ML

#Loading the packages

```
library(dplyr)

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union

library(tidyr)
library(broom)
library(purrr)
library(ggplot2)
library(plotly)

##
## Attaching package: 'plotly'

## The following object is masked from 'package:ggplot2':
##
##     last_plot

## The following object is masked from 'package:stats':
##
##     filter

## The following object is masked from 'package:graphics':
##
##     layout

library(rgdal)

## Loading required package: sp

## Please note that rgdal will be retired by the end of 2023,
## plan transition to sf/stars/terra functions using GDAL and PROJ
## at your earliest convenience.
##
## rgdal: version: 1.5-27, (SVN revision 1148)
## Geospatial Data Abstraction Library extensions to R successfully loaded
## Loaded GDAL runtime: GDAL 3.2.1, released 2020/12/29
## Path to GDAL shared files:
```

```
/Users/taliadagan/Library/R/x86_64/4.1/library/rgdal/gdal
## GDAL binary built with GEOS: TRUE
## Loaded PROJ runtime: Rel. 7.2.1, January 1st, 2021, [PJ_VERSION: 721]
## Path to PROJ shared files:
/Users/taliadagan/Library/R/x86_64/4.1/library/rgdal/proj
## PROJ CDN enabled: FALSE
## Linking to sp version:1.4-5
## To mute warnings of possible GDAL/OSR exportToProj4() degradation,
## use options("rgdal_show_exportToProj4_warnings"="none") before loading sp
or rgdal.
## Overwritten PROJ_LIB was
/Users/taliadagan/Library/R/x86_64/4.1/library/rgdal/proj

library(leaflet)
library(RColorBrewer)
library(colorRamps)
library(maps)

##
## Attaching package: 'maps'

## The following object is masked from 'package:purrr':
##
##     map

library(mapproj)
library(formattable)

##
## Attaching package: 'formattable'

## The following object is masked from 'package:plotly':
##
##     style

library(spdep)

## Loading required package: spData

## To access larger datasets in this package, install the spDataLarge
## package with: `install.packages('spDataLarge',
## repos='https://nowosad.github.io/drat/', type='source')`

## Loading required package: sf

## Linking to GEOS 3.8.1, GDAL 3.2.1, PROJ 7.2.1
```

#Reading the London Crime Dataset

```
Myfile <- read.csv('london_crime_by_lsoa.csv')
summary(Myfile)
```

```
##    lsoa_code            borough          major_category        minor_category
##  Length:10555        Length:10555        Length:10555        Length:10555
##  Class :character    Class :character    Class :character    Class :character
##  Mode  :character    Mode  :character    Mode  :character    Mode  :character
##
##
##
##
##      value               year              month             Longitude
##  Min.   : 0.00    Min.   :2008    Min.   : 1.000    Min.    :-0.45140
##  1st Qu.: 0.00    1st Qu.:2010    1st Qu.: 4.000    1st Qu.:-0.21219
##  Median : 0.00    Median :2012    Median : 6.000    Median :-0.11739
##  Mean   : 0.49    Mean   :2012    Mean   : 6.506    Mean    :-0.12417
##  3rd Qu.: 1.00    3rd Qu.:2014    3rd Qu.: 9.000    3rd Qu.:-0.01171
##  Max.   :72.00    Max.   :2016    Max.   :12.000    Max.    : 0.21276
##                                                     NA's    :7
##      Latitude
##  Min.   :51.37
##  1st Qu.:51.46
##  Median :51.51
##  Mean   :51.52
##  3rd Qu.:51.58
##  Max.   :51.67
##  NA's   :7
```

#Clustering using Hierarchial Clustering

```r
library(sp)
library(rgdal)
library(geosphere)

#Removing missing values from the dataset
X <- na.omit(Myfile)
xy <- X[,8:9]

#converting points into a spatialpoints data frame
spdf <- SpatialPointsDataFrame(coords = xy, data = X,
                        proj4string = CRS("+proj=longlat +datum=WGS84
+ellps=WGS84 +towgs84=0,0,0"))

# use the distm function to generate a geodesic distance matrix in meters
mdist <- distm(spdf)


# cluster all points using hierarchical clustering
hc <- hclust(as.dist(mdist), method="complete")
hc

##
## Call:
```

```
## hclust(d = as.dist(mdist), method = "complete")
##
## Cluster method   : complete
## Number of objects: 10548
```

```
# define the distance threshold, in this case an average of 500
d=1000
# define clusters based on a tree "height" cutoff "d" and add them to the
SpDataFrame
spdf$clust <- cutree(hc, h=d)

#visualizing the spatial data
library(sp)
library(rgdal)
data(spdf)
```

```
## Warning in data(spdf): data set 'spdf' not found
```

```
coordinates(spdf)
```

```
##          Longitude Latitude
## 1      -0.09631794 51.38259
## 2       0.01003716 51.49328
## 3       0.01400743 51.41045
## 4       0.08250620 51.59773
## 5      -0.18901141 51.45894
## 6      -0.30342843 51.51473
## 7      -0.30342843 51.51473
## 8      -0.37384439 51.46939
## 9       0.03307815 51.53119
## 10     -0.19514135 51.36602
## 11     -0.11461497 51.59851
## 12     -0.12266768 51.46062
## 13     -0.30320903 51.46316
## 14     -0.18901141 51.45894
## 15     -0.45140058 51.54113
## 16      0.21276082 51.58296
## 17      0.12988840 51.56167
## 18      0.08250620 51.59773
## 19     -0.30138440 51.41824
## 20     -0.19514135 51.36602
## 21      0.08250620 51.59773
## 22     -0.13704033 51.50553
## 23     -0.07450626 51.58104
## 24     -0.11738716 51.66902
## 25     -0.30342843 51.51473
## 26     -0.07450626 51.58104
## 27     -0.33994379 51.58901
## 28     -0.30342843 51.51473
## 29     -0.11461497 51.59851
## 30     -0.01170935 51.44908
```

```
## 31      -0.30342843 51.51473
## 32      -0.37384439 51.46939
## 33       0.01400743 51.41045
## 34       0.21276082 51.58296
## 35      -0.45140058 51.54113
## 36      -0.27106553 51.57616
## 37      -0.11461497 51.59851
## 38      -0.37384439 51.46939
## 39      -0.12266768 51.46062
## 40      -0.08912003 51.51082
## 41       0.21276082 51.58296
## 42       0.03307815 51.53119
## 43      -0.09631794 51.38259
## 44      -0.09631794 51.38259
## 45      -0.19562056 51.66238
## 46      -0.00902464 51.59495
## 47      -0.13704033 51.50553
## 48      -0.12266768 51.46062
## 49      -0.01170935 51.44908
## 50       0.01400743 51.41045
## 51      -0.30342843 51.51473
## 52      -0.27106553 51.57616
## 53      -0.11461497 51.59851
## 54      -0.16211228 51.55180
## 55       0.15157167 51.44755
## 56      -0.09631794 51.38259
## 57      -0.01170935 51.44908
## 58      -0.37384439 51.46939
## 59      -0.16211228 51.55180
## 60      -0.19246075 51.50498
## 61      -0.37384439 51.46939
## 62      -0.01170935 51.44908
## 63      -0.30138440 51.41824
## 64      -0.27106553 51.57616
## 65      -0.08912003 51.51082
## 66      -0.33994379 51.58901
## 67       0.01400743 51.41045
## 68      -0.12266768 51.46062
## 69      -0.00902464 51.59495
## 70      -0.10215668 51.54494
## 71      -0.08912003 51.51082
## 72       0.03307815 51.53119
## 73      -0.19562056 51.66238
## 74      -0.27106553 51.57616
## 75      -0.13704033 51.50553
## 76       0.01003716 51.49328
## 77       0.08250620 51.59773
## 78      -0.07450626 51.58104
## 79      -0.11461497 51.59851
## 80      -0.19514135 51.36602
```

```
## 81      0.08250620 51.59773
## 82     -0.07450626 51.58104
## 83     -0.02797504 51.52616
## 84     -0.09631794 51.38259
## 85     -0.23053203 51.50705
## 86     -0.10215668 51.54494
## 87      0.03307815 51.53119
## 88     -0.33994379 51.58901
## 89     -0.27106553 51.57616
## 90      0.01400743 51.41045
## 91     -0.07450626 51.58104
## 92     -0.09631794 51.38259
## 93     -0.30342843 51.51473
## 94     -0.07450626 51.58104
## 95      0.03307815 51.53119
## 96     -0.11461497 51.59851
## 97      0.21276082 51.58296
## 98     -0.19514135 51.36602
## 99      0.15157167 51.44755
## 100    -0.19562056 51.66238
## 101     0.01003716 51.49328
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## 104    -0.37384439 51.46939
## 105     0.08250620 51.59773
## 106    -0.37384439 51.46939
## 107     0.01400743 51.41045
## 108    -0.19246075 51.50498
## 109    -0.30342843 51.51473
## 110    -0.30138440 51.41824
## 111    -0.07450626 51.58104
## 112    -0.30320903 51.46316
## 113     0.21276082 51.58296
## 114    -0.08912003 51.51082
## 115    -0.30138440 51.41824
## 116     0.03307815 51.53119
## 117    -0.19246075 51.50498
## 118    -0.30342843 51.51473
## 119    -0.01170935 51.44908
## 120    -0.19562056 51.66238
## 121    -0.09631794 51.38259
## 122     0.12988840 51.56167
## 123    -0.12266768 51.46062
## 124    -0.08912003 51.51082
## 125    -0.37384439 51.46939
## 126    -0.12266768 51.46062
## 127    -0.30320903 51.46316
## 128    -0.00902464 51.59495
## 129    -0.21219045 51.41654
## 130    -0.23053203 51.50705
```

```
## 131     -0.01170935 51.44908
## 132     -0.27106553 51.57616
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## 134     -0.30320903 51.46316
## 135     -0.13704033 51.50553
## 136     -0.16211228 51.55180
## 137      0.12988840 51.56167
## 138      0.12988840 51.56167
## 139      0.12988840 51.56167
## 140     -0.09631794 51.38259
## 141     -0.23053203 51.50705
## 142     -0.01170935 51.44908
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## 152     -0.00902464 51.59495
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```

