LOGOS:
The Logistics Optimisation System

DECISION LAB

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Presented at Gurobi Days Paris 2022


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GARDE

By World War I and II

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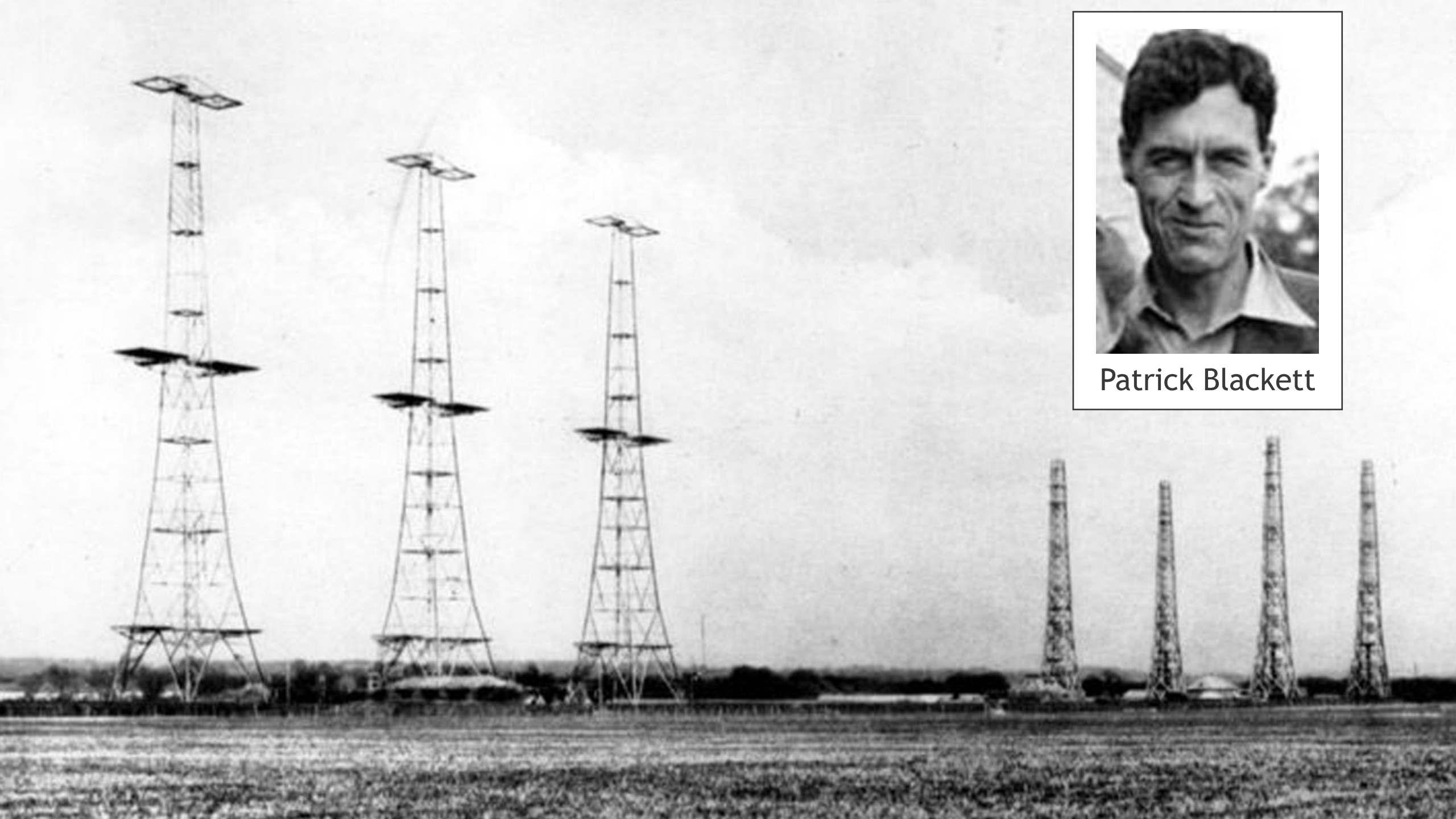

Patrick Blackett


CHALLENGE

Right On Time:
Automating Military Logistics

The project

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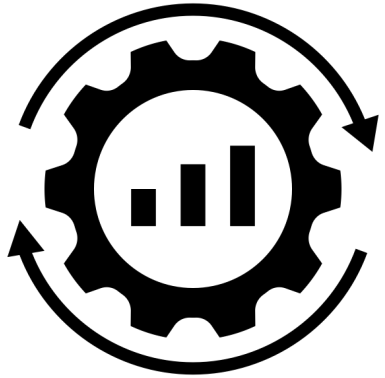
Overall Solution: LOGOS



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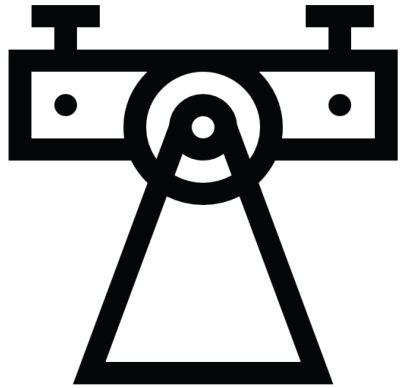
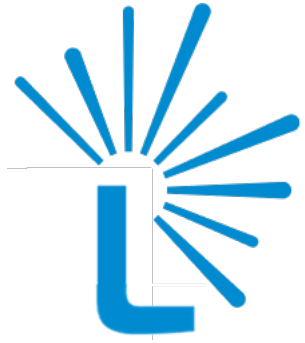
Logistic Optimisation Engine – multi-stage approach finds optimal picking and packing solution

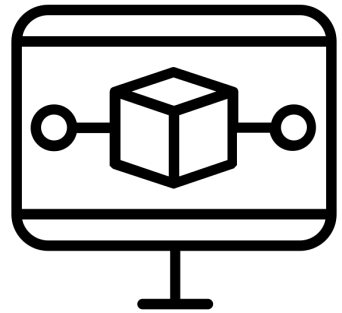


Visual Assistant projects contextual instructions to packers, guiding them through their work

FIRSTCo.



