

The Significance of Problem-Oriented Approach to Swarm Intelligence

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Introduction

Swarm Intelligence is the global intelligent behaviour emerged from the interaction of groups of simple agents. The existing swarm intelligence research mainly refers to swarm intelligence optimization, which with ant colony optimization and particle swarm optimization as a representative. And the relevant research work focuses on the performance improvements of the optimization algorithm, which can be called “method-oriented approach to swarm intelligence”.

Based on the practical problems, we carried out a series of modeling and simulation approaches to ant colony’s labor division aiming at the division and cooperation problems in swarm intelligence. For the structure emergence problem in swarm intelligence, we investigated the structure emergence mechanism under swarm intelligence, and established both solid structure emergence model and virtual structure emergence model [1]. Different from “method-oriented approach to swarm intelligence”, the key to the success of such problems, viz., division and cooperation problems and structure emergence problems, is to grasp the features of the problem objects sufficiently, which can be called “problem-oriented approach to swarm intelligence”.

“Problem-oriented approach to swarm intelligence” shows the customization features of swarm intelligence modeling, thus possesses the ability to solve practical problems with better performance. Therefore, the key to implement problem-oriented approach to swarm intelligence is “feature extraction based on problem objects”.

Before feature extraction based on problem objects, there is an important pre-processing link that makes a comparative analysis on characteristics of the swarm intelligence model and the application background. Only by knowing the similarity between these two, could it be targeted. That is to say, firstly, we should make arguments and statements about whether the problem is suitable for adopting swarm intelligence model to solve it. These arguments and statements are generally based on bionic metaphor. In view of this, “similarity analysis based on bionic metaphor” is also a key point to implement problem-oriented approach to swarm intelligence.

Due to the complexity of the problem objects, to achieve its solution generally needs simulation and usually adopts advanced simulation technologies, such as Agent-based modelling simulation. Therefore, as the follow-up step of feature extraction based on problem objects, “advanced simulation based on agent technology” is the basic technology to implement problem-oriented approach to swarm intelligence.

In summary, the logical structure of the key points to implement “problem-oriented approach to swarm intelligence” is: 1. similarity analysis based on bionic metaphor; 2. Feature extraction based on problem objects; 3. Advanced simulation based on agent technology, where the second is the core of the three points [2].

It is of great significance to develop “problem-oriented approach to swarm intelligence”, which is mainly reflected in the following aspects:

Revealing the operation mechanism of complex systems

One of the fundamental problems of complex systems research is

to understand their inherent working principle, namely the operation mechanism of complex systems, the core of which is system emergence mechanism, and emergence is the theme of complex systems research. There is no doubt that this is a rather difficult task. Accordingly, it is necessary to explore the inner operation law of complex systems at the level of mechanism research, and strive to achieve breakthrough. Swarm intelligence itself is the global intelligent behaviour generated by emergence, and the “problem-oriented approach to swarm intelligence” pays more attention to explore emergence phenomena, its research findings are profoundly enlightening and great for revealing the operation mechanism of complex systems, the significance is self-evident.

Promoting the innovation of organizational management mode

With the rapid process of society informatization, more knowledgeable economy and business activity globalization, the environment that human depend on for survival and activities is becoming increasingly complicated and uncertain, as a result, it seems hardly possible to solve the social problems by the existing conventional organization management principle and mode. The model and object in “problem-oriented approach to swarm intelligence” are naturally similar with organizational management, the former research findings can be introduced into organizational management by means of bionic metaphor, and this will promote important changes in organizational management mode. The traditional enterprise management belongs to other-organization mode based on command-control, which lacks flexibility; it can effectively overcome this problem by learning from the thought in “problem-oriented approach to swarm intelligence”, and achieve a flexible self-organization mode of enterprise management.

Artificial intelligence has passed through three phases: symbolic intelligence, computational intelligence and swarm intelligence. If symbolic intelligence and computational intelligence just simulate human thinking inside the brain, then the “problem-oriented approach to swarm intelligence” profoundly reveals that human intelligence comes from social feature of interaction between individuals. The level of intelligence activities is mainly characterized by comprehensive performance and expansion capability of intelligence. The expansion capability of symbolic intelligence is weak, its comprehensive performance is even worse. Computational intelligence has much improvement in expansion capability, but is still inadequate in

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comprehensive performance. The “problem-oriented approach to swarm intelligence” can exhibit emergence feature of the whole intelligence, which further enhances comprehensive performance of intelligence, it takes the position of an even higher intelligence level.

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