Bournemouth University

National Centre of Computer Animation

Crowd Simulation based on Emergent Behaviours

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MSc Computer Animation and Visual Effects

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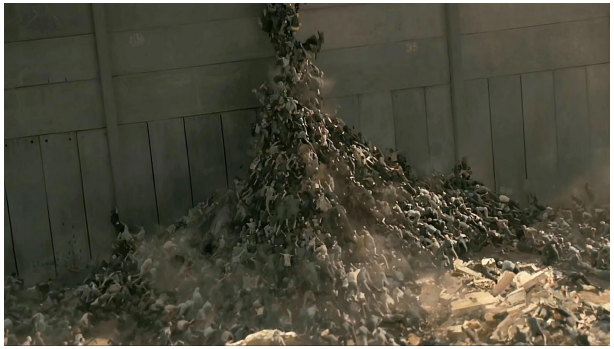
Crowd in Films



Crowd in Films

Contributions

- Visually stunning
- Catches public's attention
- Enriches story
- The story may just need it

Crowd in Films

Contributions

- Visually stunning
- Catches public's attention
- Enriches story
- The story may just need it

Issues

- Requires either real extra cast
- or more animators.
- Requires more time and money

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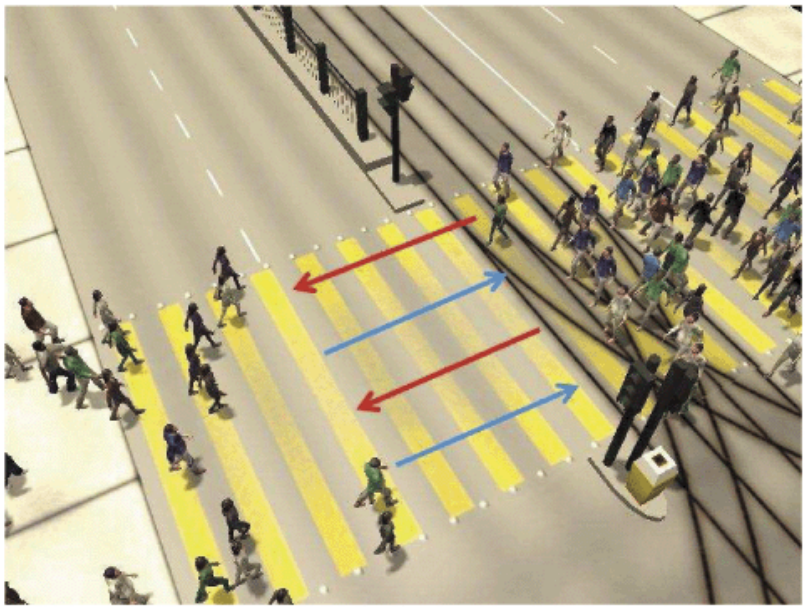
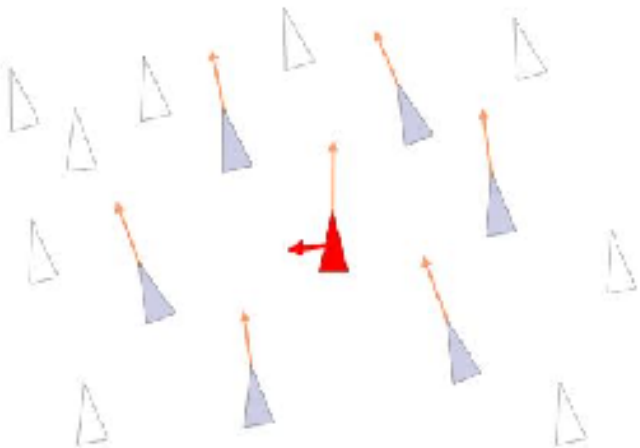
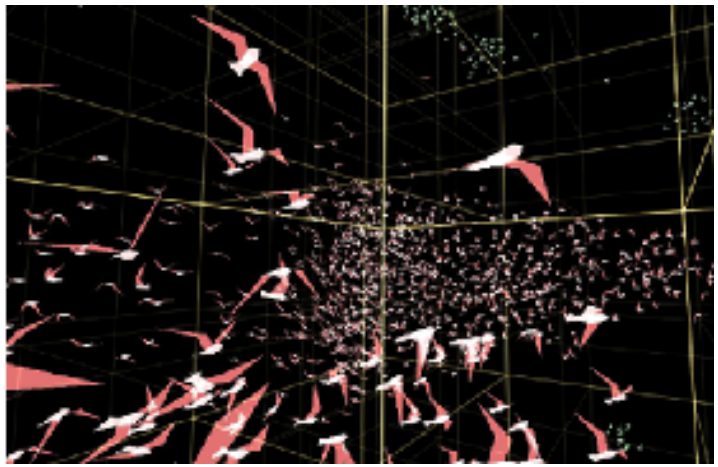
Motion Planning for Crowd

