



Bee Colony Optimization for Traveling Salesperson Problem: finding optimal tour route to explore New Orleans



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ABSTRACT

Tourism is an integral part of the economy of New Orleans. Touring companies, in particular, provide tourists of this wonderful city with enjoyment and stimulate the economy by exploring restaurants, historical landmarks, and other points of interest. Touring companies, however, rely on having their routes be optimized to achieve these goals in a timely and efficient manner. Using Google Maps to compute point-to-point distances, various preexisting tour routes are evaluated as a Traveling Salesperson Problem (TSP) to be better optimized using Bee Colony Optimization (BCO) algorithms. This investigation is to utilize a BCO algorithm that solves the TSP to find an optimal path for commercial touring by bus or by walking.

OBJECTIVES

Take the 19 points-of-interest used by the touring company and..

- Find a locally optimal solution
- Use the Bee Colony Optimization Algorithm to find an optimal route for tours
- Use the Bee Colony Optimization Algorithm to find an optimal walking route.

TRAVELING SALESMAN PROBLEM AND BEE COLONY OPTIMIZATION ALGORITHM

$$C(\pi) = \sum_{i=1}^{n-1} d_{\pi(i),\pi(i+1)} + d_{\pi(n),\pi(1)},$$

where $C(\pi)$ is the cost equation, $d_{i,j}$ is the distance between city i and city j , $i, j = 1, 2, \dots, n$, $\pi(i)$ is the i th city in π .

