Mecenatúra

ZÁRÓ SZAKMAI JELENTÉS
MECENATÚRA (MEC_21) pályázat
1. ALPROGRAM (MEC_R_21)

Részvétel külföldön megrendezésre kerülő nemzetközi tudományos és innovációs rendezvényeken, konferenciákon

EPR pályázat azonosító: MEC_R 141075

Pályázó kutató: Dr. Dulai Tibor

Befogadó intézmény: Pannon Egyetem

Amennyiben több rendezvény látogatására igényelt támogatást, kérjük, mindegyikre vonatkozóan válaszolja meg az alábbi kérdéssort.

1. A külföldi rendezvény megnevezése:

a. 36th Conference of the European Chapter on Combinatorial Optimization (ECCO XXXVI)

b. Operations Research 2023 (OR 2023)

2. A rendezvény helyszíne és időpontja (város, ország, kezdő és záró dátum):

a. Chania, Kréta, Görögország, 2023. május 11-14.

b. Hamburg, Németország, 2023. augusztus 29 - szeptember 1.

3. A rendezvény honlapja:

a. https://ecco2023.euro-online.org/

b. https://www.or2023.uni-hamburg.de/

4. A megvalósult részvétel formája (jelenléti vagy online):

Mindkét konferencia esetén jelenléti.

5. A részvétel szakmai tartalma (pl. előadás, poszter, egyéb aktivitás):

Mindkét konferencia esetén konferencia-előadást tartottam:

a. Tibor Dulai, Daniil Baldouski, Balázs Dávid, György Dósa, Miklós Krész, Zsuzsanna Nagy, Ágnes Werner-Stark: **Design and analysis of vehicle scheduling and routing methods on a port logistics problem from the aspect of environmental impact and cost-efficiency**

b. Tibor Dulai, Daniil Baldouski, Balázs Dávid, György Dósa, Miklós Krész, Zsuzsanna Nagy, Ágnes Werner-Stark: **Framework for multi-objective analysis of port logistic scheduling and routing algorithms**

6. A részvétel hatása és jelentősége a saját kutatói karrier építésében (max. 1000 karakter):

A konferenciákon lehetőségem nyílt az aktuális kutatási területemen kutatócsoportunkon belül végzett munkám eredményeinek - kikötői logisztikai feladat megoldására készített algoritmusaim, valamint az algoritmusok elemzésére létrehozott keretrendszerem - bemutatására. A szakértők által megfogalmazott kérdések és javaslatok nagy segítséget jelentenek a munkám továbbfejlesztése során.

A pályázat által biztosított konferencia-részvételeim megteremtették azt a lehetőséget, hogy az operációkutatás területének nemzetközi szaktekintélyeivel találkozhassam, folytathassak beszélgetéseket és köthessek ismeretséget. Ez kutatómunkám újabb eredményeit képes katalizálni, és nemzetközi pályázatok benyújtásához adhat hátteret.

Kiemelendő, hogy az OR 2023 konferencia helyszíne Hamburg, Európa legnagyobb kikötővárosa volt, így lehetőségem nyílt megismerni egy nagy kikötő működését, mely új ismereteket a kikötői logisztika területére fókuszáló kutatásaimban remekül tudok hasznosítani.

Kelt: Veszprém, 2024. január 4.

Mellékletek:

1. A két konferencia-részvételem igazolásáról szóló certificate-ek
2. A konferenciákon megtartott prezentációim fóliái

....

Pályázó kutató aláírása (vagy fokozott biztonságú elektronikus aláírás és időbélyegző)

EURO THE ASSOCIATION OF EUROPEAN OPERATIONAL RESEARCH SOCIETIES

EWG ECCO COMBINATORIAL OPTIMIZATION

Technical University of Crete

ECCO XXXVI CONFERENCE 2023

11th - 13th May 2023, Chania, Crete, Greece

(https://ecco2023.euro-online.org/)

Chania, May 15, 2023

Certification of Attendance

To whom it may concern

This is to certify that,

Tibor Dulai

attended the **36th Conference of the European Chapter on Combinatorial Optimization (ECCO XXXVI)** in Chania, Crete, Greece, from Thursday 11th to Saturday 13th May 2023.

