How does the distance from the town centre affect the variation of the price of amenities?

INVESTIGATING TOBLER’S FIRST LAW AND SPATIAL ANALYSIS



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# **Project Overview**

Since September 2017 I have been applying Tobler’s Law of Spatial Autocorrelation to my home town of Hitchin, this concept is otherwise known as the First Law of Geography and states that *‘everything is related to everything else, but near things are more related than distant things (Tobler 1970)’[[1]](#footnote-1)*. Please see page 4.

There are two main methods of analysing Tobler’s First Law – semivariograms as graphs or my chosen method of spatial analysis – according to GIS Geography[[2]](#footnote-2).

To investigate this law, I have decided to compare the price of a small black coffee across Hitchin. Hitchin is a small town situated in the South-East of England, 31 miles North of central London – the main body of water that flows through Hitchin is the River Hiz. Hitchin is a coffee hot spot, with over 80 places to buy a coffee from in the town centre alone, and approximately £14.3 million spent on coffee each week, what better amenity to consider?

I believe this is a good project to share with my local community.

## **PREDICTION**

As the distance from the town centre increases, the variation in the price of amenities will increase.

## **REASONING**

The distance between each shop will be greater meaning less competition between shops to sell the best priced amenity. Tobler’s Law specifies that the prices will be related but very different at a wide distance. Shops on the High Street compete to give the best value for money as they have a smaller distance between them.

## **RECOMMENDATIONS**

As there is always scope to do more in future I would like to investigate a larger cohort by extending my data collection across all of Hitchin and not just the transect data. This will make my conclusions more reliable. It would also be interesting to see how the price of coffee changes within a big chain branch such as Costa as this could be different in a service station to Hitchin’s town centre.

# **Background Theory**

Tobler’s First Law of Geography states that *‘everything is related to everything else, but near things are more related than distant things (Tobler 1970)’.* This is otherwise known as the ‘nearest neighbour’ concept as closer things are more similar than those further away.

To explain this, I have decided to use a black coffee as a constant as shown in Figure 1. Each lettered box represents a coffee shop on a road. By using the ‘nearest neighbour’ concept and taking the price of coffee shop B as £1.50. I can predict that all 5 coffee shops will have a similar price within the range of £1.50. Looking closer, shop A will be more similar to B than to C, but B will be similar to both A and C. A would also be less similar to D and E.

As a general rule, things that are close together are more likely to be similar.

Figure 1 - Diagram to explain the 'nearest neighbour' concept.

A

E

D

C

B

# **Problem Statement**

What is a coffee? And, more importantly, what *is* a coffee shop? A place that sells coffee? Well, that is a good starting place but does a restaurant or hairdressers count as a coffee shop?

Here, we start to see the problems.

Whilst not seeming to be a coffee shop on the surface, most hairdressers and real estate agencies will serve coffee – even if you are not paying for the coffee directly, this still counts as a coffee shop. Suddenly, I find myself inundated by places that technically count as coffee shops.

Characterising a coffee is another conundrum in itself, a ‘coffee’ is defined as “a hot drink made from the roasted and ground bean-like seeds of a tropical shrub”[[3]](#footnote-3) by the Google dictionary. There are several different types of coffee; americano, latte, mocca – but is a mocca any less of a coffee than an americano? Well, arguably yes as a mocca has the addition of chocolate however, both are hot drinks containing roasted and grounded beans produced from a tropical shrub.

For the purpose of this project, I will use a black coffee as the object of comparison as it is a fair assumption that any coffee shop will sell a black coffee but some coffee shops will not have different variations of milk – they may sell a latte but not necessarily a flat white.

I am investigating how the price of an americano changes as distance from the town centre increases. More problems arise; where is the town centre? How does the town centre change in the day-time to the night-time? Where are the limits of the town?

After careful consideration, I have decided that covering Hitchin as a whole is too big a project and so I have decided to do a transect of 4 roads leading out of the town centre. I have defined the town centre as being the clock tower situated in Hitchin’s Town Square, marked as the red dot in Figure 2.

A control variable to consider is the size of the coffee as this will be a factor in determining the price. To overcome this, I will compare the price of each fluid ounce.

## Parameters

Final parameters feature a small black coffee otherwise known as an americano, Hitchin’s town centre is the clock tower situated in the Town Square. I will be comparing the price per fluid ounce of coffee as different shops will sell different quantities of coffee, another factor to consider is how full the mugs are filled – to the top? Or only half way? My transect consists of; the Town Square, Arcade Walk, Bucklersbury Road, Sun Street, Brand Street, Bedford Road, Bancroft Road, Hermitage Road and the Churchyard.

