



WOXBOT

WOX Bot

An Open Extensible Robot for Virtual World Simulations

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Outline



WOXBOT

- introduction
- previous work
- project overview
- foundations and concepts
- implementation
- conclusion and future work

Introduction

artificial life



WOXBOT

- simulation of large societies of single beings
 - biologists and physicists
 - study of life origin and evolution
 - mathematicians
 - theoretical aspects (is it possible?)
 - how can programs evolve by themselves?

Introduction

artificial life



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- simulation of complex evolved creatures (single or multiple bodies)
 - computer graphics community
 - modeling and animation
 - virtual actors
 - individual and population behaviors

Introduction

research goal



WOBOT

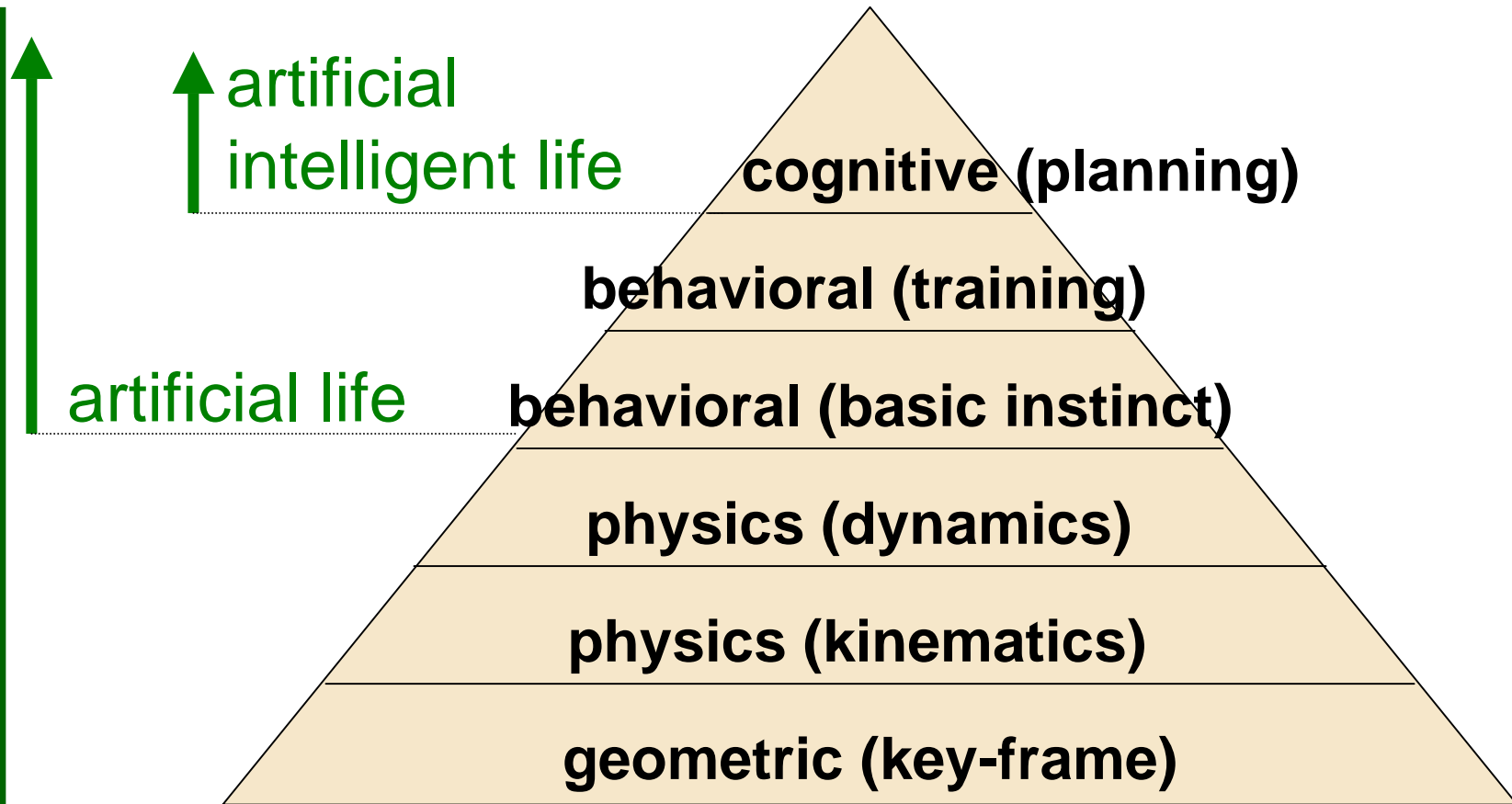
- to study different aspects of artificial life
- character features
 - environment recognition
 - cognition / reasoning / planning / decision making
 - learning abilities
 - action control
 - use of language



