

# MixAll (PMS + additional variables)

PMS

19 May, 2023

---

## Assumptions of the Algorithm

The `clusterDiagGaussian()` model assumes that the data is generated from a mixture of Gaussian distributions. It assumes independence and diagonal covariance thus meaning no correlation between variables. Each component follows a Gaussian distribution with estimated mean and standard deviation parameters. The model represents a mixture of  $K$  components, allowing for equal or different standard deviations within each component.

## How it works

The MixAll model is basically a mixture model. Mixture models assume data is generated from a combination of probability distributions. Parameter estimation is achieved by maximizing the observed log-likelihood or integrated log-likelihood for data with missing values. Estimation algorithms like EM, SEM, and CEM are used and the default is EM which is highlighted below, involving steps such as imputation, conditional probability calculation, and parameter updates. The EM algorithm iteratively performs these steps until convergence.

1. **I step:** Impute the missing values  $x_i^m$  using the current MAP value provided by the current parameter  $\theta^{m-1}$ .
2. **E step:** Compute the current conditional probabilities  $t_{ik}^m$  for  $i = 1, \dots, n$  and  $k = 1, \dots, K$  using the current parameter  $\theta^{m-1}$ .
3. **M step:** Update the maximum likelihood estimate  $\theta^m$  of  $\theta$  using the conditional probabilities  $t_{ik}^m$  as conditional mixing weights, aiming to maximize the log-likelihood function, where  $t^m = (t_{ik}^m, i = 1, \dots, n, k = 1, \dots, K)$ .
4. **Parameter update:** The updated expression of mixture proportions  $p_k^m$  for  $k = 1, \dots, K$  are computed. Detailed formulas for updating the parameters  $\lambda_k$  and  $\alpha$  depend on the component parameterization.

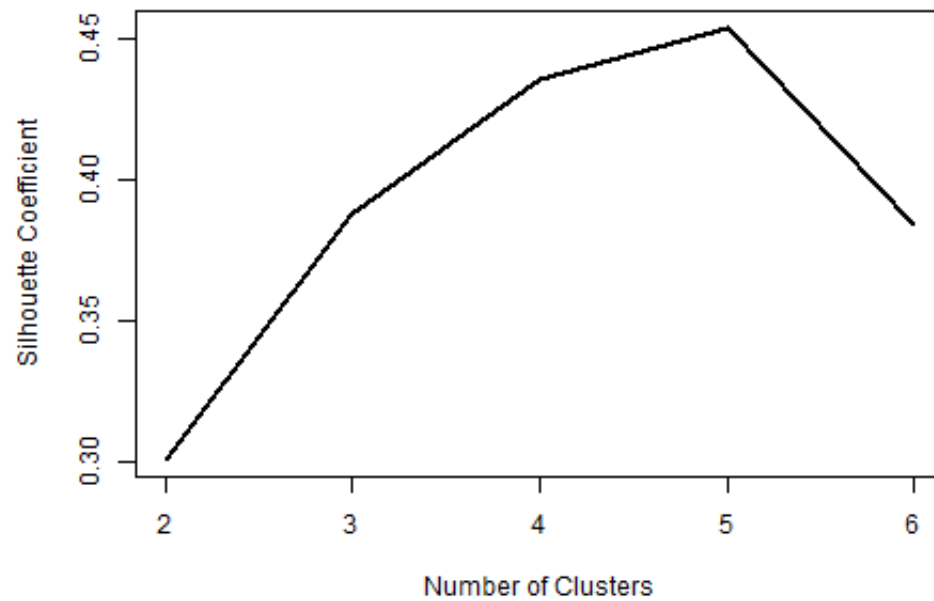
Note that there are one of two strategies that can be used as a function call: `clusterFastStrategy()` and `clusterSemiSEMStrategy()`. When using the `clusterFastStrategy()`, result is not guaranteed if the model is quite difficult to estimate (overlapping class for examples). If there are lots of missing values its suggested that the `fff` is used as it uses a MonteCarlo estimator to estimate unbiased estimators. In our case the fast strategy was used as the other would take way too long and we dont have the computing power especially for all 10 measures and trying numerous different number of clusters...

[More information can be found here](#)

---

Amenities

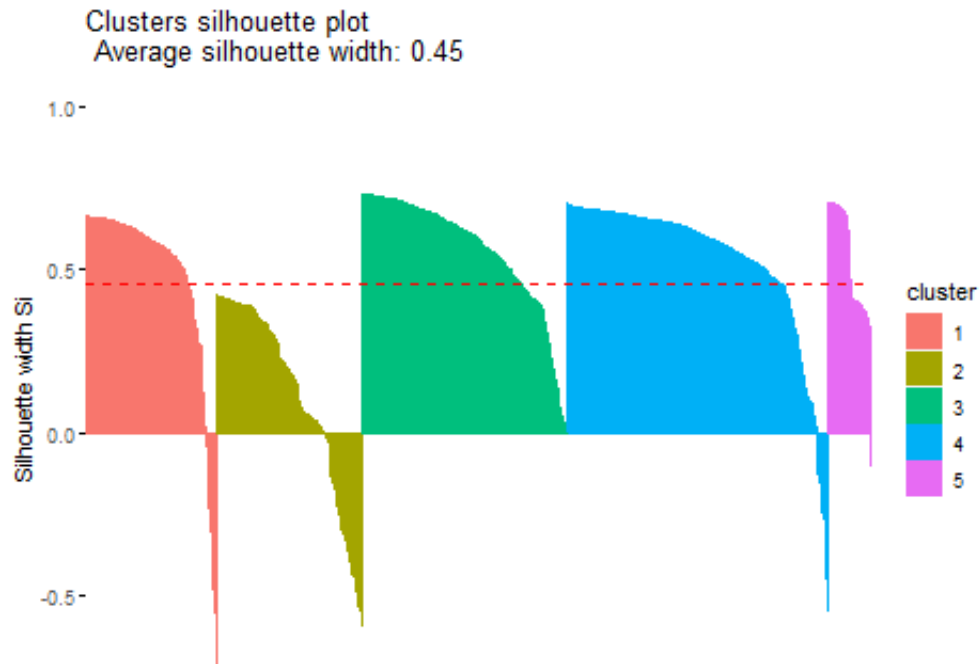
Employment



```
## [1] "Maximum silhouete coefficient: 0.453913615124246 For 5 clusters."
```



```
##      cluster size ave.sil.width
## 1      1 2127      0.48
## 2      2 2328      0.11
## 3      3 3297      0.56
## 4      4 4196      0.53
## 5      5  705      0.54
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
##   Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      2466      2682      3855      4863      824
##
##
##
## DB Population:
##   Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      76.5      74.8      69.2      71.8      73.5
##
##
##
## CSD Population:
##   Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##  232260.6  227298.6  233408.8  237110.9  250940.5
##
##
##
## CMA Type:
##   Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      1091      1160      1698      2141      348
```

```

## B      1017      1143      1577      2027      351
## D      274      283      453      513      95
## K      84      96      127      182      30
##
##
##
## Index of Remoteness:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.23      0.229      0.229      0.226      0.23
##
##
##
## Provinces:
##
##      Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## Alberta      57      82      116      178      25
## BritishColumbia 134      150      186      226      27
## NewBrunswick   22      25      30      36      9
## NorthwestTerritories 1      0      4      2      0
## NovaScotia     88      72      127      135      28
## Ontario      365      402      576      764      133
## Quebec        143      151      229      283      52
## Saskatchewan   16      12      22      21      0
## NA's          1640     1788     2565     3218     550
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0      2212      2424      3491      4427      740
## 1      196      206      278      336      68
## 2      32      22      42      45      6
## F      26      30      44      55      10
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.0264      0.02479      0.0256      0.02479      0.02597
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.04694      0.04221      0.04583      0.04499      0.04364
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.07614      0.07359      0.07714      0.07704      0.08094
##
##
##
## PMS_prox_idx_health :

```

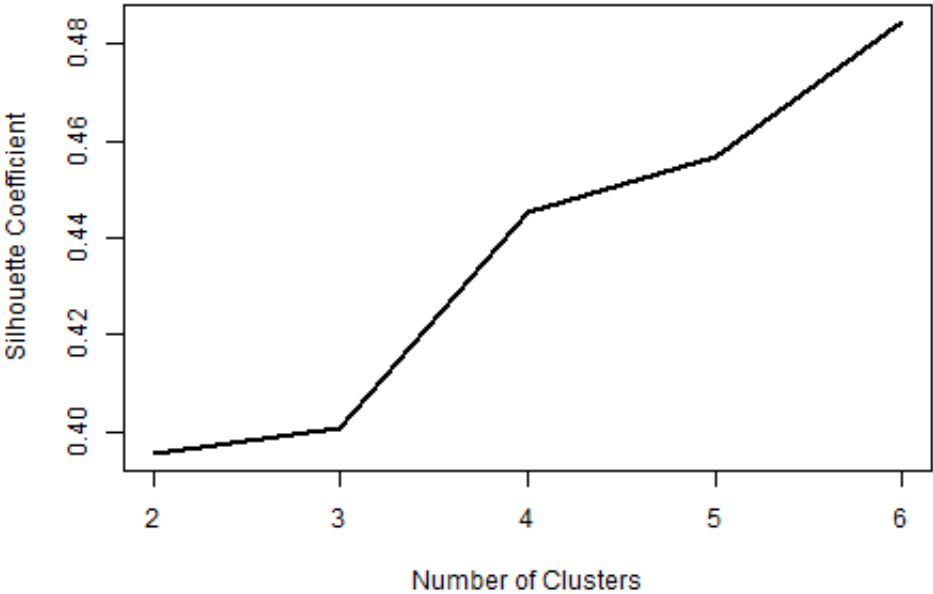
```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.01502 0.01304 0.01365 0.01348 0.01483
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.07147 0.06975 0.07003 0.07183 0.07125
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.11913 0.11419 0.11766 0.11617 0.12003
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.10638 0.10563 0.10289 0.10079 0.10644
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.11405 0.11443 0.11485 0.1128 0.1055
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.07299 0.06593 0.06955 0.0664 0.06963
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.01877 0.01657 0.01872 0.01796 0.01728

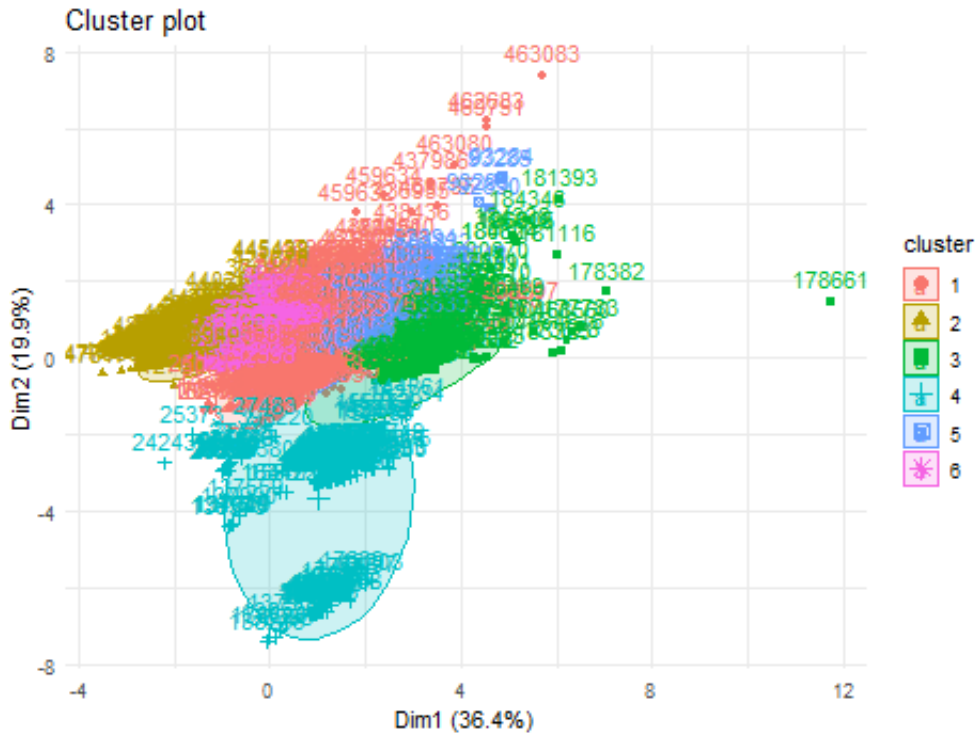
```

