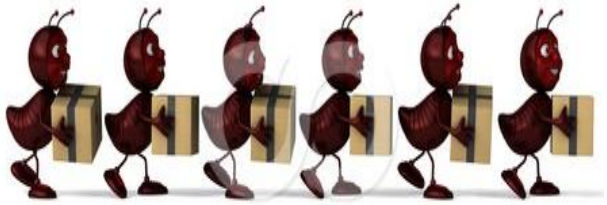
Evolving Aggregation Behaviors in a Swarm of robots

THE UNIVERSITY of NEW MEXICO



WuZhenni Hu,

Mustafa Sinan Çetin

Tairen Chen

Feb, 25, 2013

THE UNIVERSITY of NEW MEXICO

If you have one robot,

What you will do?

How you teach it to make a cup of coffee?

Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

THE UNIVERSITY of NEW MEXICO

When you have a Lot of robots.....

How you teach them to make a cup of coffee?

How to control and

Organize them?

Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

THE UNIVERSITY of NEW MEXICO

Study the aggregation of Swarm-bots

Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

Introduction

• Aggregation

• S-bot, swarm-bot

•Inspired by swarm intelligence, a novel approach inspired by effectiveness and robustness observed in social insects.

Introduction

- Defining the control system for the swarm-bot using artificial evolution.

- Artificial evolution, exploiting the complex interactions among s-bots and between s-bots and the environment, is able to produce simple but general solutions to the aggregation problem.

Aggregation in Biological Systems

Positive feedback ; form of attraction

chemical,
tactile,
visual

Negative feedback; serves as a regulatory mechanism

Thus controlling the formation of the aggregate.

Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

THE UNIVERSITY of NEW MEXICO

Aggregation in Biological Systems

Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

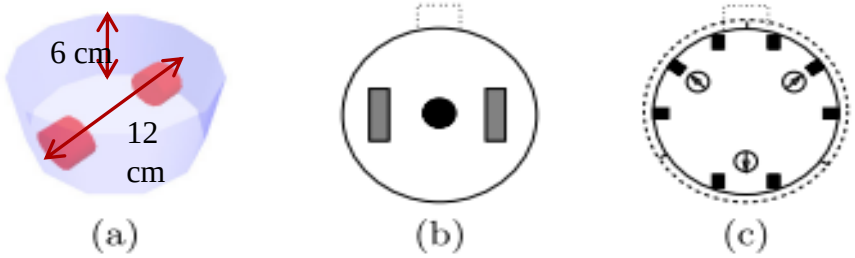
THE UNIVERSITY of NEW MEXICO

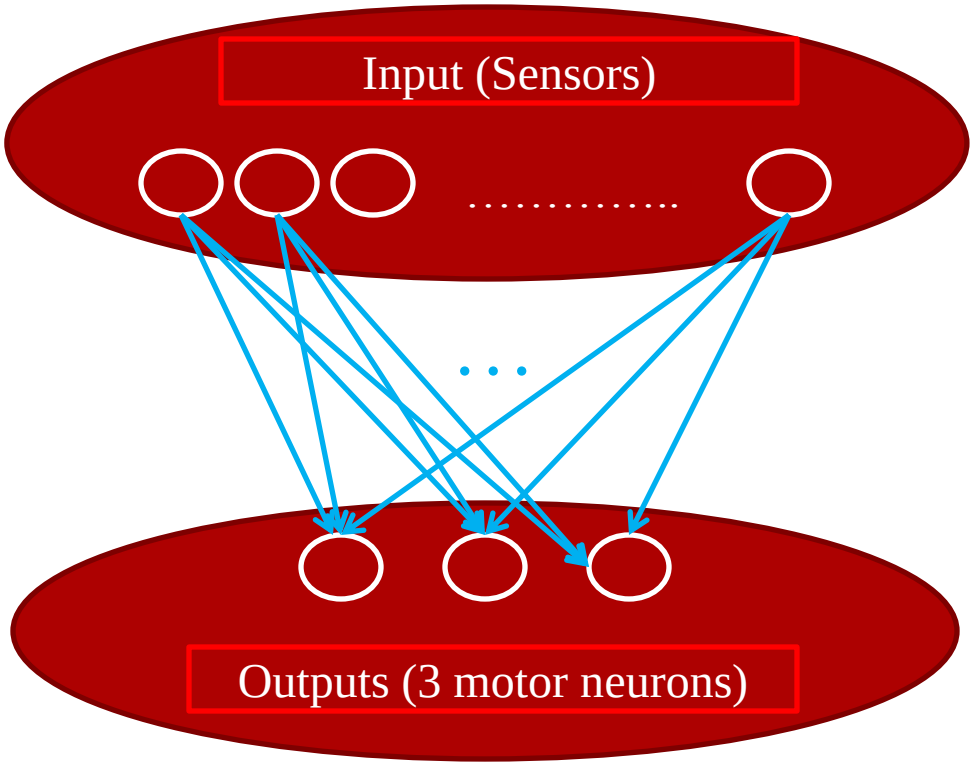
Aggregation in Biological Systems

THE UNIVERSITY of NEW MEXICO

Evolving Aggregation Behaviors

Experimental Setup



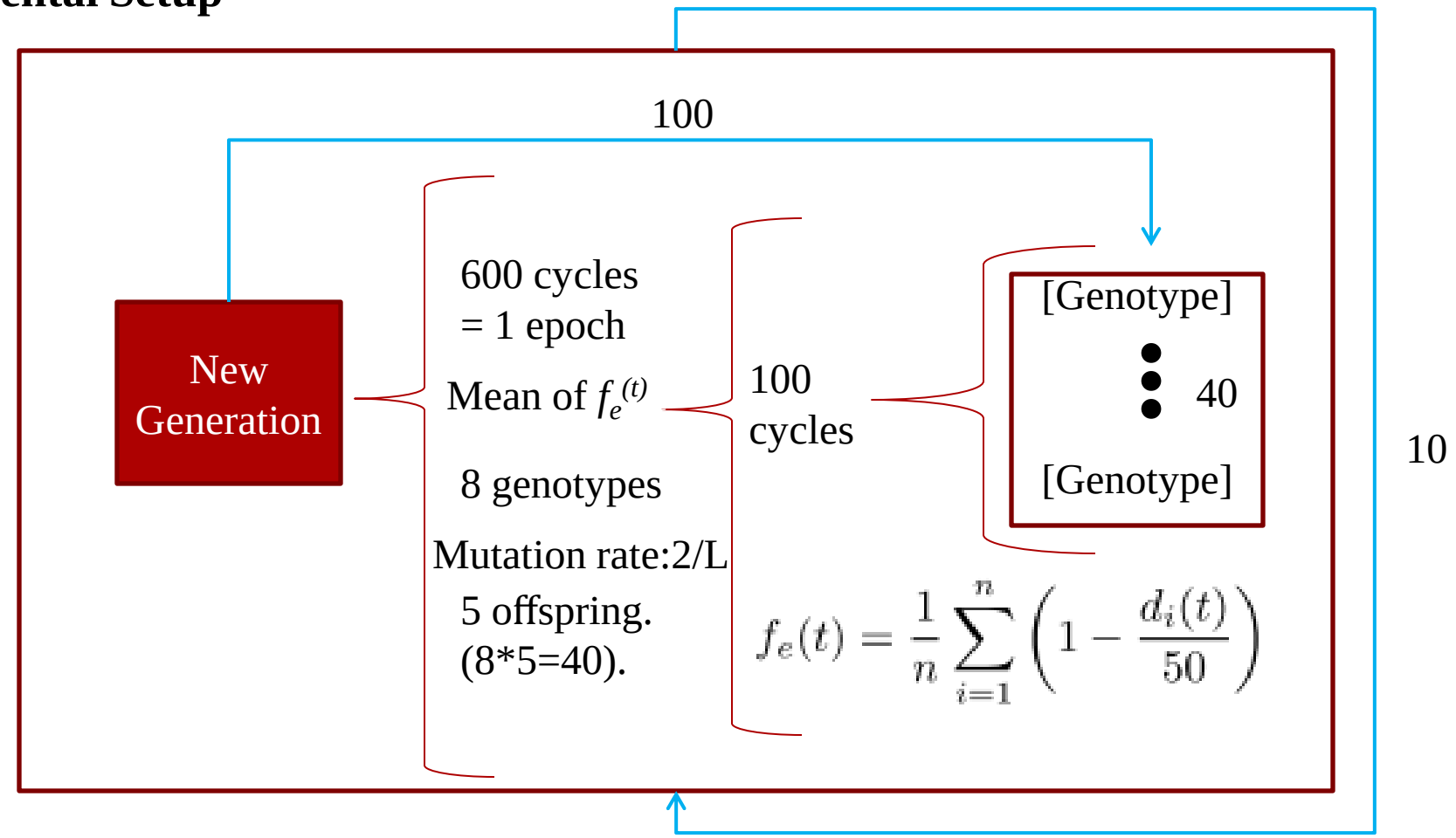


