Traversing New York City's Subway System

MATH 358 TSP Project

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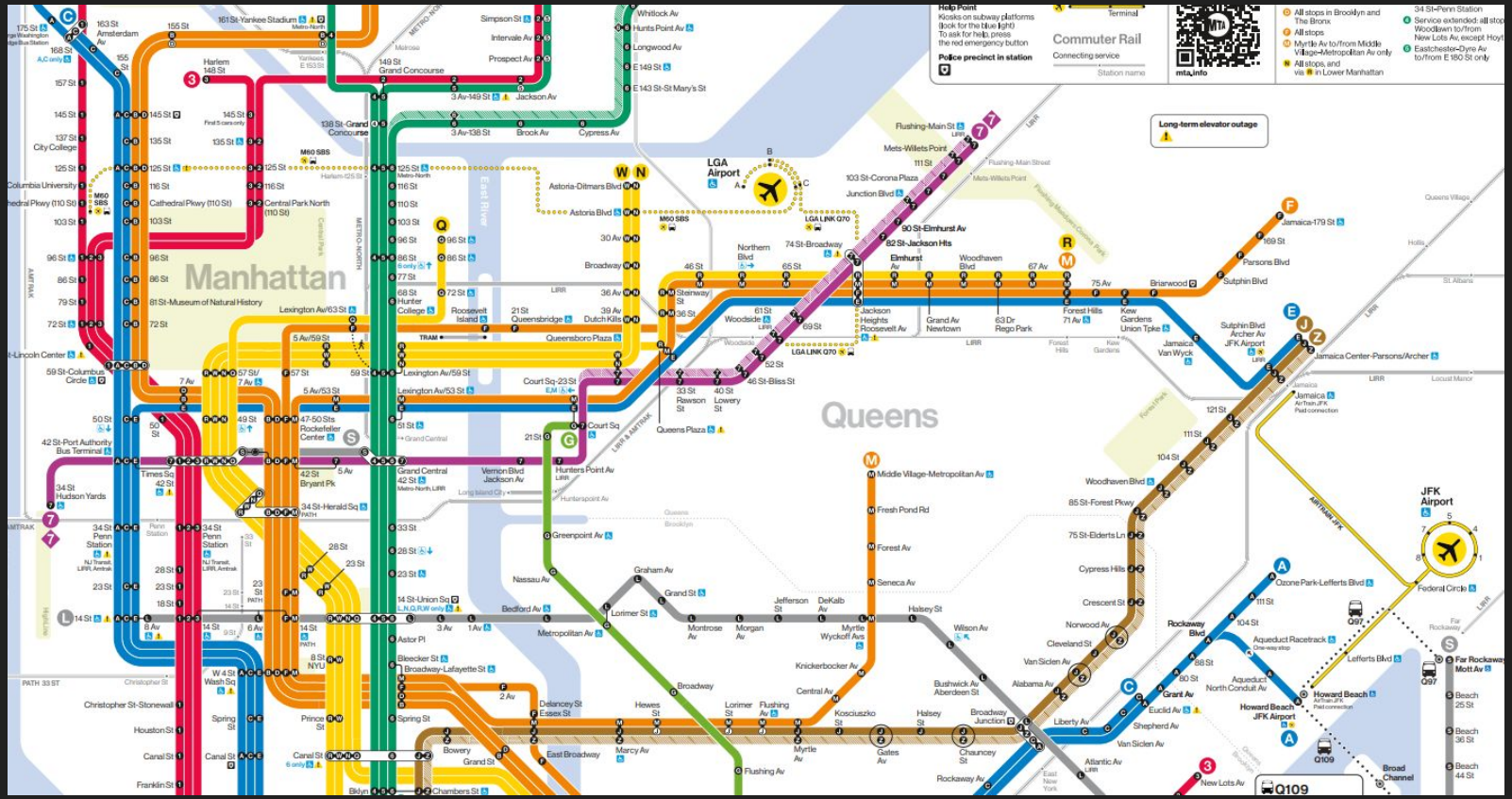
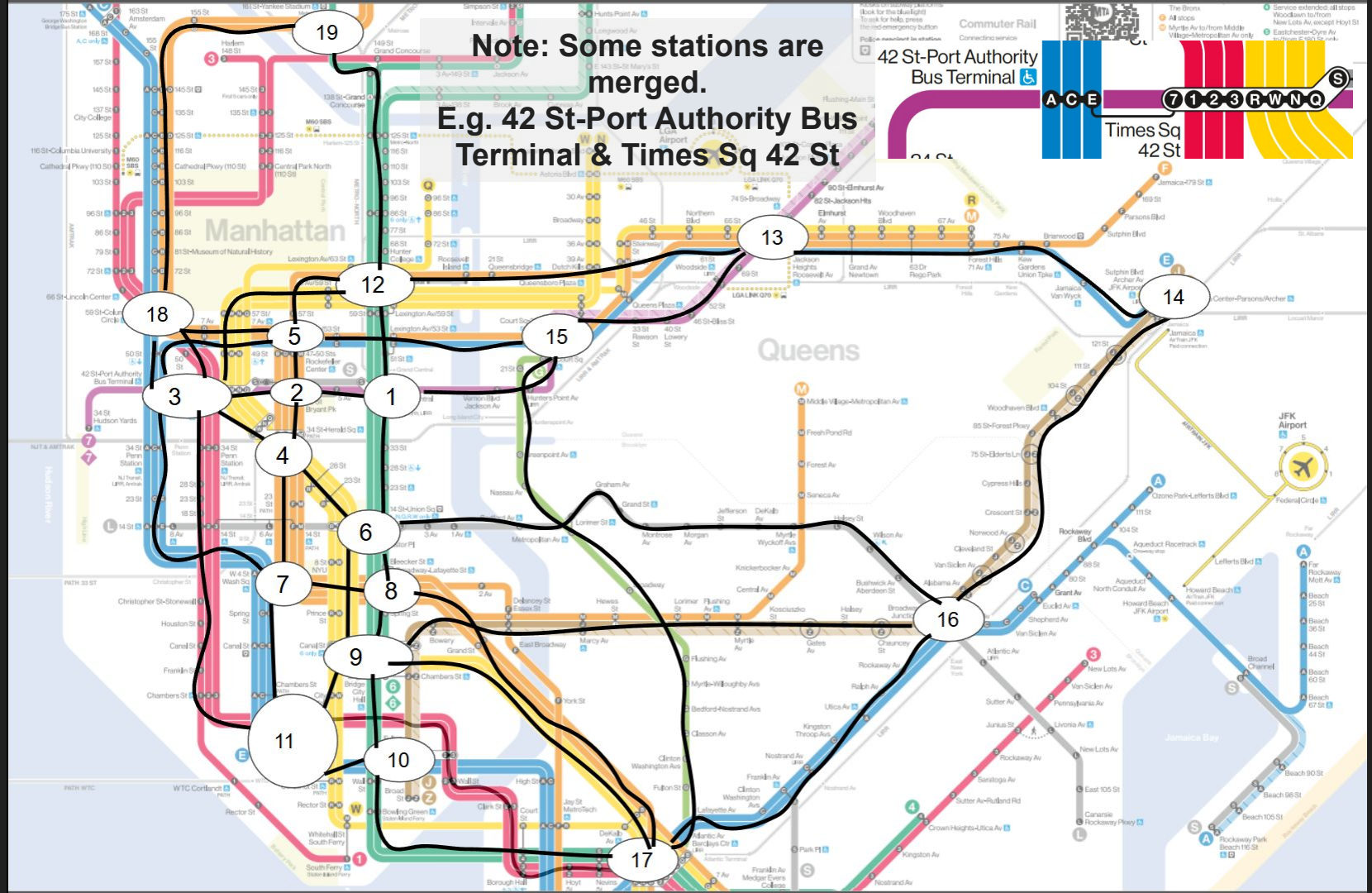
Selecting a Traveling Salesman Problem