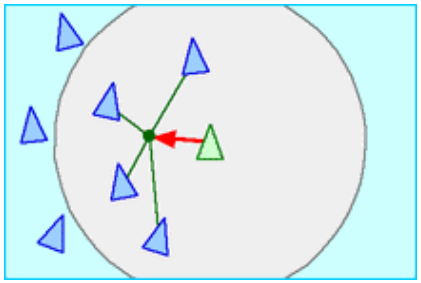


Crowd Motion Simulation

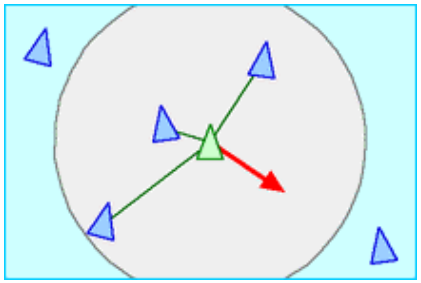




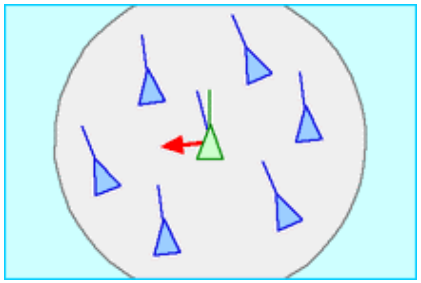
C. Reynolds' Flocking Model



Cohesion



Separation



Alignment

Concept of Emerge

"A system which is designed and defined by certain rules or mathematical equations may configure itself in a way that could not be anticipated" (Kleinrock, 2010)

MASSIVE Software

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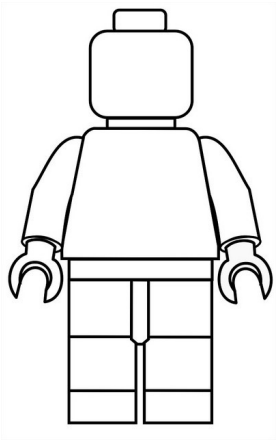
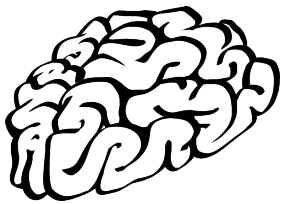
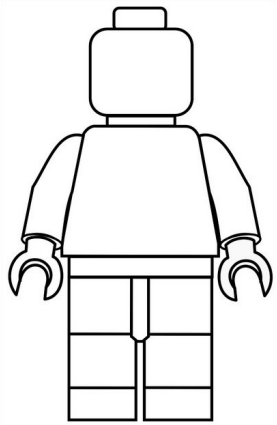
Agent



Agent





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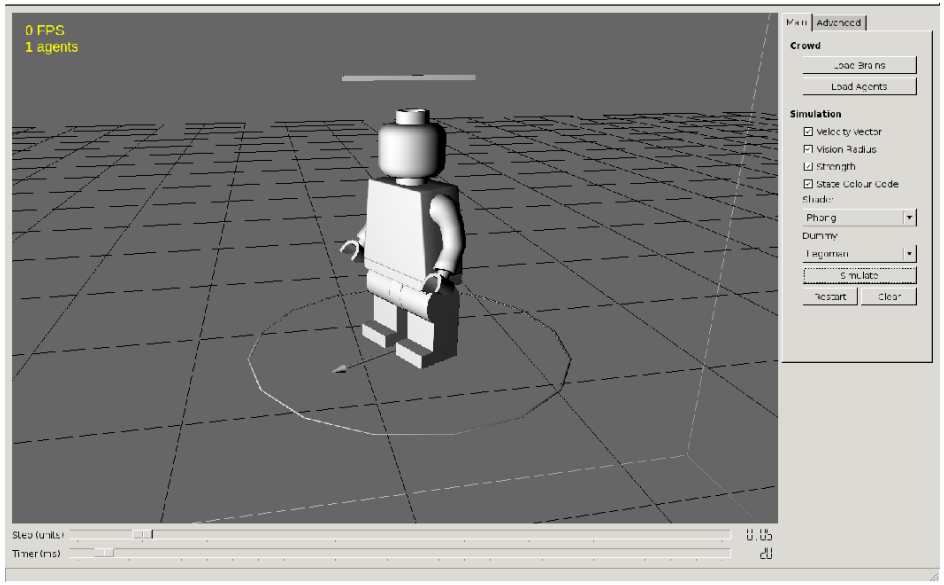
Agent Body