(16 Sensors + 1 bias unit) x 8 bits= 136 bits= [Genotype]

THE UNIVERSITY of NEW MEXICO

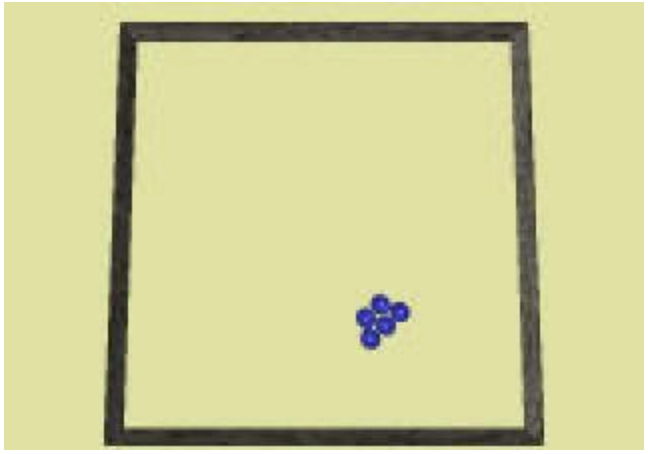
Evolving Aggregation Behaviors

Experimental Setup



Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

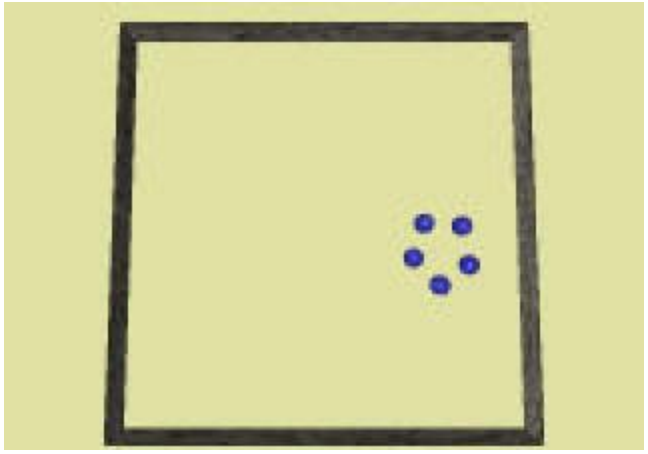
Behavioral Analysis



Static clustering

Behavior

Compact, stable, Do not change relative position



Dynamic clustering

Behavior

Loose but moving aggregates

Better ?

