

Assignment 4: Converting Primal to Dual in Linear Programming using Python

In this assignment, you have to write a Python program that converts a given primal linear programming (LP) problem into its dual form. For your motivation (how this concept is used in ML) please follow the [link1](#), [link2](#).

Linear programming is an optimization technique used to maximize or minimize a linear objective function subject to linear constraints. The primal problem is formulated as:

maximize $c^T x$

subject to $Ax \leq b, x \geq 0$

where:

- c is a vector of coefficients of the objective function
- x is a vector of decision variables
- A is a matrix of coefficients of the constraints.
- b is a vector of the right-hand side values of the constraints
- The dual problem of this primal problem is formulated as:

minimize $b^T y$

subject to $A^T y \geq c, y \geq 0$

where:

- y is a vector of coefficients of the constraints in the primal problem

Your task is to write a Python function that takes the coefficients of the primal problem (c, A, b) as input and returns the coefficients of the dual problem (b, A^T, c). you also have to handle for any equality constraints (using slack variable).

Here are some hints to follow (Optional):

1. Define the number of decision variables and constraints in the primal problem and dual problem.
2. Define the coefficient matrix **A_dual** for the dual problem as the transpose of the coefficient matrix **A** for the primal problem.
3. Define the objective coefficient vector **c_dual** for the dual problem as the list of constants on the right-hand side of each primal constraint.
4. Define the right-hand side vector **b_dual** for the dual problem as the list of coefficients of the decision variables in the primal objective function.
5. Determine the variable types for the dual problem. (non-negative or unrestricted).

Rules and guidance:

1. Please submit the assignment before time.
2. Any kind of plagiarism is strictly prohibited.
3. If your code is detected by and AI detector, you'll be called for the viva.
4. Students are requested to follow [PEP 8 – Style Guide for Python](#).

Best wishes for the assignment.