LOGOS Application – enables scenario problems to be set up and the optimiser run



Created by Justin Blake
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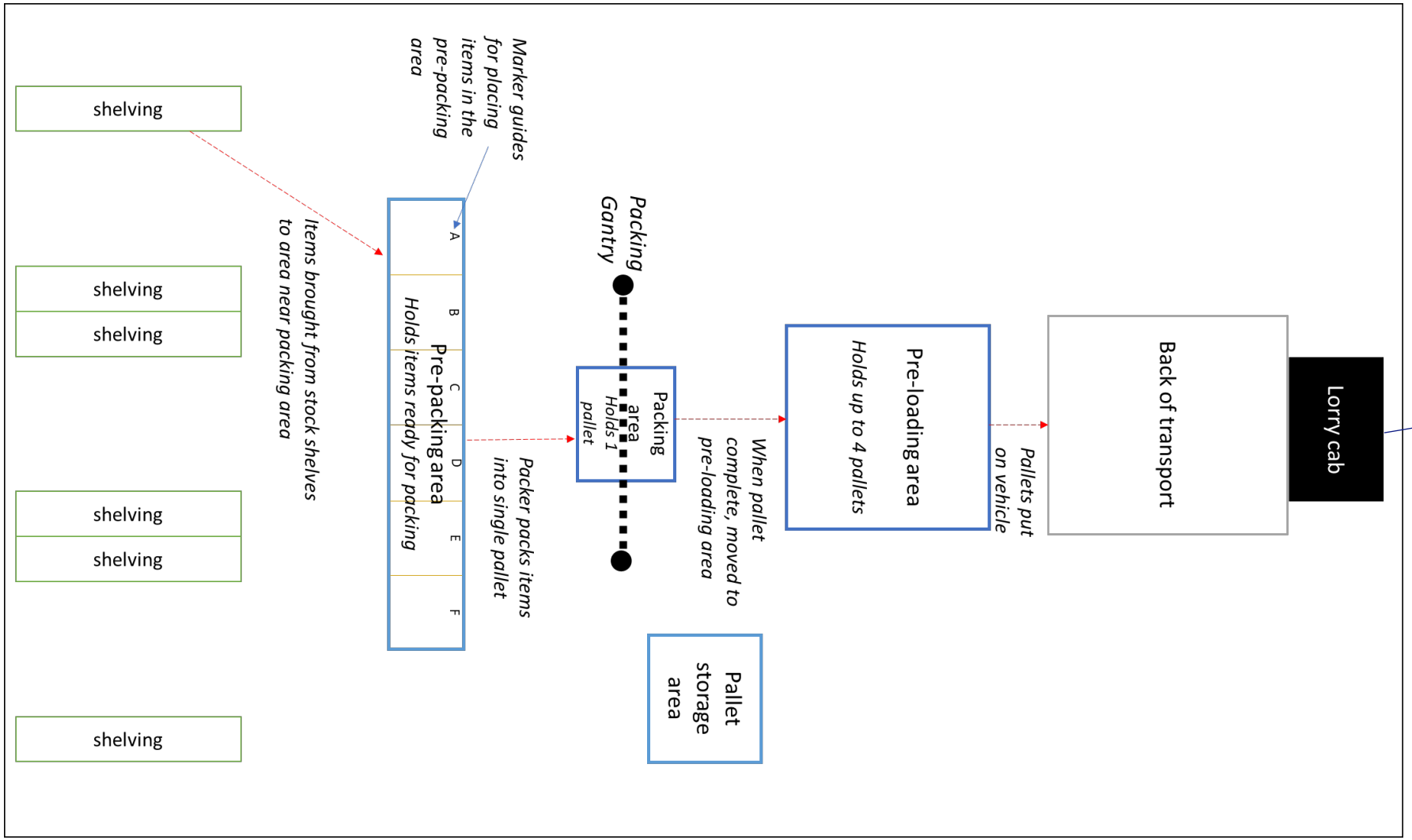
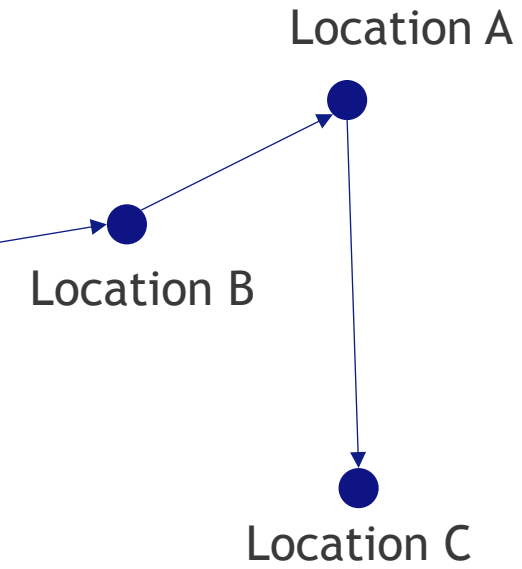
Simulation allows concepts to be tested and evaluated

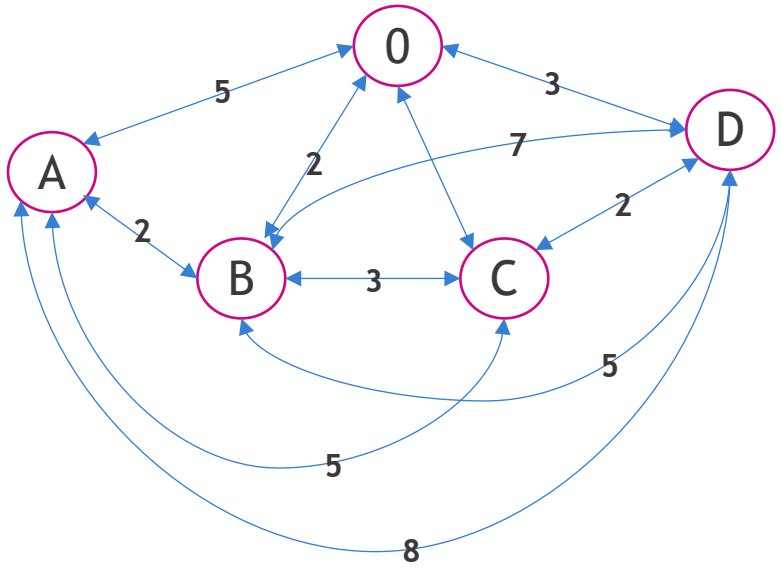
Developed focused on a demonstration event