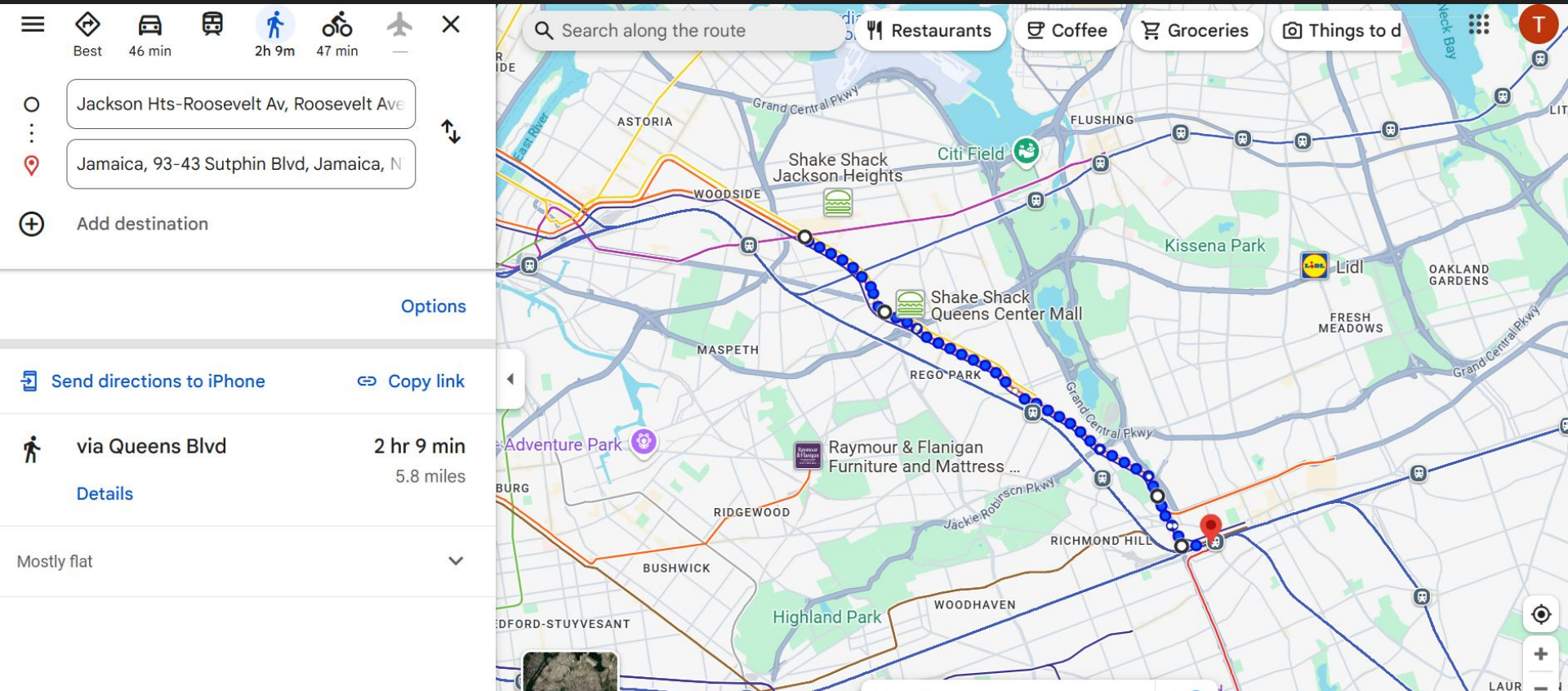


Selected Stations

1. Grand Central 42st
2. 42st Bryant Park
3. Times Sq 42 St
4. 34St Herald Sq
5. 47-50 Rockfeller Center
6. 14st Union Sq
7. W4 St Wash Sq
8. Broadway-Lafeyette
9. Canal Street
10. Fulton Street
11. Park Place
12. Lexington Av/59 St
13. Jackson Heights Roosevelt Av
14. JFK Airport
15. Court Sq-23 St
16. Broadway Junction
17. Atlantic Avenue
18. 59 St Columbus Circle
19. 161 St Yankee Stadium


Note: Some stations are merged.
E.g. 42 St-Port Authority Bus Terminal & Times Sq 42 St
42 St-Port Authority Bus Terminal
A C E
7 1 2 3 R W N Q S
Times Sq 42 St
Manhattan
Queens
JFK Airport
19
12
13
14
18
5
15
3
2
1
4
6
7
8
16
9
11
10
17

Finding the distance between stations



Keeping track of the distances

(miles)	Grand Central 42st	42st Bryant Park	TImes Sq 42	34St Herald Sq-MSG	47-50 Rockfeller Center	14st Union Sq	W4St Wash Sq	Broadway-Lafeyette	Canal Street	Fulton Street	Park Pl	Lexington Av/59 St	Jackson Heights Roosevelt Av	JFK Airport	Court Sq-23 St	Broadway Junction	Atlantic Terminal	59 St Columbus Circle	161 St Yankee Stadium
Grand Central 42st	0	0.1				1.4						0.9			2.2				
42st Bryant Park	0.1	0	0.2	0.6	1.1														
TImes Sq 42		0.2	0	0.3	0.2		1.6				3.1	1.7						1	
34St Herald Sq-MSG		0.6	0.3	0		0.9	1.2												
47-50 Rockfeller Center		1.1	0.2		0							0.9			3			0.8	
14st Union Sq	1.4			0.9		0		0.7	1.2							6.5			
W4St Wash Sq				1.2			0	0.6			1.4								
Broadway-Lafeyette						0.7	0.6	0	0.5								3.5		
Canal Street									0	0.8	0.7					6.3	2.8		
Fulton Street										0	0.4						3.8		
Park Pl											0						3.7		
Lexington Av/59 St												0	4.4						5.1
Jackson Heights Roosevelt Av													0	5.8	2.9				
JFK Airport														0		5.7			
Court Sq-23 St															0		6.1		
Broadway Junction																0	3.8		
Atlantic Terminal																	0		
59 St Columbus Circle																		0	6