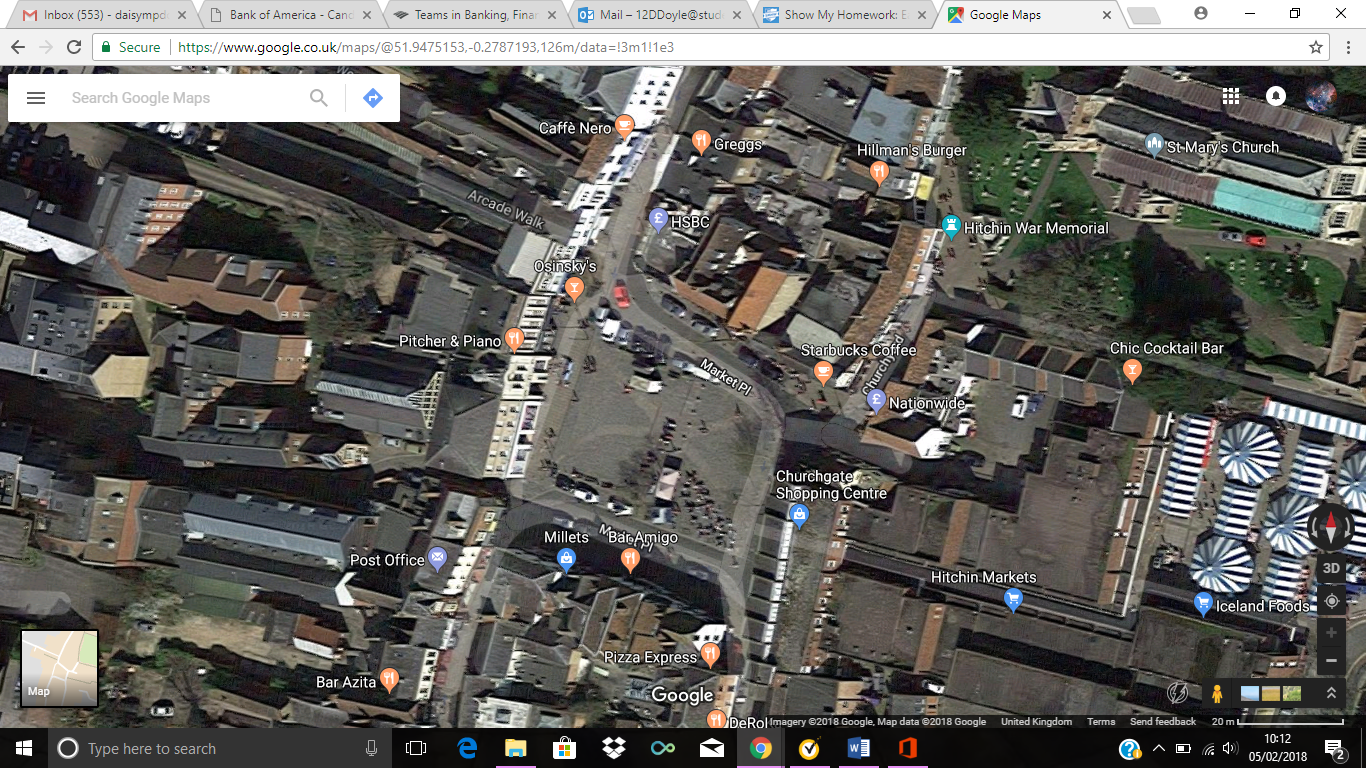
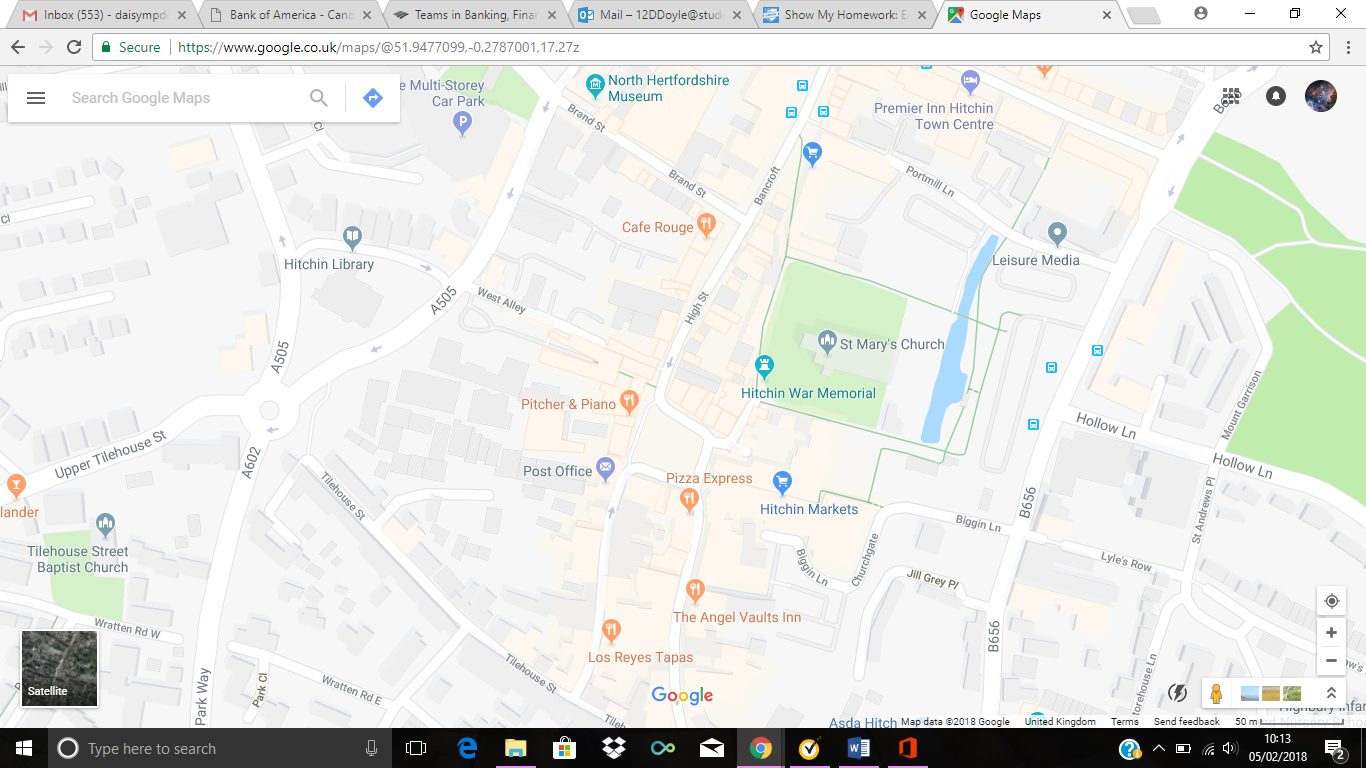


Figure - View of transect.

