Lab 6- Geodemographics & Data Reduction

GIS III Spring 2020 - Erin Abbott

Submission due on 5/31

Preparing the Data

```
# Load data

setwd("/Users/erin/Desktop/Spring2020/GIS3/labs")
load("census_2011_UK_OA.RData")
```

```
#subset to liverpool

Census_2011_Count <- merge(Liverpool,Census_2011_Count_All,by="OA",all.x=
TRUE)
```

```
# calculate the numerators

head(OAC_Input_Lookup[,])
```

```
##   VariableCode  Type Denominator      SubDomain      Domain VariableDe
scription
## 1         k001 Count KS102EW0001 Population Age Demographic          A
ge 0 to 4
## 2         k002 Count KS102EW0001 Population Age Demographic         Ag
e 5 to 14
## 3         k003 Count KS102EW0001 Population Age Demographic        Age
25 to 44
## 4         k004 Count KS102EW0001 Population Age Demographic        Age
45 to 64
## 5         k005 Count KS102EW0001 Population Age Demographic        Age
65 to 89
## 6         k006 Count KS102EW0001 Population Age Demographic     Age 90
and over
##                          England_Wales
## 1                          KS102EW0002
## 2 KS102EW0003,KS102EW0004,KS102EW0005
## 3             KS102EW0010,KS102EW0011
## 4             KS102EW0012,KS102EW0013
## 5 KS102EW0014,KS102EW0015,KS102EW0016
## 6                          KS102EW0017
```

```
OAC_Input <- as.data.frame(Census_2011_Count$OA)
colnames(OAC_Input) <- "OA"
# Loop through each row in the OAC input table
for (n in 1:nrow(OAC_Input_Lookup)){
      # Get the variables to aggregate for the row specified by n
      select_vars <- OAC_Input_Lookup[n,"England_Wales"]

      # Create a list of the variables to select
      select_vars <- unlist(strsplit(paste(select_vars),","))

      # Create variable name
      vname <- OAC_Input_Lookup[n,"VariableCode"]

      # Creates a sum of the census variables for each Output Area
      tmp <- data.frame(rowSums(Census_2011_Count[,select_vars, drop=FALS
E]))
      colnames(tmp) <- vname

      # Append new variable to the OAC_Input object
      OAC_Input <- cbind(OAC_Input,tmp)

      # Remove temporary objects
      remove(list = c("vname","tmp"))
} # END: Loop through each row in the OAC input table

#Remove attributes for SIR
OAC_Input$k035 <- NULL
```

```
# calculate the denominators

OAC_Input_den <- as.data.frame(Census_2011_Count$OA)
colnames(OAC_Input_den) <- "OA"
# Create a list of unique denominators
den_list <- unique(OAC_Input_Lookup[,"Denominator"])
den_list <- paste(den_list[den_list != ""])
# Select denominators
OAC_Input_den <- Census_2011_Count[,c("OA",den_list)]

#Merge
OAC_Input <- merge(OAC_Input,OAC_Input_den, by="OA")
```

```r
# calculate percentages

# Get numerator denominator list where the Type is "Count" - i.e. not rat
io
K_Var <- OAC_Input_Lookup[OAC_Input_Lookup$Type == "Count",c(1,3)]
# View top 6 rows
head(K_Var)
```

```
##   VariableCode Denominator
## 1         k001 KS102EW0001
## 2         k002 KS102EW0001
## 3         k003 KS102EW0001
## 4         k004 KS102EW0001
## 5         k005 KS102EW0001
## 6         k006 KS102EW0001
```