```
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```

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## 421    -0.23053203 51.50705
## 422    -0.07450626 51.58104
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## 1455    0.12988840 51.56167
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## 1460   -0.19514135 51.36602
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## 1631   -0.12266768 51.46062
```

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## 1641   -0.19246075 51.50498
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## 1680   -0.12266768 51.46062
## 1681    0.15157167 51.44755
```

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## 1687    -0.02797504 51.52616
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## 1693    -0.30138440 51.41824
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## 1695    -0.23053203 51.50705
## 1697    -0.02797504 51.52616
## 1698    -0.08912003 51.51082
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## 1898   -0.30138440 51.41824
## 1899   -0.01170935 51.44908
## 1900   -0.23053203 51.50705
## 1901    0.01400743 51.41045
## 1902   -0.30138440 51.41824
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## 1905   -0.19246075 51.50498
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## 1913   -0.11738716 51.66902
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## 1916    0.01400743 51.41045
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## 1931   -0.27106553 51.57616
## 1932   -0.30320903 51.46316
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## 1935   -0.02797504 51.52616
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## 1938   -0.19514135 51.36602
## 1939   -0.07450626 51.58104
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## 1958   -0.13704033 51.50553
## 1959   -0.01170935 51.44908
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## 1961   -0.33994379 51.58901
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## 1981   -0.08912003 51.51082
## 1982   -0.11738716 51.66902
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## 1995     0.08250620 51.59773
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## 2021     0.03307815 51.53119
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## 2028    -0.01170935 51.44908
## 2029     0.01400743 51.41045
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## 2031     0.01400743 51.41045
## 2032    -0.30342843 51.51473
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## 2033    0.03307815 51.53119
## 2034   -0.30342843 51.51473
## 2035    0.12988840 51.56167
## 2036    0.21276082 51.58296
## 2037   -0.10215668 51.54494
## 2038   -0.08912003 51.51082
## 2039   -0.19514135 51.36602
## 2040   -0.02797504 51.52616
## 2041   -0.19562056 51.66238
## 2042   -0.37384439 51.46939
## 2043   -0.30342843 51.51473
## 2044    0.15157167 51.44755
## 2045   -0.21219045 51.41654
## 2046    0.15157167 51.44755
## 2047   -0.07450626 51.58104
## 2048    0.12988840 51.56167
## 2049   -0.08912003 51.51082
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## 2051   -0.09631794 51.38259
## 2052    0.21276082 51.58296
## 2053    0.01003716 51.49328
## 2054   -0.33994379 51.58901
## 2055   -0.21219045 51.41654
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## 2057   -0.08912003 51.51082
## 2058   -0.30342843 51.51473
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## 2061   -0.02797504 51.52616
## 2062   -0.37384439 51.46939
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## 2064    0.21276082 51.58296
## 2065   -0.18901141 51.45894
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## 2076   -0.30138440 51.41824
## 2077    0.03307815 51.53119
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## 2079   -0.19246075 51.50498
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## 2081   -0.19514135 51.36602
## 2082   -0.16211228 51.55180
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## 2085    -0.13704033 51.50553
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## 2087    -0.12266768 51.46062
## 2088    -0.19246075 51.50498
## 2089    -0.19562056 51.66238
## 2090     0.21276082 51.58296
## 2091     0.01003716 51.49328
## 2092     0.08250620 51.59773
## 2093     0.15157167 51.44755
## 2094    -0.33994379 51.58901
## 2095    -0.27106553 51.57616
## 2096     0.03307815 51.53119
## 2097    -0.18901141 51.45894
## 2098     0.15157167 51.44755
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## 2105    -0.10215668 51.54494
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## 2124    -0.02797504 51.52616
## 2125    -0.37384439 51.46939
## 2126    -0.19514135 51.36602
## 2127    -0.11461497 51.59851
## 2128     0.08250620 51.59773
## 2129    -0.02797504 51.52616
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```

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## 2135   -0.30342843 51.51473
## 2136   -0.16211228 51.55180
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## 2138    0.12988840 51.56167
## 2139   -0.08912003 51.51082
## 2140   -0.09631794 51.38259
## 2141   -0.30342843 51.51473
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## 2144    0.03307815 51.53119
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## 2146   -0.45140058 51.54113
## 2147   -0.18901141 51.45894
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## 2158   -0.19514135 51.36602
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## 2161   -0.09631794 51.38259
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## 2163   -0.13704033 51.50553
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## 2165   -0.02797504 51.52616
## 2166    0.03307815 51.53119
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## 2169   -0.13704033 51.50553
## 2170   -0.33994379 51.58901
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## 2174   -0.08912003 51.51082
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## 2176   -0.37384439 51.46939
## 2177    0.12988840 51.56167
## 2178   -0.18901141 51.45894
## 2179   -0.33994379 51.58901
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## 2181    0.21276082 51.58296
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## 2191   -0.10215668 51.54494
## 2192   -0.11461497 51.59851
## 2193   -0.30320903 51.46316
## 2194   -0.11738716 51.66902
## 2195    0.15157167 51.44755
## 2196    0.21276082 51.58296
## 2197   -0.10215668 51.54494
## 2198   -0.12266768 51.46062
## 2199   -0.30342843 51.51473
## 2200   -0.19562056 51.66238
## 2201   -0.21219045 51.41654
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## 2203    0.01400743 51.41045
## 2204   -0.30342843 51.51473
## 2205   -0.11738716 51.66902
## 2206   -0.16211228 51.55180
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## 2211   -0.13704033 51.50553
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## 2219   -0.19514135 51.36602
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## 2228    0.12988840 51.56167
## 2229   -0.23053203 51.50705
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## 2382   -0.23053203 51.50705
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## 2387   -0.02797504 51.52616
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## 2928    0.21276082 51.58296
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## 2931   -0.18901141 51.45894
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## 10370  0.01400743 51.41045
## 10371 -0.19562056 51.66238
## 10372 -0.08912003 51.51082
## 10373 -0.18901141 51.45894
## 10374  0.01400743 51.41045
## 10375  0.21276082 51.58296
## 10376 -0.19562056 51.66238
## 10377  0.08250620 51.59773
## 10378  0.01003716 51.49328
## 10379 -0.13704033 51.50553
## 10380 -0.45140058 51.54113
## 10381  0.21276082 51.58296
## 10382 -0.16211228 51.55180
## 10383  0.01003716 51.49328
## 10384 -0.27106553 51.57616
## 10385 -0.07450626 51.58104
## 10386 -0.19246075 51.50498
## 10387 -0.09631794 51.38259
```

```
## 10388 -0.19246075 51.50498
## 10389 -0.10215668 51.54494
## 10390 -0.30138440 51.41824
## 10391  0.15157167 51.44755
## 10392 -0.13704033 51.50553
## 10393 -0.10215668 51.54494
## 10394 -0.07450626 51.58104
## 10395 -0.30342843 51.51473
## 10396 -0.19246075 51.50498
## 10397 -0.19246075 51.50498
## 10398 -0.12266768 51.46062
## 10399 -0.37384439 51.46939
## 10400 -0.18901141 51.45894
## 10401 -0.11738716 51.66902
## 10402 -0.00902464 51.59495
## 10403  0.15157167 51.44755
## 10404 -0.45140058 51.54113
## 10405  0.08250620 51.59773
## 10406 -0.11461497 51.59851
## 10407 -0.27106553 51.57616
## 10408 -0.08912003 51.51082
## 10409 -0.19562056 51.66238
## 10410 -0.27106553 51.57616
## 10411 -0.08912003 51.51082
## 10412 -0.11738716 51.66902
## 10413 -0.02797504 51.52616
## 10414 -0.37384439 51.46939
## 10415  0.08250620 51.59773
## 10416 -0.18901141 51.45894
## 10417 -0.30342843 51.51473
## 10418  0.21276082 51.58296
## 10419 -0.12266768 51.46062
## 10420 -0.30138440 51.41824
## 10421 -0.30320903 51.46316
## 10422 -0.13704033 51.50553
## 10423  0.08250620 51.59773
## 10424 -0.12266768 51.46062
## 10425 -0.07450626 51.58104
## 10426 -0.19562056 51.66238
## 10427  0.03307815 51.53119
## 10428 -0.11738716 51.66902
## 10429 -0.08912003 51.51082
## 10430 -0.45140058 51.54113
## 10431 -0.13704033 51.50553
## 10432  0.15157167 51.44755
## 10433 -0.45140058 51.54113
## 10434 -0.19246075 51.50498
## 10435 -0.27106553 51.57616
## 10436  0.01003716 51.49328
## 10437  0.15157167 51.44755
```

