BOIDS SIMULATION USING SCICOS

BATCH SIMULATION IN SCILAB USING XCOS_SIMULATE

Graph Models and Simulation (Seminar course)

15.08.2016

Aditya Raj

Outline

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- Problem Statement

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- Introduction and Background

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- Boids Model in Scicos

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- Problem Statement
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- Simulation Results & Evaluation
- Improvements

Problem

- Simulate Boids behaviour in Scicos.

- In short, to demonstrate an Agent Model using the following Scilab features
  - Program new blocks in C
  - Run simulations in batch mode from Scilab environment

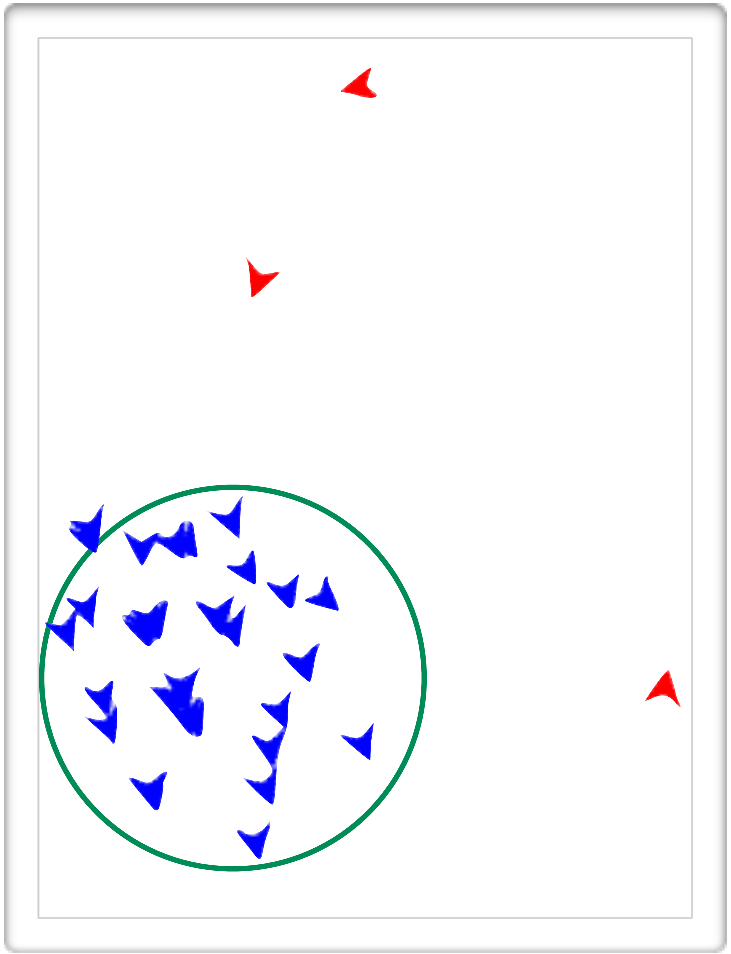
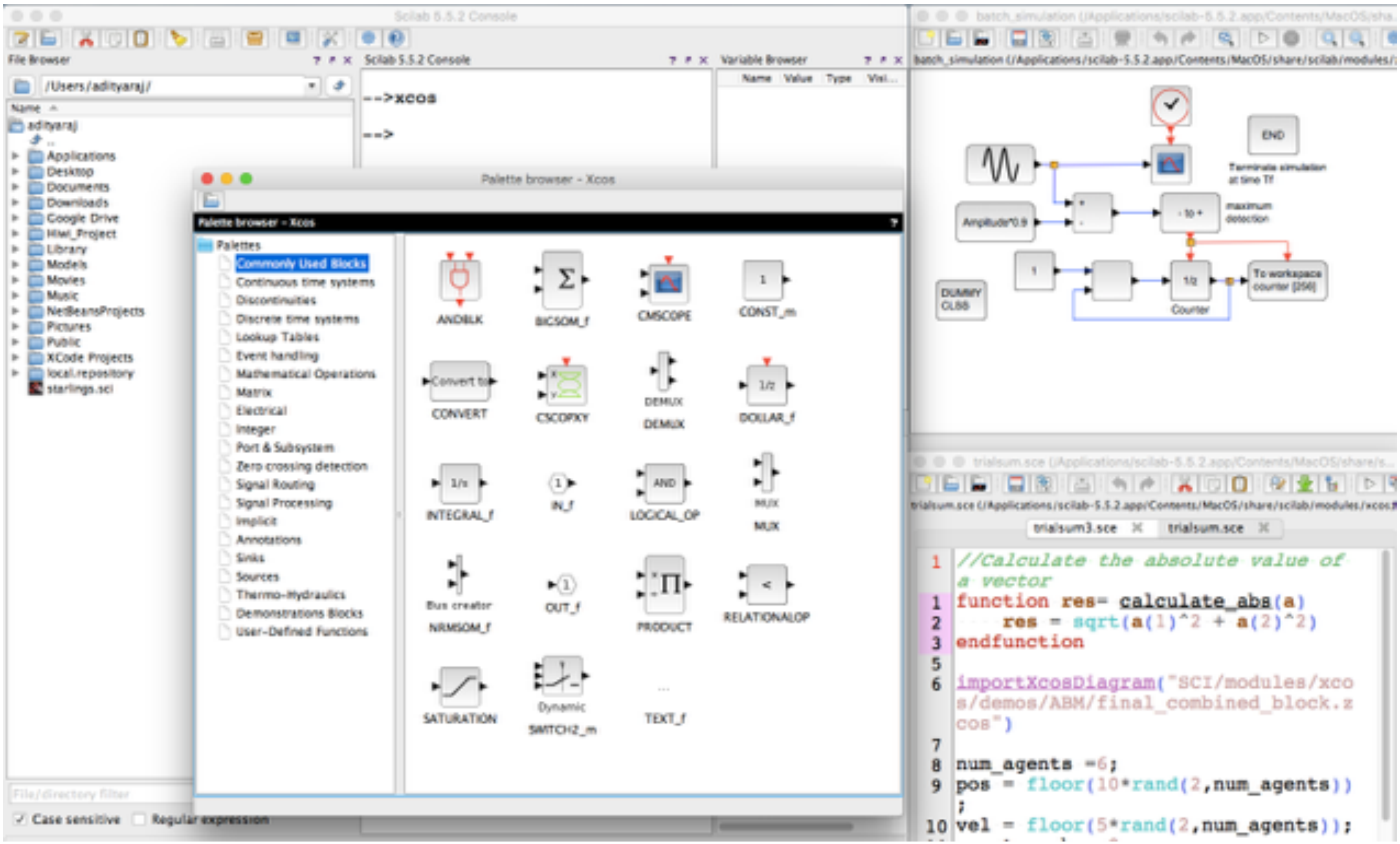
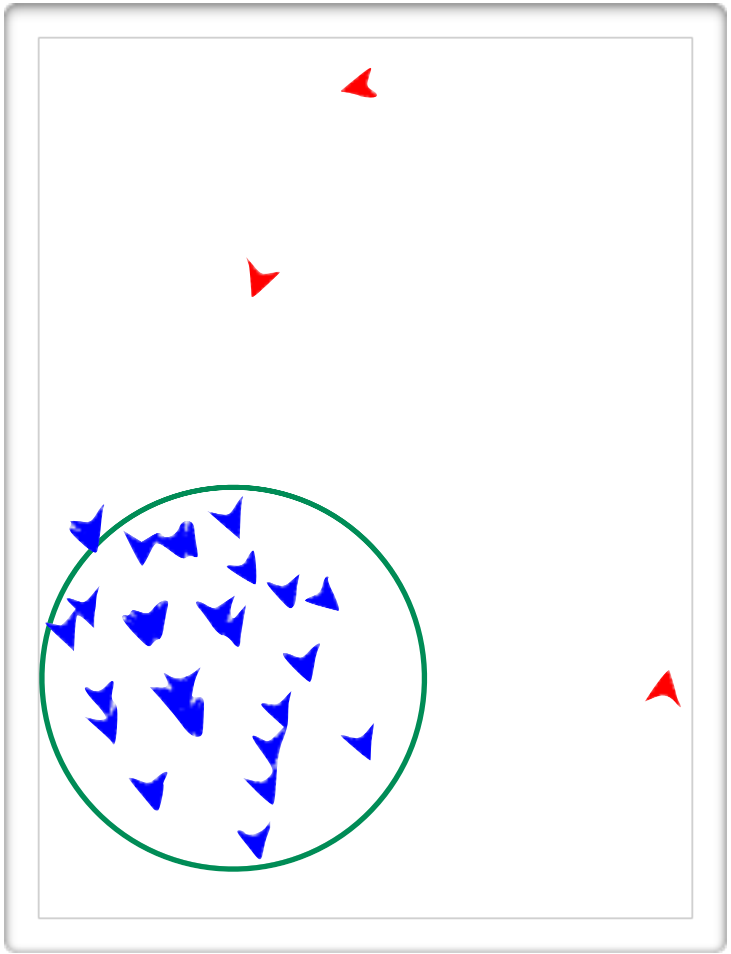


Image Src: http://blog.elyaski.com/code-snippets/boids-birds-behaviour-simulation-in-c/