Programme Committee Chairs

Sincerely,

Professor Nikolaos Matsatsinis

Professor Yannis Marinakis

EURO THE ASSOCIATION OF EUROPEAN OPERATIONAL RESEARCH SOCIETIES

EWG ECCO COMBINATORIAL OPTIMIZATION

Technical University of Crete

ECCO XXXVI CONFERENCE 2023

11th - 13th May 2023, Chania, Crete, Greece

(https://ecco2023.euro-online.org/)

Chania, May 15, 2023

Certification of Presentation

To whom it may concern

This is to certify that,

Tibor Dulai

Presented a paper titled:

'Design and analysis of vehicle scheduling and routing methods on a port logistics problem from the aspect of environmental impact and cost-efficiency'

At the ***36th Conference of the European Chapter on Combinatorial Optimization (ECCO XXXVI)*** *held in Chania, Crete, Greece, from Thursday 11th to Saturday 13th May 2023.*

Programme Committee Chairs

Sincerely,

Professor Nikolaos Matsatsinis *Professor Yannis Marinakis*

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

UHH – Präsidialverwaltung – Referat 73 - Mittelweg 177, 20148 Hamburg

University of Pannonia
Tibor Dulai
Egyetem str. 10.
H-8200, Veszprém
Hungary

Hamburg, Germany

Certificate of Attendance

This is to certify that Tibor Dulai attended the Operations Research Conference 2023 in Hamburg from 2023-08-29 to 2023-09-01. During this time, Tibor Dulai engaged in the scheduled events, seminars, and discussions, contributing to the overall success of the conference. We appreciate their participation and look forward to their continued contribution to the field of Operations Research.

Sincerely,
Guido Voigt

Guido Voigt
Faculty of Business Administration
University of Hamburg

Moorweidenstraße 18
20148, Hamburg
Germany
https://uni-hamburg.de

ECCO XXXVI. Conference
Chania, Crete, Greece
11th May 2023.

Design and analysis of vehicle scheduling and routing methods on a port logistics problem from the aspect of environmental impact and cost-efficiency

Tibor Dulai, Daniil Baldouski, Balázs Dávid, György Dósa, Miklós Krész, Zsuzsanna Nagy, Ágnes Werner-Stark

Tibor Dulai acknowledges the financial support of the National Research, Development and Innovation Office of Hungary through the grant MEC_R 141075. Balázs Dávid and Miklós Krész gratefully acknowledge the European Commission for funding the InnoRenew CoE project (Grant Agreement #739574) under the Horizon2020 Widespread-Teaming program, and the Republic of Slovenia (Investment funding of the Republic of Slovenia and the European Union of the European Regional Development Fund). They are also grateful for the support of the Slovenian Research Agency (ARRS) through the grant BI-HU/21-22-010.

Agenda

The problem

We intend to create an event-based simultaion **framework** for a port logistics system, **routing trucks and scheduling trucks and ships**.

The **port structure** should be customized in the framework.

We intend to generate **different classes of input data**.

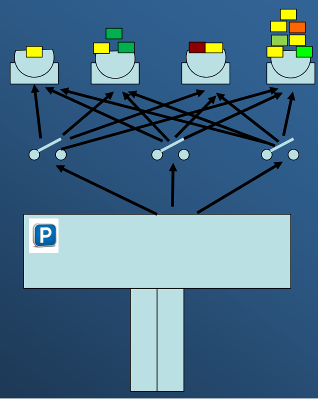
Some **decision points** of the system should be determined.

Our additional goal is to develop **algorithms** with different behaviour for the decision points.

We intend to **analyze** the efficiency of the algorithms on the input classes.