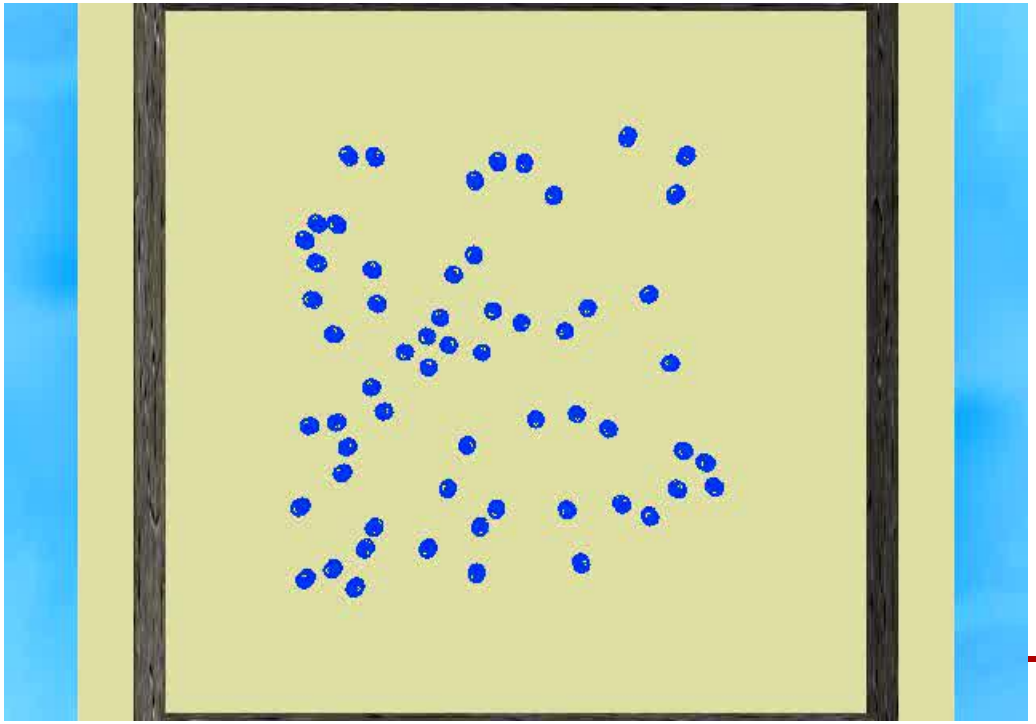
Difference?

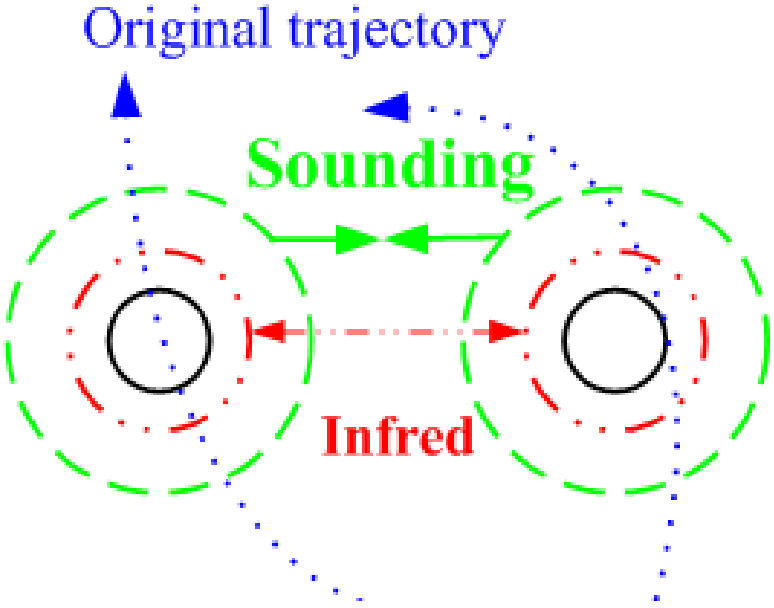
Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