Introduction -> Scicos



Introduction -> BOIDS: bird-like object



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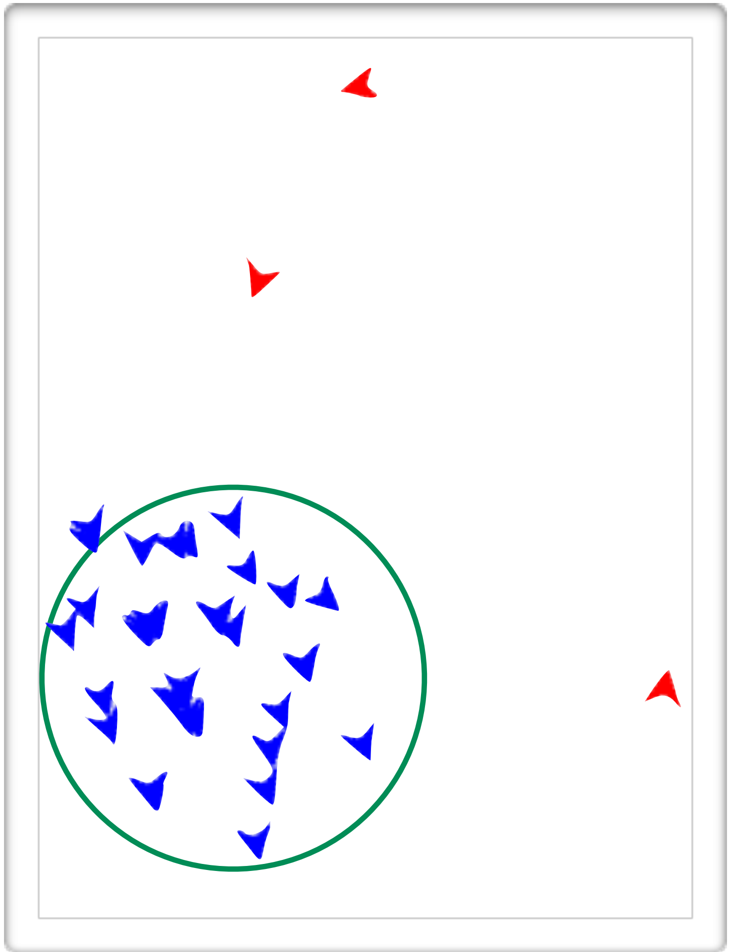
Introduction -> BOIDS: bird-like object

- Developed by Craig Reynolds in 1986



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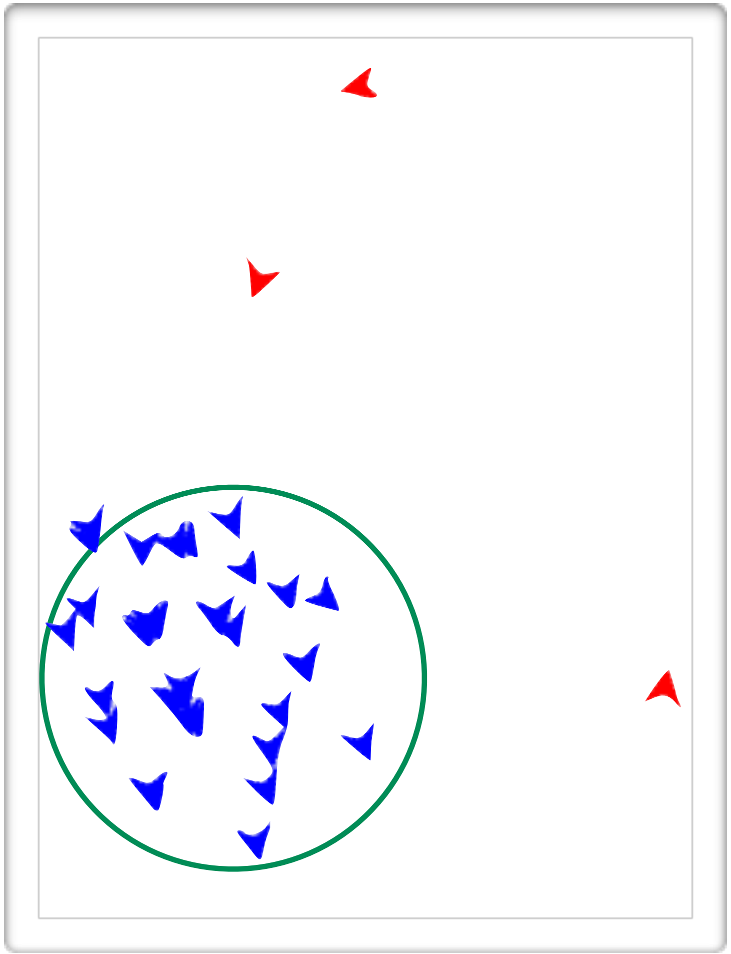
Introduction -> BOIDS: bird-like object

- Developed by Craig Reynolds in 1986
- A simple agent-based model



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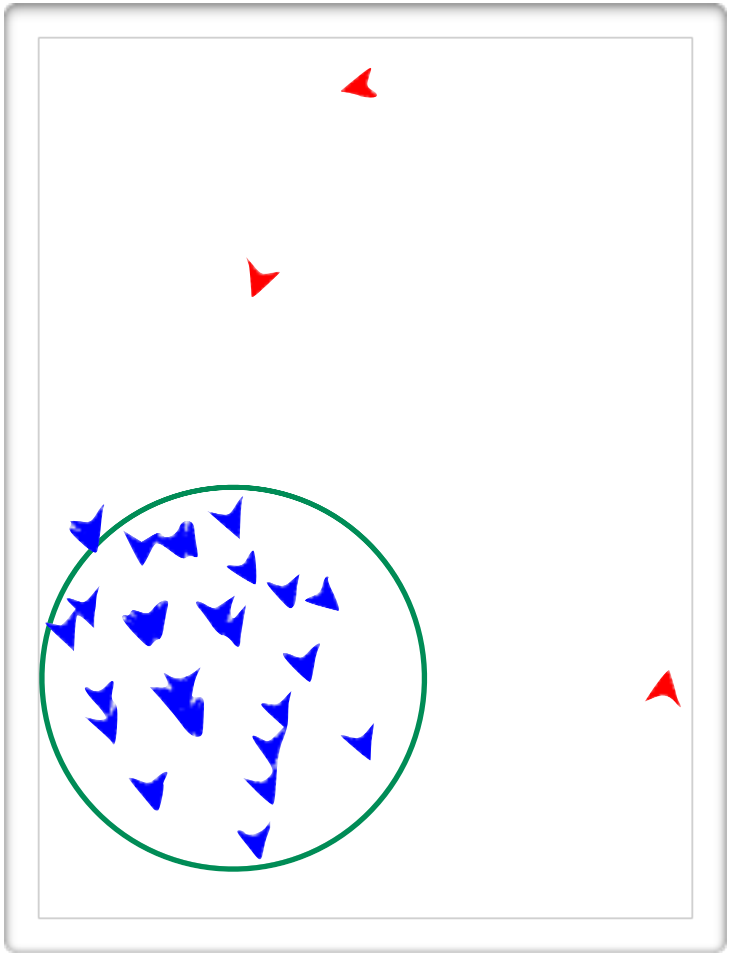
Introduction -> BOIDS: bird-like object

- Developed by Craig Reynolds in 1986
- A simple agent-based model
- Simulates the flocking behaviour of birds



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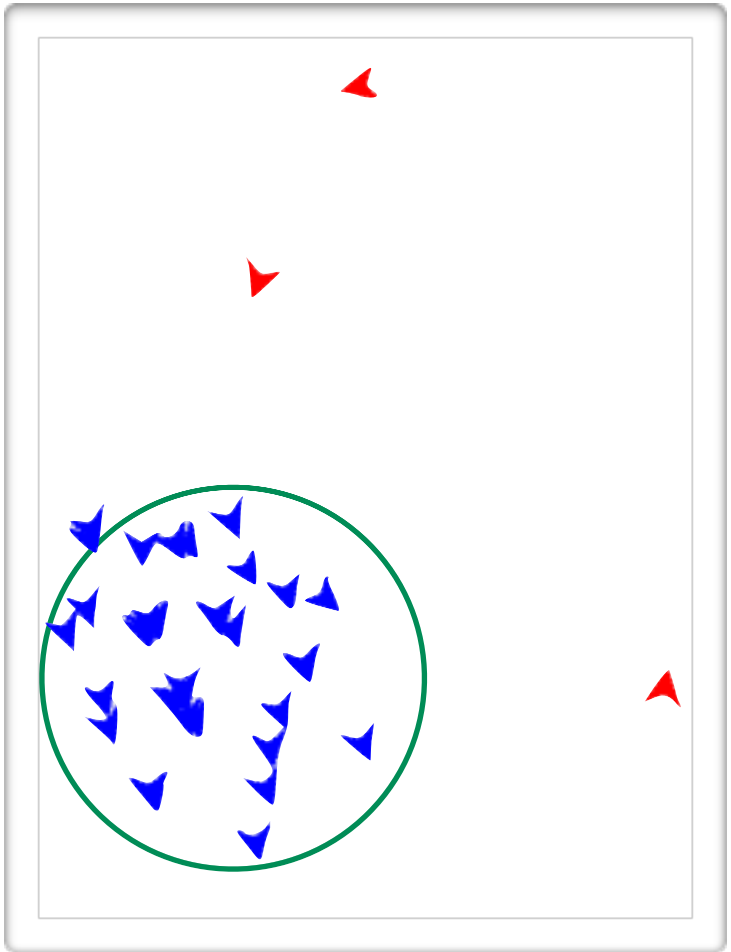
Introduction -> BOIDS: bird-like object

- Developed by Craig Reynolds in 1986
- A simple agent-based model
- Simulates the flocking behaviour of birds
- The agent checks other agents in its neighbourhood
  - And further ALIGN, SEPARATE and COHERE.