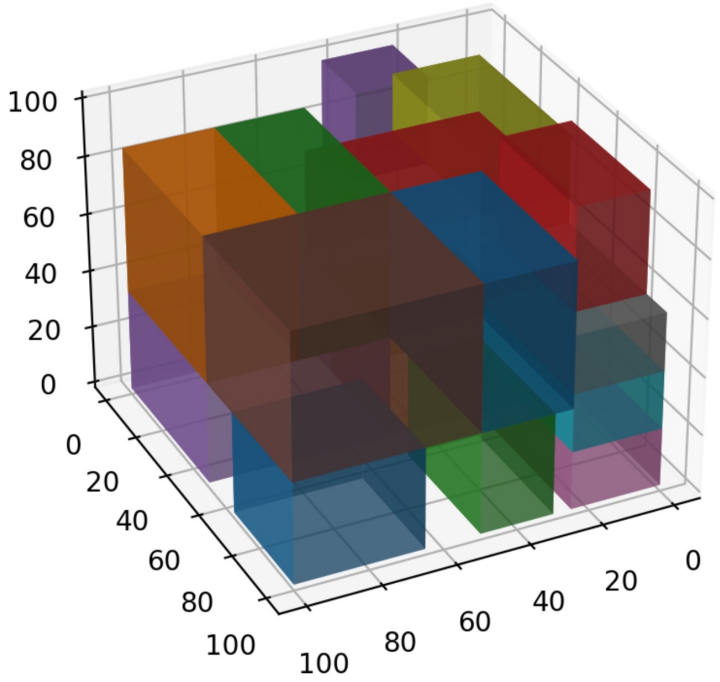


Breaking the problem up

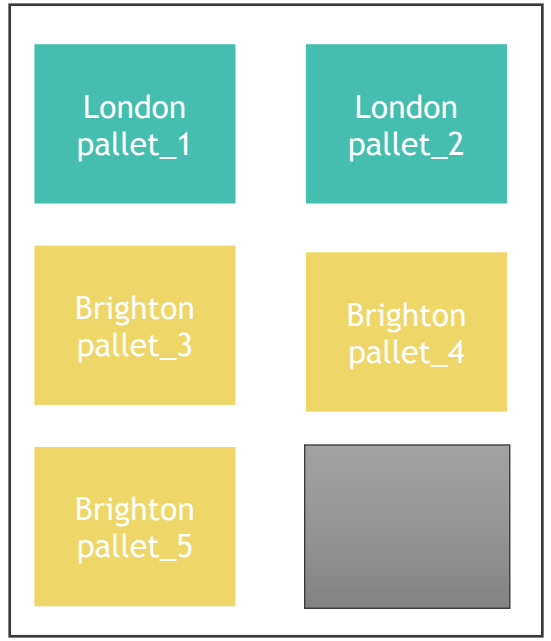
WAREHOUSE ROUTING ALGORITHM



PALLET PACKING ALGORITHM



OPTIMUM TRANSPORT LOADING ALGORITHM



LOGOS Optimisation Engine

WAREHOUSE ROUTING ALGORITHM

Purpose:

Identifies optimal picking routes inside warehouse facility

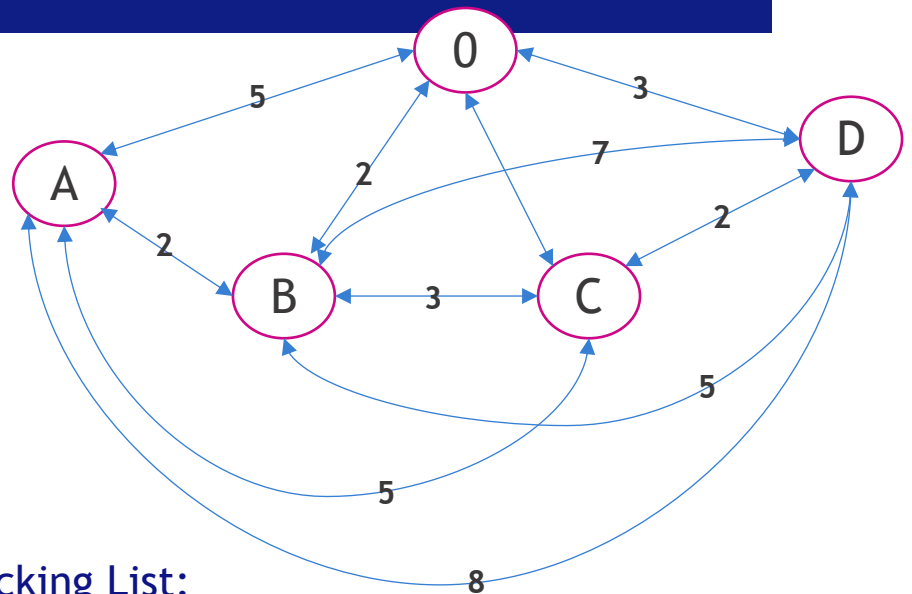
Assumptions:

- Each route starts and ends at the pre-packing area
- Each handler has a maximum capacity

Example:

- Handlers Capacity: 10 kg
- List of boxes:

Box_ID	Weight	Node
box_1	9	A
box_2	2	B
box_3	2	C
box_4	2	D



Results – Picking List:

Route_ID	Box_ID	Order
Route_1	box_4	1
Route_2	box_3	2
Route_3	box_2	3
Route_4	box_1	1