Static clustering behavior

1. Explore the arena

2. Get close, attraction to sound sources, repulse from infrared, unstable for 2 but attract other s-bots

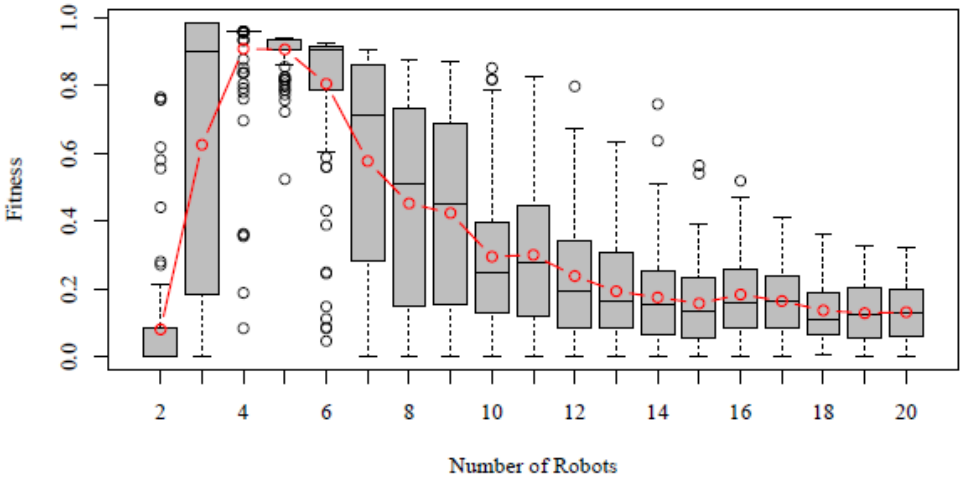


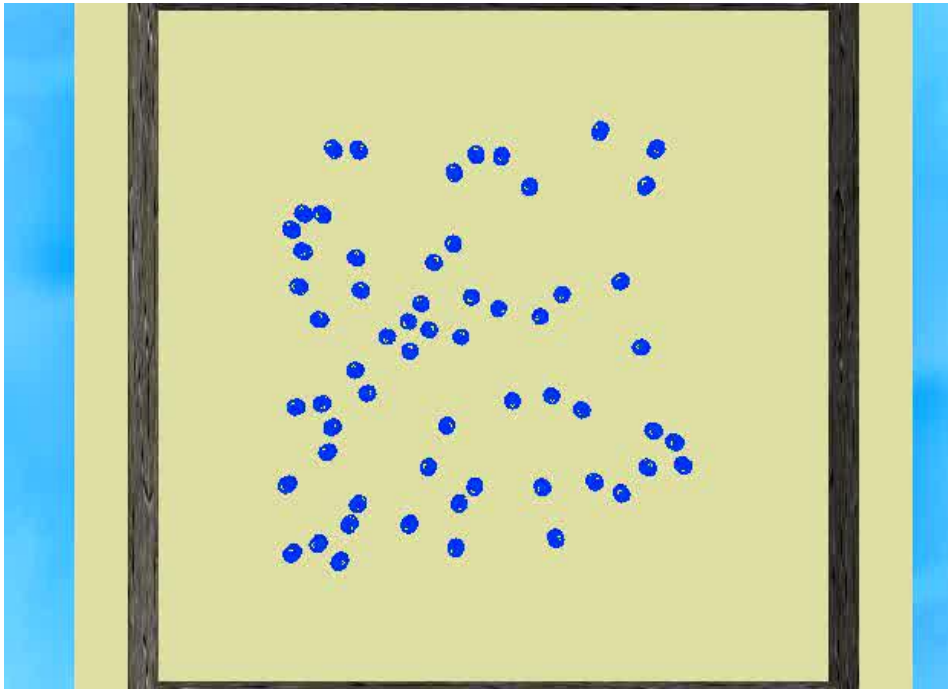


seconds 11-15

THE UNIVERSITY of NEW MEXICO

