DELTA-Rides

DELivery Transportation Algorithm for Ridesharers

image from: ww. drivingfutures.com

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Motivation: Why to Carpool and How to do it Efficiently

- Traffic is full of single-commuters, how much could be saved if people were to car-pool?

- **School case***: Parents drop & pick up their kids to & from school / events / trips MANY MANY TIMES!!! Develop a system that:
  - Enables users to rideshare in an efficient and simple way
  - Guides them with the optimal route of picking-up and delivering
  - Will save immense amounts of gas and money!

*Our algorithm will work with any carpooling situation, such as work commutes

Objectives & Challenges

- Develop a web-based system to gather information from the drivers and passengers for car-pooling.

- While assigning passengers to their drivers, cluster them in a way to minimize total distance to travel.

- Find the shortest path for drivers to pick-up and deliver the passengers.
  - This is a known problem in mathematics literature called the Travelling Salesman Problem (TSP).
  - TSP is a known NP-hard (non polynomially solvable) problem.
    - Finding the optimal route for 20 locations could take up to years with the fastest computers.

Communication / Information Gathering from Parents – Online Forum


https://docs.google.com/forms/d/1yaKmpdj2LsSL4XzTsqsY_N6E4YaUUwpLIITslPI66ss/viewform

Event Travel Optimization Manager

* Required

First Name *

Last Name *

Address *

What is Latitude coordinate of your residence? *

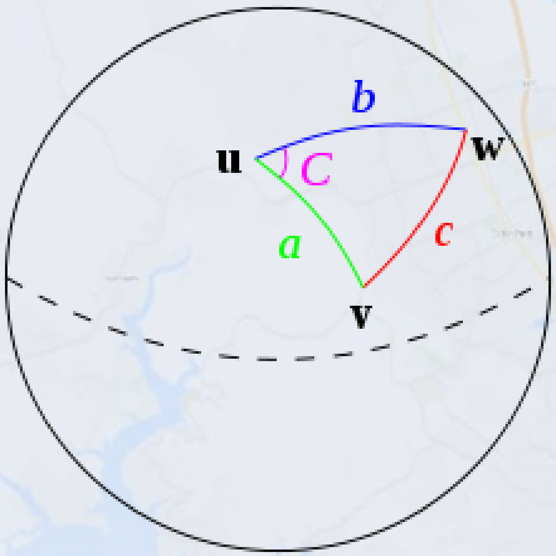
What is Longitude coordinate of your residence? *

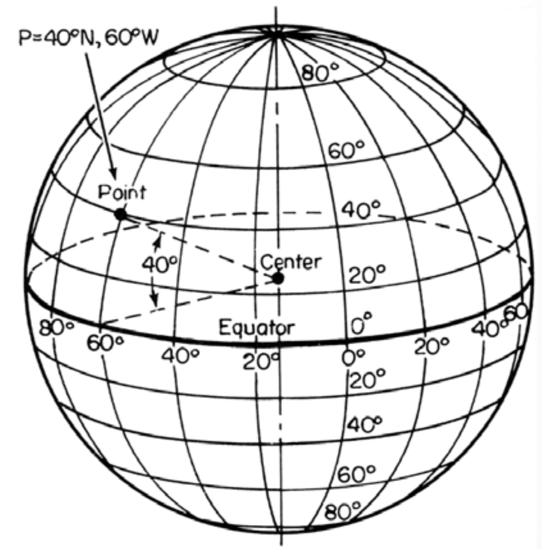
Can you volunteer to bring students? *

- Yes
- No

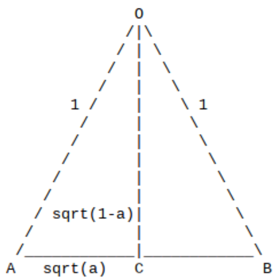
By using an online form (we used Google Forms), attendees will enter in their names, volunteer capacity (if they are able to take extra passengers), and address locations to be processed by the program.

