Project Assignment Part II: Simulation of a base scenario

Jef Jacobs
Toon Eeraerts
Wout Deleu

Semester 2

Contents

1 Introduction

For this assignment, a base scenario of the 'Yard storage assignment problem' was implemented and simulated. During this report, the basics design choices will be discussed, as well as the results of the simulation.

The basic technology used is Python. The code is written as dynamic as possible, using global variables and booleans to variate parameters and the overall flow of the simulation. The simulation is based on a discrete event simulation, with the possibility of online simulation.

To refresh the environment in brief, the goal is to simulate a yard, in which containergroups[1] come and go. They can arrive from vessels or from trucks and trains. The goal is to simulate the storage situations in the yard, as a result of the in and out flow.

2 Simulation parameters

The first and maybe most primary parameter to know is the amount of simulations that needs to be run to get significant results. This can be calculated by the following formula:

$$JEFHEEFTEENKLEINEPENIS$$

2.1 Generation of parameters

In order to emulate the basic behavior of the yard, there needs to be a stream of containergroups, with their own properties. To perform an online simulation, this stream needs to be generated on the fly. In the prior assignment, a study was held to figure out distributions, which will be used to generate the necessary information regarding the containergroups. This is necessary to generate the input to feed the simulation.

The generation of the groups happens at random times, which are calculated using the arrival time of the previous group, and a random interval time. This

[1] Containers arrive only in group. Containers are (for now) not looked at individually. This means they can't be split up, they are stored in the same place, they enter and leave the yard at the same time.

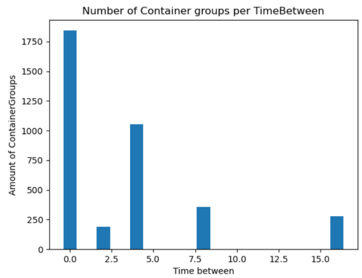

Figure 1: Inter arrival time in prior analysis

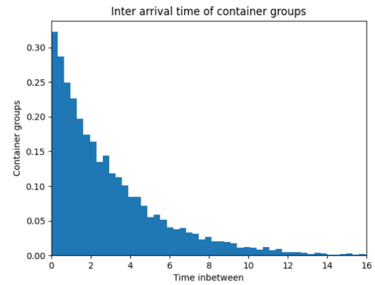

Figure 2: Inter arrival time sample distribution used in the simulation

interval time is being generated using an exponential function based upon the input data analysis of Nick De Bruyckere, Enrique Miron and Dries Van de Velde (Figure 1).

When the arrival time of a batch of containers is determined, some properties of that container group needs to be generated. The properties are:

- The type of containers
- The number of containers in the group
- The service time needed
- The arrival position of the group
- The departure position of the group
- The flow type (which can be import or export)

The type of containers is also based upon the input analysis of Nick De Bruyckere, Enrique Miron and Dries Van de Velde represented in Figure 3. Normal containers and reefer container occur respectively 69% and 31% of the times.

Each group has a certain amount of containers in them. This is chosen based upon our own analysis of the input data. The distribution is represented by a steep exponential distribution which is never lower than 1. (Figure: 5)

Each instance has a service time, which is the time containers needs to stay in the yard before further actions are taken. This factor is directly dependent on the flow type. If it is import or export, the service time is by default 48 hours. But if it is stated as a transhipment (which is technically a subtype of export),

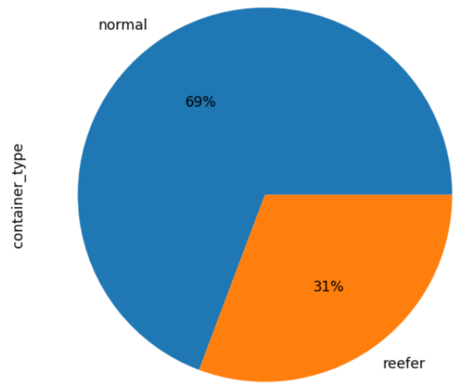

Figure 3: Container type analysis

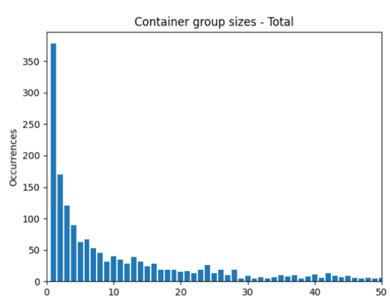

Figure 4: container group size analysis

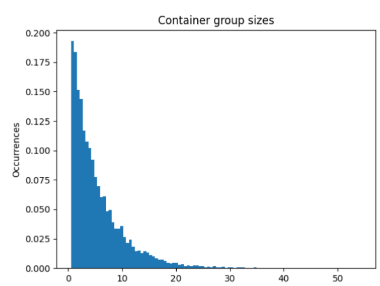

Figure 5: Cointainer group size sample distribution

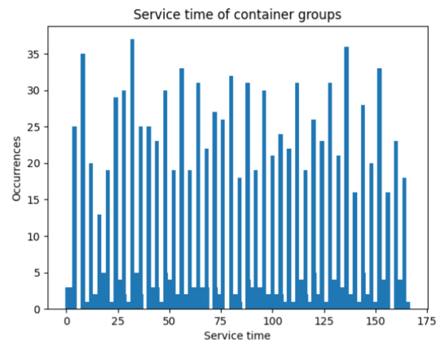

Figure 6: Service time analysis

than it can vary between 0 and 166 hours. Ths is based upon our own analysis of the input data whic shows a uniform distribution between 0 and 166 hours (Figure 6). For this reason, the service time sample always takes a random number between these two values.

