Towards Continuous Actions in Continuous Space and Time using Self-Adaptive Constructivism in Neural XCSF

Master seminar: Deep Learning in Computer Vision

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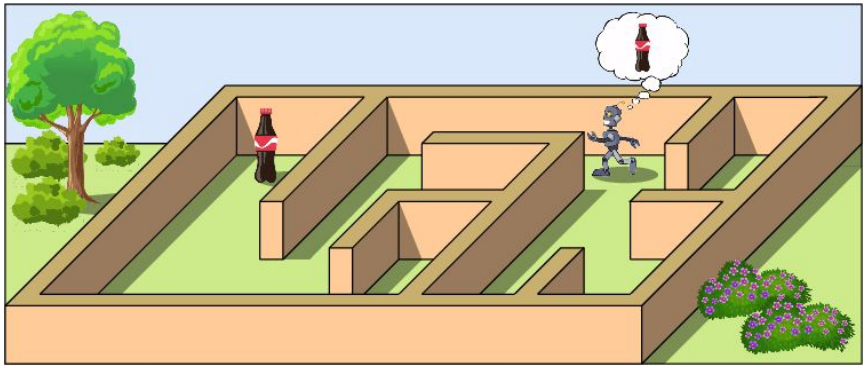
INTRODUCTION



Agent Navigation task

- ➔ Continuous environment
- ➔ solve a continuous maze environment using discrete-valued actions, continuous-valued actions or continuous-valued actions of continuous duration.
- ➔ Constructivism mechanism

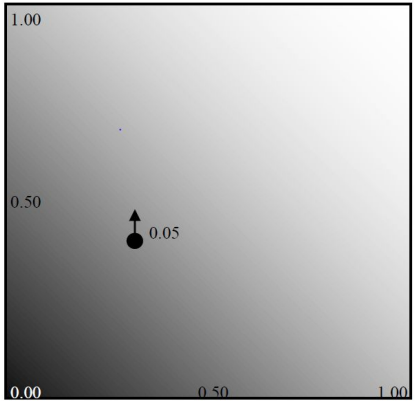
RELATED WORK

- ➔ LCS devised using Zeroth-level Classifier System (ZCS)
- ➔ The implementation of self-adaptive based on another paper
- ➔ Focused on solving continuous environments

Implementation of XCSF Framework

1. Maze environment
2. Neural XCSF (Discrete-valued actions)
3. Self-adaptation
4. Neural constructivism

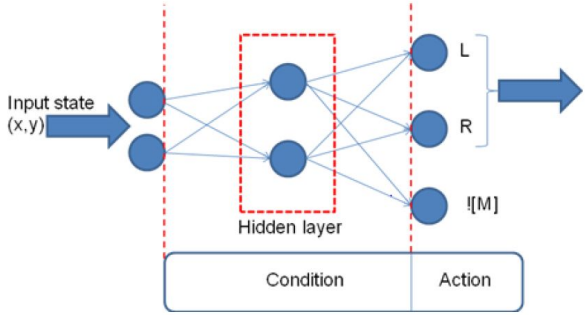
Maze environment



2D Continuous grid environment

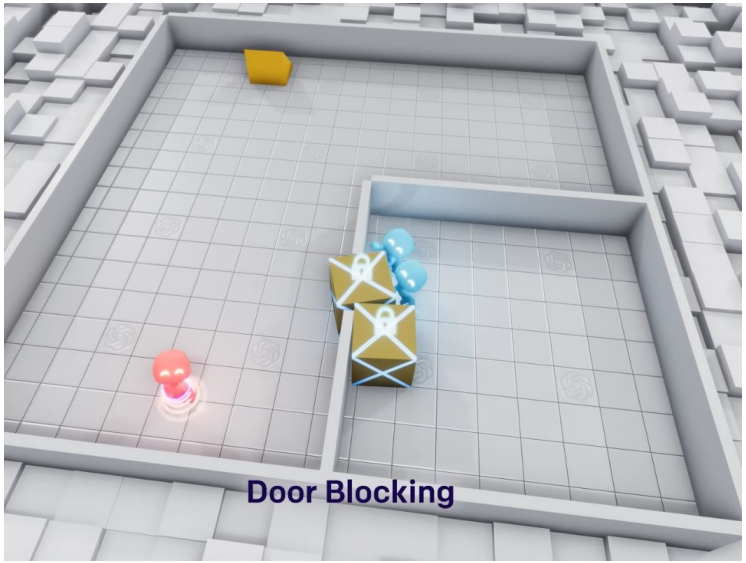
Rewards: 1000 points
Step size: 0.05
Discount factor: γ = 0.95 [The discount factor $\gamma \in [0,1]$ is the present value for future rewards]
Avg optimal step size: 21