Distance Matrix Calculation – Haversine Formula





The final step is to find the central angle AOB that corresponds to this chord length. The arctan formula can be found from this figure:



If AC = sqrt(a), then Pythagoras says that

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OC = sqrt(OA^2 - AC^2)
   = sqrt(1-a)
```

Therefore tan(<AOC) = AC/OC = sqrt(a)/sqrt(1-a), or

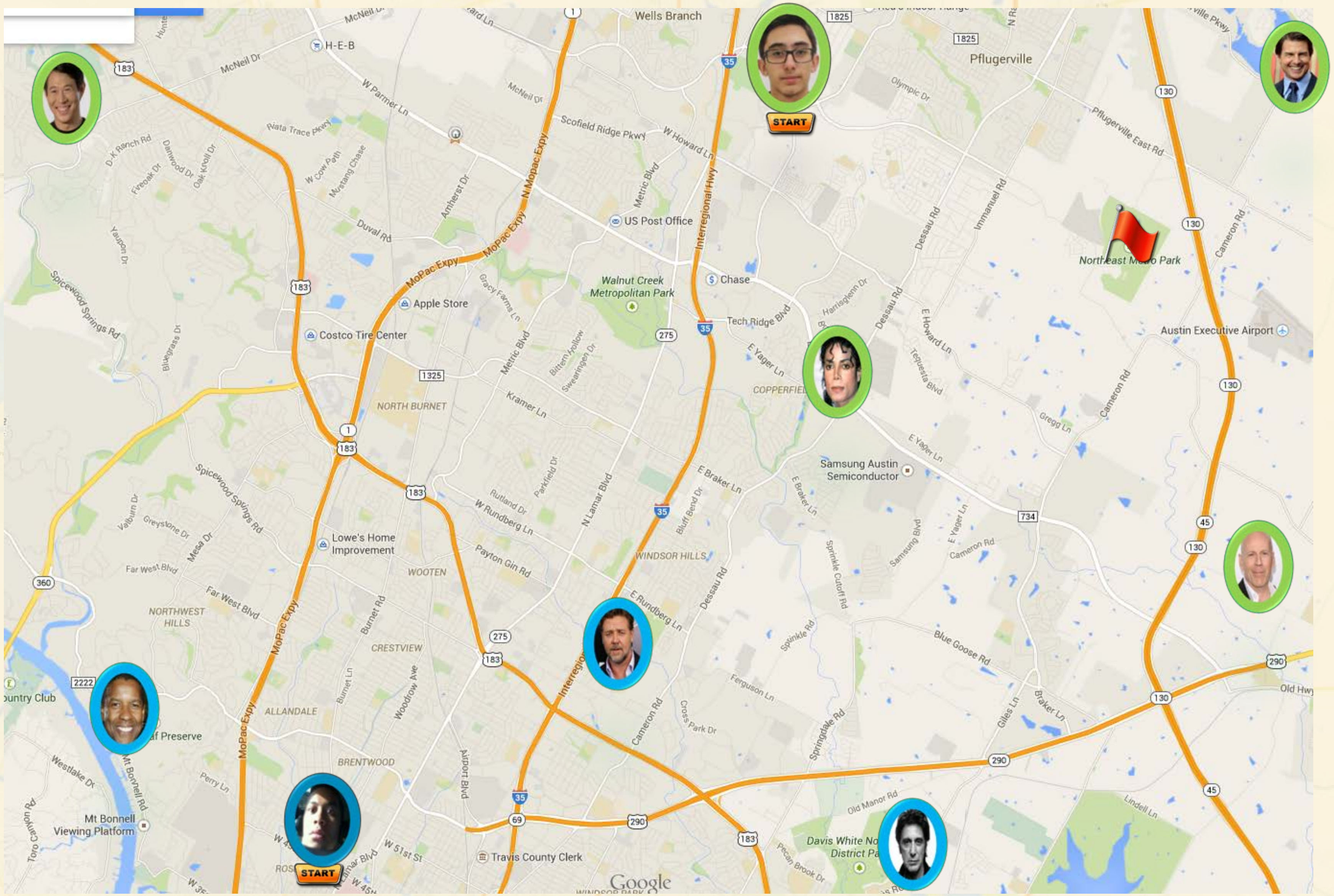