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Previous Work

comp. graph. - animation



Previous Work

computer graphics



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- Perlin 94-96: behavior animation (Improve)
- Terzopoulos 91-99: behavior and cognition (fishes)
- Talman 80's - 90's: human modeling (human bodies and population)
- Sims 94: evolved competing creatures (nice primitive creatures)

Project Overview

long term goal



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- to be able to simulate complex virtual worlds with realistic creatures, exhibiting sophisticated behaviors supported by reasoning, learning and cognition

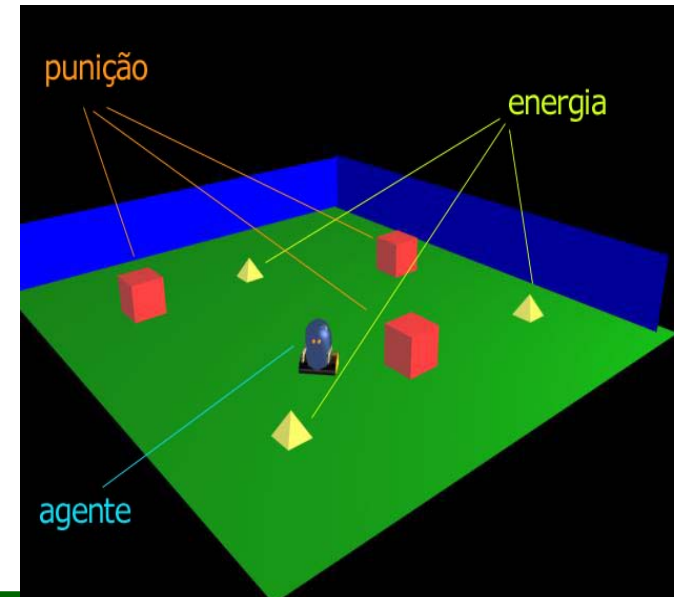
Project Overview *framework*



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- virtual character
 - WOXBot:
Wide Open
Extensible Robot
- virtual environment
 - ARENA: the
environment inhabited
by WOXBots



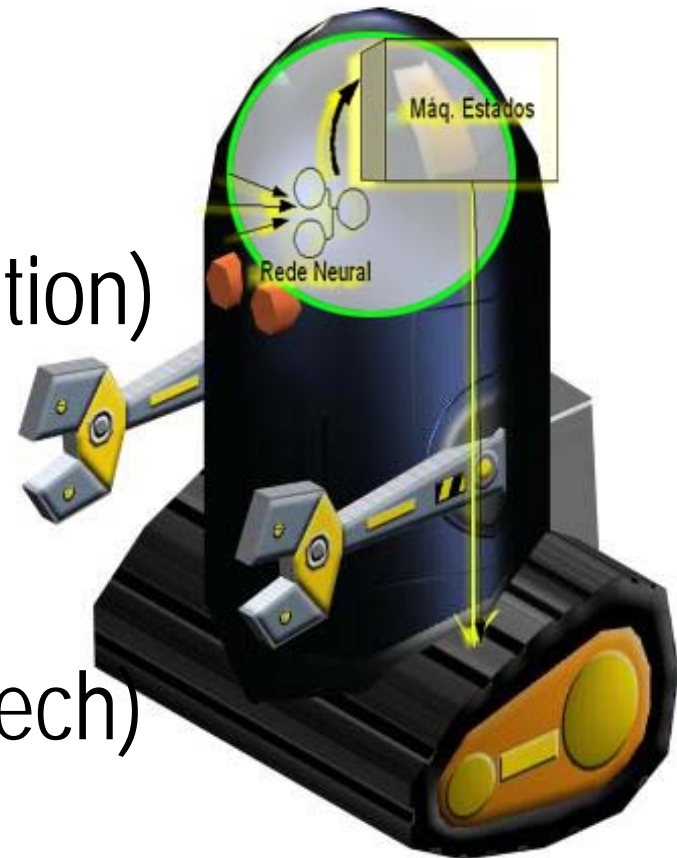
Project Overview

framework - character



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- actors are one or more robots
- perception (vision, audition)
- features recognition
- decision (behavior)
- action (movement, speech)
- evolution