```
## 10438 -0.09631794 51.38259
## 10439 -0.09631794 51.38259
## 10440 -0.19246075 51.50498
## 10441 -0.33994379 51.58901
## 10442 -0.08912003 51.51082
## 10443 -0.30342843 51.51473
## 10444 -0.12266768 51.46062
## 10445 -0.18901141 51.45894
## 10446 -0.33994379 51.58901
## 10447 -0.00902464 51.59495
## 10448  0.01003716 51.49328
## 10449 -0.30320903 51.46316
## 10450 -0.00902464 51.59495
## 10451 -0.11738716 51.66902
## 10452 -0.30320903 51.46316
## 10453 -0.13704033 51.50553
## 10454  0.01003716 51.49328
## 10455  0.01400743 51.41045
## 10456  0.21276082 51.58296
## 10457 -0.19514135 51.36602
## 10458 -0.27106553 51.57616
## 10459 -0.10215668 51.54494
## 10460  0.01400743 51.41045
## 10461 -0.09631794 51.38259
## 10462 -0.00902464 51.59495
## 10463 -0.27106553 51.57616
## 10464  0.03307815 51.53119
## 10465 -0.02797504 51.52616
## 10466 -0.08912003 51.51082
## 10467 -0.18901141 51.45894
## 10468 -0.30320903 51.46316
## 10469  0.12988840 51.56167
## 10470  0.01003716 51.49328
## 10471 -0.33994379 51.58901
## 10472 -0.13704033 51.50553
## 10473 -0.01170935 51.44908
## 10474  0.08250620 51.59773
## 10475 -0.37384439 51.46939
## 10476 -0.09631794 51.38259
## 10477 -0.19562056 51.66238
## 10478 -0.02797504 51.52616
## 10479 -0.01170935 51.44908
## 10480  0.03307815 51.53119
## 10481 -0.11461497 51.59851
## 10482 -0.00902464 51.59495
## 10483  0.03307815 51.53119
## 10484 -0.30342843 51.51473
## 10485 -0.19514135 51.36602
## 10486 -0.02797504 51.52616
## 10487 -0.30138440 51.41824
```

```
## 10488 -0.07450626 51.58104
## 10489 -0.45140058 51.54113
## 10490 -0.45140058 51.54113
## 10491  0.21276082 51.58296
## 10492 -0.33994379 51.58901
## 10493 -0.08912003 51.51082
## 10494 -0.11738716 51.66902
## 10495  0.21276082 51.58296
## 10496  0.08250620 51.59773
## 10497  0.03307815 51.53119
## 10498 -0.18901141 51.45894
## 10499 -0.13704033 51.50553
## 10500 -0.19562056 51.66238
## 10501 -0.01170935 51.44908
## 10502  0.08250620 51.59773
## 10503 -0.07450626 51.58104
## 10504 -0.33994379 51.58901
## 10505 -0.18901141 51.45894
## 10506 -0.21219045 51.41654
## 10507  0.08250620 51.59773
## 10508 -0.23053203 51.50705
## 10509 -0.19246075 51.50498
## 10510  0.01400743 51.41045
## 10511 -0.30342843 51.51473
## 10512 -0.27106553 51.57616
## 10513 -0.11738716 51.66902
## 10514 -0.45140058 51.54113
## 10515 -0.10215668 51.54494
## 10516 -0.08912003 51.51082
## 10517  0.01400743 51.41045
## 10518 -0.11461497 51.59851
## 10519 -0.09631794 51.38259
## 10520 -0.08912003 51.51082
## 10521 -0.37384439 51.46939
## 10522 -0.30342843 51.51473
## 10523  0.01003716 51.49328
## 10524 -0.19246075 51.50498
## 10525 -0.23053203 51.50705
## 10526 -0.33994379 51.58901
## 10527 -0.08912003 51.51082
## 10528  0.12988840 51.56167
## 10529 -0.23053203 51.50705
## 10530 -0.16211228 51.55180
## 10531  0.12988840 51.56167
## 10532  0.03307815 51.53119
## 10533 -0.30320903 51.46316
## 10534 -0.01170935 51.44908
## 10535 -0.01170935 51.44908
## 10536 -0.19514135 51.36602
## 10537 -0.30138440 51.41824
```

```
## 10538  0.12988840 51.56167
## 10539 -0.01170935 51.44908
## 10540 -0.19562056 51.66238
## 10541  0.21276082 51.58296
## 10542 -0.19514135 51.36602
## 10543 -0.07450626 51.58104
## 10544 -0.21219045 51.41654
## 10545  0.12988840 51.56167
## 10546 -0.30342843 51.51473
## 10547  0.08250620 51.59773
## 10548 -0.09631794 51.38259
## 10549  0.01400743 51.41045
## 10550  0.01400743 51.41045
## 10551 -0.30342843 51.51473
## 10552 -0.07450626 51.58104
## 10553  0.15157167 51.44755
## 10554 -0.11738716 51.66902
## 10555 -0.09631794 51.38259
```

```r
# by default plots the points
plot(spdf)
```
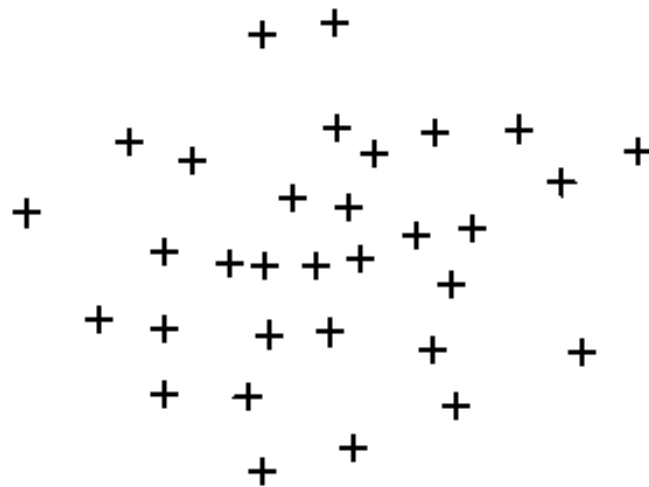
```
cc <- coordinates(spdf)
m.sl <- SpatialLines(list(Lines(list(Line(cc)), "line1")))
# plots lines connecting all the points
plot(m.sl)
```
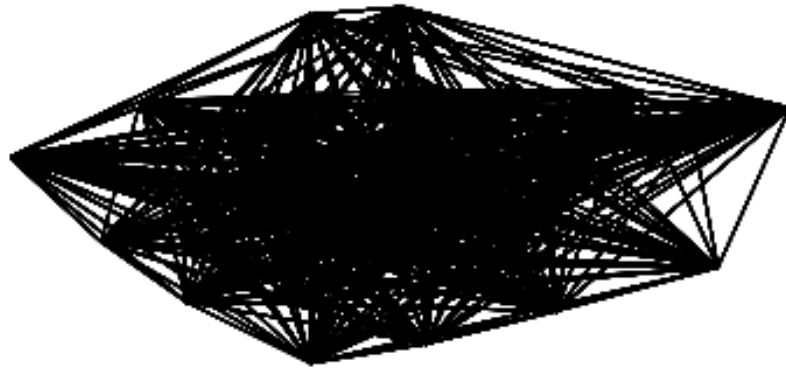


```
library(dismo)

## Loading required package: raster

##
## Attaching package: 'raster'

## The following object is masked from 'package:plotly':
##
##      select

## The following object is masked from 'package:dplyr':
##
##      select

library(rgeos)

## rgeos version: 0.5-8, (SVN revision 679)
##  GEOS runtime version: 3.8.1-CAPI-1.13.3
##  Please note that rgeos will be retired by the end of 2023,
```

```
## plan transition to sf functions using GEOS at your earliest convenience.
##  Linking to sp version: 1.4-5
##  Polygon checking: TRUE

# expand the extent of plotting frame
spdf@bbox[] <- as.matrix(extend(extent(spdf),0.01))

# get the centroid coords for each cluster
cent <- matrix(ncol=2, nrow=max(spdf$clust))
for (i in 1:max(spdf$clust))
    # Centroid from the rgeos package
    cent[i,] <- gCentroid(subset(spdf, clust == i))@coords

# compute circles around the centroid coords using a 1000 m radius from the
dismo package
ci <- circles(cent, d=d, lonlat=T)

# plot
plot(ci@polygons, axes=T)
plot(spdf, col=rainbow(4)[factor(spdf$clust)], add=T)
```



```
#Plotting the dendrogram
plot(hc, cex = 0.65, hang = -1, main = "Dendrogram of Coordinates")
```

Dendrogram of Coordinates

as.dist(mdist)
hclust (*, "complete")

##Based on the dendrogram, you can see that 7 clusters are appropriate for this data set.

