Applying an artificial neuromolecular system with autonomous learning capability to learn to control the movement of a six-axis robotic arm

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Jong-Chen Chen's resume

- Associate professor, Information Management Department, National Yunlin University of Science and Technology, Taiwan, 1994-1999
- Professor, Information Management Department, National Yunlin University of Science and Technology, Taiwan, 2000-now

Research interests

- He has published a number of papers in the fields of evolutionary computation, neural network, biological information processing, sensors, applied science, and artificial intelligence.

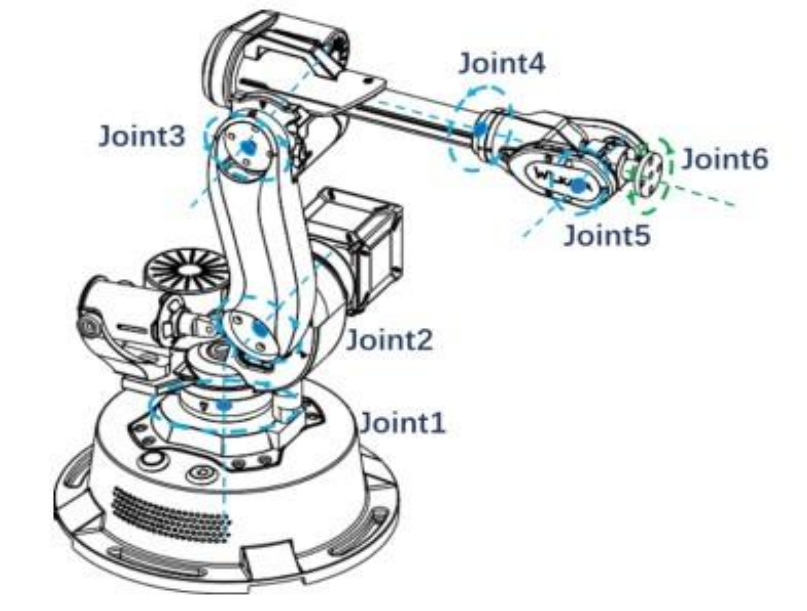
- His research interests include evolvable hardware, brain-like computer simulation, ecosystem simulation, bio-computing, artificial life, molecular electronics, evolutionary computation, genetic programming, and pattern recognition.

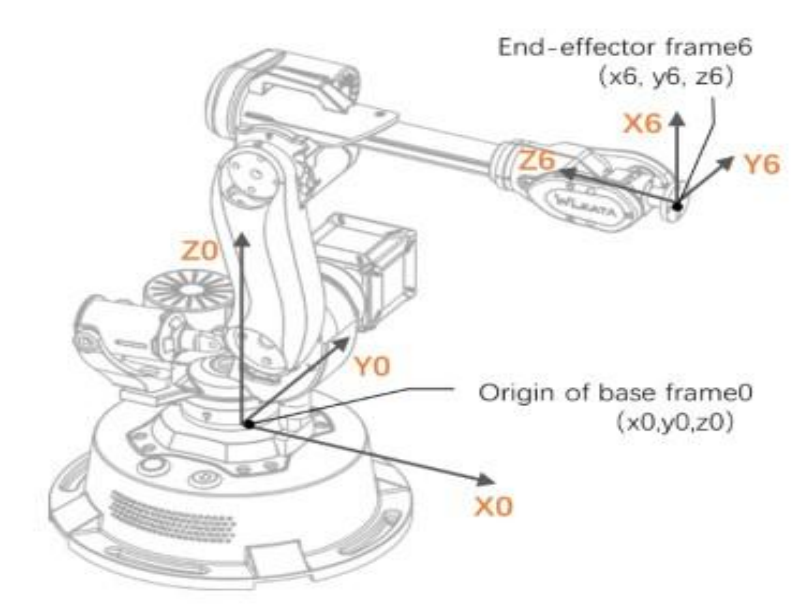
Introduction

Robotic arms play an increasingly vital role across various fields.

Currently, most robotic arms still rely on engineers' careful design and machine control, which sometimes lacks a certain degree of flexibility.

A six-axis robot





Working range of each axis

Axis	Working range	Maximum speed
Axis 1	-110° ~ +160°	85°/s
Axis 2	-35° ~ +70°	60°/s
Axis 3	°-120° ~ +60°	65°/s
Axis 4	-180° to +180°	200°/s
Axis 5	-200° ~ +30°	200°/s
Axis 6	-360° ~ +360°	450°/s

