d212_task1_revision1.R

sigsp

2022-09-28

```
############################## TITLE ########################################

## Author: Stephen E. Porter
## Title: D212 Task 1 Clustering Analysis
## Course: WGU D212: Data Mining II
## Instructor: Dr.Keiona Middleton


############################## LIBRARIES ####################################

library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.5     v dplyr   1.0.7
## v tidyr   1.1.4     v stringr 1.4.0
## v readr   2.0.2     v forcats 0.5.1
## Warning: package 'ggplot2' was built under R version 4.1.1
## Warning: package 'tibble' was built under R version 4.1.1
## Warning: package 'tidyr' was built under R version 4.1.1
## Warning: package 'readr' was built under R version 4.1.1
## Warning: package 'dplyr' was built under R version 4.1.1
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.1.2
## Loading required package: lattice
##
## Attaching package: 'caret'
## The following object is masked from 'package:purrr':
##
##     lift
```

```
library(dplyr)
library(factoextra)
```

```
## Warning: package 'factoextra' was built under R version 4.1.3
```

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

```
library(ggplot2)
library(cluster)


############################### DATA PREPARATION ################################

# Import CSV as data frame
df <- read.csv(file = 'C:/WGU/D212 Data Mining II/churn_clean.csv')

# Checking for nulls
sapply(df, function(x) sum(is.na(x)))
```

```
##            CaseOrder          Customer_id          Interaction
##                    0                    0                    0
##                  UID                 City                State
##                    0                    0                    0
##               County                  Zip                  Lat
##                    0                    0                    0
##                  Lng           Population                 Area
##                    0                    0                    0
##             TimeZone                  Job             Children
##                    0                    0                    0
##                  Age               Income              Marital
##                    0                    0                    0
##               Gender                Churn   Outage_sec_perweek
##                    0                    0                    0
##                Email             Contacts Yearly_equip_failure
##                    0                    0                    0
##               Techie             Contract           Port_modem
##                    0                    0                    0
##               Tablet      InternetService                Phone
##                    0                    0                    0
##             Multiple       OnlineSecurity         OnlineBackup
##                    0                    0                    0
##     DeviceProtection          TechSupport          StreamingTV
##                    0                    0                    0
##      StreamingMovies     PaperlessBilling        PaymentMethod
##                    0                    0                    0
##               Tenure        MonthlyCharge    Bandwidth_GB_Year
##                    0                    0                    0
##                Item1                Item2                Item3
##                    0                    0                    0
##                Item4                Item5                Item6
##                    0                    0                    0
##                Item7                Item8
##                    0                    0
```

```
str(df)
```

```
## 'data.frame':    10000 obs. of  50 variables:
##  $ CaseOrder          : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Customer_id        : chr  "K409198" "S120509" "K191035" "D90850" ...
```

```
##  $ Interaction         : chr  "aa90260b-4141-4a24-8e36-b04ce1f4f77b" "fb76459f-c047-4a9d-8af9-e0f7d4a
##  $ UID                 : chr  "e885b299883d4f9fb18e39c75155d990" "f2de8bef964785f41a2959829830fb8a" "
##  $ City                : chr  "Point Baker" "West Branch" "Yamhill" "Del Mar" ...
##  $ State               : chr  "AK" "MI" "OR" "CA" ...
##  $ County              : chr  "Prince of Wales-Hyder" "Ogemaw" "Yamhill" "San Diego" ...
##  $ Zip                 : int  99927 48661 97148 92014 77461 31030 37847 73109 34771 45237 ...
##  $ Lat                 : num  56.3 44.3 45.4 33 29.4 ...
##  $ Lng                 : num  -133.4 -84.2 -123.2 -117.2 -95.8 ...
##  $ Population          : int  38 10446 3735 13863 11352 17701 2535 23144 17351 20193 ...
##  $ Area                : chr  "Urban" "Urban" "Urban" "Suburban" ...
##  $ TimeZone            : chr  "America/Sitka" "America/Detroit" "America/Los_Angeles" "America/Los_An
##  $ Job                 : chr  "Environmental health practitioner" "Programmer, multimedia" "Chief Fi
##  $ Children            : int  0 1 4 1 0 3 0 2 2 1 ...
##  $ Age                 : int  68 27 50 48 83 83 79 30 49 86 ...
##  $ Income              : num  28562 21705 9610 18925 40074 ...
##  $ Marital             : chr  "Widowed" "Married" "Widowed" "Married" ...
##  $ Gender              : chr  "Male" "Female" "Female" "Male" ...
##  $ Churn               : chr  "No" "Yes" "No" "No" ...
##  $ Outage_sec_perweek  : num  7.98 11.7 10.75 14.91 8.15 ...
##  $ Email               : int  10 12 9 15 16 15 10 16 20 18 ...
##  $ Contacts            : int  0 0 0 2 2 3 0 0 2 1 ...
##  $ Yearly_equip_failure: int  1 1 1 0 1 1 1 0 3 0 ...
##  $ Techie              : chr  "No" "Yes" "Yes" "Yes" ...
##  $ Contract            : chr  "One year" "Month-to-month" "Two Year" "Two Year" ...
##  $ Port_modem          : chr  "Yes" "No" "Yes" "No" ...
##  $ Tablet              : chr  "Yes" "Yes" "No" "No" ...
##  $ InternetService     : chr  "Fiber Optic" "Fiber Optic" "DSL" "DSL" ...
##  $ Phone               : chr  "Yes" "Yes" "Yes" "Yes" ...
##  $ Multiple            : chr  "No" "Yes" "Yes" "No" ...
##  $ OnlineSecurity      : chr  "Yes" "Yes" "No" "Yes" ...
##  $ OnlineBackup        : chr  "Yes" "No" "No" "No" ...
##  $ DeviceProtection    : chr  "No" "No" "No" "No" ...
##  $ TechSupport         : chr  "No" "No" "No" "No" ...
##  $ StreamingTV         : chr  "No" "Yes" "No" "Yes" ...
##  $ StreamingMovies     : chr  "Yes" "Yes" "Yes" "No" ...
##  $ PaperlessBilling    : chr  "Yes" "Yes" "Yes" "Yes" ...
##  $ PaymentMethod       : chr  "Credit Card (automatic)" "Bank Transfer(automatic)" "Credit Card (aut
##  $ Tenure              : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ MonthlyCharge       : num  172 243 160 120 150 ...
##  $ Bandwidth_GB_Year   : num  905 801 2055 2165 271 ...
##  $ Item1               : int  5 3 4 4 4 3 6 2 5 2 ...
##  $ Item2               : int  5 4 4 4 4 3 5 2 4 2 ...
##  $ Item3               : int  5 3 2 4 4 3 6 2 4 2 ...
##  $ Item4               : int  3 3 4 2 3 2 4 5 3 2 ...
##  $ Item5               : int  4 4 4 5 4 4 1 2 4 5 ...
##  $ Item6               : int  4 3 3 4 4 3 5 3 3 2 ...
##  $ Item7               : int  3 4 3 3 4 3 5 4 4 3 ...
##  $ Item8               : int  4 4 3 3 5 3 5 5 4 3 ...
```

```
summary(df)
```

```
##    CaseOrder     Customer_id        Interaction            UID
##  Min.   :    1   Length:10000       Length:10000       Length:10000
##  1st Qu.: 2501   Class :character   Class :character   Class :character
##  Median : 5000   Mode  :character   Mode  :character   Mode  :character
```

```
##  Mean   : 5000
##  3rd Qu.: 7500
##  Max.   :10000
##      City              State              County               Zip
##  Length:10000       Length:10000       Length:10000       Min.   :  601
##  Class :character   Class :character   Class :character   1st Qu.:26293
##  Mode  :character   Mode  :character   Mode  :character   Median :48870
##                                                           Mean   :49153
##                                                           3rd Qu.:71867
##                                                           Max.   :99929
##       Lat              Lng            Population         Area
##  Min.   :17.97   Min.   :-171.69   Min.   :     0   Length:10000
##  1st Qu.:35.34   1st Qu.: -97.08   1st Qu.:   738   Class :character
##  Median :39.40   Median : -87.92   Median :  2910   Mode  :character
##  Mean   :38.76   Mean   : -90.78   Mean   :  9757
##  3rd Qu.:42.11   3rd Qu.: -80.09   3rd Qu.: 13168
##  Max.   :70.64   Max.   : -65.67   Max.   :111850
##    TimeZone             Job               Children           Age
##  Length:10000       Length:10000       Min.   : 0.000   Min.   :18.00
##  Class :character   Class :character   1st Qu.: 0.000   1st Qu.:35.00
##  Mode  :character   Mode  :character   Median : 1.000   Median :53.00
##                                        Mean   : 2.088   Mean   :53.08
##                                        3rd Qu.: 3.000   3rd Qu.:71.00
##                                        Max.   :10.000   Max.   :89.00
##      Income           Marital             Gender             Churn
##  Min.   :   348.7   Length:10000       Length:10000       Length:10000
##  1st Qu.: 19224.7   Class :character   Class :character   Class :character
##  Median : 33170.6   Mode  :character   Mode  :character   Mode  :character
##  Mean   : 39806.9
##  3rd Qu.: 53246.2
##  Max.   :258900.7
##  Outage_sec_perweek     Email           Contacts      Yearly_equip_failure
##  Min.   : 0.09975   Min.   : 1.00   Min.   :0.0000   Min.   :0.000
##  1st Qu.: 8.01821   1st Qu.:10.00   1st Qu.:0.0000   1st Qu.:0.000
##  Median :10.01856   Median :12.00   Median :1.0000   Median :0.000
##  Mean   :10.00185   Mean   :12.02   Mean   :0.9942   Mean   :0.398
##  3rd Qu.:11.96949   3rd Qu.:14.00   3rd Qu.:2.0000   3rd Qu.:1.000
##  Max.   :21.20723   Max.   :23.00   Max.   :7.0000   Max.   :6.000
##     Techie            Contract          Port_modem           Tablet
##  Length:10000       Length:10000       Length:10000       Length:10000
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##  InternetService       Phone             Multiple         OnlineSecurity
##  Length:10000       Length:10000       Length:10000       Length:10000
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##  OnlineBackup       DeviceProtection   TechSupport        StreamingTV
##  Length:10000       Length:10000       Length:10000       Length:10000
```