Physical Properties

- Mass
- Strength
- Maximum Strength
- Velocity
- Maximum Speed
- Vision Radius



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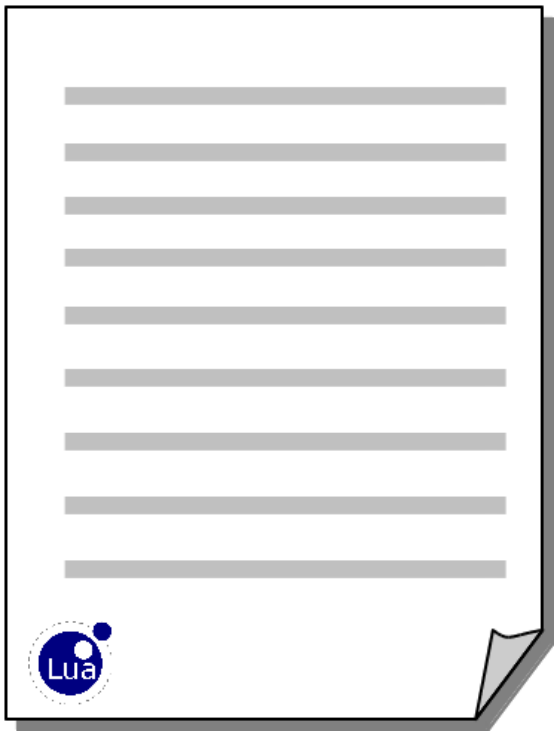
Agent Brain

Behaviour

The brain receives information about the agent body, the environment and the interactions with other agents. After processing, it determines which actions the agent must perform.



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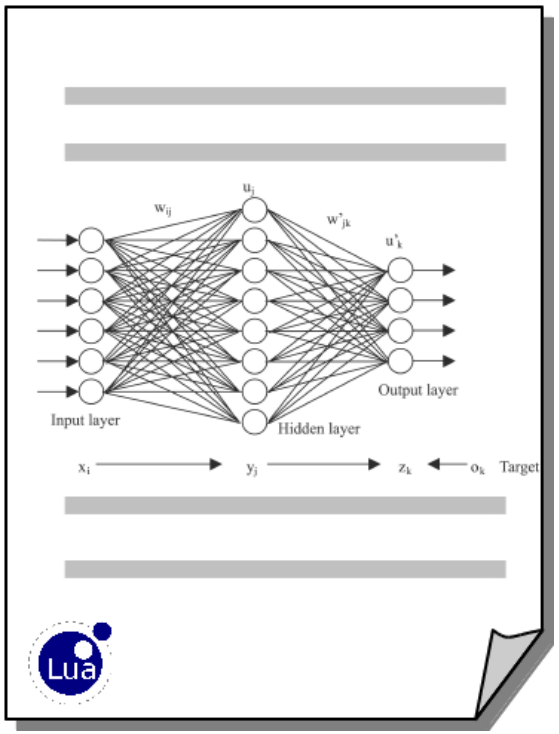

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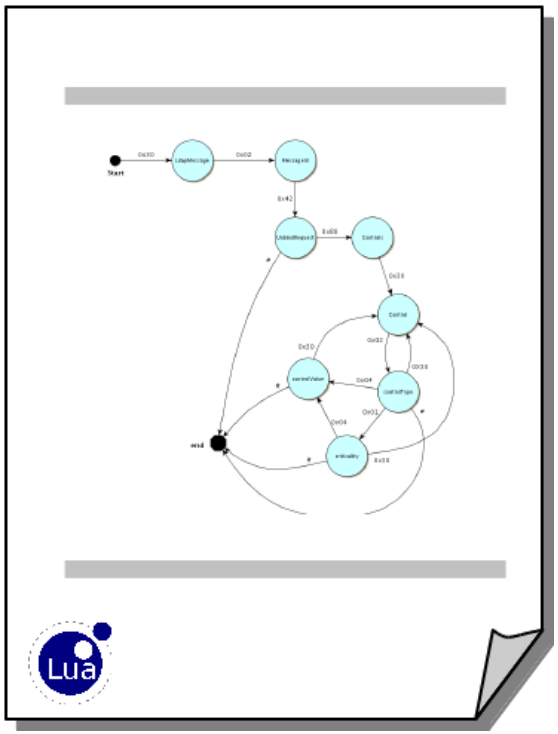

