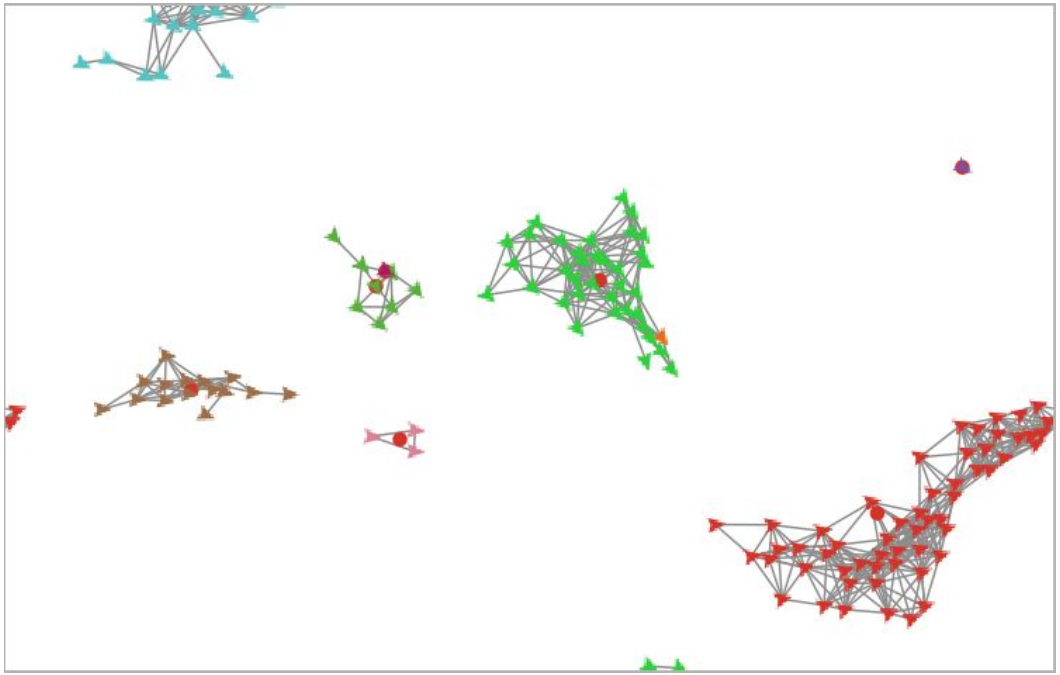
Position of the centroid

$$\left(\sum_i^n \frac{x_i}{n} ; \sum_i^n \frac{y_i}{n} \right)$$

Heading of the centroid

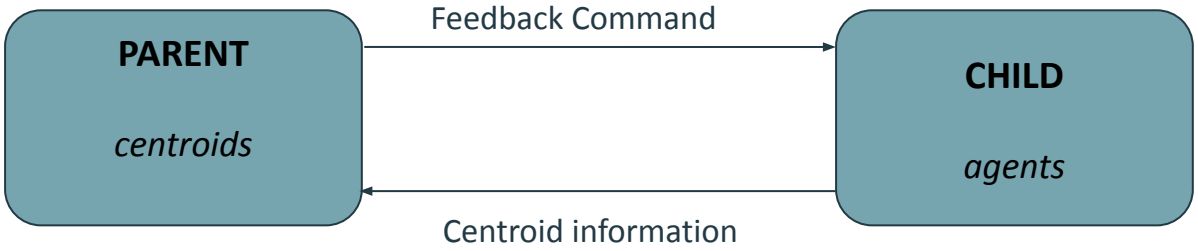
$$h = \arctan \left(\frac{\sum_i^n \sin(h_i)}{\sum_i^n \cos(h_i)} \right)$$