```
c = 2 * arctan(sqrt(a)/sqrt(1-a))
```

where c is the angle AOB.

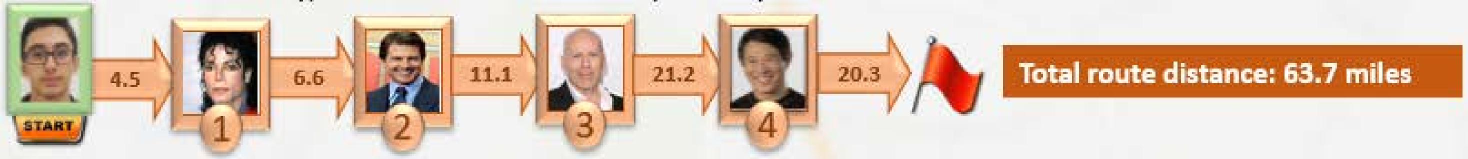
from \ to	START					
START	0	4.5	9	14.5	12	7.9
	4.5	0	6.6	16	8.7	7.2
	9	6.6	0	19.5	11.1	4.6
	14.5	16	19.5	0	21.2	20.3
	12	8.7	11.1	21.2	0	10.2
	7.9	7.2	4.6	20.3	10.2	0

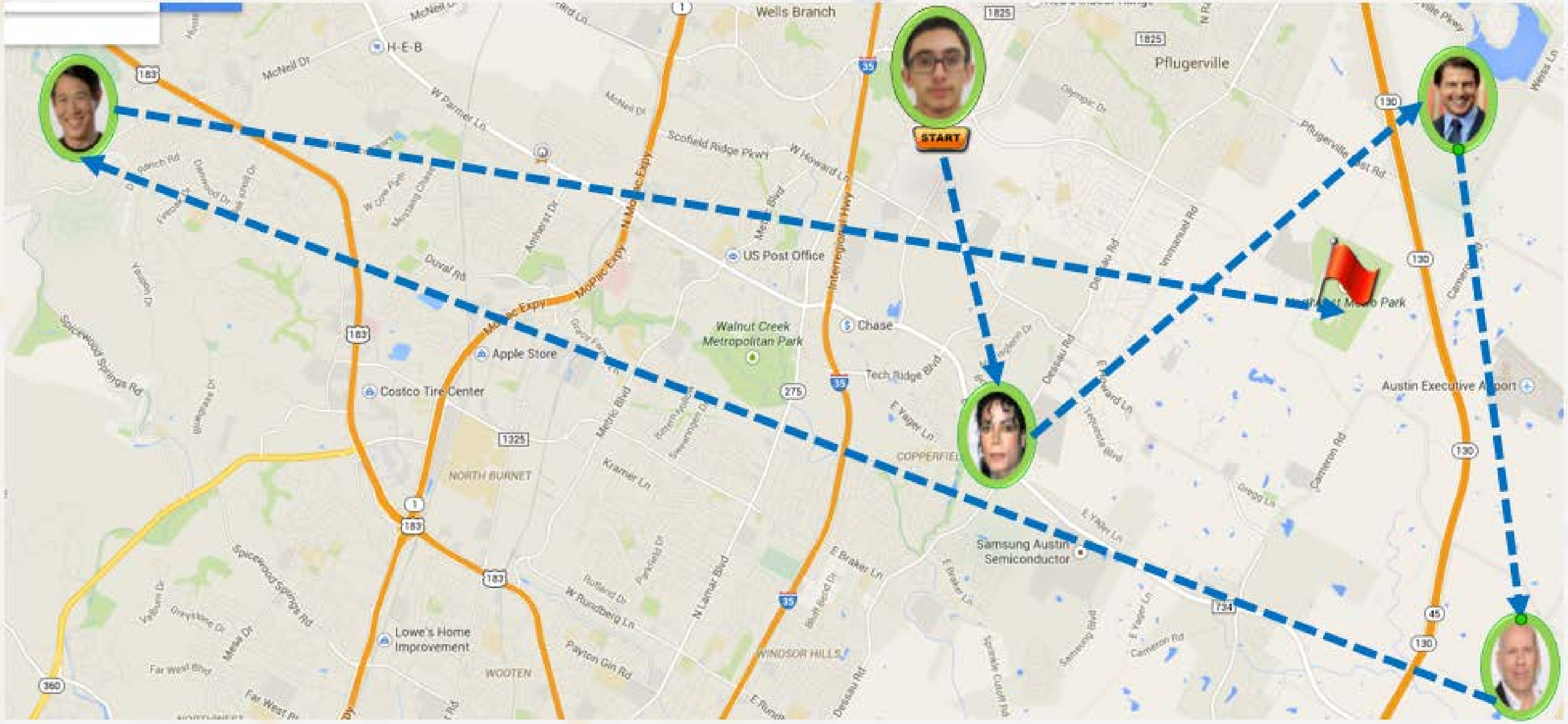
(From-to distance in miles)

Passenger Allocation to Volunteers - Clustering Algorithm