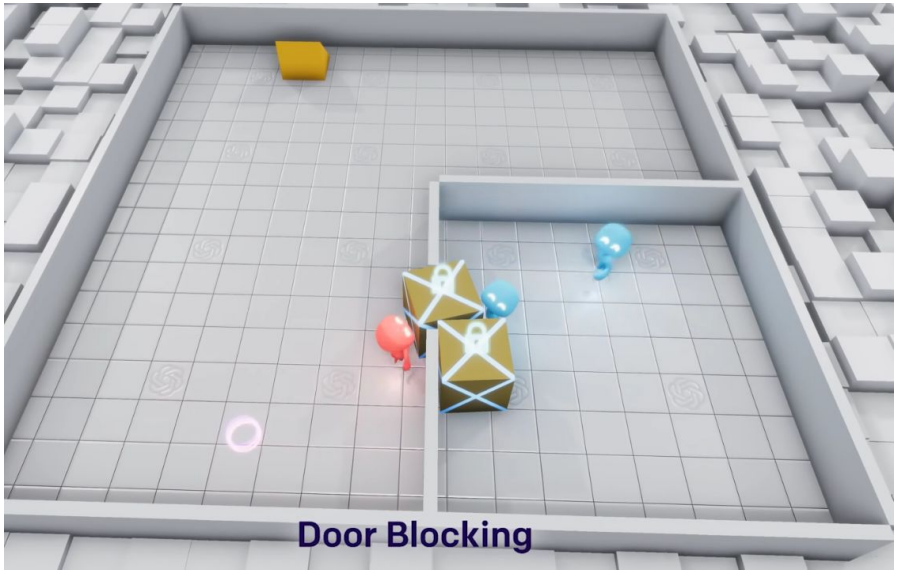
Neural XCSF



- ➔ Classifier is replaced with MLP
- ➔ Strength of action passed to the left and right motors
- ➔ Don’t Match ![M]
- ➔ $0.0 \leq x < 0.5$ (low), $0.5 \leq x \leq 1.0$ (high).

Self-adaptation





Self-adaptive $\mu \leftarrow \mu * e^{N(0,1)}$

Neural constructivism

Development begins with a small network

EXPERIMENTATION

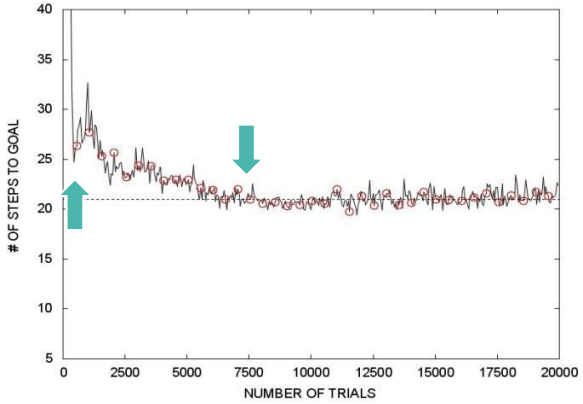
Population size N=16000, learning rate β=0.2 ,error threshold ε=0.005

fitness fraction for accelerated deletion σ=0.1,fitness power ν=5 ,GA threshold (θ)GA=50

- ➔ Discrete-valued action
- ➔ Continuous-valued action
- ➔ Continuous-duration action

DISCRETE-VALUED ACTIONS

self-adaptive μ



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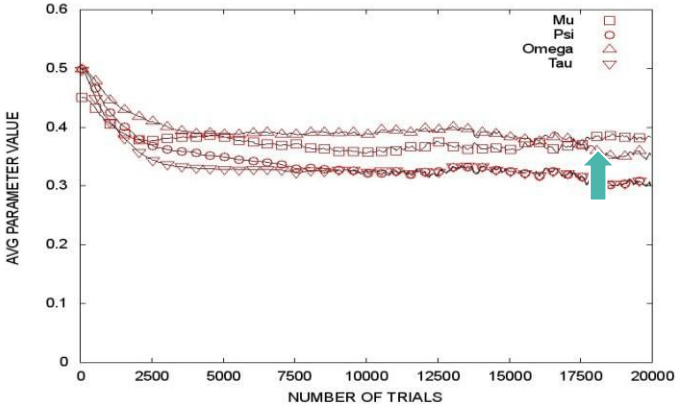

