INTRODUCTION

The Bert Show is a popular morning show on Atlanta’s Q100 radio station. They host a non-profit organization that provides a “magical, all-expenses-paid, five-day journey to Walt Disney World for children with chronic and terminal illnesses and their families” called “Bert’s Big Adventure.” On March 28th, 2018, thirty-seven locations of Jersey Mike’s participated in their Jersey Mike’s Day of Giving where 100% of sales in metro Atlanta go to support Bert’s Big Adventure. The goal was to have two popular radio show hosts Bert and Kristen visit each of these 37 locations for some photos and presence to draw in more customers! How do we optimally determine how to divide the locations into two sets, one for each radio host? And, how do we get each host through Atlanta traffic to visit their respective locations as fast as possible?

We developed a combined approach (which we refer to here as CA) to the Multiple Traveling Salesman Problem (mTSP) that pairs a custom genetic algorithm (GA) with Google’s combinatorial optimization solver. The objective of the mTSP is to assign a tour of disjoint city sets to each of m salesmen 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.

METHODS

Initially, the team attempted to separate the locations into two groups by clustering the observations by latitude and longitude. While the Euclidean distance (“as the crow flies”) does not represent the actual distance between locations traveled by car, we thought that this would still produce a decent approximation. It did not. Thus we needed to examine driving times. The first step was to use the Google Maps API to get the average drive time between each pair of locations (totaling 666 pairs of locations with a drive time between them). We modeled this information as a graph. Vertices represent the 37 locations. The weight of an edge represents the average travel time between the respective locations. Our goal is to find a disjoint paths with a similar number of vertices and a minimum sum of edge weights that visit all locations.

Can we brute force check all possibilities?

No we can’t. There are \( \binom{37}{2} \times 1.38 \times 10^{33} \) (138 tredecillion) different ways to split and visit the metro Atlanta Jersey Mike’s Subs locations. Instead, we used our CA to minimize the total drive time for each of the two paths.

Figure 2 shows the workflow of our CA. GAs have useful qualities for our project—because of the fitness measure, the crossover and introduction of mutations—We explore the whole space for a global optimum instead of getting stuck in a local optimum.

RESULTS

Our CA method produced the best solution in only 900 generations (15 minutes of run time). The solution we found (see Figure 1) divided the locations into groups of 19 and 18 locations. With a budget of 10 minutes to spend at each location, we estimated the completion time for Bert’s route (19 locations) to be 8 hrs and 51 mins, and Kristin’s route (18 locations) to be 8 hrs and 33 minutes. With most Jersey Mike’s opening at 10 AM and closing at 9 PM, these solutions more than suffice with plenty of time to spare. The team provided the color-coded mapped routes in Figure 1 to the Radio Show as a deliveryable.

These CA estimates were better than both the intuitive splits (e.g. “as the crow flies”, along I-75, inner/outer perimeter, etc.) as well as those found by Google’s combinatorial optimization solver alone.

On March 28th, these two routes were completed ahead of schedule. The weather favored faster driving and a relatively low number of traffic incidents led to better-than-average traffic flows.

CONCLUSION

In conclusion, our CA-produced solution with average drive times from the Google Maps API produced a real-world-validated successful result. Radio show hosts Bert and Kristen visited each location well-within their predicted time, and along with Jersey Mike’s raised a record $165,557 for these kids!

 SOURCES

2. DEAP: [https://github.com/DEAP/deap](https://github.com/DEAP/deap)