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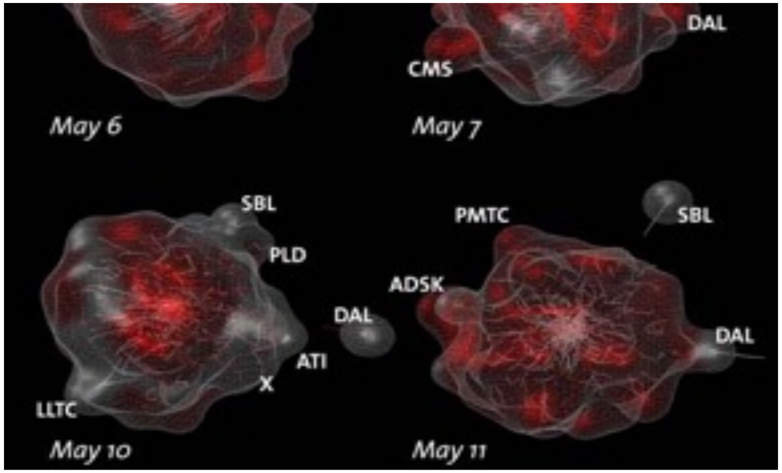
BOIDS: Application Areas



BACKGROUND

PHYSICS BEHIND BOIDS MOTION

Boids Model - Alignment

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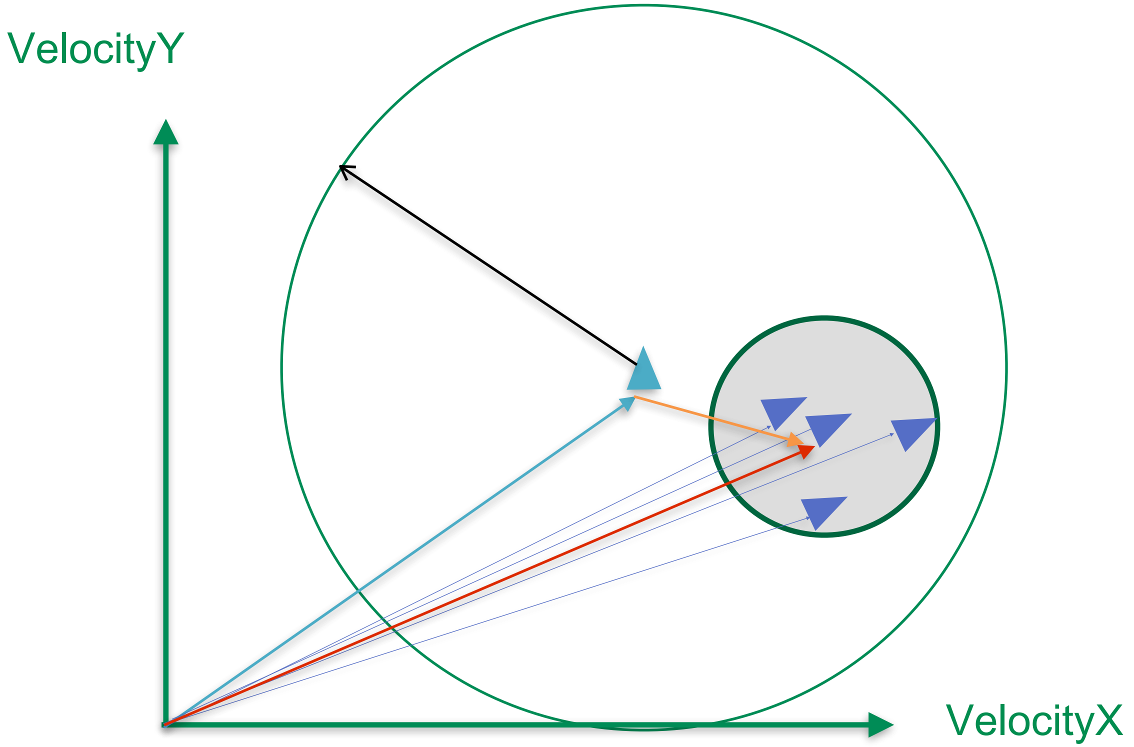
Boids Model - Alignment



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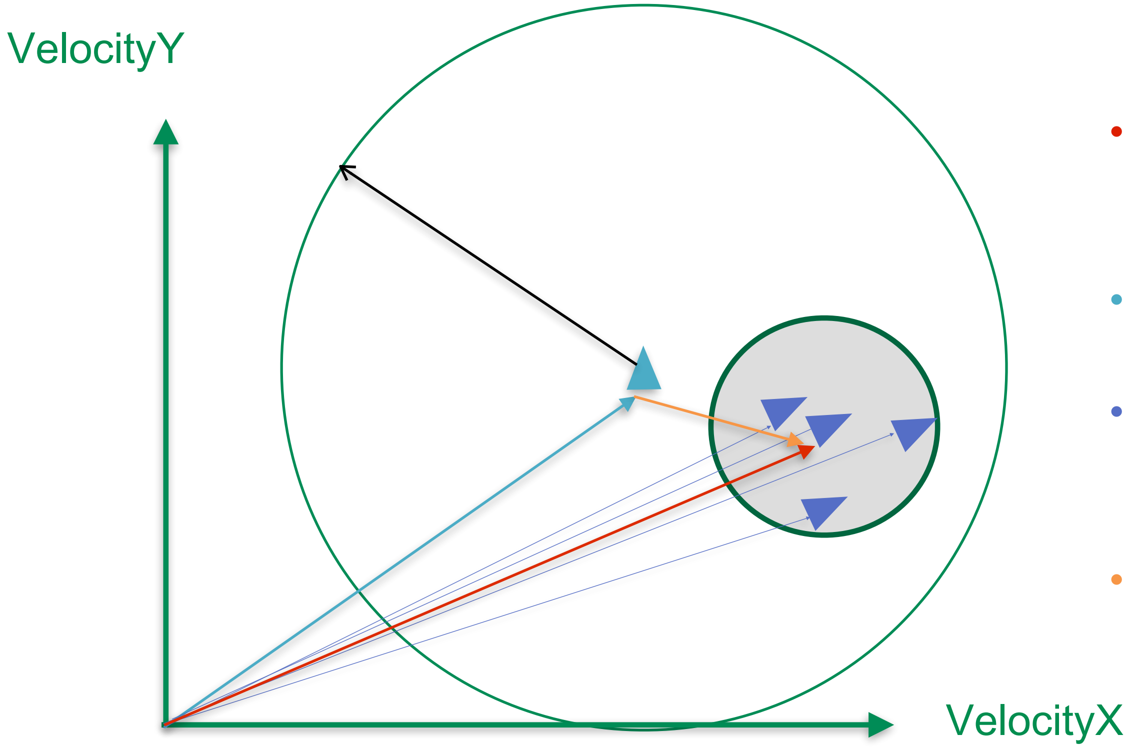
Boids Model - Alignment



- Average Heading of the flocks
- Current Position Vector
- Actual Heading of individual bonds
- Resultant Vector

Boids Model - Alignment

Boids Model - Alignment

- For every nearby boid in the system, calculate the average velocity
- Normalise it
- Calculate Steer/Resultant
  AB+BC= AC By vector law of addition

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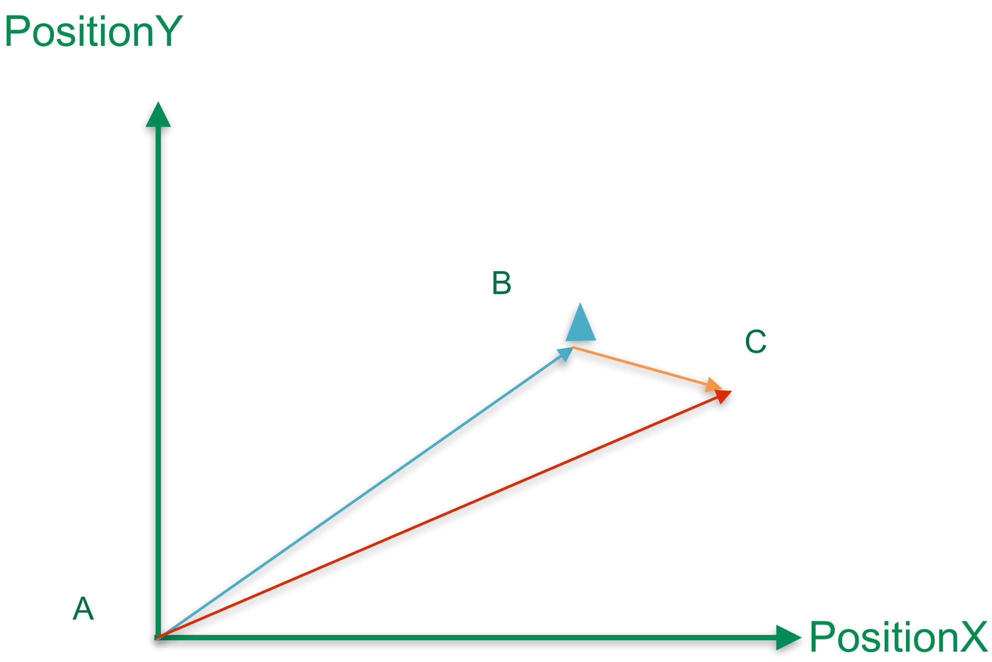