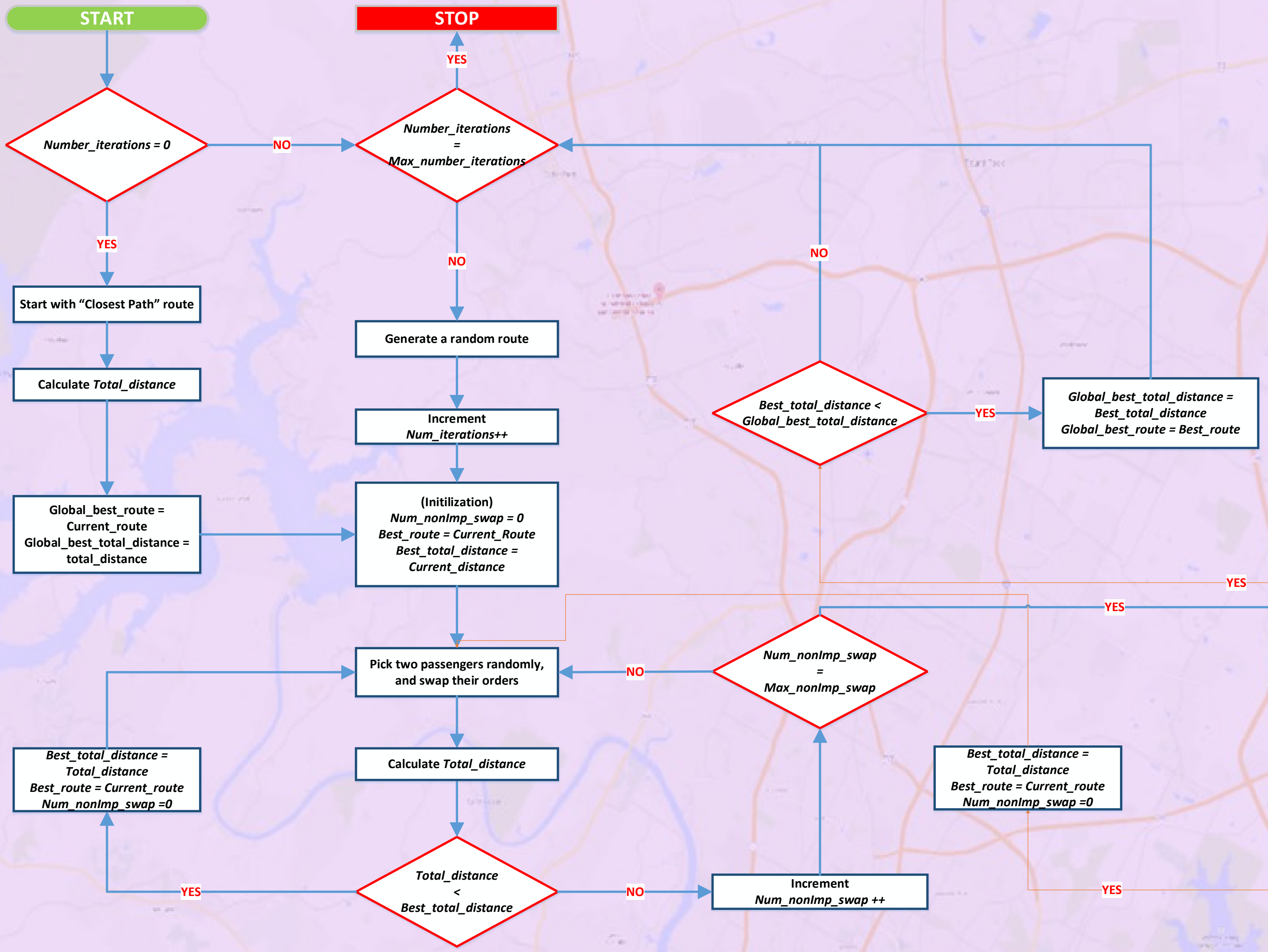


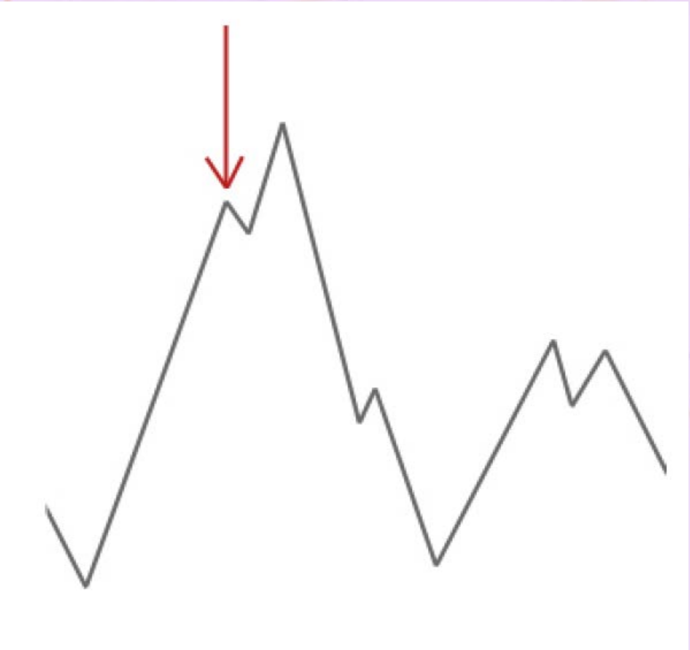
Initial Route (A "Good" Starting Solution) – Closest Path Algorithm





Optimized Route – Greedy Randomized Adaptive Search Procedure (GRASP)





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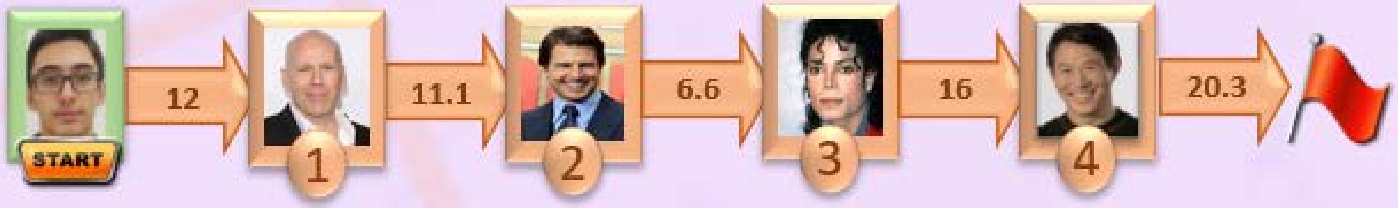
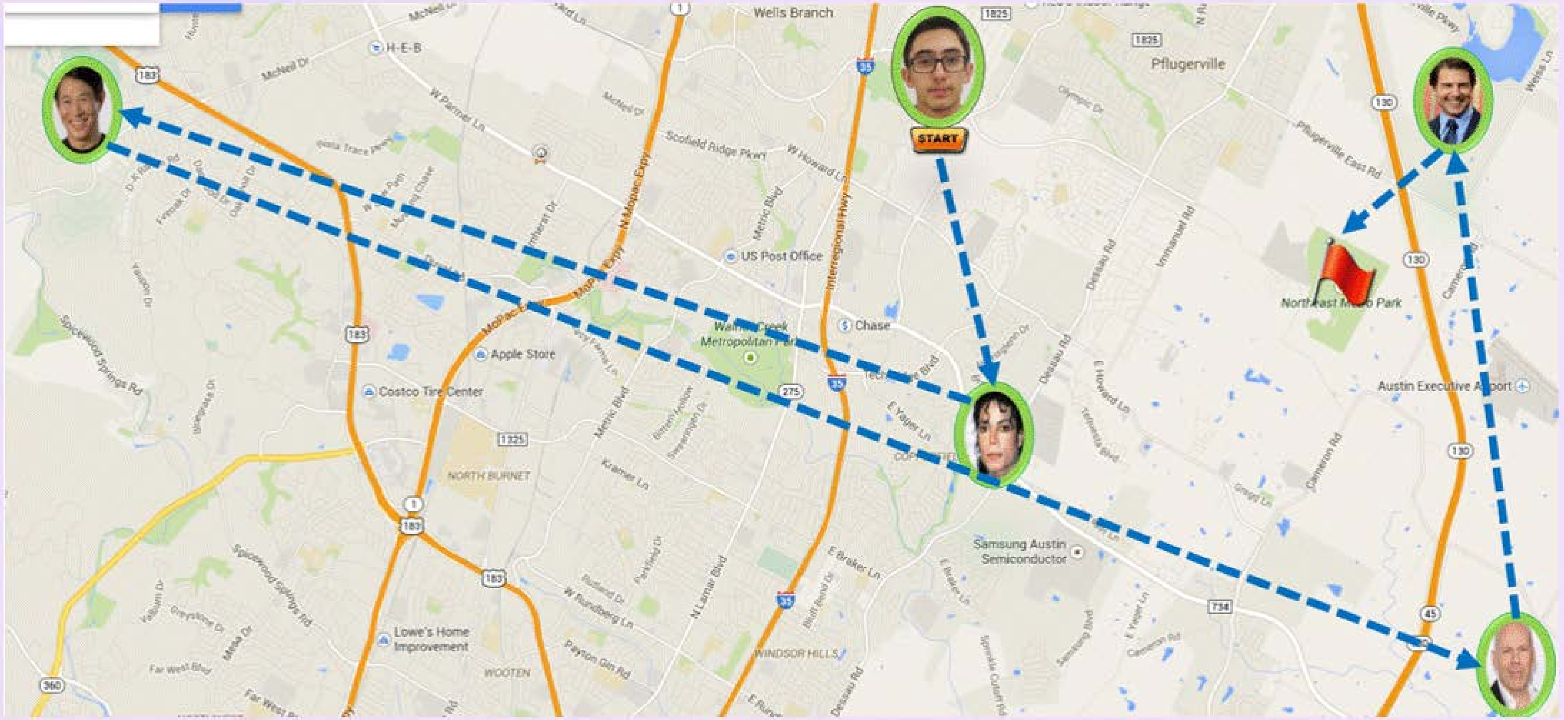


Total route distance: 66 miles

Total route distance: 57.4 miles

