The Green Yard Scheduler

Cihan Butun
Research Fellow, Brunel University London

Afshin Mansouri
Professor, Brunel University London

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PortForward

Main objectives

Smart Port Solutions: Employing ICT solutions to improve information flows between ports and port communities

Green Port Solutions: Adopting green technologies to reduce the environmental impacts of port operations and save resources

Interconnected Port Solutions: Combining different modes of transport integrating of different technologies to better monitor and control freight flows

https://www.portforward-project.eu

(Blobner, 2020)

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Green Yard Scheduler (GYS)

A decision support system for more efficient and sustainable container terminal operations

Project use case: Vigo Container Terminal

Increase the container terminal productivity

Reduce the carbon footprint of the terminal
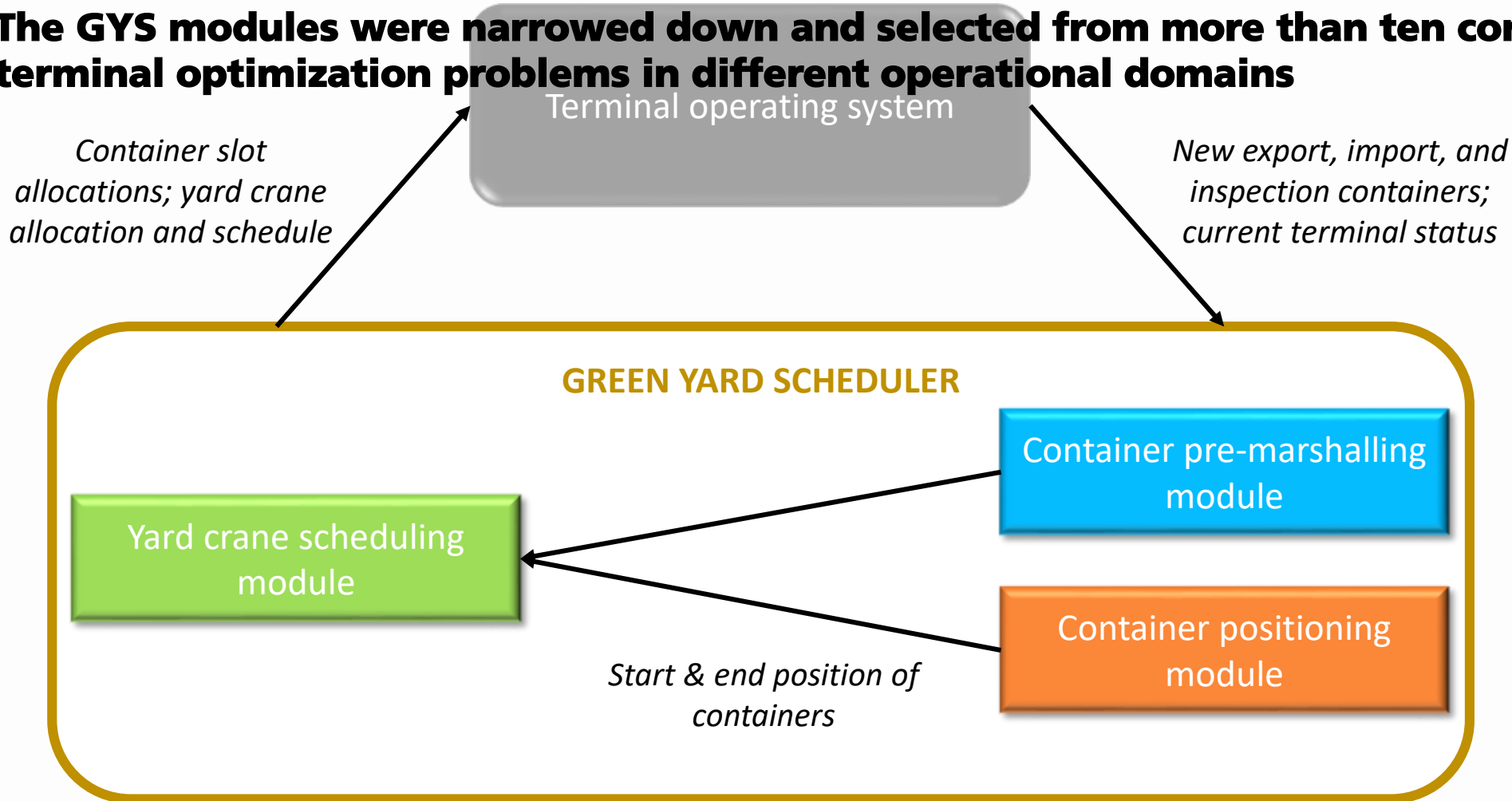
Integrate with the terminal operating system

Harmonise container yard operations

Green scheduling: Integration of environmental considerations as explicit objectives into the conventional scheduling to analyse the trade-off between the operational performance and sustainability of a system.