```
#plotting dendrogram
plot(hc, cex = .5)
rect.hclust(hc, k=7, border= 1:7)
```

Cluster Dendrogram
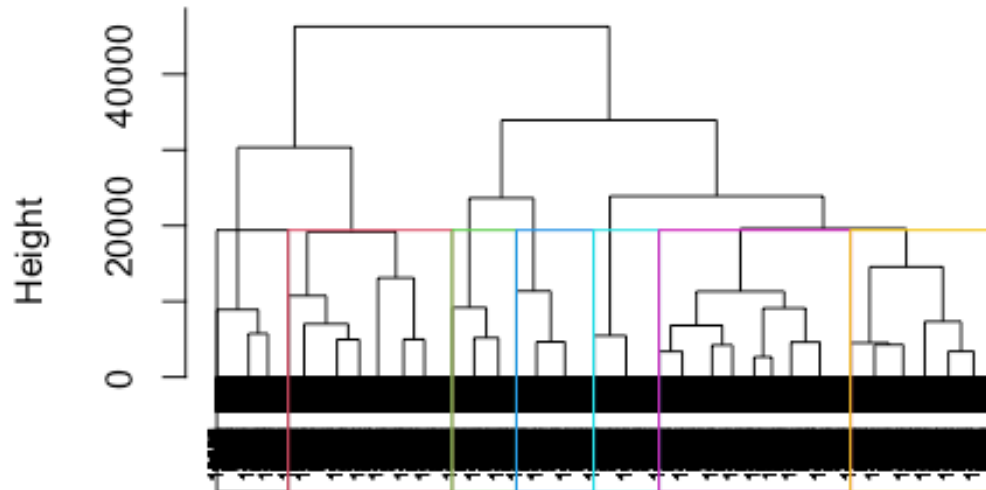
as.dist(mdist)
hclust (*, "complete")

```
#Using cutree to identify the clusters
clust <- cutree(hc, k=7)
table(clust)

## clust
##    1    2    3    4    5    6    7
##  965 1979 1045  869 2589 2217  884
```

##Clustering using K-Means method.

```
library(caret)

## Loading required package: lattice

##
## Attaching package: 'caret'

## The following object is masked from 'package:purrr':
##
##     lift

library(reshape)

##
## Attaching package: 'reshape'
```

```
## The following object is masked from 'package:plotly':
##
##     rename

## The following objects are masked from 'package:tidyr':
##
##     expand, smiths

## The following object is masked from 'package:dplyr':
##
##     rename

library(e1071)

##
## Attaching package: 'e1071'

## The following object is masked from 'package:raster':
##
##     interpolate

library(naivebayes)

## naivebayes 0.9.7 loaded

library(klaR)

## Loading required package: MASS

##
## Attaching package: 'MASS'

## The following objects are masked from 'package:raster':
##
##     area, select

## The following object is masked from 'package:formattable':
##
##     area

## The following object is masked from 'package:plotly':
##
##     select

## The following object is masked from 'package:dplyr':
##
##     select

library(bnclassify)

##
## Attaching package: 'bnclassify'
```

```
## The following objects are masked from 'package:raster':
##
##     cv, values

## The following object is masked from 'package:ggplot2':
##
##     vars

## The following object is masked from 'package:dplyr':
##
##     vars

library(rmarkdown)
library(tinytex)
library(cluster)

##
## Attaching package: 'cluster'

## The following object is masked from 'package:maps':
##
##     votes.repub

library(factoextra)

## Welcome! Want to learn more? See two factoextra-related books at
## https://goo.gl/ve3WBa

library(NbClust)

#determining the number of clusters  using elbow and silhouette method

fviz_nbclust(xy, kmeans, method= "wss") + labs(subtitle = "Elbow Method")
```

Optimal number of clusters
Elbow Method
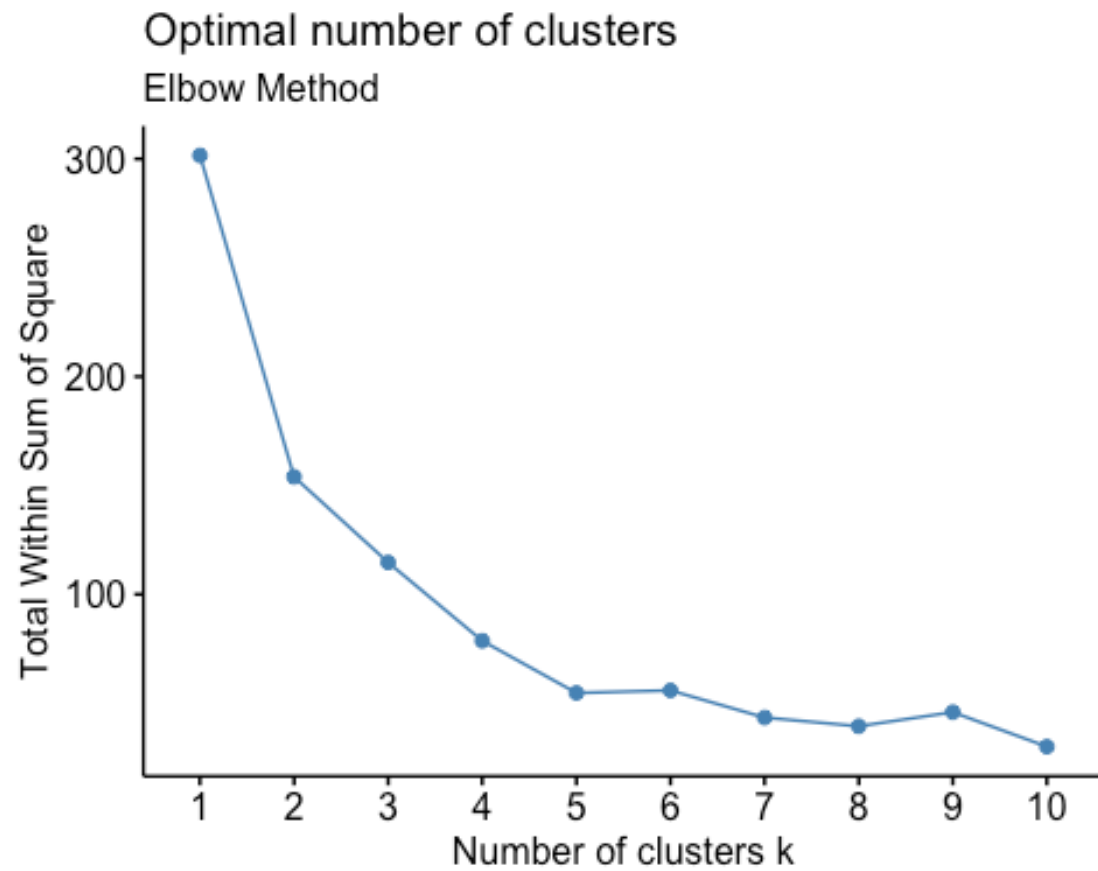
```
fviz_nbclust(xy, kmeans, method = "silhouette") + labs(subtitle = "Silhouette
Method")
```

Optimal number of clusters
Silhouette Method
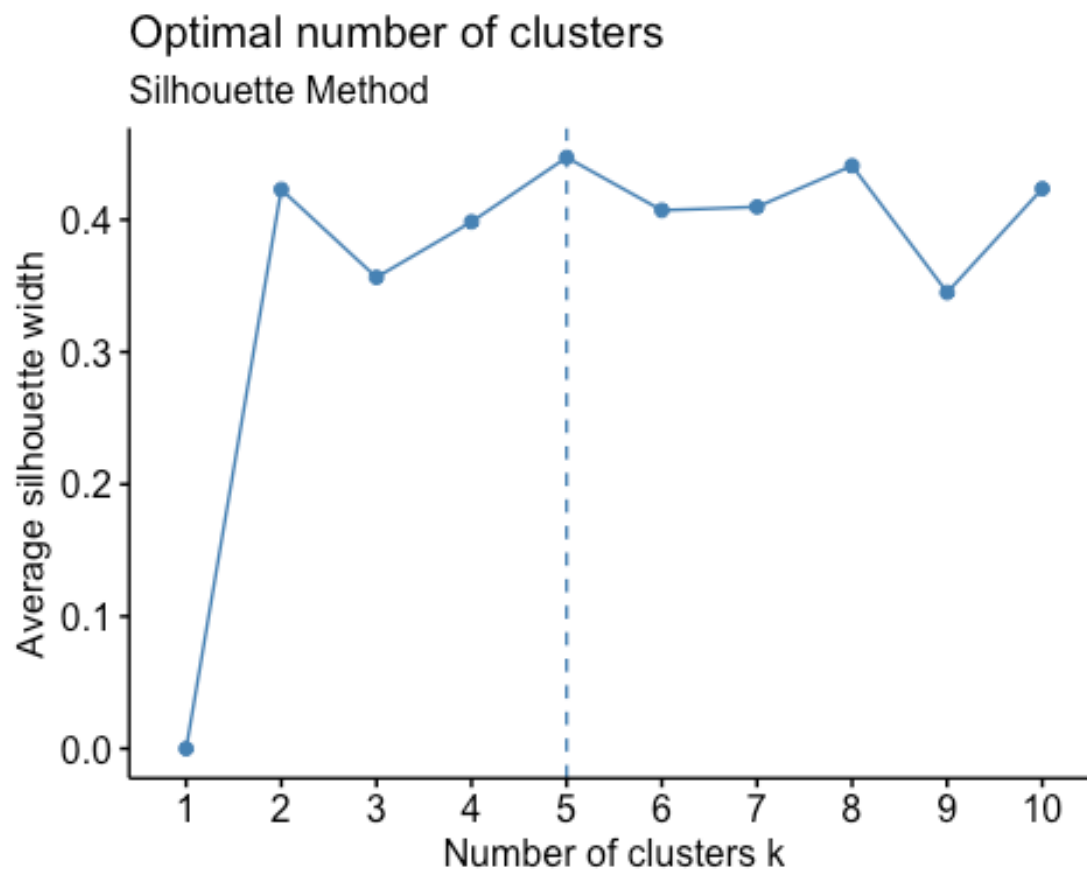