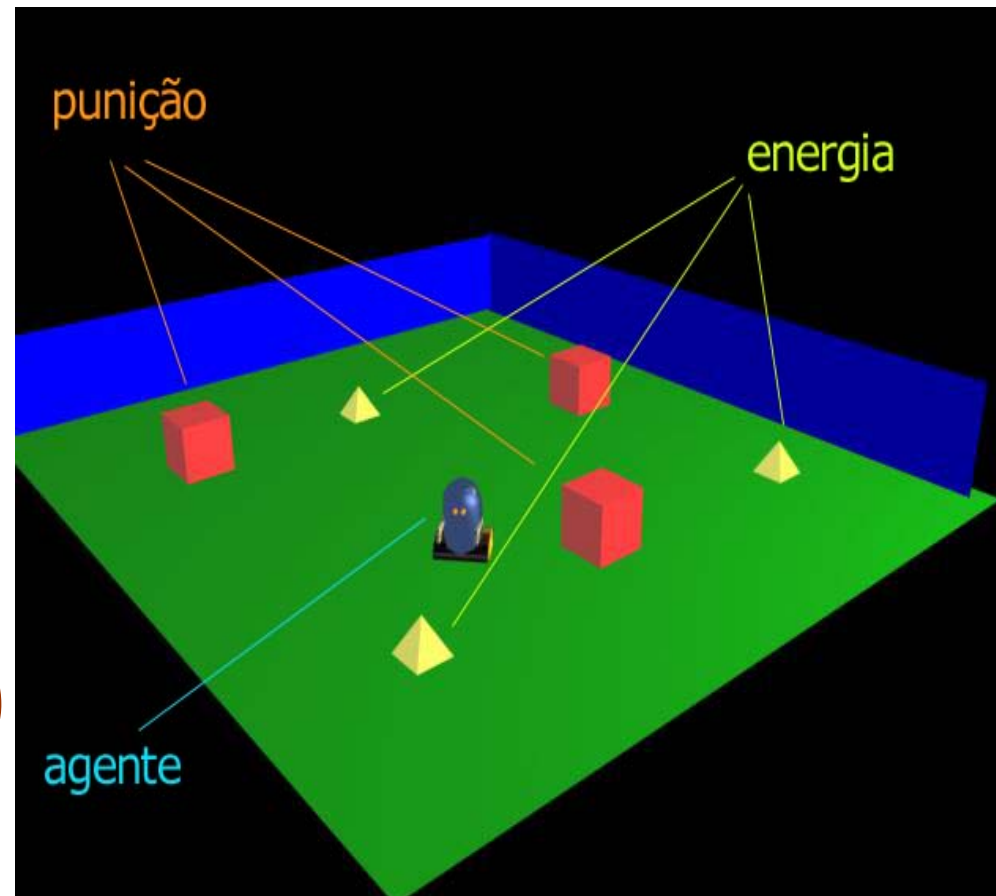
Project Overview

framework - scenario



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- scene is an area where woxbots live
- scenario for life adaptation
 - rewards
 - traps (punishment)



Concepts *artificial life*



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- cellular automata theory
 - origin and evolution of life
- computer graphics animation
 - natural behavior
- how to achieve it?
 - usage of evolution strategies

Concepts

artificial life



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- local aspects
 - ability of a character to regulate its own behavior
- global aspects
 - adaptation of a certain specie (trough generations)
 - emerges from the local one

Concepts evolution & *genetic algorithm*.



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- evolutionary strategies
 - rules of evolution and natural selection
- genetic algorithms
 - codification of beings features into genes
 - generation of new beings by reproduction and mutation

Concepts

intelligent agents



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- agents
 - to move alone (mobility)
 - to communicate (sociability)
 - to take decisions (intelligence)
- intelligent agents
 - use of knowledge
 - production / update of knowledge

Concepts

intelligent agents



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- Computational entities that behave with autonomy in order to manipulate the information associated with its knowledge
 - goals
 - motivation (?)
 - reasoning about actions and their consequence