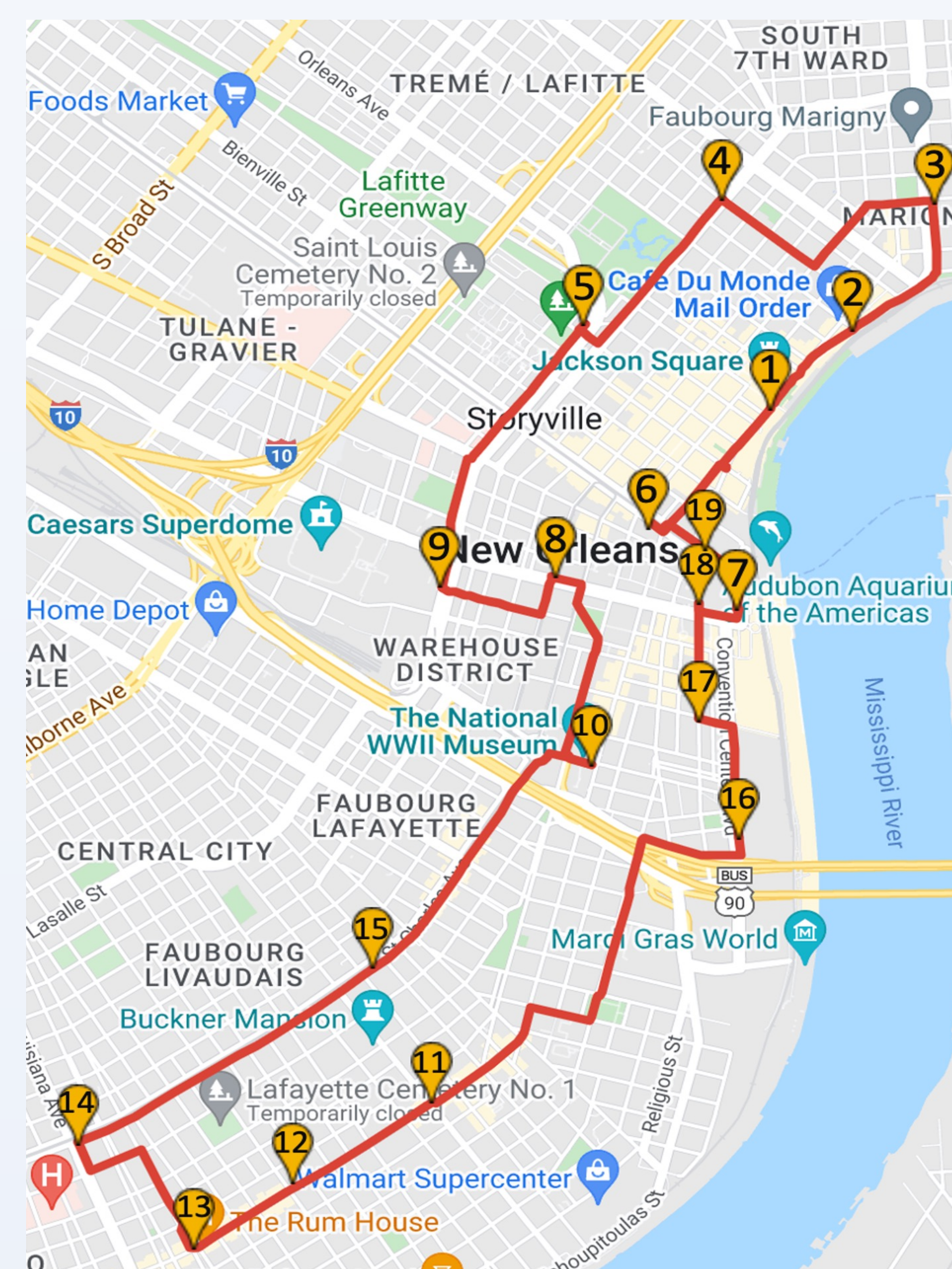
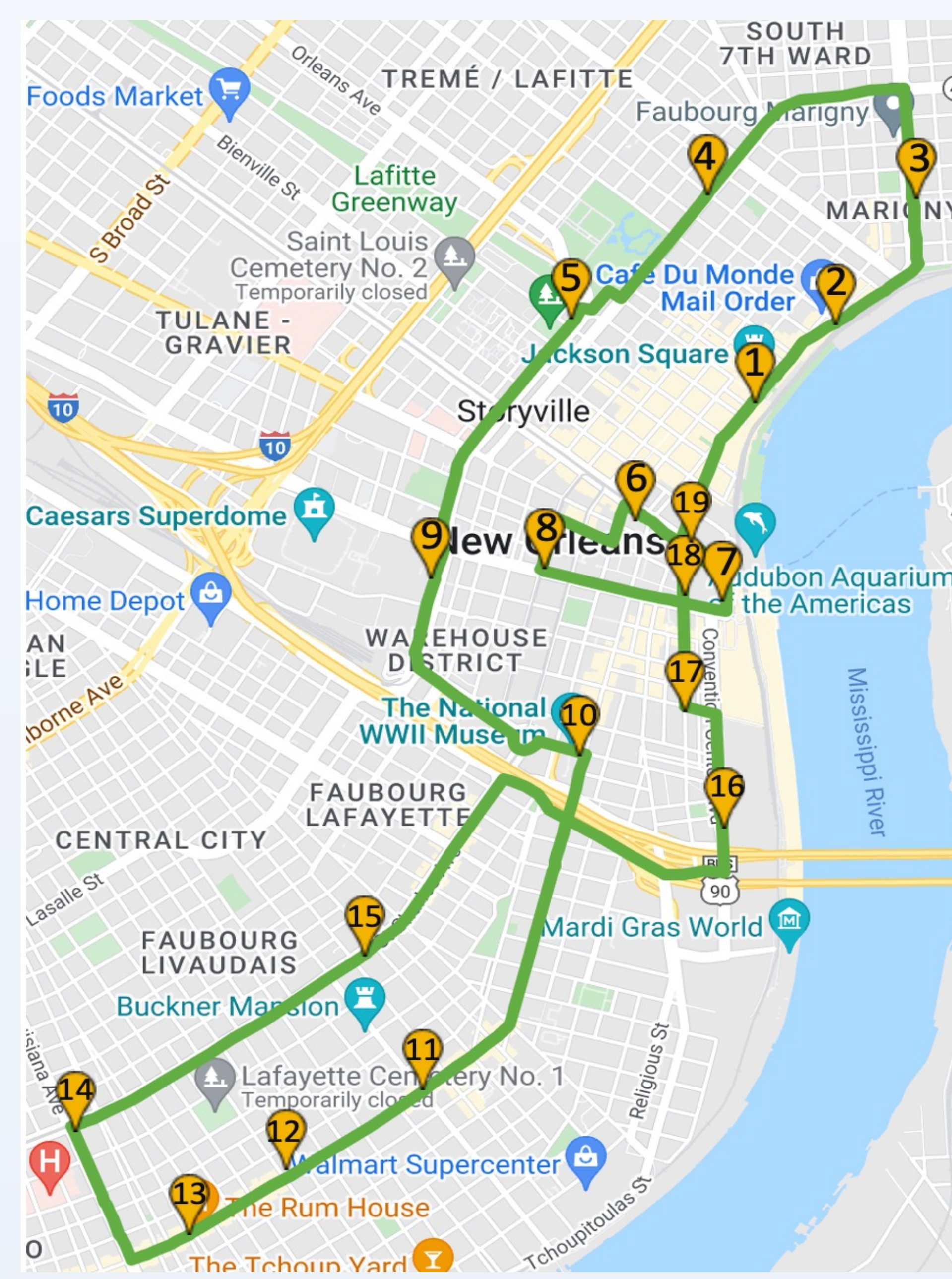