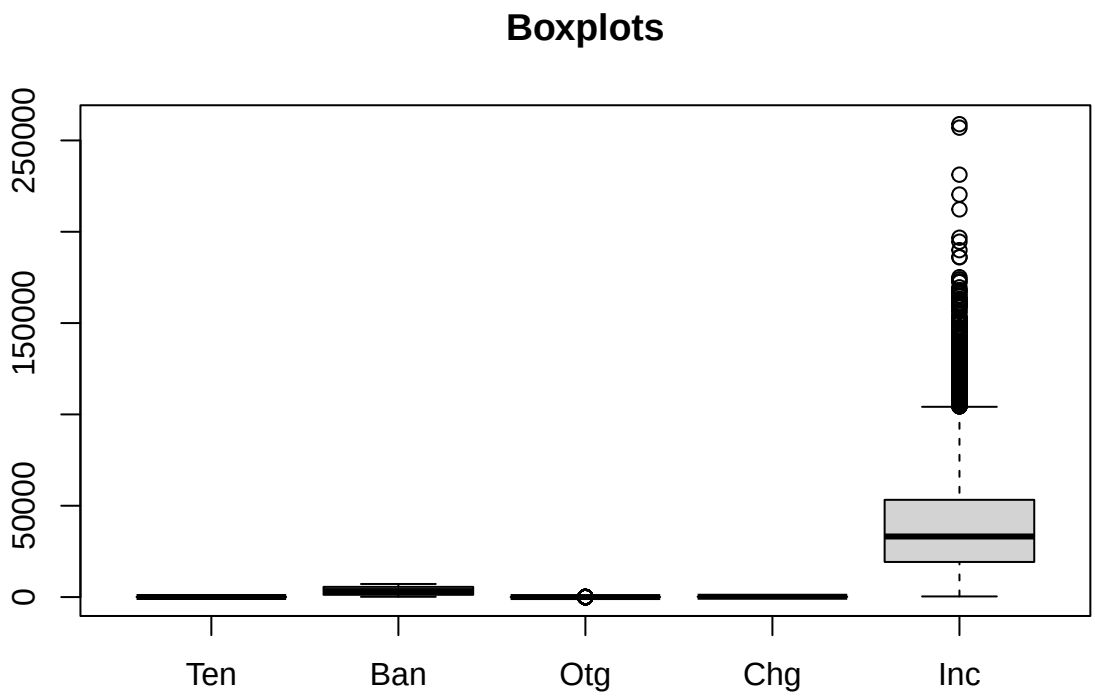
```
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##  StreamingMovies    PaperlessBilling   PaymentMethod          Tenure
##  Length:10000       Length:10000       Length:10000       Min.   : 1.000
##  Class :character   Class :character   Class :character   1st Qu.: 7.918
##  Mode  :character   Mode  :character   Mode  :character   Median :35.431
##                                                          Mean   :34.526
##                                                          3rd Qu.:61.480
##                                                          Max.   :71.999
##  MonthlyCharge    Bandwidth_GB_Year     Item1           Item2
##  Min.   : 79.98   Min.   : 155.5    Min.   :1.000   Min.   :1.000
##  1st Qu.:139.98   1st Qu.:1236.5    1st Qu.:3.000   1st Qu.:3.000
##  Median :167.48   Median :3279.5    Median :3.000   Median :4.000
##  Mean   :172.62   Mean   :3392.3    Mean   :3.491   Mean   :3.505
##  3rd Qu.:200.73   3rd Qu.:5586.1    3rd Qu.:4.000   3rd Qu.:4.000
##  Max.   :290.16   Max.   :7159.0    Max.   :7.000   Max.   :7.000
##      Item3           Item4           Item5           Item6           Item7
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.00
##  1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.00
##  Median :3.000   Median :3.000   Median :3.000   Median :3.000   Median :4.00
##  Mean   :3.487   Mean   :3.498   Mean   :3.493   Mean   :3.497   Mean   :3.51
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.00
##  Max.   :8.000   Max.   :7.000   Max.   :7.000   Max.   :8.000   Max.   :7.00
##      Item8
##  Min.   :1.000
##  1st Qu.:3.000
##  Median :3.000
##  Mean   :3.496
##  3rd Qu.:4.000
##  Max.   :8.000
```

```
# Keeping desired columns
to_keep <- c('Tenure', 'Bandwidth_GB_Year', 'Outage_sec_perweek',
             'MonthlyCharge', 'Income')

dfDropped = df[to_keep]
str(dfDropped)
```

```
## 'data.frame':    10000 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
############################### OUTLIER DETECTION ##############################

#Check for outliers in boxplot
boxplot(dfDropped$Tenure, dfDropped$Bandwidth_GB_Year,
        dfDropped$Outage_sec_perweek, dfDropped$MonthlyCharge, dfDropped$Income,
        main = "Boxplots",
        names = c("Ten", "Ban", "Otg", "Chg", "Inc"),
```

```
        horizontal = FALSE)
```




```
# Check each column for outliers
tenOut <- boxplot(dfDropped$Tenure, plot=FALSE)$out
tenOut
```

```
## numeric(0)
```

```
banOut <- boxplot(dfDropped$Bandwidth_GB_Year, plot=FALSE)$out
banOut
```

```
## numeric(0)
```

```
otgOut <- boxplot(dfDropped$Outage_sec_perweek, plot=FALSE)$out
otgOut
```

```
##  [1] 18.19542503 18.39537758 19.07180624 18.30717385 18.30369591  1.18025898
##  [7] 19.08168517  0.76027743 19.26778150 17.96334654 18.94289163  0.12005772
## [13]  1.72652484 18.28180588 17.94420077 18.07990420  0.63660795  0.50737490
## [19]  2.01774600 19.50058000 18.31879000 18.44059000 18.77915000 20.30462000
## [25]  0.99528960 18.40676000 18.19254000  2.02083400  1.55678400 18.34115000
## [31] 18.78705000 18.21093000 17.90595000  1.51649700  0.23227950 17.99204000
## [37] 18.85173000  1.86467600  1.27643800  0.90033260 21.20723000 18.25245000
## [43]  0.35504830 19.26111000  0.82699800 19.71756000 20.62504000 19.01962000
## [49] 18.11802000  0.94033040  0.39186590  2.03977100  1.33256000 18.30895000
## [55] 18.15330000  1.14479600  2.08173300 17.97393000  1.55649900  1.63663400
## [61]  1.92368900  1.88242600  1.28345800 17.91239000 19.10781000 18.19674000
## [67]  1.89642200  0.09974694 18.45023000 18.17620000  1.45088000 19.65711000
```

```
## [73] 19.01629000  2.01514300 19.20969000  0.82754400
```

```
# Outage seconds per week has outliers. Create temp data frame & remove outliers
temp <- dfDropped
temp <- temp[-which(temp$Outage_sec_perweek %in% otgOut),]
str(temp)
```

```
## 'data.frame':    9924 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
chgOut <- boxplot(temp$MonthlyCharge, plot=FALSE)$out
chgOut
```

```
## numeric(0)
```

```
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

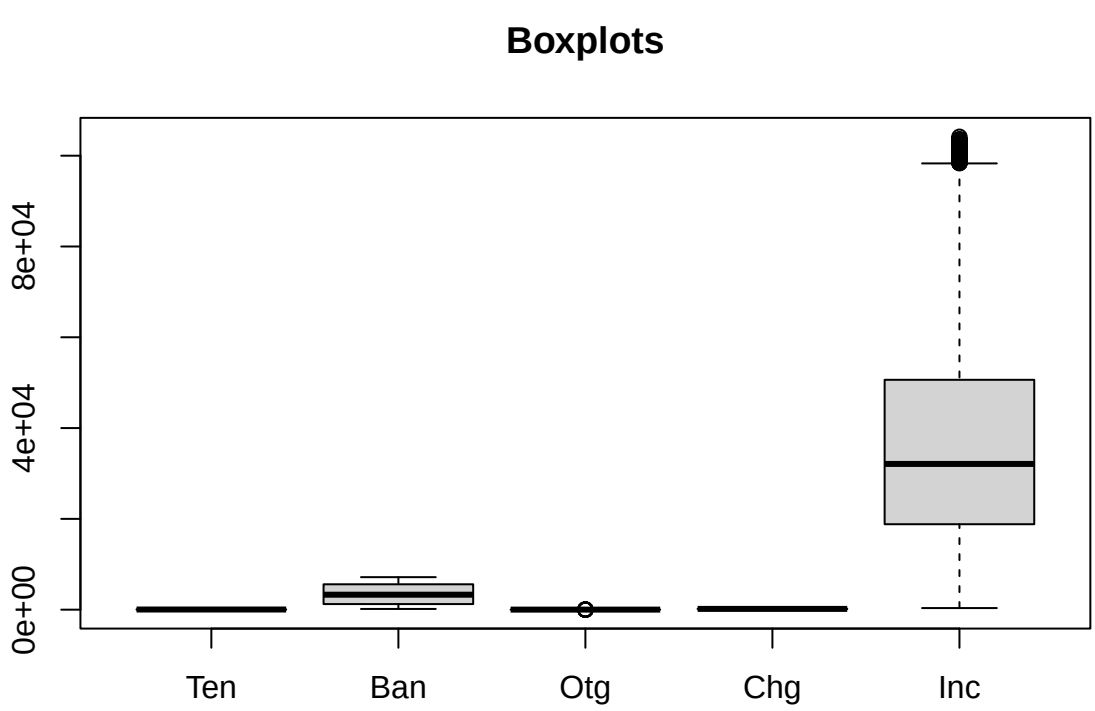
```
##   [1] 115114.6 132116.3 115510.5 125814.9 122957.2 107111.8 135727.7 118022.1
##   [9] 123763.1 119968.6 114398.4 105646.7 122263.8 112429.2 119964.8 156740.7
##  [17] 146494.7 159315.5 163086.2 172884.1 111380.5 114609.0 169580.7 168097.1
##  [25] 120435.6 112914.4 106964.8 112245.1 125002.3 113086.6 132140.0 131500.5
##  [33] 186035.0 109366.1 154718.9 117194.6 126236.2 162360.1 132334.8 122741.6
##  [41] 109373.7 112031.3 135171.3 121993.2 115520.5 122844.9 106608.4 108847.9
##  [49] 149502.9 121849.0 108698.7 118120.2 116572.8 117333.4 106581.9 104519.8
##  [57] 165151.0 108059.1 147436.9 152172.9 116888.8 115594.6 137589.2 127881.0
##  [65] 116572.3 115414.9 146782.3 104548.7 113438.3 111971.9 137119.7 143972.7
##  [73] 143217.5 116086.2 134691.3 108839.1 108135.1 111592.0 142650.5 128114.3
##  [81] 138555.9 108960.7 105396.3 115440.4 175137.3 131511.8 108914.2 152131.7
##  [89] 146951.6 145163.1 105033.0 116453.0 107174.6 122915.6 104362.5 104867.5
##  [97] 113641.2 119667.4 123891.9 117623.7 145569.5 104539.2 129628.7 160589.2
## [105] 120286.2 167566.6 117185.4 111779.6 110886.7 159113.5 121055.6 149959.8
## [113] 142086.1 125660.1 138122.3 108287.6 125769.6 152972.9 147682.0 114160.2
## [121] 172372.2 105302.4 131265.4 128906.6 138723.0 128728.3 121668.3 166553.1
## [129] 139474.8 189938.4 116396.5 129473.6 104452.6 149968.0 126678.4 119318.8
## [137] 105157.2 124493.2 111143.1 125288.6 107570.9 258900.7 105969.1 115681.5
## [145] 122756.3 114390.3 114051.7 130732.2 134838.8 156571.0 110960.3 143794.0
## [153] 114401.9 118179.2 116628.8 133161.6 120301.3 114551.7 107772.3 162842.8
## [161] 113511.5 108409.6 129137.2 120650.1 151312.2 135891.8 146518.2 120324.8
## [169] 112181.6 152813.5 141362.6 131834.1 111892.6 113028.1 115405.2 124735.8
## [177] 104931.3 116303.0 131647.5 160862.9 106700.6 220383.0 116562.7 130048.4
## [185] 106862.5 114405.4 135516.9 110579.2 151181.8 161251.0 212255.3 120330.5
## [193] 125041.1 137978.3 108982.2 114851.2 105022.5 131680.1 106634.6 115239.5
## [201] 121118.5 167846.0 132149.5 113595.2 129787.2 105193.1 123206.3 109866.0
## [209] 120864.5 119415.5 104558.0 105425.1 121444.9 110391.6 112097.3 146317.6
## [217] 196746.0 153026.4 231252.0 123991.0 108072.0 146958.0 115022.1 127578.3
## [225] 194550.7 113002.5 133882.2 124025.1 115783.2 117468.7 139625.0 118070.7
## [233] 105739.9 106704.4 121964.1 146544.6 106307.8 112803.7 142974.0 112687.7
## [241] 118983.0 110491.4 108805.1 113865.7 137977.7 109653.3 107720.5 135166.6
## [249] 140367.2 113095.0 131421.6 149891.1 126992.3 112837.8 106084.8 138155.7
## [257] 123006.6 159532.5 107804.6 150264.3 126572.7 105745.6 113254.1 117867.2
## [265] 126024.3 126805.9 146536.7 111442.1 146590.9 105005.6 113593.3 113912.9
```