```
##Looking at the plots produced above in the silhouette method you can see
that 5 clusters are appropriate.
set.seed(100)
kmeans <- kmeans(xy,centers=5,nstart=25)
kmeans$centers

##      Longitude Latitude
## 1 -0.33506345 51.51738
## 2  0.14300061 51.55046
## 3 -0.13082886 51.61048
## 4 -0.01197093 51.49923
## 5 -0.16426033 51.44740

#5 clusters, data must be fitted to
fitkmeans<- kmeans(xy,5)
library(cluster)
Y <- data.frame(xy,fitkmeans$cluster)
Y

##           Longitude Latitude fitkmeans.cluster
## 1       -0.09631794 51.38259                 1
## 2        0.01003716 51.49328                 1
## 3        0.01400743 51.41045                 1
## 4        0.08250620 51.59773                 5
```

```
## 5      -0.18901141 51.45894          4
## 6      -0.30342843 51.51473          3
## 7      -0.30342843 51.51473          3
## 8      -0.37384439 51.46939          3
## 9       0.03307815 51.53119          5
## 10     -0.19514135 51.36602          4
## 11     -0.11461497 51.59851          2
## 12     -0.12266768 51.46062          4
## 13     -0.30320903 51.46316          3
## 14     -0.18901141 51.45894          4
## 15     -0.45140058 51.54113          3
## 16      0.21276082 51.58296          5
## 17      0.12988840 51.56167          5
## 18      0.08250620 51.59773          5
## 19     -0.30138440 51.41824          3
## 20     -0.19514135 51.36602          4
## 21      0.08250620 51.59773          5
## 22     -0.13704033 51.50553          4
## 23     -0.07450626 51.58104          2
## 24     -0.11738716 51.66902          2
## 25     -0.30342843 51.51473          3
## 26     -0.07450626 51.58104          2
## 27     -0.33994379 51.58901          3
## 28     -0.30342843 51.51473          3
## 29     -0.11461497 51.59851          2
## 30     -0.01170935 51.44908          1
## 31     -0.30342843 51.51473          3
## 32     -0.37384439 51.46939          3
## 33      0.01400743 51.41045          1
## 34      0.21276082 51.58296          5
## 35     -0.45140058 51.54113          3
## 36     -0.27106553 51.57616          3
## 37     -0.11461497 51.59851          2
## 38     -0.37384439 51.46939          3
## 39     -0.12266768 51.46062          4
## 40     -0.08912003 51.51082          4
## 41      0.21276082 51.58296          5
## 42      0.03307815 51.53119          5
## 43     -0.09631794 51.38259          1
## 44     -0.09631794 51.38259          1
## 45     -0.19562056 51.66238          2
## 46     -0.00902464 51.59495          5
## 47     -0.13704033 51.50553          4
## 48     -0.12266768 51.46062          4
## 49     -0.01170935 51.44908          1
## 50      0.01400743 51.41045          1
## 51     -0.30342843 51.51473          3
## 52     -0.27106553 51.57616          3
## 53     -0.11461497 51.59851          2
## 54     -0.16211228 51.55180          4
```

```
## 55        0.15157167 51.44755              5
## 56       -0.09631794 51.38259              1
## 57       -0.01170935 51.44908              1
## 58       -0.37384439 51.46939              3
## 59       -0.16211228 51.55180              4
## 60       -0.19246075 51.50498              4
## 61       -0.37384439 51.46939              3
## 62       -0.01170935 51.44908              1
## 63       -0.30138440 51.41824              3
## 64       -0.27106553 51.57616              3
## 65       -0.08912003 51.51082              4
## 66       -0.33994379 51.58901              3
## 67        0.01400743 51.41045              1
## 68       -0.12266768 51.46062              4
## 69       -0.00902464 51.59495              5
## 70       -0.10215668 51.54494              4
## 71       -0.08912003 51.51082              4
## 72        0.03307815 51.53119              5
## 73       -0.19562056 51.66238              2
## 74       -0.27106553 51.57616              3
## 75       -0.13704033 51.50553              4
## 76        0.01003716 51.49328              1
## 77        0.08250620 51.59773              5
## 78       -0.07450626 51.58104              2
## 79       -0.11461497 51.59851              2
## 80       -0.19514135 51.36602              4
## 81        0.08250620 51.59773              5
## 82       -0.07450626 51.58104              2
## 83       -0.02797504 51.52616              1
## 84       -0.09631794 51.38259              1
## 85       -0.23053203 51.50705              4
## 86       -0.10215668 51.54494              4
## 87        0.03307815 51.53119              5
## 88       -0.33994379 51.58901              3
## 89       -0.27106553 51.57616              3
## 90        0.01400743 51.41045              1
## 91       -0.07450626 51.58104              2
## 92       -0.09631794 51.38259              1
## 93       -0.30342843 51.51473              3
## 94       -0.07450626 51.58104              2
## 95        0.03307815 51.53119              5
## 96       -0.11461497 51.59851              2
## 97        0.21276082 51.58296              5
## 98       -0.19514135 51.36602              4
## 99        0.15157167 51.44755              5
## 100      -0.19562056 51.66238              2
## 101       0.01003716 51.49328              1
## 102      -0.19514135 51.36602              4
## 103      -0.01170935 51.44908              1
## 104      -0.37384439 51.46939              3
```

```
## 105    0.08250620 51.59773                    5
## 106   -0.37384439 51.46939                    3
## 107    0.01400743 51.41045                    1
## 108   -0.19246075 51.50498                    4
## 109   -0.30342843 51.51473                    3
## 110   -0.30138440 51.41824                    3
## 111   -0.07450626 51.58104                    2
## 112   -0.30320903 51.46316                    3
## 113    0.21276082 51.58296                    5
## 114   -0.08912003 51.51082                    4
## 115   -0.30138440 51.41824                    3
## 116    0.03307815 51.53119                    5
## 117   -0.19246075 51.50498                    4
## 118   -0.30342843 51.51473                    3
## 119   -0.01170935 51.44908                    1
## 120   -0.19562056 51.66238                    2
## 121   -0.09631794 51.38259                    1
## 122    0.12988840 51.56167                    5
## 123   -0.12266768 51.46062                    4
## 124   -0.08912003 51.51082                    4
## 125   -0.37384439 51.46939                    3
## 126   -0.12266768 51.46062                    4
## 127   -0.30320903 51.46316                    3
## 128   -0.00902464 51.59495                    5
## 129   -0.21219045 51.41654                    4
## 130   -0.23053203 51.50705                    4
## 131   -0.01170935 51.44908                    1
## 132   -0.27106553 51.57616                    3
## 133   -0.12266768 51.46062                    4
## 134   -0.30320903 51.46316                    3
## 135   -0.13704033 51.50553                    4
## 136   -0.16211228 51.55180                    4
## 137    0.12988840 51.56167                    5
## 138    0.12988840 51.56167                    5
## 139    0.12988840 51.56167                    5
## 140   -0.09631794 51.38259                    1
## 141   -0.23053203 51.50705                    4
## 142   -0.01170935 51.44908                    1
## 143   -0.19562056 51.66238                    2
## 144   -0.10215668 51.54494                    4
## 145    0.01400743 51.41045                    1
## 146   -0.01170935 51.44908                    1
## 147   -0.08912003 51.51082                    4
## 148   -0.30138440 51.41824                    3
## 149   -0.08912003 51.51082                    4
## 150   -0.09631794 51.38259                    1
## 151   -0.30342843 51.51473                    3
## 152   -0.00902464 51.59495                    5
## 153   -0.19246075 51.50498                    4
## 154   -0.02797504 51.52616                    1
```