The structure of the port

Component's name	Component's capacity for trucks
Docks	1
	$c_{i,j}$
Gates	1
	c_i
Parking lot	C
Road	∞



The customizable parameters of the port structure

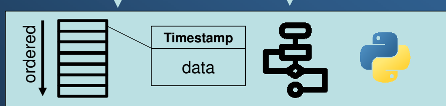
- number of gates : **G**
- number of docks : **D**
- type of the i^{th} gate: $type_i$, $i \in [1, \dots, G]$
- capacity of the parking lot: **C**
- capacity of the j^{th} dock for containers: $c^{container}_j$, $j \in [1, \dots, D]$
- time to unload a container in the j^{th} dock: t^{unload}_j, $j \in [1, \dots, D]$
- time to load a container into a ship in the j^{th} dock: t^{load}_j, $j \in [1, \dots, D]$
- time from the parking lot to the i^{th} gate: t_i, $i \in [1, \dots, G]$
- time from the i^{th} gate to the j^{th} dock: $t_{i,j}$, $i \in [1, \dots, G]$, $j \in [1, \dots, D]$
- capacity of the route from the parking lot to the i^{th} gate: c_i, $i \in [1, \dots, G]$
- capacity of the route from the i^{th} gate to the j^{th} dock: $c_{i,j}$, $i \in [1, \dots, G]$, $j \in [1, \dots, D]$

The simulation framework

- written in Python language
- event-driven approach: simulated timer-based event handling

Input Port structure /json/ | Input data (trucks/ships) /json/

Framework



Output Proposed schedule

Operation of the simulation framework
The Road (before the parking lot)

Constraints:
- works in FIFO manner
- capacity: ∞
- no overtake

Criteria for continuation: -

Event: Arrival of a truck

Event handling:

Is there at least one free place on a road from the parking lot to a gate that can lead to the target gate?
- Y → ENTER the road to a gate*
- N → Is there at least one free place in the parking lot?
  - Y → Park in the parking lot
  - N → Stand into the queue on the Road

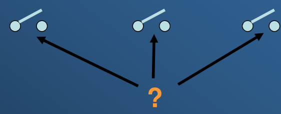
Operation of the simulation framework
The Road (before the parking lot)

ENTER the road to a gate*

Decision point: to which Gate to direct the truck?

Applied algorithms:

1. Choose the gate that results in **minimal overall cost** for the truck
2. Choose an appropriate gate **randomly**



Operation of the simulation framework
The Gate

Constraint:
- capacity: 1

Criteria for continuation:
the gate is free

Event: Arrival of a truck at a gate

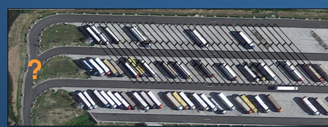
Event handling:

Is the gate free?
- Y → The truck enters the gate; +1 free place becomes available on the route from the parking lot to the gate → One truck can leave the parking lot** → One truck can enter the parking lot from the Road
- N → The „truck arrival at a gate" event is postponed till just after the next event

Operation of the simulation framework
The Gate

One truck can leave the parking lot**

Decision point: which truck to choose to leave the parking lot?



Applied algorithms:

1. Select a truck from the parking lot – amongst the vehicles that have every condition fulfilled to start to their destination - **randomly**.

2. Choose the truck **with the closest deadline** from from the parking lot – amongst the vehicles that have every condition fulfilled to start to their destination

3. Select the truck **with minimal overall cost for the truck** from from the parking lot – amongst the vehicles that have every condition fulfilled to start to their destination

Operation of the simulation framework
Route from gate to dock

Constraints:
- capacity: $c_{i,j}$
- works in FIFO manner

Criteria for continuation:
there is at least 1 place on the route to the targeted dock

Event: A truck enters the route from the gate to the desired dock

Event handling:

Is there free place on the route to the dock?
- Y → The truck enters the route → One truck can enter the gate (if it previously reached that) → One truck can leave the parking lot** → One truck can enter the parking lot from the Road
- N → The „truck enters the route to the dock" event is postponed till just after the next event