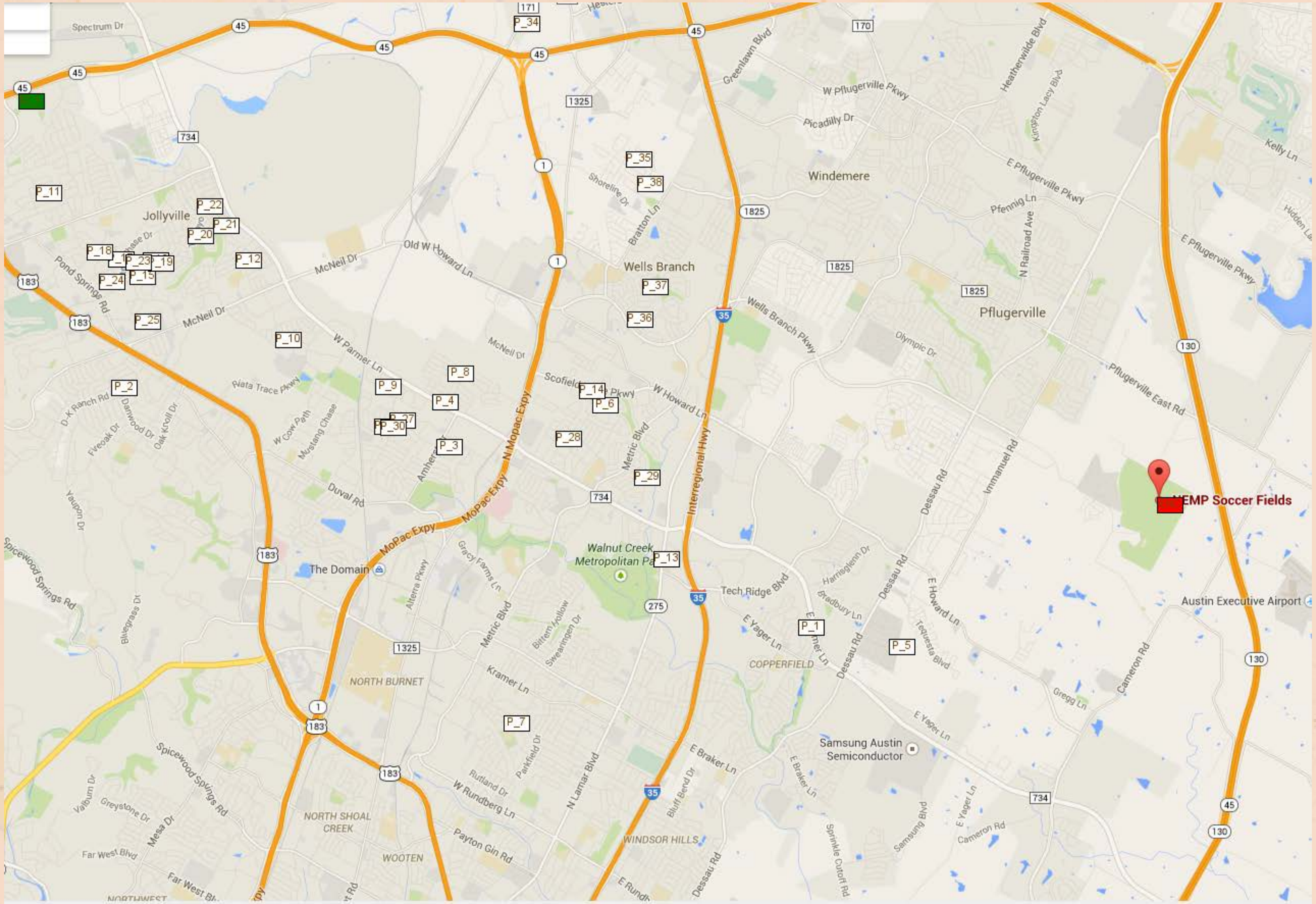


- Continue to search to reach optimal route. (see algorithm for details)

Experimental Study

Setup:

- 50 random diverse addresses throughout Austin
- 20 different scenarios



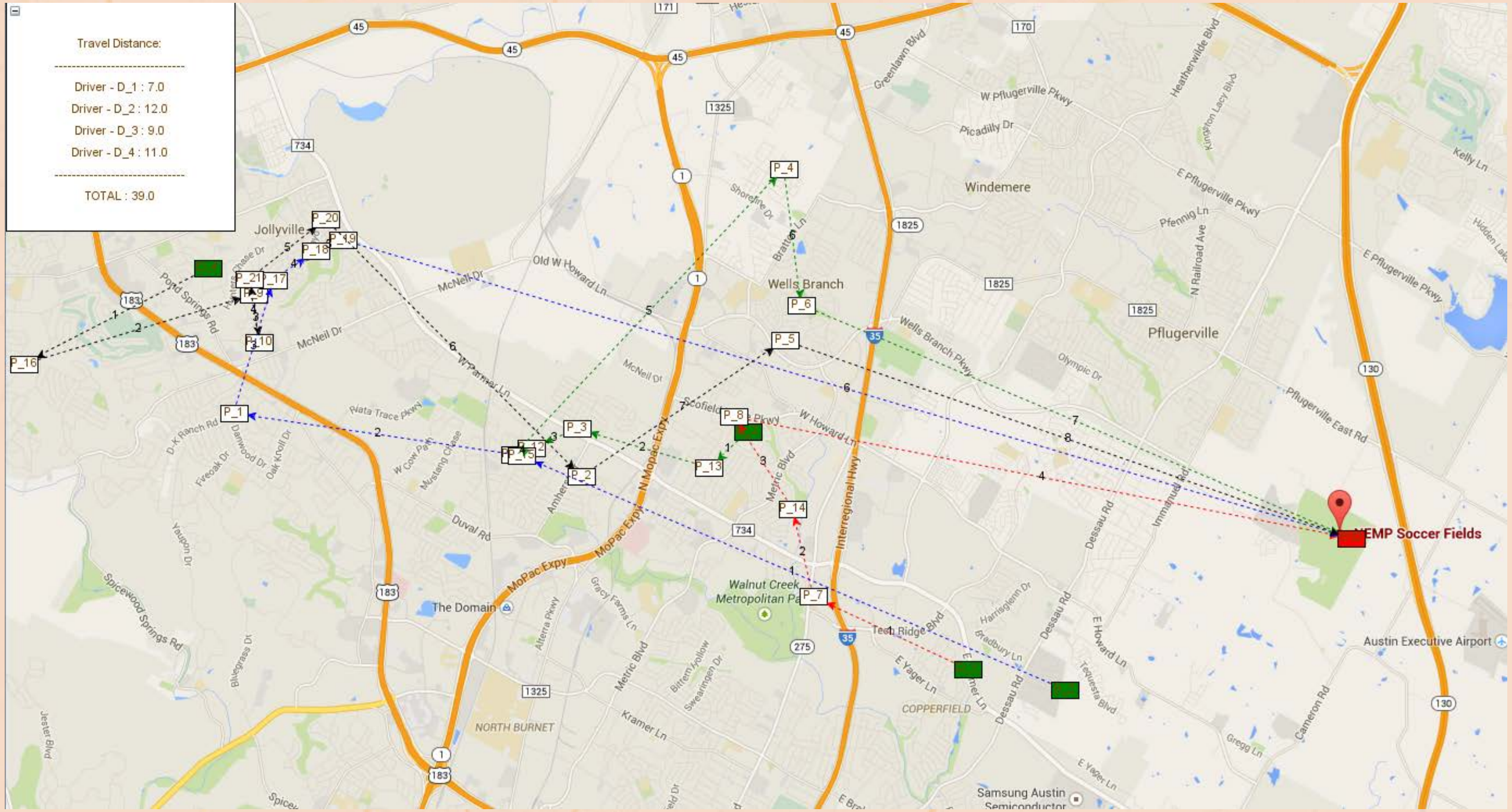
Experimental Study

Case 17:

4 volunteers (capacity of 3, 5, 6, 6)

21 passengers

25 people to travel



Base Case	ETRAM (travel distance)	DELTA	Improvement %	Saved Mileage	Saved Gas (estimated 20mpg)
