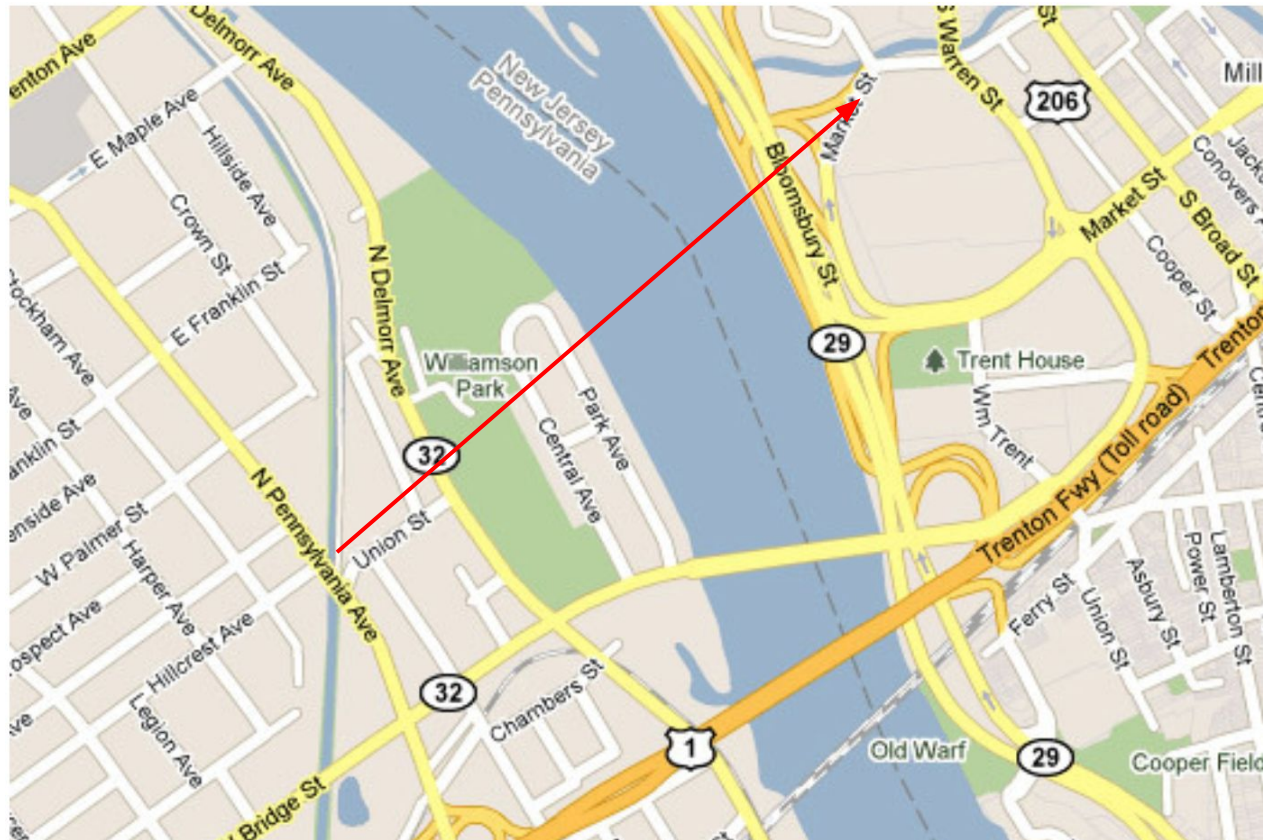


# The Traveling Salesman Problem: Mapping with Optimization

A close-up photograph of a map with several pushpins. The map shows a network of roads and geographical features. A red pushpin is prominently placed in the lower right foreground. Other pushpins in green, blue, and yellow are scattered across the map, some in the background and some in the mid-ground. The text 'The Traveling Salesman Problem: Mapping with Optimization' is overlaid on the top half of the image.

# PROBLEM



# PROBLEMS SOLVING

Problems this particular method for the Traveling Salesman Problem would solve are time, costs, and is an NP-Hard



## TIME TO FIND EFFICIENT ROUTES

Finding the shortest route to visit a set of locations is an exponentially difficult problem (finding the shortest path for 20 locations is twice as hard as 10 locations).



## NP-HARD PROBLEM

TSP is problem in which correct solutions are easy to verify, but there is no efficient way to solve the problem itself.