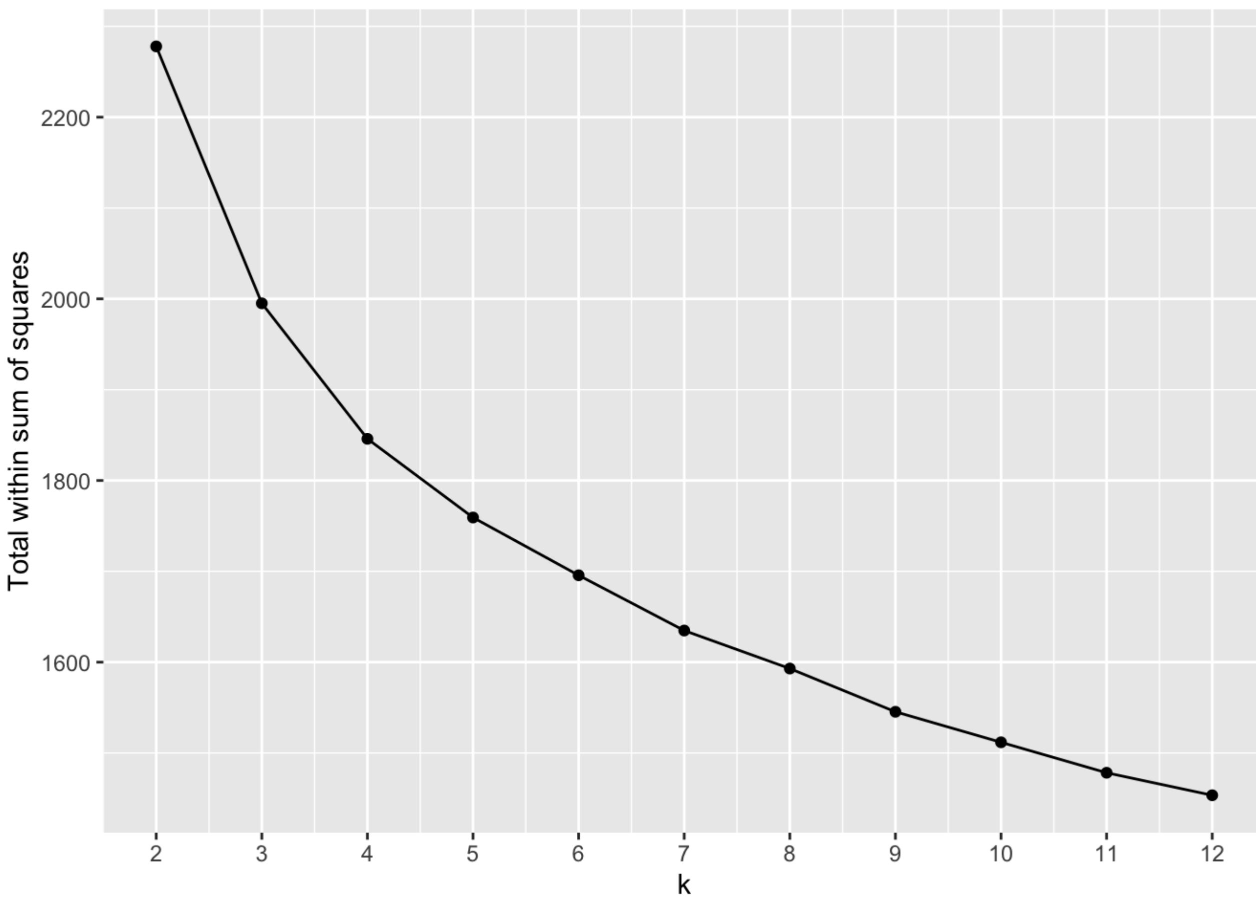
```r
# Create an OA list / data frame
OAC_Input_PCT_RATIO <- subset(OAC_Input, select = "OA")
# Loop
for (n in 1:nrow(K_Var)){

  num <- paste(K_Var[n,"VariableCode"]) # Get numerator name
  den <- paste(K_Var[n,"Denominator"]) # Get denominator name
  tmp <- data.frame(OAC_Input[,num] / OAC_Input[,den] * 100) # Calculate
 percentages
  colnames(tmp) <- num
  OAC_Input_PCT_RATIO <- cbind(OAC_Input_PCT_RATIO,tmp) # Append the perc
entages

  # Remove temporary objects
  remove(list = c("tmp","num","den"))
}

#Extract Variable
tmp <- Census_2011_Count[,c("OA","KS101EW0008")]
colnames(tmp) <- c("OA","k007")
#Merge
OAC_Input_PCT_RATIO <- merge(OAC_Input_PCT_RATIO,tmp,by="OA")
```

```
# Calculate SIR for each subset of the Liverpool data

# Calculate rates of ill people 15 or less and greater than or equal to 6
5
ill_16_64 <- rowSums(Census_2011_Count[,c("KS301EW0005","KS301EW0006")])
# Ill people 16-64
ill_total <-   rowSums(Census_2011_Count[,c("KS301EW0002","KS301EW0003"
)]) # All ill people
ill_L15_G65 <- ill_total - ill_16_64 # Ill people 15 or less and greater
 than or equal to 65
# Calculate total people 15 or less and greater than or equal to 65
t_pop_16_64 <- rowSums(Census_2011_Count[,c("KS102EW0007","KS102EW0008",
"KS102EW0009","KS102EW0010","KS102EW0011","KS102EW0012","KS102EW0013")])
# People 16-64
t_pop <- Census_2011_Count$KS101EW0001 # All people
t_pop_L15_G65 <- t_pop - t_pop_16_64 # All people 15 or less and greater
 than or equal to 65
# Calculate expected rate
ex_ill_16_64 <- t_pop_16_64 * (sum(ill_16_64)/sum(t_pop_16_64)) # Expecte
d ill 16-64
ex_ill_L15_G65 <- t_pop_L15_G65 * (sum(ill_L15_G65)/sum(t_pop_L15_G65)) #
Expected ill people 15 or less and greater than or equal to 65
ex_ill <- ex_ill_16_64 + ex_ill_L15_G65 # total expected ill people
# Ratio
SIR <- as.data.frame(ill_total / ex_ill * 100) # ratio between ill people
and expected ill people
colnames(SIR) <- "k035"
# Merge data
OAC_Input_PCT_RATIO <- cbind(OAC_Input_PCT_RATIO,SIR)
# Remove unwanted objects
remove(list=c("SIR","ill_16_64","ill_total","ill_L15_G65","t_pop_16_64",
"t_pop","t_pop_L15_G65","ex_ill_16_64","ex_ill_L15_G65","ex_ill"))
```

```
# apply the procedures to the input data

# Calculate inverse hyperbolic sine
OAC_Input_PCT_RATIO_IHS <- log(OAC_Input_PCT_RATIO[,2:61]+sqrt(OAC_Input_
PCT_RATIO[,2:61]^2+1))
# Calculate Range
range_01 <- function(x){(x-min(x))/(max(x)-min(x))} # range function
OAC_Input_PCT_RATIO_IHS_01 <- apply(OAC_Input_PCT_RATIO_IHS, 2, range_01)
# apply range function to columns
# Add the OA codes back onto the data frame as row names
rownames(OAC_Input_PCT_RATIO_IHS_01) <- OAC_Input_PCT_RATIO$OA
```

