Heuristics Part 2a:

Greedy Algorithms

Video (17 mins): https://youtu.be/2DmkGbKvgLc

1st Greedy Algorithm for TSP

- Pseudocode:

```
❖ let S be set of cities to be included in the tour
❖ let T be the initial tour of 1 city picked randomly
❖ remove this city from S
❖ while there are still cities in S:
    ► find the city x in S with the smallest distance to the
      last selected city y
    ► remove x from S
```

Example

	Belfast	Cork	Dublin	Galway	Limerick
Belfast	—	425	167	306	323
Cork	425	—	257	209	105
Dublin	167	257	—	219	198
Galway	306	209	219	—	105
Limerick	323	105	198	105	—

1st Greedy Solution

- Step 0: (pick a random city)
  - Belfast
  - Univisited: {Cork, Dublin, Galway, Limerick}
- Step 1: choose Dublin with smallest distance 167 from Belfast
  - Tour: Belfast - Dublin - Belfast, distance 334
  - Unvisited: {Cork, Galway, Limerick}
- Step 2: choose Limerick with smallest distance 198 from Dublin
  - Tour: Belfast – Dublin – Limerick - Belfast , distance 688
  - Unvisited: {Cork, Galway}
- Step 3: both Cork and Galway have distance 105 from Limerick, so pick Cork randomly out of the two
  - Tour: Belfast – Dublin – Limerick – Cork – Belfast, distance 895
  - Unvisited: {Galway}
- Step 4: choose the last unvisited city Galway with distance 209 from Cork
  - Tour: Belfast – Dublin – Limerick – Cork – Galway – Belfast, distance 985

TSP Support in GraphLab.py

- `greedy1(graph, start)`
  - Returns a tuple in the format of (distance, sequence)

2nd Greedy Algorithm for TSP

- Pseudocode:

```
1. let S be set of cities to be included in the tour
2. let T be the initial tour of 2 cities with closest distance
3. remove these 2 cities from S
4. while there are still cities in S:
   4a. find the city x in S with the smallest distance to any city y
   in the current tour T
   4b. choose the one with lower overall distance:
          insert x between y and its next destination z in T
          insert x between y and its previous destination u in T
   4c. remove x from S
```

2nd Greedy Solution

- Step 0:
  - Tour: Limerick - Galway - Limerick, distance 210
  - Univisited: {Cork, Dublin, Belfast}
- Step 1: choose Cork with smallest distance 105 from Limerick
  - Tour: Limerick - Cork - Galway - Limerick, distance 419
  - Unvisited: {Dublin, Belfast}
- Step 2: choose Dublin with smallest distance 198 from Limerick
  - Tour: Limerick - Cork - Galway - Dublin - Limerick, distance 731
  - Unvisited: {Belfast}
- Step 3: choose Belfast with smallest distance 167 from Dublin
  - Tour: Limerick - Cork - Galway - Belfast - Dublin - Limerick, distance 985
- Finish

Tour	Distance
belfast, :cork, :dublin, :galway, :limerick	1329
belfast, :cork, :dublin, :limerick, :galway	1291
belfast, :cork, :limerick, :dublin, :galway	1253
belfast, :limerick, :cork, :dublin, :galway	1210
belfast, :limerick, :cork, :galway, :dublin	1023
belfast, :cork, :limerick, :galway, :dublin	1021
belfast, :cork, :galway, :limerick, :dublin	1104
belfast, :cork, :galway, :dublin, :limerick	1374
belfast, :galway, :cork, :dublin, :limerick	1293
belfast, :galway, :cork, :limerick, :dublin	985
belfast, :galway, :limerick, :cork, :dublin	940
belfast, :limerick, :galway, :cork, :dublin	1061

Greedy solution

Optimal solution

TSP Support in GraphLab.py

- `greedy2(graph)`
  - Returns a tuple in the format of (distance, sequence)