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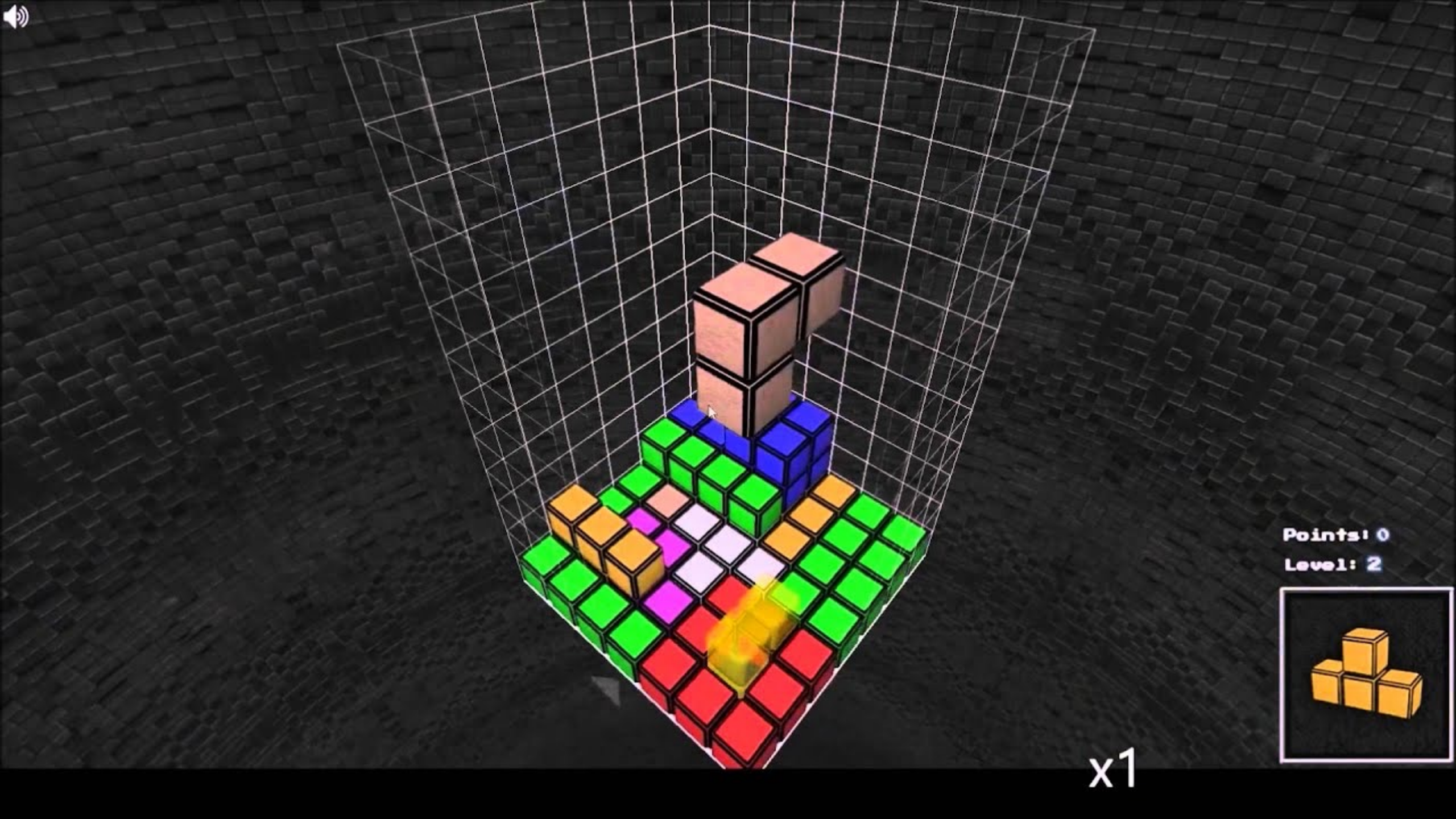

Points: 0
Level: 2
x1

LOGOS Optimisation Engine

PALLET PACKING ALGORITHM

Purpose:

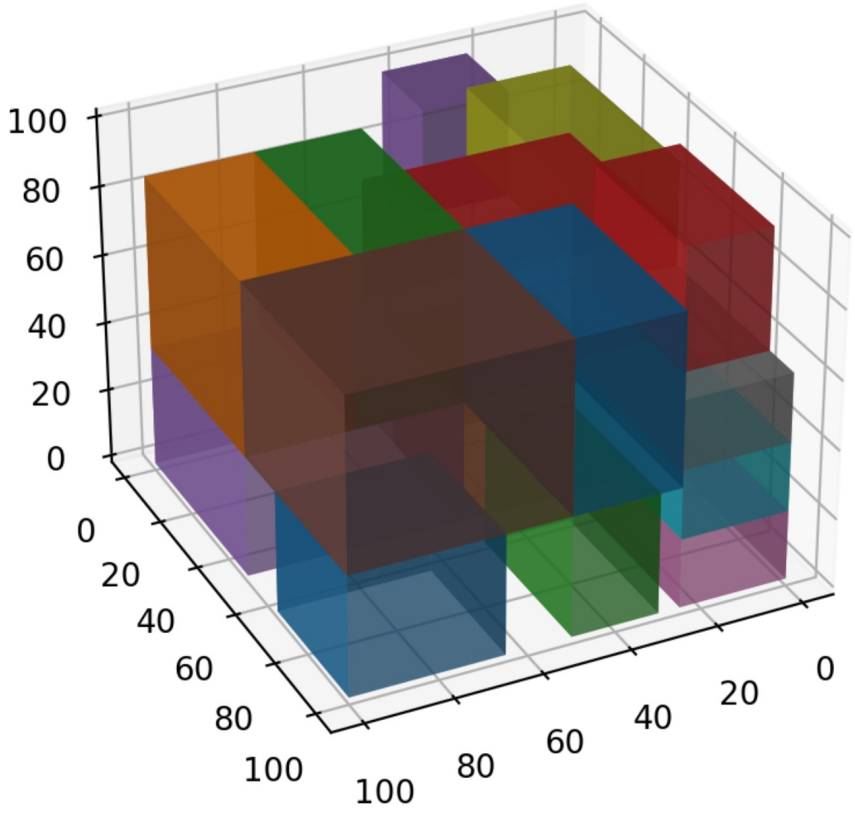
Identify optimum packing of boxes in pallets

Pre-processing step:

1. Groups boxes per final destination
2. Triggers Pallet Packing Algorithm for each destination
3. Bundles sets in one set of output datasets

Example - pallet packing with layering:

- 15 boxes of various shapes and sizes
- No fragility constraint (e.g. all boxes have the same weight)



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LOGOS Optimisation Engine

OPTIMUM LORRY LOADING ALGORITHM

Purpose:

Identifies the optimum “fit” of ready pallets on a truck respecting a LIFO (Last In First Out) policy

Assumptions:

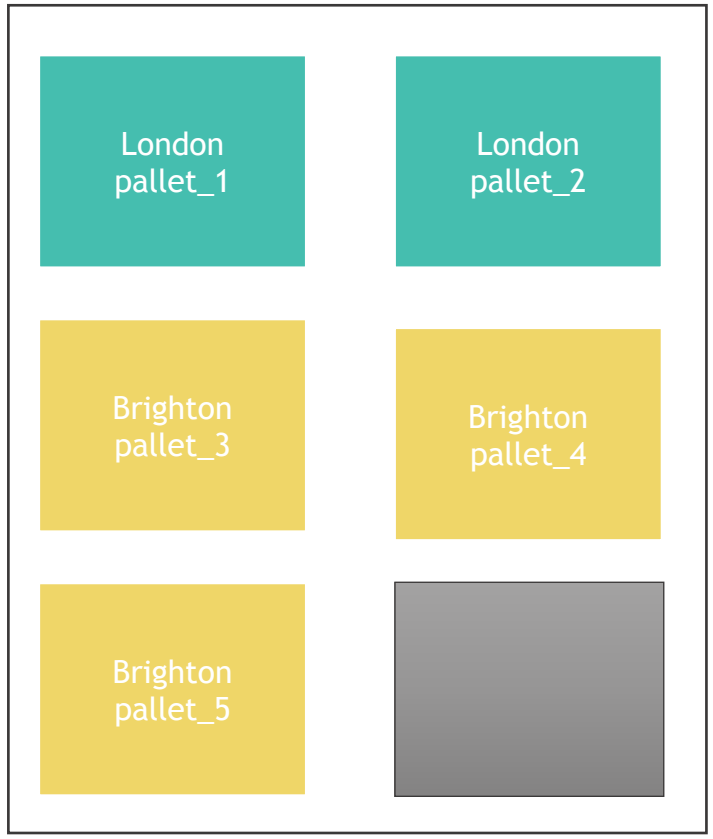
- Uniform size of pallets
- The pallets are not stackable