```
## [273] 119599.4 146600.8 164529.0 114044.9 107341.5 108956.8 115758.0 112961.8
## [281] 112839.8 105294.0 116972.1 124590.0 128842.9 121986.8 143641.2 111778.1
## [289] 117715.3 110343.8 186156.6 140110.0 117890.3 117418.8 140030.5 107207.5
## [297] 160216.1 119017.8 142119.3 158549.3 125568.9 128998.6 256998.4 147889.4
## [305] 125034.1 163082.1 173978.0 146719.5 123006.3 117683.5 163156.7 122765.4
## [313] 123272.3 134967.2 120895.0 115029.8 105644.8 130319.3 149952.7 136818.5
## [321] 111497.4 118340.8 112773.2 109574.2 105986.5 113392.5 134443.3 108806.6
## [329] 128468.0 121219.6 109058.0 117089.4
```

```
# Income has many outliers - remove them
temp <- temp[-which(temp$Income %in% incOut),]
str(temp)
```

```
## 'data.frame':    9592 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
# View boxplot for outliers
boxplot(temp$Tenure, temp$Bandwidth_GB_Year,
        temp$Outage_sec_perweek, temp$MonthlyCharge, temp$Income,
        main = "Boxplots",
        names = c("Ten", "Ban", "Otg", "Chg", "Inc"),
        horizontal = FALSE)
```



```
# Income still has outliers. Repeat process until none remain
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

```
##  [1] 100076.65 103311.26  99195.08 100232.53  99519.26  99482.26 101000.30
##  [8]  99007.42 100626.29  99100.10 101771.45  98906.55  99800.11  99754.87
## [15] 100437.39 102905.68 102080.72 100033.86  99787.78  99199.26  98366.83
## [22] 101907.80  99291.94 100861.70 101807.80 103435.70 102090.50 101534.00
## [29]  98436.93 103306.60  99411.44  98555.98 100685.60 103112.30  98660.88
## [36]  99120.55 104166.70 102089.70 100860.90 101628.90 102072.00 100585.10
## [43] 100785.50  99168.20 100171.60 101766.00  99537.72 102059.00  98665.78
## [50] 100029.10 103625.10 103476.10 100352.40 102806.50 102609.30 103510.70
## [57]  98376.58  99873.57 101771.00  99342.82 102544.20  99108.60 100224.40
## [64]  98862.21 103499.70 101607.90 102823.40 102504.90 101681.00 103076.70
## [71] 101429.40 100711.60 100608.20 102928.60  99932.29  98425.53 101307.00
## [78] 103098.00 100257.60  99132.61  99699.68 102431.30 102702.50 100050.00
## [85]  98836.20 102633.90  99071.31 102173.50 102629.60
```

```
temp <- temp[-which(temp$Income %in% incOut),]
str(temp)
```

```
## 'data.frame':    9503 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

