First Progress Report

Leah Chrestien

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1 Introduction

This informal progress report is intended to briefly highlight the aims and objective of the 'Range - Anxiety' project and describe in details, the work accomplished in the first month of GSoC 2017.

2 Range Anxiety: Road Map

The ideas governing the 'Range-anxiety' project can be summarised as follows.

- Develop a reasonable analogy between vertices in a graph and vertices in the real world.
- Filter the relevant data from the large database to ease the process of execution and coding.
- Develop a distance tree that stores the distance of each node from the origin (chosen coordinate).
- Find the best possible editor that can be used to draw polygons.
- Sketch a polygon joining the end vertices at the desired distance.
- Design an API interface that executes all the above mentioned steps.

3 The cities as 'nodes'

The 'uk-towns.csv' file stores the data associated with 48,206 cities of the United Kingdom. Given the size of the country, it would not be completely unreasonable to use the coordinates of these cities as nodes. This approximation can be valid for other European countries but might fail for countries like the United States, where the distance between two cities/towns can be more than just a few miles. In such a scenario, it becomes necessary to re-define the 'nodes'. One possible assumption is to take into account the coordinates of the charging stations as well as the cities. This however, is an open ended question and is subject to much discussion. Figure 1 shows all 48,206 U.K. cities on the map and the dense population of these cities may be used as a justification for using 'cities' as nodes.