Example:

- Ready Pallets :

Pallet_id	Destination
Pallet_1	London
Pallet_2	London
Pallet_3	Brighton
Pallet_4	Brighton
Pallet_5	Brighton

- Lorry : Maximum 6 pallets
- Trip : Warehouse – Brighton – London



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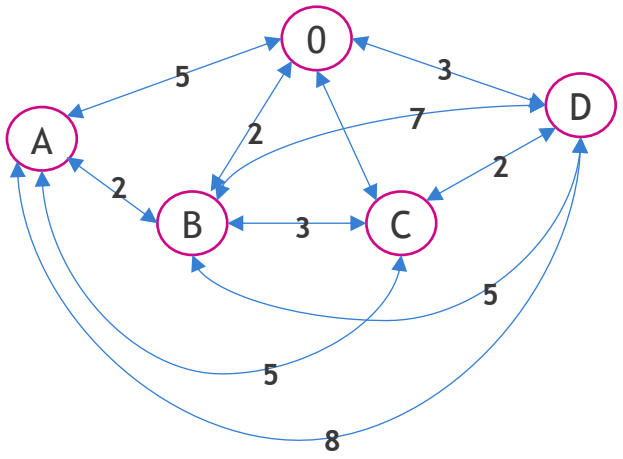
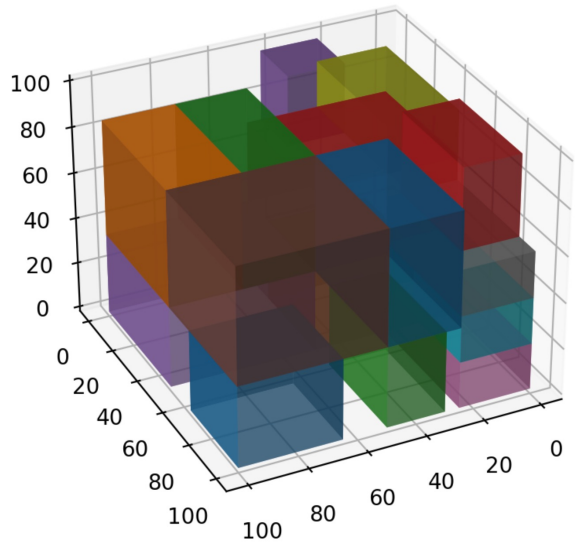
Order of the algorithm

