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Physics of Life Reviews 29 (2019) 29–31

PHYSICS of LIFE reviews

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Comment

Understanding the network optimization based on the Physarum-inspired model
Comment on "Does being multi-headed make you better at solving problems? A survey of Physarum-based models and computations" by C. Gao et al.

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Received 18 January 2019; accepted 28 January 2019
Available online 30 January 2019
Communicated by J. Fontanari

Keywords: Physarum polycephalum; Mathematical modeling; Network optimization; Pattern formation

The new generation network optimization method is an emerging topic which can be applied on many areas, including the development of biological medicine, social communication, local transportation and so on. These challenging questions are considered as very hard to be solved. We may develop the corresponding methods using the clues provided by the bio-intelligence during hundreds of thousand years evolution. Actually, scientists have exploited a lot of bio-intelligence technologies to solve different types of network optimization problems, which greatly refined the existing methods in our researches. However, there are many questions related to network optimization are still poorly studied, and we urgently need new methods to solve these problems in our research community.

It worth to mention that, the physarum-inspired model is a type of efficient methods to solve network optimization problems. Specially, physarum polycephalum is a type of slime mold that lives in the moist, shady and low temperature areas. We have found that the physarum polycephalum shows an excellent intelligence in constructing the biological network in the existing experiments, including the network topology [1] and steiner tree theory [2–4]. Therefore, more and more researches and attentions have focused on the network optimization algorithms based on the physarum-inspired model.

Gao et al. [5] review the latest developments in the field of Physarum-based models and computations in the context of modelling and applications alike. They ad-dressed three types of physarum-inspired models and their hidden mechanisms, i.e. morphology, taxis, and positive feedback dynamics found in top-down and bottom-up modelling techniques, which can be modeled via stylized mathematical tools. In particular, they also survey the applications of

DOI of original article: https://doi.org/10.1016/j.plrev.2018.05.002.
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https://doi.org/10.1016/j.plrev.2019.01.018

each core and fundamental features of Physarum to solving difficult computational problems with real-world applications. At last, they highlighted a few open questions and claimed the directions of the future research. The clusters or communities are highlighted especially when the nodes in the network can be naturally divided into some sub-graphs which are closely connected internally, i.e., separating the network into several sub-groups which have dense internal connections and low external connections. These clusters are essential for their scientific significance in terms of networked interactions, as well as for the real-world applications. For example, clustering agents in webclients with similar interests or geographical proximity can help us improve internet systems and provide better web environment, recognizing customer groups with identical needs and preference makes it possible to increase sales volumeand reach supply-demand balance, selecting proteins with similar functions may prompt the deep research into human systems, etc. The study of cluster in networks may provide different insights in understanding the physarum-based models and computations.

There are a number of physarum-inspired network optimization method have been developed, including network topology [6], the network salesman [7], the steiner tree [8,9] and so on. Scientists have theoretically proved the efficiency of physarum-inspired methods in solving the network optimization applications. For instance, Bonifaci et al. [10] found that the physarum-inspired network optimization method proposed by Tero et al. [11] can be used to calculate the shortest paths without using the information of network topology. However, even have a high level performance than the classical algorithms, the existing physarum-inspired network optimization methods don't have a solid theoretical basis [12,13]. Moreover, the existing physarum-inspired network optimization methods are not organized perfectly so far [14,15]. Thus, the physarum-inspired network optimization methods still don't develop maturely and don't well-recognized, and some fundamental questions are still poorly studied until now.

In conclusion, Gao et al. [5] highlight three typical physarum-inspired models and their hidden mechanisms including morphology, taxis, and positive feedback dynamics found in top-down and bottom-up modelling techniques. Most of these solutions are supported by a lot of real-world applications or examples. With fast development in big data technology and computational science, similar success has also been achieving for understanding the physarum-inspired network optimization problems.

Acknowledgements

This study was supported by a commissioned grant from the National Natural Science Foundation of China (nos. 71871233, 71473285 and 712471223) and Beijing Natural Science Foundation (grant no. 9182015). The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding bodies.

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