(Mansouri et al., 2016)

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Modules of GYS

The GYS modules were narrowed down and selected from more than ten container terminal optimization problems in different operational domains

Terminal operating system

Container slot allocations; yard crane allocation and schedule

New export, import, and inspection containers; current terminal status

GREEN YARD SCHEDULER

Yard crane scheduling module

Container pre-marshalling module

Container positioning module

Start & end position of containers

Optimization problems in GYS

1.Container pre-marshalling	Reorder containers in the storage yard to eliminate relocations during peak hours
2. Container positioning	Assign slots to inbound and outbound containers in the storage yard
3. Yard crane scheduling	Determine the allocation and scheduling of terminal operations to yard cranes

(Source: https://www.termavi.com/en/multimedia-2/)

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Objective criteria

Each problem involves one performance-oriented and sustainability-oriented minimisation objective

Container pre-marshalling
- Container movements
- Energy consumption of yard cranes

Container positioning
- Container reshuffles
- Energy consumption of movement vehicle

Yard crane scheduling
- Tardiness of operations
- Energy consumption of yard cranes

T5.1 SUSTAINABILITY ASSESSMENT (INITIAL RESULTS)

Carbon footprint: 45.549 kg CO_2 eq. / TEU

1	2	3	4	5
21.308 kg CO_2 eq.	14.161 kg CO_2 eq.	4.584 kg CO_2 eq.	4.048 kg CO_2 eq.	1.448 kg CO_2 eq.
47%	31%	10%	9%	3%

(Claret, 2019)

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Computational experiments

Preliminary results provide important insights

Container pre-marshalling problem: Energy savings can be achieved without disrupting the operational efficiency of the terminal

4-6% energy reduction

Container positioning problem: The performance- and sustainability-oriented objectives conflict with each other

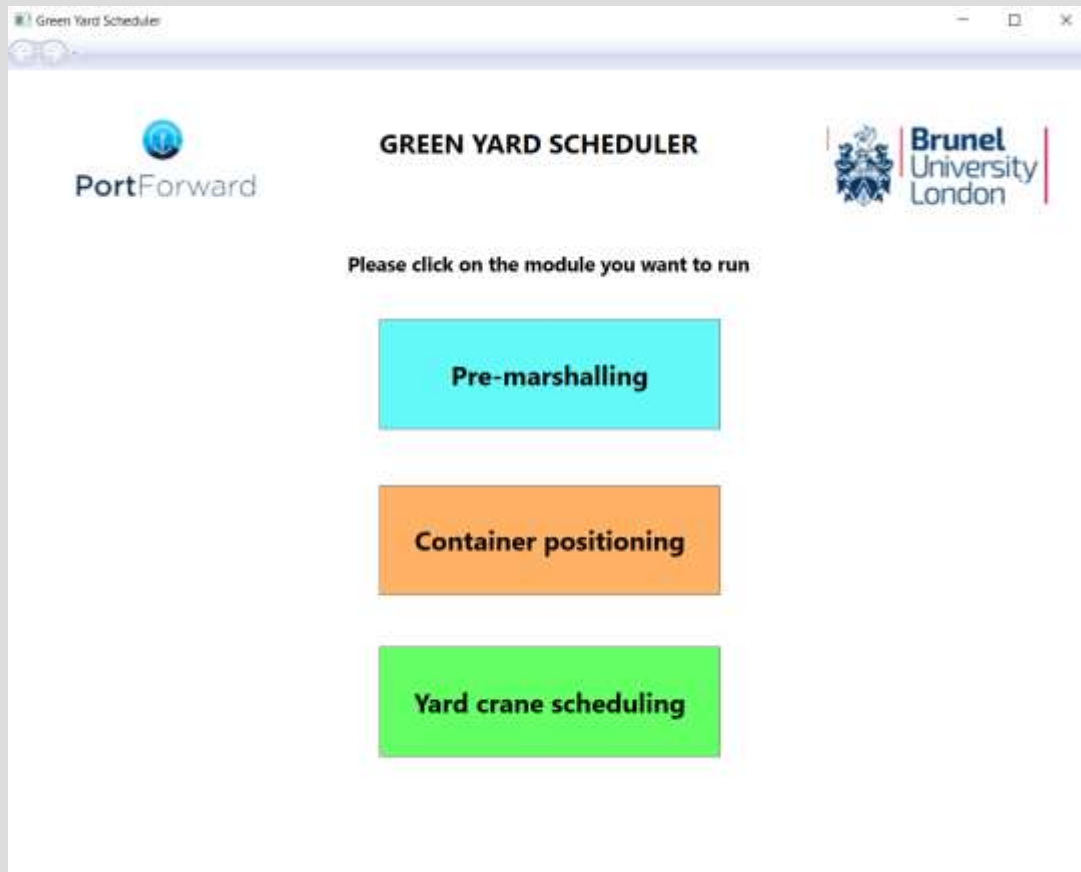**13-34%** energy reduction in expense of greater reshuffles