```
##  [1] 97761.18 98173.49 97592.52 97479.21 97462.46 97463.90 98189.95 98298.22
##  [9] 97763.56 97694.83 97691.33 98147.26 98176.66 98072.18 97769.66 97916.45
## [17] 97310.88 97539.36 97871.03 97230.00 97729.46 97997.05 97499.39 98120.00
```

```
temp <- temp[-which(temp$Income %in% incOut),]
str(temp)
```

```
## 'data.frame':    9479 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

```
## [1] 96857.54 97057.93 96753.80 96788.12 97020.52 96898.83 97088.50 96925.17
```

```
temp <- temp[-which(temp$Income %in% incOut),]
str(temp)
```

```
## 'data.frame':    9471 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
```

```
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

```
## [1] 96624.28 96579.40 96575.06
```

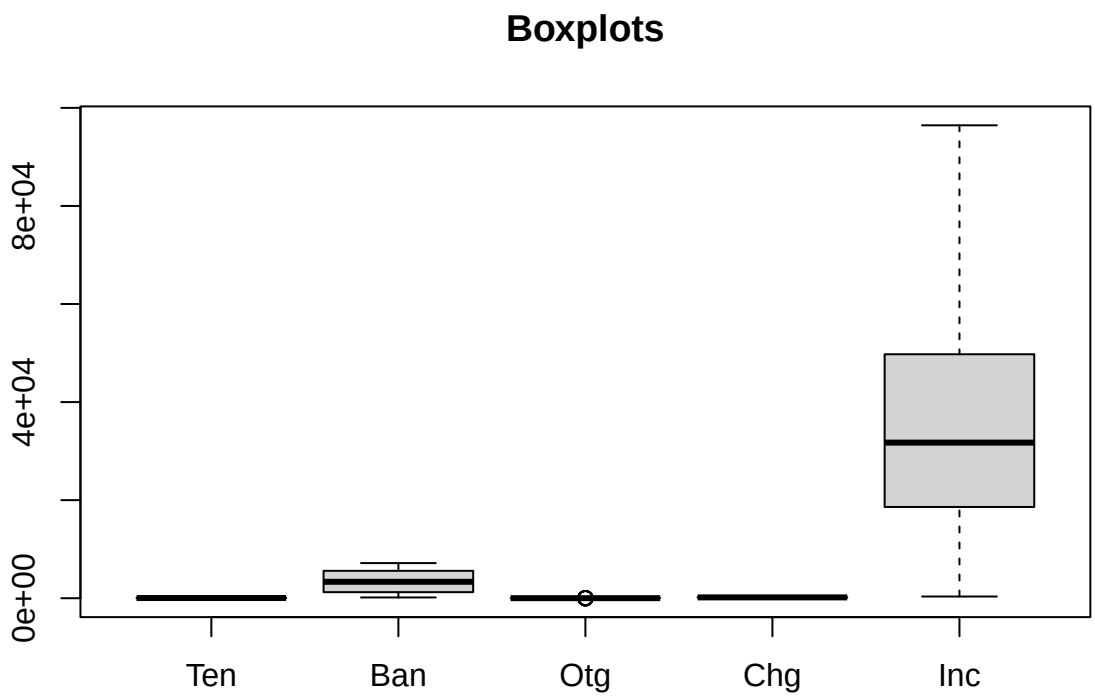
```
temp <- temp[-which(temp$Income %in% incOut),]
str(temp)
```

```
## 'data.frame':    9468 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

```
## numeric(0)
```

```
# Income has no outliers. Check boxplots
boxplot(temp$Tenure, temp$Bandwidth_GB_Year,
        temp$Outage_sec_perweek, temp$MonthlyCharge, temp$Income,
        main = "Boxplots",
        names = c("Ten", "Ban", "Otg", "Chg", "Inc"),
        horizontal = FALSE)
```



```
# Removing rows has created outliers in Outage - repeat process
otgOut <- boxplot(temp$Outage_sec_perweek, plot=FALSE)$out
otgOut
```

```
## [1]  2.110607  2.096375  2.094319  2.104824 17.833720 17.861530
```

```
temp <- temp[-which(temp$Outage_sec_perweek %in% otgOut),]
str(temp)
```

```
## 'data.frame':    9462 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
otgOut <- boxplot(temp$Outage_sec_perweek, plot=FALSE)$out
otgOut
```

```
## [1] 17.82932
```

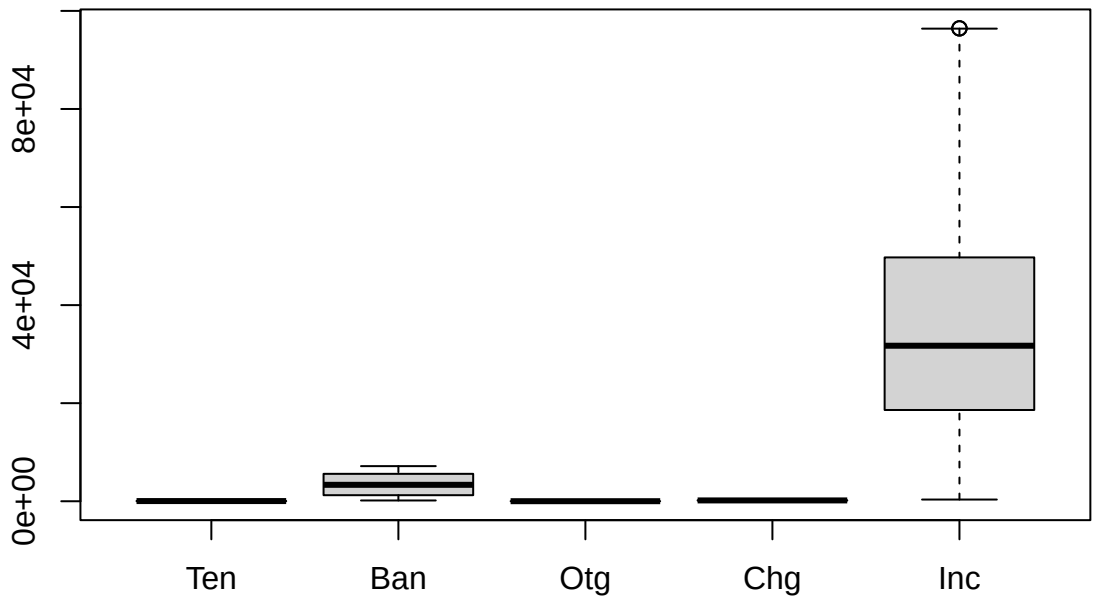
```
temp <- temp[-which(temp$Outage_sec_perweek %in% otgOut),]
str(temp)
```

```
## 'data.frame':    9461 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
otgOut <- boxplot(temp$Outage_sec_perweek, plot=FALSE)$out
otgOut
```

```
## numeric(0)
```

```
boxplot(temp$Tenure, temp$Bandwidth_GB_Year,
        temp$Outage_sec_perweek, temp$MonthlyCharge, temp$Income,
        main = "Boxplots",
        names = c("Ten", "Ban", "Otg", "Chg", "Inc"),
        horizontal = FALSE)
```




```
# Removing rows has caused outliers in Income - repeat process
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