Operation of the simulation framework
The Dock - arrival

Constraint:
- capacity: 1

Criteria for continuation:
- the dock is free
- there is place for at least 1 container

Event: Arrival of a truck at a dock

Event handling:

Is the dock free with at least one free place for container?
- Y → The truck enters the dock → One truck can enter the route to the dock → One truck can enter the gate (if it previously reached that) → One truck can leave the parking lot** → One truck can enter the parking lot from the Road
- N → The „truck arrival at the dock" event is postponed till just after the next event

Operation of the simulation framework
The Dock - unload

Constraints:

- Capacity for truck: 1
- Capacity for container: $c^{container}_j$

Criteria for continuation: -

Event: Truck unloaded at the dock

Event handling:

1. The truck „disappears" from the system
2. One truck can enter the dock
3. One truck can enter the route to the dock
4. One truck can enter the gate (if it previously reached that)
5. One truck can leave the parking lot**
6. One truck can enter the parking lot from the Road

13/21

Operation of the simulation framework
The Ship-related part

Constraints:

- Capacity for ships: 1
- Capacity for container: $c^{container}_j$

Event: A ship arrives at the port

Event handling:

Is there 0 ship in the dock AND is there at least one container for the ship?

- Y: The ship enters the dock
- N: The „ship arrival at the dock" event is postponed till just after the next event (the ship waits for its dock)

14/21

The structure of the input data 1/2
(related to the trucks / ships)

- number of trucks: T
- number of ships: S
- ID of the m^{th} truck: id^T_m, $m \in [1, \dots, T]$
- ID of the n^{th} ship: id^S_n, $n \in [1, \dots, S]$
- Arrival time of the m^{th} truck at the port: T^A_m, $m \in [1, \dots, T]$
- Deadline for the m^{th} truck to leave the port: T^B_m, $m \in [1, \dots, T]$
- Arrival time of the n^{th} ship at the port: S^A_n, $n \in [1, \dots, S]$
- Deadline for the n^{th} ship to leave the port: S^B_n, $n \in [1, \dots, S]$
- The ID of the ship for which the m^{th} truck carries its container: $ship(id^T_m)$, where $ship(id^T_m) \in \{id^S_n\}, m \in [1, \dots, T], n \in [1, \dots, S]$

15/21

The structure of the input data 2/2
(related to the trucks / ships)

- Cost of the m^{th} truck for one time unit while stading on the Road: C^{queue}_m
- Cost of the m^{th} truck for one time unit while using it: $C^{TruckOp}_m$
- Cost of the n^{th} ship for one time unit while using it: C^{ShipOp}_n
- Penalty of the n^{th} ship for one time unit while using it after its deadline: $C^{penalty}_n$
- Transfer time of the m^{th} truck on a gate with type $type_i$: $T^{transfer}_{m,i}$, where $i \in [1, \dots, G]$, $m \in [1, \dots, T]$
- Ordered list of dock indices for the n^{th} ship: $docks_n$, $n \in [1, \dots, S]$, and each element of $docks_n$ is between 1 and D.

16/21

Example for an input data (parts)
(related to the trucks / ships)


```
{
  "numberOfTrucks":100,
  "numberOfShips":20,
  "Trucks":[
    {
      "id":1,
      "arrivalDatetime":"2023-05-08 20:48",
      "shipId":16,
      "queueCost":15,
      "vehicleCost":6,
      "gateTypeTransferTimes":{
        "A":1,
        "B":5
      },
      "deadline":"2023-05-08 22:49"
    },
    {
      "id":2,
      "arrivalDatetime":"2023-05-07 07:52",
      "shipId":19,
      "queueCost":19,
      "vehicleCost":20,
      "gateTypeTransferTimes":{
        "A":8,
```

```
"Ships":[
    {
      "name":1,
      "earliestDatetime":"2023-05-11 12:47",
      "latestDatetime":"2023-05-12 08:34",
      "dockIndex":[
        0
      ],
      "shipCost":27,
      "penaltyAfterDeadline":387
    },
    {
      "name":2,
      "earliestDatetime":"2023-05-10 19:24",
      "latestDatetime":"2023-05-11 17:09",
      "dockIndex":[
        3
      ],
      "shipCost":142,
      "penaltyAfterDeadline":214
    },
```


