MEC Day 3 Assignment Results

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Q1 Shortest path via Gurobi

Results are following:

```
[1] "Gurobi achieved optimation in 0.0499999999999545s"
[1] "With Gurobi, minimized cost from origin to destination is 12133.8094663484"
```

Q2 nodes of the shortest path

```
[1] "Flow is equal to zero except at the following arcs:"
1141
  1215
  1228
  1233
> print("The shortest path is as following:")
[1] "The shortest path is as following:"
14 St - Union Sq
  Canal St
  Atlantic Av - Barclays Ctr
  36 St
  59 St
```

Q3 Bellman-Ford algorithm

```
"With Bellman-Ford algorithm, minimized cost from Origin to Destination is 12133.8094663484"
```

I didn't figure out how to track each update to back out the optimal path yet...

Q4 Regularized problem (Approximate Min-Cost Problem)

I used the gradient method in optimization formulation to solve this regularized problem when $T = 1$

```
[1] "Gradient converged in 38.5699999999999s."
[1] "Value of the minimization problem = -12124.6405919238"
```

Writing out all μ is too cumbersome, here I listed the values on the optimal path in previous problem:

```
[1] "Values of mu at the shortest path in the non-regularization problem are:"
0.994647571626107
  0.97607734142164
  0.884248393810579
  0.313988123779411
```

We can see it's pretty close to 1, except the last one.

Q5 Random trajectories simulation

With 10000 simulations, here is the mean of the distances travelled:

```
> mean
[1] 14233.56
> mean_remove_outlier
[1] 12133.81
```

In a few simulations, the distance travelled is far larger than the optimal cost and individuals also have to travel more than 1000 arcs, this increased the mean from 12133. After removing those outliers, the mean value is pretty similar to previous solution. In this case, $T = 1$ is very small relative to the distance (average is 2760), hence we should expect that the travel trajectory is the same as the optimal path in most simulations. However, if we increase T to $T = 1000$, we should expect much more randomness and much more deviations from the optimal path.