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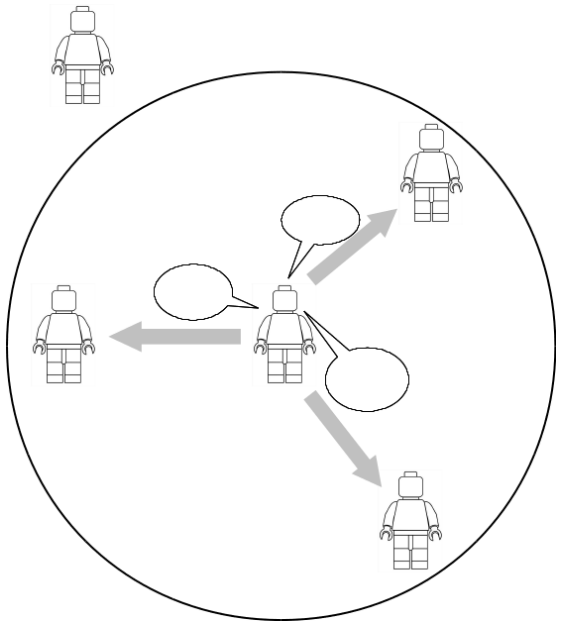
Interconnections

"The complexity does not reside in the individuals, but on the way they are interconnected and they interact to each other"
(Kleinrock, 2010)

Interactions Among Agents

Message

- Agent Identification
- Label
- Position
- Strength



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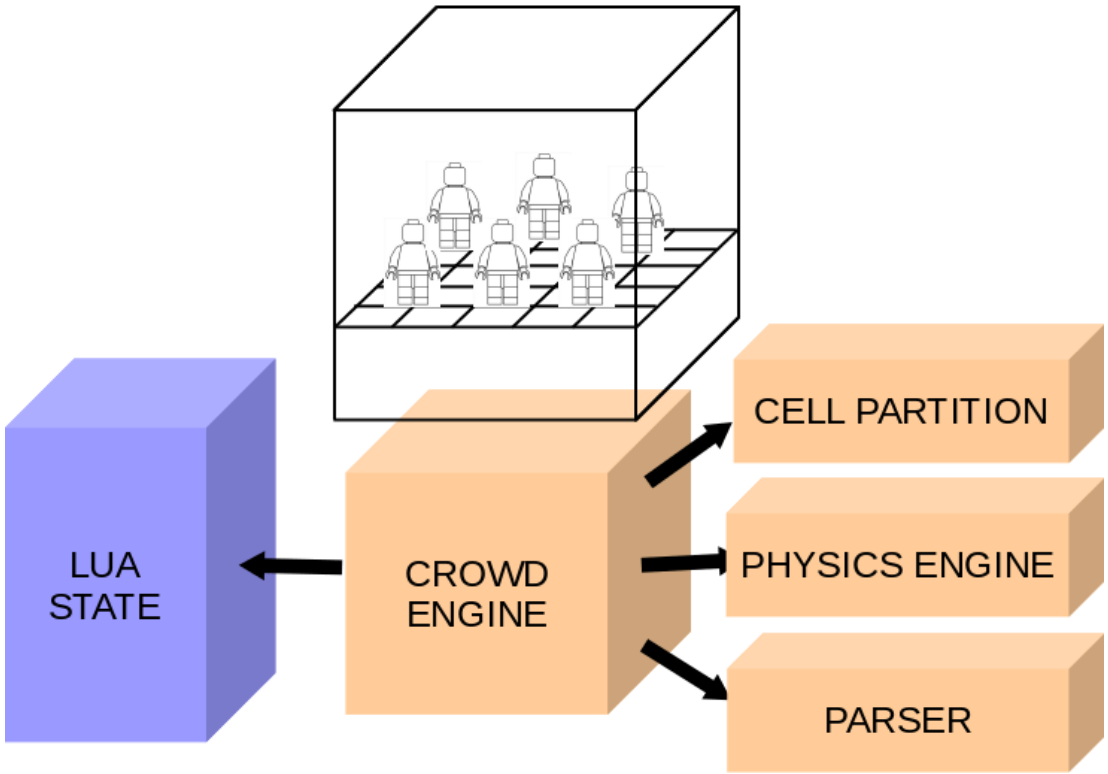
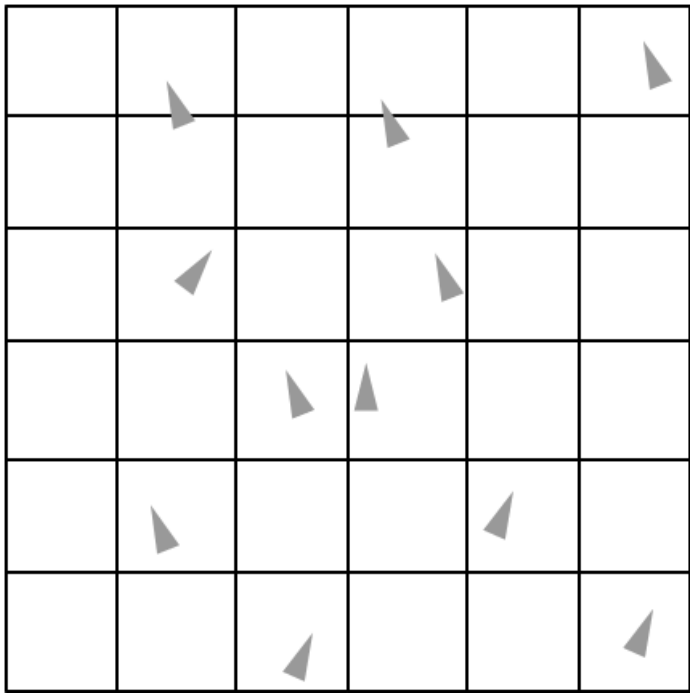
Agent