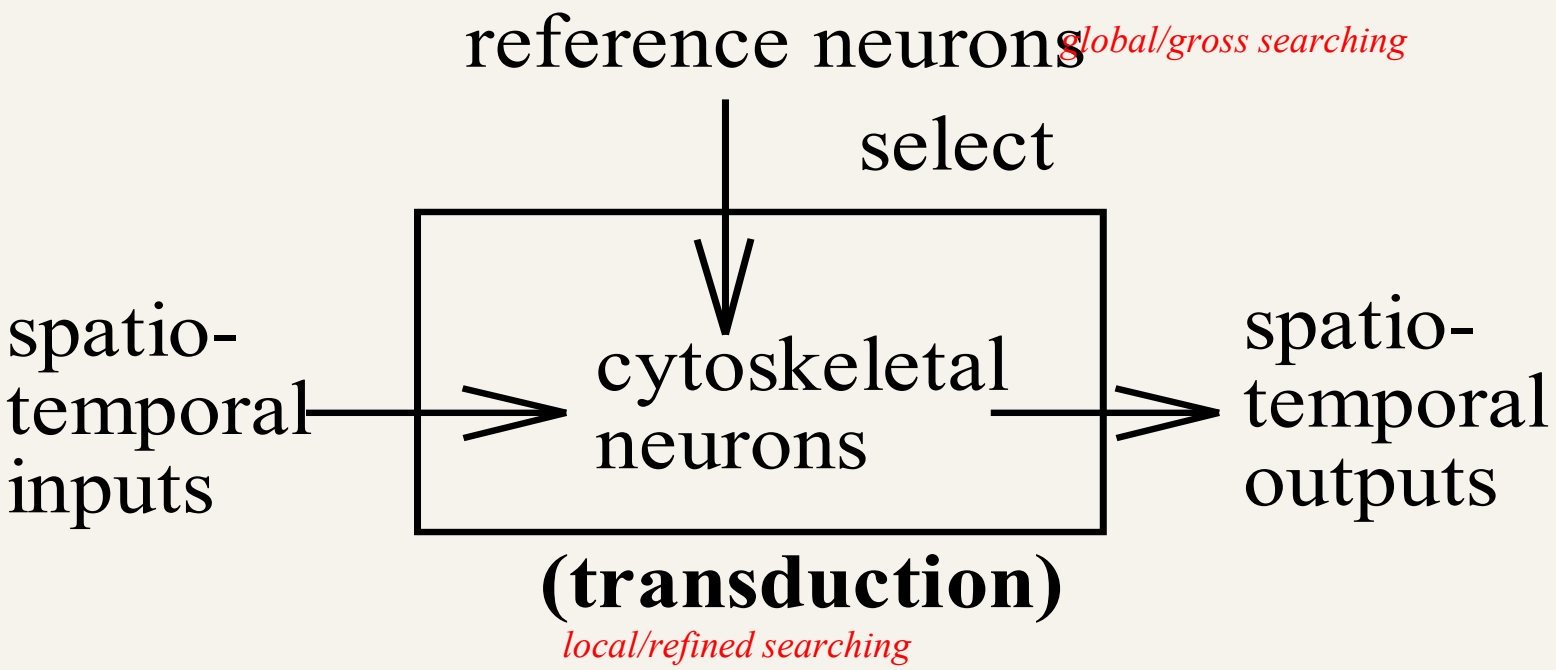
- The goal of this study is to explore using a system endowed with autonomous learning capabilities to learn and control the movements of a six-axis robotic arm.

- The research method enables this robotic arm to autonomously determine its movement trajectory, transitioning from a specific point to a fixed position while grasping an object at a designated angle.

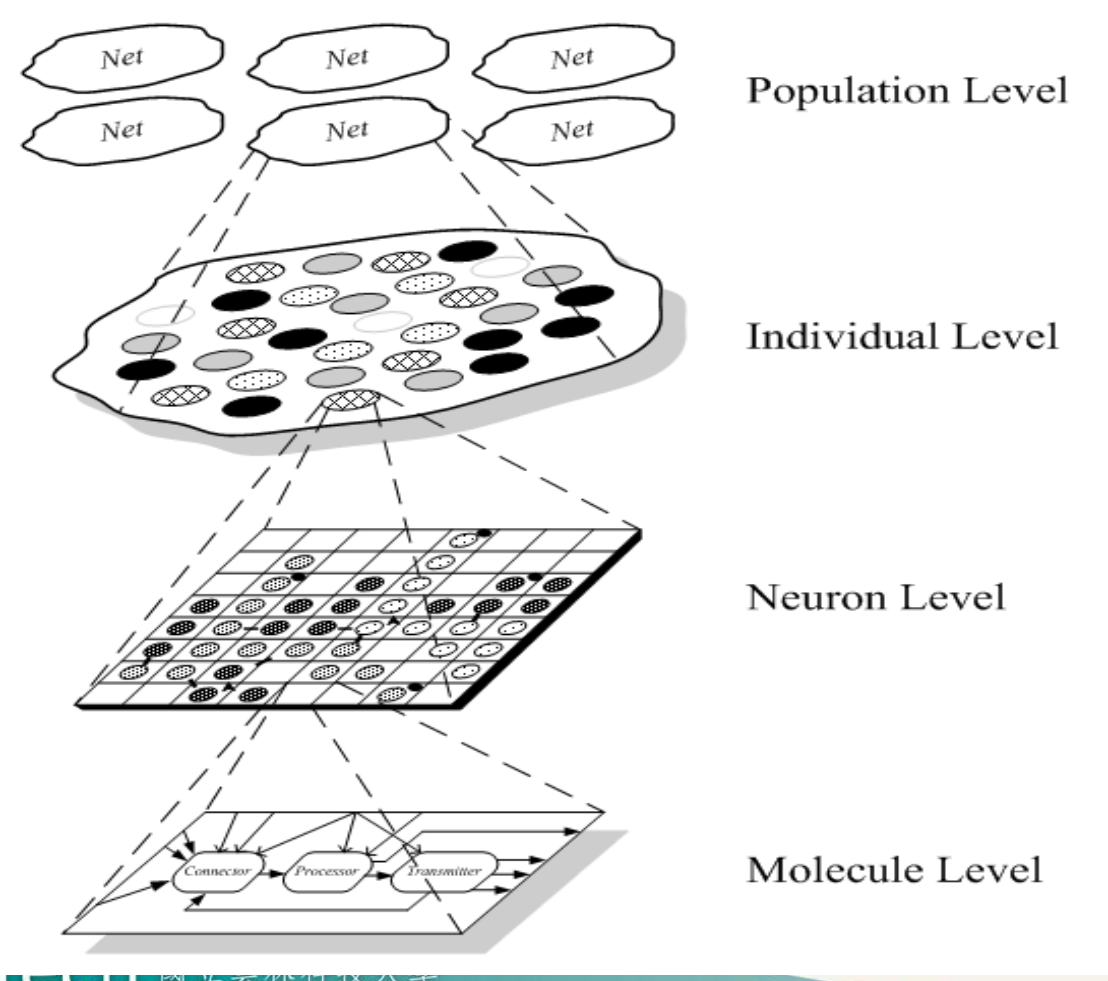
The Learning System
(An artificial neuromolecular system)