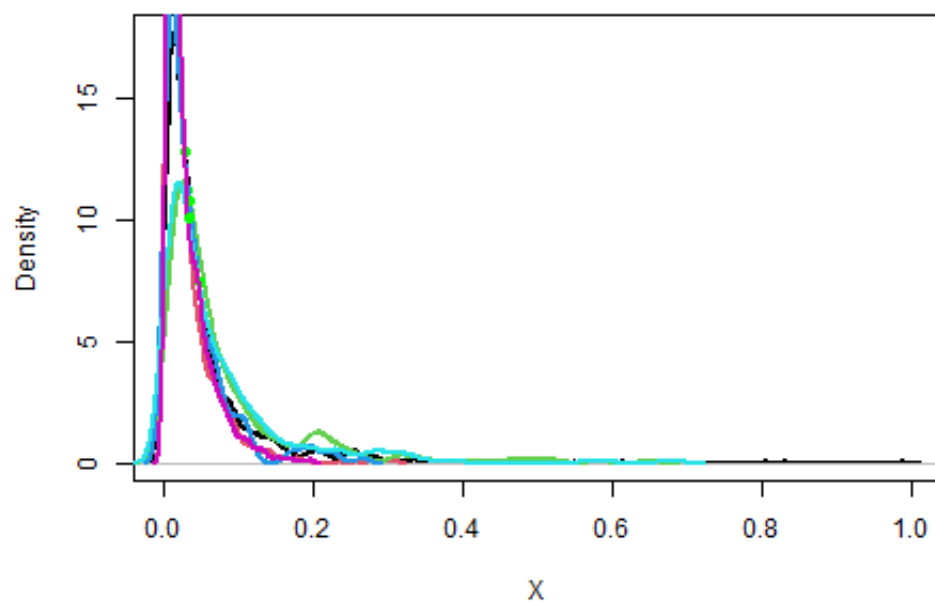
---

Pharmacy



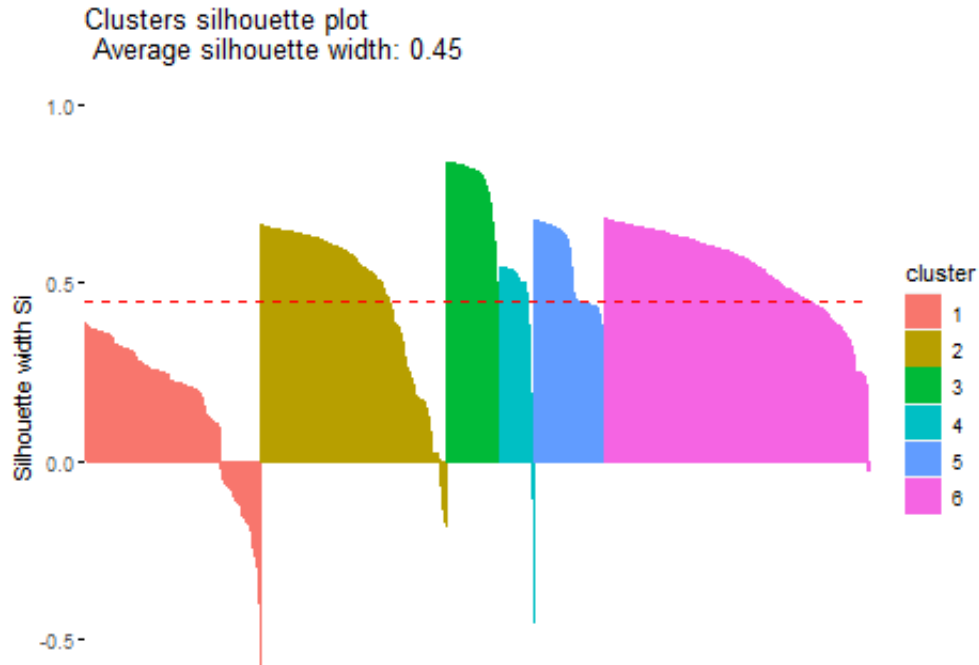
## [1] "Maximum silhouette coefficient: 0.484630393948967 For 6 clusters."





```
## [1] "Segment cutoff values:"
## [1] 0.02996502
## [1] 0.03332466
## [1] 0.03666365
## [1] 0.04853615
## [1] 0.03432414
##   cluster size ave.sil.width
## 1      1 1178      0.16
## 2      2 1233      0.47
## 3      3  355      0.77
## 4      4  234      0.44
## 5      5  471      0.54
## 6      6 1760      0.53
```





```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      3297      3474      1001      659      1342      4917
##
##
## DB Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      74.4      70.3      66.6      90.2      65.9      73.4
##
##
## CSD Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 225881.2 232901 226387.6 280690.5 245546.7 233289
##
##
## CMA Type:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      1485      1540      457      268      558      2130
## B      1318      1427      409      283      590      2088
## D       374       383      104       86      152       519
## K       120       124       31       22       42       180
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.231 0.228 0.23 0.222 0.223 0.229
##
##
##
## Provinces:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## Alberta 111 122 39 21 44
## BritishColumbia 144 166 46 24 60
## NewBrunswick 26 29 7 3 16
## NorthwestTerritories 2 1 0 1 1
## NovaScotia 83 119 36 14 40
## Ontario 498 521 140 121 218
## Quebec 185 213 54 33 76
## Saskatchewan 16 16 3 3 6
## NA's 2232 2287 676 439 881
## Cluster 6
## Alberta 121
## BritishColumbia 283
## NewBrunswick 41
## NorthwestTerritories 2
## NovaScotia 158
## Ontario 742
## Quebec 297
## Saskatchewan 27
## NA's 3246
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0 3004 3137 909 612 1204 4428
## 1 222 262 71 36 113 380
## 2 33 33 9 7 15 50
## F 38 42 12 4 10 59
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.02483 0.02552 0.0254 0.02281 0.02629 0.02562
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.04437 0.04401 0.04762 0.03881 0.0441 0.04645
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.07516 0.07809 0.0727 0.0713 0.07681 0.07766
##

```

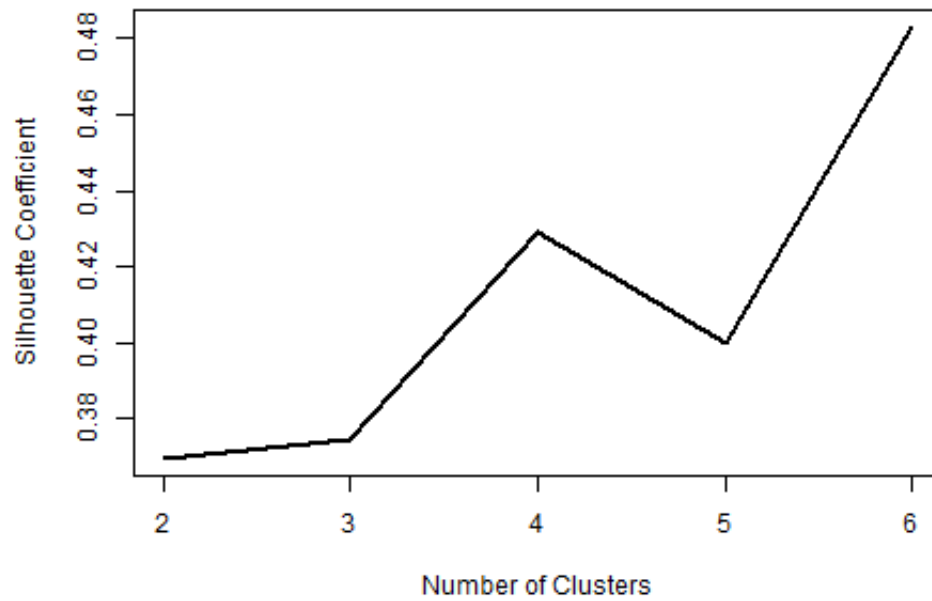
```

##
##
## PMS_prox_idx_health :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.01363 0.01375 0.01451 0.01236 0.01347 0.01403
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.06945 0.07124 0.07214 0.06089 0.07015 0.07267
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.1132 0.1176 0.12229 0.10985 0.11568 0.11917
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.10165 0.10581 0.10359 0.10308 0.10217 0.10352
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.1176 0.11106 0.12301 0.11645 0.10623 0.11199
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.0684 0.06722 0.06862 0.06617 0.067 0.06996
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.01815 0.01806 0.01812 0.01675 0.01756 0.01814

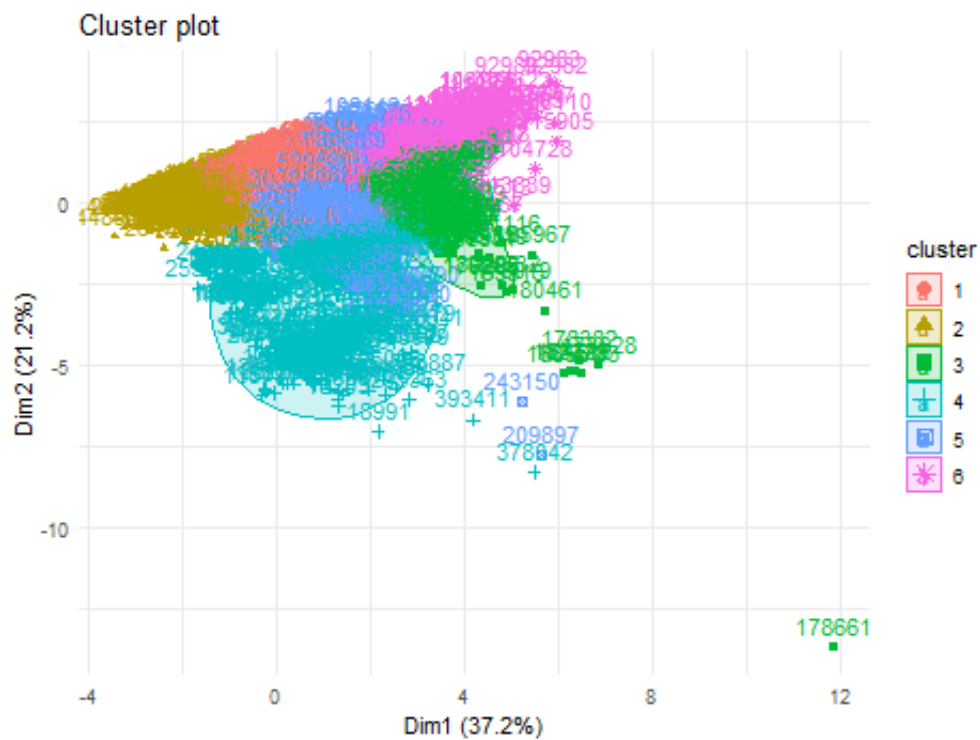
```