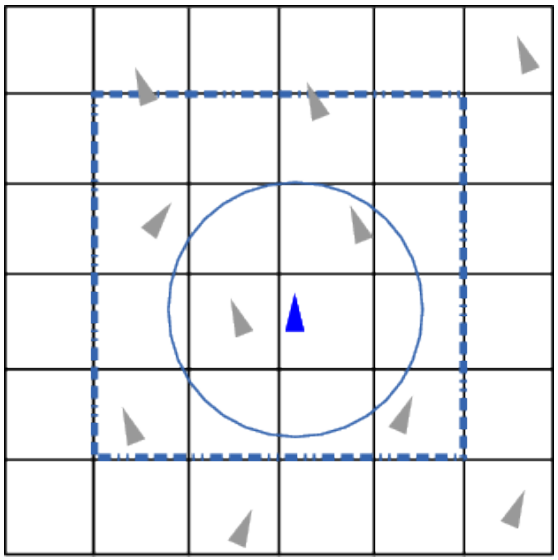

LUA
STATE
CROWD
ENGINE
CELL PARTITION
PHYSICS ENGINE
PARSER

Index

2D Grid Cell Partition



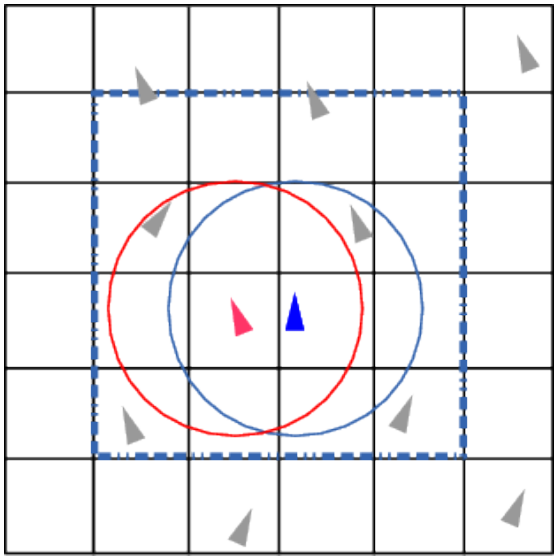
Searching Neighbours in Vision Radius Algorithm



Two procedures

- Find the agents in the cells which include the vision radius
- Find the neighbours from those agents

Searching Neighbours in Vision Radius Algorithm



Heuristic

"Two agents that are spatially close may share many common neighbours" (Lee, 2010)

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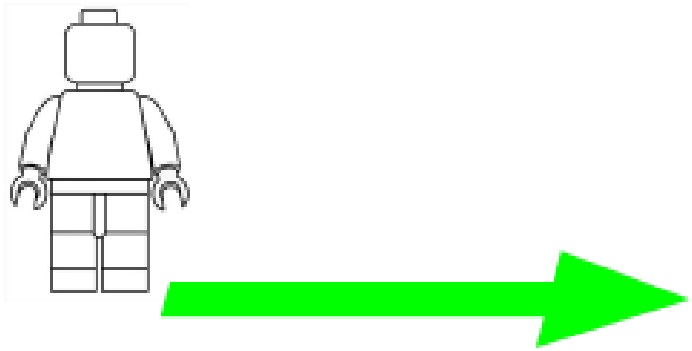
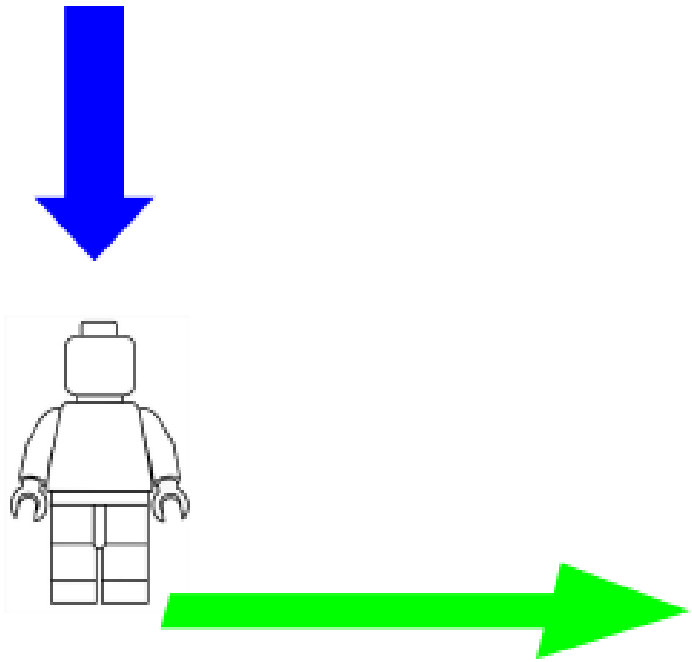
Forces