Implementation *intelligent agents*



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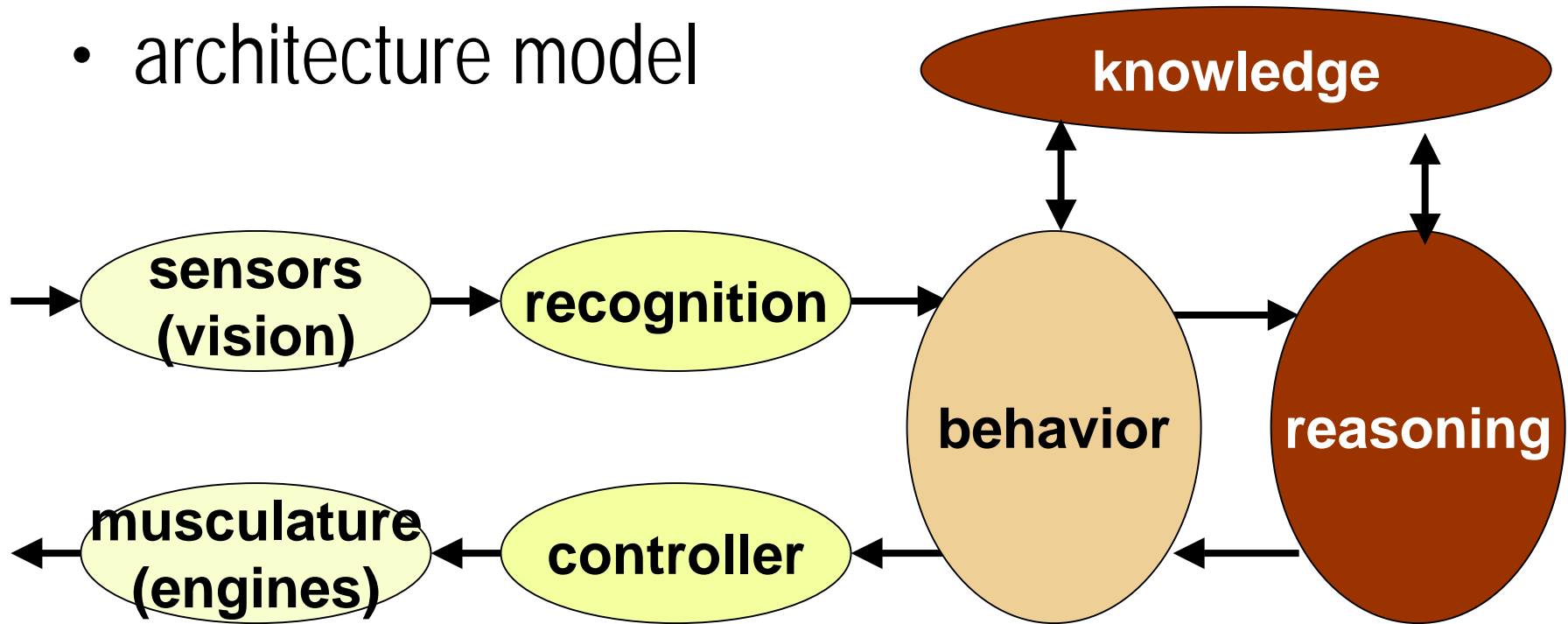
- each module can be
 - pre-specified (hard coded)
 - does not allow adaptations without programmer interference
 - able to be trained or not
 - based on evolution concepts
 - naturally adapted
 - allow improvements to be achieved spontaneously



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Implementation *intelligent agents*

- architecture model



Implementation

perceptual modules



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- vision
 - observation of their environment through simulated vision process
 - image generation (computer graphics camera)
 - image interpretation and recognition (neural nets)
 - learning / training
 - neuronal nets
 - identification of objects and other robots

Implementation

perceptual modules



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- audition (listening)
 - observation of their environment through simulated listening process
 - symbol generation (sound recognition)
 - information interpretation and recognition (neural nets)
 - learning / training
 - neuronal nets
 - identification of objects and other robots



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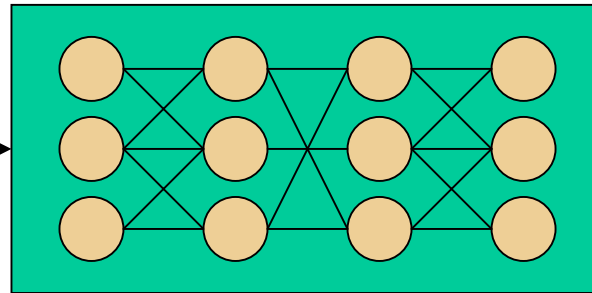
Implementation