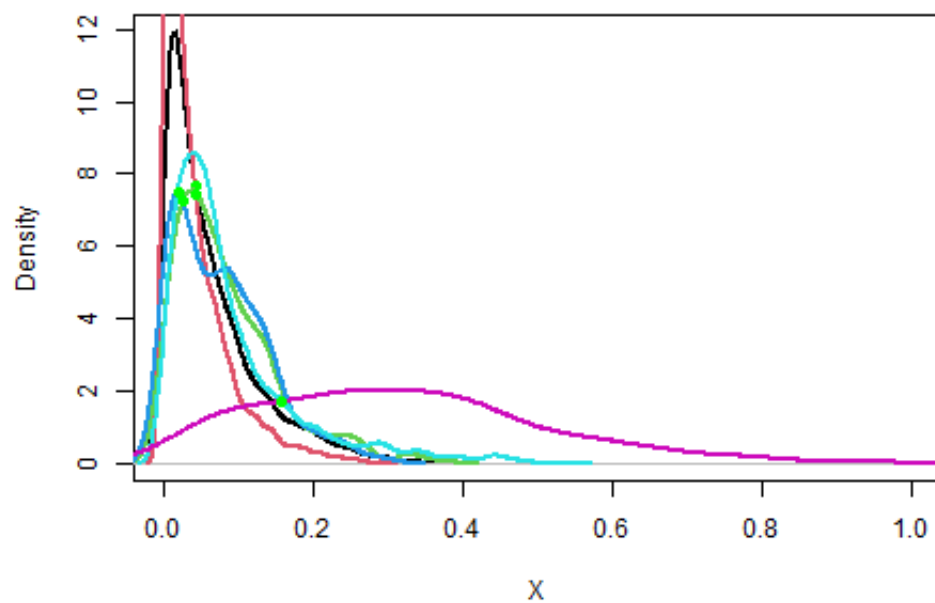
---

## Childcare

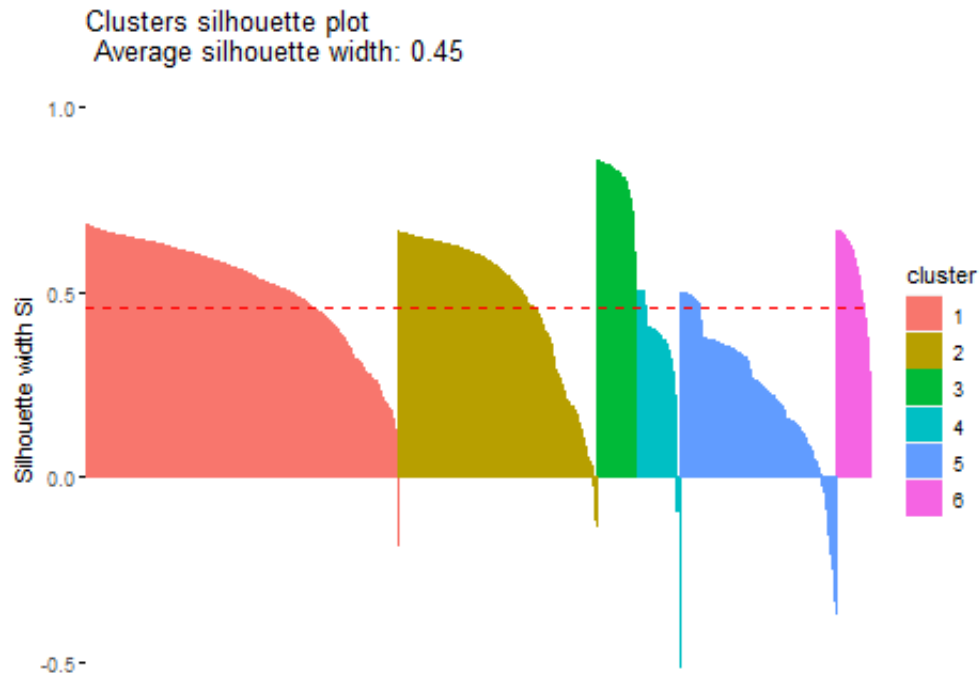


```
## [1] "Maximum silhouette coefficient: 0.483270342858147 For 6 clusters."
```





```
## [1] "Segment cutoff values:"
## [1] 0.04371247
## [1] 0.04485045
## [1] 0.02727702
## [1] 0.02043799
## [1] 0.1592765
##   cluster size ave.sil.width
## 1      1 2884      0.51
## 2      2 1823      0.48
## 3      3  377      0.79
## 4      4  396      0.34
## 5      5 1441      0.23
## 6      6  310      0.55
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      5860      3703      766      805      2926      630
##
##
## DB Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      72.5      70.9      72.5      74.4      75.4      67.1
##
##
## CSD Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##  228710.3 242745.1 257839.7  230057  232376.5 222637.1
##
##
## CMA Type:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      2619      1578      338      386      1244      273
## B      2393      1589      319      303      1246      265
## D       640       405       85       91       333       64
## K       208       131       24       25       103       28
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.23      0.223      0.235      0.243      0.227      0.225
##
##
##
## Provinces:
##
##      Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## Alberta      187      124      27      27      78
## BritishColumbia 267      213      28      26      155
## NewBrunswick   51      34      7      3      22
## NorthwestTerritories 3      3      0      0      1
## NovaScotia    188      113      23      24      92
## Ontario      893      569      117     109      451
## Quebec       351      208      35      52      184
## Saskatchewan   27      18      5      3      16
## NA's         3893     2421      524     561     1927
##
##      Cluster 6
## Alberta      15
## BritishColumbia 34
## NewBrunswick   5
## NorthwestTerritories 0
## NovaScotia    10
## Ontario      101
## Quebec       28
## Saskatchewan   2
## NA's         435
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0      5324      3334      684      721      2663      568
## 1      428      278      61      64      201      52
## 2      49      43      5      8      36      6
## F      59      48      16      12      26      4
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.02488  0.02688  0.02555  0.02567  0.02428  0.02472
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.0453  0.04506  0.04438  0.04963  0.04351  0.04258
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.07672  0.07801  0.07533  0.07793  0.07485  0.07296
##

```

```

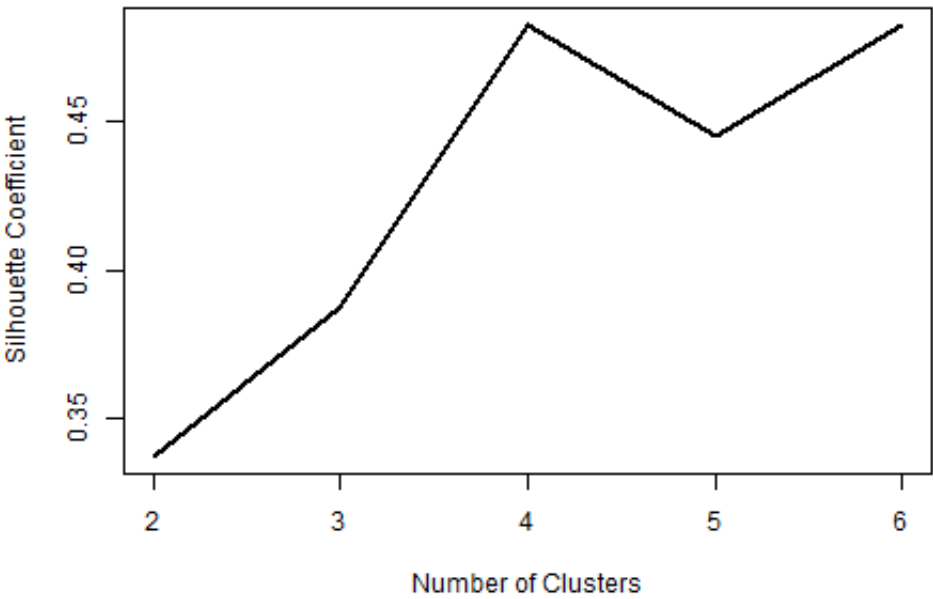
##
##
## PMS_prox_idx_health :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.0138   0.01434   0.01365   0.01479   0.01287   0.01349
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.07103   0.0734   0.07195   0.08067   0.0667   0.06114
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.11454   0.11829   0.11985   0.12092   0.11703   0.12153
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.10192   0.10328   0.09756   0.11323   0.10436   0.11025
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.11374   0.11327   0.10241   0.11559   0.11472   0.11626
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.06976   0.06749   0.06854   0.07026   0.06603   0.07082
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      0.01815   0.01769   0.02048   0.02058   0.01671   0.01875

```

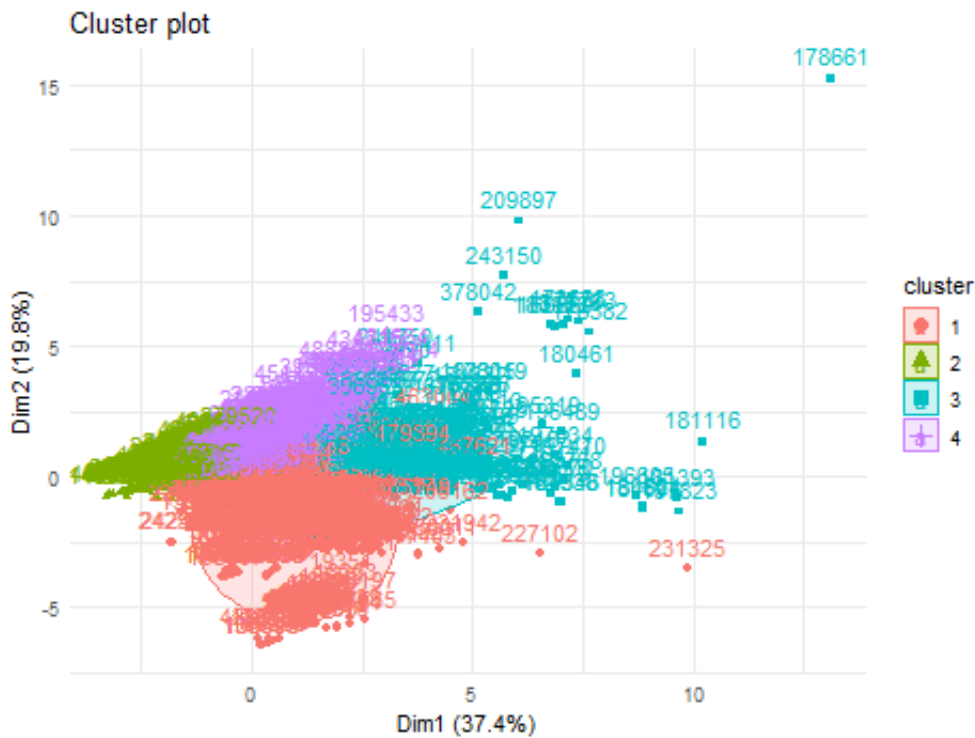
---

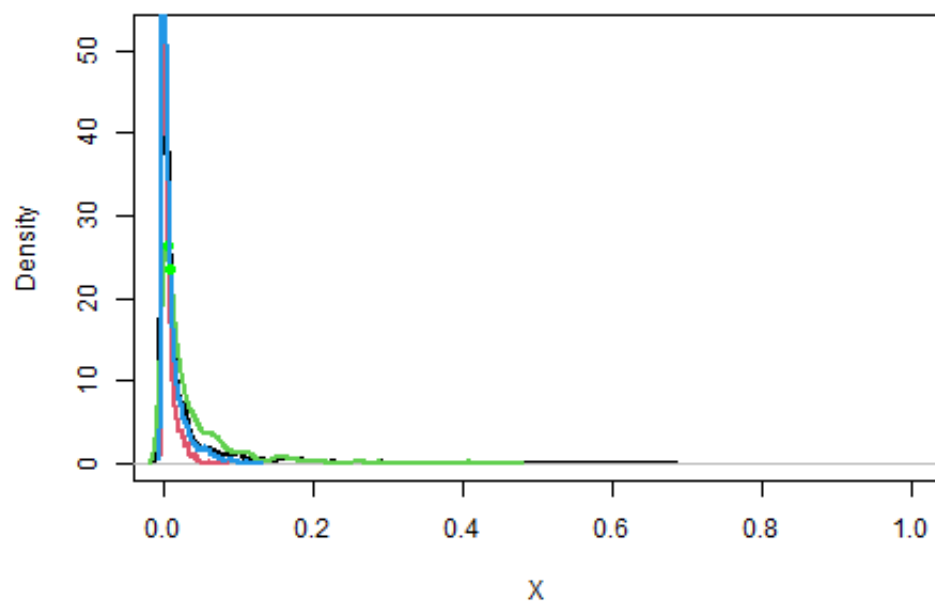


Health

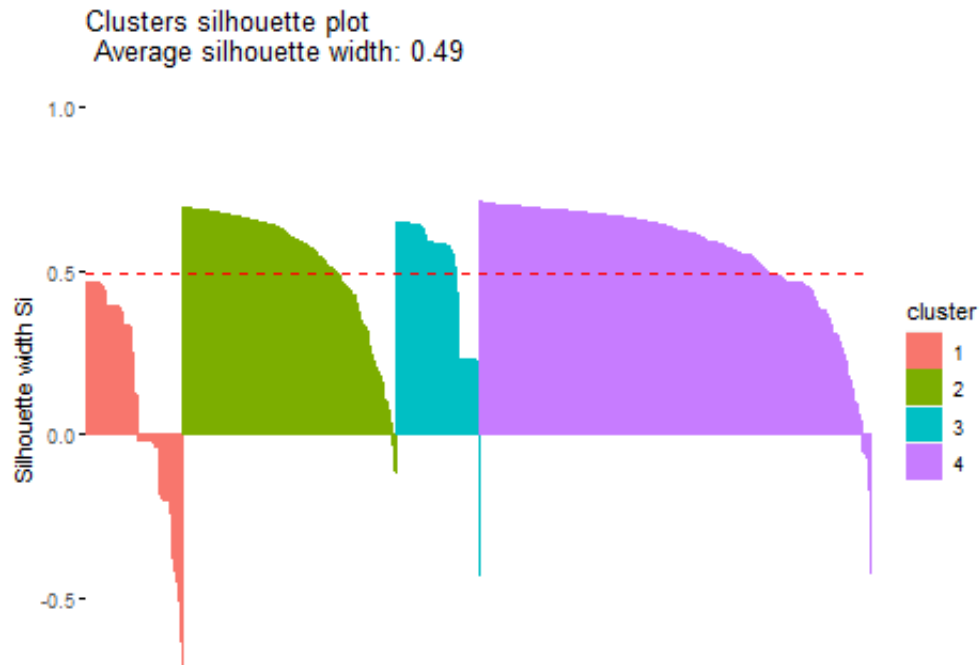


```
## [1] "Maximum silhouete coefficient: 0.482817114920051 For 4 clusters."
```





```
## [1] "Segment cutoff values:"
## [1] NA
## [1] 0.00794005
## [1] 0.01110317
##   cluster size ave.sil.width
## 1      1 1089      0.13
## 2      2 2432      0.53
## 3      3  950      0.50
## 4      4 4442      0.56
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      1783      3994      1594      7319
##
##
## DB Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      69.3      73.2      78.9      71.6
##
##
## CSD Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
## 221110.3 237947.3 230390.1 236396.8
##
##
## CMA Type:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      754      1772      725      3187
## B      761      1676      646      3032
## D      212      414      167      825
## K       56      132       56      275
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.227      0.227      0.235      0.228
##
##
##
## Provinces:
##           Cluster 1 Cluster 2 Cluster 3 Cluster 4
## Alberta           68      117      47      226
## BritishColumbia   96      207      76      344
## NewBrunswick      14       33       7       68
## NorthwestTerritories  2        1        0        4
## NovaScotia        61      123      47      219
## Ontario          263      623     235     1119
## Quebec            97      211      99      451
## Saskatchewan       5       20      13       33
## NA's              1177     2659     1070     4855
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
## 0      1632      3617      1427      6618
## 1       123       295       136       530
## 2        16        33        14        84
## F        12        49        17        87
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.02385      0.0257      0.02439      0.02571
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.04131      0.04364      0.04437      0.04665
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.07258      0.07741      0.07487      0.07731
##
##
##
## PMS_prox_idx_health :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.01289      0.01335      0.01506      0.01396
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4