Yard crane scheduling problem: The performance- and sustainability-oriented objectives conflict with each other

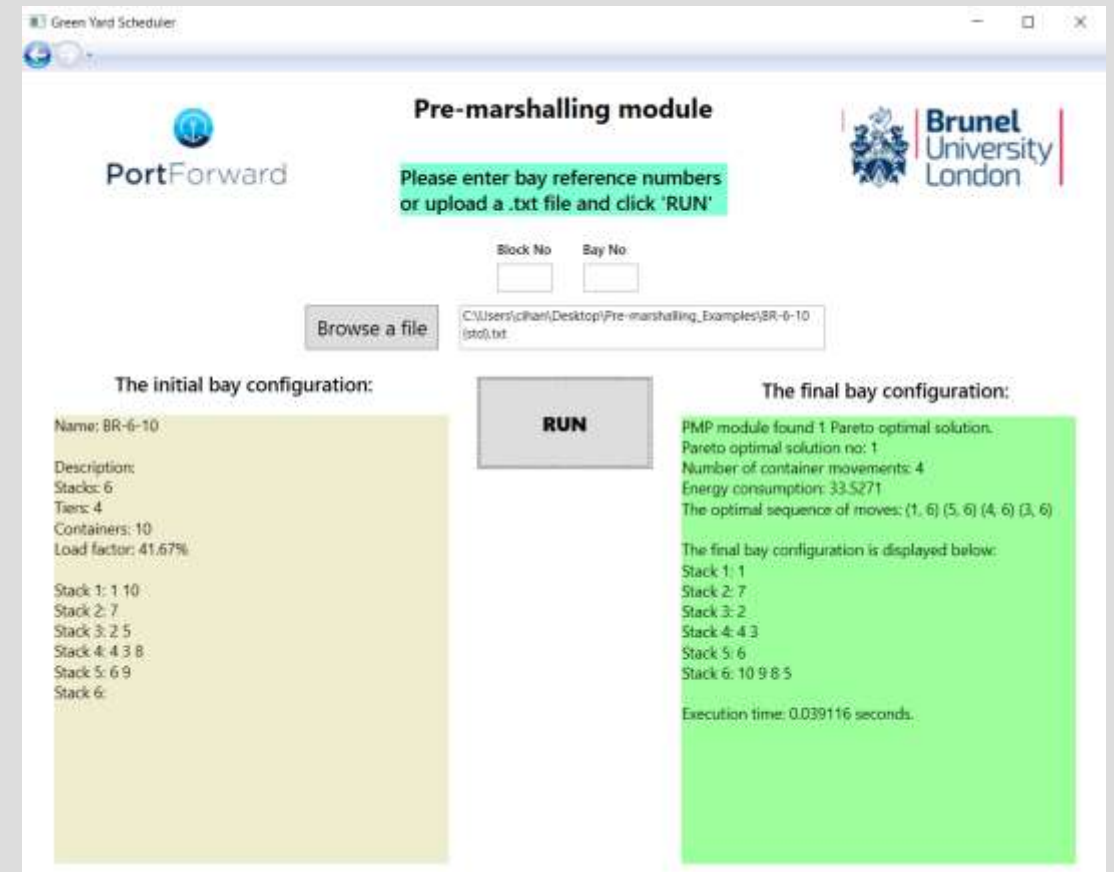Up to **38%** energy reduction in expense of greater delays

