KENNESAW STATE UNIVERSITY

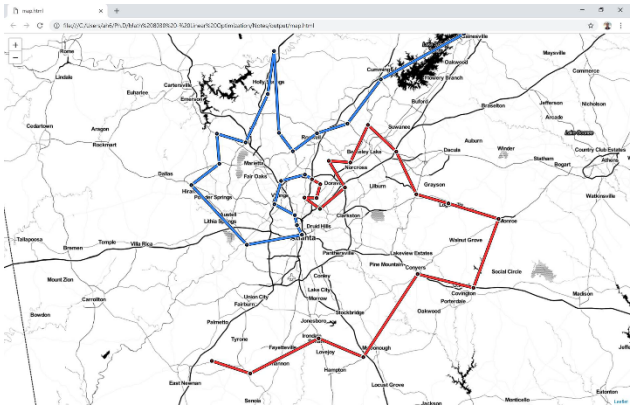
Analytics and Data Science Institute

datascience.kennesaw.edu

Data Science Research Series

Data Doing Good: Optimizing Travel Routes to Raise Money for Bert's Big Adventure

Genetic Algorithm Guidance of a Constraint Programming Solver for *m*TSP



BACKGROUND

In this project, we developed a two-phase approach to the Multiple Traveling Salesman Problem (*m*TSP) that pairs a custom genetic algorithm (GA) with a combinatorial optimization solver. This combined approach was used to build an optimal route for two popular radio show hosts to visit each of the 37 Atlanta area Jersey Mike's on the restaurant's "Day of Giving" to raise money for the show's charity, Bert's Big Adventure.

The objective of the *m*TSP is to assign a tour of disjoint city sets to each of *m* salesman such that the maximum of the travel times for each salesman is minimized. In our program, the GA determines the assignment of cities to each radio host, while the combinatorial solver generates an optimal TSP route for each assignment. The maximum time for each single-TSP solution provides the cost function for the GA. The genetic algorithm provides an efficient search of the solution space and we show that this metaheuristic approach provides significant performance benefits over the use of the constrained combinatorial optimization solver alone.

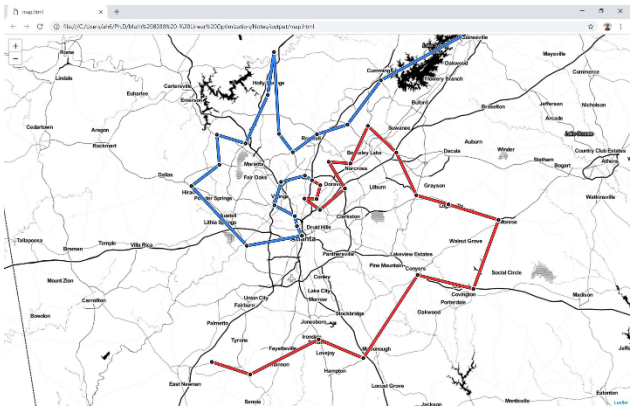
APPROACH

The genetic algorithm used a population of 20 potential solutions (individuals), each initialized with a random genome of 37 binary digits representing the 37 stops and 2 routes required for this specific problem. The fitness function was evaluated by mapping the genome into two waypoint lists, which were individually processed by the combinatorial solver for separate optimum routes. The longer of the two trip times was used as the fitness score for each individual genome. A new population was produced by selecting the four

fittest individuals and performing dual-point crossover replication using various combinations of those four genomes. The process was repeated until the rate of improvement dropped to zero.

RESULTS

The method developed in this project produced a good solution in 900 generations (15 minutes of run time) whereas a brute force method would have had to examine $1.38X10^{43}$ combinations. Figure 1 shows that the optimal path generated by the genetic algorithm seems to be logical, dividing the locations into groups of 18 and 19.



With a budget of 10 minutes to spend at each location, we estimated the time to complete Radio Host 1 route (19 locations) would be 8 hours and 51 minutes, and Radio Host 2 route (18 locations) would be 8 hours and 33 minutes. With most Jersey Mike's opening at 10 AM and closing at 9 PM, these solutions provided enough time to complete the routes. On March 28th, 2018 these two routes were successfully completed ahead of schedule.

Predicted and Actual Route Times

	Stops	Predicted Time	Actual Time
Radio Host 1	19	8hr51m	8hr15m
Radio Host 2	18	8hr33m	7hr22m

CONCLUSIONS

The multiple traveling salesman class of problems are applicable to a variety of industries and functions. However, exact solutions become computationally expensive when the network size increases. In conclusion, our combined approach produced a solution that was successfully validated in a real-world application. The two radio show hosts visited each location within their predicted time and, along with Jersey Mike's, raised a record $165,557 for their charity organization.