Learning Branch and Bound strong branching scores via supervised learning

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***Abstract*—Abstract**

I. Introduction

The goal of Operational Research is to obtain the optimal solution to a problem by determining the minimum or maximum of a real-valued function (known as *objective function*), while ensuring that certain constraints are satisfied. This can be achieved by adjusting the value of unknown quantities termed *decision variables.*

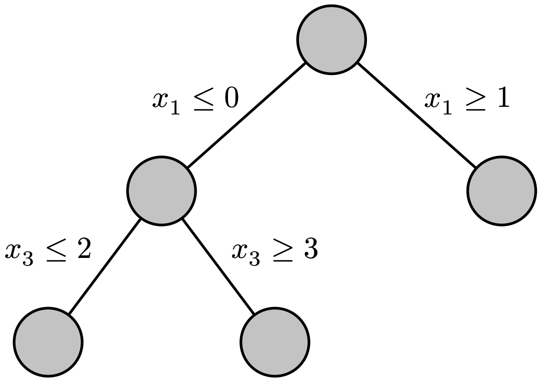
The present project exclusively focuses on problems with linear objective functions and constraints; these fall into three main categories based on the nature of their decision variables:

- Linear Programming (LP) problems: all variables can take real values;
- Integer Linear Programming (ILP) problems: all variables are integer or binary;
- Mixed Integer Linear Programming (MILP) problems: some (not necessarily all) variables can take real values.

ILP and MILP problems are inherently harder to solve than LP problems because their set of feasible solutions (the so-called *feasible region*) is non-convex[1]; the Branch and Bound (B&B) algorithm is a commonly employed in these cases. This method constructs an *optimization tree* where each node represents a subproblem derived by adding an integrality constraint on a specific variable. For every node, the LP relaxation[2] is solved to yield an optimistic estimate of the optimal objective value within its corresponding subtree.

[1]When integrality constraints are introduced, the feasible region of the problem becomes a non-convex set of isolated points, hence it's not possible to move smoothly from one feasible integer solution to another, as would instead be possible for continuous regions. For this reason, algorithms such as the Simplex method cannot be applied.

[2]The LP relaxation is a modified version of a problem where the integrality constraints on some or all variables are removed, allowing them to take on continuous (fractional) values.



References