Figure 3 - Satellite view of Hitchin's town centre.

# **Academic Research**

Table 1 shows and evaluates the credibility and usefulness of the sources I have used as secondary research.

I would like to thank Stephan Gray and the Centre of Advanced Spatial Analysis at University College London for their reading suggestions.

Table 1- Source Table.

|  |  |  |  |
| --- | --- | --- | --- |
| Source | Reference | Creditability | Usefulness |
| Tobler’s First Law of Geography | http://gisgeography.com/tobler-first-law-of-geography/ | GIS Geography is a very credible source.  Tobler is world renowned and highly published. | Although this source lacked detail, a clear explanation of the two of methods of measuring Tobler’s Law given. These were very useful. |
| How to make a map using open data from a spreadsheet. | https://www.gislounge.com/make-map-open-data-using-spreadsheet/ | GIS Geography is a very credible source. | This source helped me to display my data in a clear and easy format that the people of Hitchin would be able to understand. |
| Tobler’s First Law and Spatial Autocorrelation | *Tobler’s First Law and Spatial Autocorrelation* Harvey J. Miller of the University of Utah. | Miller has written multiple reports for the University of Utah. However, this report was written in 2004 and may be outdated. | This source gave a clear explanation of Tobler’s First Law and critically evaluates the relevance of Tobler’s First Law in terms of spatial analysis in 2004. Which is significant in evaluating the usefulness of my project. |
| Top 10 Mapping APIs | <https://www.programmable>  web.com/api/openstreetmap | This is an unknown website to me and blatantly biased. | This source has given me a list of APIs to investigate – I believe it is biased in its evaluations of the various APIs. |
| OpenStreetMap |  | This is credible but not as well known as google and so could create problems when the local community wish to view my data. | This source is very useful but only shows a map view unlike Google’s satellite view. However, in terms of ownership of the data, OSM would allow me to own the data. |
| Google Maps |  | Very credible and easily accessed by anyone. | Google Maps presents reliable data with both a satellite and map view of Hitchin and shows the location of every shop investigated. But due to Google’s licensing agreement I would not maintain ownership of the data. |
| API Information | https://techterms.com/definition/api | This source is credible. | I have included this weblink for the benefit of the reader as I already have prior knowledge of APIs. |
| Rosetta Code | https://rosettacode.org/wiki/Haversine\_formula |  |  |
| Big Mac Index | https://en.wikipedia.org/wiki/Big\_Mac\_Index |  |  |
| Great Circle Distances | https://en.wikipedia.org/wiki/Great-circle\_distance |  |  |

# **Methodology**

On Saturday 17th December 2017 between the hours of 2pm-4pm, myself and 9 peers collected data for the prices and sizes of black coffees in Hitchin.

At 2pm we met by the clock tower in the Town Square. I then briefed them all saying that they needed to identify the price and size in fluid ounces of a small black coffee for each shop/restaurant on the list given to them. We split into 4 groups. Each group carried a Pyrex jug – they had to first poor water into the mug provided at the venue and then poor this water into the jug and record the size in fluid ounces and specify if it was an eat in price or take away.

The experiment ended shortly after 4pm – I then collected the data sheets and entered the data into an Excel Spreadsheet. After this a latitude and longitude were applied to each coffee shop so data could then be exported as a heat map.

## **DATA CAPTURE**

Data was recorded with a form I created. For each coffee shop pre-listed there were spaces for the price (£) and size (fl Oz) for an americano to eat in and to take away. Researchers all used this form correctly and so my data capture was consistent. This data was of a high quality that was fit for purpose and informative.

All forms were collected at the end of the experiment where I check these individually to see that they had been filled in correctly. I also asked the researchers for their comments – research team B stated that coffee shops had been reluctant to let them measure the size of their mugs, The Snug Bar said ‘a mug’ in response to the size of their coffee whereas the Four-Leaf Clover said ‘a couple’. These vague responses were unhelpful and not included in the coffee map. Some coffee shops gave us their sizes in pints or millilitres as not all would let us measure the size with our jugs. This data was still incorporated.

Later that day I entered the data collected into an Excel spreadsheet. I converted all sizes to fluid ounces assuming a pint to be 20 fluid ounces and a fluid ounce to be 29.5735 millilitres. I then calculated the price per fluid ounce of the coffee. My data was verified by an independent assessor.

The original source data has been kept.

## **DATA MANAGEMENT**

Firstly, data was recorded on a paper form. This was then digitalised into an Excel spreadsheet. On 10th February 2018 the latitude and longitude of each shop was recorded with a geo code attached so as to present the data as a heat map.

I have managed my data suitably and ensured a high level of accuracy.

## **INTERPRETATION**

Initially I represented my data in an Excel Spreadsheet. This was the clearest format to show the name, price per fluid ounce, latitude and longitude, please see Table 2. The ID shows the region of Hitchin – 1-4 town square, 5-6 Arcade, 7-9 Bucklersbury Road, 10-14 the Churchyard, 15-17 Sun Street, 18 Bedford Road, 19-29 Hermitage Road and 30 Bancroft Road. These are not exact indicators of the distance from the town centre. Attached is the latitude and longitude of each shop, this is central for the visualisation stage of my project.