```
## [1] 96431.37 96442.41
```

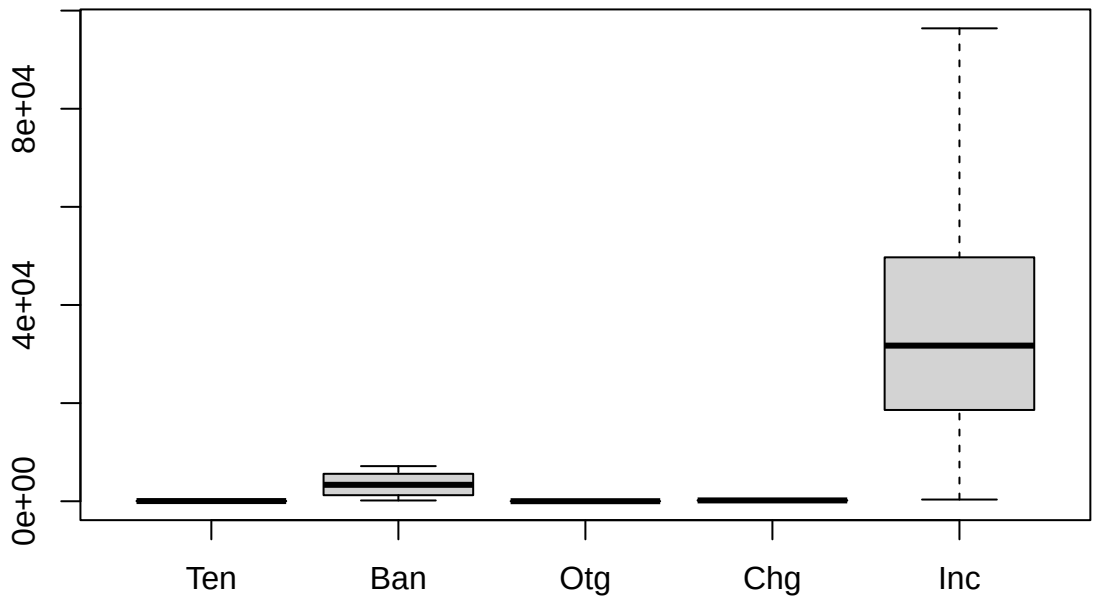
```
temp <- temp[-which(temp$Income %in% incOut),]
str(temp)
```

```
## 'data.frame':    9459 obs. of  5 variables:
##  $ Tenure            : num  6.8 1.16 15.75 17.09 1.67 ...
##  $ Bandwidth_GB_Year : num  905 801 2055 2165 271 ...
##  $ Outage_sec_perweek: num  7.98 11.7 10.75 14.91 8.15 ...
##  $ MonthlyCharge     : num  172 243 160 120 150 ...
##  $ Income            : num  28562 21705 9610 18925 40074 ...
```

```
incOut <- boxplot(temp$Income, plot=FALSE)$out
incOut
```

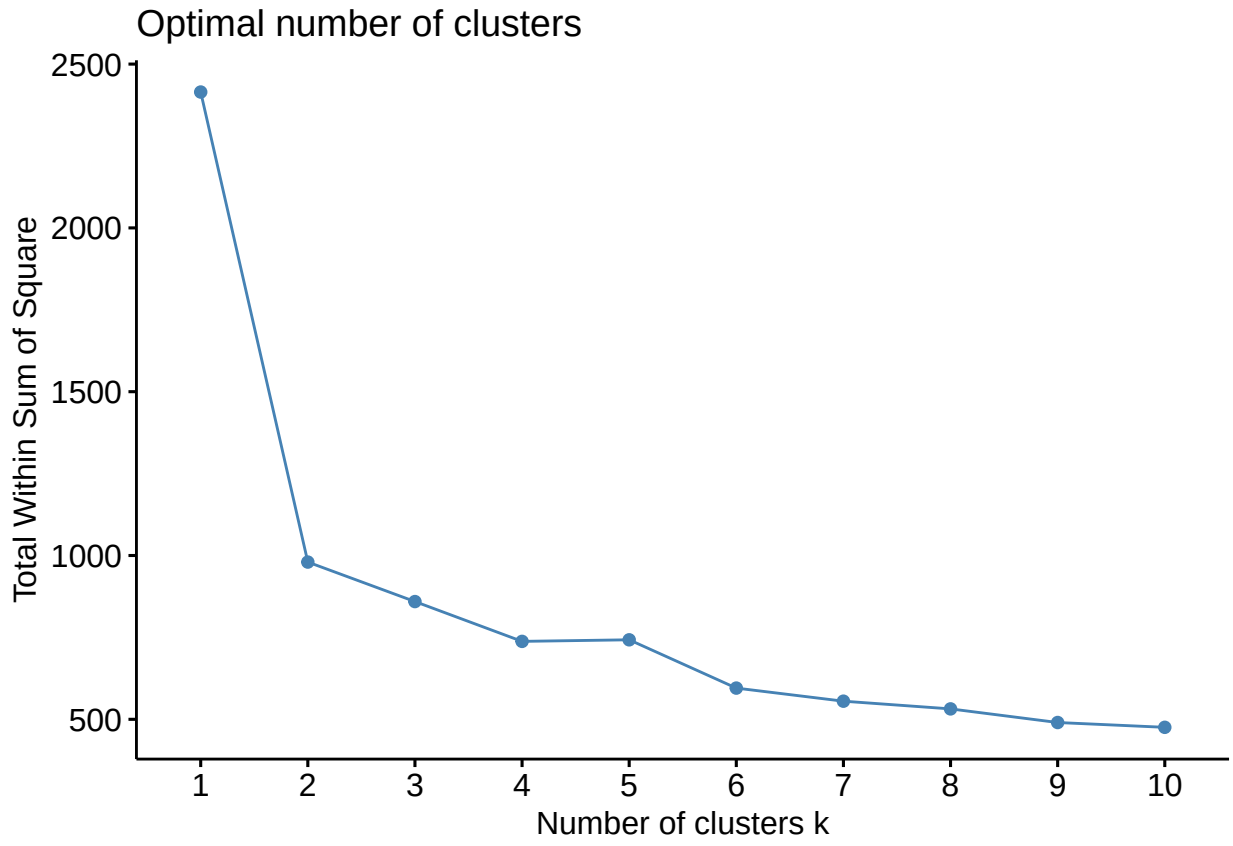
```
## numeric(0)
```

```
# Check boxplots for outliers
boxplot(temp$Tenure, temp$Bandwidth_GB_Year,
        temp$Outage_sec_perweek, temp$MonthlyCharge, temp$Income,
        main = "Boxplots",
        names = c("Ten", "Ban", "Otg", "Chg", "Inc"),
        horizontal = FALSE)
```

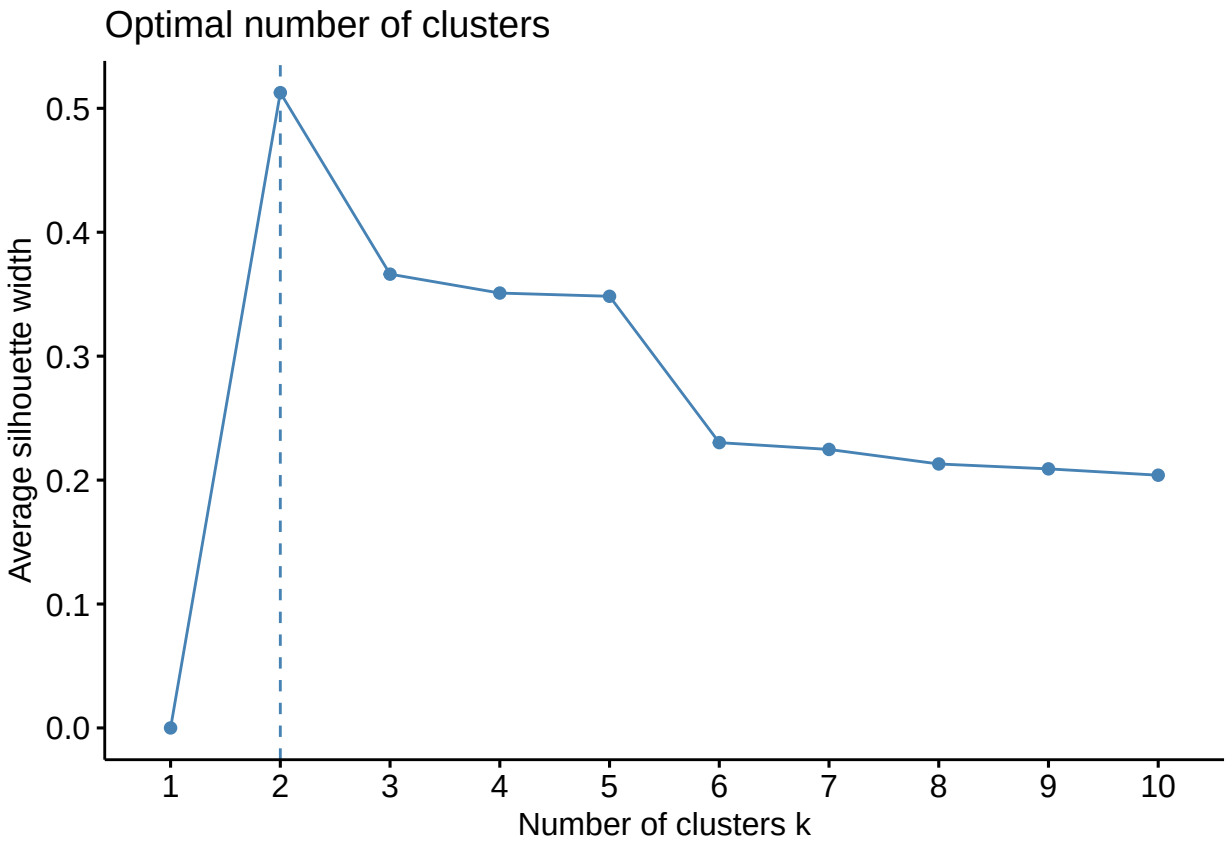