17/21

The examined input classes

For all the inputs, the structure of the port and the number of the vehicles were the same: **G = 3, D = 4, T = 100, S = 20**

The input classes differ in the **time windows** of the trucks and the ships.

1st input class

Trucks:

Arrival: now + random(0-3 days)

Deadline: arrival + random(1-10 hours)

Ships:

Arrival: now + random(0-3 days)

Deadline: max(last truck's arrival to it; arrival) + 1 hour

2nd input class: Extended deadlines: by 3 days

18/21

The applied algorithm variants

The two decision points:

1. To which gate to direct the arrived truck?

1.1. to the gate that results in **minimum overall cost** for the truck

1.2. to a **random** gate, from which the destination dock can be reached

2. Which truck to select from the parking lot to start?

2.1. the one with the **closest deadline**

2.2. the one with the **mimimum overall cost**

2.3. select the truck **randomly**

Results

Target function: **minimum overall cost** of the trucks/ships   3 x 2 x 2 x 10 runs

Results on input class1 (class2 – ext. deadline)

Truck-selection policy from the parking lot

Gate-selection policy	Closest deadline	Minimum cost	Random
Minimum cost	- 79 (87)% overall cost related to the worst found on average - 16 (1)% deadline overrun	- **72 (73)% overall cost related to the worst found on average** - 42 (2)% deadline overrun	- 89 (89)% overall cost related to the worst found on average - 36 (4)% deadline overrun
Random	- 85 (86)% overall cost related to the worst found on average - **13 (0)% deadline overrun**	- 83 (85)% overall cost related to the worst found on average - 30 (0)% deadline overrun	- 97 (92)% overall cost related to the worst found on average - 40 (2)% deadline overrun

Summary

An event-based simulation framework was developed that can handle cutomized port structures

2 decision points were identified (gate and truck selection).

3 x 2 approaches were developed for these decision points.

Input data of two input classes were generated.

The behaviour of the different approaches were analyzed on the input by the framework.

Future plans

- **Handling of more decisions (e.g., releasing the FIFO manner)**
- **Analysis of other input classes**
- **Multi-objective target function (or switching between the applied algorithms based on the circumstances)**

Thank you for your kind attention!

OR 2023
Hamburg, Germany
30th Aug. 2023.

Framework for multi-objective analysis of port logistic scheduling and routing algorithms

Tibor Dulai, Daniil Baldouski, Balázs Dávid, György Dósa, Miklós Krész, Zsuzsanna Nagy, Ágnes Werner-Stark

Tibor Dulai acknowledges the financial support of the National Research, Development and Innovation Office of Hungary through the grant MEC_R 141075. Balázs Dávid and Miklós Krész gratefully acknowledge the European Commission for funding the InnoRenew CoE project (Grant Agreement #739574) under the Horizon2020 Widespread-Teaming program, and the Republic of Slovenia (Investment funding of the Republic of Slovenia and the European Union of the European Regional Development Fund). They are also grateful for the support of the Slovenian Research Agency (ARRS) through the grant BI-HU/21-22-010.

Agenda

- Presentation of the problem
- Basic structure of the port
- The customizable parameters of the port structure
- The framework – how the different components of the port are handled
- Input data structure
- Input classes
- The examinations
- Analysis of the results

The problem

We intend to create an event-based simulation **framework** for a port logistics system, **routing trucks and scheduling trucks and vessels**.

The **port structure** should be customized in the framework.