EI stands for eat in, TG stands for take away. If neither code is specified, the data provided is just to eat in.

Table 2 - Price per fluid ounce of a small black coffee for various coffee shops in Hitchin.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Name** | **Price per flOz (£)** | **Lattitude** | **Longitude** |
| 2 | Kinetic Cycles | 1.3 | 51.947405 | -0.280064 |
| 30 | Prezzo EI | 0.73 | 51.949785 | -0.277675 |
| 26 | Hermitage Road Café EITG | 0.6 | 51.949506 | -0.275338 |
| 7 | Bar Azita | 0.5 | 51.947043 | -0.279627 |
| 1 | Pitcher and Piano | 0.5 | 51.947612 | -0.279262 |
| 8 | Chilli Banana | 0.46 | 51.946822 | -0.279589 |
| 6 | Hatters Café | 0.43 | 51.948123 | -0.279178 |
| 11 | Chia | 0.38 | 51.948523 | -0.277488 |
| 28 | Fabios Gelato EITG | 0.34 | 51.948000, | -0.27951 |
| 27 | Hermitage Road Restaurant EI | 0.34 | 51.949506 | -0.275338 |
| 9 | Los Reyas Tapas | 0.31 | 51.946365 | -0.279172 |
| 10 | Groundworks | 0.3 | 51.947758 | -0.278084 |
| 16 | Hitchin Coffee LAB EI | 0.3 | 51.946835 | -0.278822 |
| 17 | Hitchin Coffee LAB TG | 0.3 | 51.946835 | -0.278822 |
| 22 | Gatefold Record Lounge EI | 0.28 | 51.949029 | -0.27508 |
| 23 | Gatefold Record Lounge TG | 0.28 | 51.949029 | -0.27508 |
| 12 | Simmons | 0.27 | 51.948551 | -0.277549 |
| 4 | Café Air | 0.25 | 51.947392 | -0.278743 |
| 5 | Rosebud Café | 0.25 | 51.947962 | -0.279346 |
| 19 | Premier Inn (Costa) | 0.22 | 51.949323 | -0.276325 |
| 20 | Hitchin Café EI | 0.2 | 51.949135 | -0.275220 |
| 21 | Hitchin Café TG | 0.2 | 51.949135 | -0.275220 |
| 29 | The Little Deli TG | 0.2 | 51.949618 | -0.27598 |
| 18 | Waitrose | 0.17 | 51.950036 | -0.281822 |
| 3 | Starbucks | 0.16 | 51.947737 | -0.277311 |
| 13 | Frydays EI | 0.14 | 51.947165 | -0.277625 |
| 15 | Quotidian Bakery | 0.12 | 51.945923 | -0.278703 |
| 25 | Town Fryers TG | 0.12 | 51.949275 | -0.274951 |
| 14 | Frydays TG | 0.11 | 51.947165 | -0.277625 |
| 24 | Town Fryers EI | 0.09 | 51.949275 | -0.274951 |
|  |  |  |  |  |

By presenting my data in this format, I could apply filters to sort into price order as shown in the Table 2. Already I have noticed an anomalous result at Kinetic Cycles. However, I cannot compare my results to my question *‘how does the distance from the town centre affect the variation of the prices of local amenities?’* while it is still in this format, hence the need for a visualisation stage.

## **VISUALISTAION**

The clearest method of displaying this data is through a map.

I have decided to use the OpenStreetMap API rather than through Google. This is because Google’s License agreement would force me to surrender my data to Google, unlike OpenStreetMap where I can retain ownership. OpenStreetMap shows a more accurate visualisation of Hitchin with much more detail applied to individual buildings despite not having Google’s satellite viewing option.

API is an acronym for Application Programming Interface, this is a set of code accessible to programmers so they do not have to start a program from scratch. For more information please see the attached footnote[[4]](#footnote-4).

The map was created on the 16th February 2018 with help from my peer Jake Davis. We tried many different methods while trying to understand how to use the Google API. I had already assigned the correct latitude-longitude coordinates to the individual shops in Hitchin by right-clicking the shop on the Google map of Hitchin and then selecting the ‘what’s here?’ option. A box crops up at the base of the page with the name of the road, shop and coordinates. I then copied and pasted the latitude-longitude coordinates into their respective columns of my Excel spreadsheet – this was more reliable than writing the coordinates down by hand for fear of copying an incorrect number.

A problem encountered was that Excel would not hold all of my figures for coordinates ending with a ‘0’ this is because coordinates are written in a decimal format and programs like Excel immediately remove unnecessary data. To overcome this, I set the value of each cell to 6 decimal places.

The first visualisation method we tried was to actually calculate the distance from the town centre using Pythagoras’ Theorem. We found the subtracted the coffee shop latitude coordinate from the clock tower latitude coordinate and then repeated this for the longitude coordinate. I then used the SUMSQ function in Excel – this squares the latitude value and adds this to the square of the longitude value. I then calculated the square root of these values.

In hindsight this was rather counterintuitive as these calculations were not needed when programming the map. Also, the values were so small that they had to be calculated using the scientific form option of Excel – this method was becoming steadily more complicated, especially when we realised we could only compare with arbitrary units instead of metres.