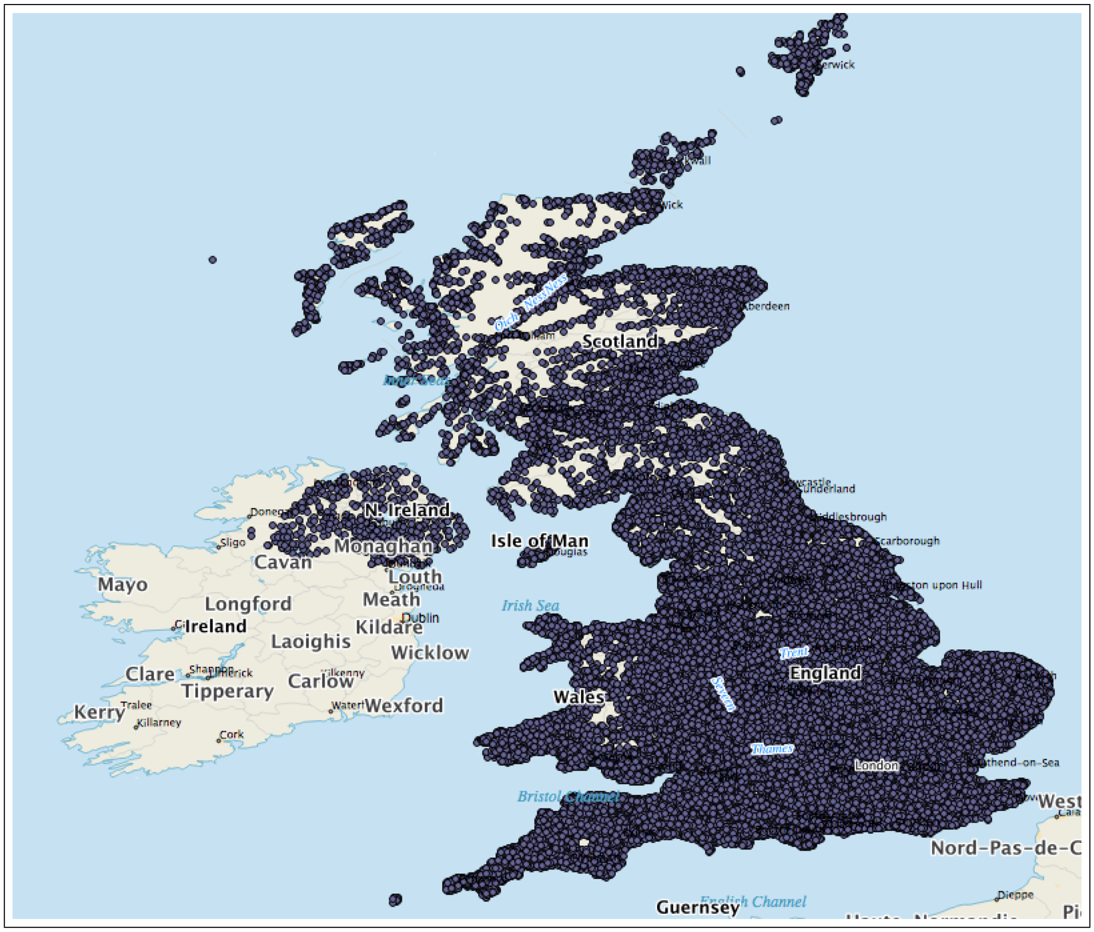

Figure 1: 48,206 U.K cities as nodes.

4 Some important approximations

For all practical purposes, it becomes necessary to add some constraints on the nodes with respect to its definition and location.

- As pointed out in Section 3, the coordinates of the U.K cities are being used as 'nodes' while calculating the shortest path.
- Another important assumption is that the driver always intends to reach a city. In other words, the end vertices of the range polygon necessarily ends in a city/node and not in any other location.
- To reduce computation time, it is possible that the end points of the range polygon only considers cities where the population exceeds a threshold value.
- On joining the nodes at a particular distance from the centre, the edges of the polygon may sometimes pass through inaccessible places.
- As a substitute for real-world data, we design a hypothetical model where the car runs out of charge at the 100th node in each direction from a starting location. For this model to be valid, it is very important that we define a distance(in miles) which defines a reasonable scale for the placement of nodes. Here, we assume that the cities take the form of concentric circles(in an ideal situation) where the difference between any two consecutive radii is 10 miles. Thus, the nodes/cities in the 10th circle will be at a distance of 100 miles from a starting point.

5 Some useful codes used in the .wls files

```
MapThread[
GeoDistance[{centre[[1]], centre[[2]]}, {#1, #2}] &,
{latitudes,
longitudes}];
```

Figure 2: This code computes the geographic distance between the centre coordinates and every other nodes in the city data.

```
Quiet[
MapThread[
TravelDirections[{GeoPosition[{centre[[1]], centre[[2]]}],
GeoPosition[{#1, #2}]}] &, {sortlat, sortlon}]];
```

Figure 3: This code computes the driving distance between the centre coordinates and all the chosen nodes from the original city data.

```
{dist,route}=Quiet[FindShortestTour[centres]];
```

Figure 4: This code computes the shortest distance between all the coordinates centres chosen from the original city data.

```
Flatten[Position[milesInt,_?(40<#<50&)]];
```

Figure 5: This code finds the position of the nodes which are at distance of 40-50 miles from the centre coordinates.

6 Visualisations

Sections 6.1 to 6.5 documents the different kinds of results obtained on executing their respective .wls files. A short description explains the creation and performance of each of these outputs.

6.1 The shortest tour polygon

The 'nearest50poygons.wls' file is executed and Figure 6 shows the polygons formed after determining the shortest path between the first 50 coordinates. These 50 coordinates are the nodes/coordinates that are closest to four randomly chosen centre coordinates.

