AbstractSwarm Multi-Agent Logistics Competition

Multi-Agent Collaboration for Improving A Priori Unknown Logistics Scenarios

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ABSTRACT

This competition abstract provides a brief introduction to the AbstractSwarm Multi-Agent Logistics Competition, which runs in 2024 in the fourth year in series at the Genetic and Evolutionary Computation Conference (GECCO) and has been part of the IEEE World Congress on Computational Intelligence from 2021 to 2022. In this work, we also briefly introduce the AbstractSwarm multi-agent modeling and simulation system to provide a common starting point for researchers interested in the competition's rules and its challenges.

CCS CONCEPTS

• **Computing methodologies** → **Artificial intelligence**; Modeling and simulation; • **Applied computing** → *Education*.

KEYWORDS

Artificial Intelligence, Competition, Logistics, Multi-agent simulation, Optimization

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1 INTRODUCTION

Improving workflows and creating schedules that meet the requirements of many different stakeholders is a challenging task. While similar problems have been considered in the past already, the *AbstractSwarm* project aims at solving different problems of this kind based on a multi-agent view.

For this purpose, following the introduction of the graphical modeling language in [1], the AbstractSwarm system strictly separates the scenario description ("what to do") and the implementation of agent behavior ("how to do it"). By this means, the same agent implementation can be easily (re)used in multiple different scenarios. As a consequence, agents can be created to cooperatively improve scenarios, even if the specific scenarios are a priori unknown (both for the agents and for their developers).

Following [2], the *AbstractSwarm Multi-Agent Logistics Competition* aims at stimulating research in this field with applications, e.g., in hospital logistics and other domains. Next to motivating multiple submissions from the research community, it has been used in the context of a bachelor's and a master's thesis highlighting its use case as an entry point to the research community while actively contributing to the research in this field (see [5, 6]).

This competition abstract is mainly based on [1, 5] and is organized as follows: At first, the AbstractSwarm system will be briefly presented (Section 2). After that, the competition's rules and challenges are described (Section 3). Finally, a brief summary with some hints on how to participate is provided (Section 4).

2 ABSTRACT SWARM SYSTEM

AbstractSwarm (e.g., [1]) is an open-source multi-agent framework that aims at simple and comprehensible graph-based modeling and simulation of different problems from the broad field of logistics and adjoining fields (see, e.g., [3] for an example in the context of hospital processes). The idea behind AbstractSwarm is to model problem scenarios and agent behavior *independently* of each other. This allows for implementing agents that can be put ad-hoc into different modeled problem scenarios for finding solutions or improving the underlying processes.

To achieve this, problem scenarios are modeled as graphs comprising mobile components (*agents*, graphically represented as circles) and immobile components (*stations*, graphically represented as squares) as well as (spatiotemporal) relations and attributes for more detailed modeling (cf. Figure 1).

Agents can be implemented through an agent programming interface which allows for accessing the static graph structure as well as the dynamic state of a scenario (including all agents). Moreover, agents can communicate with each other to cooperatively solve or optimize a scenario. Since the agent behavior is implemented independently from a specific scenario (and thus scenarios are potentially a priori unknown to the agents), the implementation of such agents represents a challenging task that can be tackled, e.g., by different artificial intelligence (AI) approaches (such as reinforcement learning).

According to [2], an agent can interact with a scenario graph by (1) deciding which station to visit next, (2) communicating with other agents, and (3) retrieving a reward for its previous decision.

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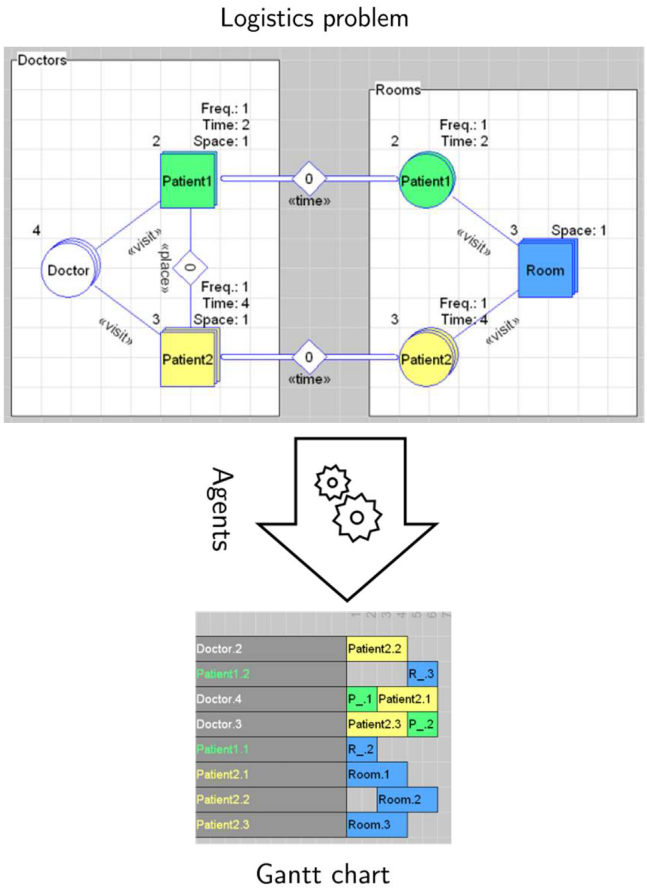

Figure 1: Exemplary hospital scenario with multiple types of agents (circles) and stations (squares), where doctors treat patients in rooms. Agents are controlled by the submitted implementations, trying to reduce waiting times in the resulting Gantt charts (see, e.g., [4]). (Source: adapted from [2])

While simulating a scenario, a timetable in the form of a Gantt chart [4] is created according to the decisions of all agents (see Figure 1).

3 COMPETITION

This section briefly introduces the AbstractSwarm Multi-Agent Logistics Competition mainly based on [2]. Further details can be found there as well as in the competition's proposal for the respective year.

The goal of the competition is to foster comparability of multi-agent implementations in logistics-related problems (e.g., in hospital logistics). For this purpose, benchmarks from various domains are provided for which the framework allows the development of multi-agent swarms based on a common programming interface. According to [2], scenarios can be extremely diverse, highly dynamic, and variable in size. Such scenarios can be easy to comprehend, but hard to solve, and finding efficient solutions for the more complex scenarios remains a challenging task for practitioners and researchers alike. Participants of the competition must develop agents that are able to cooperatively solve different a priori unknown scenarios. Submissions will be ranked according to the total number of idle times of all agents in conjunction with the number of iterations needed to come to the solution across an unknown test set of scenarios.

4 CONCLUSION

This competition abstract briefly summarized the ideas of the AbstractSwarm Multi-Agent Logistics Competition running in the fourth year at GECCO. Submissions can be easily provided by mail, following the competition's guidelines and rules. Details can be accessed through [2].

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