We then tried an alternative method using Excel Macros, this is a very early form of Visual Basic Studio which we were both familiar with although not in this format. This is turn present a whole stream of problems – we started by entering and testing an example program of the Haversine Formula to calculate the distance between London and Paris before applying this to my coffee data. According to Rosetta Code, the Haversine Formula gives ‘the great-circle distances between two points on a sphere from their longitudes and latitudes’[[5]](#footnote-5). A great-circle distance is the shortest distance between two points on the surface of a sphere.

In other words, the previous method of simple trigonometry was proven wrong as the curvature of the Earth was not incorporated. Macros was more sophisticated with a clearer user interface although data could not be outputted in map form.

Our final visualisation method was to surrender to the corruptive yet conducive tyranny that is the Google Maps API. By using Notepad we could save this as a HTML file and program the map. HTML is a programming language that provides the backbone of website programming. This is a simple yet effective programming language and was highly suitable for the task as we could implement some Javascript into our program. Javascript is a more complicated programming language for advanced programmers and we used this to….

When the file is executed, the code in the sub-section HTML FILE page 13, runs and displays a Google Map as its own tab in Google Chrome. Red markers are assigned to each coffee shop that data has been collected for. When the user selects these markers, the name of the coffee shop, price per fluid ounce of coffee and the distance from the clock tower marker in metres is outputted in a text bubble like manner as shown in Figure 4.

There is also a heatmap option on the map labelled ‘Toggle Heatmap’, when this button is pressed the area surrounding various points is colour coded to show both coffee hotspots and areas on the map with higher than average coffee prices coloured in red. Areas further from the town centre or with lower than average prices are coloured with a light green. This heatmap option can be turned on and off. Please see Figure 5.

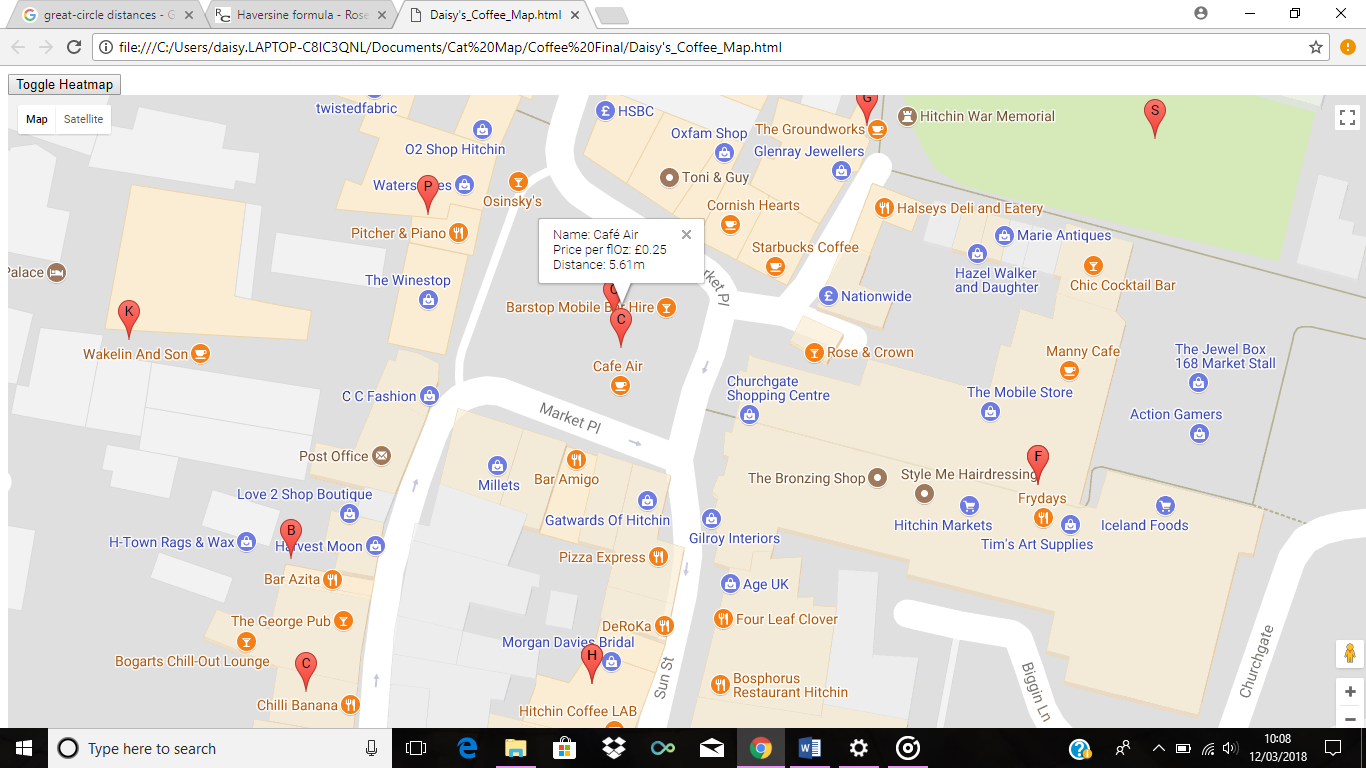


Figure 4 - Displaying coffee data as a text box.