We intend to generate **different classes of input data**.

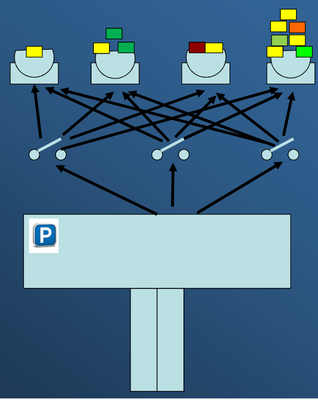
Some **decision points** of the system should be determined.

Our additional goal is to develop **algorithms** with different behaviour for the decision points.

We intend to **analyze** the efficiency of the algorithms on the input classes.

The structure of the port

Component's name	Component's capacity for trucks
Dock	1
	$c_{i,j}$
Gate	1
	c_i
Parking lot	C
Road	∞

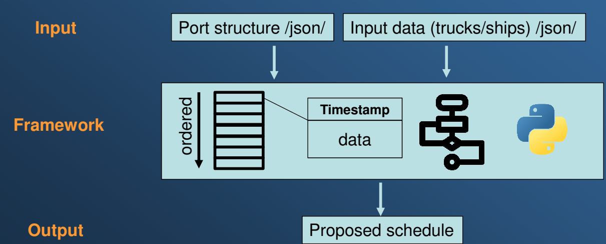


The customizable parameters of the port structure

- number of gates : **G**
- number of docks : **D**
- type of the i^{th} gate: $\mathbf{type}_i$, $i \in [1, \dots, G]$
- capacity of the parking lot: **C**
- capacity of the j^{th} dock for containers: $c^{container}_j$, $j \in [1, \dots, D]$
- time to unload a container in the j^{th} dock: t^{unload}_j, $j \in [1, \dots, D]$
- time to load a container into a ship in the j^{th} dock: t^{load}_j, $j \in [1, \dots, D]$
- time from the parking lot to the i^{th} gate: t_i, $i \in [1, \dots, G]$
- time from the i^{th} gate to the j^{th} dock: $t_{i,j}$, $i \in [1, \dots, G]$, $j \in [1, \dots, D]$
- capacity of the route from the parking lot to the i^{th} gate: c_i, $i \in [1, \dots, G]$
- capacity of the route from the i^{th} gate to the j^{th} dock: $c_{i,j}$, $i \in [1, \dots, G]$, $j \in [1, \dots, D]$

The simulation framework

- written in Python language
- event-driven approach: simulated timer-based event handling



Operation of the simulation framework
The Road (before the parking lot)

Constraints:
- works in FIFO manner
- capacity: ∞
- no overtake

Criteria for continuation: -

Event: Arrival of a truck

Event handling:

Is there at least one free place on a road from the parking lot to a gate that can lead to the target dock?
- Y → ENTER the road to a gate*
- N → Is there at least one free place in the parking lot?
  - Y → Drive in the parking lot
  - N → Stand in the queue on the Road

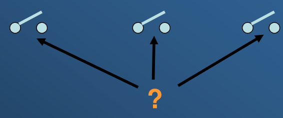
Operation of the simulation framework
The Road (before the parking lot)

ENTER the road to a gate*

Decision point: to which Gate to direct the truck?

Applied algorithms:

1. Choose the gate that results in **minimal overall cost** for the truck
2. Choose an appropriate gate **randomly**



Operation of the simulation framework
The Gate

Constraint:
- capacity: 1

Criteria for continuation:
the gate is free

Event: Arrival of a truck at a gate

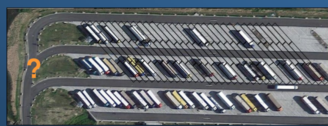
Event handling:

Is the gate free?
- Y → The truck enters the gate; +1 free place becomes available on the route from the parking lot to the gate → One truck can leave the parking lot** → One truck can enter the parking lot from the Road
- N → The „truck arrival at a gate" event is postponed till just after the next event

Operation of the simulation framework
The Gate

One truck can leave the parking lot**

Decision point: which truck to choose to leave the parking lot?



