THE INTEGRATED 2D-CVRPTW WITH CARGO LOADING AND BALANCE CONSTRAINTS

Elsa Silva[a], Ana Moura[b], António Ramos[a,c]

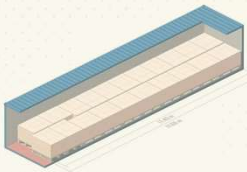
[a] INESC TEC, [b] University of Aveiro, [c] School of Engineering, Polytechnic of Porto

Problem definition

In this 2D-CVRPTW, the goods placed in **pallets are delivered** to the different **clients** in **identical vehicles** while guaranteeing that the **distribution of the weight** of the load plan between the vehicle axles is within the limits determined **by regulatory and technical requirements**.

Constraints related to the routes:

- Each client is visited by one vehicle and only once;
- Depot time windows:
- Clients time windows.

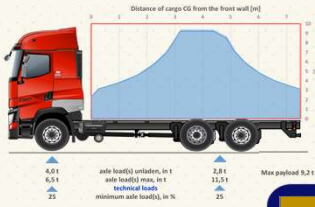


Constraints related to the loading and load balance:

- Pallets can not overlap when loaded in the vehicle;
- The length and width of the vehicle cannot be exceeded;
- The pallets of a given client must be in only one vehicle;
- LIFO strategy for the loading.

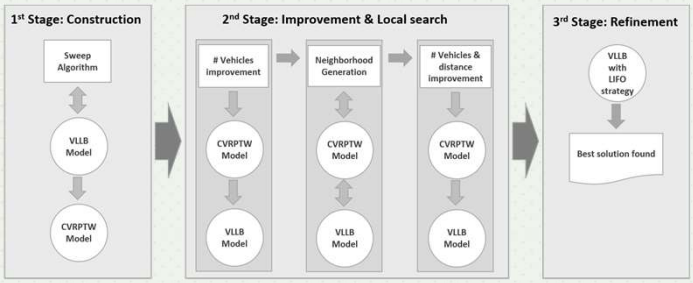
Constraints related to the Load Distribution Diagram (LDD):

- Maximum permissible front axle load;
- Maximum permissible rear axle load;
- Maximum payload;
- Minimum steering axle load;
- Minimum driving axle load;
- Maximum value for the load transfer ratio.



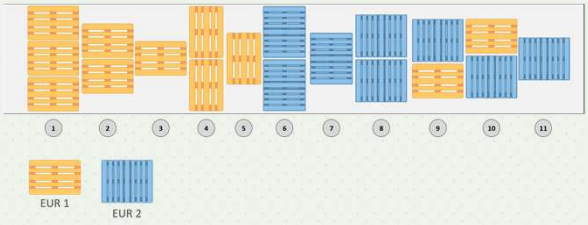
Methodology

3-STAGE LOADING AND ROUTING BALANCE (3S-PRB) MATH-HEURISTIC APPROACH



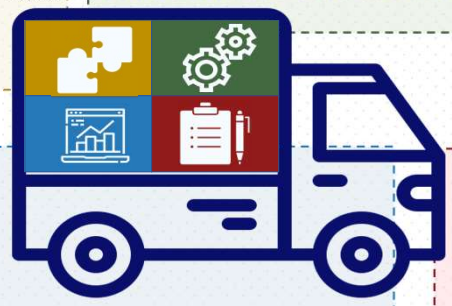
MILP MODEL FOR THE VEHICLE LOADING WITH LOAD BALANCE (VLLB)

- It is possible to enumerate all the different vertical configurations (blocks) that euro pallets EUR1 and EUR2 can have in a vehicle.

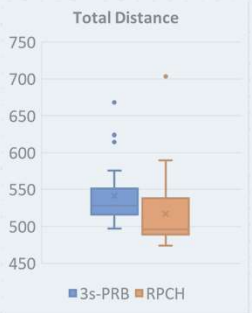


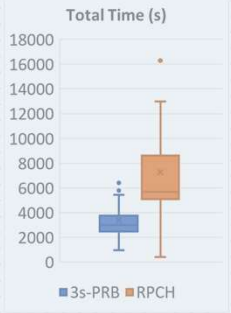
MILP MODEL FOR THE CAPACITATED VEHICLE ROUTING PROBLEM WITH TIME-WINDOWS (CVRPTW)

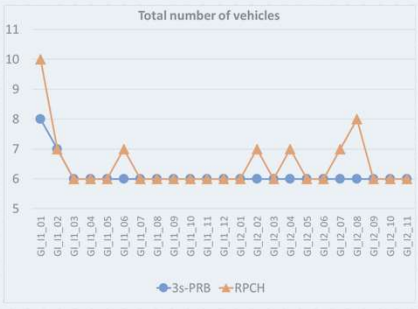
- Decision variables are related with the arcs and the vehicles.



Computational Results







ROUTING AND PACKING COMPOSED HEURISTIC (RPCH)

1. Routes built with the CVRPTW model;
2. For each route the VLLB model is used to load the pallets;
3. Solution admissibility test: if loading is infeasible the CVRPTW model determines new routes.

COMPUTATIONAL EXPERIMENTS

A set of 22 instances from data sets R1 and R2 with 25 clients from Solomon (1987) were extended. Includes:

- Demand in pallets and weight for each client;
- Vehicle parameters.

Intel Xeon Gold 6148 CPU 2.40GHz with 96 GB of RAM with Cplex 12.7.

1 hour time limit for each model (CVRPTW and VLLB).

Outcomes

A Math-heuristic for the integration of the vehicle routing with time windows and a 2D vehicle loading considering cargo load balance constraints was proposed.

A new MILP model for the VLLB taking advantage of the standard dimension of the pallets was proposed.

A problem generator for the 2D-CVRBP with cargo loading and load balance.

Conclusions

In 3S-PRB, priority is given to the loading and then to the routing problem.

Several computational testes were performed, proving the efficiency and quality of the 3S-PRB math-heuristic.

INESCTEC

This work is financed by National Funds through the Portuguese funding agency, FCT - Fundação para a Ciência e a Tecnologia, within project UIDB/50014/2020.

io2021 ANALYTICS FOR A BETTER WORLD

APDIO ASSOCIAÇÃO PORTUGUESA DE INVESTIGAÇÃO OPERACIONAL