Boids Model - Cohesion

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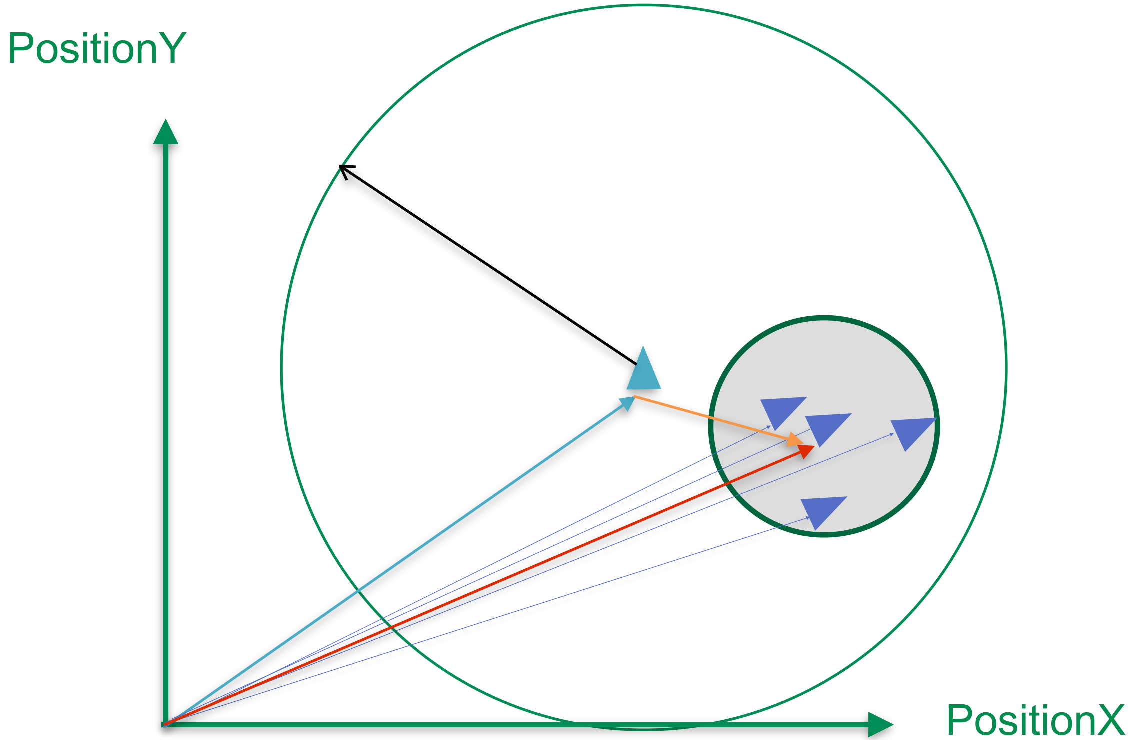

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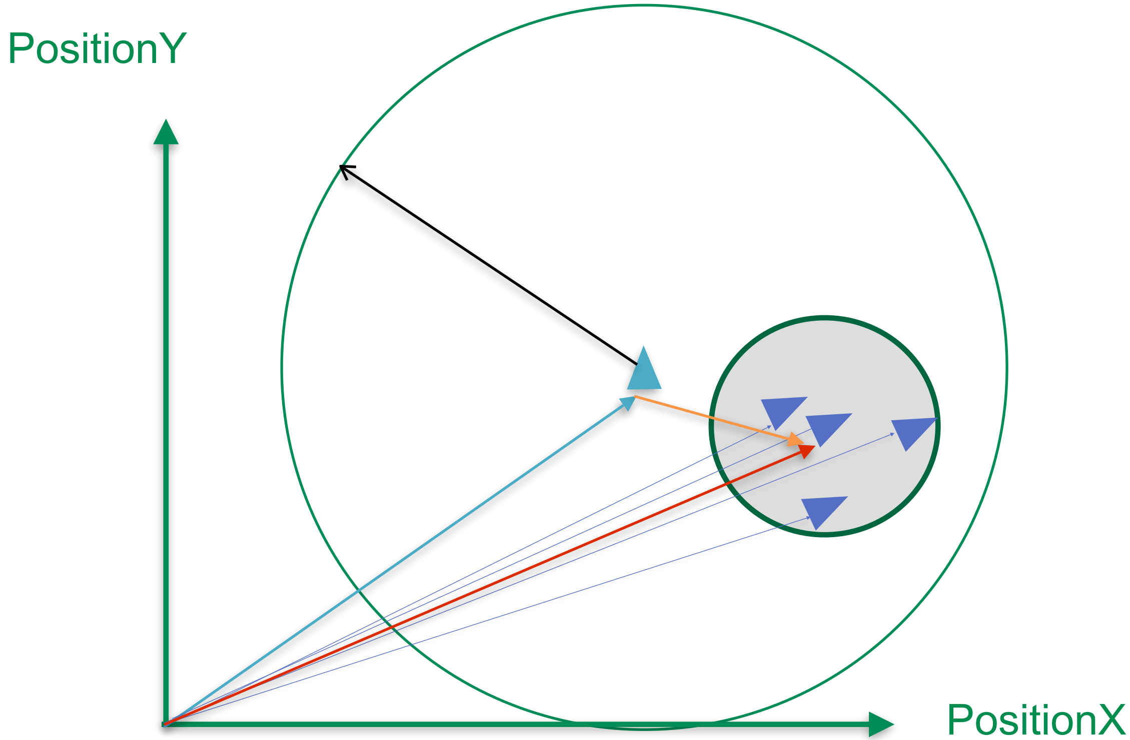
Boids Model - Cohesion



- Average Heading of the flocks
- Current Position Vector
- Actual Heading of individual bonds
- Resultant Vector
- Flocking Radius

Boids Model - Cohesion

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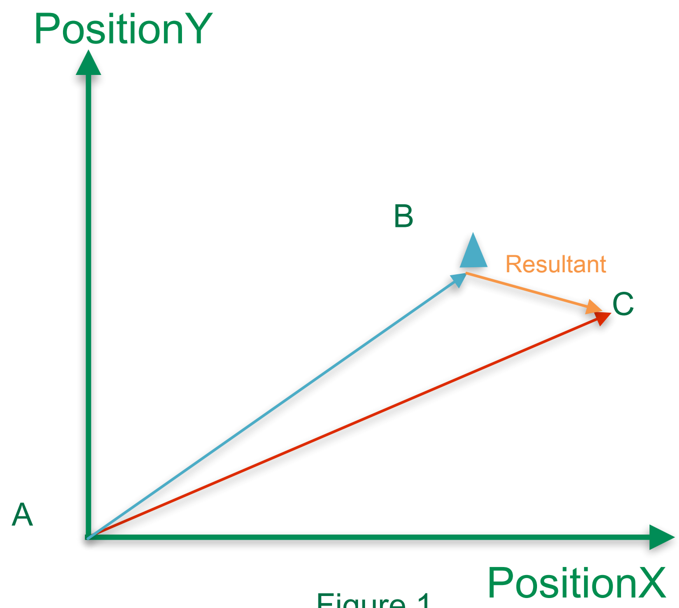


Figure 1

Boids Model - Cohesion

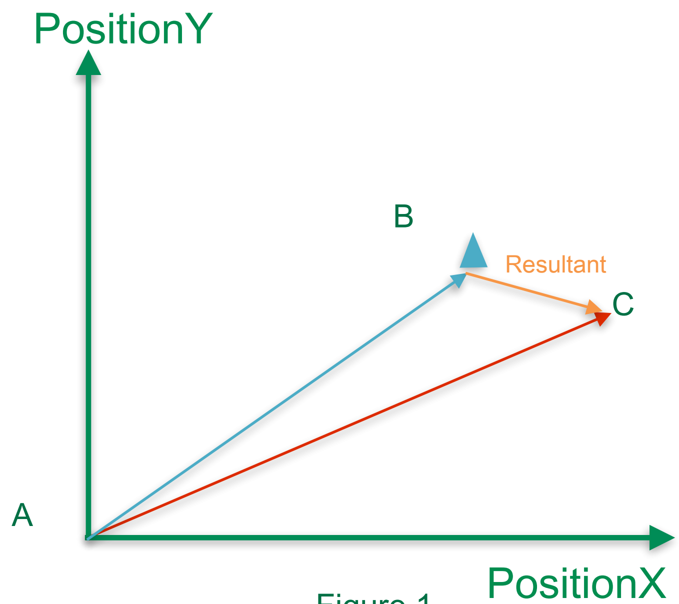


Figure 1

- For the average location (i.e. Center) of all nearby boids
- Calculate a vector pointing from the location to the target
- Normalise it