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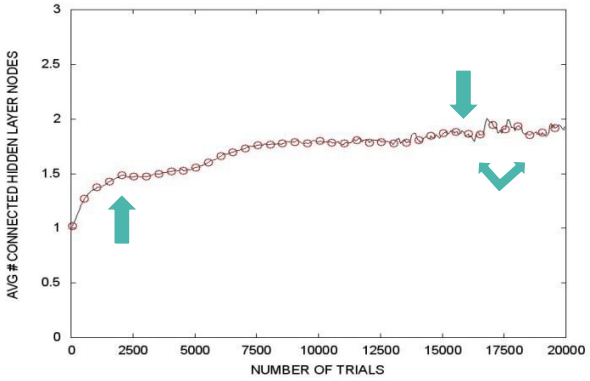

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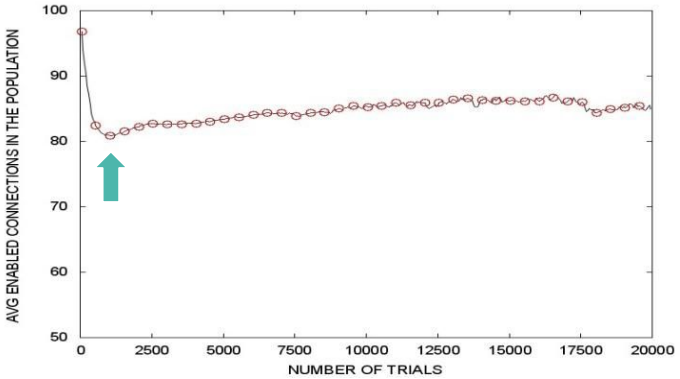
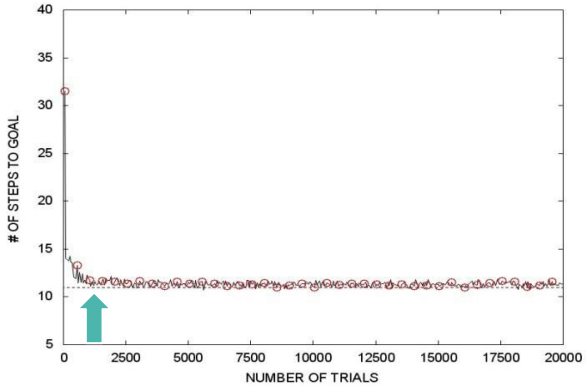


(d)

CONTINUOUS-VALUED ACTIONS

- ➔ simulation and reality robots
- ➔ Output [-0.05, 0.05] (1) movement in X (2) movement in Y (3) participation in match set.
- ➔ Steps-to-goal 11, Identical parameter as DVA

CONTINUOUS-VALUED ACTIONS



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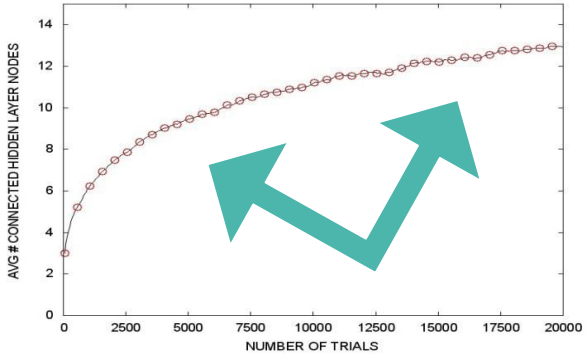

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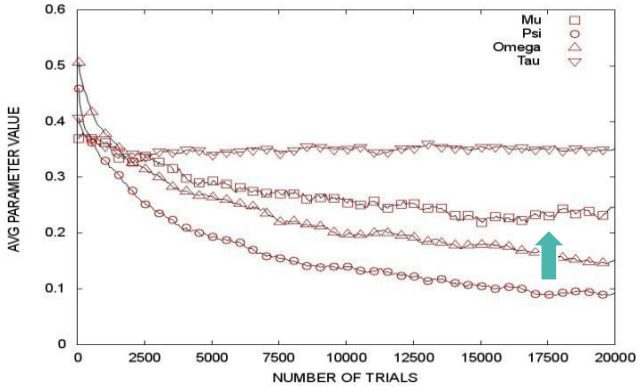