Proposed algorithms:

1. Select a truck from the parking lot – amongst the vehicles that have every condition fulfilled to start to their destination - **randomly**.

2. Choose the truck **with the closest deadline** from from the parking lot – amongst the vehicles that have every condition fulfilled to start to their destination

3. Select the truck **with minimal overall cost for the truck** from from the parking lot – amongst the vehicles that have every condition fulfilled to start to their destination

Operation of the simulation framework
Route from gate to dock

Constraints:
- capacity: $c_{i,j}$
- works in FIFO manner

Criteria for continuation:
there is at least 1 place on the route to the targeted dock

Event: A truck enters the route from the gate to the desired dock

Event handling:

Is there free place on the route to the dock?
- Y → The truck enters the route → One truck can enter the gate (if it previously reached that) → One truck can leave the parking lot** → One truck can enter the parking lot from the Road
- N → The „truck enters the route to the dock" event is postponed till just after the next event

Operation of the simulation framework
The Dock - arrival

Constraint:
- capacity: 1

Criteria for continuation:
- the dock is free
- there is place for at least 1 container

Event: Arrival of a truck at a dock

Event handling:

Is the dock free with at least one free place for container?
- Y → The truck enters the dock → One truck can enter the route to the dock → One truck can enter the gate (if it previously reached that) → One truck can leave the parking lot** → One truck can enter the parking lot from the Road
- N → The „truck arrival at the dock" event is postponed till just after the next event

Operation of the simulation framework
The Dock - unload

Constraints:

- Capacity for truck: 1
- Capacity for container: $c^{container}_j$

Criteria for continuation: -

Event: Truck unloaded at the dock

Event handling:

The truck „disappears” from the system
↓
One truck can enter the dock
↓
One truck can enter the route to the dock
↓
One truck can enter the gate
(if it previously reached that)
↓
One truck can leave the parking lot**
↓
One truck can enter the parking lot from the Road

Operation of the simulation framework
The vessel-related part

Constraints:

- Capacity for vessels: 1
- Capacity for container: $c^{container}_j$

Event: A vessel arrives at the port

Event handling:

Is there 0 ship in the dock AND is there at least one container for the vessel?

- Y: The vessel enters the dock
- N: The „vessel arrival at the dock” event is postponed till just after the next event (the vessel waits for its dock)

The structure of the input data 1/2
(related to the trucks / vessels)

- number of trucks: T
- number of ships: S
- ID of the m[th] truck: id^T_m, $m \in [1, \ldots, T]$
- ID of the n[th] ship: id^S_n, $n \in [1, \ldots, S]$
- Arrival time of the m[th] truck at the port: T^A_m, $m \in [1, \ldots, T]$
- Deadline for the m[th] truck to leave the port: T^B_m, $m \in [1, \ldots, T]$
- Arrival time of the n[th] ship at the port: S^A_n, $n \in [1, \ldots, S]$
- Deadline for the n[th] ship to leave the port: S^B_n, $n \in [1, \ldots, S]$
- The ID of the ship for which the m[th] truck carries its container: $ship(id^T_m)$, where $ship(id^T_m) \in \{id^S_n\}, m \in [1, \ldots, T], n \in [1, \ldots, S]$

The structure of the input data 2/2
(related to the trucks / vessels)

- Cost of the m[th] truck for one time unit while stading on the Road: C^{queue}_m
- Cost of the m[th] truck for one time unit while using it: $C^{TruckOp}_m$
- Cost of the n[th] ship for one time unit while using it: C^{ShipOp}_n
- Penalty of the n[th] ship for one time unit while using it after its deadline: $C^{penalty}_n$
- Transfer time of the m[th] truck on a gate with type type$_i$: $T^{transfer}_{m,i}$, where $i \in [1, \ldots, G]$, $m \in [1, \ldots, T]$
- Ordered list of dock indices for the n[th] ship: $docks_n$, $n \in [1, \ldots, S]$, and each element of $docks_n$ is between 1 and D.