- **It integrates inter- and intra-neuronal information processing.**
- **It consists of two types of neurons: one for** local/refined searching and the other for global/gross searching**.**

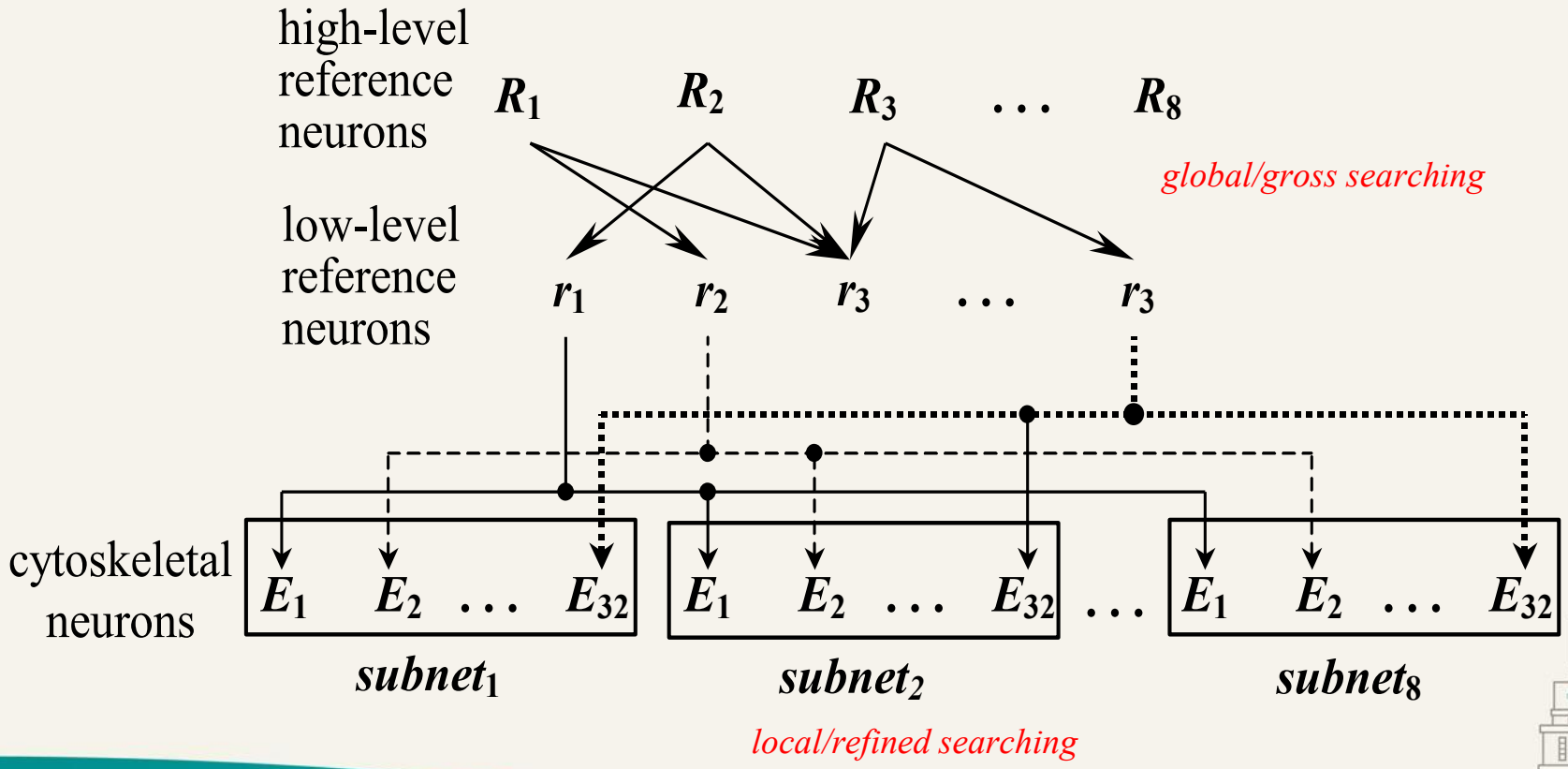
Central Architecture



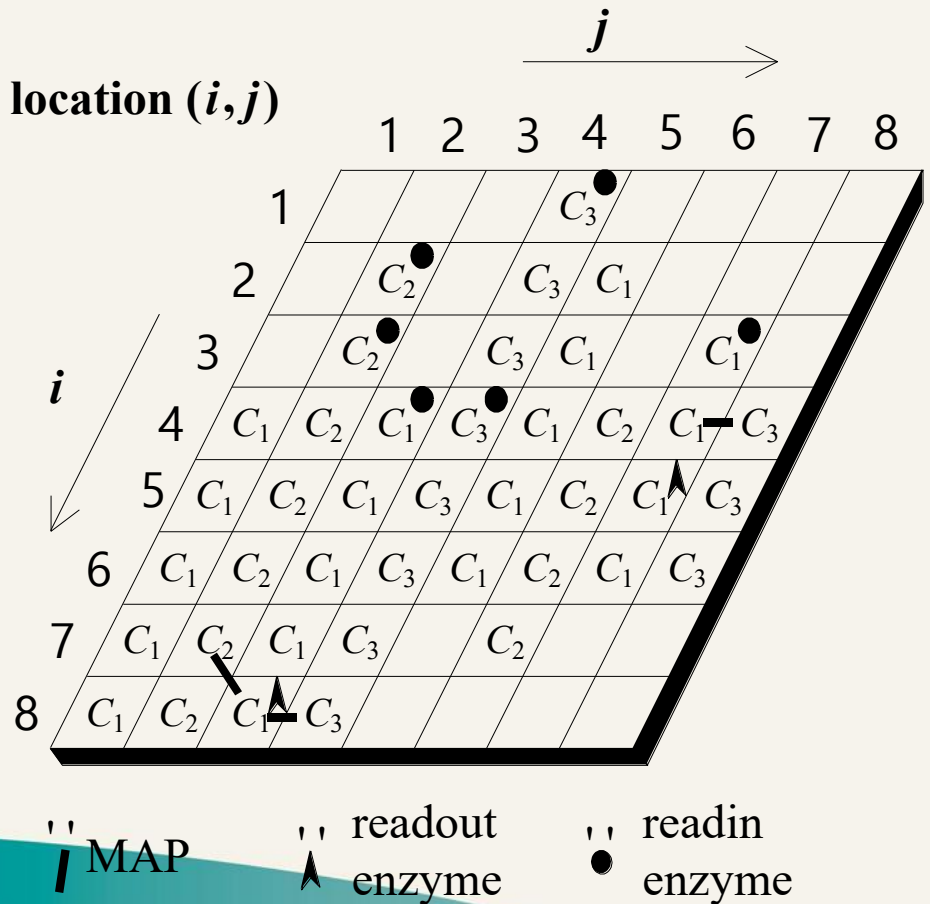
Overall architecture



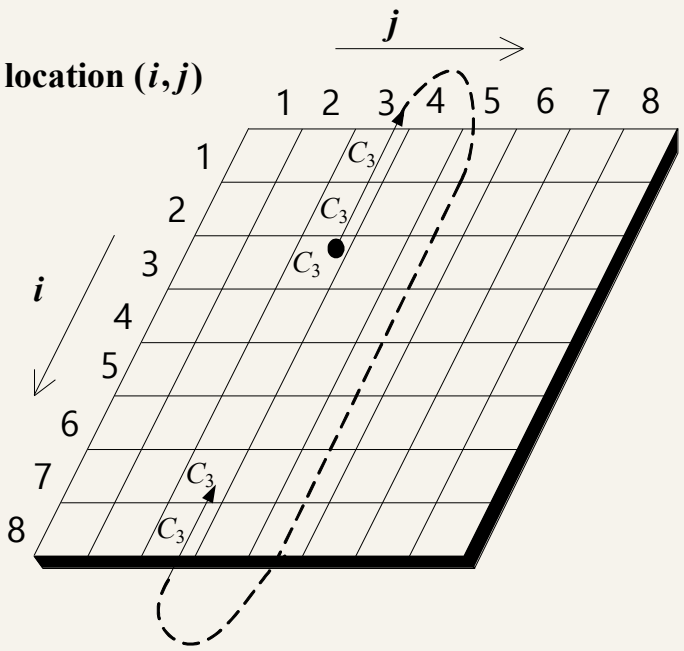