The arrival and departing position of vessels and trucks is randomly selected out of the available locations.

2.2 Resulting values

Each simulation run will store different characteristics which, will be used to evaluate the performance of the simulation. The most important characteristics are:

- Amount of rejected containers and container groups (total and for each type individually)
- The total and average travel distance
- Per YardBlock:
  - The maximal occupancy at any given time
  - The maximal occupancy per day (= **average occupancy per day**)
- Average daily occupancy over all containers: The average occupancy per day over all the YardBlocks

$$\forall i \in days : \frac{\sum_{(x \in YardBlocks)} \overline{Occupancy_{i,x}}}{\#YardBlocks}$$

After seeing the first tests, i t was clear that with 159 Yardblocks in total, it is not the most useful thing to list the individual occupancy for every block, and include this in this rather short report. But to give an idea of this data, some basic statistics are given over the data:

- The amount of YardBlocks which are close to being full (90% average occupancy[2])
- The amount of YardBlocks which are never used (5% average occupancy[2])

3 Results

3.1 Basic scenario

The basic scenario that is discussed in this report describes a decision rule which stores every containergroup that arrives, if there is space in the yard. If there is no space, the container is rejected. This will be referred to as *FIFO (First In First Out)*. This apply's to arrival of containers, and wether or not they are kept in the yard. FIFO says that the first container that arrives, has a priority over the ones which arrive after the first one. If there is no space for an arriving containergroup, it will be rejected. While the next containergroup arrives, the check for space will happen again, and so on.

Two different approaches to block assignment are implemented. The block assignment rule has affect on which block is chosen to store a containergroup. The two different situations studied here are *arrival based* and *departure based*. Arrival based and departure based both are both based on the minimal distance between 2 points. The yard block chosen is the closest block to the arrival point, in case of arrival based, or closest to the departure point, in case of departure based.

The 2 different approaches give somewhat similar results. The main difference is in the travel distance. This is significantly higher with departure based approach. This could be explained by the fact that groups leave the yard on more similar positions, than they arrive, which could lead to containers being stored somewhat further from there optimal point. This is a rather unlikely scenario, because individual blocks are (almost) never close to full. It is consequently

[2] Because the simulation is run many times, the averages of 100% for example are hard to reach, thats why a small margin has been taken into account.

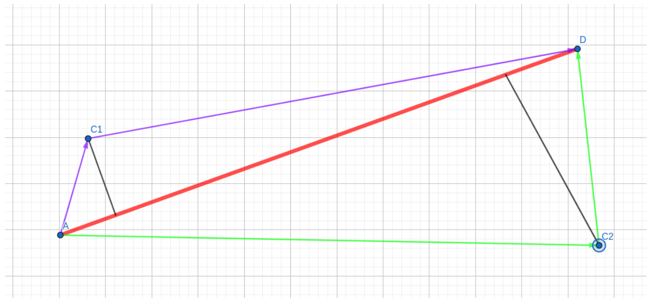

Figure 7: Closest block to arrival and departure point

unlikely containergroups would be stored somewhere else than it's optimal position. Another and more likely explanation is that the temporary storage of containers on the yard could, when searching for the closest block to the departure point, is further from the optimal route than when searching for the closest block to the arrival point. This can maybe a vague description, but on Figure 7 could clarify this. Point A could be an arrival point, point D a departure point. C1 is the yardblock closest to the arrival point, and C2 to the departure point. The shortest path from A to B is the straight line. We can see that C2 is further from the optimal path than C1.

The fact that there are no containers rejected, and the fact that the occupancy is so low, is noteworthy. This implies that the yard is too big, and the stream of containers is to little to stress the simulation, even in the slightest way. This could imply that the stream of containers is to light for this yard.

Containers Rejected	0.0
CG Rejected	0.0
Normal Rejected	0.0
Reefer Rejected	0.0
Total Travel Distance	6051683.63
AVG Travel Distance Containers	380.31
AVG daily total Occupancy	0.0366
Portion of YB never used	0.7799
Portion of YB close to full (at some point)	0
Portion of YB close to full (average)	0

Table 1: FIFO arrival based statistics

Containers Rejected	0.0
CG Rejected	0.0
Normal Rejected	0.0
Reefer Rejected	0.0
Total Travel Distance	7468862.53
AVG Travel Distance Containers	468.10
AVG daily total Occupancy	0.05272
Portion of YB never used	0.7799
Portion of YB close to full (at some point)	0
Portion of YB close to full (average)	0

Table 2: FIFO departure based statistics

3.2 Stressing the system

4 Conclusion