Boids Model - Cohesion

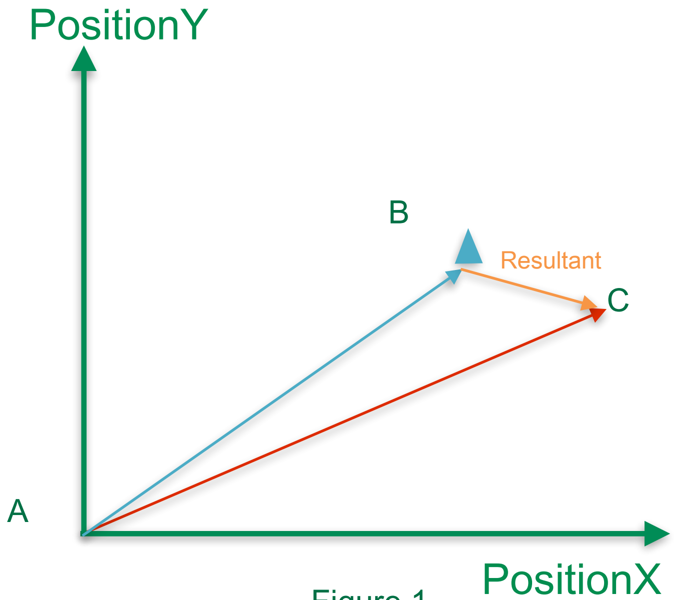


Figure 1

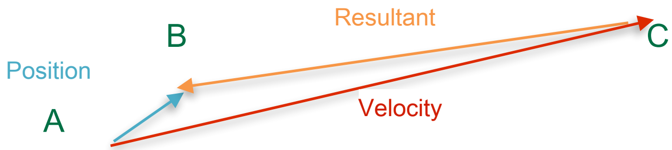


Figure 2

- For the average location (i.e. Center) of all nearby boids
- Calculate a vector pointing from the location to the target
- Normalise it

Boids Model - Cohesion

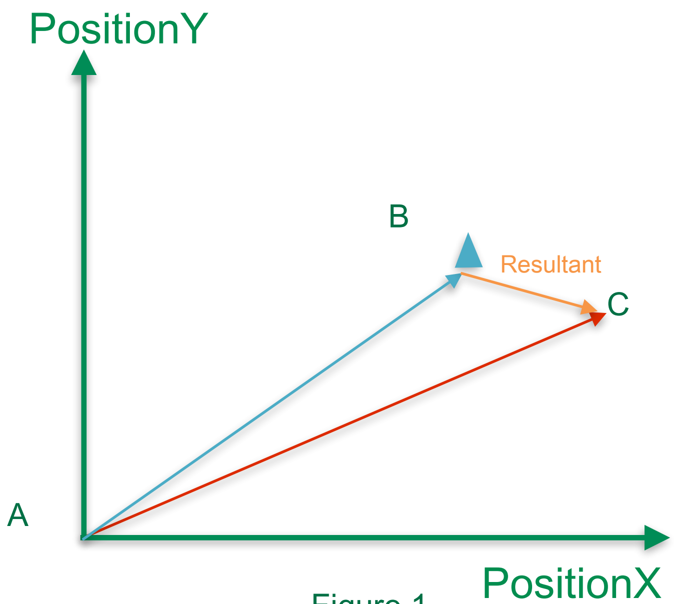


Figure 1

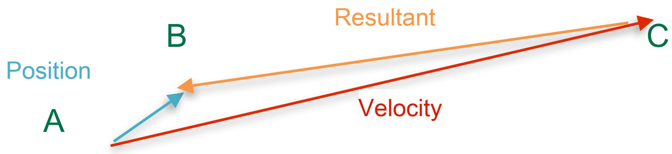


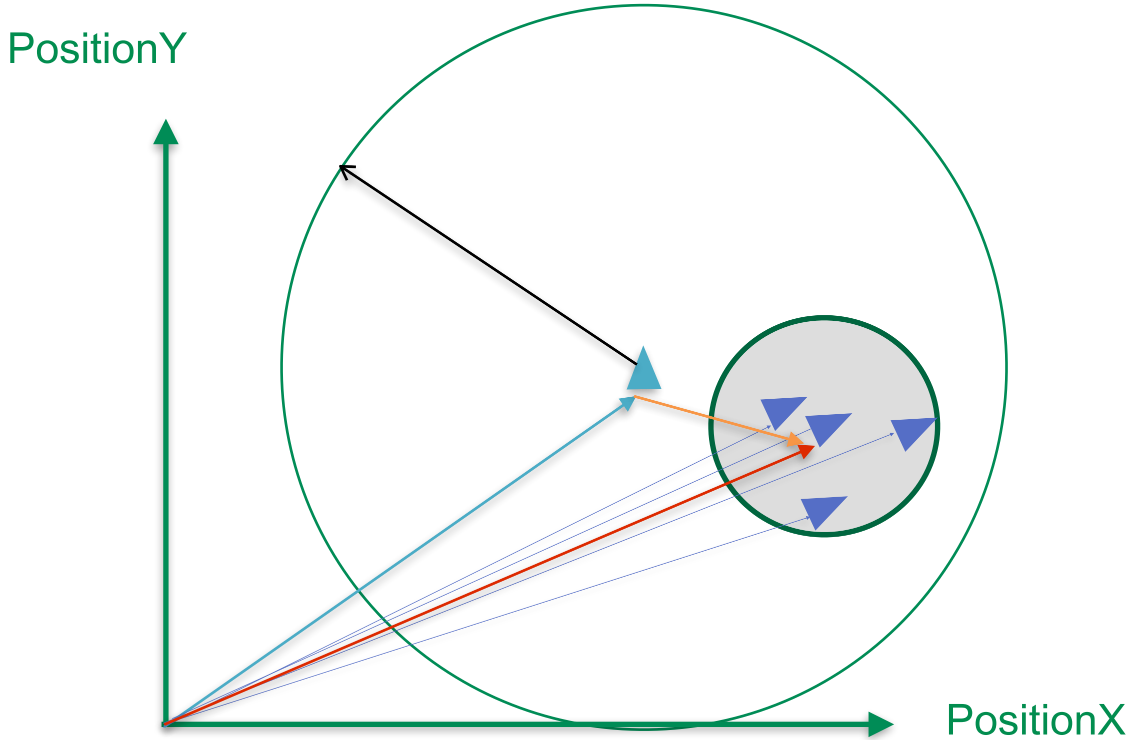
Figure 2

- For the average location (i.e. Center) of all nearby boids
- Calculate a vector pointing from the location to the target
- Normalise it

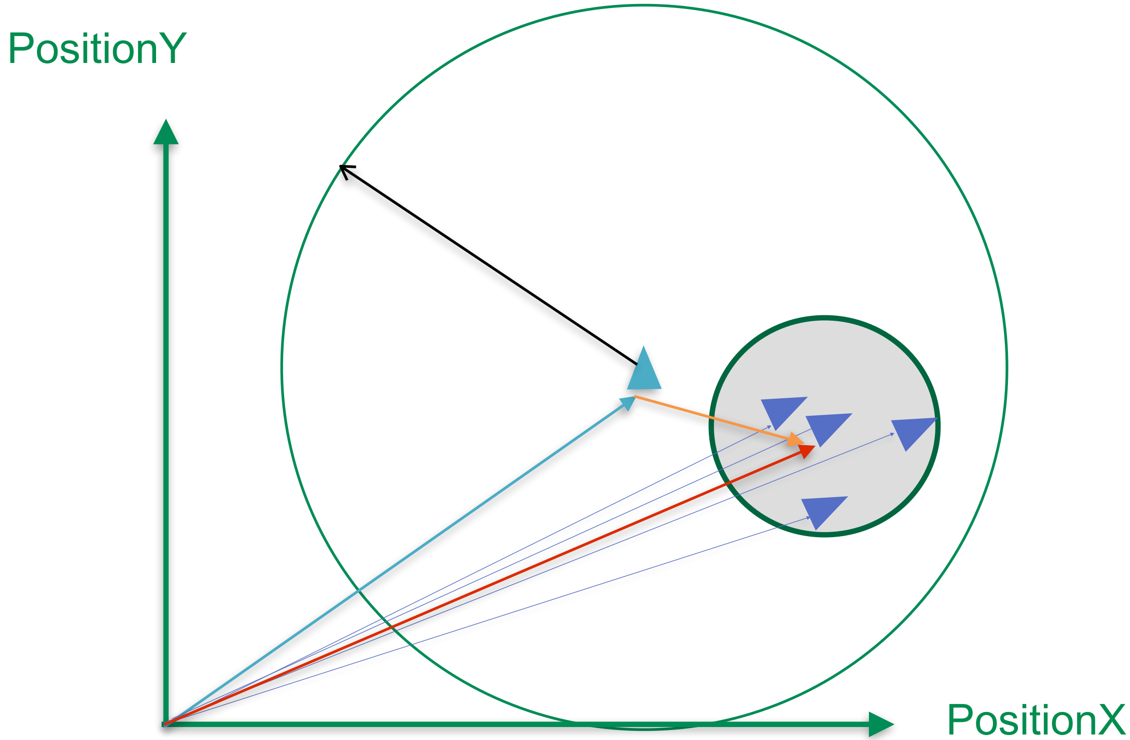
- Calculate steering vector towards that location(Steering = Desired - Velocity)
- Steering Vector
- Resultant= Position-Velocity