Clusters:

```
library(ggplot2)
# Create a new empty numeric object to store the wss results
wss <- numeric()
# Run k means for 2-12 clusters and store the wss results
for (i in 2:12) wss[i] <- sum(kmeans(OAC_Input_PCT_RATIO_IHS_01, centers=
i,nstart=20)$withinss)
# Create a data frame with the results, adding a further column for the c
luster number
wss <- data.frame(2:12,wss[-1])
# Plot the results
names(wss) <- c("k","Twss")
ggplot(data=wss, aes(x= k, y=Twss)) + geom_path() + geom_point() + scale_
x_continuous(breaks=2:12) + labs(y = "Total within sum of squares")
```




```
# moving forward with 7 clusters
```

Geodemographic

```
# Load cluster object
setwd("/Users/erin/Desktop/Spring2020/GIS3/labs")
load("cluster_7.Rdata")

# Show object content
str(cluster_7)
```

```
## List of 9
##  $ cluster     : Named int [1:1584] 7 5 7 5 5 7 5 1 1 4 ...
##   ..- attr(*, "names")= chr [1:1584] "E00032987" "E00032988" "E0003298
9" "E00032990" ...
##  $ centers     : num [1:7, 1:60] 0.553 0.584 0.677 0.666 0.391 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:7] "1" "2" "3" "4" ...
##   .. ..$ : chr [1:60] "k001" "k002" "k003" "k004" ...
##  $ totss       : num 2827
##  $ withinss    : num [1:7] 286 308 250 255 159 ...
##  $ tot.withinss: num 1635
##  $ betweenss   : num 1192
##  $ size        : int [1:7] 259 340 279 334 109 73 190
##  $ iter        : int 6
##  $ ifault      : int 0
##  - attr(*, "class")= chr "kmeans"
```

```
# Lookup Table
lookup <- data.frame(cluster_7$cluster)
# Add OA codes
lookup$OA <- rownames(lookup)
colnames(lookup) <- c("K_7","OA")
# Recode clusters as letter
lookup$SUPER <- LETTERS[lookup$K_7]

table(lookup$K_7)
```

```
##
##   1   2   3   4   5   6   7
## 259 340 279 334 109  73 190
```