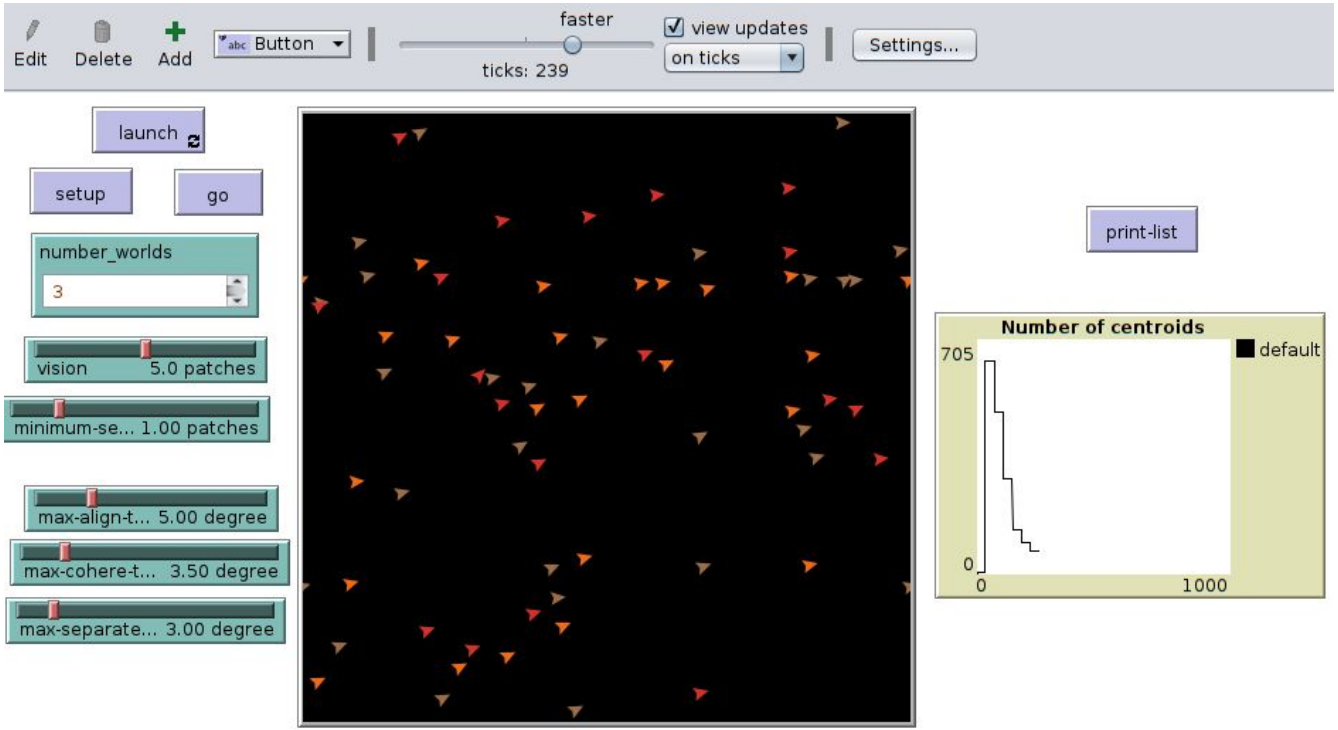
Swarm detection



Multi-Scale

Level-Space


PARENT
centroids
Feedback Command
Centroid information
CHILD
agents


Edit
Delete
Add
Button
faster
ticks: 239
view updates
on ticks
Settings...
launch
setup
go
number_worlds
3
vision 5.0 patches
minimum-se... 1.00 patches
max-align-t... 5.00 degree
max-cohere-t... 3.50 degree
max-separate... 3.00 degree
print-list
Number of centroids
default
705
0
0
1000

