Adaptive randomized rounding in the big parsimony problem

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A phylogenetic tree is a binary tree where each node represents a sequence of the states and all the input sequences are represented at the leaf nodes. Given sequences of the states of the same length, the big parsimony problem constructs the most parsimonious phylogenetic tree along with labeling the internal nodes at the maximum parsimony. The big parsimony problem is known to be NP-hard. We describe randomized rounding methods that allow us to obtain good solutions.

Our first randomized rounding method starts with a fractional optimal solution to the LP-relaxation of an integer linear programming formulation of the big parsimony problem, and repeats randomized rounding based on this fractional solution, which we refer to as fixed randomized rounding without changing the fractional solution. Solutions obtained using the fixed randomized rounding approach are superior to the best solutions obtained using branch-and-bound with GUROBI and can be obtained quicker.

We then describe an adaptive randomized rounding approach where the underlying fractional solution changes based on the best integer solution observed so far and produces solutions that are superior to the fixed randomized rounding approach.