Mapping the clusters

```
# Load packages
library(rgdal)
```

```
## Loading required package: sp
```

```
## rgdal: version: 1.4-8, (SVN revision 845)
##  Geospatial Data Abstraction Library extensions to R successfully load
ed
##  Loaded GDAL runtime: GDAL 2.4.2, released 2019/06/28
##  Path to GDAL shared files: /Library/Frameworks/R.framework/Versions/
3.6/Resources/library/rgdal/gdal
##  GDAL binary built with GEOS: FALSE
##  Loaded PROJ.4 runtime: Rel. 5.2.0, September 15th, 2018, [PJ_VERSION:
520]
##  Path to PROJ.4 shared files: /Library/Frameworks/R.framework/Version
s/3.6/Resources/library/rgdal/proj
##  Linking to sp version: 1.3-2
```

```
library(tmap)
```

```
## Warning: package 'tmap' was built under R version 3.6.2
```

```
# Import OA boundaries
setwd("/Users/erin/Desktop/Spring2020/GIS3/labs")
liverpool_SP <- readOGR("Liverpool_OA_2011.geojson", layer="Liverpool_OA_
2011")
```

```
## OGR data source with driver: GeoJSON
## Source: "/Users/erin/Desktop/Spring2020/GIS3/labs/Liverpool_OA_2011.ge
ojson", layer: "Liverpool_OA_2011"
## with 1584 features
## It has 1 fields
```

```
# Merge lookup
liverpool_SP <- merge(liverpool_SP, lookup, by.x="oa_code",by.y="OA")
m <- tm_shape(liverpool_SP, projection=27700) +
    tm_polygons(col="SUPER", border.col = "grey50",   palette="Set3",bord
er.alpha = .3, title="Cluster", showNA=FALSE) +
  tm_layout(legend.position = c("left", "bottom"), frame = FALSE) +
  tm_basemap(leaflet::providers$CartoDB.DarkMatter)
```