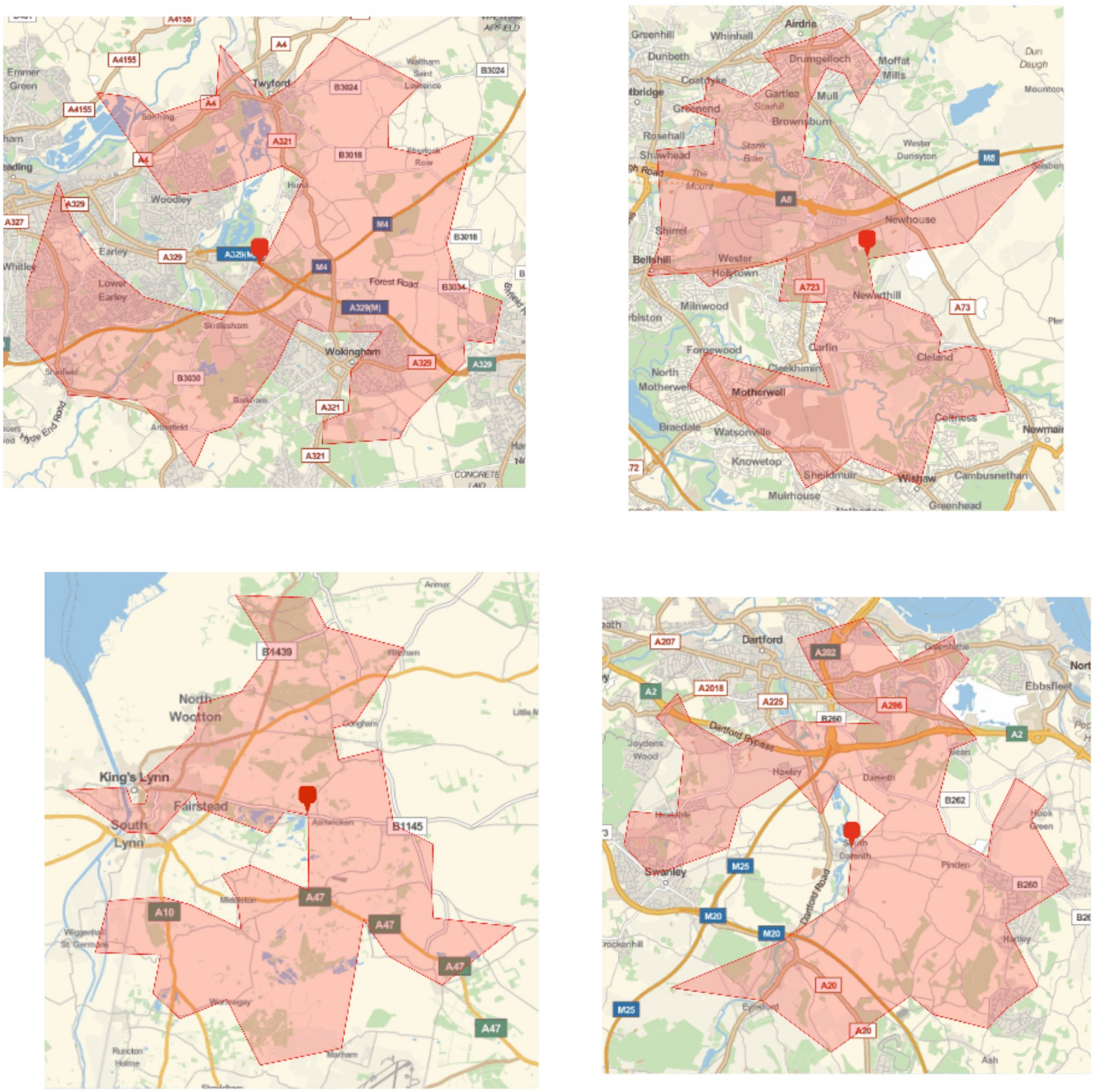

Figure 6: The centre coordinates(shown as a red marker) from the top left in a clockwise manner are {{51.43565, -0.86909}, {55.82241, -3.94089}, {51.40348, 0.24693} and {52.74746, 0.50422}}

6.2 The 50 nearest driving routes

The 'nearest50routes.wls' file is executed and Figure 7 shows the 50 nearest driving routes from four randomly chosen centre coordinates.