Prime Mover Force

Determined by the brain

Forces



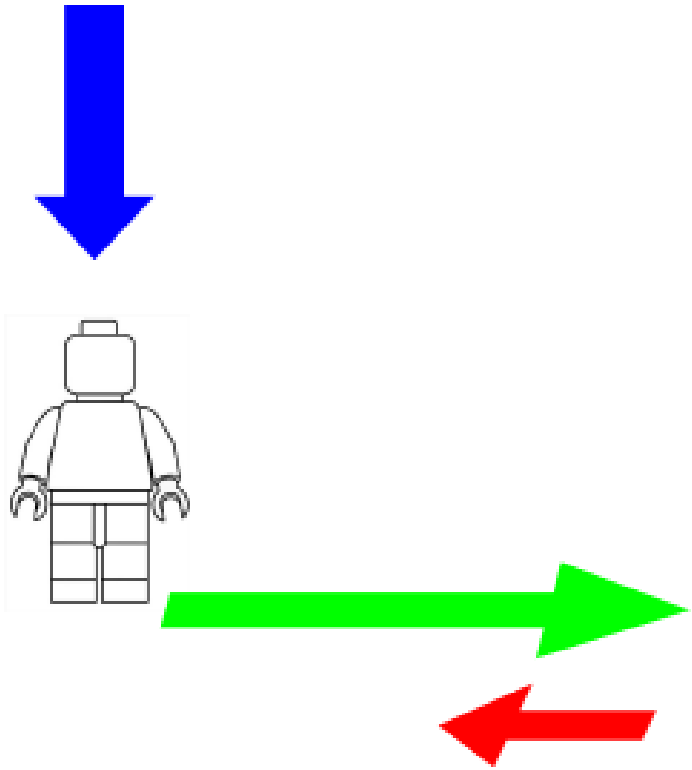
Prime Mover Force

Determined by the brain

Gravity

Vertical towards the ground

Forces



Prime Mover Force

Determined by the brain

Gravity

Vertical towards the ground

Friction

Opposite to the movement

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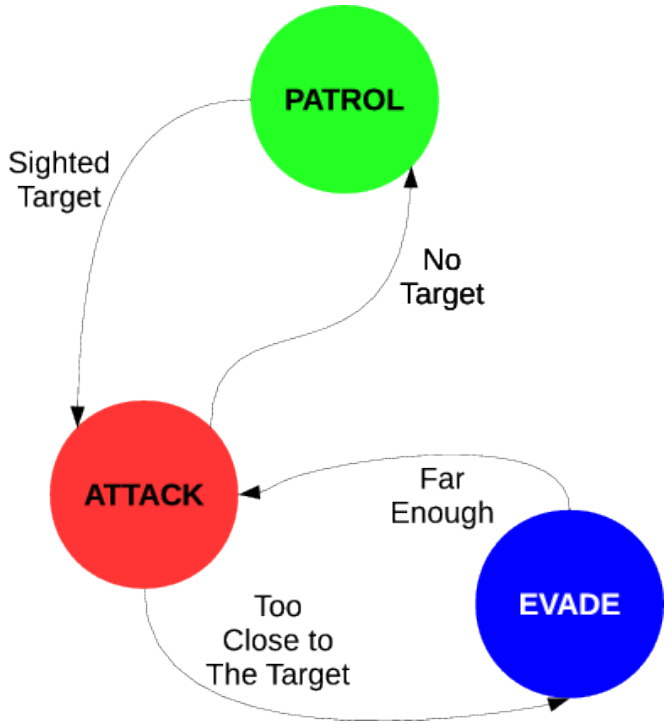
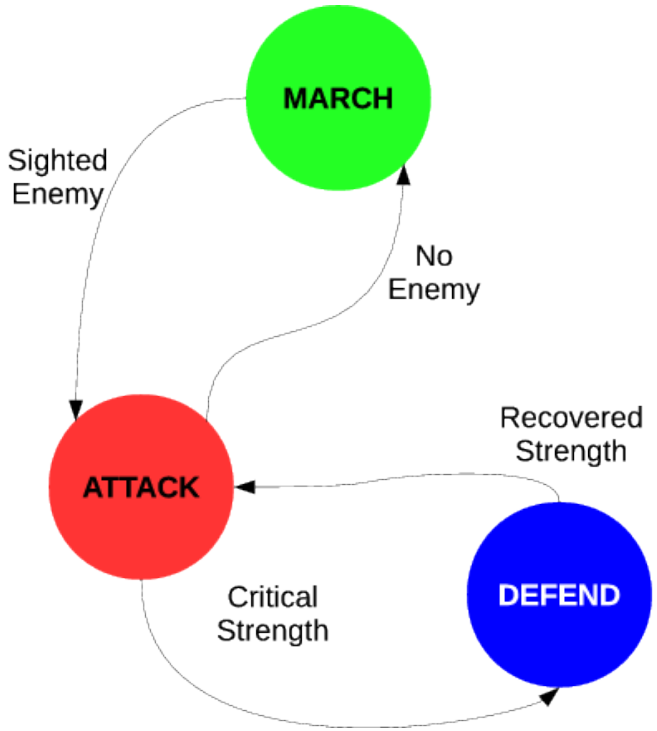
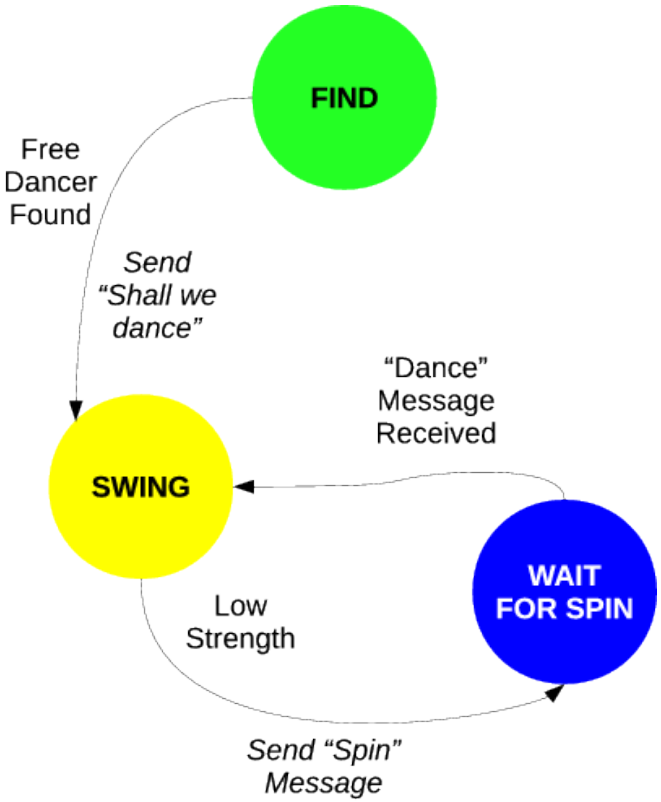
Shooter Droid FSM

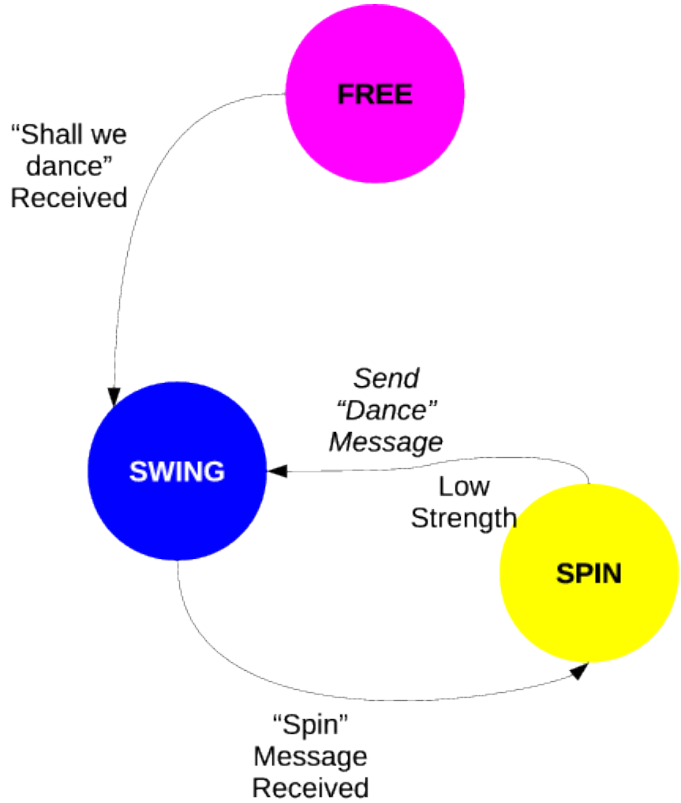


Warrior FSM


MARCH
Sighted Enemy
No Enemy
ATTACK
Recovered Strength
Critical Strength
DEFEND

DanceLeader and Dancer FSM's





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Summary

Crowd Simulation based in Emergent Behaviours

- Complexity is born from simplicity
- Flexible and scalable approach due to script-based behavious
- Robust and solid physically-based virtual world
- Scalable application design
- Easy and quickly testing of AI behaviours due to brain independence
- Adaptable to any sort of simulation