Resulting Clustered Map

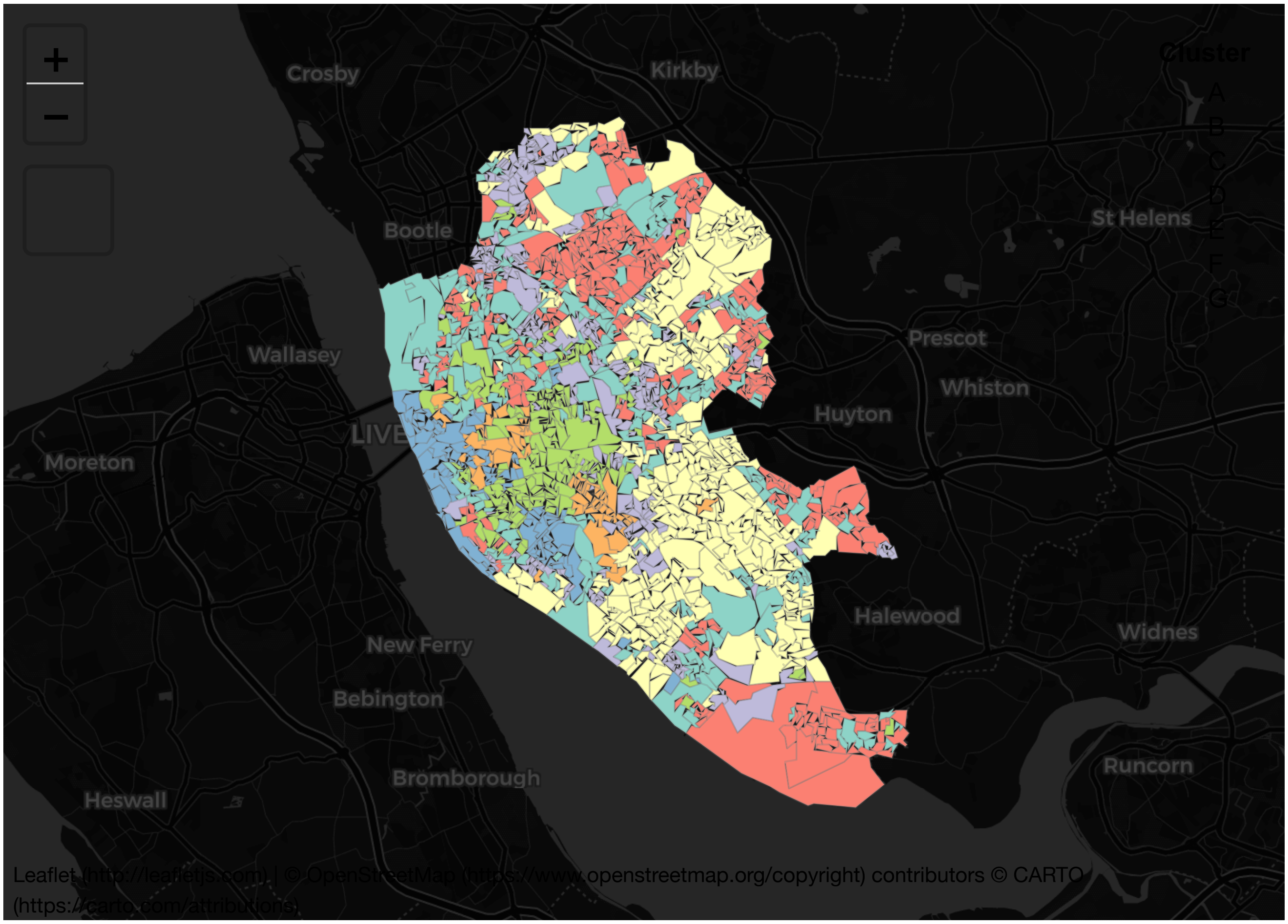
```
#Create leaflet plot
tmap_leaflet(m)
```

```
## Warning: The shape liverpool_SP is invalid. See sf::st_is_valid
```

```
## Warning: package 'sf' was built under R version 3.6.2
```

```
## Linking to GEOS 3.7.2, GDAL 2.4.2, PROJ 5.2.0
```

```
## legend.postion is used for plot mode. Use view.legend.position in tm_v
iew to set the legend position in view mode.
```



Interpretation of the cluster map

- From the cluster map, I gathered that classes A, C, and D, are more dispered around Liverpool, while classes B, E, F, and G seem to be more clustered in certain areas. The central-west side of the city has a lot of variation in classes in different neighborhoods, with more classes appearing in a small number of neighborhoods. This is in contrast to areas farther away from downtown (closer to the boundaries of the city) that have many neighorhoods of the same class. Class B is mostly located on the east side with neighborhoods that appear to be of larger size than those close to downtown, while E, F, and G seem to be confined to smaller tracts that are more centrally located. Based on the spatial distribution of the clustered neighborhood map, I would claim that E, F, and G are the most urban areas with G potentially considered as true “downtown”, and classes B and D are the less urban with larger neighborhood sizes on the outskirts of the city.