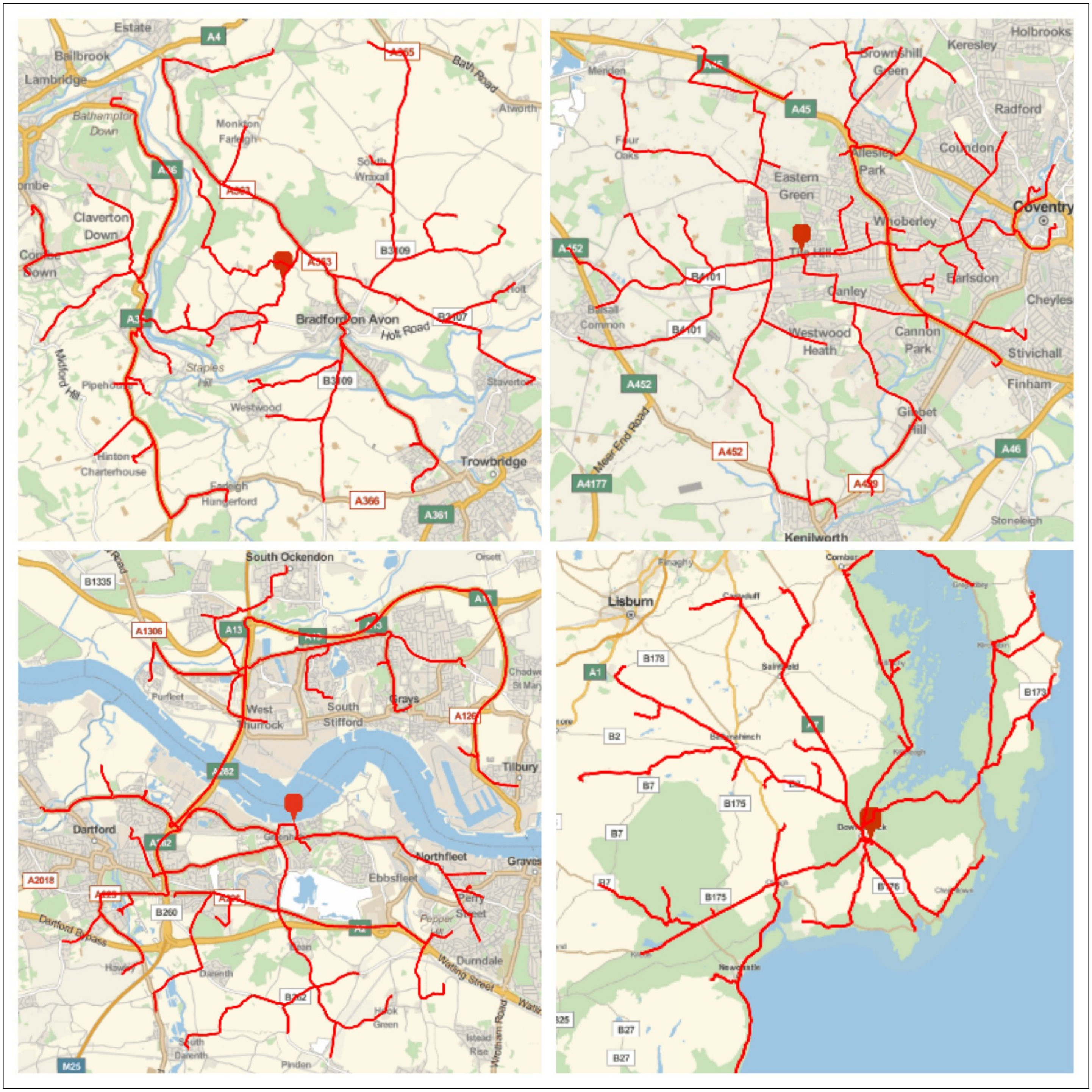

Figure 7: The centre coordinates(shown as a red marker) from the top left in a clockwise manner are {{51.35703, -2.27004}, {52.4018, -1.58603}, {54.322, -5.703} and {51.45307, 0.2844}}

6.3 Polygons at 20-30 miles

The 'range.wls' file is executed and Figure 8 shows the polygons formed after joining the first 100 nodes which are at a distance of 20-30 miles from four randomly chosen centres.