```
# No outliers remain. Ready for train/test split


################################ TRAIN/TEST SPLIT ################################

# Set seed
set.seed(22)
trainId = createDataPartition(temp$Tenure, times = 1, p = 0.7, list = FALSE)

dfTrain = temp[trainId,]
dfTest = temp[-trainId,]

# Normalize Function
normalize = function(x) {
  result = (x - min(x)) / (max(x) - min(x))
  return(result)
}

# Normalize data set
dfTrainNorm <- dfTrain
for (i in colnames(dfTrainNorm)) {
  dfTrainNorm[i] <- normalize(dfTrainNorm[i])
}

# Normalize data set
dfTestNorm <- dfTest
```

```r
for (i in colnames(dfTestNorm)) {
  dfTestNorm[i] <- normalize(dfTestNorm[i])
}

# Export data set for analysis
write.csv(dfTrainNorm, 'C:/WGU/D212 Data Mining II/churn_kmeans_train.csv',
          row.names = FALSE)
write.csv(dfTestNorm, 'C:/WGU/D212 Data Mining II/churn_kmeans_test.csv',
          row.names = FALSE)


############################### TRAINING ########################################

# Identify optimal number of clusters
fviz_nbclust(dfTrainNorm, FUNcluster = kmeans, method = "wss")
```




```r
fviz_nbclust(dfTrainNorm, FUNcluster = kmeans, method = "silhouette")
```



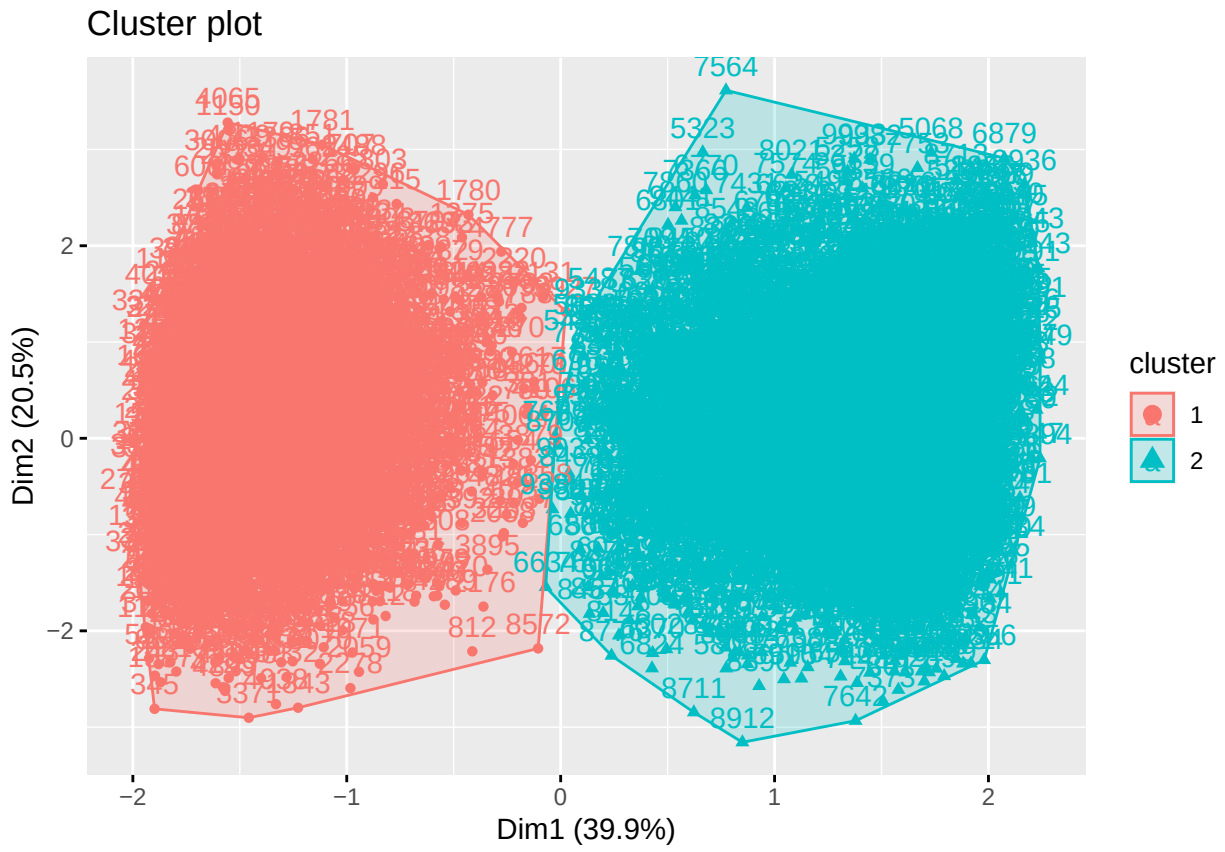

```
# k-means: 2 centers, 50 starting assignments
clusters2Train <-kmeans(dfTrainNorm, centers=2, nstart=50)
clusters2Train$centers
```

```
##      Tenure Bandwidth_GB_Year Outage_sec_perweek MonthlyCharge    Income
## 1 0.1146104         0.1645299          0.4981661     0.4421037 0.3701757
## 2 0.8307966         0.7591695          0.4972854     0.4419805 0.3686264
```

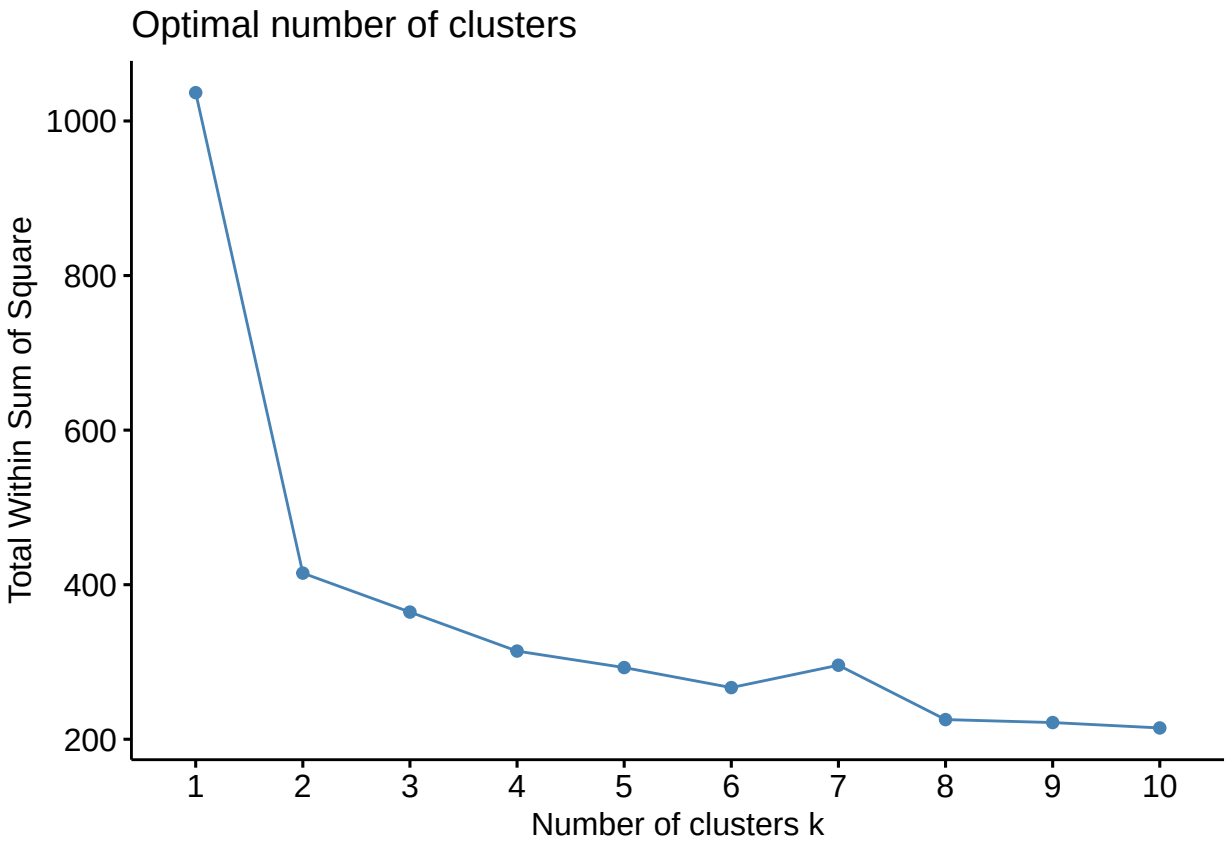
```
clusters2Train$betweenss / clusters2Train$totss
```