Cluster Descriptions

```
# Merge Original Data (inc. denominators)
LiVOAC_Lookup_Input <- merge(lookup,OAC_Input,by="OA",all.x=TRUE)
# Remove Ratio Variables
LiVOAC_Lookup_Input$k007 <- NULL
LiVOAC_Lookup_Input$k035 <- NULL
# Create Aggregations by SuperGroup
SuperGroup <-aggregate(LiVOAC_Lookup_Input[,4:78], by=list(LiVOAC_Lookup_
Input$SUPER),  FUN=sum)
# Create a data frame that will be used to append the index scores
G_Index <- data.frame(SUPER=LETTERS[1:7])
# Loop
for (n in 1:nrow(K_Var)){

  num <- paste(K_Var[n,"VariableCode"]) # Get numerator name
  den <- paste(K_Var[n,"Denominator"]) # Get denominator name
  tmp <- data.frame(round((SuperGroup[,num] / SuperGroup[,den]) / (sum(Su
perGroup[,num])/sum(SuperGroup[,den]))*100)) # Calculate index score - th
ese are also rounded
  colnames(tmp) <- num

  G_Index <- cbind(G_Index,tmp) # Append the index calculations

  # Remove temporary objects
  remove(list = c("tmp","num","den"))
}
# View the index scores
G_Index
```

```
##   SUPER k001 k002 k003 k004 k005 k006 k008 k009 k010 k011 k012 k013 k0
14 k015
## 1     A   83   91   91  114  147  237   90   92   84  144  106   81
38   40
## 2     B   90  109   84  129  124  121   23   65  164   71  106   60
97   92
## 3     C  125  104  115   98   87   66    8   98  105  102  106   78
71   56
## 4     D  121  129   92  104  108   75   31   95   98  117  107   63
59   23
## 5     E   45   21  184   59   33   41   98  152   42   80   89  171  2
10  197
## 6     F   35   31   62   32   30   37  933  171   29   33   84  137  2
80  348
## 7     G  129  113  120   83   73   50   20  112   76  125   77  238  1
39  195
##   k016 k017 k018 k019 k020 k021 k022 k023 k024 k025 k026 k027 k028 k02
9 k030
## 1   41   43   59   46  105   60   73   51   73   95    6   51   89   8
2  155
## 2   48   73   25   32  105   68   29   44  142  130   11  317  221   2
4   30
## 3   44   47   48   38  104   81   75   55  115  100   58   30   45  18
5   43
## 4   29   39   49   22  106   41   76   57   79  140    4   66  119  14
7   11
## 5   79  171  146  275   86  432  186  136  144   14  283   14    9
8  375
## 6  393  415  131  143   86  199  116  148   71   42 1040   31   26  10
1  199
## 7  305  186  408  408   84  134  291  357   68   70  128   57   59  10
9  143
##   k031 k032 k033 k034 k036 k037 k038 k039 k040 k041 k042 k043 k044 k04
5 k046
## 1   70  183   61   92  109  100   62   64   44   57   97   83   83  12
8   98
## 2  181   11   43   23  123  110   84  143   54  236   80  157   61   5
3   91
## 3  127   31  128   59   98  113   94  105   64   93  128  115   98   9
7   90
## 4   87  164   48   69  113  117   68   45   54   65  104   87   89  13
2  111
## 5   39   67  263  302   53   57  112  227  148   61  105   87  260   7
9   64
## 6   54   71  231  261   42   47  322   97  480   77   72   42  114   3
8  178
## 7   48  152  140  159   82   93   84   88  101   39  111   65  117  15
8  112
```

```
##   k047 k048 k049 k050 k051 k052 k053 k054 k055 k056 k057 k058 k059 k06
0
## 1  101   56  114  112  107  103  126   90   76   93  120   99   84  10
2
## 2  104   73  115  106  104   87   94   58  119  121   70  125  124   9
6
## 3  104   98  100  100  104   98  106   80   97  107   92  114  104  10
4
## 4   95  110  120  121  123  113  126   93   54   82  136   87   68  11
0
## 5  117   98   48   67   61   78   58  132  209  117   78   82  121   9
0
## 6   64  295   37   43   25  143   44  258  102   60   76   54  105   7
5
## 7   95  108   81   90  102  105   89  165   82   80  137   71   86  10
3
```