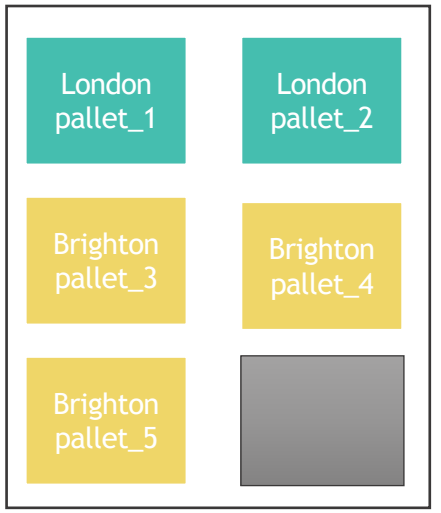
WAREHOUSE ROUTING ALGORITHM



PALLET PACKING ALGORITHM



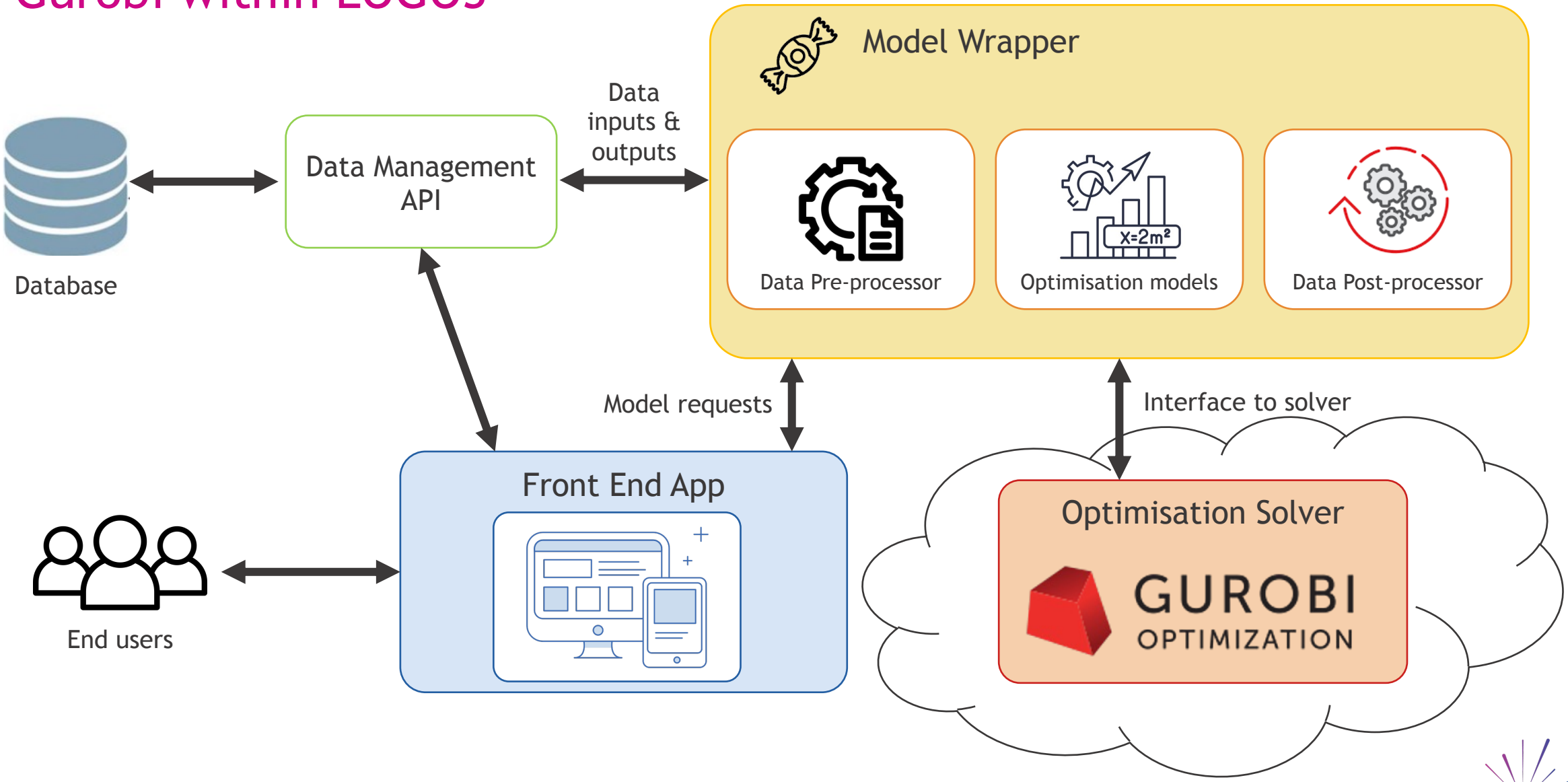
OPTIMUM TRANSPORT LOADING ALGORITHM



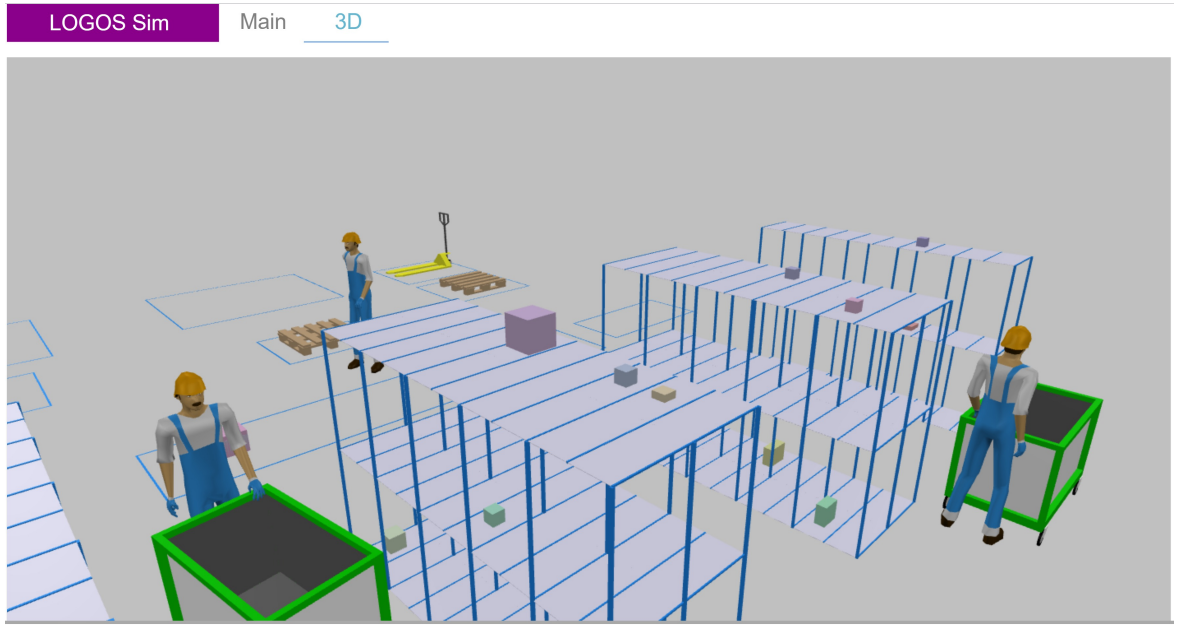
4. Stores routing optimisation

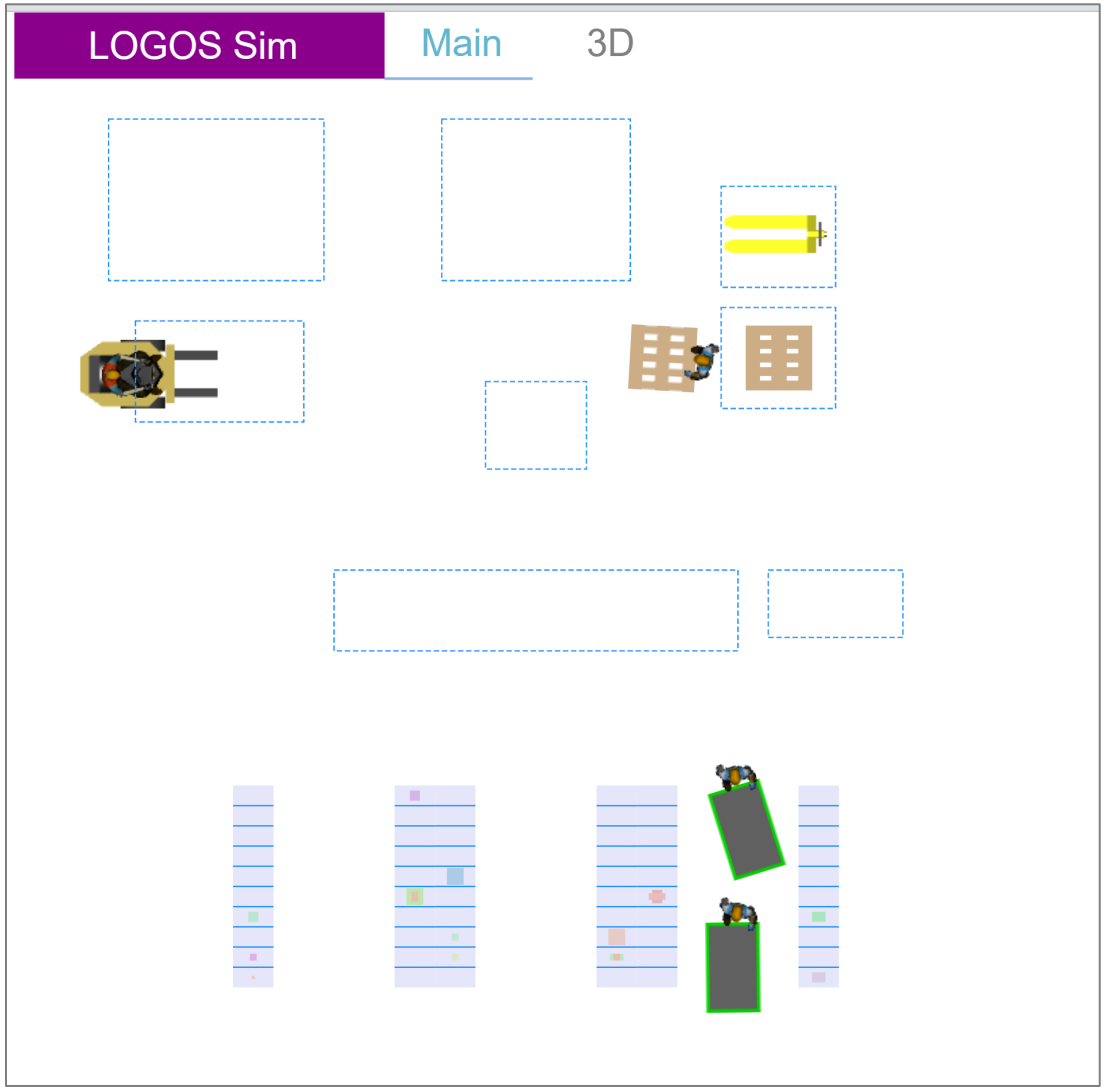
1. Group items per destination → 2. Pallet packing optimisation → 3. Pallet loading optimisation