learning in perception

– information recognition from achieved data



vision image



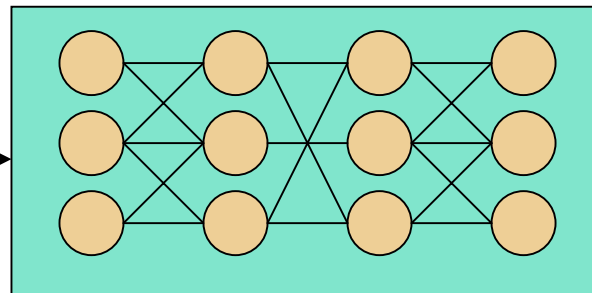
identification system

- 0: no object
- 1: obj. @ left
- 2: obj. @ right
- 3: obj. @ center

coded information



audio



identification system

- 0: no sound
- 1: high freq. near
- 2: high freq. far
- 3: low freq. near

coded information

Implementation

action and behavior



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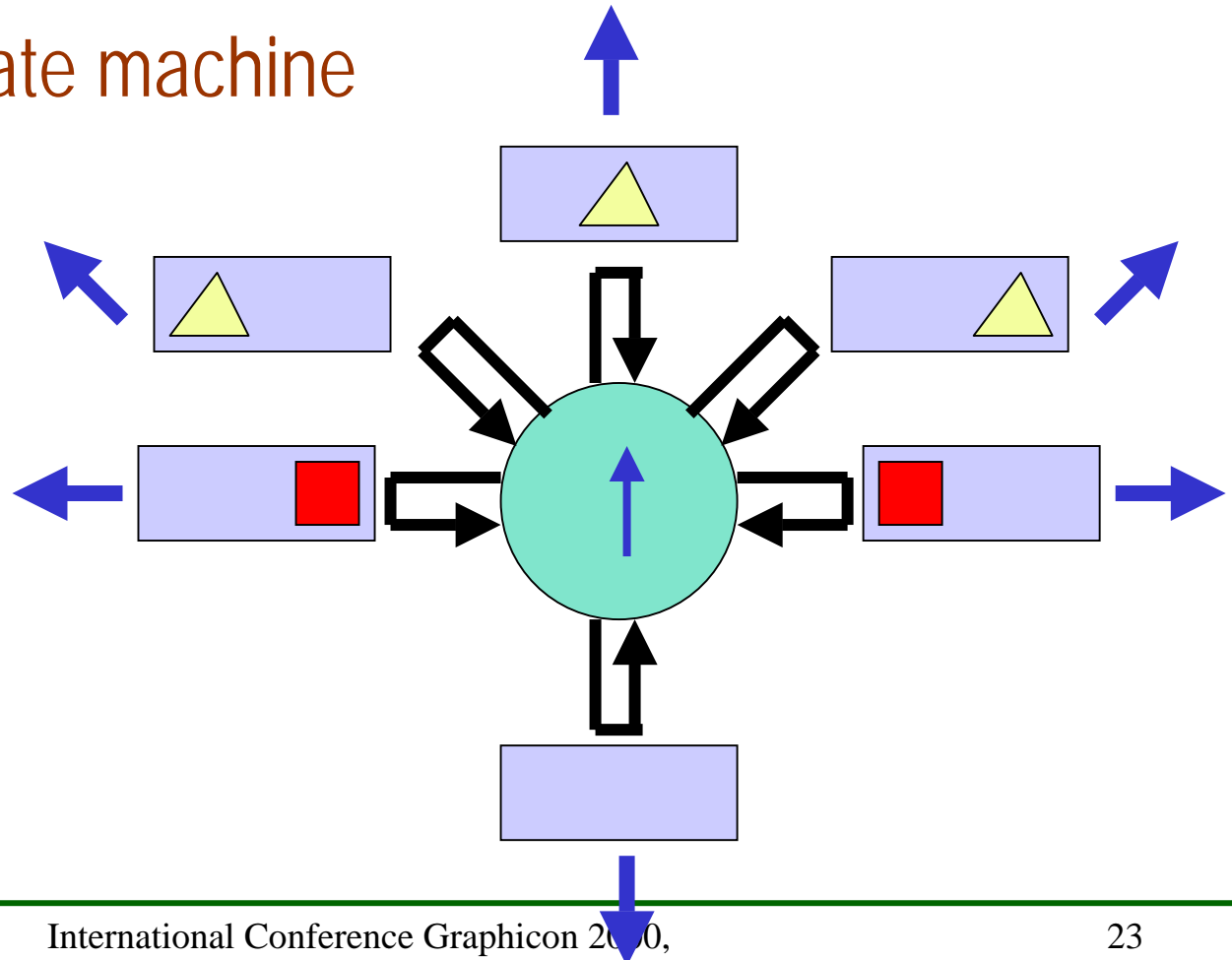
- behavior defined in a state evolved machine
 - trough evolution there is a natural improvement in the state machine
- actions are related to state transitions
- sensor inputs control state transitions
- states represent a memory about the current situation



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Implementation *action and behavior*