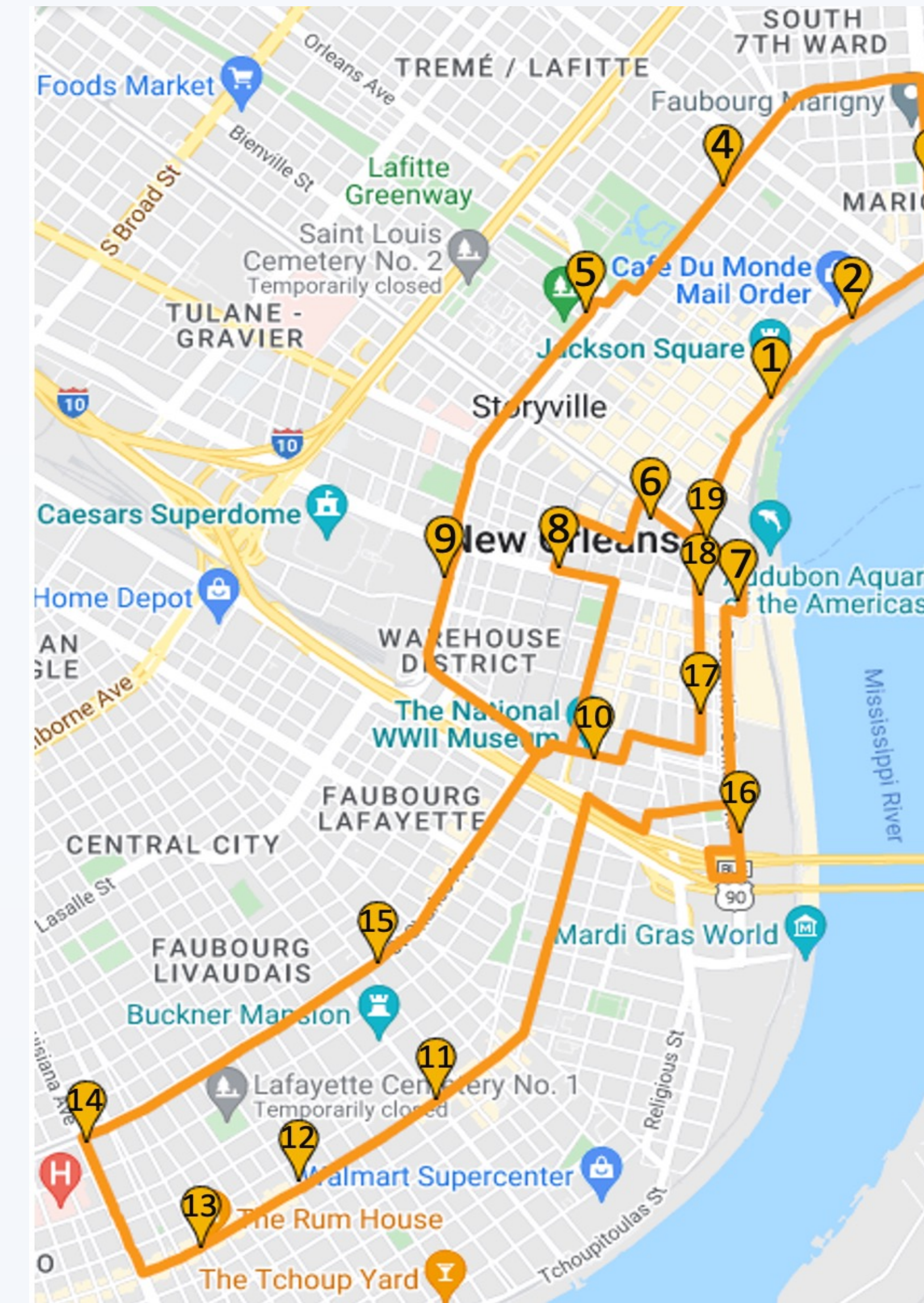
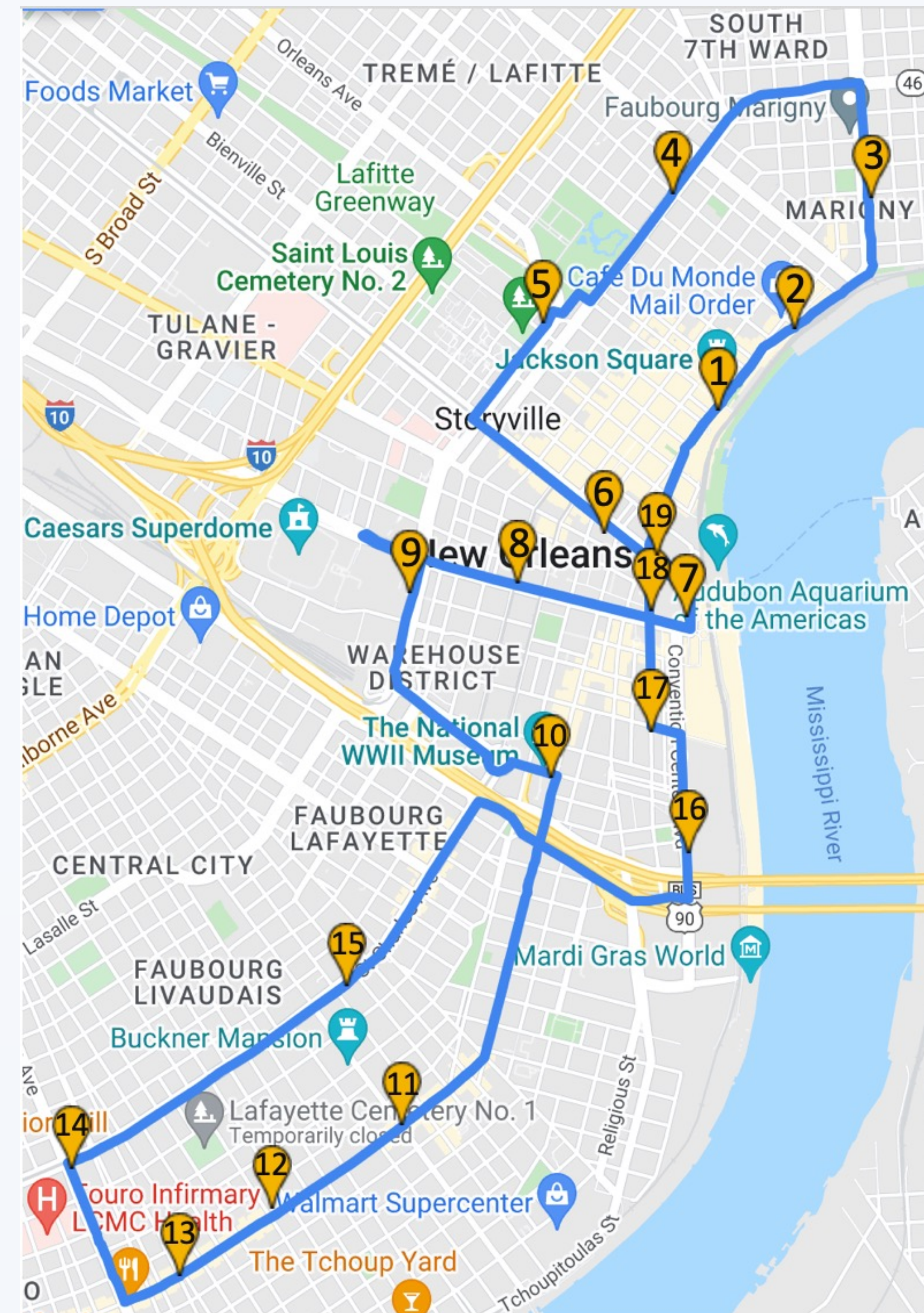
$$P_{i,j}(t) = \frac{[\rho_{i,j}(t)]^\alpha [d_{i,j}^{-1}]^\beta}{\sum_{j \in A_i(t)} [\rho_{i,j}(t)]^\alpha [d_{i,j}^{-1}]^\beta},$$

