

A Genetic Algorithm Based Decision Support Tool for Scheduling Multiple Yard Cranes in Container Port Terminals

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1 Introduction

The rise in container shipments causes higher demands on the seaport container terminals, container logistics and management, as well as on technical equipment. An increased competition between seaports, especially between geographically close ones, is a result of this development. The competitiveness of a container seaport is marked by different success factors, particularly the time in port for ships (transshipment time) combined with low rates for loading and discharging. Therefore a crucial competitive advantage is the rapid turnover of the containers. That is, as a rule of thumb, one may refer to the minimization of the time a ship is in port as an overall objective with respect to terminal operations. Yard cranes (Rubber Tyred Gantry Cranes or RTGs) are some of the most important equipment in yards. Allocating them and scheduling their work is crucial to the efficiency of operations in container port terminals. In this paper we present a rich optimisation model for scheduling yard cranes with non-interference constraint for a rolling horizon. Apart from conventional constraints related to operational requirements, we have also introduced an interference risk factor, which will reduce the chance of cranes interfering as a result of some disturbances that might occur during work. Our genetic algorithm combined with an auxiliary heuristic will solve the scheduling problem. The results of the schedule based on some predefined threshold will guide the operator to take decisions to allocate appropriate number of yard cranes to each berthed ship.

2 Related Work

Several optimisation problems associated with container port operations have been studied extensively under different categories regarding model representation as well as algorithms to solve them, [2]. With regard to quay crane scheduling optimisation, some research has been carried out in [3]. Although yard crane scheduling might seem similar to yard crane problem, there are specific details that require careful attention to solve the yard crane problem.

In [1] the Yard Crane Scheduling Problem (YCSP) has been formulated as an integer program and solved with a dynamic programming-based heuristic; the model allocates a single yard crane to each block, i.e. it does not include multiple yard cranes.

3 Optimisation and the Decision Support Framework

The general RTG problem in a yard environment can address the questions of which yard crane handles which job and when? There are typically various yard layouts for storage of containers.

However, the problem is, mostly, which zones the yard crane will cover and within that zone which jobs have to be handled by the yard crane. Each job also has different characteristics and depending on the type of job, different priorities. These include Shipping jobs (import/export, restow) hauliers, rail jobs and shuffling (in-stack shuffle, inter-terminal shuffle).

The decision support and optimisation framework creates feasible schedules for multiple yard cranes in each zone. The input data required for the framework is related to information regarding availability of each container box both for loading and discharge to vessels. For this, we assign a time to each container (job) and will call this due time. Furthermore each container has a due time location in block. The number of RTGs present in each block is an input to the system and based on these the scheduler performs both allocation and scheduling of the RTGs work order.

We use a Genetic Algorithm (GA) and Simulated Annealing (SA), combined with a heuristic to solve the optimisation problem. The objective function is a weighted aggregated function to evaluate the candidate solutions. The user is able to select required objectives based on operational requirements and the objective weights could be future tuned to match the requirements.

4 Experimental Results

The output of the optimisation process is a detailed schedule for each RTG with the sequence of jobs it has to complete. In an aggregated form, the programme can provide block changes requirements. We solve the model using GA and SA. The results show the effectiveness of the approach and its robustness; high quality schedules are generated and the problem is solved to near optimality. Figure (1) is the graphical interface of the yard crane scheduler.

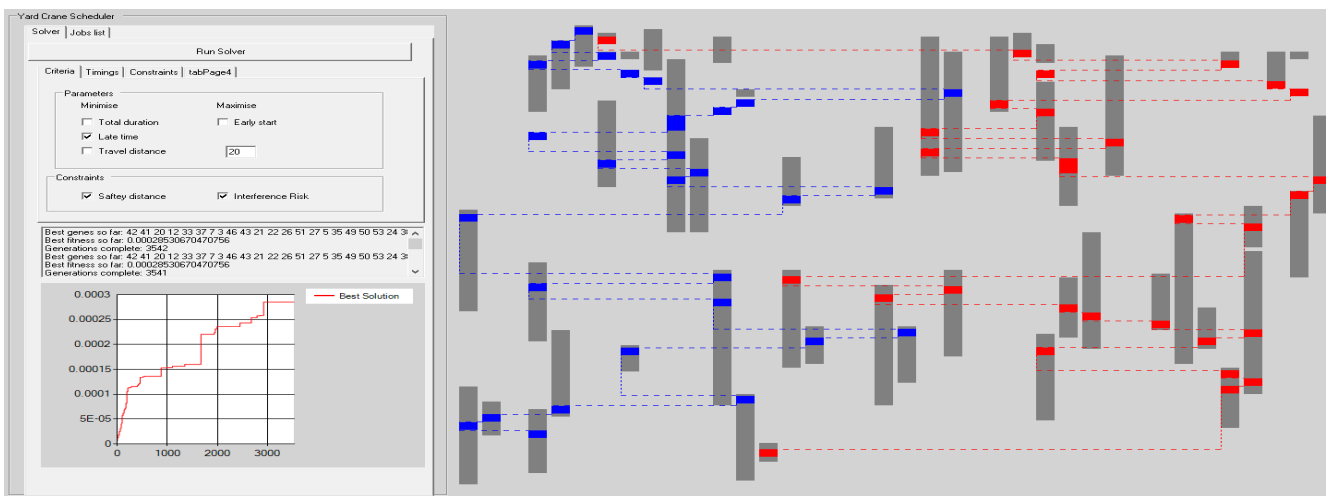


Figure (1) Optimisation Application

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