Example for an input data (parts)
(related to the trucks / vessels)


```
{
  "numberOfTrucks":100,
  "numberOfShips":20,
  "Trucks":[
    {
      "id":1,
      "arrivalDatetime":"2023-05-08 20:48",
      "shipId":16,
      "queueCost":15,
      "vehicleCost":6,
      "gateTypeTransferTimes":{
        "A":1,
        "B":5
      },
      "deadline":"2023-05-08 22:49"
    },
    {
      "id":2,
      "arrivalDatetime":"2023-05-07 07:52",
      "shipId":19,
      "queueCost":19,
      "vehicleCost":20,
      "gateTypeTransferTimes":{
        "A":8,
```

```
"Ships":[
  {
    "name":1,
    "earliestDatetime":"2023-05-11 12:47",
    "latestDatetime":"2023-05-12 08:34",
    "dockIndex":[
      0
    ],
    "shipCost":27,
    "penaltyAfterDeadline":387
  },
  {
    "name":2,
    "earliestDatetime":"2023-05-10 19:24",
    "latestDatetime":"2023-05-11 17:09",
    "dockIndex":[
      3
    ],
    "shipCost":142,
    "penaltyAfterDeadline":214
  },
```


The examined input classes

For all the inputs, the structure of the port was identical: **G = 3, D = 4**

Randomly generated temporal data:

Trucks:

Arrival: now + random offset (0-3 days)

Deadline: arrival + random offset (1-10 hours)

Vessels:

Arrival: now + random offset (0-3 days)

Deadline: max(last truck's arrival to it; arrival) + 1 hour

The input data classes differ in the **number of the trucks and the number of the vessels:**

1[st] input class: T = 100, S = 20

2[nd] input class: T = 50, S = 5

The examinations so far

- 5-5 random instances were generated for both input data classes.
- Two algorithms were implemented for the **decision point „To which gate to direct the truck?"**.
- 10 runs were executed for all input data with both algorithms.
- The **makespan** of the results was analyzed.

The number of the input data classes

The number of the algorithms

5 x 2 x 2 x 10 runs

The number of runs of the same configuration

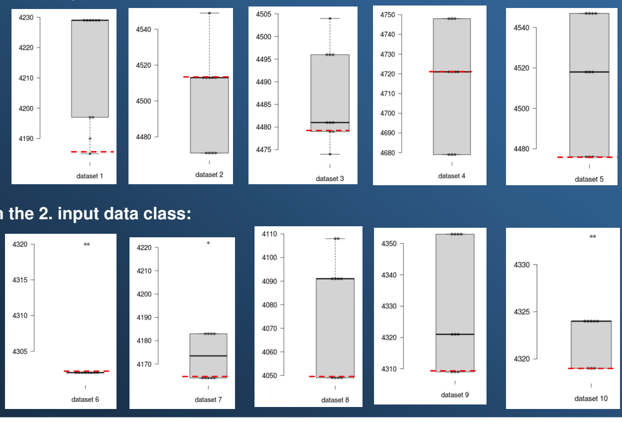
The number of the instances for a data class

Results

The obtained result when selecting the gate that results in the minimal overall cost.

On the 1. input data class:

On the 2. input data class:



Summary

An event-based simulation framework was developed that can handle cutomized port structures

2 decision points were identified (gate and truck selection).

2 algorithms were implemented for the gate selection decision point.

Input data of two input classes were generated.

The behaviour of the different approaches were analyzed on the input by the framework.

Future plans

- **Handling of more decisions (e.g., releasing the FIFO manner)**
- **Implementation of more algorithms and make comparison between them**
- **Analysis of other input classes**
- **Multi-objective target function (or switching between the applied algorithms based on the circumstances)**

Thank you for your kind attention!