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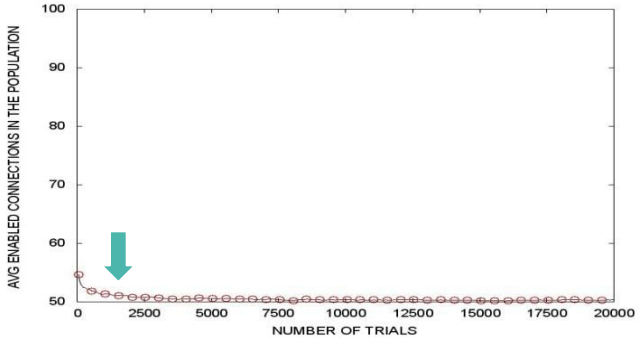

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CONTINUOUS-DURATION ACTIONS

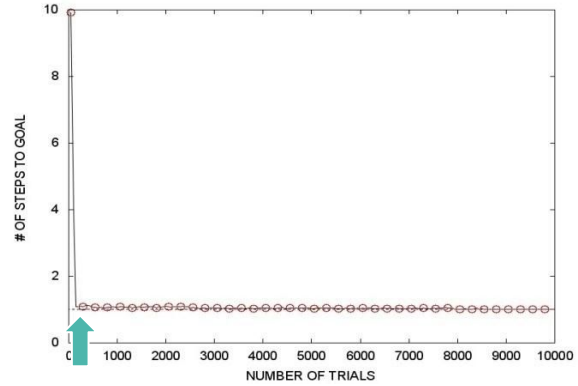
ψ = probability of constructivism event

$\mathscr{P}$ = Probability of adding a neuron

$$P = r + \gamma * maxP$$

$$P = (e^{-\varphi t^t})r + (e^{-pt^i})r * maxP$$

CONTINUOUS-DURATION ACTIONS



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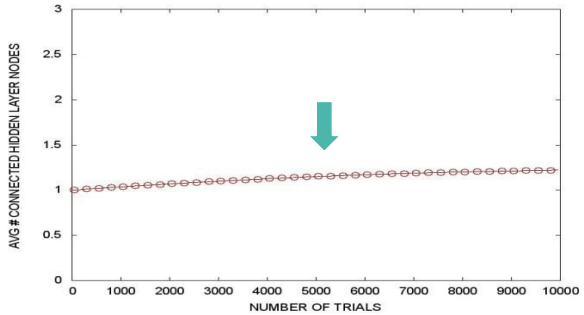

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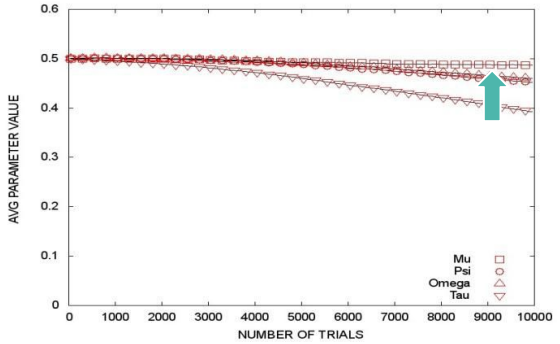

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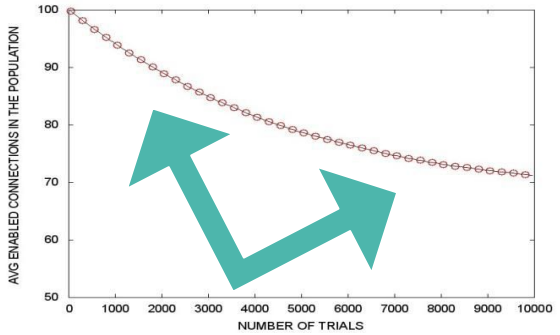

(d)

Conclusion and Future work

- ➔ A self-adaptive neural XCSF employing constructivism is capable of solving the 2D Grid environment.
- ➔ First implementation with LCS for CV action in response CV input
- ➔ More complex environment

About the paper

Towards continuous actions in continuous space and time using self-adaptive constructivism in neural XCSF

GD Howard, L Bull, PL Lanzi - ... of the 11th Annual conference on Genetic ..., 2009 - dl.acm.org

This paper presents a Learning Classifier System (LCS) where each classifier condition is represented by a feed-forward multi-layered perceptron (MLP) network. Adaptive behavior is realized through the use of self-adaptive parameters and neural constructivism, providing the system with a flexible knowledge representation. The approach allows for the evolution of networks of appropriate complexity to solve a continuous maze environment, here using either discrete-valued actions, continuous-valued actions, or continuous-valued actions of ...

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