Gurobi within LOGOS



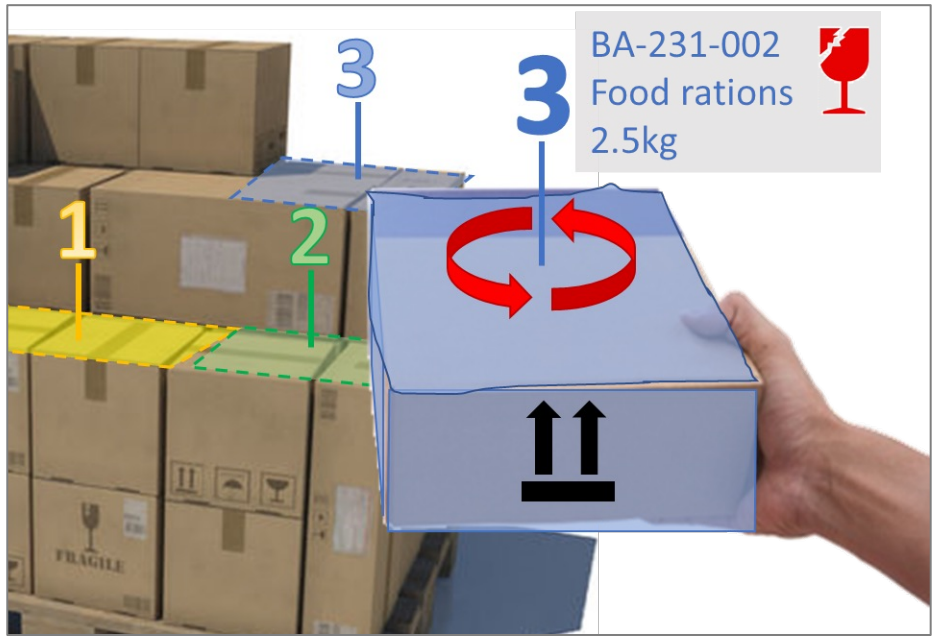
Use of simulation





LOGOS concept of use

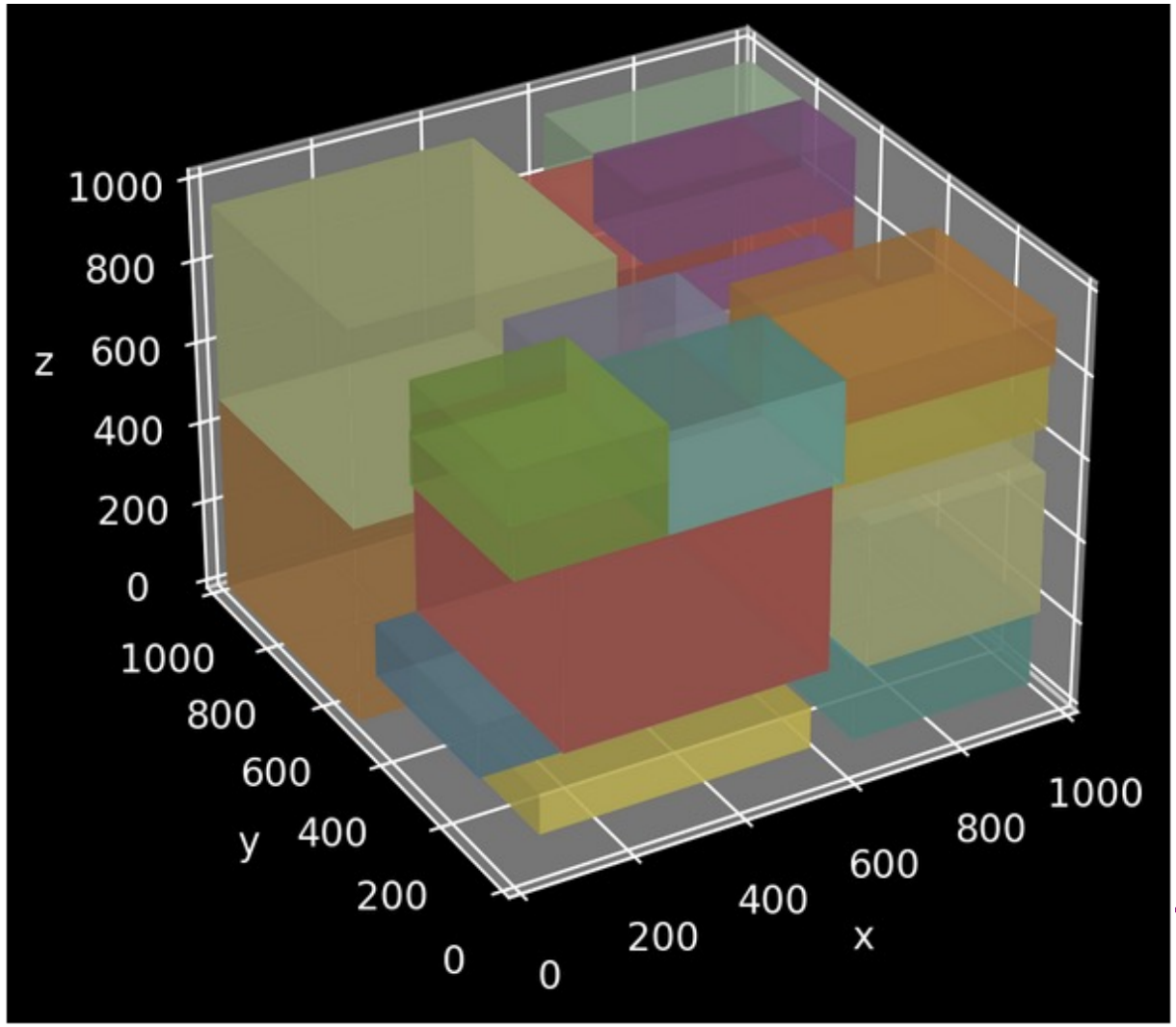
- AR enabled guidance




A
B
C
D
E

Toilet rolls
B423M
Zone B
Tent
L215D
Zone D
Panels
Y824Z
Zone F
Rations C
A570X
Zone B
Pallet: 1 of 1
Layer: 1 of 5
Image Size
Show 3D view
Previous
Next

How did LOGOS perform?