```

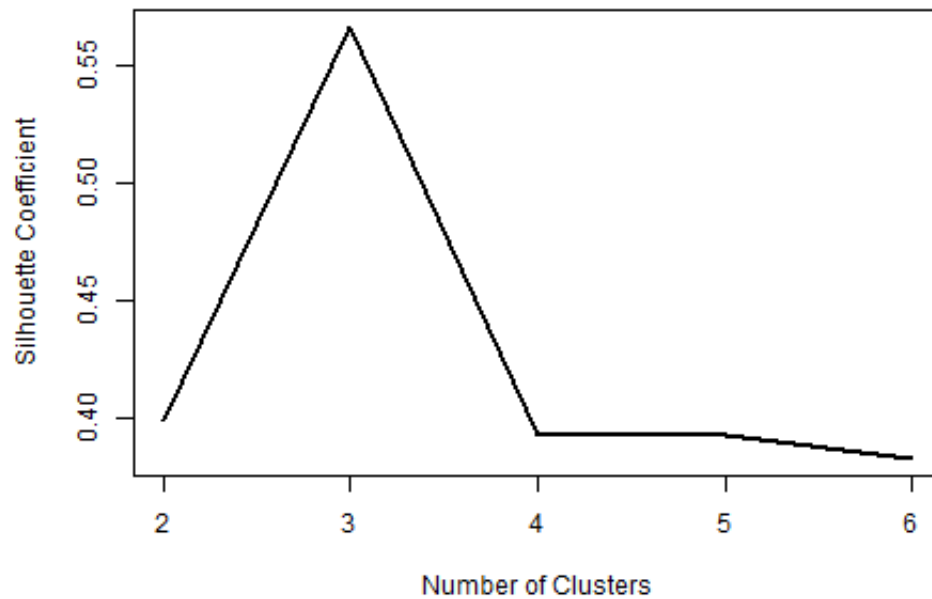
```

##      0.06895    0.06925    0.06708    0.07307
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.11003    0.11921    0.11658    0.11741
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.09925    0.10647    0.10269    0.10299
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.11508    0.11296    0.12192    0.11138
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.06571    0.07029    0.06518    0.06874
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.01711    0.01817    0.017    0.01836

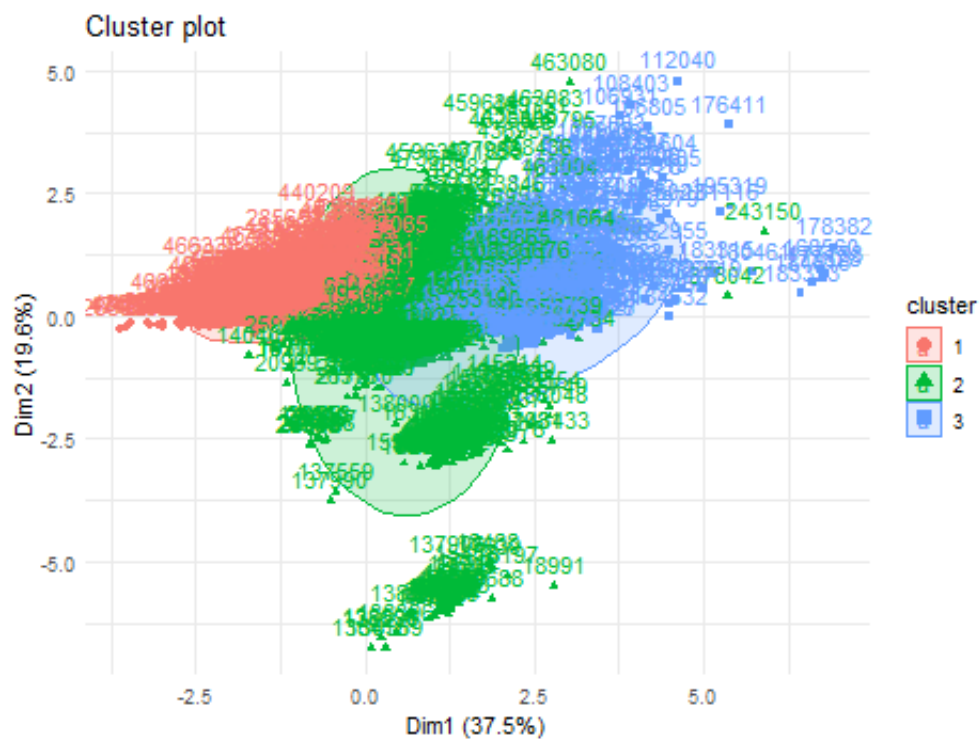
```

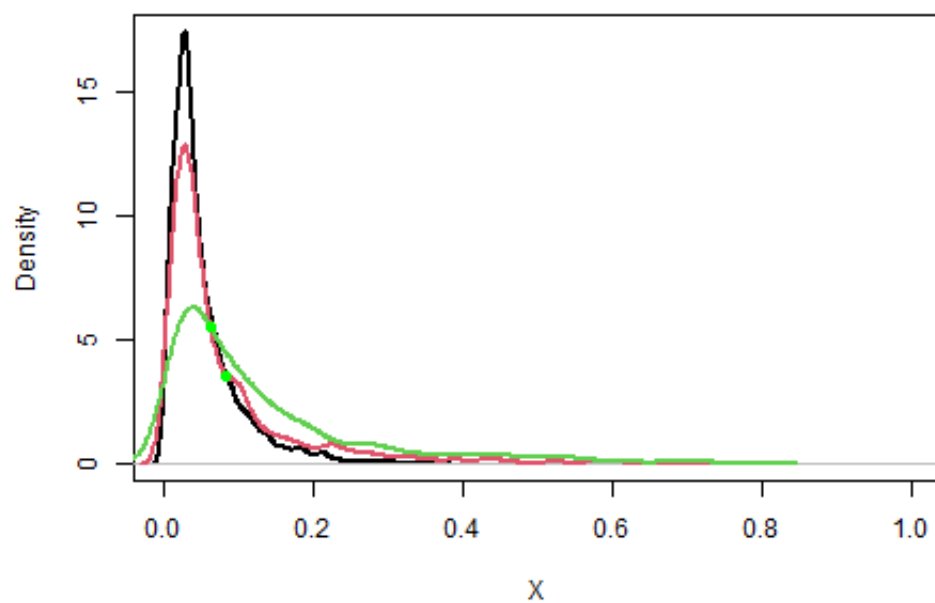
---

## Grocery

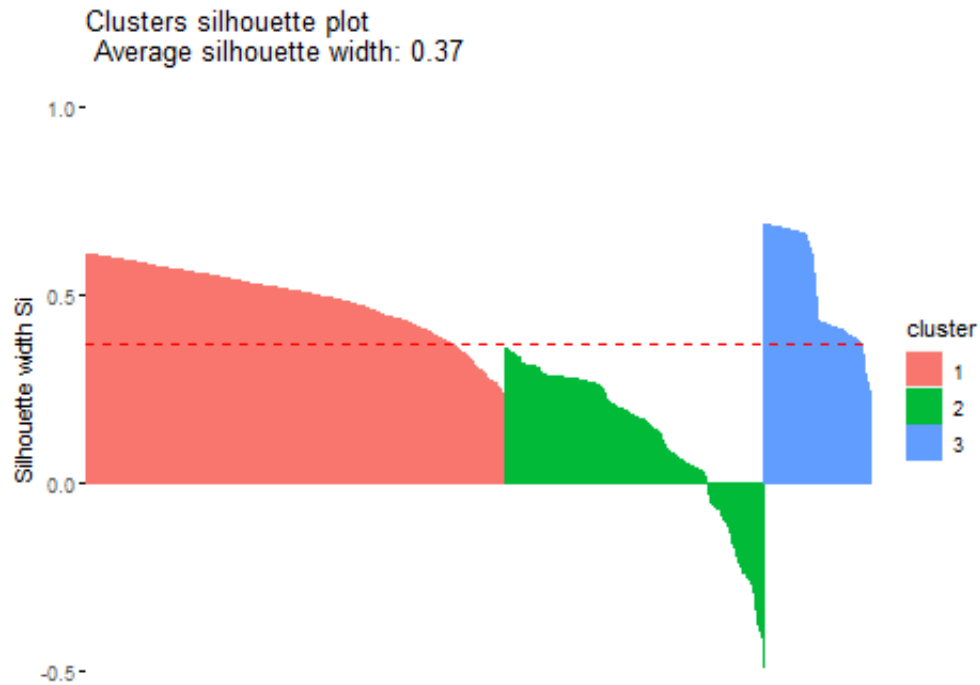


```
## [1] "Maximum silhouette coefficient: 0.566940929333278 For 3 clusters."
```





```
## [1] "Segment cutoff values:"
## [1] 0.08472272
## [1] 0.06377446
##   cluster size ave.sil.width
## 1      1 2243      0.49
## 2      2 1382      0.12
## 3      3  570      0.52
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
##   Cluster 1 Cluster 2 Cluster 3
##      7843      4835      2012
##
##
##
## DB Population:
##   Cluster 1 Cluster 2 Cluster 3
##      72.9      71.9      72.6
##
##
##
## CSD Population:
##   Cluster 1 Cluster 2 Cluster 3
##  237753.1  224706.5  243965.4
##
##
##
## CMA Type:
##   Cluster 1 Cluster 2 Cluster 3
##      3458      2115      865
## B      3251      2012      852
## D       869       527      222
## K       265       181       73
##
##
##
## Index of Remoteness:
```



```

## Cluster 1 Cluster 2 Cluster 3
##      0.229      0.229      0.225
##
##
##
## Provinces:
##           Cluster 1 Cluster 2 Cluster 3
## Alberta           237       155       66
## BritishColumbia   379       225      119
## NewBrunswick       57        52       13
## NorthwestTerritories  4         3        0
## NovaScotia        230       167       53
## Ontario          1219       735      286
## Quebec            461       270      127
## Saskatchewan       30        27       14
## NA's              5226      3201     1334
##
##
##
## Amenity dense:
##      Cluster 1 Cluster 2 Cluster 3
## 0      7097      4398      1799
## 1       577       343       164
## 2        84        39        24
## F        85        55        25
##
##
##
## PMS_prox_idx_emp :
##      Cluster 1 Cluster 2 Cluster 3
##      0.02557   0.02458   0.02625
##
##
##
## PMS_prox_idx_pharma :
##      Cluster 1 Cluster 2 Cluster 3
##      0.04505   0.04397   0.04671
##
##
##
## PMS_prox_idx_childcare :
##      Cluster 1 Cluster 2 Cluster 3
##      0.0764    0.07563   0.07906
##
##
##
## PMS_prox_idx_health :
##      Cluster 1 Cluster 2 Cluster 3
##      0.01387   0.01349   0.01409
##
##
##
## PMS_prox_idx_grocery :
##      Cluster 1 Cluster 2 Cluster 3

