Available online at www.elixirpublishers.com (Elixir International Journal)

Bio Physics

Elixir Bio Phys. 46 (2012) 8135-8137

ISSN: 2229-712X

Simulating memory function in the human brain using ant

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ARTICLE INFO

Article history:

Received: 7 March 2012;

Received in revised form:

15 April 2012;

Accepted: 28 April 2012;

Keywords

Ant,

Memory,

Complex network,

Ant Colony Optimization Algorithm.

ABSTRACT

Simulating is an effective method to identify and comprehend the abstract and complex phenomena. In order to find the point of penetration of memory in the human brain, we put forward an idea to simulate memory function using ant action by their similarities. By analysis of their structure and action, we discuss the brain functional memory complex network like the ant network, the results imply that it is feasible to make research on brain functional memory complex network with the theory of ant action and colony optimization.

Introduction

To a complex question, we can use our imagination to discuss its solution even if it is not enough for the difficulty. The memory network is just like that.

In the past several decades, the scientists and researchers have explored many methods to reveal the phenomena of brain memory, especially in the clinical area, the anatomical structure has provided us many real physical structures of brain. Memory was one of the functions in brain actions, but it is not enough for us to recognize its structure and function thoroughly. So many people will find many thoughts to act the memory, such as in the film. Also it allows us to simulate the memory with our imagination.

Nobody believe that the ant can help us find a scientific difficulty in the computer graph theory with the path optimization until 1991 M.Dorigo and V.Maniezzo in Italy put forward the ant colony optimization algorithm.

The ants always can find the shortest path between nest and food by many findings. M.Dorigo made researches on the ant actions in finding the path and put the try into the path optimization, finally, the ant give them a great finding in path searching algorithm and the results has been applied in many optimizations. Based on the ant colony optimization, many new expanding optimization algorithms have been put forward.

Neuron is the basic unit of the nervous system, the human brain is a complex neural network composed of 14 billions neurons from the clinical anatomy. The memory action is the expression of the neurons actions. We have known that the physical structure of the anatomical nervous system, but the functional structure is not so good as the anatomical structure though there were many methods and results in the memory researches.

Methods

In this paper, we give a new simulation in the human brain using ant, that is, we look on the neuron as the ant. From the theory of ant colony optimization, we discuss the brain functional memory network. The structure basis is graph theory. From the physical structure, we look on the ant as the node, the path from nest to food as the connection path, thus the ant and their finding path shaped a complex network graph. If the nest is the root, the food is the leaf, the graph is a tree. To the brain, the neuron is the node, the position connection is the edge, the structure of the nervous system also is a complex network, that is, a graph or a tree.

From the functional view, the aim to the ant is to find the food. From nest to food is a successful path. To the memory network, the aim is to recall the knowledge. So from this view, an ant is just like a dynamic or mobile neuron, the results is to find, that is recall. Thus we can use the ant colony optimization thoughts to the brain functional memory network to find the inner mechanic and character.

Since the ant can quickly find the food, the neuron also can recall the knowledge just like the ant finding action if we put the pheromone in the brain functional memory network to analyze and design. Of course, the detailed realization involves the data structure and algorithm design of the neuron.

Results and discussion

Simulating the ant to neuron can help us give up the useless information in the network. The quantity of the ant and neuron is so big that it can not to demonstrate their true organizations. If we only put the function into consideration, we can cascade the real surrounding factors and use the abstract concept to define the network, that is the node and edge.

If we consider the truth of the anatomical structure of the brain, we can define a hybrid model to simulate the memory network. The brain can be regarded as the component with cortex that is composed of neuron, so we can define the nest area as cortex and different finding tasks as a cortex. In this perspective, we neglect the cortex quantity comparing with large amount of the neurons.

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Previous studies in brain functional network have found that the memory functional network had the small-world character result. Because of the exchange of pheromone, the ant finding path graph also has the characters of high cluster coefficient and short average path length, so we take the ant into the brain functional memory network and also can get the same conclusion with small-world character.

The hybrid brain functional network with ant finding simulation has the ability of ant colony optimization, so the brain functional memory network has high path optimization ability, that is, the memory characteristics. Meanwhile, the neuron characteristic, for example, the Hebb, can also be expressed by the pheromone communication and coordination.

The detailed process and the small-world character results can be referred in our two papers, one is "A novel model of memory network and retrieval algorithm" that has submitted to Neurocomputing journal, the other is "A deterministic small-world model and algorithm of memory network" that has been accepted by Microelectronics and Computer journal.

Conclusion

In this paper, we simulate the brain functional memory network with ant from the structure and algorithm function. It is a new view to discuss the methods and designs though we did not give the expressions and computational model. The results give the memory research a hint to find the memory algorithm.

Of course, we can apply other evolutionary computations in the simulation of brain functional memory network, such as particle swarm optimization, artificial fish-warm algorithm, artificial bee swarm optimization algorithm and so on.

Perhaps it is not enough for memory network computing and simulation in detailed, but the similar structure and function can promote us to continue to find and test the complex memory model. In the subsequent studies, we will continue to pay close attention to the brain functional memory network in the depth of algorithm and width of memory characters.

Acknowledgements

This research was supported by Institutes of Higher Education Science and Technique Foundation of Shandong Province J10LC59, College Student Science and Technique Innovation Action Program of Taian 2010D2033, 2010D2034, 2011D1035, 2011D2035 and Scientific Research Tasks of Tainshan Medical University General Program 2010ZR100.

The authors thank the Institute of Neuroinformatics in Dalian University of Technology staff for assistance with data collection and the College of Information and Engineering Taishan Medical University colleagues for manuscript comments. Special thanks to Polly and Xiaochen Xu for suggestions on writing in the English language. The authors are grateful to the anonymous referees for their valuable comments and suggestions.

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