185	45	39	~76/80%	140/146	7 gal

Summary of Study

Case #	Base Case	ETRAM (previous yr travel distance)	DELTA (travel distance)	Improvement % (Base Case to: ETRAM / DELTA)	Saved Mileage	Saved Gas
1	25	13	13	48 %	12	.6 gal
2	65	26	20	60% / 69 %	39 / 45	~2 gal
3	81	26	26	68 %	55	2.75 gal
4	54	16	16	70 %	38	~2 gal
5	156	52	47	~67 % / 70%	104 / 109	~5 gal
6	117	34	28	~71 % / 76%	83 / 89	~4 gal
7	96	34	27	65 % / 72%	62 / 69	~3 gal
8	74	47	47	36 %	27	1.35 gal
9	128	54	54	58 %	74	3.7 gal
10	273	55	43	~80 % / 84%	218 / 230	~11 gal
11	205	72	70	~65 % / 66%	133 / 135	6.65 gal
12	59	34	34	~65 %	34	6.65 gal
13	257	80	76	~69 % / 70%	177 / 181	~9 gal
14	117	44	44	~62 %	73	3.65 gal
15	32	23	23	~28 %	9	0.45 gal
16	87	27	22	~69% / 74%	60 / 65	3 gal
17	185	45	39	~76% / 80%	140 / 146	7 gal
18	74	16	16	~78 %	58	~3 gal
19	72	35	32	~51% / 56%	37 / 40	~2 gal
20	152	62	58	~59 % / 60%	90 / 94	4.5 gal

Results and Benefits

Quantitative savings:

- Average overall savings: 62% / 65%
  - Average gas savings: 4 gallons
  - Average money savings: ~$8.03 ($8.025)
  - Average distance savings: 76.15 miles / 79.84 miles

Qualitative savings:

- Reduction in traffic congestion and stress
- Reduced traffic accidents due to having less cars in traffic