Recording 50 answers

E55

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	User	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
2	1	13	14	16	17	10	11	7	8	9	6	4	3	18	19	12	5	2	1	15	
3	2	19	18	3	2	4	6	8	7	11	9	10	17	16	14	13	15	5	12	19	
4	3	14	13	12	19	18	3	5	2	4	7	11	10	9	8	6	1	15	17	16	
5	4	14	13	15	5	12	19	18	3	2	4	7	11	10	9	6	16	17	0	0	
6	5	19	18	3	7	11	10	9	8	6	4	2	5	12	1	15	13	14	16	17	
7	6	17	16	14	13	12	19	18	3	11	10	9	8	7	4	6	1	2	5	15	
8	7	19	18	5	15	1	2	3	4	7	8	6	9	11	10	17	16	14	13	12	
9	8	1	12	19	18	5	2	3	4	7	8	6	9	11	10	17	16	14	13	15	
10	9	11	10	17	16	14	13	15	1	12	5	18	3	2	4	6	8	7	11	0	
11	10	19	18	3	7	11	10	17	9	8	6	16	14	13	15	1	2	5	12	19	
12	11	11	9	8	6	4	7	3	18	19	12	5	2	1	15	13	14	16	17	10	
13	12	18	19	12	13	14	16	17	11	10	7	8	9	6	1	15	5	2	4	3	
14	13	14	16	17	10	11	9	8	6	4	7	3	18	19	12	5	2	1	15	13	
15	14	19	12	13	14	16	17	10	9	8	6	1	15	5	18	3	2	4	7	11	
16	15	14	13	15	1	2	5	12	19	18	3	4	7	11	10	9	6	8	17	16	
17	16	3	18	19	12	5	2	1	15	13	14	16	17	10	11	9	8	6	4	7	
18	17	14	16	17	10	11	9	8	7	3	18	19	12	5	2	4	6	1	15	13	
19	18	9	10	17	16	14	13	12	19	18	5	15	1	2	3	4	6	8	7	11	
20	19	19	12	5	2	1	15	13	14	16	17	10	11	9	8	6	4	7	3	18	
21	20	17	10	11	9	8	6	7	3	4	2	1	5	18	19	12	15	13	14	16	