```

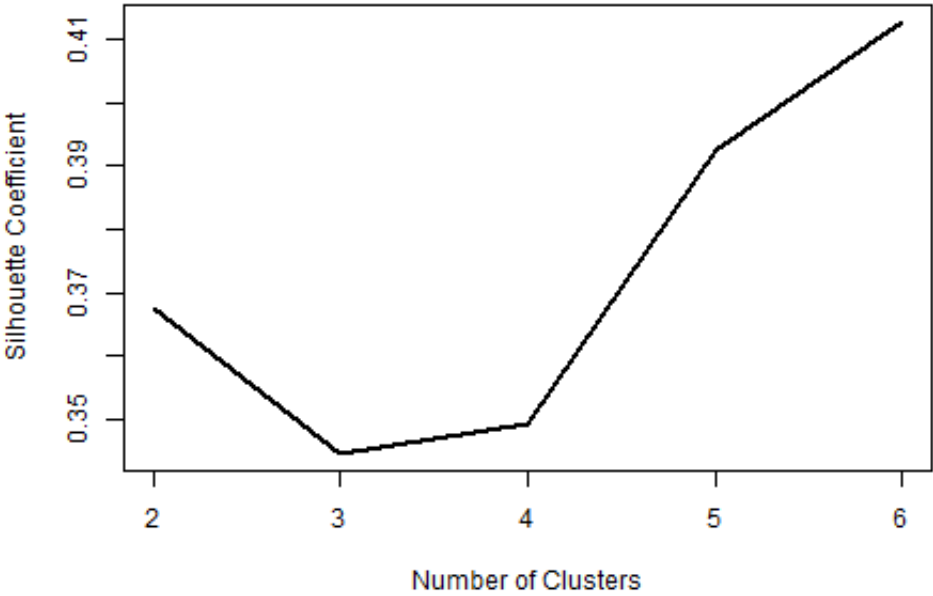
```

##      0.07046    0.07076    0.07274
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3
##      0.11687    0.11657    0.11792
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3
##      0.10335    0.10372    0.10338
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3
##      0.11252    0.11512    0.11293
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3
##      0.06838    0.0683    0.06884
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3
##      0.01779    0.01827    0.01822

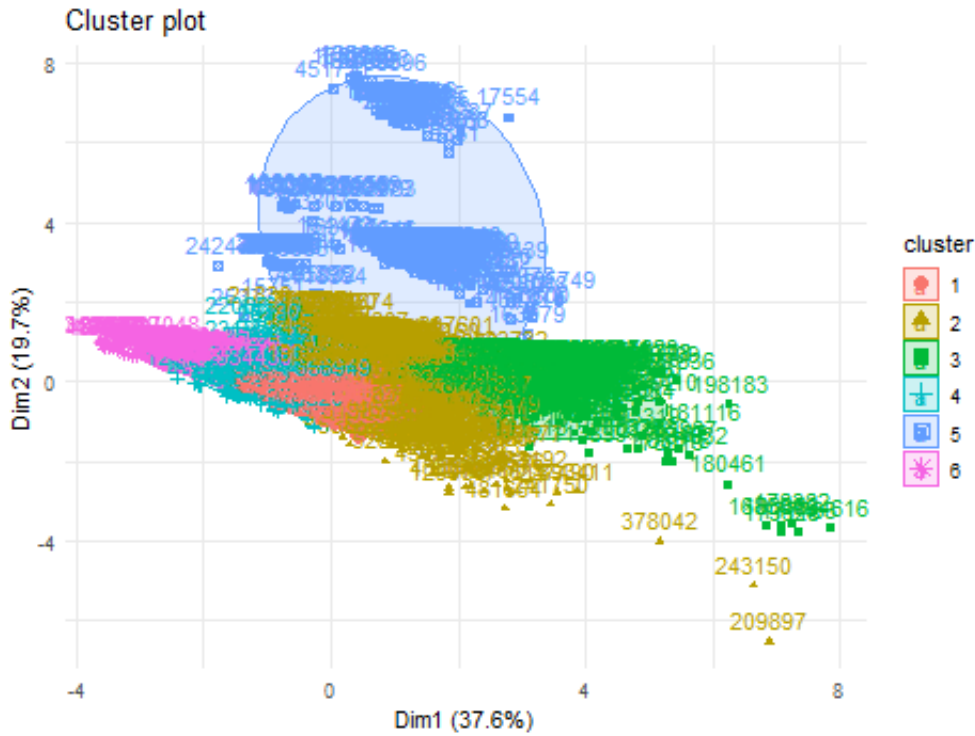
```

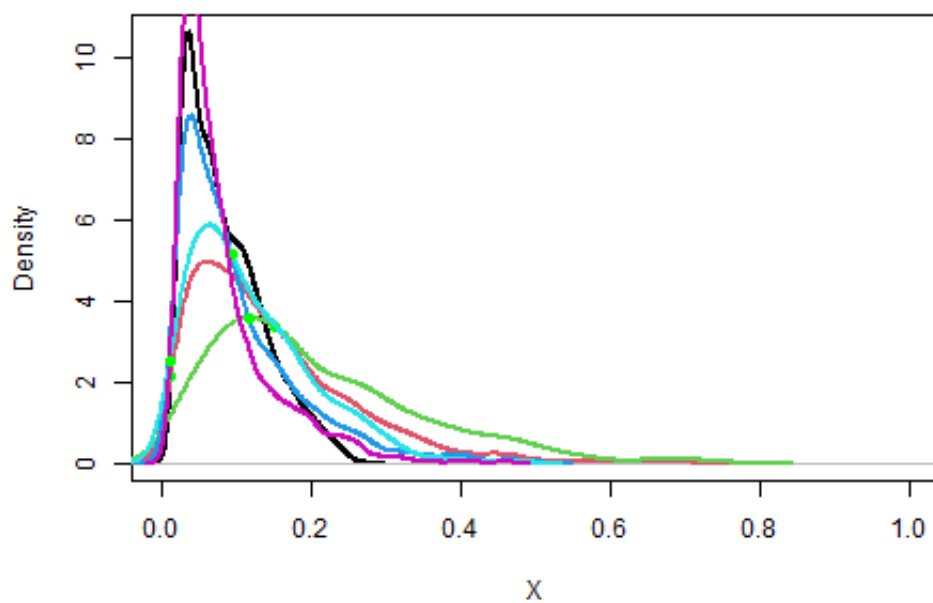
---

Primary Education

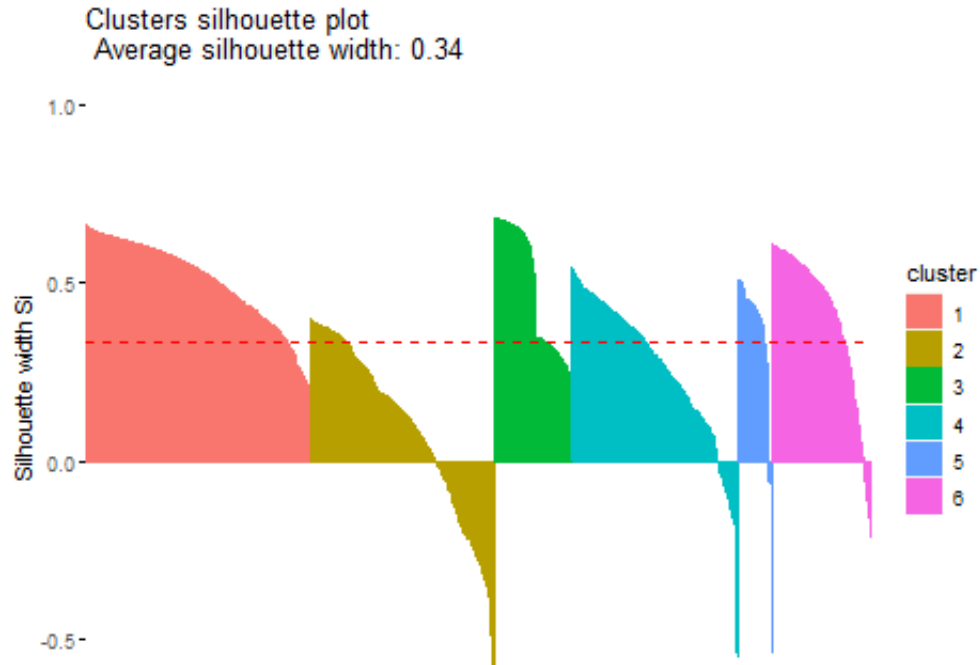


## [1] "Maximum silhouette coefficient: 0.412917609447697 For 6 clusters."





```
## [1] "Segment cutoff values:"
## [1] 0.01404555
## [1] 0.1523268
## [1] 0.1176075
## [1] 0.09526776
## [1] 0.01249324
##   cluster size ave.sil.width
## 1      1 1911      0.51
## 2      2 1568      0.09
## 3      3  661      0.49
## 4      4 1415      0.26
## 5      5  301      0.36
## 6      6  835      0.41
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      4205      3420      1465      3082        668      1850
##
##
## DB Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      71.9      73.2      68.1       74        84      69.6
##
##
## CSD Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##  248449.9 220696.5  223028  244073  240995.6 217603.7
##
##
## CMA Type:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
##      1807      1514      644      1370      290      813
## B      1782      1411      601      1292      280      749
## D       462       358      179       320       80      219
## K       154       137       41       100       18       69
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.227 0.23 0.229 0.229 0.221 0.229
##
##
##
## Provinces:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## Alberta 120 106 53 100 15
## BritishColumbia 223 157 81 146 36
## NewBrunswick 36 27 11 27 2
## NorthwestTerritories 0 2 1 2 0
## NovaScotia 120 104 39 107 21
## Ontario 624 520 230 479 101
## Quebec 266 193 75 175 47
## Saskatchewan 22 17 7 13 2
## NA's 2794 2294 968 2033 444
## Cluster 6
## Alberta 64
## BritishColumbia 80
## NewBrunswick 19
## NorthwestTerritories 2
## NovaScotia 59
## Ontario 286
## Quebec 102
## Saskatchewan 10
## NA's 1228
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0 3788 3110 1328 2785 605 1678
## 1 333 234 106 230 57 124
## 2 42 37 12 35 3 18
## F 42 39 19 32 3 30
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.02631 0.02458 0.02344 0.02661 0.02473 0.02413
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.04557 0.04643 0.0436 0.04555 0.04624 0.04036
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.07636 0.07625 0.07125 0.07605 0.0851 0.07937
##

```

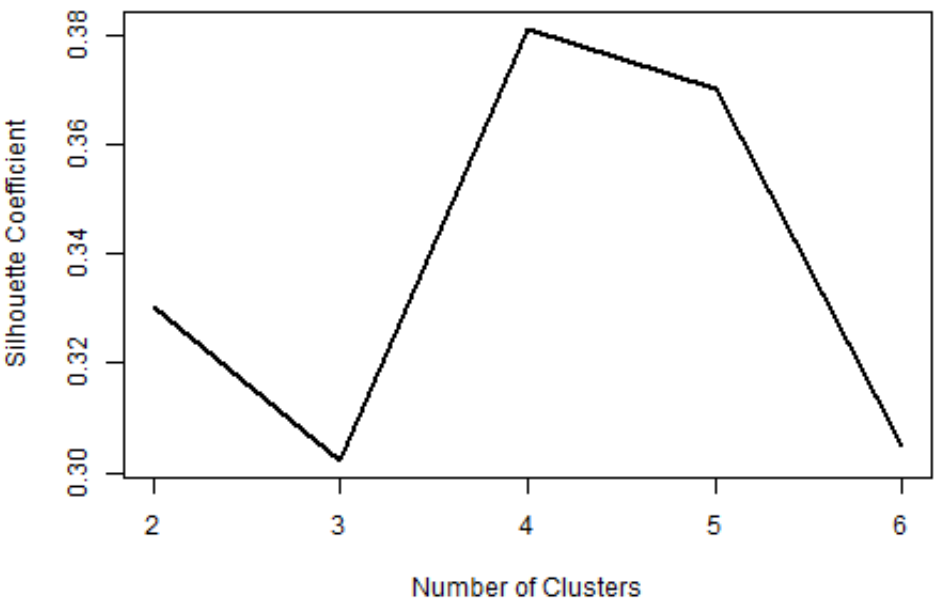
```

##
##
## PMS_prox_idx_health :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.01452 0.01392 0.01274 0.01402 0.01234 0.01276
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.07062 0.07421 0.06359 0.07187 0.07327 0.06884
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.11582 0.11917 0.11119 0.12033 0.11405 0.11527
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.10578 0.10313 0.09707 0.1052 0.10206 0.10142
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.11351 0.11552 0.1126 0.10978 0.11345 0.11587
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.0682 0.0678 0.07136 0.06936 0.06284 0.06819
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5 Cluster 6
## 0.01905 0.01787 0.01705 0.0177 0.0171 0.01733