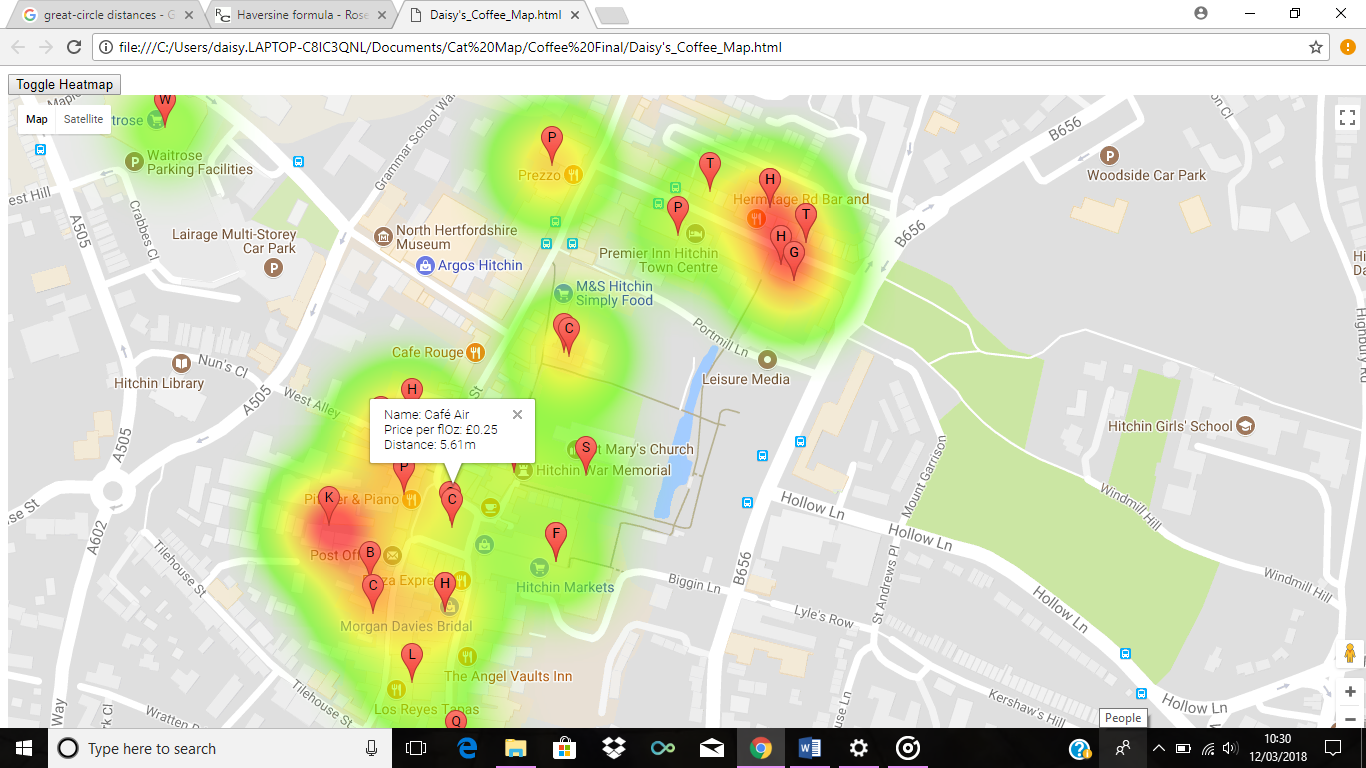


Figure 5 - Heatmap

### **HTML FILE**

<!DOCTYPE html>

<html>

<head>

<style>

#map {

height: 100%;

width: 100%;

position: fixed !important;