```
## [1] 0.5941728
```

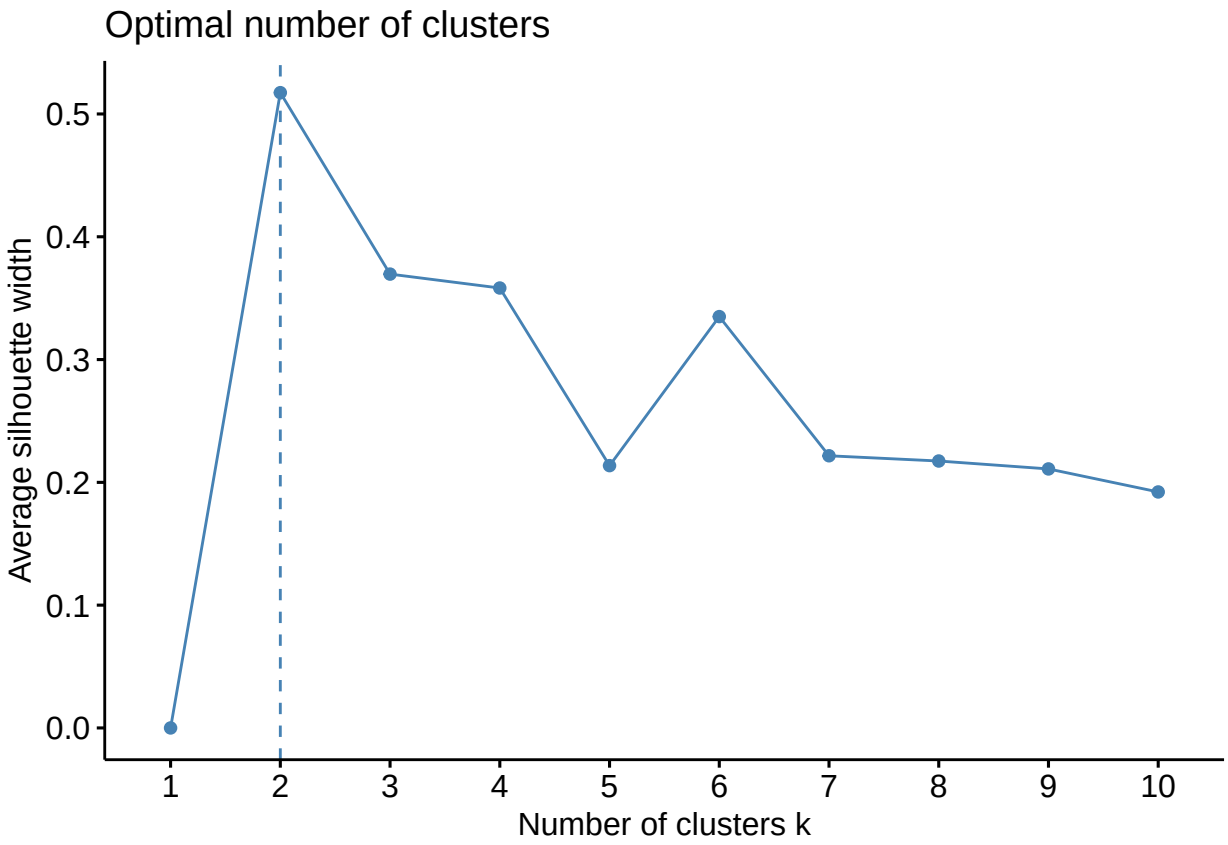
```
# View clusters in plot
fviz_cluster(object=clusters2Train, data=dfTrainNorm)
```




```
################################ TESTING ######################################

# Identify optimal number of clusters
fviz_nbclust(dfTestNorm, FUNcluster = kmeans, method = "wss")
```




```
fviz_nbclust(dfTestNorm, FUNcluster = kmeans, method = "silhouette")
```



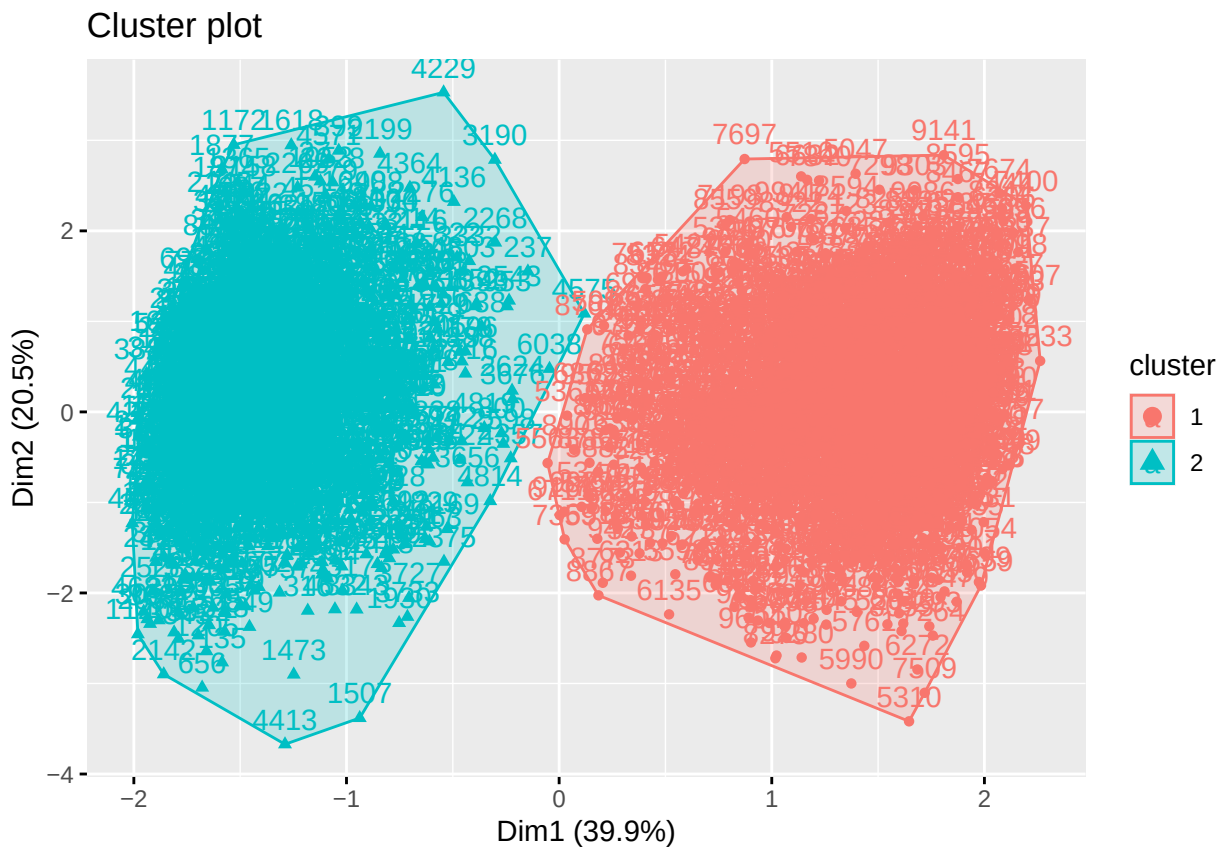

```
# k-means: 2 centers, 50 starting assignments
clusters2Test <-kmeans(dfTestNorm, centers=2, nstart=50)
clusters2Test$centers
```

```
##      Tenure Bandwidth_GB_Year Outage_sec_perweek MonthlyCharge    Income
## 1 0.8297110         0.7692332          0.5044006     0.4393181 0.3738120
## 2 0.1135891         0.1659293          0.4988044     0.4391322 0.3699392
```

```
clusters2Test$betweenss / clusters2Test$totss
```

```
## [1] 0.5997034
```

```
# View clusters in plot
fviz_cluster(object=clusters2Test, data=dfTestNorm)
```




```
################################ INITIAL COMPARISON ##############################

# Centers
clusters2Train$centers
```

```
##      Tenure Bandwidth_GB_Year Outage_sec_perweek MonthlyCharge    Income
## 1 0.1146104         0.1645299          0.4981661     0.4421037 0.3701757
## 2 0.8307966         0.7591695          0.4972854     0.4419805 0.3686264
```