Detailed Central Architecture

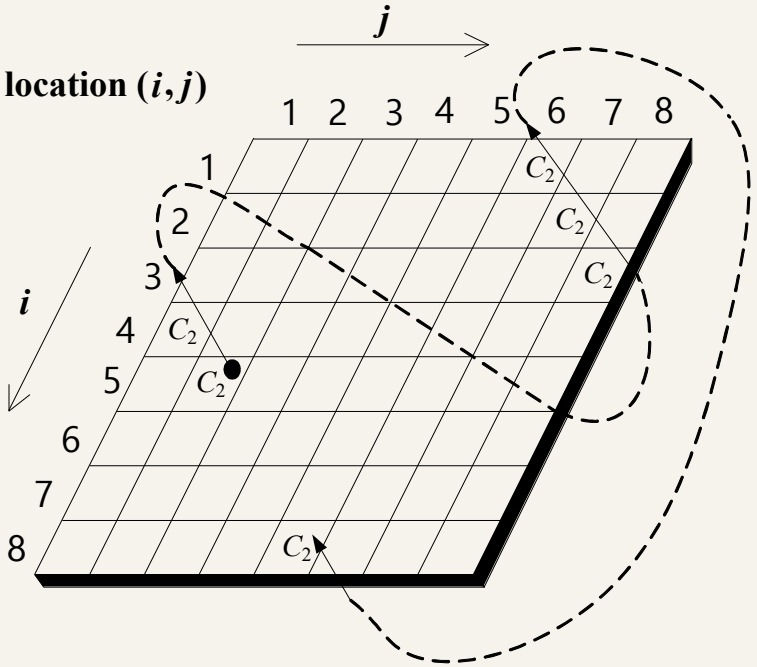


Cytoskeletal neuron

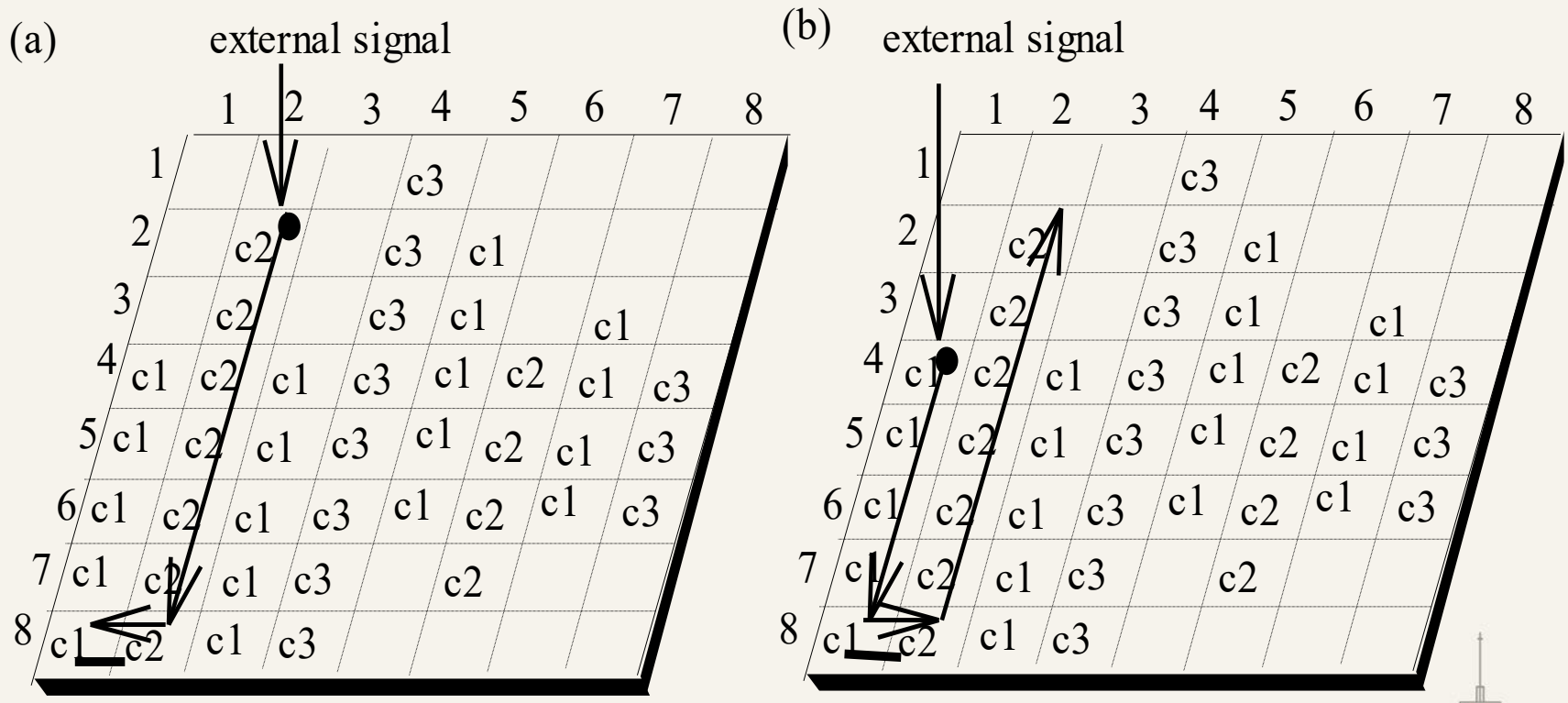


Signal flow

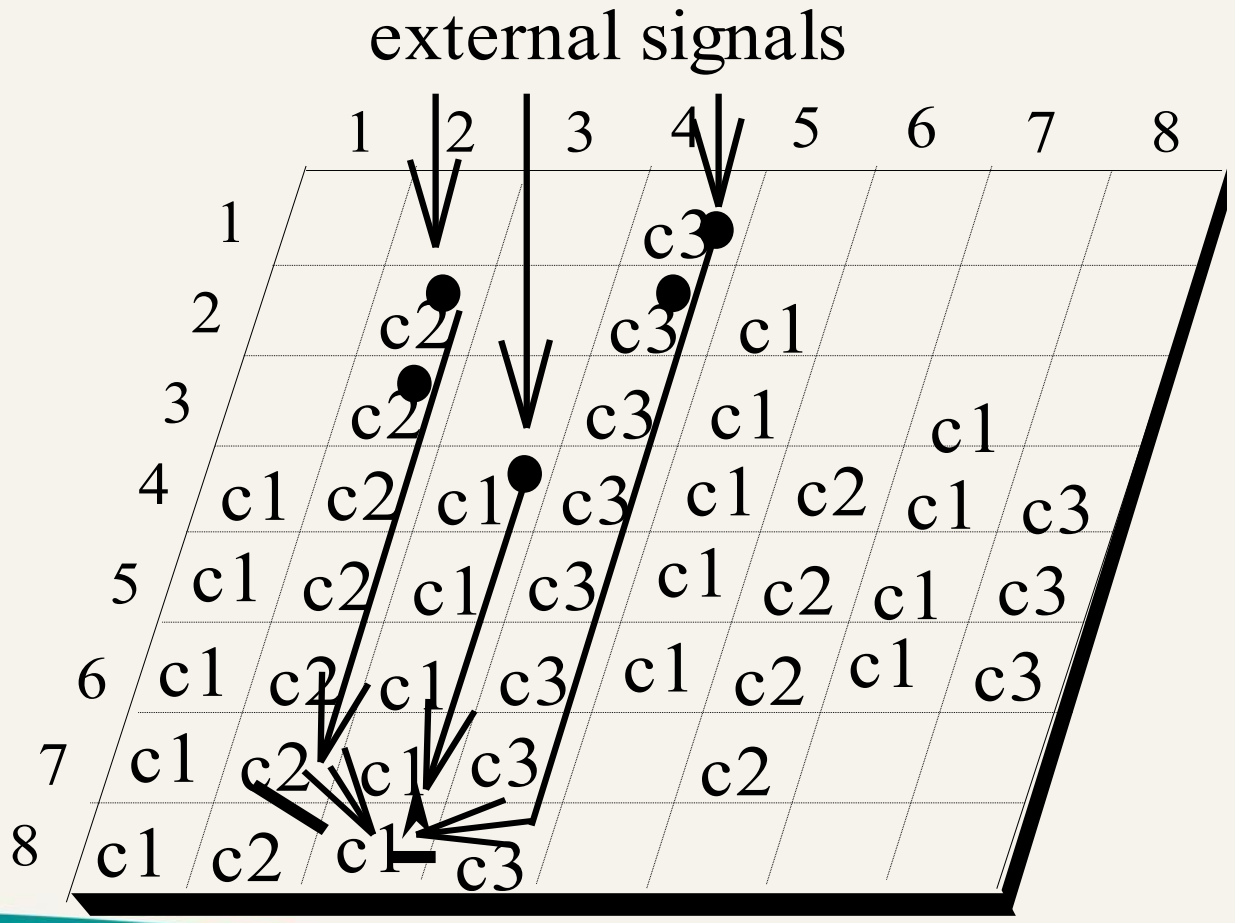




