**Technical Document**

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**I. Class Structure**

- classes

**II. The Genetic Algorithm**

We begin by reading in data from the file specified by the global variable FILE\_NAME. We then randomly created NUM\_ROUTE parent routes. This serves as the initial population. This initial population is sorted and the best solution is printed. Then, each successive generation is created by taking 50% of the best routes and combining them to get new routes that fill up the remaining 50% of the population. We use a merge sort to determine the best solutions.

For the sorting of our parents, we use a merge sort due to its efficiency and its ability to be parallelized. To start our project, we used a bubble sort. With 1000 parents the bubble sort version ran in approximately 13 hours. With the implementation of a merge sort in serial, our run time was reduced to approximately 57 minutes.

The crossover function that is used to generate the new solutions is based on the Edge Recombination Algorithm. This algorithm works by merging two routes into a new route that mostly consists of connections that existed in either of the parents. This algorithm also has an element of randomness in it, which can cause mutations through a few different methods. The algorithm works by taking a union of both parent’s adjacency matrices. This adjacency matrix represents any possibly connection that can be followed from one city to another in either of the parent routes. The route is then created by selecting the next city to travel to by valuing cities that have the least amount of connections over cities with more connections. If there is ever a point where there are no more possible connections within the parents that haven’t been used already for the current city then the next city is picked randomly from the remaining destinations that have not been travelled to – this is a mutation. Mutations are pretty rare, but do occur.

Each successive generation would once again have the top 50% best routes taken so that the best of the previous generation are not lost by creating the children. Whenever there is no improvement in the best solution from one generation to another generation we increment a counter. When the counter reaches NUM\_GENERATION\_STOPPER the program stops running and the current best solution is chosen.

**III. Parallel**

One of the areas of our code that is parallelized is the merge sort. If the global variable NUM\_THREADS is greater than one the merge sort will run in parallel. We set the OMP setting omp\_nested to true to allow for nested parallelism. Then, using parallel OMP sections, we divide the recursive merge sort calls up among NUM\_THREADS.