Extensions

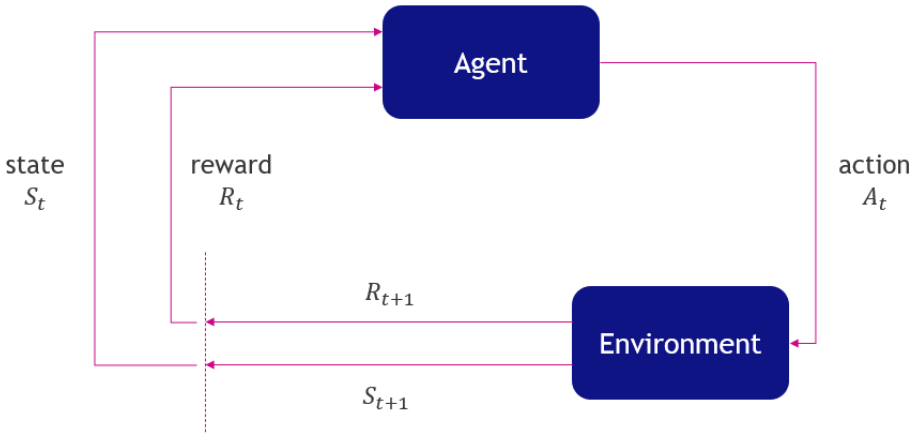
Sustainment

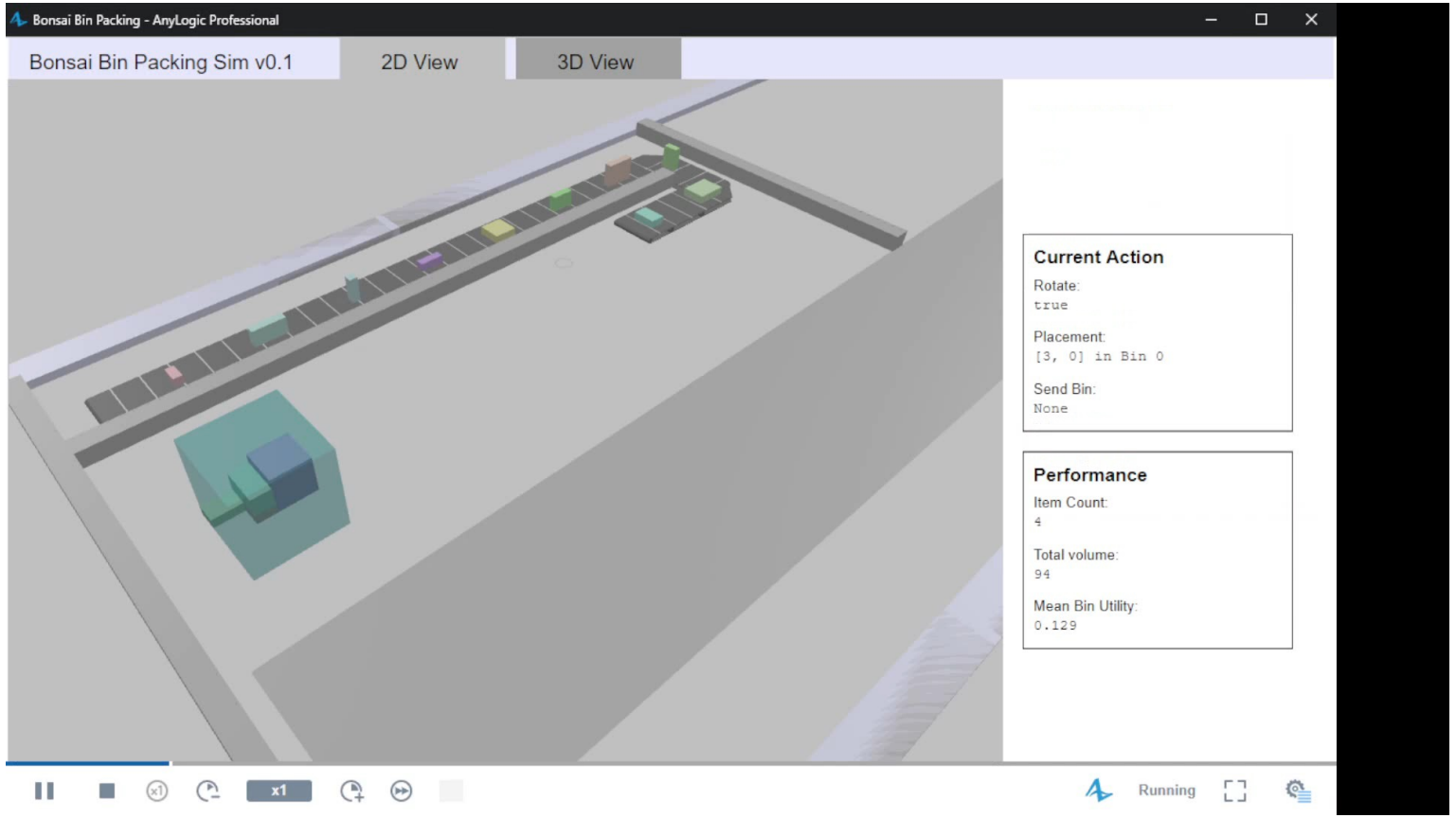
Optimising the logistics to sustain a military force in theatre

Prioritisation

Some items are higher priority than others or delivery is time critical

Reinforcement Learning





Formulating into a single model

$$\min \sum_i \sum_j c_{ij} X_{ij}$$

$$\sum_i X_{ij} = 1, \qquad \forall j$$

$$Y_i \geq \frac{\sum_j X_{ij} D_j}{CAP}, \qquad \forall i$$

$$\sum_j X_{ij} D_j \geq U * CAP * Y_i, \qquad \forall i$$

$$\forall i, j$$

Application

Military

Application

- Non defence

THANK YOU

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