BEE HIVE AT WORK: MODEL WITH SEARCHING AND OPTIMIZING POTENTIAL

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Abstract. Methods of solving problems inspired by nature or biologically are used more frequently in Informatics nowadays. Their potential in proposing new and making the well-known methods of solving various kinds of problems more effective confirms. Inspired by social insect´s behaviour and following the analysis of information mentioned in several publications we proposed a model that clearly separates the self-organizing decision-making behaviour of the bees in the hive and the problem-specific behaviour of the bees outside the hive. This separation allows to applicate the model for problem solving in different domains - web search, function optimization.

1. Introduction

Various social insect colonies such as ants, wasps, termites and bees exhibit remarkable problem solving behaviour. Although a single insect is quite limited in its ability, complex behaviour is exhibited at the level of the colony that emerges from the interactions of the individual insects [3]. This phenomenon is called Self-Organization.

The foraging behaviour of honey bees has been extensively studied and is a useful example of self-organization.

The behaviour of the honey bees inspired various researchers in the fields of biology, informatics or mathematics, each with partly differing objectives. Their interests, however, are basically twofold :

- Modelling of bees' behaviour. Several biologists have tried to study the collective foraging behaviour during nectar source selection by bees [9, 10, 11]. In [12] a mathematical simulation describing dynamical interaction among bees in the process of carrying nectar from two sources is presented.

– Constructing algorithms inspired by bees' behaviour.

There are several algorithms inspired by the bee behaviour, a good overview can be found in [12]. These algorithms can be divided to more categories. An important category of bee inspired algorithms are algorithms applied to the optimization of mathematical functions [14, 15]. A next category of these algorithms are multi-agent systems. A prototype of multi-agent recommending system was proposed in [16]. They make use of the bee hive metaphor, generalizing the model of [12] by allowing more than two sources of food. However, their model assumes there are as many bees as there are sources.

Our work belongs to these two categories and our aim is to develop a simple model of the bee hive applicable to solving problems in different domains. We applied this algorithm to the domain of on-line crawling and the second domain where we have applied the bee hive model was the optimization of mathematical functions.

2. Bee hive model

Our model uses a preset number of bees to find the best of the sources by evaluating them and using social interaction to agree upon the best source. The mechanism of interaction is shown in [4].

The bee according to this model can be in four states – In Dance room, In Auditorium, In Dispatch room and Outside the Hive. The bees propagate their sources in the dance floor, the auditorium is a place, where the bees are able to watch the dancers in the dance floor. The dispatch room contains the sources where the bees can start their search for food.

The Outside the Hive is a very general state and the exact behaviour of the bee in this state is not defined. It can be specified according to the problem domain.

3. Web Search

Finding and reading most relevant and up to date articles requires continuously observing all the new sources for updates of stories one is interested in. It also includes discovering new data sources. All this can be problematic if not impossible for a human, so a system capable of doing these tasks might be helpful.

We propose to use a focused crawler to download relevant pages. We took an inspiration for constructing the crawler from nature, particularly from the social behaviour of honey bees.

We chose the model [4] and specified the behaviour of the bee outside the hive in [5]. Experiments with parameters of the model are described in [6]. The web page was used as the source and the aim of the hive was to find the most relevant pages and thus focus the search for new pages into the more promising areas.

We assume that aim of on-line search is not to retrieve some single information, the aim is to find a relevant set of pages which would create a story. It is supposed to be used on sites containing frequently changing or added information. Our work is described in more details in [7, 8, 1].

4. Function optimization

Another problem domain where we have applied the bee hive model [4] was the optimization of mathematical functions. We proposed a behaviour of a bee outside the hive. Sources in this case are different vectors of values of function arguments. We introduce two new parameters [7, 2] for the model to suit the optimisation task.

We tested this algorithm on a set of benchmark functions taken from [10]. From experiments published in [14, 17] we can conclude that the proposed algorithm is able to optimize nontrivial mathematical functions in a reasonably good time comparing to other commonly used algorithms.

5. Conclusions

In the paper, we presented a model of the bee hive based on the interactions of individual bees that allows to emerge the self-organizing decision-making behaviour of the hive.

We present the results, achieved during the multiannual research, oriented in the possibility of using the bee hive model. The results we have achieved in function optimisation, web search and following developing stories on the web, confirms the suitability of using this model in various applications. Currently, we are exploring the possibilities of using the model to DNA sequence assembly and image segmentation.

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to other papers publishing the results that are summarized here

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