where $P_{i,j}(t)$ is the state transition probability equation, $A_i(t)$ is the set of allowed cities that a bee can travel to from city i at time t , $d_{i,j}$ is the distance from city i to city j , $\rho_{i,j}$ is the weight that a bee is influenced by the preferred path of traveling from city i to j at time t , α is either 1 or 0 to turn on or off the influence of the preferred path, and β is the parameter that controls the significant level of distance.

$$\rho_{i,j}(t) = \begin{cases} \lambda & \text{when } j \in F_i(t), \\ \frac{1-\lambda}{|A_i(t)|-1} & \text{when } j \notin F_i(t), \text{ and when } A_i(t) \cap F_i(t) \neq \emptyset, \\ \frac{1}{|A_i(t)|} & \text{when } j \notin F_i(t), \text{ and when } A_i(t) \cap F_i(t) = \emptyset, \end{cases}$$

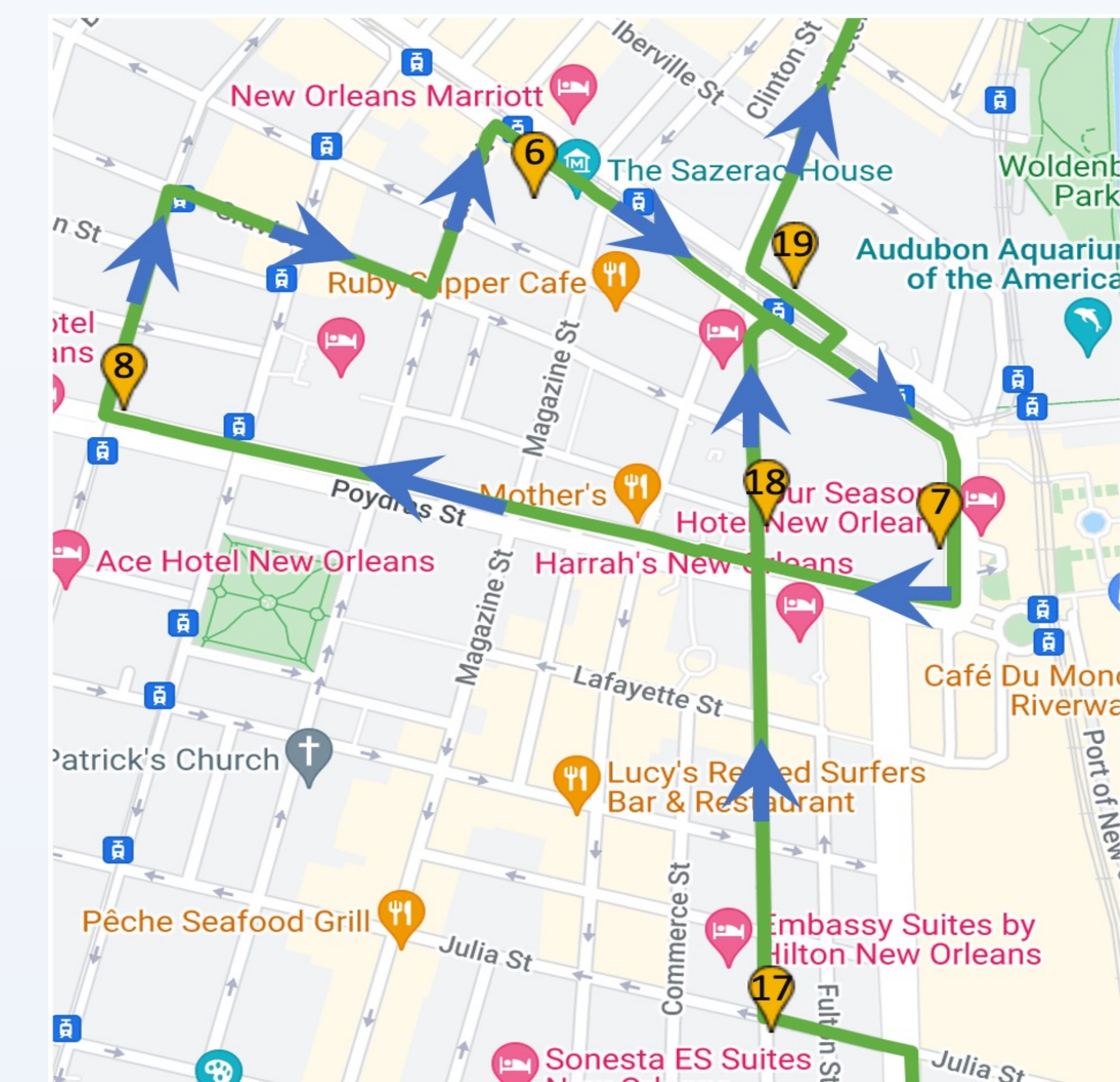
where λ is a number between 0 and 1

MAP DATA



MAP KEY

- **Blue Route:** The original, non-optimal route used by the bus touring company in their tours around the city of New Orleans. (10.849 Miles)
1 → 2 → 3 → ⋯ → 19 → 1.
- **Orange Route:** The locally optimal route that starts at a point and then goes to the closest, non-visited point until the route is completed. (11.7 Miles)
8 → 6 → 19 → 1 → 2 → 3 → 4 → 5 → 9 → 10 → 17 → 18 → 7 → 16 → 11 → 12 → ⋯ → 15 → 8
- **Green Route:** The optimal route we found using the Bee Colony Optimization Algorithm. (10.7 Miles)
16 → 17 → 18 → 7 → 8 → 6 → 19 → 1 → 2 → 3 → 4 → 5 → 9 → 10 → ⋯ → 15 → 16



- **Red Route:** The optimal route for walking. (9.7 Miles)
1 → 2 → 3 → 4 → 5 → 9 → 8 → 10 → 15 → 14 → 13 → 12 → 11 → 16 → 17 → 18 → 7 → 19 → 6 → 1

ACKNOWLEDGEMENTS

We would like to thank Xavier University of Louisiana's Center for Undergraduate Research and Graduate Opportunity (CURGO). We would also like to thank Xavier University of Louisiana's GRADstar program for funding our research.