}

</style>

</head>

<body>

<button type="button" onclick="toggleHeatmap()">Toggle Heatmap</button>

<div id="map"></div>

<script>

shops = [

{

"ID": 28,

"Name": "Fabios Gelato EITG",

"Price per flOz (£)": 0.34,

"Lattitude": 51.948,

"Longitude": -0.27951,

"Weight": 3

},

{

"ID": 2,

"Name": "Kinetic Cycles",

"Price per flOz (£)": 1.3,

"Lattitude": 51.947405,

"Longitude": -0.280064,

"Weight": 13

},

{

"ID": 4,

"Name": "Café Air",

"Price per flOz (£)": 0.25,

"Lattitude": 51.947392,

"Longitude": -0.278743,

"Weight": 2.5

},

{

"ID": 1,

"Name": "Pitcher and Piano",

"Price per flOz (£)": 0.5,

"Lattitude": 51.947612,

"Longitude": -0.279262,

"Weight": 5

},

{

"ID": 26,

"Name": "Hermitage Road Café EITG",

"Price per flOz (£)": 0.6,

"Lattitude": 51.949506,

"Longitude": -0.275338,

"Weight": 6

},

{

"ID": 22,

"Name": "Gatefold Record Lounge EI",

"Price per flOz (£)": 0.28,

"Lattitude": 51.949029,

"Longitude": -0.27508,

"Weight": 2.5

},

{

"ID": 10,

"Name": "Groundworks",

"Price per flOz (£)": 0.3,

"Lattitude": 51.947758,

"Longitude": -0.278084,

"Weight": 3

},

{

"ID": 7,

"Name": "Bar Azita",

"Price per flOz (£)": 0.5,

"Lattitude": 51.947043,

"Longitude": -0.279627,

"Weight": 5

},

{

"ID": 5,

"Name": "Rosebud Café",

"Price per flOz (£)": 0.25,

"Lattitude": 51.947962,

"Longitude": -0.279346,

"Weight": 2.5

},

{

"ID": 16,

"Name": "Hitchin Coffee LAB EI",

"Price per flOz (£)": 0.3,

"Lattitude": 51.946835,

"Longitude": -0.278822,

"Weight": 3

},

{

"ID": 25,

"Name": "Town Fryers TG",

"Price per flOz (£)": 0.12,

"Lattitude": 51.949275,

"Longitude": -0.274951,

"Weight": 1

},

{

"ID": 23,

"Name": "Gatefold Record Lounge TG",

"Price per flOz (£)": 0.28,

"Lattitude": 51.949029,

"Longitude": -0.27508,

"Weight": 2.5

},

{

"ID": 14,

"Name": "Frydays TG",

"Price per flOz (£)": 0.11,

"Lattitude": 51.947165,

"Longitude": -0.277625,

"Weight": 1

},

{

"ID": 30,

"Name": "Prezzo EI",

"Price per flOz (£)": 0.73,

"Lattitude": 51.949785,

"Longitude": -0.277675,

"Weight": 7

},

{

"ID": 19,

"Name": "Premier Inn (Costa)",

"Price per flOz (£)": 0.22,

"Lattitude": 51.949323,

"Longitude": -0.276325,

"Weight": 2

},

{

"ID": 17,

"Name": "Hitchin Coffee LAB TG",

"Price per flOz (£)": 0.3,

"Lattitude": 51.946835,

"Longitude": -0.278822,

"Weight": 3

},

{

"ID": 12,

"Name": "Simmons",

"Price per flOz (£)": 0.27,

"Lattitude": 51.948551,

"Longitude": -0.277549,

"Weight": 2.5

},

{

"ID": 11,

"Name": "Chia",

"Price per flOz (£)": 0.38,

"Lattitude": 51.948523,

"Longitude": -0.277488,

"Weight": 3.5

},

{

"ID": 9,

"Name": "Los Reyas Tapas",

"Price per flOz (£)": 0.31,

"Lattitude": 51.946365,

"Longitude": -0.279172,

"Weight": 3

},

{

"ID": 15,

"Name": "Quotidian Bakery",

"Price per flOz (£)": 0.12,

"Lattitude": 51.945923,

"Longitude": -0.278703,

"Weight": 1

},

{

"ID": 3,

"Name": "Starbucks",

"Price per flOz (£)": 0.16,

"Lattitude": 51.947737,

"Longitude": -0.277311,

"Weight": 1.5

},

{

"ID": 8,

"Name": "Chilli Banana",

"Price per flOz (£)": 0.46,

"Lattitude": 51.946822,

"Longitude": -0.279589,

"Weight": 4.5

},

{

"ID": 13,

"Name": "Frydays EI",

"Price per flOz (£)": 0.14,

"Lattitude": 51.947165,

"Longitude": -0.277625,

"Weight": 1

},

{

"ID": 6,

"Name": "Hatters Café",

"Price per flOz (£)": 0.43,

"Lattitude": 51.948123,

"Longitude": -0.279178,

"Weight": 4

},

{

"ID": 20,

"Name": "Hitchin Café EI",

"Price per flOz (£)": 0.2,

"Lattitude": 51.949135,

"Longitude": -0.27522,

"Weight": 2

},

{

"ID": 21,

"Name": "Hitchin Café TG",

"Price per flOz (£)": 0.2,

"Lattitude": 51.949135,

"Longitude": -0.27522,

"Weight": 2

},

{

"ID": 29,

"Name": "The Little Deli TG",

"Price per flOz (£)": 0.2,

"Lattitude": 51.949618,

"Longitude": -0.27598,

"Weight": 2

},

{

"ID": 18,

"Name": "Waitrose",

"Price per flOz (£)": 0.17,

"Lattitude": 51.950036,

"Longitude": -0.281822,

"Weight": 1.5

},

{

"ID": 27,

"Name": "Hermitage Road Restaurant EI",

"Price per flOz (£)": 0.34,

"Lattitude": 51.949506,

"Longitude": -0.275338,

"Weight": 3

},

{

"ID": 31,

"Name": "Hitchin Town Football Club TG",

"Price per flOz (£)": 0.1,

"Lattitude": 51.954524,

"Longitude": -0.283709,

"Weight": 1

},

{

"ID": 24,

"Name": "Town Fryers EI",

"Price per flOz (£)": 0.09,

"Lattitude": 51.949275,

"Longitude": -0.274951,

"Weight": 0.5

}

]

function precisionRound(number, precision) {

var factor = Math.pow(10, precision);

return Math.round(number \* factor) / factor;

}

heatmapOn = true;

function toggleHeatmap() {

heatmapOn = !heatmapOn

if (heatmapOn) {

heatmap.setMap(map)

} else {

heatmap.setMap(null)

}

}

/\*function changeGradient() {

var gradient = [

'rgba(0, 255, 255, 0)',

'rgba(0, 255, 255, 1)',

'rgba(0, 191, 255, 1)',

'rgba(0, 127, 255, 1)',

'rgba(0, 63, 255, 1)',

'rgba(0, 0, 255, 1)',

'rgba(0, 0, 223, 1)',

'rgba(0, 0, 191, 1)',

'rgba(0, 0, 159, 1)',

'rgba(0, 0, 127, 1)',

'rgba(63, 0, 91, 1)',

'rgba(127, 0, 63, 1)',

'rgba(191, 0, 31, 1)',

'rgba(255, 0, 0, 1)'

]

heatmap.set('gradient', heatmap.get('gradient') ? null : gradient);

}

function changeRadius() {

heatmap.set('radius', heatmap.get('radius') ? null : 200);

}

function changeOpacity() {

heatmap.set('opacity', heatmap.get('opacity') ? null : 0.2);