```
## 155     0.12988840 51.56167                    5
## 156    -0.30320903 51.46316                    3
## 157    -0.30138440 51.41824                    3
## 158    -0.02797504 51.52616                    1
## 159    -0.21219045 51.41654                    4
## 160    -0.08912003 51.51082                    4
## 161    -0.12266768 51.46062                    4
## 162    -0.00902464 51.59495                    5
## 163    -0.16211228 51.55180                    4
## 164    -0.08912003 51.51082                    4
## 165    -0.37384439 51.46939                    3
## 166    -0.13704033 51.50553                    4
## 167    -0.19246075 51.50498                    4
## 168     0.08250620 51.59773                    5
## 169    -0.27106553 51.57616                    3
## 170    -0.12266768 51.46062                    4
## 171     0.03307815 51.53119                    5
## 172     0.12988840 51.56167                    5
## 173    -0.27106553 51.57616                    3
## 174     0.12988840 51.56167                    5
## 175    -0.11461497 51.59851                    2
## 176    -0.09631794 51.38259                    1
## 177    -0.45140058 51.54113                    3
## 178    -0.01170935 51.44908                    1
## 179     0.12988840 51.56167                    5
## 180    -0.19514135 51.36602                    4
## 181     0.15157167 51.44755                    5
## 182    -0.10215668 51.54494                    4
## 183    -0.19514135 51.36602                    4
## 184     0.01400743 51.41045                    1
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## 454      -0.09631794 51.38259                1
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## 653    -0.45140058 51.54113                    3
## 654    -0.45140058 51.54113                    3
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## 658    -0.11738716 51.66902              2
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## 660    -0.12266768 51.46062              4
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## 1093   -0.19246075 51.50498                        4
## 1094    0.21276082 51.58296                        5
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## 1096    0.03307815 51.53119                        5
## 1097   -0.30138440 51.41824                        3
## 1098   -0.02797504 51.52616                        1
## 1099   -0.01170935 51.44908                        1
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## 1101   -0.11738716 51.66902                        2
## 1102   -0.11461497 51.59851                        2
## 1103   -0.07450626 51.58104                        2
## 1104   -0.30342843 51.51473                        3
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## 1106   -0.16211228 51.55180                    4
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## 1109   -0.33994379 51.58901                    3
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## 1133   -0.33994379 51.58901                    3
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## 1144   -0.11738716 51.66902                    2
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## 1188    0.12988840 51.56167                5
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## 1253  -0.19514135 51.36602              4
## 1254  -0.07450626 51.58104              2
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## 1293    0.08250620 51.59773                    5
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## 1304   -0.08912003 51.51082                    4
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## 1344   -0.18901141 51.45894                4
## 1345   -0.07450626 51.58104                2
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## 1356   -0.02797504 51.52616                 1
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## 1385    0.01400743 51.41045                 1
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## 1406   -0.19562056 51.66238                    2
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## 1455    0.12988840 51.56167                    5
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## 1536   -0.19514135 51.36602                 4
## 1537   -0.37384439 51.46939                 3
## 1538    0.15157167 51.44755                 5
## 1539   -0.13704033 51.50553                 4
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## 1543   -0.37384439 51.46939                 3
## 1544   -0.23053203 51.50705                 4
## 1545   -0.11461497 51.59851                 2
## 1546   -0.18901141 51.45894                 4
## 1547   -0.09631794 51.38259                 1
## 1548   -0.08912003 51.51082                 4
## 1549    0.15157167 51.44755                 5
## 1550   -0.10215668 51.54494                 4
## 1551   -0.11738716 51.66902                 2
## 1552   -0.16211228 51.55180                 4
## 1553   -0.00902464 51.59495                 5
## 1554   -0.01170935 51.44908                 1
## 1555   -0.02797504 51.52616                 1
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## 1556   -0.00902464 51.59495                    5
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## 1595   -0.30342843 51.51473                    3
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## 1615   -0.33994379 51.58901                3
## 1616   -0.23053203 51.50705                4
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## 1652    0.03307815 51.53119                5
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## 1654   -0.07450626 51.58104                2
## 1655   -0.12266768 51.46062                4
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## 1662   -0.30320903 51.46316                3
## 1663    0.03307815 51.53119                5
## 1664   -0.21219045 51.41654                4
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## 1667    0.12988840 51.56167                5
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## 1675    0.01400743 51.41045                1
## 1676   -0.45140058 51.54113                3
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## 1681    0.15157167 51.44755                5
## 1682   -0.21219045 51.41654                4
## 1683   -0.30320903 51.46316                3
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## 1695   -0.23053203 51.50705                4
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## 1698   -0.08912003 51.51082                4
## 1699    0.08250620 51.59773                5
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## 1702   -0.13704033 51.50553                4
## 1703    0.15157167 51.44755                5
## 1704    0.03307815 51.53119                5
## 1705   -0.18901141 51.45894                4
## 1706   -0.12266768 51.46062                4
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## 1710   -0.08912003 51.51082                    4
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## 1714   -0.27106553 51.57616                    3
## 1715   -0.19562056 51.66238                    2
## 1716    0.12988840 51.56167                    5
## 1717    0.03307815 51.53119                    5
## 1718   -0.13704033 51.50553                    4
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## 1720   -0.01170935 51.44908                    1
## 1721   -0.21219045 51.41654                    4
## 1722   -0.08912003 51.51082                    4
## 1723   -0.08912003 51.51082                    4
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## 1726   -0.30342843 51.51473                    3
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## 1734   -0.45140058 51.54113                    3
## 1735   -0.30320903 51.46316                    3
## 1736   -0.07450626 51.58104                    2
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## 1738   -0.02797504 51.52616                    1
## 1739   -0.19562056 51.66238                    2
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## 1742    0.12988840 51.56167                    5
## 1743   -0.19246075 51.50498                    4
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## 1745   -0.37384439 51.46939                    3
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## 1752   -0.27106553 51.57616                    3
## 1753   -0.30342843 51.51473                    3
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## 1755    0.08250620 51.59773                    5
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```

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## 1757   -0.09631794 51.38259                  1
## 1758   -0.30320903 51.46316                  3
## 1759   -0.19514135 51.36602                  4
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## 1761   -0.00902464 51.59495                  5
## 1762   -0.30320903 51.46316                  3
## 1763   -0.11738716 51.66902                  2
## 1764    0.03307815 51.53119                  5
## 1765   -0.30342843 51.51473                  3
## 1766   -0.16211228 51.55180                  4
## 1767   -0.37384439 51.46939                  3
## 1768   -0.18901141 51.45894                  4
## 1769   -0.30342843 51.51473                  3
## 1770    0.15157167 51.44755                  5
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## 1772   -0.30342843 51.51473                  3
## 1773   -0.01170935 51.44908                  1
## 1774   -0.30320903 51.46316                  3
## 1775   -0.12266768 51.46062                  4
## 1776   -0.19514135 51.36602                  4
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## 1778   -0.13704033 51.50553                  4
## 1779   -0.11461497 51.59851                  2
## 1780   -0.30138440 51.41824                  3
## 1781   -0.16211228 51.55180                  4
## 1782   -0.10215668 51.54494                  4
## 1783   -0.37384439 51.46939                  3
## 1784   -0.30342843 51.51473                  3
## 1785   -0.18901141 51.45894                  4
## 1786   -0.45140058 51.54113                  3
## 1787    0.15157167 51.44755                  5
## 1788   -0.23053203 51.50705                  4
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## 1791   -0.00902464 51.59495                  5
## 1792   -0.27106553 51.57616                  3
## 1793   -0.37384439 51.46939                  3
## 1794   -0.00902464 51.59495                  5
## 1795   -0.09631794 51.38259                  1
## 1796   -0.18901141 51.45894                  4
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## 1801   -0.02797504 51.52616                  1
## 1802    0.03307815 51.53119                  5
## 1803   -0.16211228 51.55180                  4
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## 1805   -0.30342843 51.51473                  3
## 1806   -0.00902464 51.59495                  5
```

```
## 1807   -0.11461497 51.59851                        2
## 1808   -0.02797504 51.52616                        1
## 1809   -0.30320903 51.46316                        3
## 1810   -0.01170935 51.44908                        1
## 1811   -0.00902464 51.59495                        5
## 1812   -0.30138440 51.41824                        3
## 1813   -0.33994379 51.58901                        3
## 1814   -0.21219045 51.41654                        4
## 1815   -0.07450626 51.58104                        2
## 1816   -0.27106553 51.57616                        3
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## 1818   -0.10215668 51.54494                        4
## 1819    0.15157167 51.44755                        5
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## 1821   -0.19562056 51.66238                        2
## 1822   -0.09631794 51.38259                        1
## 1823   -0.30320903 51.46316                        3
## 1824   -0.45140058 51.54113                        3
## 1825   -0.16211228 51.55180                        4
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## 1828   -0.08912003 51.51082                        4
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## 1833   -0.13704033 51.50553                        4
## 1834   -0.21219045 51.41654                        4
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## 1836   -0.30342843 51.51473                        3
## 1837   -0.01170935 51.44908                        1
## 1838   -0.27106553 51.57616                        3
## 1839    0.15157167 51.44755                        5
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## 1843   -0.33994379 51.58901                        3
## 1844    0.01003716 51.49328                        1
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## 1846   -0.30342843 51.51473                        3
## 1847   -0.11461497 51.59851                        2
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## 1849   -0.07450626 51.58104                        2
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## 1851   -0.10215668 51.54494                        4
## 1852   -0.30342843 51.51473                        3
## 1853   -0.27106553 51.57616                        3
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## 1855   -0.30320903 51.46316                        3
## 1856   -0.19562056 51.66238                        2
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## 1859   -0.21219045 51.41654                    4
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## 1861   -0.16211228 51.55180                    4
## 1862   -0.13704033 51.50553                    4
## 1863   -0.11461497 51.59851                    2
## 1864   -0.11738716 51.66902                    2
## 1865   -0.18901141 51.45894                    4
## 1866   -0.11461497 51.59851                    2
## 1867    0.03307815 51.53119                    5
## 1868   -0.11738716 51.66902                    2
## 1869   -0.09631794 51.38259                    1
## 1870    0.01003716 51.49328                    1
## 1871   -0.18901141 51.45894                    4
## 1872    0.12988840 51.56167                    5
## 1873   -0.23053203 51.50705                    4
## 1874   -0.02797504 51.52616                    1
## 1875   -0.45140058 51.54113                    3
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## 1877    0.03307815 51.53119                    5
## 1878   -0.11738716 51.66902                    2
## 1879   -0.09631794 51.38259                    1
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## 1883   -0.01170935 51.44908                    1
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## 1885    0.03307815 51.53119                    5
## 1886   -0.19514135 51.36602                    4
## 1887   -0.11461497 51.59851                    2
## 1888   -0.30138440 51.41824                    3
## 1889   -0.18901141 51.45894                    4
## 1890   -0.11461497 51.59851                    2
## 1891    0.01003716 51.49328                    1
## 1892   -0.27106553 51.57616                    3
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## 1897   -0.19562056 51.66238                    2
## 1898   -0.30138440 51.41824                    3
## 1899   -0.01170935 51.44908                    1
## 1900   -0.23053203 51.50705                    4
## 1901    0.01400743 51.41045                    1
## 1902   -0.30138440 51.41824                    3
## 1903   -0.01170935 51.44908                    1
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## 1906   -0.21219045 51.41654                    4
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## 1913   -0.11738716 51.66902                    2
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## 1916    0.01400743 51.41045                    1
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## 1925    0.01400743 51.41045                    1
## 1926   -0.18901141 51.45894                    4
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## 1933   -0.09631794 51.38259                    1
## 1934   -0.30342843 51.51473                    3
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## 1936   -0.18901141 51.45894                    4
## 1937   -0.19246075 51.50498                    4
## 1938   -0.19514135 51.36602                    4
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## 1941   -0.16211228 51.55180                    4
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## 1944   -0.27106553 51.57616                    3
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## 1946    0.12988840 51.56167                    5
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## 1950   -0.02797504 51.52616                    1
## 1951   -0.09631794 51.38259                    1
## 1952   -0.09631794 51.38259                    1
## 1953   -0.30320903 51.46316                    3
## 1954   -0.30138440 51.41824                    3
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## 1978   -0.30138440 51.41824                    3
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## 1990   -0.11738716 51.66902                    2
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## 1992   -0.13704033 51.50553                    4
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## 1996    0.03307815 51.53119                    5
## 1997    0.08250620 51.59773                    5
## 1998    0.21276082 51.58296                    5
## 1999   -0.21219045 51.41654                    4
## 2000   -0.02797504 51.52616                    1
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## 2021    0.03307815 51.53119                    5
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## 2023   -0.11738716 51.66902                    2
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## 2206  -0.16211228 51.55180                    4
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## 2286    0.08250620 51.59773                     5
## 2287   -0.13704033 51.50553                     4
## 2288   -0.23053203 51.50705                     4
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## 2290   -0.30320903 51.46316                     3
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## 2292    0.01400743 51.41045                     1
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## 2296    0.12988840 51.56167                     5
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## 2886   -0.18901141 51.45894                    4
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## 2908   -0.08912003 51.51082            4
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## 2912    0.03307815 51.53119            5
## 2913   -0.30138440 51.41824            3
## 2914    0.01003716 51.49328            1
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## 3006   -0.09631794 51.38259                    1
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## 3753   -0.07450626 51.58104                    2
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## 4157   -0.27106553 51.57616                3
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## 4194   -0.37384439 51.46939                    3
## 4195   -0.45140058 51.54113                    3
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## 4201   -0.23053203 51.50705                    4
## 4202   -0.27106553 51.57616                    3
## 4203   -0.16211228 51.55180                    4
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## 4206   -0.45140058 51.54113                    3
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## 4208   -0.10215668 51.54494                    4
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## 4209   -0.08912003 51.51082                4
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## 4215    0.15157167 51.44755                5
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## 4241   -0.18901141 51.45894                4
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## 4244    0.15157167 51.44755                5
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```

