

Advanced Forest Planning

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Assignment 6 – Tabu Search

The most difficult part of Tabu Search has been in properly initializing the harvest schedule such that it is feasible. An initial attempt was to simply use the output of the mixed integer program which was written at the beginning of the semester, however this solution was already very nearly optimal and so Tabu Search did not improve upon it at all. The result of this run can be found in Appendix I, and the MIP schedule will be attached to the submission.

The second attempt at initialization was to use the function I wrote for the Simulated Annealing assignment, which simply randomly initializes a feasible schedule. At which point objective values were returned which roughly corresponded to those shown in the lecture slides, squared deviations around 2,000,000. These will be found in Appendix II. At this point the “cycling” was beginning to become apparent, so I decided that it would be necessary to implement search reversion.

Once reversion had been implemented, and with additional parameter tuning, the objective function value was more than cut in half to 876,000, these results and the parameters for the search used will be included in Appendix III. Interestingly, in this run 62% (546,121) of the squared deviations were from period 8 alone. I’m not too sure why this was the case.

At the conclusion of this assignment, I was left curious about parameter optimization. It seems now we have been given many different tools and heuristics to work with, including their improvements like reversion and 2-opt moves. Yet, I am still more or less guessing as to what values I should be using for each of these different parameters: max_iterations, neighborhood_size, tabu_state, reversion_threshold, etc. I think in the next few weeks I would like to explore optimization over the parameters themselves. Including adaptive methods which adjust their own parameters on the fly, Bayesian optimization, and even genetic algorithms for parameter optimization.

Appendix I. (Tabu Search with Initial MIP Solution)

Volume Harvested by Period:

Period 1: 11744.00 cubic feet, Squared Deviation: 529.00

Period 2: 11712.00 cubic feet, Squared Deviation: 81.00

Period 3: 11696.00 cubic feet, Squared Deviation: 625.00

Period 4: 11732.00 cubic feet, Squared Deviation: 121.00

Period 5: 11724.00 cubic feet, Squared Deviation: 9.00

Period 6: 11720.00 cubic feet, Squared Deviation: 1.00

Period 7: 11724.00 cubic feet, Squared Deviation: 9.00

Period 8: 11720.00 cubic feet, Squared Deviation: 1.00

Harvest Schedule:

Period 1: Stands 13, 19, 37, 39, 44, 51, 81, 84, 92, 95, 100, 104, 107, 109

Period 2: Stands 11, 25, 33, 38, 45, 46, 48, 56, 67, 75, 113

Period 3: Stands 14, 22, 27, 43, 50, 57, 68, 69, 111

Period 4: Stands 2, 10, 31, 32, 42, 60, 71, 72, 78, 87, 96

Period 5: Stands 6, 29, 55, 65, 74, 82, 93, 102, 106, 108

Period 6: Stands 1, 5, 36, 40, 49, 53, 63, 94, 99, 105, 112

Period 7: Stands 9, 12, 17, 20, 30, 54, 64, 77, 86, 88, 90, 101

Period 8: Stands 3, 16, 21, 26, 28, 41, 58, 59, 83, 114

Sum of squared deviations: 1376.0

Constraint Violations: []

Appendix II. (Tabu Search with Random Initialization)

Volume Harvested by Period:

Period 1: 11176.00 cubic feet, Squared Deviation: 297025.00

Period 2: 12108.00 cubic feet, Squared Deviation: 149769.00

Period 3: 12100.00 cubic feet, Squared Deviation: 143641.00

Period 4: 11856.00 cubic feet, Squared Deviation: 18225.00

Period 5: 11800.00 cubic feet, Squared Deviation: 6241.00

Period 6: 11888.00 cubic feet, Squared Deviation: 27889.00

Period 7: 12584.00 cubic feet, Squared Deviation: 744769.00

Period 8: 12076.00 cubic feet, Squared Deviation: 126025.00

Harvest Schedule:

Period 1: Stands 48, 46, 62, 72, 37, 42, 39, 112, 19, 33, 11, 95, 45, 68, 102

Period 2: Stands 70, 81, 113, 4, 2, 89, 76, 43, 67, 99, 13, 49, 55
Period 3: Stands 60, 69, 44, 74, 38, 28, 31, 57, 73, 52, 111
Period 4: Stands 84, 104, 56, 54, 82, 65, 87, 71, 27, 78, 32, 24
Period 5: Stands 107, 10, 50, 103, 93, 97, 101, 5, 96, 91, 35, 64, 63, 53, 29, 8
Period 6: Stands 108, 22, 75, 98, 3, 26, 77, 30, 105, 79, 47, 36
Period 7: Stands 14, 92, 25, 51, 90, 58, 66
Period 8: Stands 61, 83, 23, 18, 109, 100, 106, 34
Error: 1513584.0
Constraint Violations: []

Appendix III. (Tabu Search with Random Feasible Initialization & Search Reversion)

Period 1: 11420.00 cubic feet, Squared Deviation: 90601.00
Period 2: 11516.00 cubic feet, Squared Deviation: 42025.00
Period 3: 11924.00 cubic feet, Squared Deviation: 41209.00
Period 4: 11864.00 cubic feet, Squared Deviation: 20449.00
Period 5: 11596.00 cubic feet, Squared Deviation: 15625.00
Period 6: 12000.00 cubic feet, Squared Deviation: 77841.00
Period 7: 11928.00 cubic feet, Squared Deviation: 42849.00
Period 8: 12460.00 cubic feet, Squared Deviation: 546121.00

Harvest Schedule:

Period 1: Stands 14, 95, 4, 46, 67, 39, 43, 55, 37, 84, 109, 107, 113, 111, 50
Period 2: Stands 92, 108, 11, 49, 89, 75, 81, 2, 28, 62, 102, 52
Period 3: Stands 19, 72, 44, 54, 13, 57, 38, 103, 106, 27, 99, 76, 87
Period 4: Stands 69, 10, 42, 32, 82, 65, 73, 78, 96, 94, 71, 24, 45, 31
Period 5: Stands 22, 25, 70, 100, 35, 110, 40, 41, 93, 36
Period 6: Stands 60, 48, 74, 86, 114, 3, 47, 9, 12, 83, 5, 53
Period 7: Stands 58, 112, 33, 1, 20, 88, 66, 23, 85, 105, 26, 64, 7
Period 8: Stands 68, 104, 56, 51, 18, 34

Error: 876720.0

Constraint Violations: []

Parameters used:

TABU_STATE = 100
MAX_ITER = 25000

NEIGHBORHOOD_SIZE = 200
REVERSION_THRESHOLD = 1000