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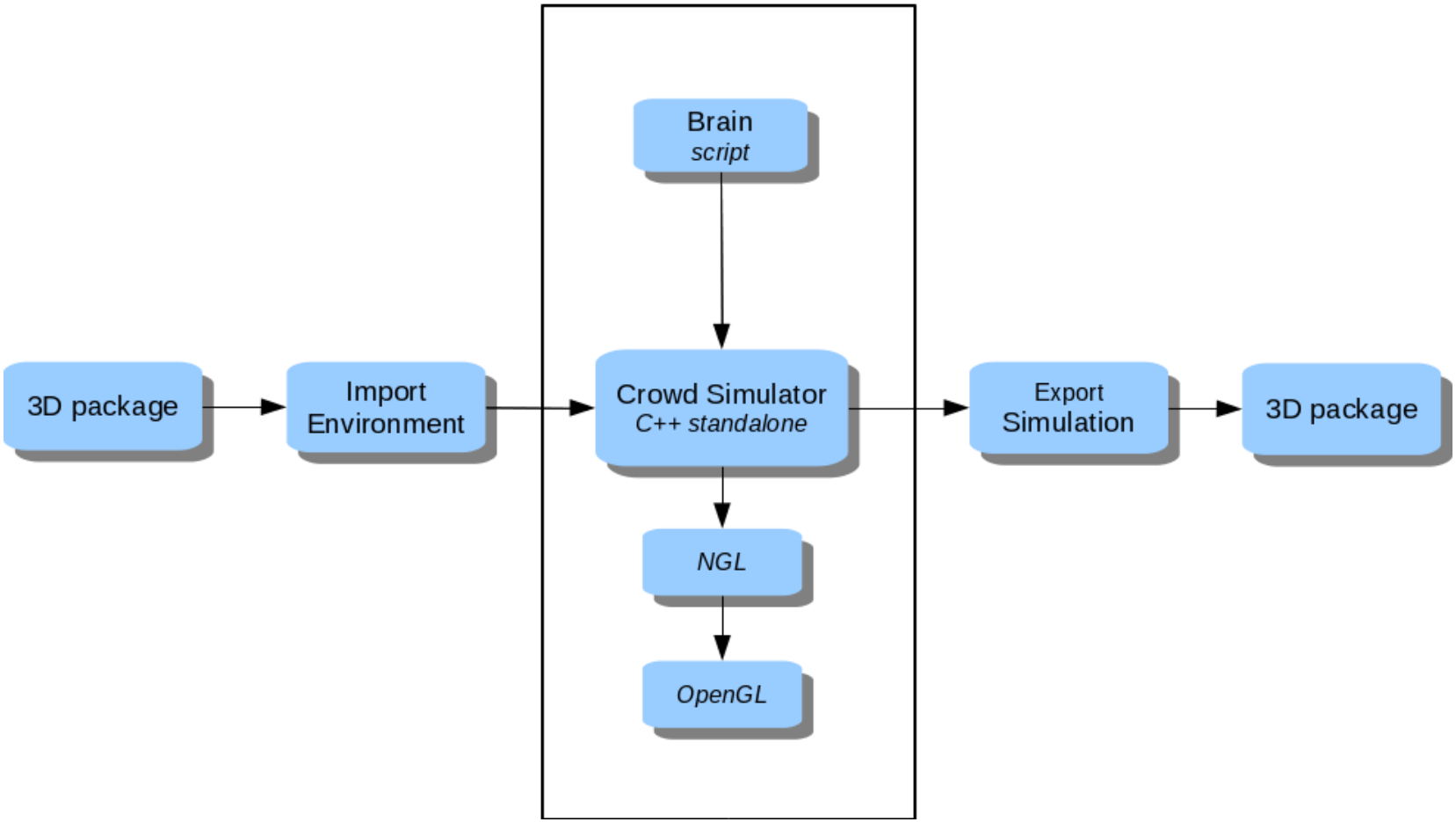
Summary

- The emergent crowd behaviou is hard to anticipate
- Simulations remains empirical
- Many tests required
- This thesis presents a part of a whole process, there is no finished product to present.

Possible Pipeline



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Future work

- Import environment, such as terrain, from 3D package
- Export the simulation. Associate animations to the states
- Include a robust physics engine
- Integrate it in a real pipeline
- Or write a plugin

Thank you for your attention