– single state machine



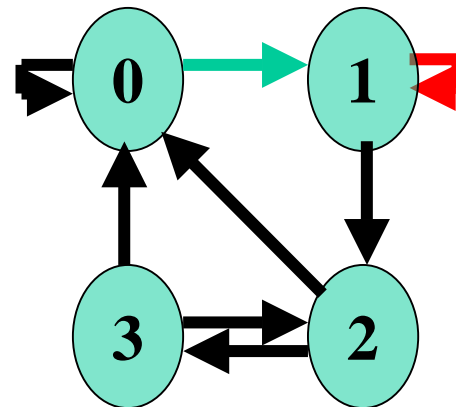
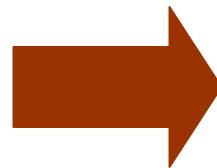
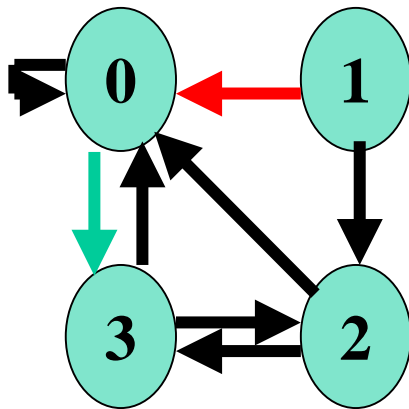


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Implementation

action and behavior

– behavior state machine (without special meaning)



states

- 0 stay
- 1 going ahead
- 2 turning right
- 3 turning left

<i>S</i>	<i>ISA</i>	<i>ISA</i>
0	0 0 X	1 3 Z
1	0 2 Y	1 0 Z

<i>S</i>	<i>ISA</i>	<i>ISA</i>
0	0 0 X	1 1 Z
1	0 2 Y	1 1 Z

Implementation

action and behavior



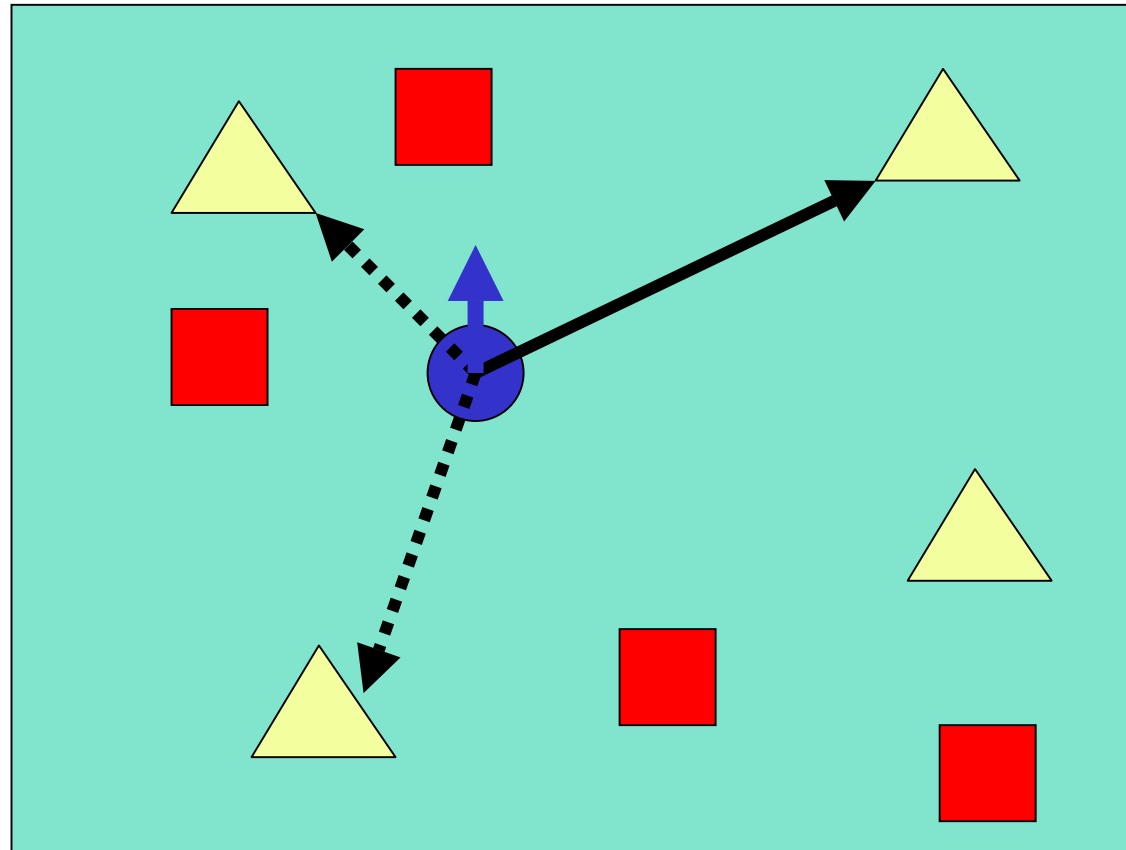
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path planning