```

---

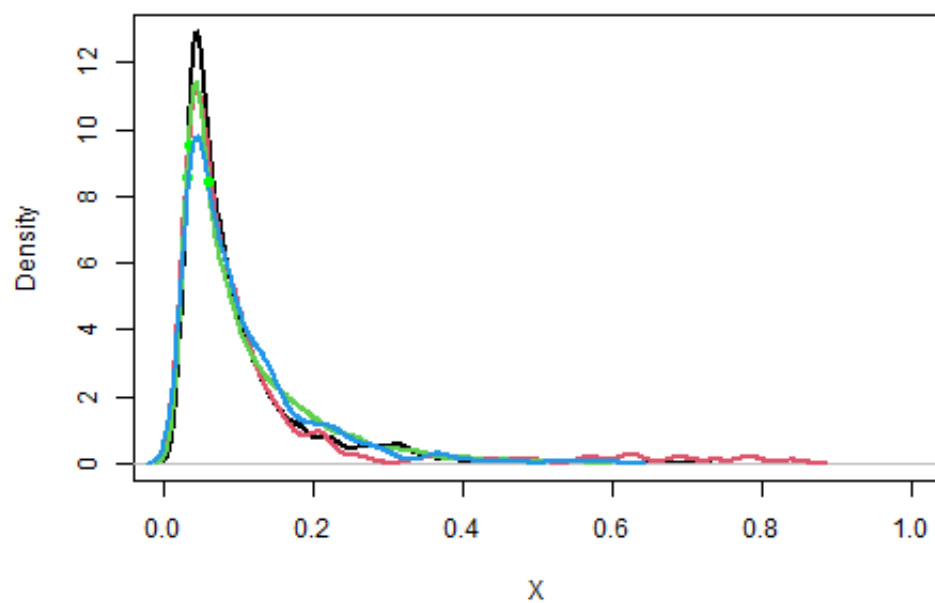
Secondary Education



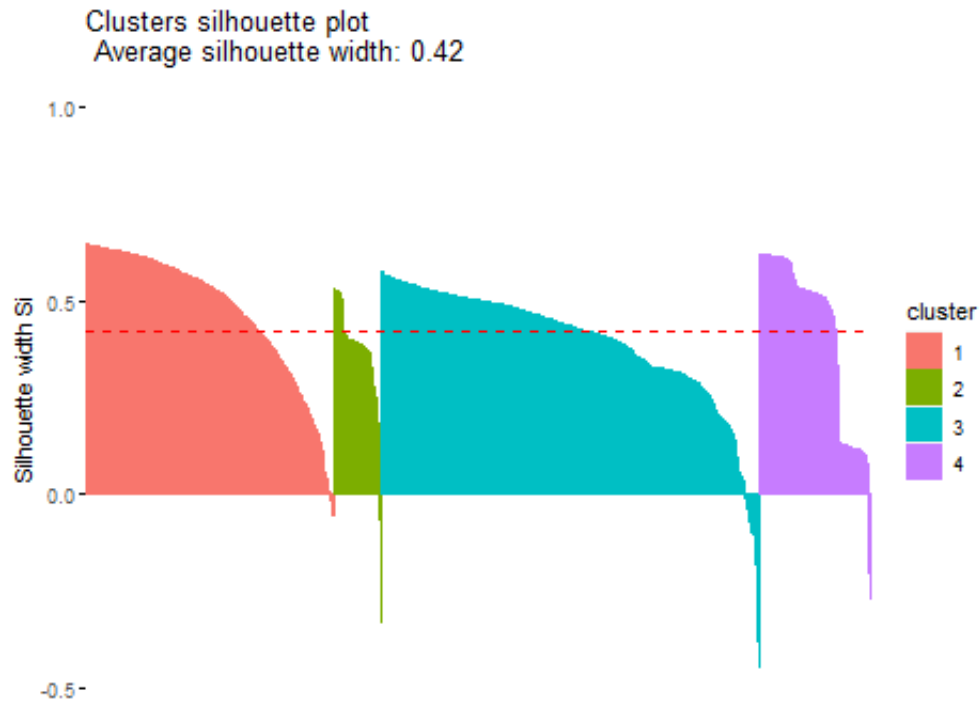
## [1] "Maximum silhouette coefficient: 0.381205852075235 For 4 clusters."







```
## [1] "Segment cutoff values:"
## [1] 0.03175105
## [1] 0.03467993
## [1] 0.06137318
##   cluster size ave.sil.width
## 1      1 1323      0.47
## 2      2  259      0.36
## 3      3 2010      0.39
## 4      4  597      0.42
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      4622      911      7046      2111
##
##
## DB Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      73.8      71      71.1      75.2
##
##
## CSD Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
## 230209.7 231695.3 241274.1 221162.6
##
##
## CMA Type:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      2028      398      3061      951
## B      1906      382      2966      861
## D       525      102       759      232
## K       163       29       260       67
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.227      0.223      0.228      0.233
##
##
##
## Provinces:
##           Cluster 1 Cluster 2 Cluster 3 Cluster 4
## Alberta           164       23       210       61
## BritishColumbia   240       41       335      107
## NewBrunswick       42        5        59       16
## NorthwestTerritories  4         0         2        1
## NovaScotia        128       20       240       62
## Ontario           677      168      1075      320
## Quebec            279       58       412      109
## Saskatchewan       14        4        43       10
## NA's              3074      592      4670     1425
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
## 0      4169      820      6394      1911
## 1       346       66       525       147
## 2        50       12        61        24
## F        57       13        66        29
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.02598  0.02546  0.02534  0.02383
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.04501  0.04182  0.04539  0.04468
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.07763  0.07296  0.07685  0.07435
##
##
##
## PMS_prox_idx_health :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.01432  0.01346  0.01368  0.01305
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4

```

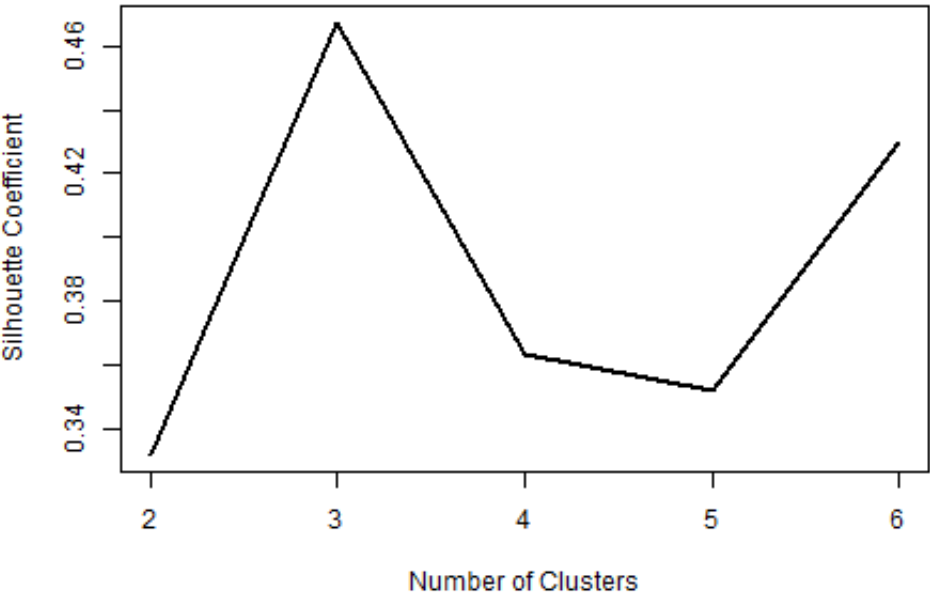
```

##      0.07271      0.0692      0.06978      0.07153
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.11777      0.11756      0.11673      0.11537
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.10285      0.11256      0.10118      0.1093
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.11272      0.11697      0.11338      0.1134
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.07033      0.06081      0.06893      0.06581
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.01877      0.01606      0.01798      0.01723

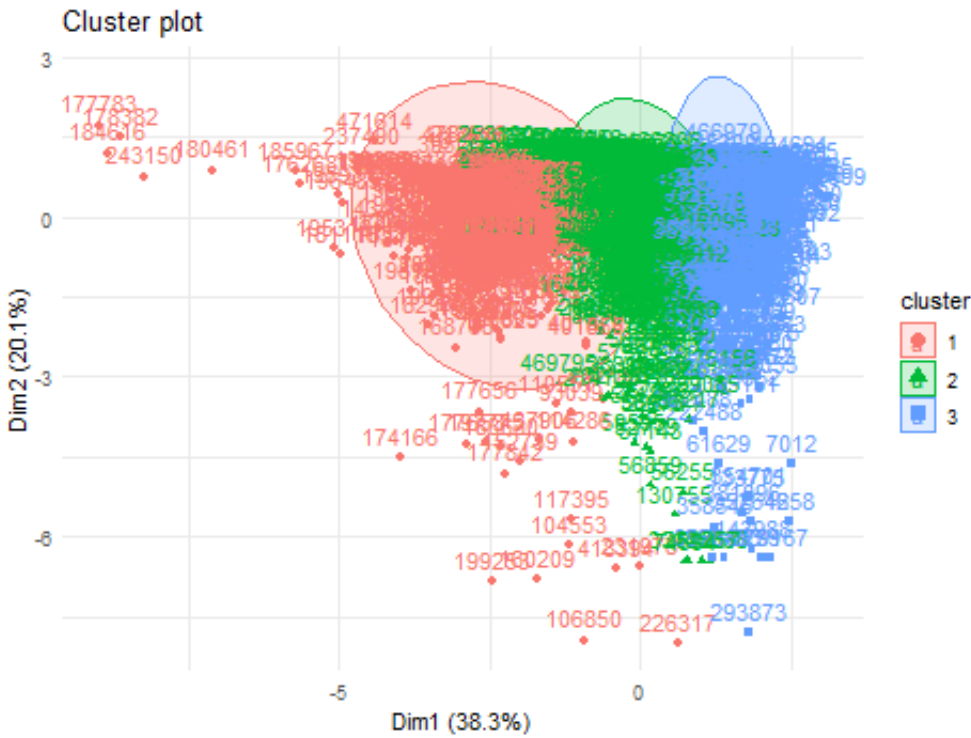
```