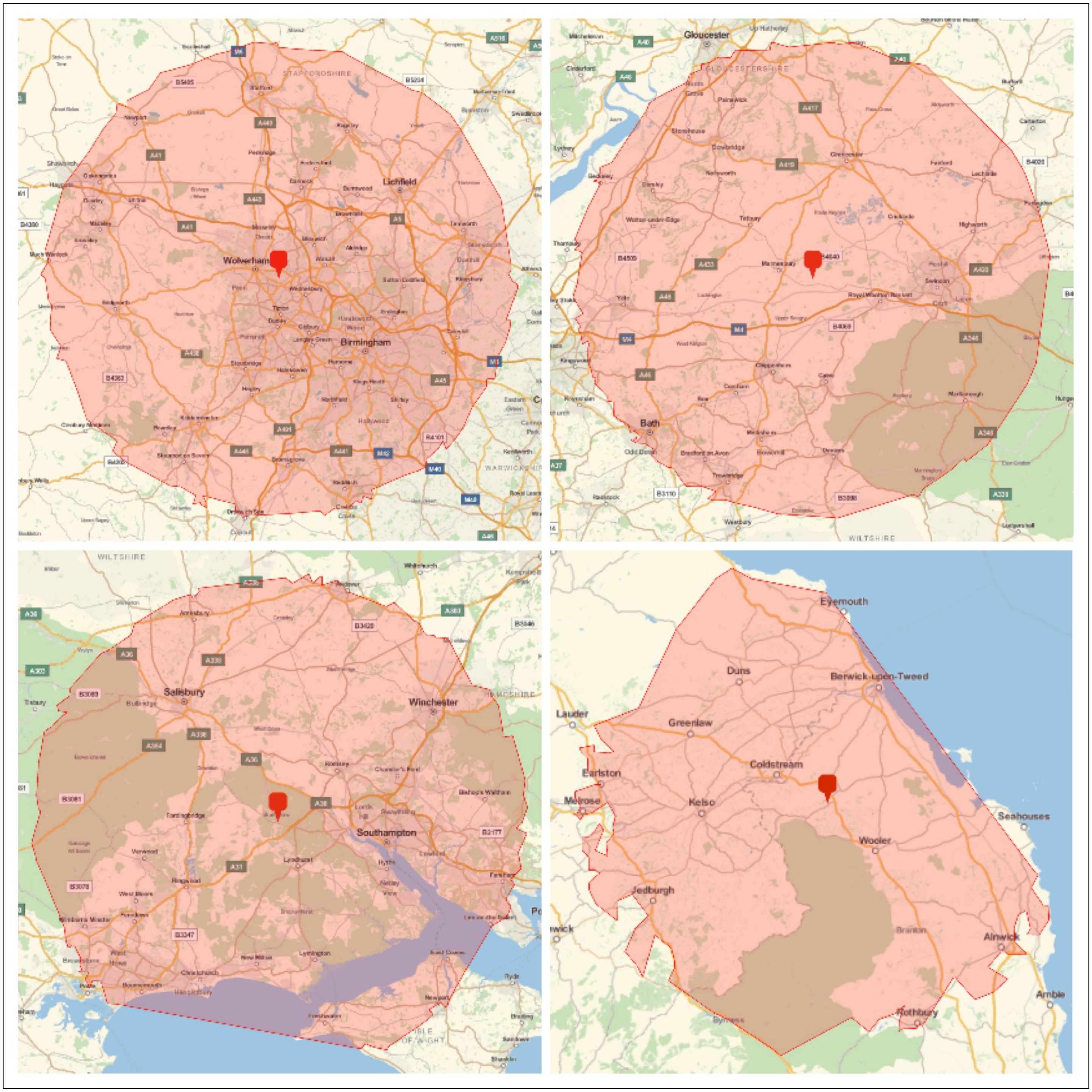

Figure 8: The centre coordinates(shown as a red marker) from the top left in a clockwise manner are {{50.92555, -1.61258}, {51.57017, -2.03319}, {55.61024, -2.1272} and {50.92555, -1.61258}

6.4 Driving routes at 20-30 miles

The 'rangeroutes.wls' file is executed and Figure 9 shows the first 100 driving routes from four randomly chosen centres.