Signal interaction

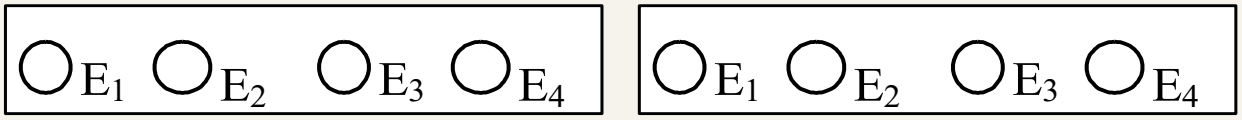


Signal integration



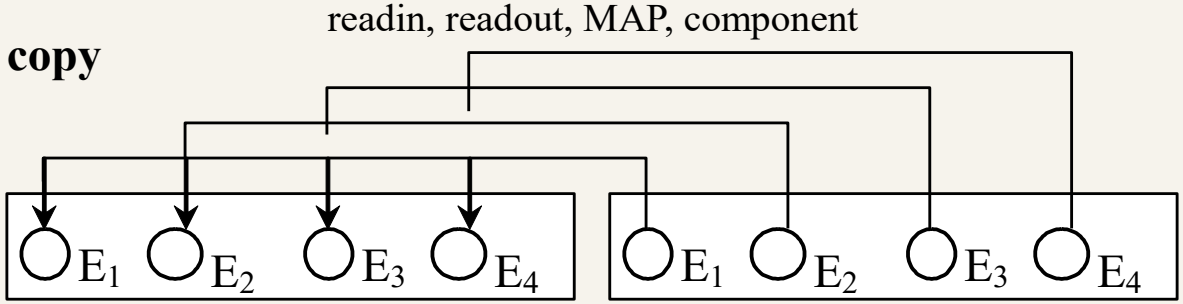
Evolutionary learning
(cytoskeletal neurons)