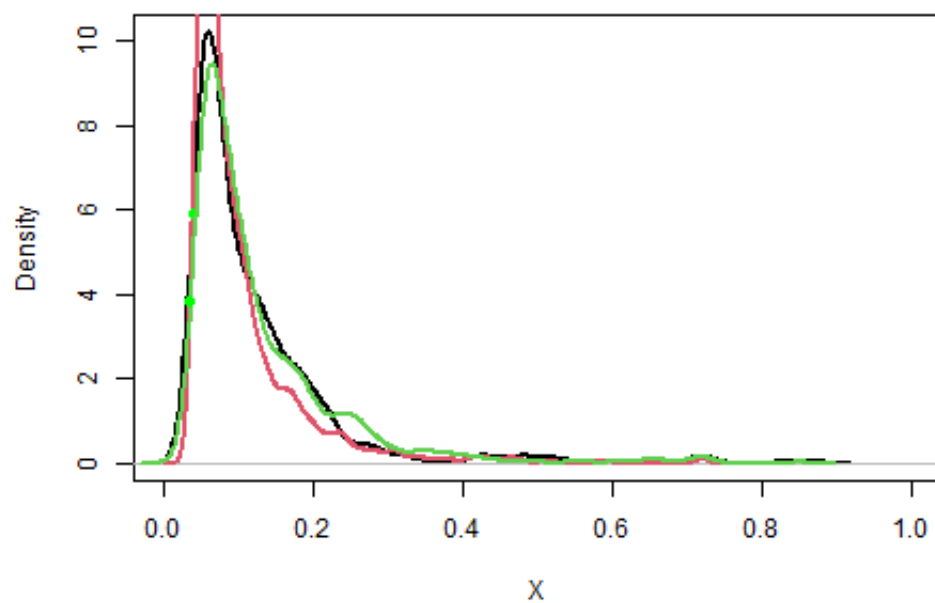
---

Libraries

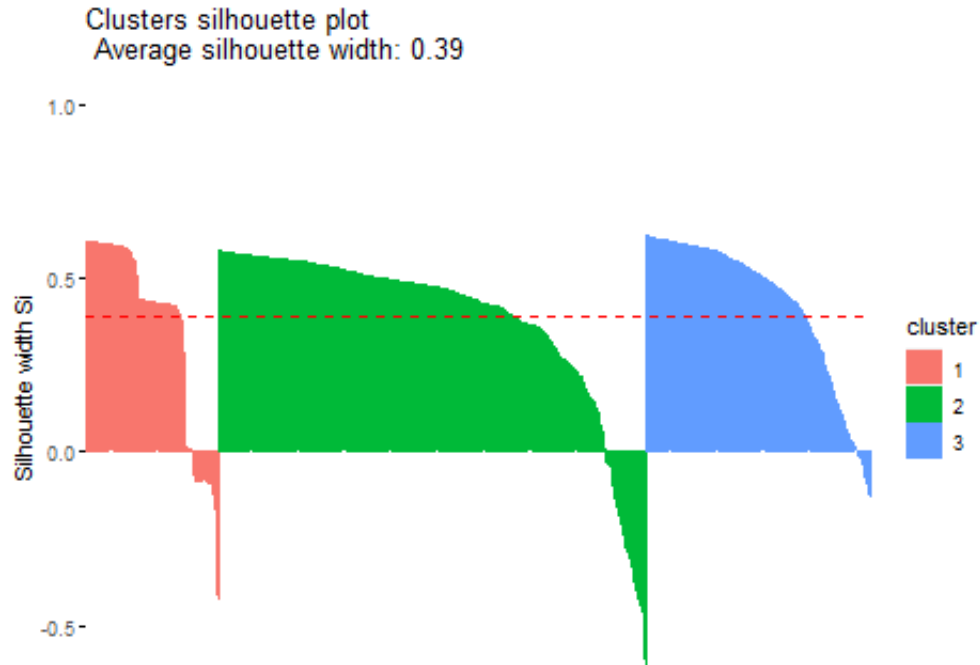


```
## [1] "Maximum silhouete coefficient: 0.467538049527606 For 3 clusters."
```





```
## [1] "Segment cutoff values:"
## [1] 0.03986984
## [1] 0.03686486
##   cluster size ave.sil.width
## 1      1  557      0.36
## 2      2 1794      0.38
## 3      3  939      0.43
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
##   Cluster 1 Cluster 2 Cluster 3
##       2499      8004      4187
##
##
##
## DB Population:
##   Cluster 1 Cluster 2 Cluster 3
##       70.4      72.5      73.8
##
##
##
## CSD Population:
##   Cluster 1 Cluster 2 Cluster 3
##  221579.1   234172   242170.4
##
##
##
## CMA Type:
##   Cluster 1 Cluster 2 Cluster 3
##       1117      3522      1799
## B       1030      3311      1774
## D        270       886       462
## K         82       285       152
##
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3
##      0.232      0.228      0.227
##
##
##
## Provinces:
##           Cluster 1 Cluster 2 Cluster 3
## Alberta              70      263      125
## BritishColumbia      113      405      205
## NewBrunswick          24       66       32
## NorthwestTerritories   1        5        1
## NovaScotia            65      272      113
## Ontario              371     1204      665
## Quebec               143      467      248
## Saskatchewan          13       38       20
## NA's                 1699     5284     2778
##
##
##
## Amenity dense:
##      Cluster 1 Cluster 2 Cluster 3
## 0      2268      7236      3790
## 1       183       595       306
## 2        26        77        44
## F        22        96        47
##
##
##
## PMS_prox_idx_emp :
##      Cluster 1 Cluster 2 Cluster 3
##      0.02361   0.02621   0.02472
##
##
##
## PMS_prox_idx_pharma :
##      Cluster 1 Cluster 2 Cluster 3
##      0.04286   0.04558   0.04486
##
##
##
## PMS_prox_idx_childcare :
##      Cluster 1 Cluster 2 Cluster 3
##      0.07621   0.07559   0.07847
##
##
##
## PMS_prox_idx_health :
##      Cluster 1 Cluster 2 Cluster 3
##      0.01279   0.01414   0.01365
##
##
##
## PMS_prox_idx_grocery :
##      Cluster 1 Cluster 2 Cluster 3

```



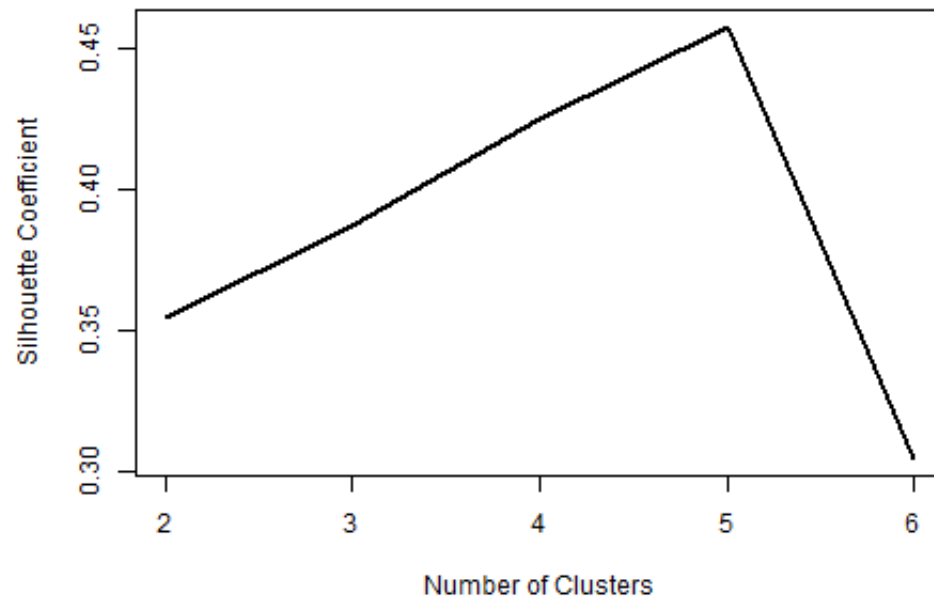
```

##      0.06776    0.07033    0.07374
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3
##      0.11537    0.11724    0.11721
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3
##      0.10408    0.10211    0.10588
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3
##      0.11517    0.11592    0.10739
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3
##      0.06642    0.06883    0.0688
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3
##      0.01823    0.01774    0.01839

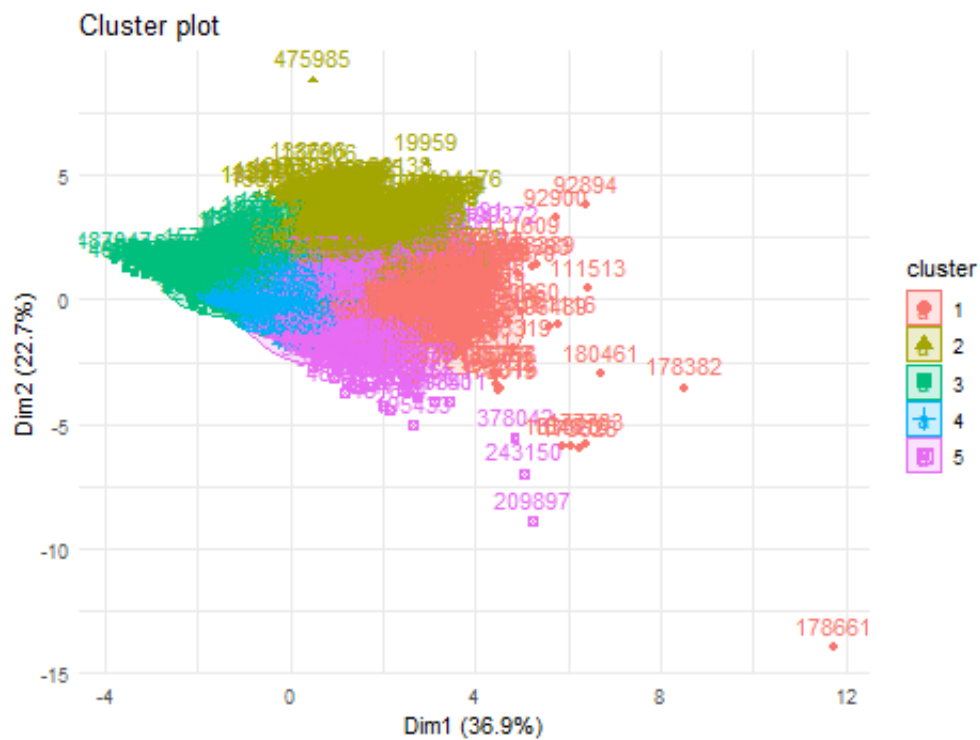
```

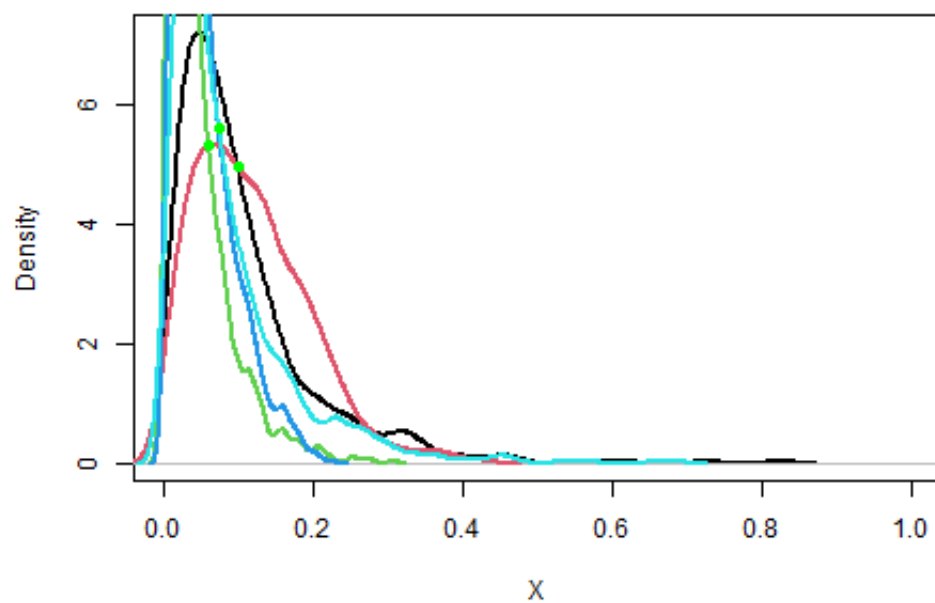
---

## Parks

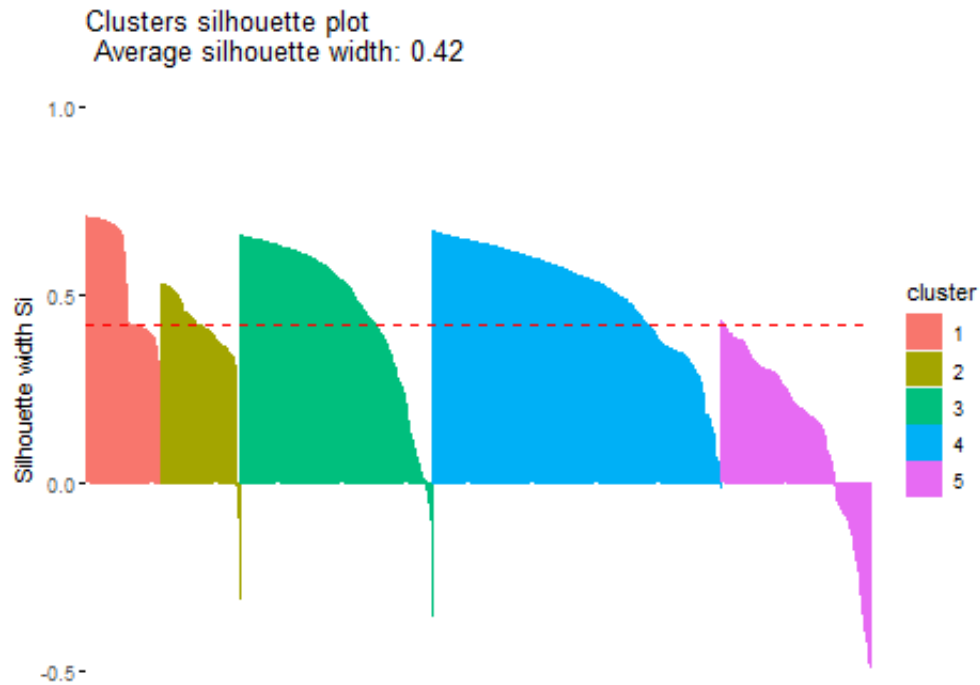


```
## [1] "Maximum silhouette coefficient: 0.458217559993582 For 5 clusters."
```





```
## [1] "Segment cutoff values:"
## [1] 0.099798
## [1] 0.06144807
## [1] 0.03872832
## [1] 0.07473094
##   cluster size ave.sil.width
## 1      1  673      0.55
## 2      2  707      0.39
## 3      3 1703      0.46
## 4      4 2553      0.51
## 5      5 1333      0.15
```



```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      1419      1479      3612      5370      2810
##
##
## DB Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      66.9      72.4      72.4      72.7      75.2
##
##
## CSD Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##    207982  236747.5  251391.6  225362.8  241463.8
##
##
## CMA Type:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      636      652      1592      2368      1190
## B      564      631      1525      2195      1200
## D      173      146      366      610      323
## K       46       50      129      197      97
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.233 0.23 0.227 0.229 0.225
##
##
##
## Provinces:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## Alberta 42 42 107 180 87
## BritishColumbia 69 81 173 252 148
## NewBrunswick 10 19 33 41 19
## NorthwestTerritories 0 0 3 3 1
## NovaScotia 51 46 118 157 78
## Ontario 212 223 573 793 439
## Quebec 73 92 218 314 161
## Saskatchewan 8 3 18 22 20
## NA's 954 973 2369 3608 1857
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0 1300 1337 3249 4860 2548
## 1 85 113 294 388 204
## 2 15 13 36 49 34
## F 19 16 33 73 24
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.02198 0.02436 0.02707 0.02513 0.02568
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.04082 0.04273 0.04985 0.04397 0.04359
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.07478 0.07479 0.08001 0.07558 0.07557
##
##
##
## PMS_prox_idx_health :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
## 0.01275 0.01294 0.01447 0.01387 0.01367
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5