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## 4455   -0.19514135 51.36602                    4
## 4456   -0.37384439 51.46939                    3
## 4457   -0.02797504 51.52616                    1
## 4458   -0.09631794 51.38259                    1
## 4459    0.03307815 51.53119                    5
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## 4609   -0.27106553 51.57616                    3
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## 4610   -0.16211228 51.55180                    4
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## 4637   -0.19514135 51.36602                    4
## 4638   -0.33994379 51.58901                    3
## 4639   -0.08912003 51.51082                    4
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## 4642    0.21276082 51.58296                    5
## 4643   -0.19246075 51.50498                    4
## 4644    0.01003716 51.49328                    1
## 4645   -0.37384439 51.46939                    3
## 4646   -0.45140058 51.54113                    3
## 4647   -0.08912003 51.51082                    4
## 4648   -0.01170935 51.44908                    1
## 4649   -0.27106553 51.57616                    3
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## 4652   -0.12266768 51.46062                    4
## 4653   -0.30342843 51.51473                    3
## 4654   -0.23053203 51.50705                    4
## 4655   -0.19514135 51.36602                    4
## 4656    0.03307815 51.53119                    5
## 4657    0.01400743 51.41045                    1
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## 4660   -0.11461497 51.59851                2
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## 4664   -0.11738716 51.66902                2
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## 4666   -0.30342843 51.51473                3
## 4667   -0.37384439 51.46939                3
## 4668    0.08250620 51.59773                5
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## 4706   -0.07450626 51.58104                2
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## 4709   -0.18901141 51.45894                4
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## 4720  -0.33994379 51.58901                    3
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## 4723  -0.21219045 51.41654                    4
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## 4729  -0.10215668 51.54494                    4
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## 4734  -0.08912003 51.51082                    4
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## 4741  -0.00902464 51.59495                    5
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## 4748  -0.45140058 51.54113                    3
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## 4758  -0.16211228 51.55180                    4
## 4759  -0.01170935 51.44908                    1
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## 4793   -0.02797504 51.52616                                1
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## 4796    0.01400743 51.41045                                1
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## 4805    0.15157167 51.44755                                5
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## 4817   -0.11738716 51.66902                2
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## 4854   -0.01170935 51.44908                1
## 4855   -0.21219045 51.41654                4
## 4856   -0.27106553 51.57616                3
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## 4879  -0.19514135 51.36602                4
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## 4882  -0.02797504 51.52616                1
## 4883  -0.12266768 51.46062                4
## 4884  -0.10215668 51.54494                4
## 4885  -0.11461497 51.59851                2
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## 4899  -0.21219045 51.41654                4
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## 4904  -0.30342843 51.51473                3
## 4905  -0.37384439 51.46939                3
## 4906  -0.19562056 51.66238                2
## 4907  -0.11738716 51.66902                2
## 4908  -0.30342843 51.51473                3
## 4909  -0.27106553 51.57616                3
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## 4918   -0.19514135 51.36602                   4
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## 4934   -0.37384439 51.46939                   3
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## 4937    0.01003716 51.49328                   1
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## 4942    0.15157167 51.44755                   5
## 4943    0.12988840 51.56167                   5
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## 4946   -0.19562056 51.66238                   2
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## 4955   -0.21219045 51.41654                   4
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## 4959   -0.19514135 51.36602                   4
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## 4997  -0.00902464 51.59495                    5
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## 5008   0.03307815 51.53119                    5
## 5009  -0.19562056 51.66238                    2
```

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## 5958   -0.30320903 51.46316                  3
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## 5960   -0.02797504 51.52616                  1
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## 5962   -0.12266768 51.46062                   4
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## 7146    -0.11738716 51.66902              2
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## 10387 -0.09631794 51.38259                    1
## 10388 -0.19246075 51.50498                    4
## 10389 -0.10215668 51.54494                    4
## 10390 -0.30138440 51.41824                    3
## 10391  0.15157167 51.44755                    5
## 10392 -0.13704033 51.50553                    4
## 10393 -0.10215668 51.54494                    4
## 10394 -0.07450626 51.58104                    2
## 10395 -0.30342843 51.51473                    3
## 10396 -0.19246075 51.50498                    4
## 10397 -0.19246075 51.50498                    4
## 10398 -0.12266768 51.46062                    4
## 10399 -0.37384439 51.46939                    3
## 10400 -0.18901141 51.45894                    4
## 10401 -0.11738716 51.66902                    2
## 10402 -0.00902464 51.59495                    5
## 10403  0.15157167 51.44755                    5
## 10404 -0.45140058 51.54113                    3
## 10405  0.08250620 51.59773                    5
## 10406 -0.11461497 51.59851                    2
## 10407 -0.27106553 51.57616                    3
## 10408 -0.08912003 51.51082                    4
## 10409 -0.19562056 51.66238                    2
## 10410 -0.27106553 51.57616                    3
## 10411 -0.08912003 51.51082                    4
```

```
## 10412 -0.11738716 51.66902                2
## 10413 -0.02797504 51.52616                1
## 10414 -0.37384439 51.46939                3
## 10415  0.08250620 51.59773                5
## 10416 -0.18901141 51.45894                4
## 10417 -0.30342843 51.51473                3
## 10418  0.21276082 51.58296                5
## 10419 -0.12266768 51.46062                4
## 10420 -0.30138440 51.41824                3
## 10421 -0.30320903 51.46316                3
## 10422 -0.13704033 51.50553                4
## 10423  0.08250620 51.59773                5
## 10424 -0.12266768 51.46062                4
## 10425 -0.07450626 51.58104                2
## 10426 -0.19562056 51.66238                2
## 10427  0.03307815 51.53119                5
## 10428 -0.11738716 51.66902                2
## 10429 -0.08912003 51.51082                4
## 10430 -0.45140058 51.54113                3
## 10431 -0.13704033 51.50553                4
## 10432  0.15157167 51.44755                5
## 10433 -0.45140058 51.54113                3
## 10434 -0.19246075 51.50498                4
## 10435 -0.27106553 51.57616                3
## 10436  0.01003716 51.49328                1
## 10437  0.15157167 51.44755                5
## 10438 -0.09631794 51.38259                1
## 10439 -0.09631794 51.38259                1
## 10440 -0.19246075 51.50498                4
## 10441 -0.33994379 51.58901                3
## 10442 -0.08912003 51.51082                4
## 10443 -0.30342843 51.51473                3
## 10444 -0.12266768 51.46062                4
## 10445 -0.18901141 51.45894                4
## 10446 -0.33994379 51.58901                3
## 10447 -0.00902464 51.59495                5
## 10448  0.01003716 51.49328                1
## 10449 -0.30320903 51.46316                3
## 10450 -0.00902464 51.59495                5
## 10451 -0.11738716 51.66902                2
## 10452 -0.30320903 51.46316                3
## 10453 -0.13704033 51.50553                4
## 10454  0.01003716 51.49328                1
## 10455  0.01400743 51.41045                1
## 10456  0.21276082 51.58296                5
## 10457 -0.19514135 51.36602                4
## 10458 -0.27106553 51.57616                3
## 10459 -0.10215668 51.54494                4
## 10460  0.01400743 51.41045                1
## 10461 -0.09631794 51.38259                1
```

```
## 10462 -0.00902464 51.59495                    5
## 10463 -0.27106553 51.57616                    3
## 10464  0.03307815 51.53119                    5
## 10465 -0.02797504 51.52616                    1
## 10466 -0.08912003 51.51082                    4
## 10467 -0.18901141 51.45894                    4
## 10468 -0.30320903 51.46316                    3
## 10469  0.12988840 51.56167                    5
## 10470  0.01003716 51.49328                    1
## 10471 -0.33994379 51.58901                    3
## 10472 -0.13704033 51.50553                    4
## 10473 -0.01170935 51.44908                    1
## 10474  0.08250620 51.59773                    5
## 10475 -0.37384439 51.46939                    3
## 10476 -0.09631794 51.38259                    1
## 10477 -0.19562056 51.66238                    2
## 10478 -0.02797504 51.52616                    1
## 10479 -0.01170935 51.44908                    1
## 10480  0.03307815 51.53119                    5
## 10481 -0.11461497 51.59851                    2
## 10482 -0.00902464 51.59495                    5
## 10483  0.03307815 51.53119                    5
## 10484 -0.30342843 51.51473                    3
## 10485 -0.19514135 51.36602                    4
## 10486 -0.02797504 51.52616                    1
## 10487 -0.30138440 51.41824                    3
## 10488 -0.07450626 51.58104                    2
## 10489 -0.45140058 51.54113                    3
## 10490 -0.45140058 51.54113                    3
## 10491  0.21276082 51.58296                    5
## 10492 -0.33994379 51.58901                    3
## 10493 -0.08912003 51.51082                    4
## 10494 -0.11738716 51.66902                    2
## 10495  0.21276082 51.58296                    5
## 10496  0.08250620 51.59773                    5
## 10497  0.03307815 51.53119                    5
## 10498 -0.18901141 51.45894                    4
## 10499 -0.13704033 51.50553                    4
## 10500 -0.19562056 51.66238                    2
## 10501 -0.01170935 51.44908                    1
## 10502  0.08250620 51.59773                    5
## 10503 -0.07450626 51.58104                    2
## 10504 -0.33994379 51.58901                    3
## 10505 -0.18901141 51.45894                    4
## 10506 -0.21219045 51.41654                    4
## 10507  0.08250620 51.59773                    5
## 10508 -0.23053203 51.50705                    4
## 10509 -0.19246075 51.50498                    4
## 10510  0.01400743 51.41045                    1
## 10511 -0.30342843 51.51473                    3
```

```
## 10512 -0.27106553 51.57616                         3
## 10513 -0.11738716 51.66902                         2
## 10514 -0.45140058 51.54113                         3
## 10515 -0.10215668 51.54494                         4
## 10516 -0.08912003 51.51082                         4
## 10517  0.01400743 51.41045                         1
## 10518 -0.11461497 51.59851                         2
## 10519 -0.09631794 51.38259                         1
## 10520 -0.08912003 51.51082                         4
## 10521 -0.37384439 51.46939                         3
## 10522 -0.30342843 51.51473                         3
## 10523  0.01003716 51.49328                         1
## 10524 -0.19246075 51.50498                         4
## 10525 -0.23053203 51.50705                         4
## 10526 -0.33994379 51.58901                         3
## 10527 -0.08912003 51.51082                         4
## 10528  0.12988840 51.56167                         5
## 10529 -0.23053203 51.50705                         4
## 10530 -0.16211228 51.55180                         4
## 10531  0.12988840 51.56167                         5
## 10532  0.03307815 51.53119                         5
## 10533 -0.30320903 51.46316                         3
## 10534 -0.01170935 51.44908                         1
## 10535 -0.01170935 51.44908                         1
## 10536 -0.19514135 51.36602                         4
## 10537 -0.30138440 51.41824                         3
## 10538  0.12988840 51.56167                         5
## 10539 -0.01170935 51.44908                         1
## 10540 -0.19562056 51.66238                         2
## 10541  0.21276082 51.58296                         5
## 10542 -0.19514135 51.36602                         4
## 10543 -0.07450626 51.58104                         2
## 10544 -0.21219045 51.41654                         4
## 10545  0.12988840 51.56167                         5
## 10546 -0.30342843 51.51473                         3
## 10547  0.08250620 51.59773                         5
## 10548 -0.09631794 51.38259                         1
## 10549  0.01400743 51.41045                         1
## 10550  0.01400743 51.41045                         1
## 10551 -0.30342843 51.51473                         3
## 10552 -0.07450626 51.58104                         2
## 10553  0.15157167 51.44755                         5
## 10554 -0.11738716 51.66902                         2
## 10555 -0.09631794 51.38259                         1

fviz_cluster(kmeans, data = xy)
```