Boids Model - Separation

Boids Model - Separation



Boids Model - Separation



- Average Heading of the flocks
- Current Position Vector
- Actual Heading of individual bonds
- Resultant Vector
- Flocking Radius

Boids Model - Separation

- Checks for nearby boids and calculate the separation vector from each individual boid
- Normalise it
- Weight by distance (For smoothness)
- Loop and find average

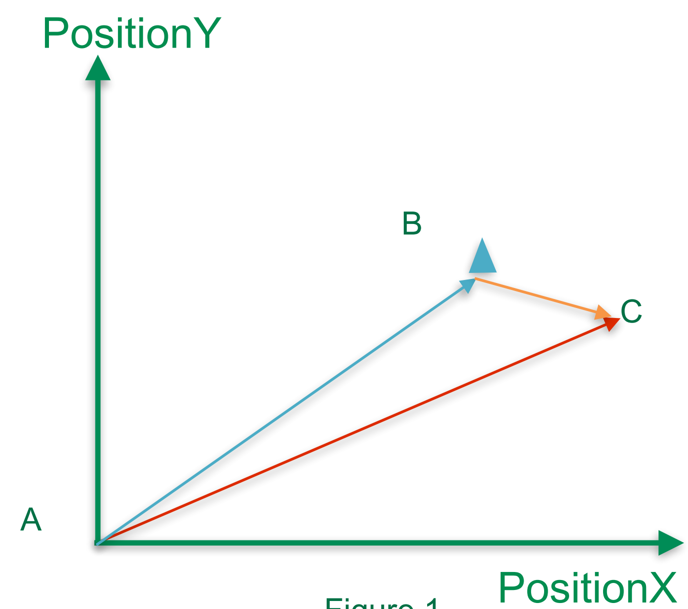


Figure 1

THE MODEL

IMPLEMENTATION

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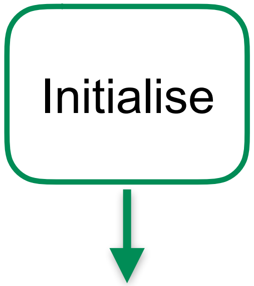
Workflow

