Agent-Based Simulation for Creating Robust Plans and Schedules

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Abstract

The paper describes methods for constructing the robust schedules using agent-based simulation. The measure of robustness represents the resistance of the schedule to random phenomena and we present the method for calculating robustness of the schedule. The procedure for creating the robust schedule combines standard solutions for planning and scheduling with computer simulation. It is described in detail and allows creation an executable robust schedule. Three different procedures for increasing the robustness (by changing the order of allocation of resources, by changing a plan and increasing time reserves) are short explained. The presented techniques were tested using real detailed simulation model of an existing container terminal.

Keywords: Simulation, robustness, schedules

1 Introduction

This paper follows-up previously published paper [4]. In last two years we have made many changes in simulation program. Some solutions we have speed up and reconfigured (process for creating a robust schedule), some evaluations are now more flexible. In this paper we present an agent-based architecture of the simulation model and the complete process for creating a robust schedule. In this section we need to define some verbalises.

Exist many approaches for solving the problem of finding the optimal plan and the subsequent localization of resources for its provision. Standard approaches mainly focus on the mathematical description of the problem. However, thus obtained plan has large limitations because of stochastic character of many phenomena of the real world and its execution carries the risk of failure.

In addition to the various specific requirements for plans and schedules, the requirement on the robustness of the plan or schedule is important. Today, a large attention is given to the problem of determination of robustness of a plan and its increasing. These schedules are needed especially for rail and air transport, but also in manufacturing processes with the aim to reduce downtime of machines in disorders.
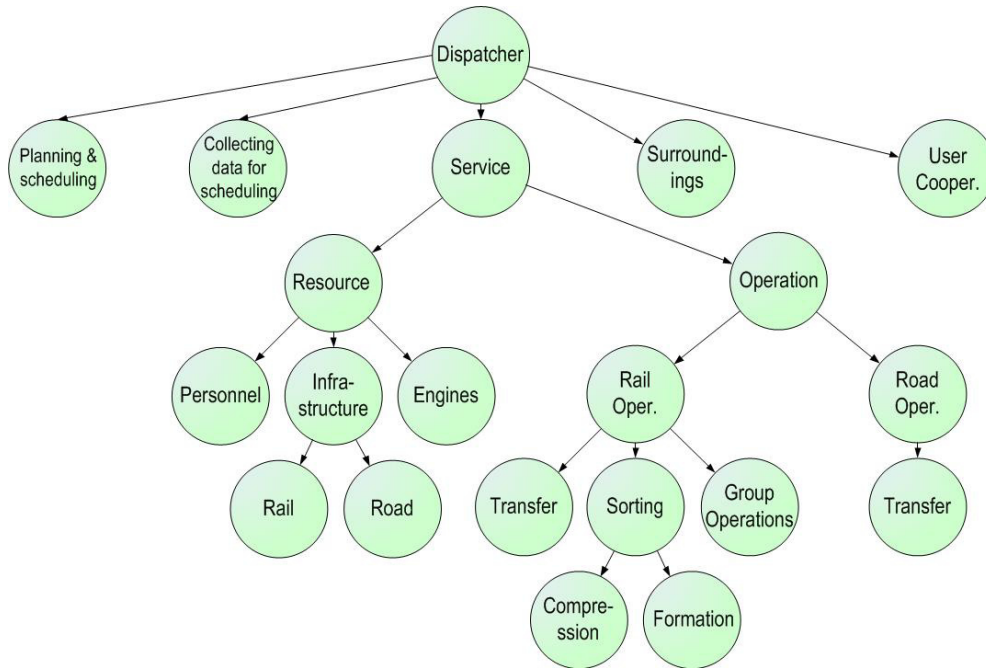
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Figure 1: Agents used in the simulation model

Planning is in generally the process of creating a plan. The plan is a sequence of activities. These activities must be applied so that the planning system is getting from the initial (default) state to the terminal state (destination). In the real conditions, there are the mostly required resources for the fulfilment of activities, without which it is impossible to carry out. Just allocation of resources plays a key role in the practical application of the plan. This issue is solved by scheduling.

In the case that there is already a plan, such as a sequence of activities, it is appropriate to specify in what time will be different activities performed. Scheduling means the assigning of resources to activities in time. Activity is the basic technological operation, which is not divided in partial technological operations. The resource is a device which is able to perform one or several operations. In general, it is available a set of types of resources, while the number of resources of a type is defined for each type. Then, for each activity is defined a set of needed types of resources and their count. For example, for the start of the activity it is necessary to have four staff workers of type A, one crane and one car.

2   Agent-Based Simulation

The core of created application uses a hierarchical agent-based architecture. The architecture is based on reactive agents. The agents allow us modelling the system so that its inner implementation approaches the real system. The behaviour of individual agents is described by Petri nets. The figure 1 shows the whole structure of the agents which we have used for creating microscopic simulation of container terminal. For creating a robust schedule, agents "Planning and scheduling" and "Collecting data for scheduling" are necessary. The first one