3. How many *s-bots* is stable? More *s-bots* more stable?





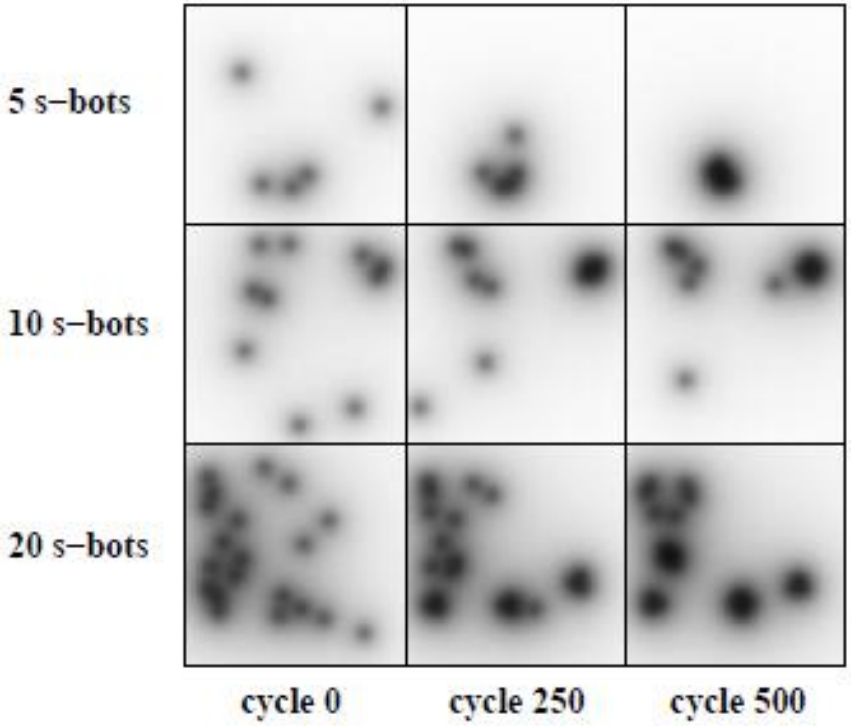
seconds 12-16

Static clustering behavior

4. Why more *s-bots* also unstable?

A. More *s-bots*, *more* small clusters

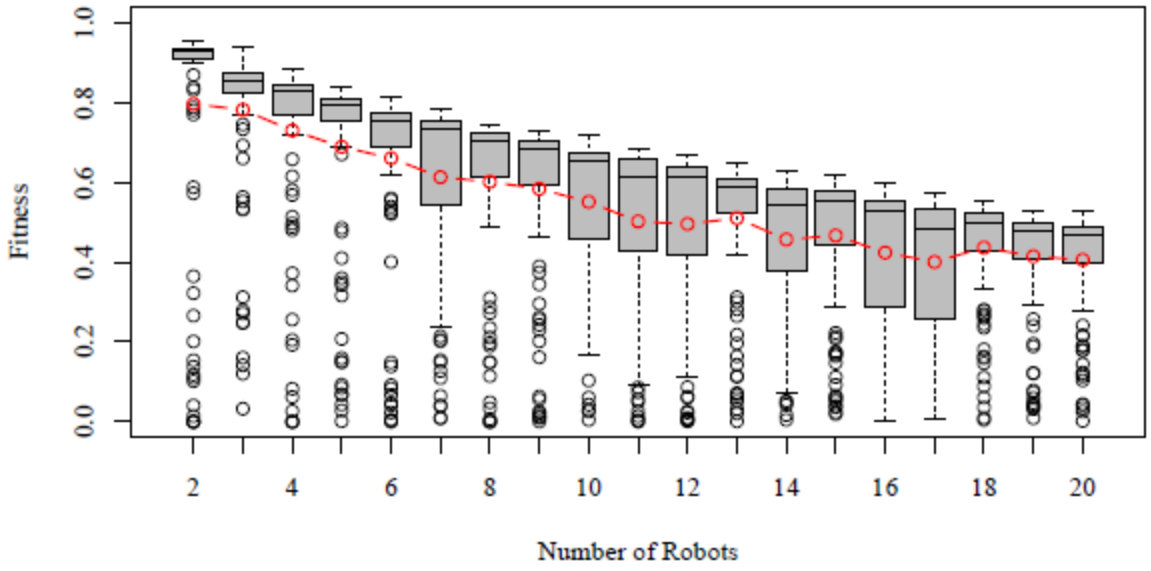
B. High density of sound in arena, causing whirl, join near neighbor