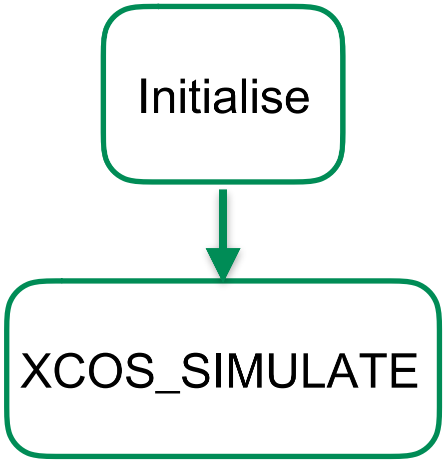
Workflow

Initialise

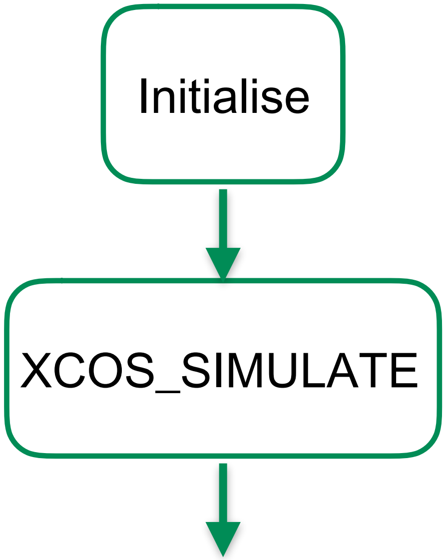
Workflow



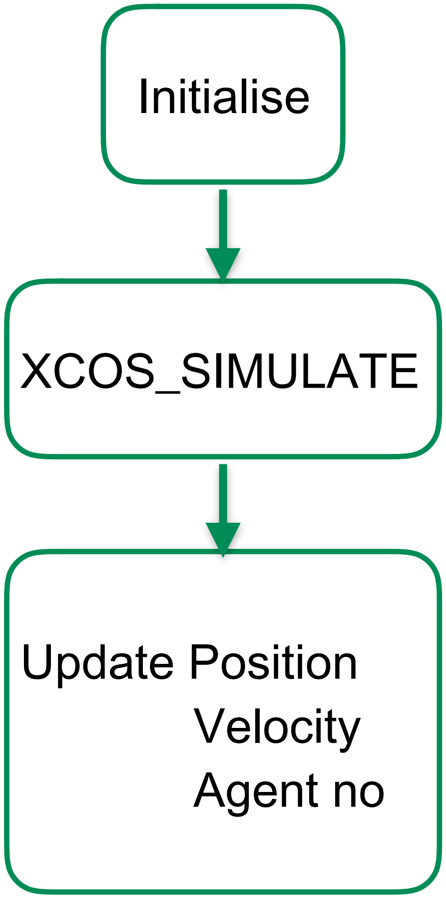
Workflow



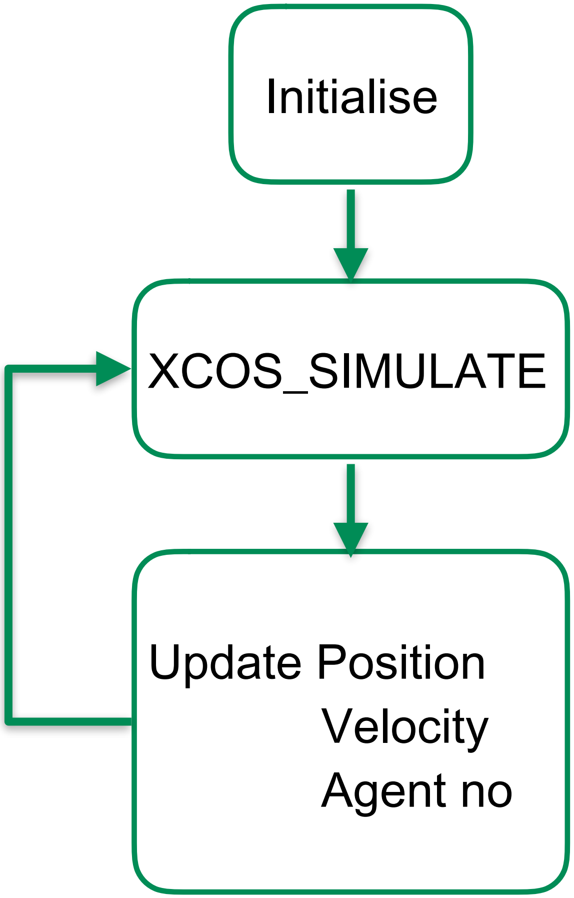
Workflow



Workflow


Initialise
XCOS_SIMULATE
Update Position
Velocity
Agent no

Workflow


Initialise
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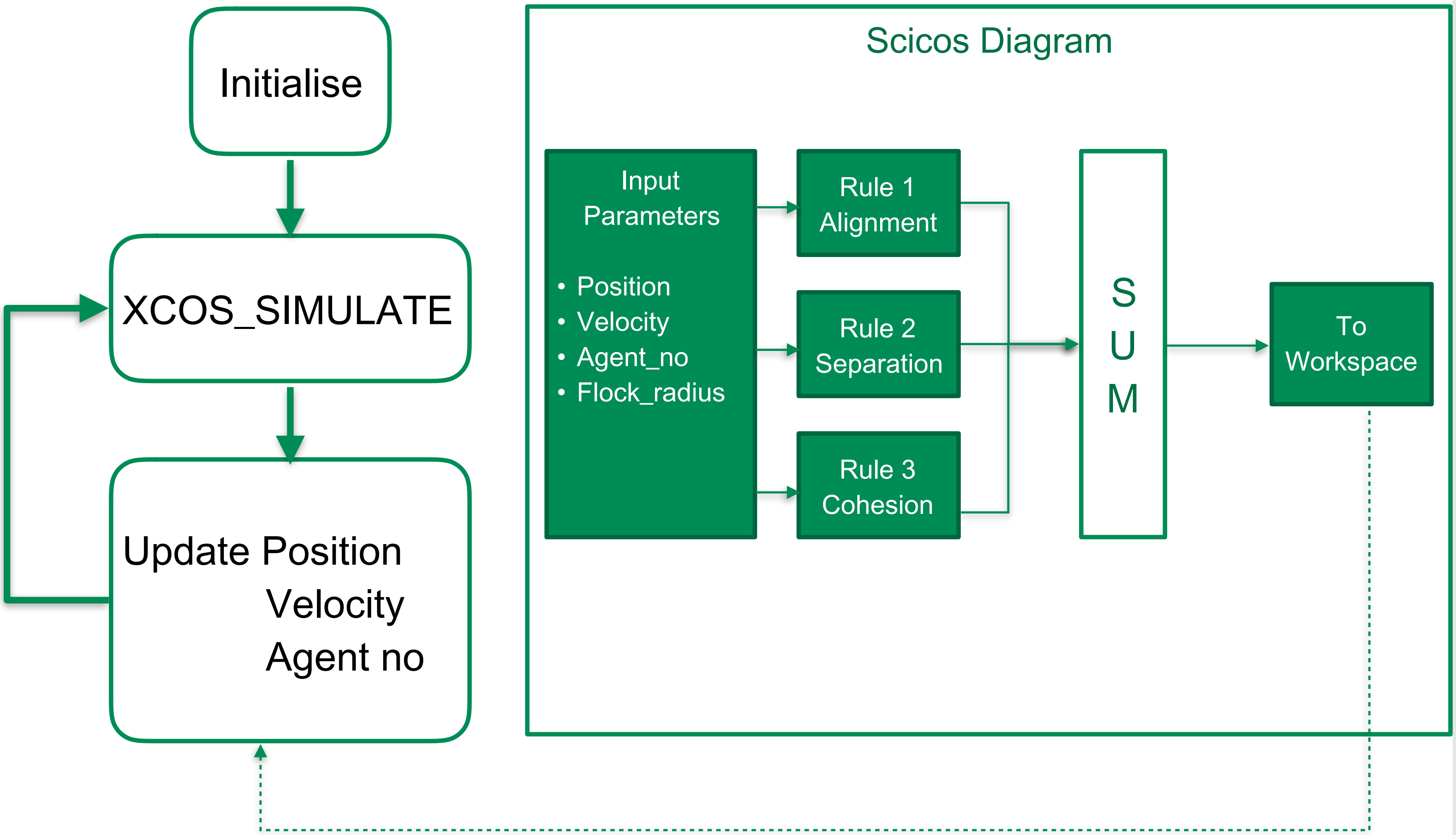
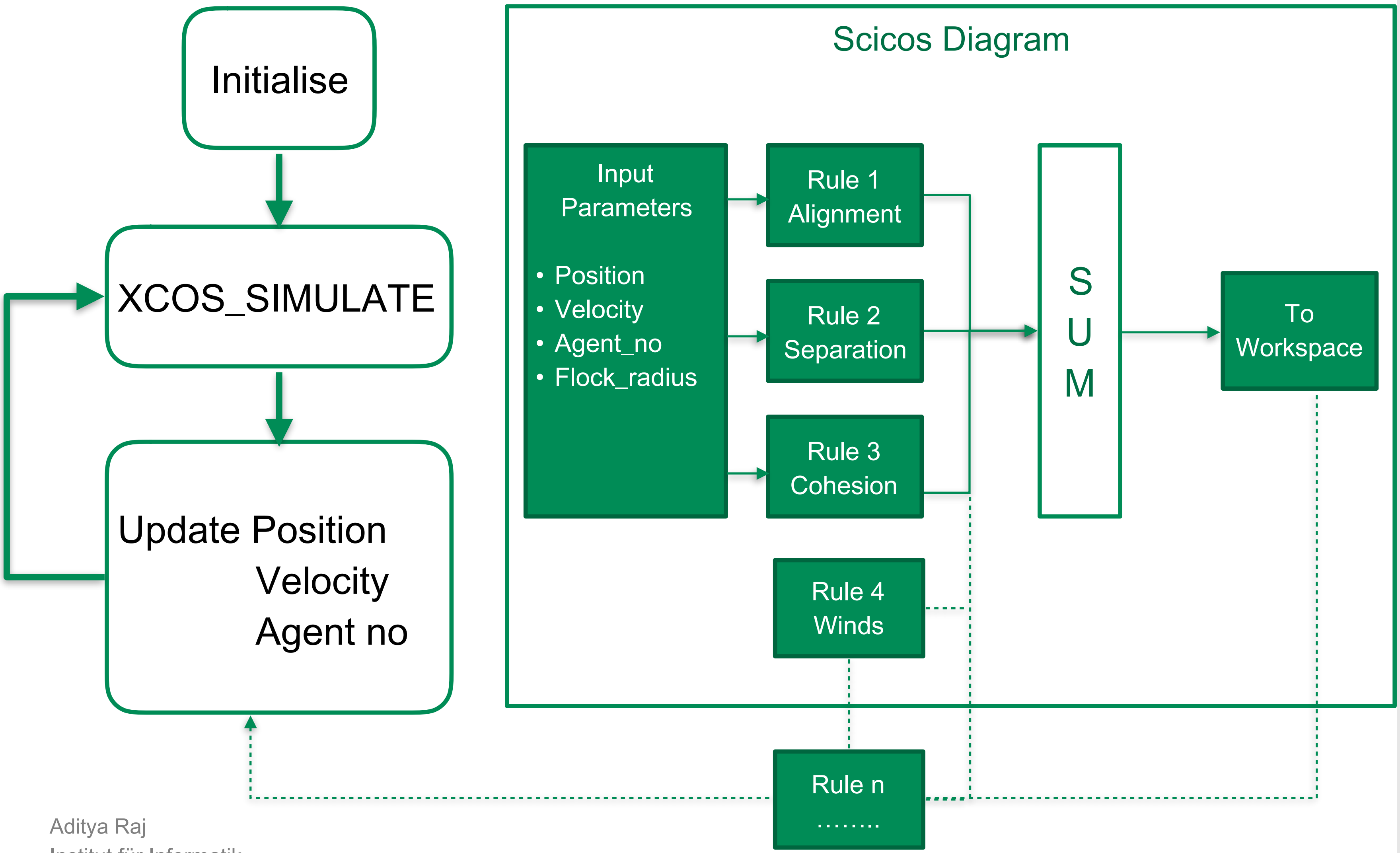
Workflow


Initialise
XCOS_SIMULATE
Update Position
Velocity
Agent no
Scicos Diagram
Input
Parameters
• Position
• Velocity
• Agent_no
• Flock_radius
Rule 1
Alignment
Rule 2
Separation
Rule 3
Cohesion
S
U
M
To
Workspace

Workflow


Initialise
XCOS_SIMULATE
Update Position
Velocity
Agent no
Scicos Diagram
Input Parameters
• Position
• Velocity
• Agent_no
• Flock_radius
Rule 1 Alignment
Rule 2 Separation
Rule 3 Cohesion
Rule 4 Winds
Rule n
……..
S U M
To Workspace

SIMULATION RESULTS

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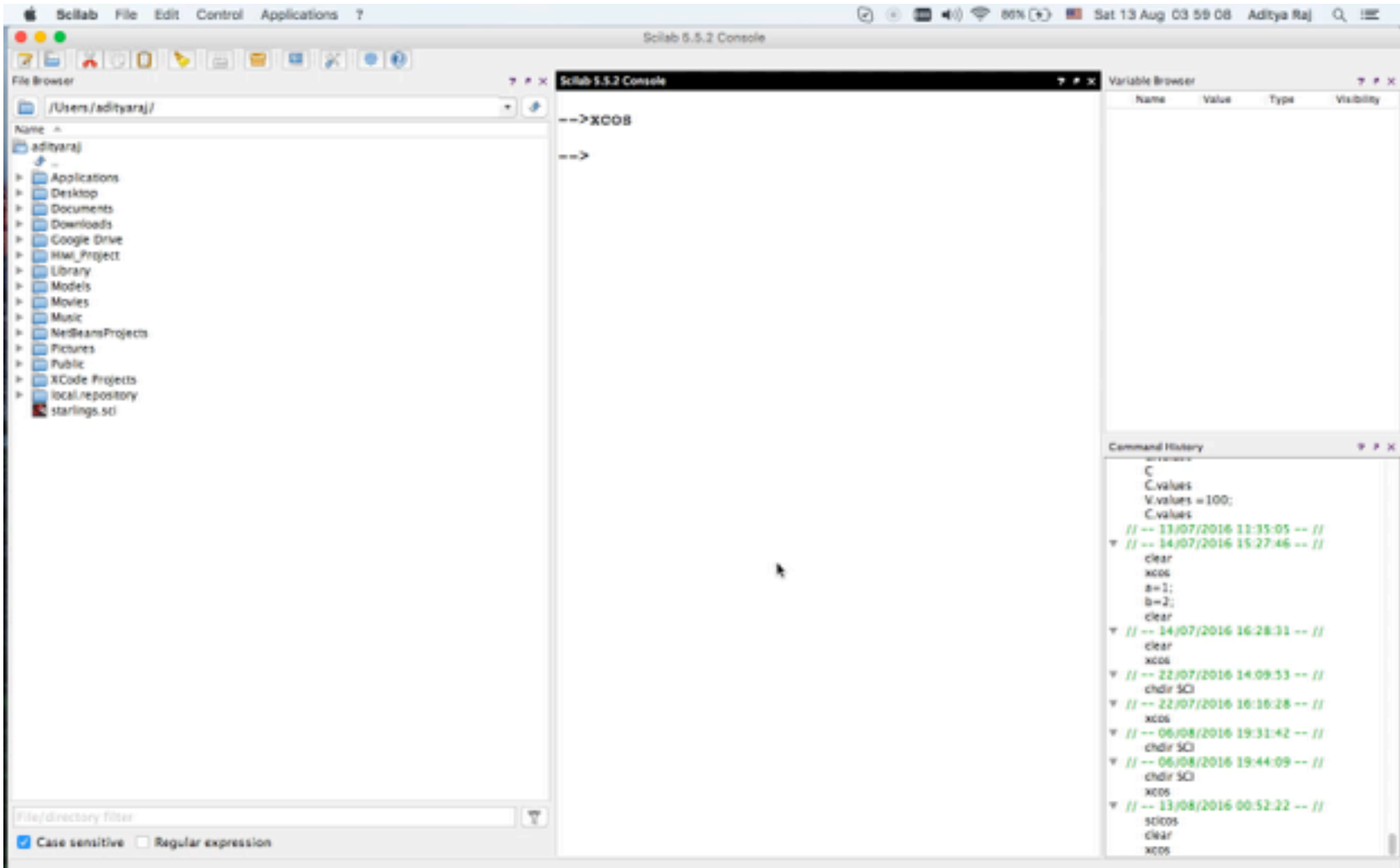
Results