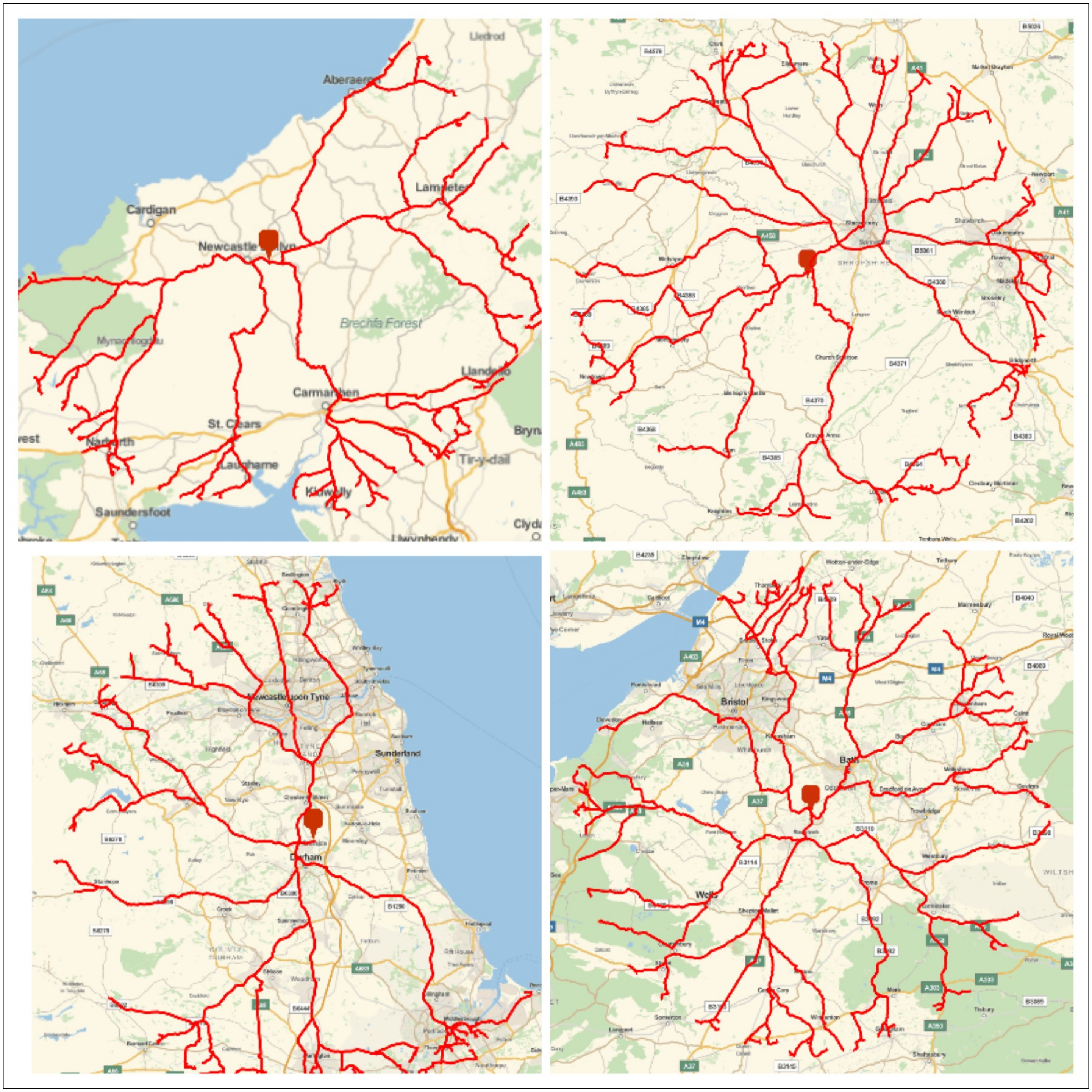

Figure 9: The centre coordinates(shown as a red marker) from the top left in a clockwise manner are {{52.03557, -4.42291}, {52.64407, -2.86602}, {51.32159, -2.43664} and {54.80644, -1.55736}

6.5 Multiple range polygons

The 'mulpol.wls' file is executed and the three overlapping polygons in Figure 10 shows three different distances from four randomly chosen centre coordinates. The nodes on the green layer are at a distance of 60-70 miles from a centre. The nodes on the blue layer are at a distance of 40-50 miles from a centre. The nodes on the red layer are at a distance of 20-30 miles from a centre.