```

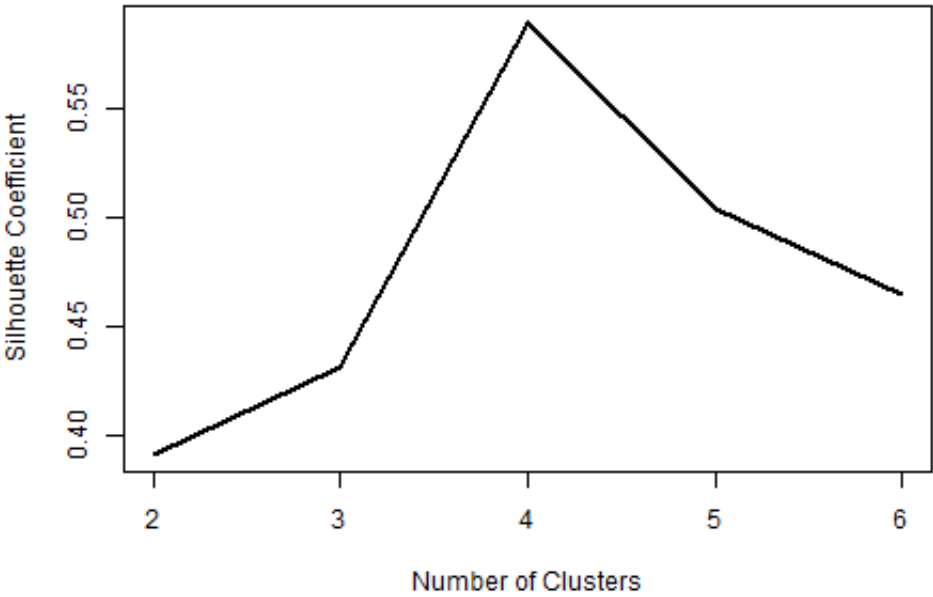
```

##      0.06626    0.06556    0.07431    0.07202    0.06925
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.10987    0.11576    0.11619    0.11751    0.12067
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.10682    0.09644    0.10113    0.10789    0.10028
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.12027    0.11211    0.11397    0.11323    0.11053
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.06263    0.06478    0.07285    0.06757    0.0692
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4 Cluster 5
##      0.01571    0.01646    0.01962    0.01813    0.01762

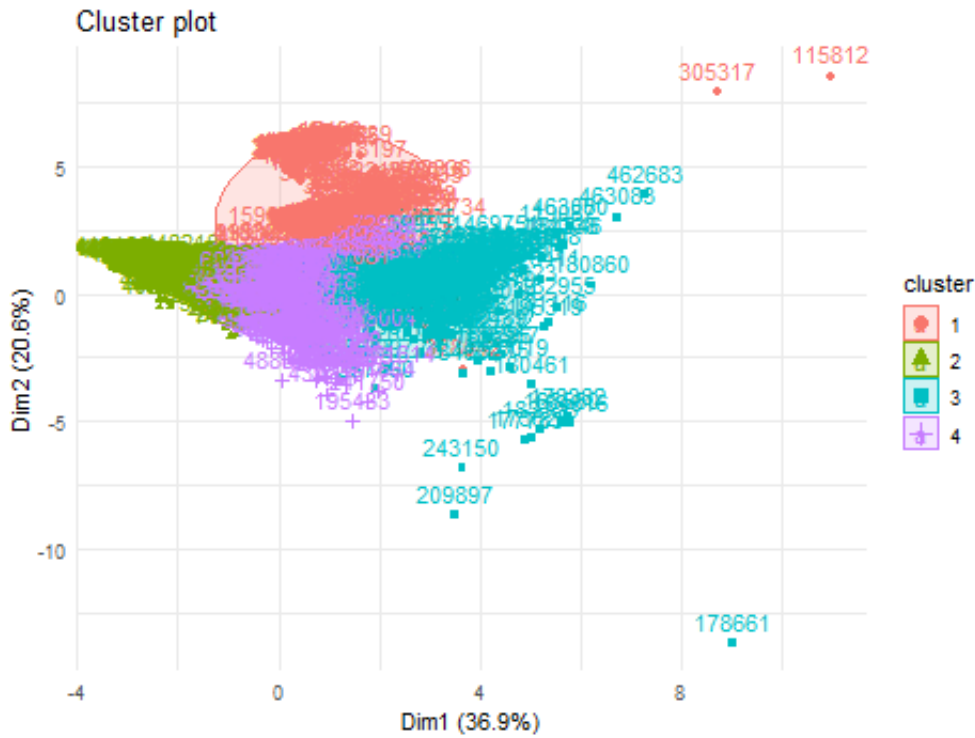
```

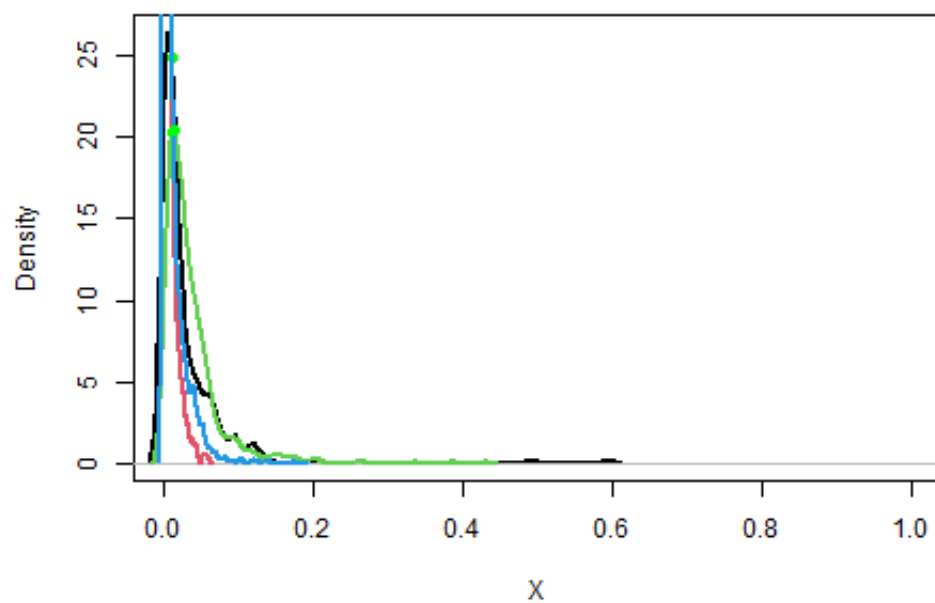
---

Transit



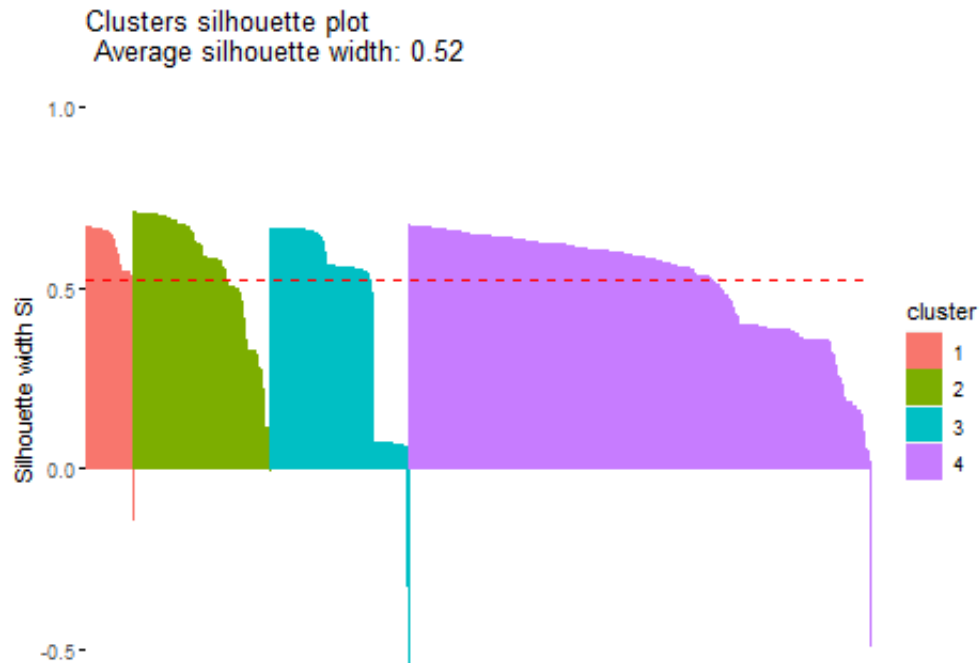
```
## [1] "Maximum silhouette coefficient: 0.589553719705251 For 4 clusters."
```





```
## [1] "Segment cutoff values:"
## [1] 0.01239267
## [1] 0.01377094
## [1] 0.0148541
##   cluster size ave.sil.width
## 1      1 324      0.60
## 2      2 938      0.55
## 3      3 944      0.46
## 4      4 3146     0.52
```





```
## [1] "Cluster profiles:"
## [1] "Num of DBs:"
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      893      2566      2609      8622
##
##
## DB Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      67.3      74.6      71.6      72.7
##
##
## CSD Population:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##    236830  250653.5  246468.5  225505.2
##
##
## CMA Type:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      398      1122      1155      3763
## B      358      1079      1107      3571
## D      105       273       277       963
## K       32       92        70       325
##
##
## Index of Remoteness:
```

```

## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.229      0.228      0.228      0.228
##
##
##
## Provinces:
##           Cluster 1 Cluster 2 Cluster 3 Cluster 4
## Alberta                21      93      74      270
## BritishColumbia        39     132     131     421
## NewBrunswick           8      23      20      71
## NorthwestTerritories    0       0       0       7
## NovaScotia             27      76      89     258
## Ontario                120     395     414    1311
## Quebec                 63     148     150     497
## Saskatchewan           6      12      12      41
## NA's                   609    1687    1719    5746
##
##
##
## Amenity dense:
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
## 0         818      2299      2384      7793
## 1          54       201       176       653
## 2          13        36        23        75
## F           8        30        26       101
##
##
##
## PMS_prox_idx_emp :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.0241  0.02907  0.02417  0.02472
##
##
##
## PMS_prox_idx_pharma :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.04836  0.05005  0.04158  0.04407
##
##
##
## PMS_prox_idx_childcare :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.07638  0.08168  0.07366  0.07586
##
##
##
## PMS_prox_idx_health :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.01403  0.01534  0.01253  0.01367
##
##
##
## PMS_prox_idx_grocery :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4

```

```

##      0.07782    0.07821    0.06698    0.06922
##
##
##
## PMS_prox_idx_educpri :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.11187    0.12443    0.11919    0.11449
##
##
##
## PMS_prox_idx_educsec :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.10558    0.10841    0.10701    0.10065
##
##
##
## PMS_prox_idx_lib :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.11585    0.11547    0.11696    0.11149
##
##
##
## PMS_prox_idx_parks :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.06435    0.06964    0.06858    0.0684
##
##
##
## PMS_prox_idx_transit :
## Cluster 1 Cluster 2 Cluster 3 Cluster 4
##      0.01668    0.0197    0.01744    0.0178

```

---

## Conclusion

text