Dynamic clustering behavior

1. Sense each other, aggregate and start to moving together to explore environment, cause interplay of two forces

2. During the moving, create the possibility to merge to other clusters, adjust relative position , form a large cluster



Questions about this figure?
Why is linear decreasing?

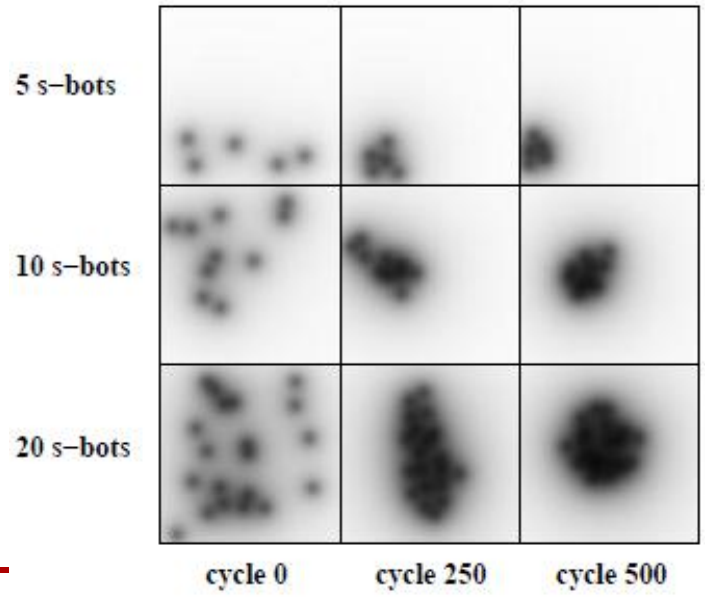
Dynamic clustering behavior

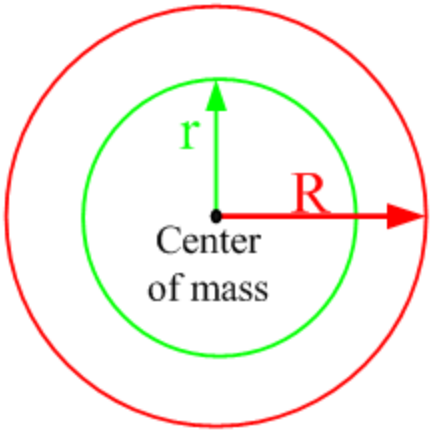
Answers about this figure:

Not by aggregation but by average distance to the center of mass due to the growth of number s-bots

$$f_e(t) = \frac{1}{n}\sum_{i=1}^{n}\left(1 - \frac{d_i(t)}{50}\right)$$

4. Snapshots of dynamic cluster behavior





Presenters: Wuzhenni Hu, Mustafa Sinan Çetin , Tairen Chen

Conclusions

• Described the phenomenon of aggregation in biological systems and the evolution of controllers for a group of simulated robots in order to obtain a similar process.

• The obtained results show that evolution is able to find simple but effective solutions to the aggregation problem, mainly exploiting some invariants present in the environment and the complex interactions among s-bots and between s-bots and the environment.

Discussion

1. What are the difference between dynamic and static clustering behavior and which one is better?

2. What are the application scenarios for static and dynamic clustering behavior?