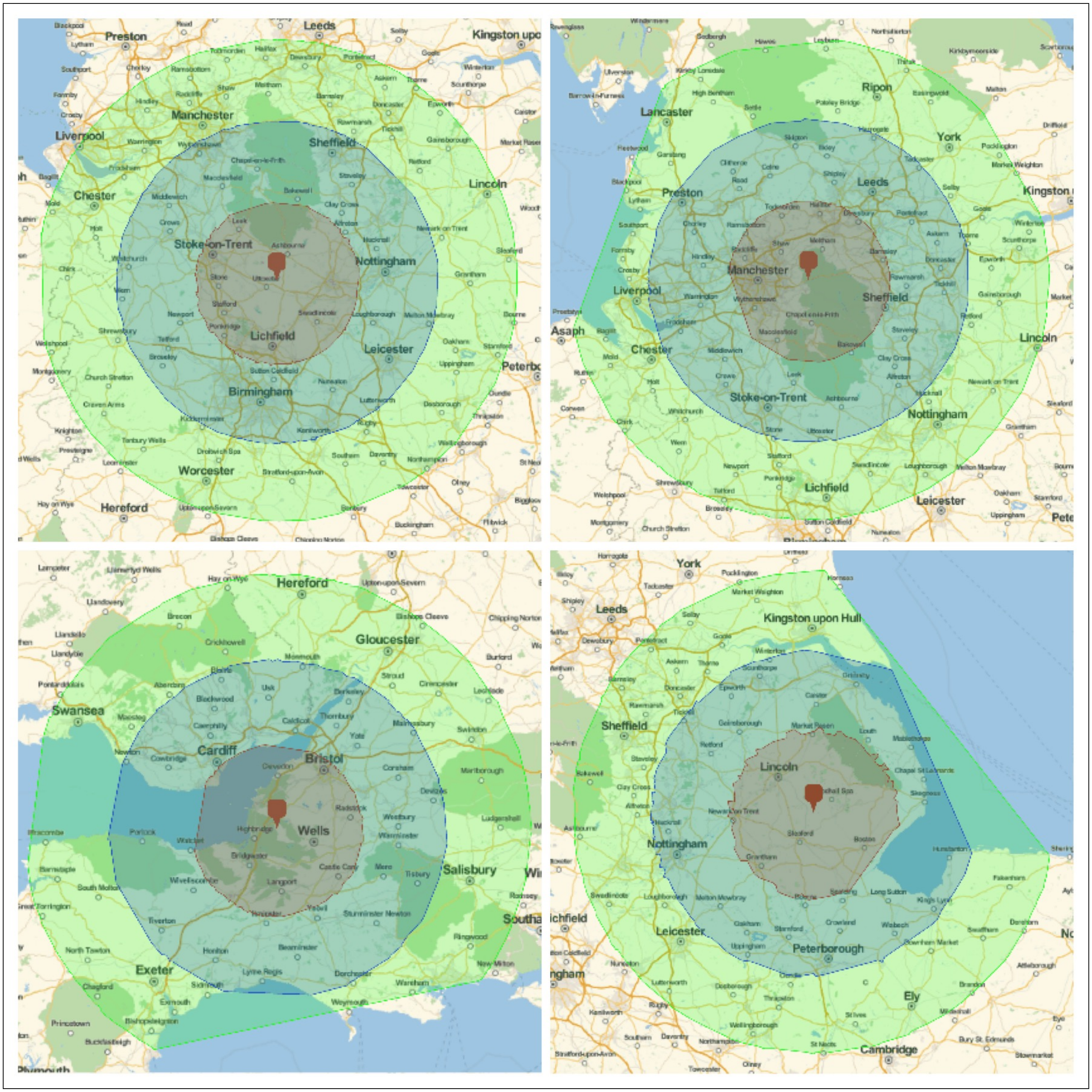

Figure 10: The centre coordinates(shown as a red marker) from the top left in a clockwise manner are {{51.24795, -2.84994}, {53.47421, -1.93367} , {53.10052, -0.32745} and {52.9141, -1.79666}