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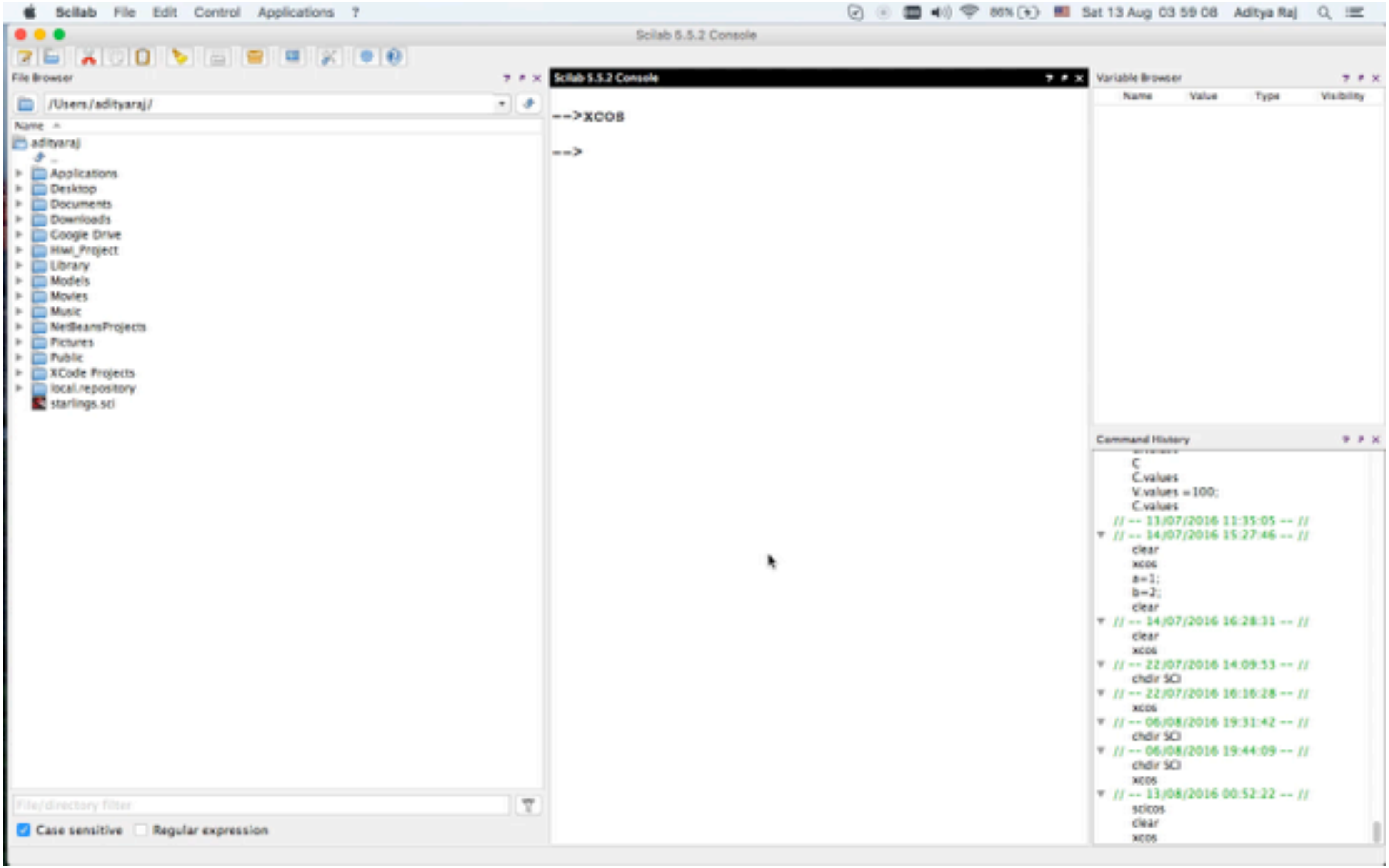
Results



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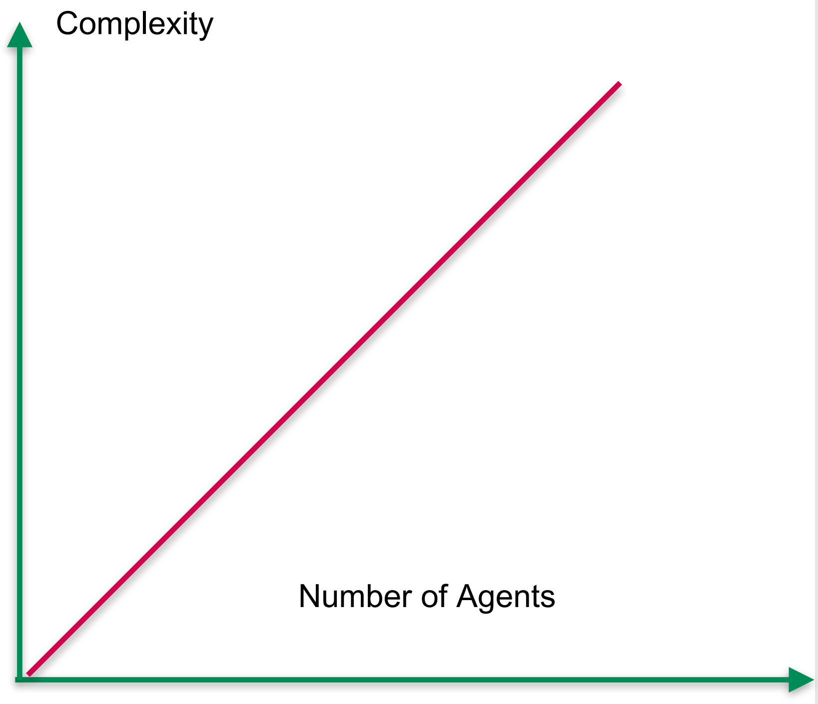
EVALUATION

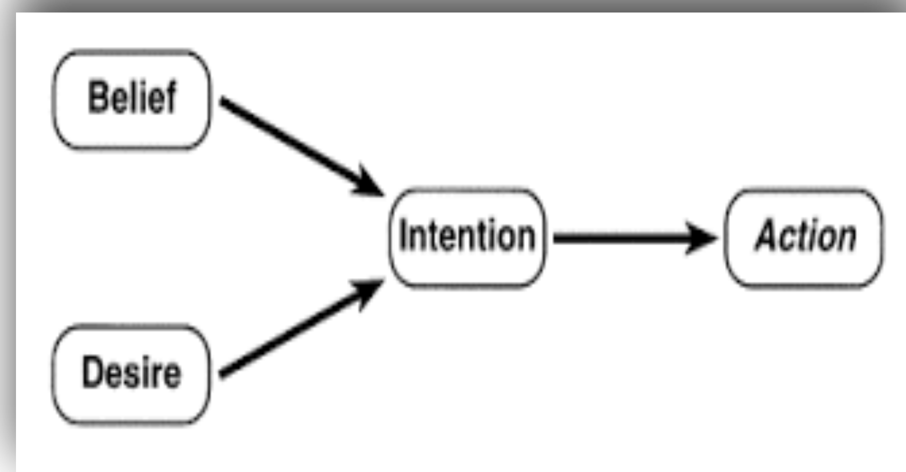
COMPLEXITY

Complexity

- Compilation of User-Defined Blocks.
- Let n= Number of Agents. Complexity for Alignment
  - Alignment: O(n) for finding it's neighbours and further adding it to the sum vector
  - Separation: Same as of alignment
  - Cohesion: Same as of alignment
- Workspace read and write delay.
- O(n) for each cycle of plot.



Future Improvements



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References

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2. Min, Hongkyu; Wang, Zhidong (2011). Design and analysis of Group Escape Behavior for distributed autonomous mobile robots. IEEE International Conference on Robotics and Automation (ICRA).

3. Saska, Martin; Jan, Vakula; Libor, Preucil (2014). Swarms of micro aerial vehicles stabilized under a visual relative localization. IEEE International Conference on Robotics and Automation (ICRA).

4. Moere, A V (2004). "Time-Varying Data Visualization Using Information Flocking Boids". Proceedings of the IEEE Symposium on Information Visualization. pp. 97–104. doi:10.1109/INFVIS.2004.65.

5. Cui, Zhihua; Shi, Zhongzhi (2009). "Boid particle swarm optimisation". International Journal of Innovative Computing and Applications. 2 (2): 77–85. doi:10.1504/IJICA.2009.031778.

6. Lebar Bajec, Iztok; Heppner, Frank H. (2009). "Organized flight in birds" (PDF). Animal Behaviour. pp. 777–789. doi:10.1016/j.anbehav.2009.07.007.

7. Weblink: https://processing.org/examples/flocking.html

8. Tutorial Creating C Function BLOCKS: http://www.scicos.org/ScicosCBlockTutorial.pdf

Any questions?

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