Cluster plot

```
#visualizing the clusters
clusplot(xy,fitkmeans$cluster, color = TRUE, shade = TRUE, labels= 2, lines =
0)
```

CLUSPLOT(xy)
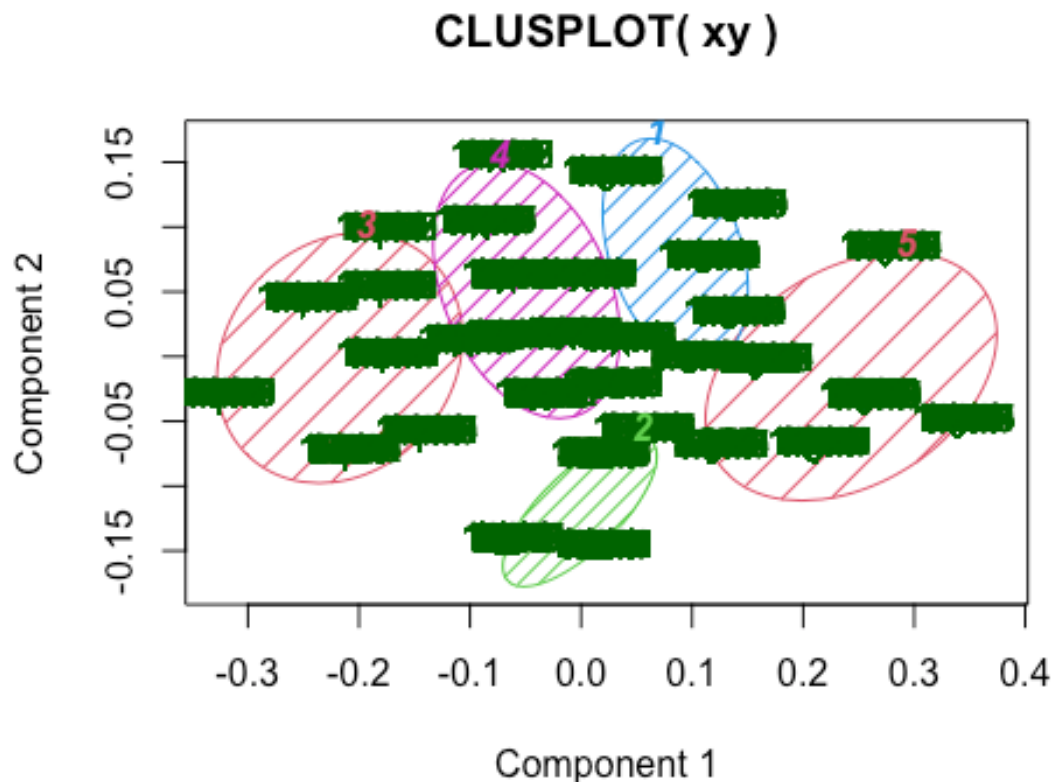
Component 1

These two components explain 100 % of the point variab

```
#mean of longitude and latitude for each cluster using aggregate function
eachpoint <- aggregate(xy, by=list(fitkmeans$cluster), FUN=mean)
eachpoint
```

```
##   Group.1   Longitude Latitude
## 1       1 -0.02491060 51.44546
## 2       2 -0.13069592 51.63352
## 3       3 -0.33506345 51.51738
## 4       4 -0.15786929 51.48282
## 5       5  0.09354143 51.55414
```

```
#Using ggpmap to visualize
library(ggmap)
```

```
## Google's Terms of Service: https://cloud.google.com/maps-platform/terms/.
```

```
## Please cite ggmap if you use it! See citation("ggmap") for details.
```

```
##
## Attaching package: 'ggmap'
```

```
## The following object is masked from 'package:dismo':
##
##      geocode
```

```
## The following object is masked from 'package:plotly':
##
##      wind

#Getting the API key
api <- "AIzaSyCMcVp83BTwhbYzRtnFHIj1wQWce6gyduE"

#registering a google key`
register_google(key= api)

#loading a london map for visualization
LondonMap <- get_map("London", zoom= 11)

## Source :
https://maps.googleapis.com/maps/api/staticmap?center=London&zoom=11&size=640
x640&scale=2&maptype=terrain&language=en-EN&key=xxx

## Source :
https://maps.googleapis.com/maps/api/geocode/json?address=London&key=xxx

ggmap(LondonMap)
```