Grand Index Table Trends

```
library(reshape2)
```

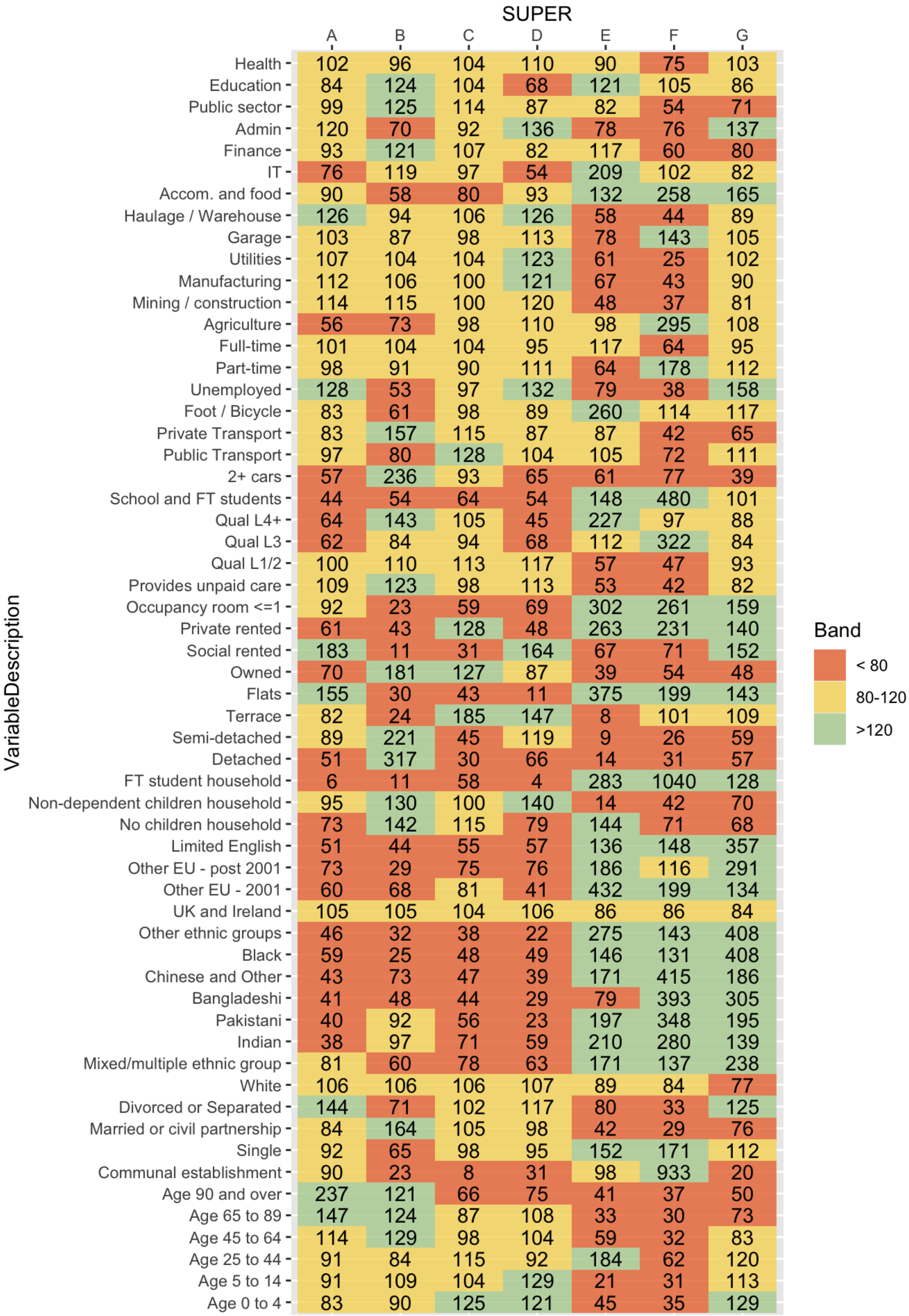
```
## Warning: package 'reshape2' was built under R version 3.6.2
```

```
# Convert from wide to narrow format
G_Index_Melt <- melt(G_Index, id.vars="SUPER")
# View the top of the new narrow formatted data frame
head(G_Index_Melt)
```

```
##   SUPER variable value
## 1     A     k001    83
## 2     B     k001    90
## 3     C     k001   125
## 4     D     k001   121
## 5     E     k001    45
## 6     F     k001    35
```

```
# Recode the index scores into aggregate groupings
G_Index_Melt$band <- ifelse(G_Index_Melt$value <= 80,"< 80",ifelse(G_Inde
x_Melt$value > 80 & G_Index_Melt$value <= 120,"80-120",">120"))
# Add a column with short descriptions of the variables
setwd("/Users/erin/Desktop/Spring2020/GIS3/labs")
short <- read.csv("OAC_Input_Lookup_short_labels.csv")
G_Index_Melt <- merge(G_Index_Melt,short,by.x="variable",by.y="VariableCo
de",all.x=TRUE)
# Order the created factors appropriately - needed to ensure the legend a
nd axis make sense in ggolot2
G_Index_Melt$band <- factor(G_Index_Melt$band, levels = c("< 80","80-120"
,">120"))
G_Index_Melt$VariableDescription <- factor(G_Index_Melt$VariableDescripti
on, levels = short$VariableDescription)
```

```
library(ggplot2)
p <- ggplot(G_Index_Melt, aes(x=SUPER, y=VariableDescription, label=valu
e, fill=band)) +
  scale_fill_manual(name = "Band",values = c("#EB753B","#F7D865","#B3D09
F")) +
  scale_x_discrete(position = "top") +
  geom_tile(alpha=0.8) +
  geom_text(colour="black")
p
```