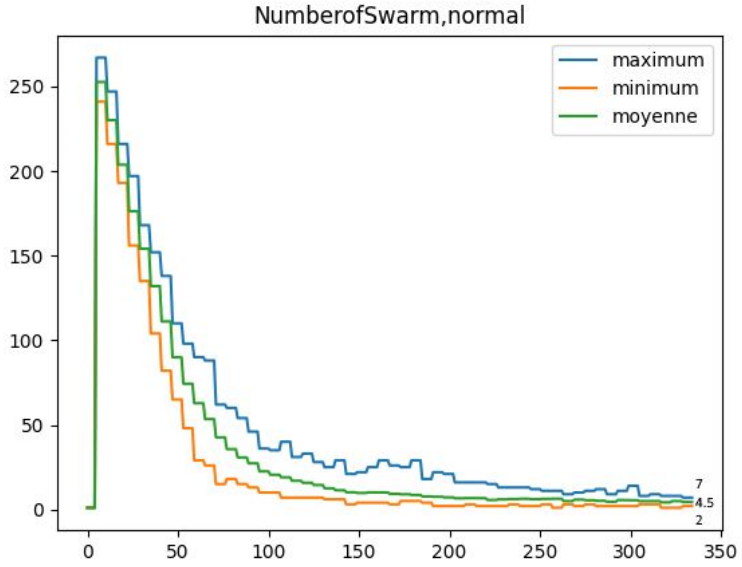
Experiments

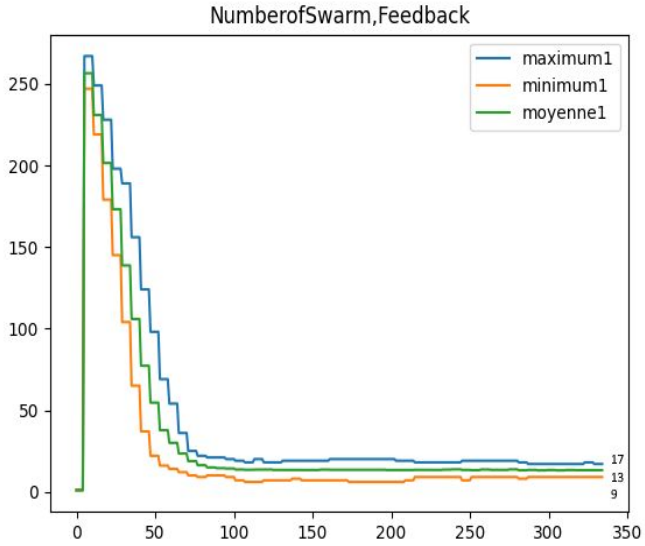
Parameter impact

(child model)

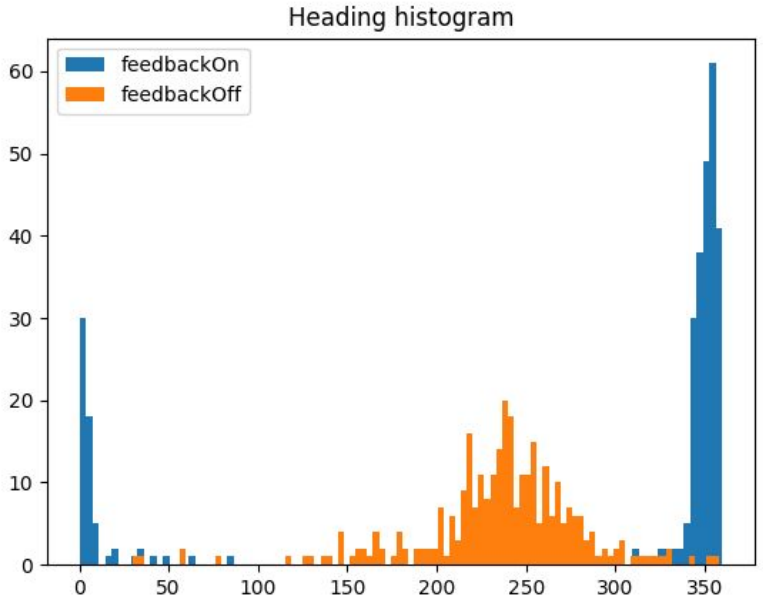
Parameters	**Effect**
max-separate-turn	Increase => swarms are less likely to form
vision	Increase => swarms are more likely to form
minimum-distance	Increase => swarms are less likely to form => Increase spacing in swarms
max-align-turn	Increase => swarms are more likely to form
max-cohere-turn	Increase => swarms are less likely to form
distanceSwarm	Increase => bigger swarm
deltaDirection	Increase => bigger swarm