tradeoff

gain \Leftrightarrow lost

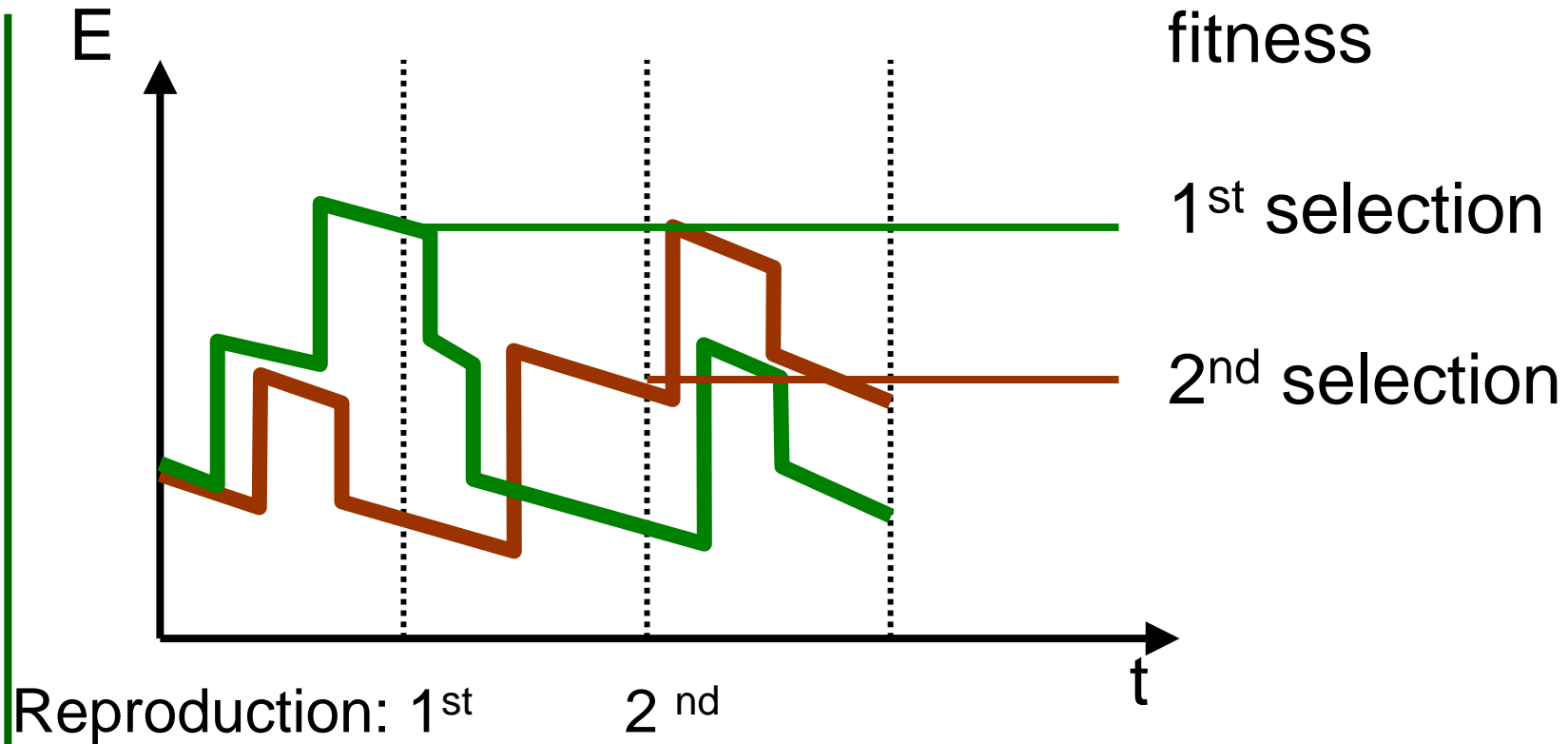
look for pyramids
avoiding cubes or
their proximity