GYS user interface development

The terminal operator access to GYS through the GUI under development

*Main navigation window*

PMP module window

This project receives funding in the European Commission's Horizon 2020 Research Program under Grant Agreement Number 769267

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GYS user interface development

The GUI shows the trade-off between decision alternatives in Pareto Front plots

Pareto Front of a CPP instance

(Source: https://www.termavi.com/en/multimedia-2/)
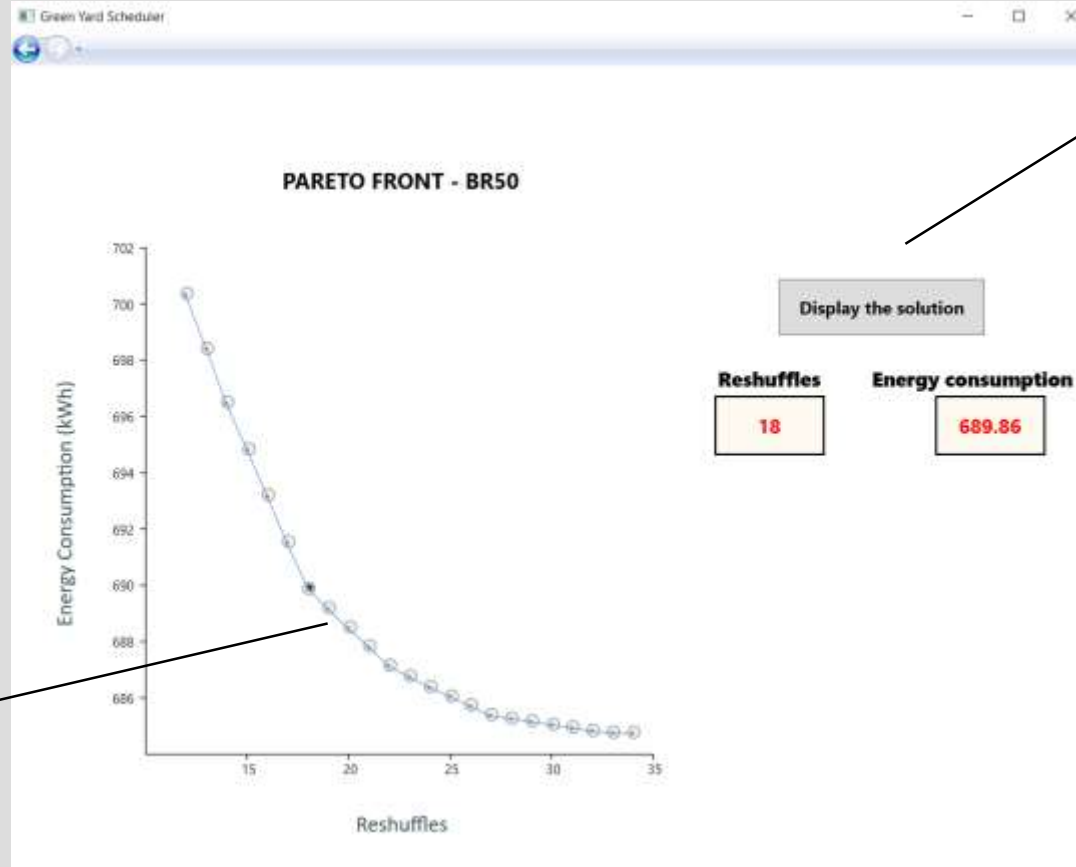
The user can check solutions on the plot and display them

The Pareto front of the experiment instance "BR50"

(Source: https://www.termavi.com/en/multimedia-2/)

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GYS: Future steps

In future, we aim to achieve:

- Development of the GYS solver and GUI (beta version)

- Testing and implementation in Vigo container terminal

- Completion of the functional module in 1-2 years for the use of other container terminals

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Contact Details

Professor Afshin Mansouri

Dr Cihan Butun

Address: Brunel University London, Uxbridge, Middlesex UB8 3PH, United Kingdom
Web: http://www.brunel.ac.uk

Department: Brunel Business School

Tel: +44-1895-265361

Email: Afshin.Mansouri@brunel.ac.uk

Email: cihan.butun@brunel.ac.uk

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