Basic impact of Multi-Scale

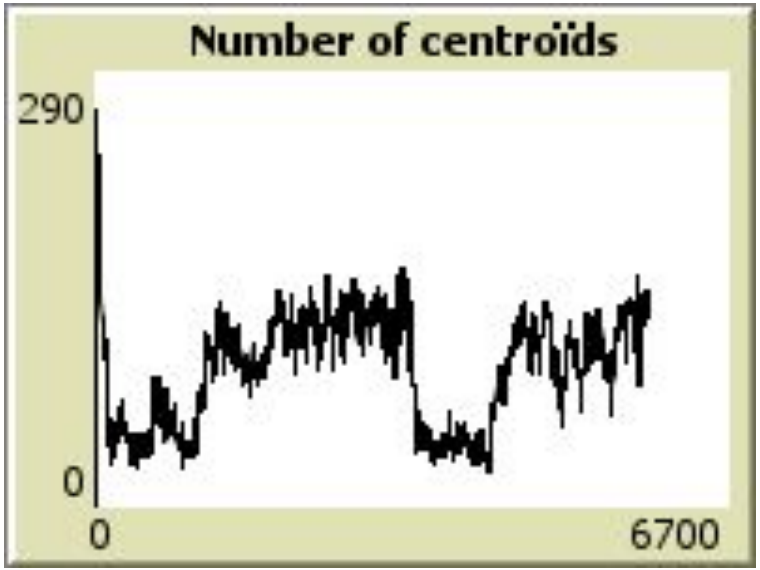




Stabilization



Dynamics switch

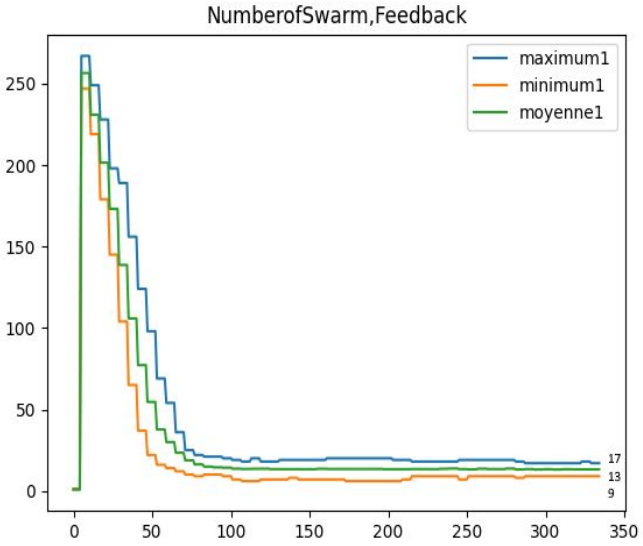


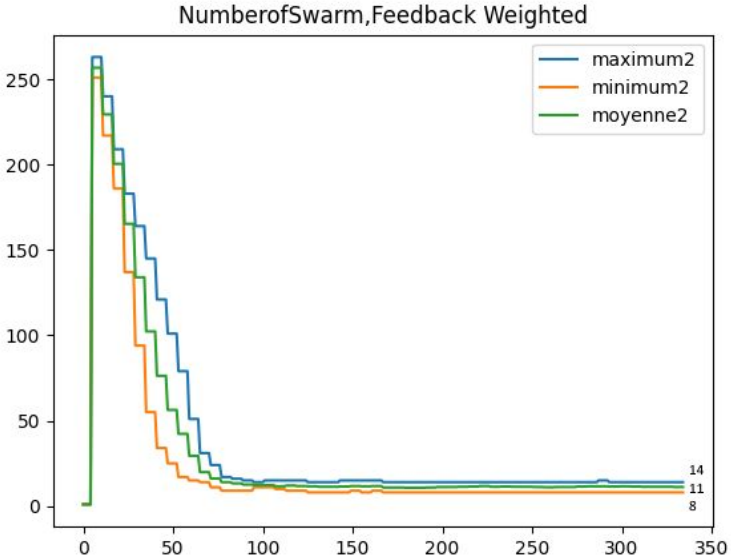
- Child min-separate-distance = 1

- Create random dynamic

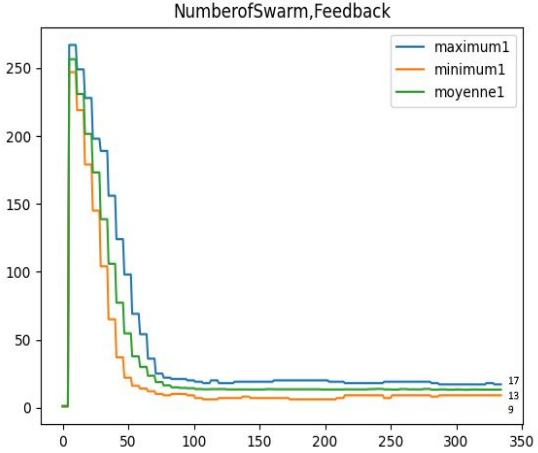
  without feedback

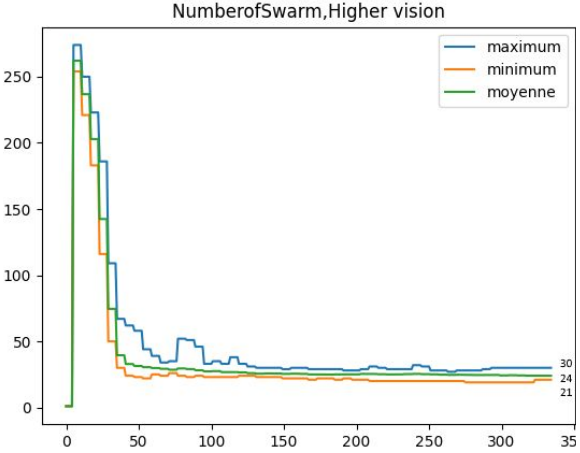
Weighted feedback

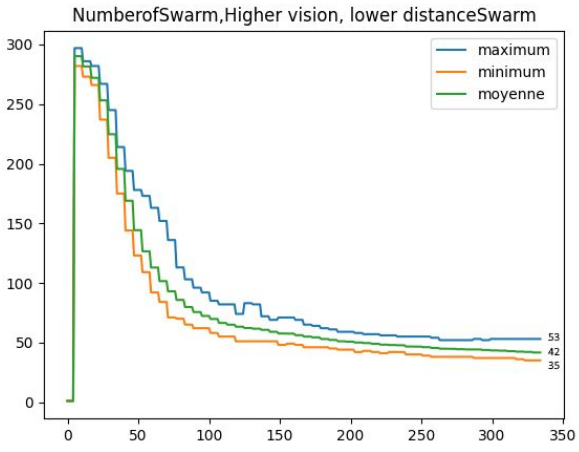




Increase number of swarm





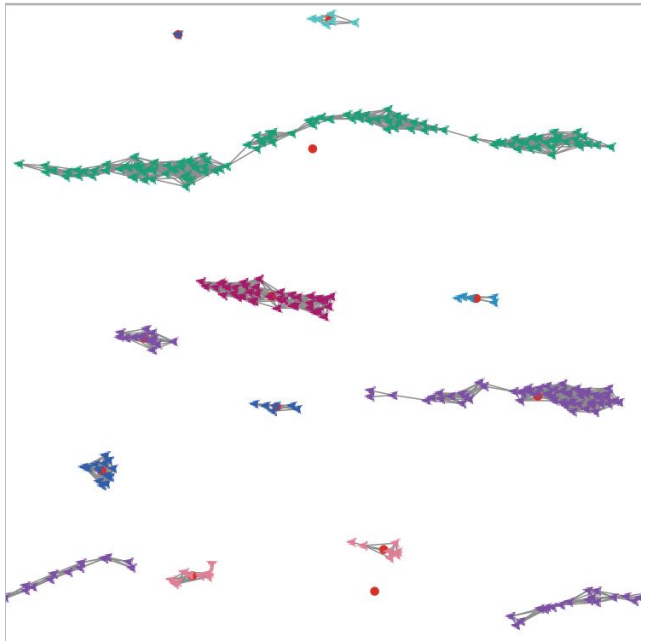


Number of steps in centroïds dynamics

- Impact badly dynamics !?
- Little effect
- Need to ensure ticks consistency

Parameters of centroid dynamics

- Lower impact on global dynamics (in general)
- Need a higher value for vision
- Feedback max-turn is important



Parameter impact

(parent model)

Parameters	**Effect**
max-separate-turn	Increase => swarms are more likely to form
vision	Increase => big swarms are less likely to form
minimum-separation	Increase => swarms are less likely to form => Could be increase a bit after reaching balance
max-align-turn	Increase => swarms are less likely to form
max-cohere-turn	Increase => swarms are more likely to form (not too high) => Increase time to stabilize
max-swarm-turn	Increase => depend on others parameters !

Parameter impact comparison

	Child	Parent
max-separate-turn	-	+
vision	+	-
minimum-separation	-	-
max-align-turn	+	-
max-cohere-turn	-	+

Conclusion

Conclusion

- Multi-Scale brings stability
- Multi-Scale speeds-up swarm formations
- Parameters in swarms of swarms have less impact.

QUESTIONS ?