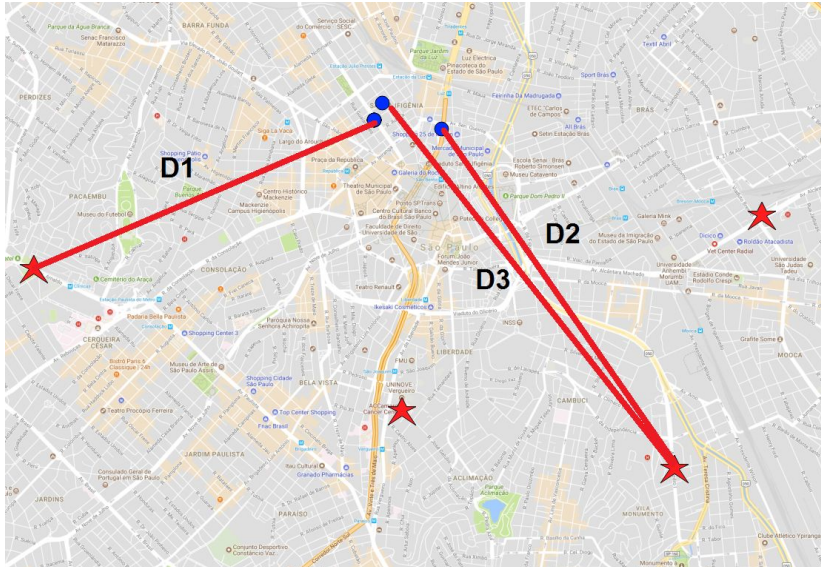
## MINIMIZING COSTS

Can reduce costs in areas including transportation, electronics, and genetics.



# METHOD AND SOLUTIONS

Using Google Maps API and Qiskit's TSP algorithm, we wrote a program that would perform TSP while accounting for the real distance between 2 destinations



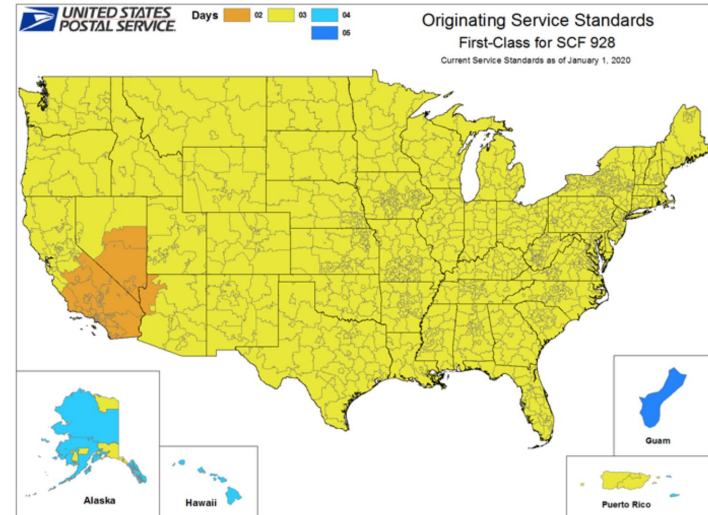
# HOW IT WORKS

- 1) Using Google Maps' API, map out desired destinations and construct a distance matrix
- 2) Find the Hamiltonian of the distance matrix
- 3) Mapping to the Ising Problem
- 4) Checking if Hamiltonian gives right cost
- 5) Run optimization routine using feedback loop on quantum computer

# BENEFITS

For travelers (commercial delivery services bus companies) to find the most efficient routes

Navigation with boats and airplanes, avoid passing through prohibited places, areas with poor weather and other obstructions/barriers



# PROJECTS FOR FUTURE INVESTIGATION

Expanding to a round-trip: coming back from where we started

## Implications

The potential of the traveling salesman problem ranges to applications in transportation, genetics, and electronics, with fiber optic network and chip design



### TRANSPORTATION

Military, commercial delivery services (ordering and delivering packages or mail), companies scheduling home service calls, bus companies



### GENETICS

Following a path through the genome that can return the shortest genetic distance map in order to optimally build genetic maps.



### FIBER OPTIC NET. DESIGN

Fiber Optic Network Design: network consisting of optical fibers (roads) connecting all nodes (towns)



### CHIP DESIGN

Chip Design: ideal chip design needs to hold as many components as possible so the length of circuits must be as short as possible