Computing distances using Google Colab Notebook

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[25] solution_records
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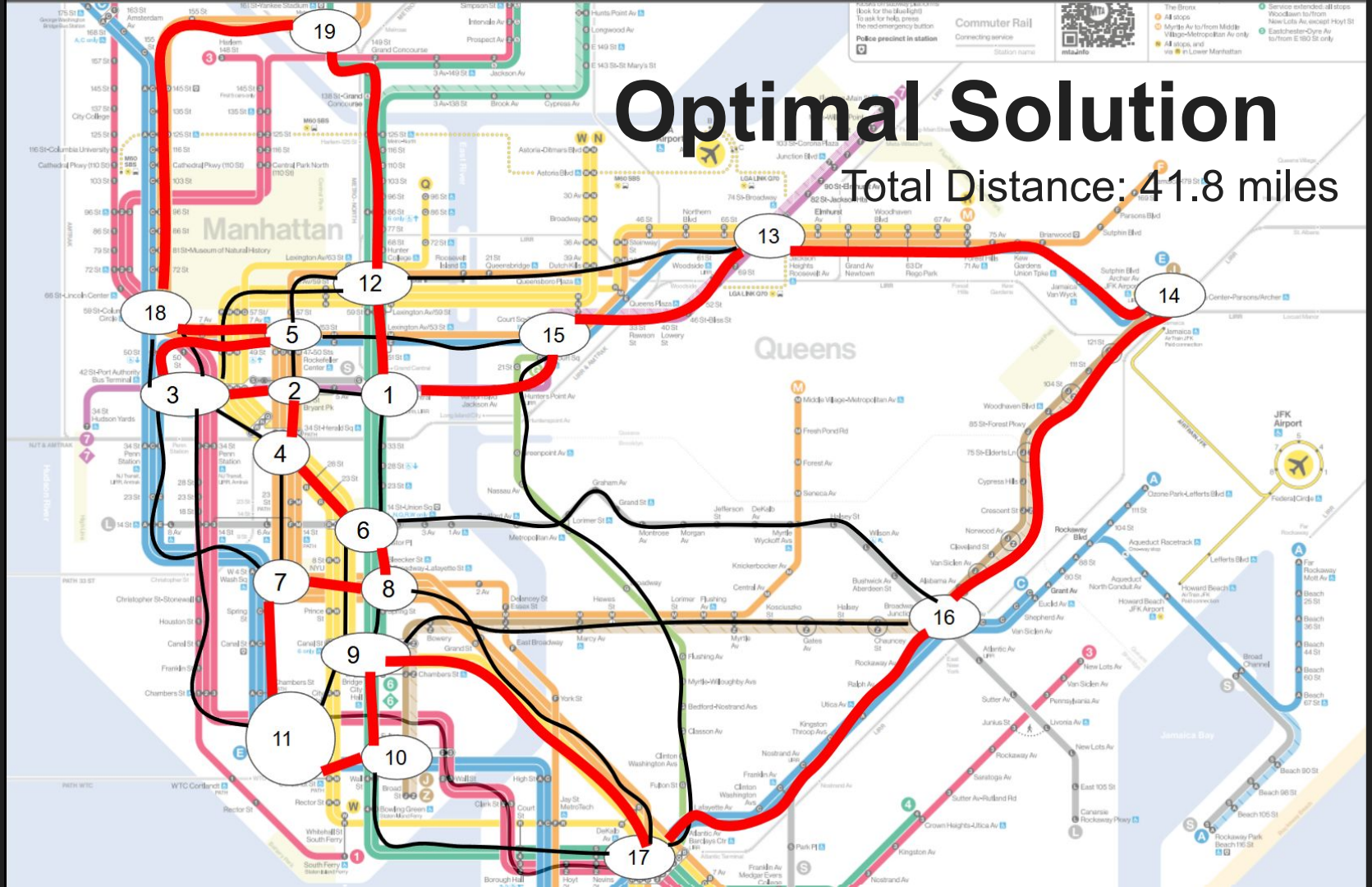
	User	1	2	3	4	5	6	7	8	9	...	12	13	14	15	16	17	18	19	Distance	Notes
0	1	13	14	16	17	10	11	7	8	9	...	3	18	19	12	5	2	1	15	43.7	
1	2	19	18	3	2	4	6	8	7	11	...	17	16	14	13	15	5	12	19	NaN	Missing stations: [1]
2	3	14	13	12	19	18	3	5	2	4	...	10	9	8	6	1	15	17	16	48.4	
3	4	14	13	15	5	12	19	18	3	2	...	11	10	9	6	16	17	0	0	NaN	Missing stations: [1, 8]
4	5	19	18	3	7	11	10	9	8	6	...	5	12	1	15	13	14	16	17	NaN	Invalid cycle: Station 17 to Station 19 is not...
5	6	17	16	14	13	12	19	18	3	11	...	8	7	4	6	1	2	5	15	51.0	
6	7	19	18	5	15	1	2	3	4	7	...	9	11	10	17	16	14	13	12	46.0	
7	8	1	12	19	18	5	2	3	4	7	...	9	11	10	17	16	14	13	15	43.4	
8	9	11	10	17	16	14	13	15	1	12	...	3	2	4	6	8	7	11	0	NaN	Missing stations: [9, 19]
9	10	19	18	3	7	11	10	17	9	8	...	14	13	15	1	2	5	12	19	NaN	Missing stations: [4]
10	11	11	9	8	6	4	7	3	18	19	...	2	1	15	13	14	16	17	10	44.4	
11	12	18	19	12	13	14	16	17	11	10	...	9	6	1	15	5	2	4	3	NaN	Invalid cycle: Station 10 to Station 7 is not ...


Optimal Solution
Total Distance: 41.8 miles
19
12
18
5
15
13
14
3
2
1
4
6
7
8
16
9
11
10
17
Manhattan
Queens
JFK Airport

Findings

- 35 volunteers found a valid route while 15 volunteers returned invalid routes
- A person who successfully completed the TSP took a path that was 3.703 miles longer than the optimal route on average.
- The longest route was 9.8 miles longer than the optimal route, and the shortest route was 1.4 miles longer than the optimal route
    - Hence, none of the volunteers found the optimal route