Optimization Methods - Assignment 2.1

A Description

In the previous assignments, students implemented and analyzed the One-Dimensional Bin Packing Problem (1D-BPP) using IBM CPLEX. In this assignment, the objective is to investigate the duality theory for the 1D Bin Packing Problem and related models.
This activity aims to help students:

- Formulate the **primal and dual** problems for the 1D Bin Packing Problem and/or related set covering/partitioning models.
- Solve both **primal and dual** problems using an optimization solver (e.g., IBM CPLEX, Gurobi, or PuLP).
- Interpret the **dual variables** and **shadow prices** in the context of the bin packing problem.

B Guidelines

Consider the following task:

- Select or construct a 1D Bin Packing Problem instance (or use a benchmark instance from previous assignments).
- Formulate the **primal** model (e.g., set covering or set partitioning formulation for bin packing).
- Derive and write the **dual** of the chosen formulation.
- Implement and solve both the primal and dual problems using an optimization solver.
- Interpret the **dual variables** and **shadow prices**: what do they represent in the context of bin packing?
- Discuss the implications of **sensitivity analysis**: what happens if the right-hand side of a constraint (e.g., item demand) increases by one unit?
- **(Bonus)** Modify one of the constraints and observe the change in shadow prices. Discuss the implications for decision-making in bin packing or resource allocation.

C Submission Guidelines

Students are required to submit the following deliverables by the specified deadline:

- A comprehensive report in PDF format detailing the formulations, optimal solutions, and analysis of results.
- A zip file containing the code implementation used to solve the primal and dual problems.

The report must include the following:

- The **primal formulation** for the 1D Bin Packing Problem.
- The **dual formulation** for the chosen model.
- The **primal and dual solutions** (values of variables, optimal objective function).
- An explanation of **dual variables, shadow prices, and sensitivity analysis** in the context of bin packing.

Note that the report should be well-structured, clearly written, and properly formatted. The source code should be well-documented and organized for easy understanding. Late submissions will not be accepted.