SUPER
A B C D E F G
Health 102 96 104 110 90 75 103
Education 84 124 104 68 121 105 86
Public sector 99 125 114 87 82 54 71
Admin 120 70 92 136 78 76 137
Finance 93 121 107 82 117 60 80
IT 76 119 97 54 209 102 82
Accom. and food 90 58 80 93 132 258 165
Haulage / Warehouse 126 94 106 126 58 44 89
Garage 103 87 98 113 78 143 105
Utilities 107 104 104 123 61 25 102
Manufacturing 112 106 100 121 67 43 90
Mining / construction 114 115 100 120 48 37 81
Agriculture 56 73 98 110 98 295 108
Full-time 101 104 104 95 117 64 95
Part-time 98 91 90 111 64 178 112
Unemployed 128 53 97 132 79 38 158
Foot / Bicycle 83 61 98 89 260 114 117
Private Transport 83 157 115 87 87 42 65
Public Transport 97 80 128 104 105 72 111
2+ cars 57 236 93 65 61 77 39
School and FT students 44 54 64 54 148 480 101
Qual L4+ 64 143 105 45 227 97 88
Qual L3 62 84 94 68 112 322 84
Qual L1/2 100 110 113 117 57 47 93
Provides unpaid care 109 123 98 113 53 42 82
Occupancy room <=1 92 23 59 69 302 261 159
Private rented 61 43 128 48 263 231 140
Social rented 183 11 31 164 67 71 152
Owned 70 181 127 87 39 54 48
Flats 155 30 43 11 375 199 143
Terrace 82 24 185 147 8 101 109
Semi-detached 89 221 45 119 9 26 59
Detached 51 317 30 66 14 31 57
FT student household 6 11 58 4 283 1040 128
Non-dependent children household 95 130 100 140 14 42 70
No children household 73 142 115 79 144 71 68
Limited English 51 44 55 57 136 148 357
Other EU - post 2001 73 29 75 76 186 116 291
Other EU - 2001 60 68 81 41 432 199 134
UK and Ireland 105 105 104 106 86 86 84
Other ethnic groups 46 32 38 22 275 143 408
Black 59 25 48 49 146 131 408
Chinese and Other 43 73 47 39 171 415 186
Bangladeshi 41 48 44 29 79 393 305
Pakistani 40 92 56 23 197 348 195
Indian 38 97 71 59 210 280 139
Mixed/multiple ethnic group 81 60 78 63 171 137 238
White 106 106 106 107 89 84 77
Divorced or Separated 144 71 102 117 80 33 125
Married or civil partnership 84 164 105 98 42 29 76
Single 92 65 98 95 152 171 112
Communal establishment 90 23 8 31 98 933 20
Age 90 and over 237 121 66 75 41 37 50
Age 65 to 89 147 124 87 108 33 30 73
Age 45 to 64 114 129 98 104 59 32 83
Age 25 to 44 91 84 115 92 184 62 120
Age 5 to 14 91 109 104 129 21 31 113
Age 0 to 4 83 90 125 121 45 35 129
VariableDescription
Band
< 80
80-120
>120