}\*/

function getPoints() {

points = []

for (var i = 0; i <= shops.length; i++) {

if (shops[i] != null) {

for (var x = 0; x <= shops[i]["Price per flOz (£)"]\*100; x++) {

points.push(new google.maps.LatLng(shops[i]["Lattitude"], shops[i]["Longitude"]))

}

}

}

return points

}

function initMap() {

var clock\_tower = {lat: 51.947441, lng: -0.278762};

map = new google.maps.Map(document.getElementById('map'), {

zoom: 17,

center: clock\_tower

});

var clockTowerMarker = new google.maps.Marker({

position: clock\_tower,

map: map,

label: "C"

});

heatmap = new google.maps.visualization.HeatmapLayer({

data: getPoints(),

map: map,

radius: 100

});

info = new google.maps.InfoWindow()

for (var i = 0; i <= shops.length; i++) {

shop = shops[i]

marker = new google.maps.Marker({

position: {lat: shop["Lattitude"], lng: shop["Longitude"]},

map: map,

label: shop["Name"][0],

id: shop["ID"]

});

(function(marker,shop){

google.maps.event.addListener(marker, 'click', function() {

console.log(marker); console.log(shop);

distance = google.maps.geometry.spherical.computeDistanceBetween (clockTowerMarker["position"], marker["position"]);

content = "Name: " + shop["Name"] + "</br>Price per flOz: £" + shop["Price per flOz (£)"] + "</br>Distance: " + precisionRound(distance, 2) + "m"

info.setContent(content)

info.open(map, marker)

});

})(marker,shop);

}

}

</script>

<script async defer

src="https://maps.googleapis.com/maps/api/js?key=AIzaSyD9BoiO6IDSLETjyByFq36RfcZmcgKIpGU&callback=initMap&sensor=false&v=3&libraries=geometry,visualization">

</script>

</body>

</html>

# **Data Analysis**

The distance from the town centre has little effect on the variation of the price of amenities but rather the distribution of shops and restaurants. In respect to coffee prices, Hermitage Road seems to be the centre of coffee in Hitchin, with the greatest coffee shop density in Hitchin. An anomalous result is Kinetic Cycles, 89.43m East of the clock tower. The recorded price was £1.30 per fluid ounce of coffee which is dramatically high considering the next highest americano price is Prezzo at £0.74 per fluid ounce which is understandable considering the mug size is 4 fluid ounces hence why the Kinetic Cycles result stood out to me. Returning to the original paper record sheets I discovered the data for Kinetic Cycles had been recorded as £2.20 for a 50ml shot of coffee, after speaking to the coffee collectors for the town square area I was informed that the coffee shop refused to let them measure the size of the mug using our water pouring in method and were instead informed that a 50ml shot of coffee was added in without knowing the volume of water.

This anomalous result gave me more ideas for future improvements; I would like to consider the ratio of coffee beans to water within the mugs and also find from coffee shops where they buy their coffee beans from. This would be interesting to analyse to see if there is a correlation between distance from coffee source to the coffee shop, the ratio of coffee beans to water and the price of a small black americano. Of course, I would need to keep in mind that correlation does not mean causation – the distance coffee beans are transferred and the quantity of coffee beans used in an americano may play into the price of an americano but are not the sole factors in determining this price. This would be a logical mistake to make considering the factors investigated.

In terms of distance from the town centre affecting the price of americanos, there seems to be some hold on this as Waitrose is the furthest point plotted at 357.11m and has one of the lowest prices at £0.17 per fluid ounces as oppose to Bar Azita which is 74.07m from the town centre at a cost of £0.50 per fluid ounce. However, this is a week trend in respect to the high prices of Hermitage Road.

In respect to Tobler’s First Law of Geography where everything is connected but near things are more similar than those further away; I believe my data provides evidence to support this theory. When looking at coffee hotspots at the Western end of Hermitage Road and the West Alley roads; all of these prices are very similar to each other but not as similar to those shops that are further away. Hermitage Road Restaurant has a price of £0.34 per fluid ounce, across the road from here is Gatefold Record Lounge with a price of £0.28 per fluid ounce this only has a price difference of £0.06 per fluid ounce. The Hitchin Café has a price of £0.20 per fluid ounce, although this is only £0.08 per fluid ounce difference to the Gatefold Record Lounge, this is a £0.14 per fluid ounce price difference to the Hermitage Road Restaurant which is 20m further from the Hitchin Café than Gatefold Record Lounge. This support my hypothesis that ‘near things are more similar than those further away’.

1. *Tobler’s First Law and Spatial Autocorrelation* Harvey J. Miller of the University of Utah. http://www.tandfonline.com/doi/abs/10.1111/j.1467-8306.2004.09402005.x [↑](#footnote-ref-1)
2. http://gisgeography.com/tobler-first-law-of-geography/ [↑](#footnote-ref-2)
3. https://www.google.co.uk/search?safe=strict&rlz=1C1GGRV\_enGB774&ei=SzUlWrqLNMHqULbVjMgM&q=define+coffee&oq=define+coffee&gs\_l=psy-ab.3..0l10.695981.698470.0.698669.13.13.0.0.0.0.159.1053.8j5.13.0....0...1.1.64.psy-ab..0.13.1048...0i131k1j0i67k1j0i131i67k1j0i10k1.0.sTYlv-0nPUg [↑](#footnote-ref-3)
4. https://techterms.com/definition/api [↑](#footnote-ref-4)
5. https://rosettacode.org/wiki/Haversine\_formula [↑](#footnote-ref-5)