(a) evaluate



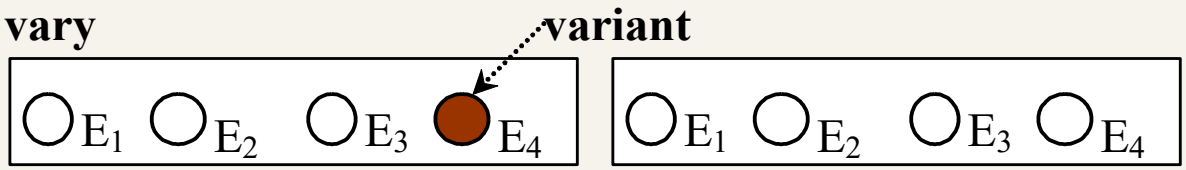
***subnet* 1** ***subnet* 2**

(b) copy



***subnet* 1** ***subnet* 2**

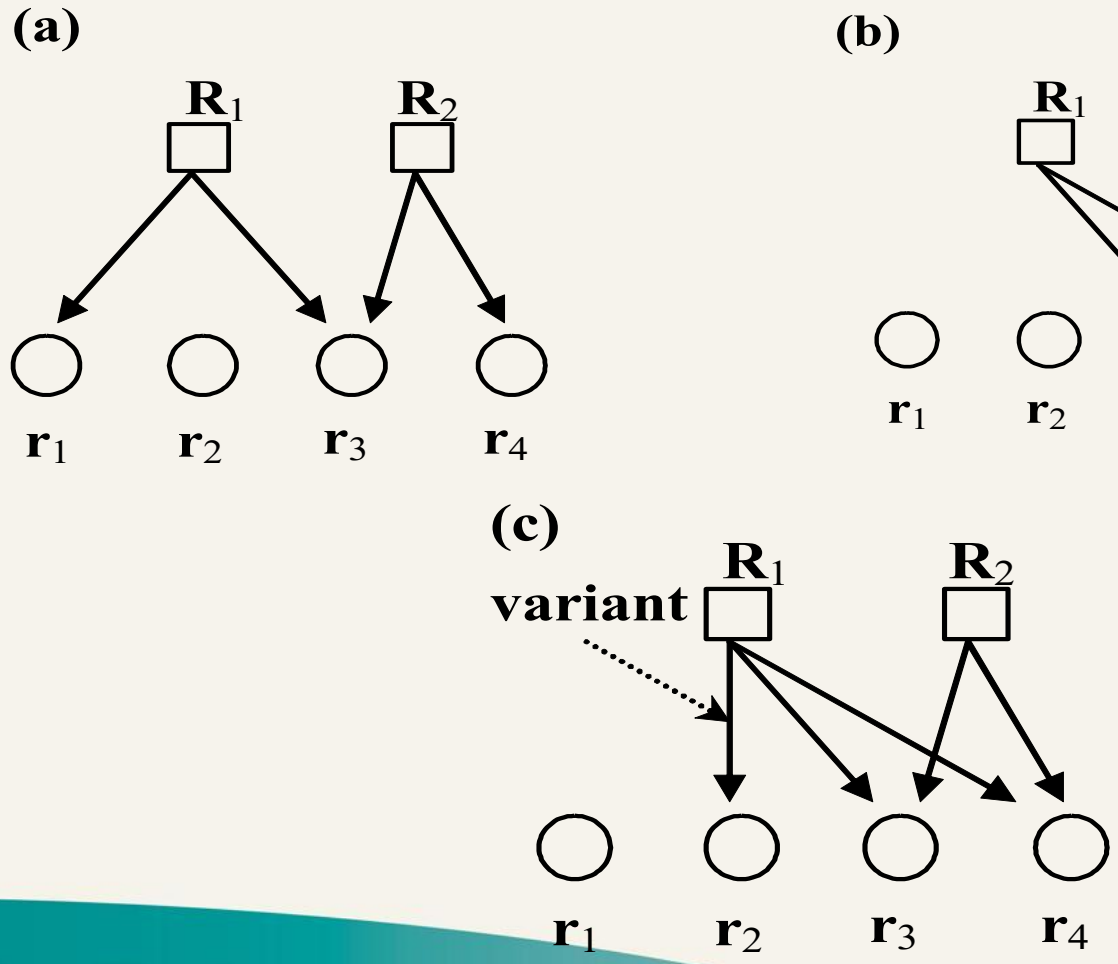
(c) vary



***subnet* 1** ***subnet* 2**

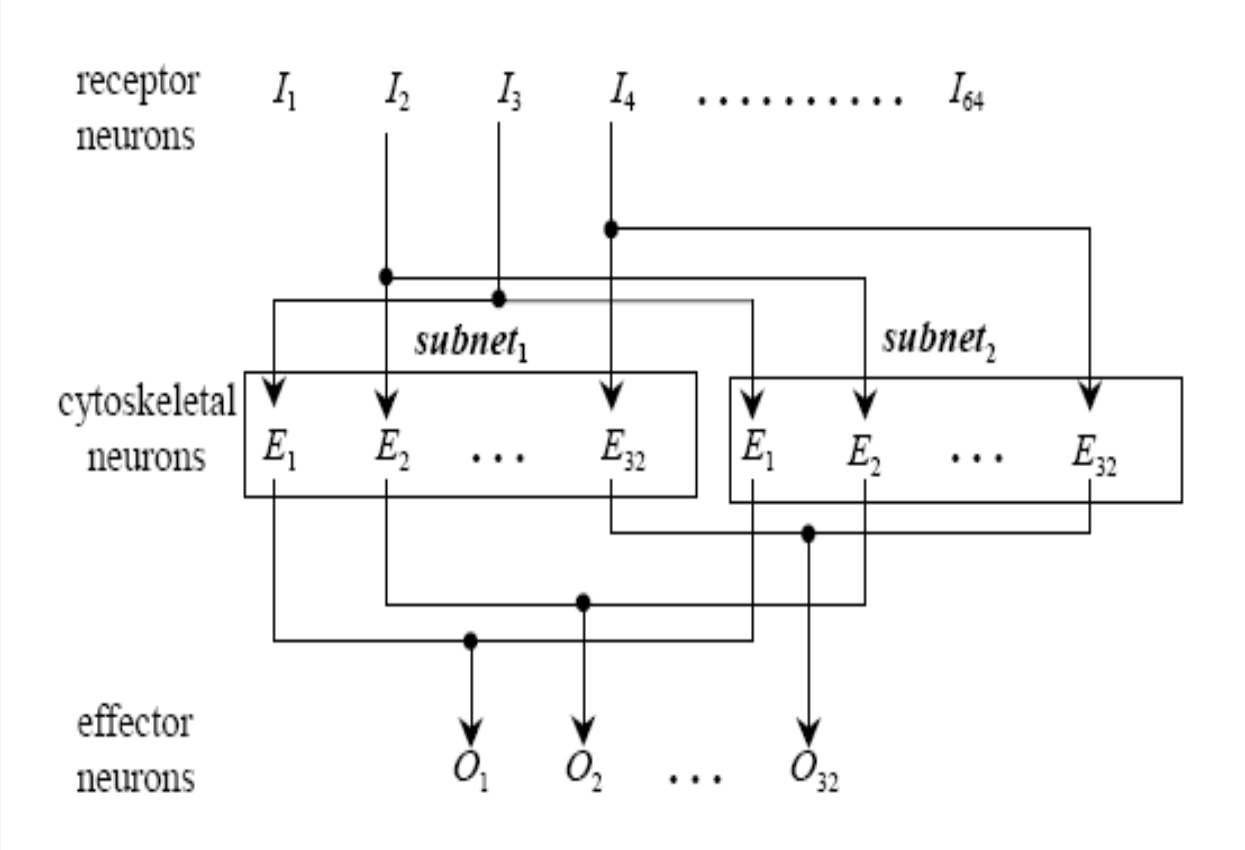
Evolutionary learning

(reference neurons)



global/gross searching

Input-output interface

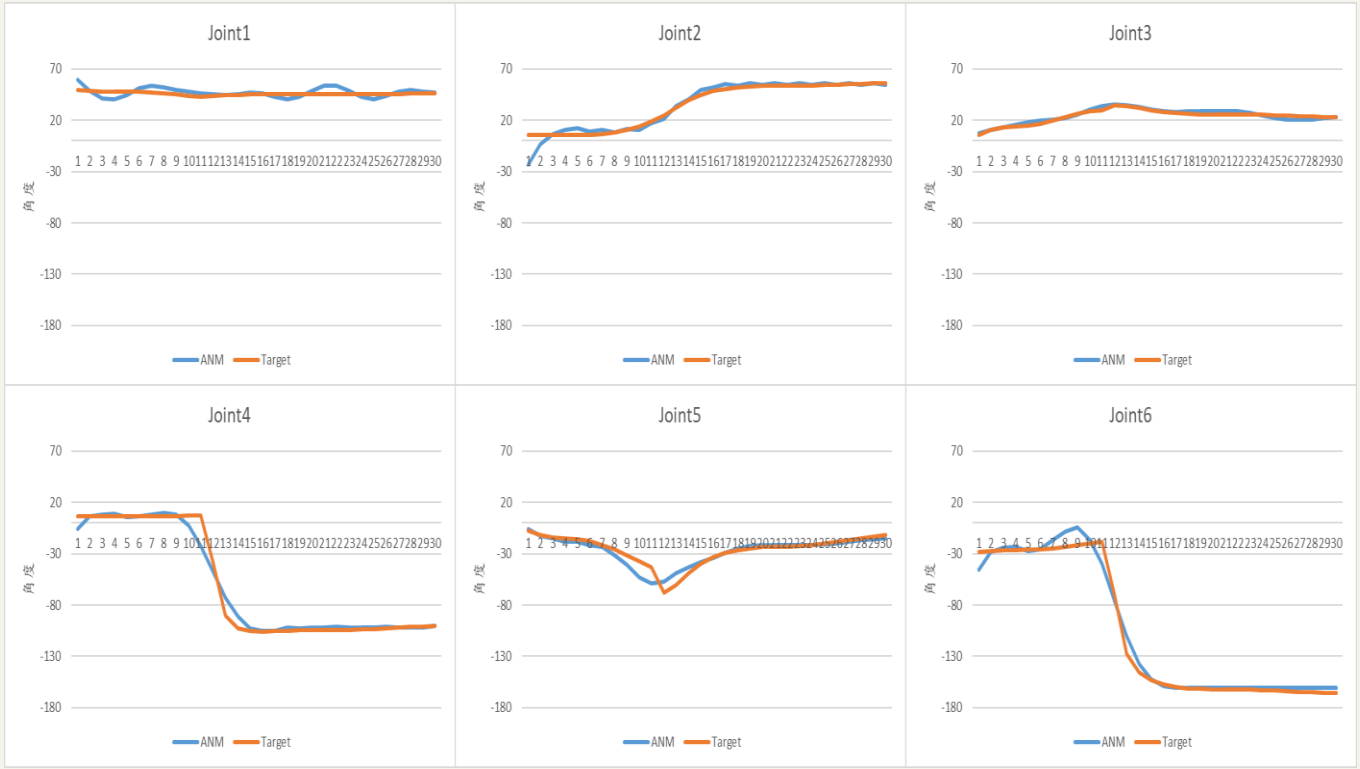


Two Parts of the Experiments

- The first part is a large-scale movement experiment in which the system has to learn how to control the relatively large movement trajectory of the six-axis robot arm.

- The second part is a small-scale movement experiment in which the system has to learn how to coordinate the six-axis robot arms to produce detailed suction movements.

Large scale movement



Small scale movement

Conclusions

- The results indicate that the system can successfully reach target points and effectively grasp objects. Additionally, thorough testing was conducted to evaluate whether the molecular-like nervous system allows the robotic arm to execute corresponding movements proficiently.

Conclusions

- The study shows that this molecular-like jumpy system can effectively utilize previously learned actions after a learning period. This adaptability enables the robotic arm to adjust its operations for similar tasks, thereby achieving what is known as the transfer learning effect.

Thanks for listening.