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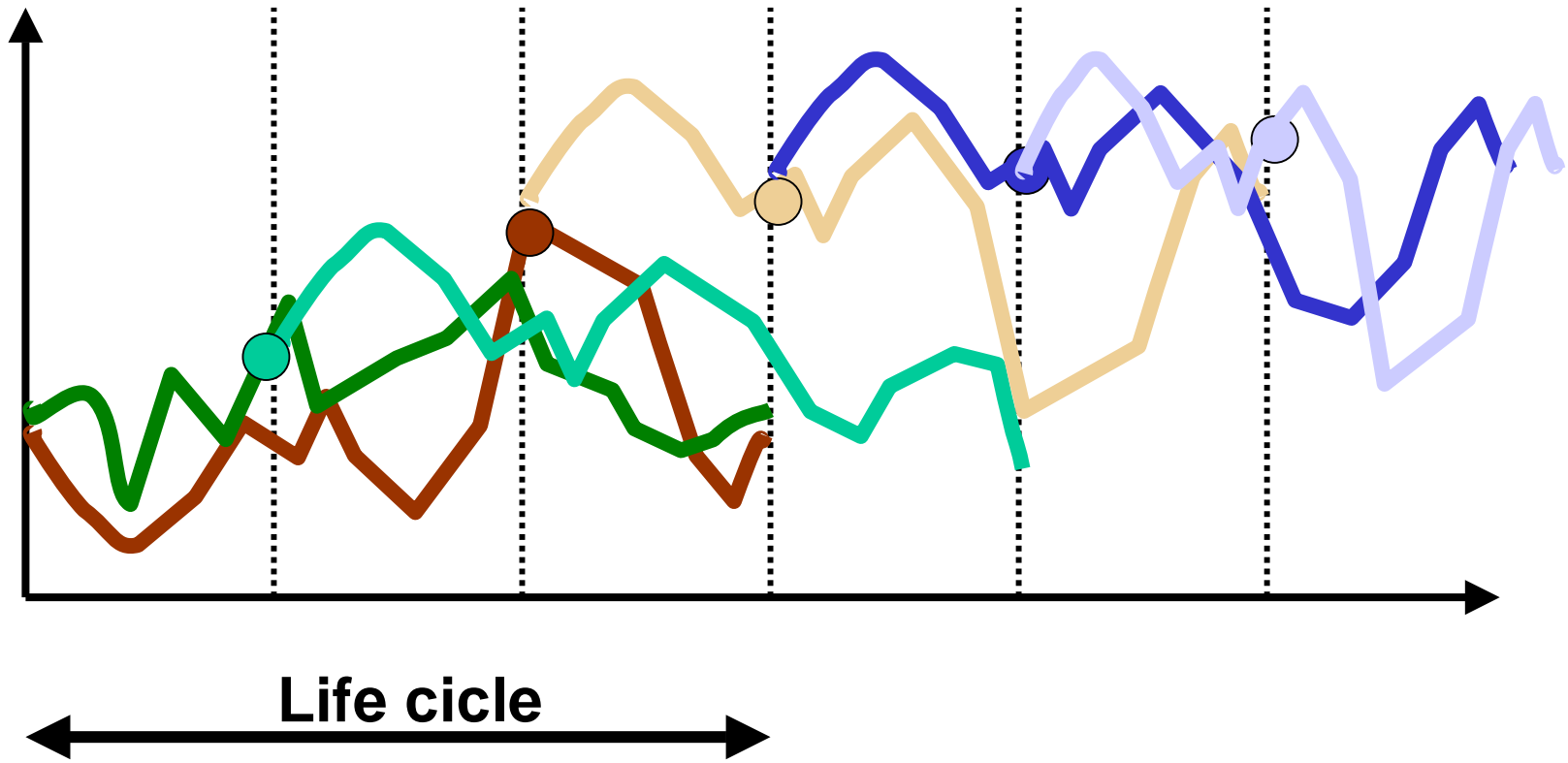
Implementation *evolution strategies*





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Implementation *evolution strategies*



Implementation

evolution strategies



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- life cycle
 - the same for all characters (less interesting)
 - dependent on their energy reserves (more interes.)
- new generation
 - reproduction from best fitted (higher energy)
 - mutation

Conclusion



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- we presented a new artificial life framework
 - multi-modal perception sensors, with training (learning) capabilities
 - adaptable behavior mechanisms, based on evolutionary concepts
 - until now we have worked with non communicating characters (no language usage)

Conclusion

future work



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- test and improve communication mechanisms
 - speech and its recognition
 - language development
 - requires improvements in audition simulation
- improvements in state machine evolution
 - allowing an increase in the number of states

Conclusion

future work



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- incorporate planning
 - knowledge base
 - how to evolve to natural cognition based on evolution ???
 - how to add emotion, and its consequences ???
 - how to incorporate the possibility to choose reproduction partners ???