```
clusters2Test$centers
```

```
##      Tenure Bandwidth_GB_Year Outage_sec_perweek MonthlyCharge    Income
## 1 0.8297110         0.7692332          0.5044006     0.4393181 0.3738120
## 2 0.1135891         0.1659293          0.4988044     0.4391322 0.3699392
```

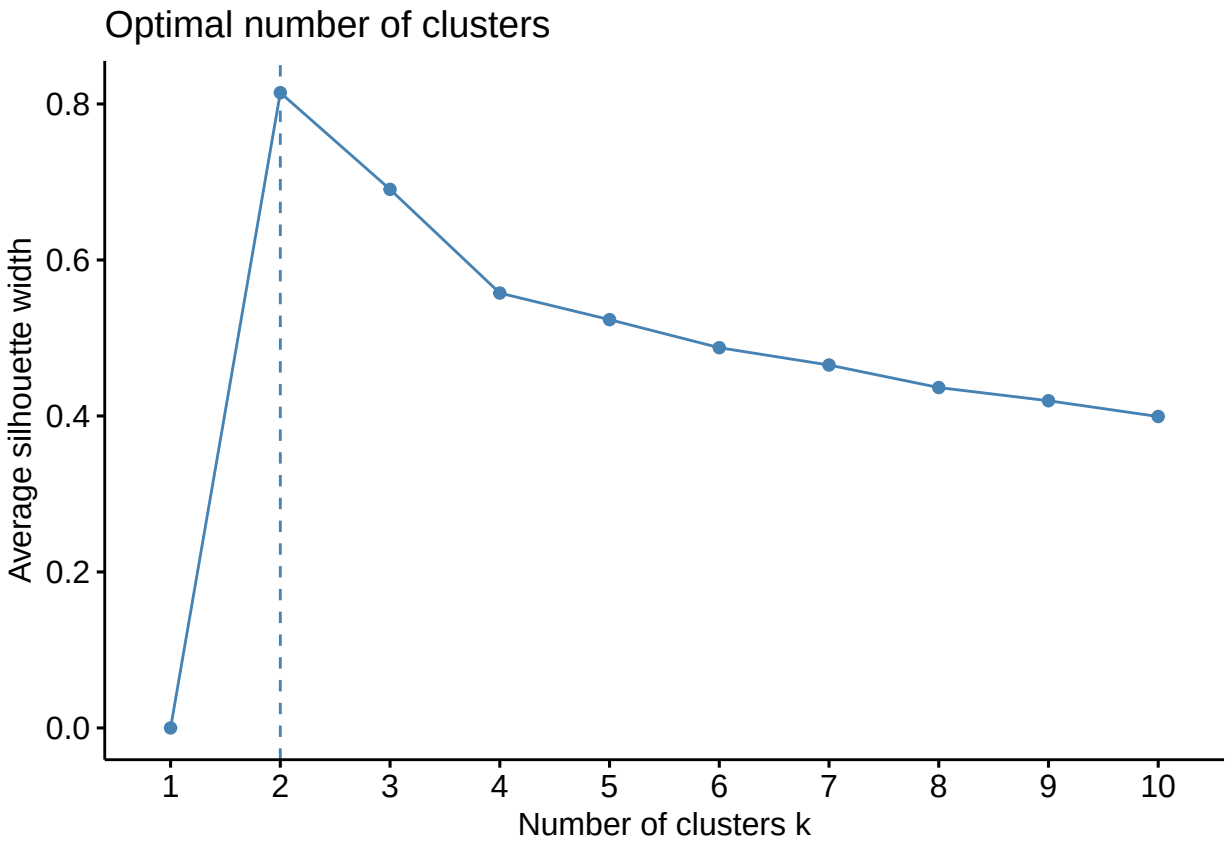
```
# Ratio
clusters2Train$betweenss / clusters2Train$totss
```

```
## [1] 0.5941728
```

```
clusters2Test$betweenss / clusters2Test$totss
```

```
## [1] 0.5997034
```

```
################################ TENURE & BANDWIDTH ##############################

dfTrainFinal <-dfTrainNorm[c('Tenure', 'Bandwidth_GB_Year')]
fviz_nbclust(dfTrainFinal, FUNcluster = kmeans, method = "silhouette")
```




```
clusters2TrainFinal <- kmeans(dfTrainFinal, centers=2, n=50)
clusters2TrainFinal
```

```
## K-means clustering with 2 clusters of sizes 3308, 3315
##
## Cluster means:
##      Tenure Bandwidth_GB_Year
## 1 0.1146104         0.1645299
## 2 0.8307966         0.7591695
##
## Clustering vector:
##    1    2    3    5    6    7   10   12   13   15   16   17   19   20   21   22
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##   23   24   25   26   28   30   31   32   34   35   36   37   38   39   40   41
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##   42   43   44   49   50   51   53   55   56   57   59   60   61   62   64   66
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##   67   68   69   70   72   74   75   76   77   78   79   80   81   82   83   85
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##   86   87   88   90   91   92   95   96   98  100  101  102  103  104  105  106
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  107  110  111  112  113  114  115  116  118  120  122  123  124  125  126  127
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  128  130  132  133  134  138  139  140  141  142  144  146  147  148  150  152
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  154  155  156  157  159  162  163  164  165  166  168  169  170  175  177  178
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
##  179  180  182  183  184  185  186  189  190  192  194  195  196  197  200  201
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  203  207  210  213  215  216  218  219  220  224  226  227  228  229  230  232
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  233  234  235  236  239  240  241  243  245  246  247  248  249  250  252  253
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  254  255  256  257  258  259  261  262  263  264  266  267  268  270  271  272
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  273  274  277  279  280  281  282  284  285  287  288  289  290  292  293  295
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  297  299  300  301  303  304  305  309  311  315  318  321  322  324  325  326
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  327  328  330  331  332  334  335  336  339  341  342  343  344  345  346  348
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  349  350  351  353  355  356  360  362  365  367  368  369  371  372  373  374
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  375  376  377  378  381  382  383  386  388  393  394  395  396  397  398  401
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  403  407  408  409  410  412  413  415  417  419  420  422  424  426  427  428
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  429  430  431  432  433  434  435  436  437  440  443  444  445  447  452  453
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  454  455  457  458  459  460  462  463  465  470  474  475  476  477  478  479
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  481  482  483  484  485  487  488  489  491  492  493  494  495  498  499  500
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  502  503  504  507  508  509  510  511  513  517  518  520  521  524  526  527
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  530  532  534  535  537  539  541  543  544  546  547  549  550  551  552  553
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  554  556  557  559  560  561  563  567  568  570  571  572  573  574  579  581
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  583  584  585  586  587  588  590  591  593  596  599  600  602  603  604  606
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  607  608  609  610  612  613  614  615  617  618  619  621  622  623  626  631
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  632  633  634  635  636  637  640  641  643  644  645  646  647  649  651  653
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  654  655  658  659  660  663  664  665  668  670  672  673  674  675  676  678
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  682  683  685  690  691  692  693  695  699  700  701  703  704  705  707  708
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  709  712  713  714  715  718  719  721  722  723  724  726  727  728  729  730
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  731  732  733  735  737  740  741  746  748  750  751  752  754  755  756  757
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  758  759  760  761  763  764  765  766  768  771  772  773  775  776  777  779
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  781  782  783  785  786  787  788  789  791  792  793  794  795  796  798  799
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  802  803  804  805  807  810  811  812  815  816  818  819  820  824  826  827
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  829  830  831  832  833  835  836  837  840  841  842  843  845  846  847  850
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
##  851  853  854  856  857  858  859  861  862  863  864  865  866  867  868  870
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  871  872  873  874  876  877  878  879  880  882  883  884  885  886  888  890
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  891  894  897  898  900  901  903  904  905  906  910  911  913  915  917  918
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  919  923  924  925  926  928  929  930  931  932  933  934  935  937  938  939
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  940  941  943  945  946  947  949  952  954  959  960  961  962  964  965  966
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  967  968  969  970  971  972  975  978  979  981  982  983  985  986  987  989
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  990  991  992  993  994  996 1000 1002 1003 1005 1008 1009 1010 1011 1012 1014
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1015 1016 1019 1020 1022 1026 1028 1030 1031 1032 1033 1035 1037 1038 1039 1044
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1045 1047 1048 1049 1054 1057 1058 1059 1061 1062 1063 1065 1066 1067 1068 1069
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1070 1071 1072 1073 1076 1078 1080 1081 1082 1083 1084 1085 1086 1088 1091 1092
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1094 1096 1098 1100 1102 1103 1104 1105 1106 1107 1110 1111 1113 1114 1115 1117
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1118 1122 1124 1125 1127 1130 1132 1133 1134 1135 1136 1137 1138 1140 1141 1142
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1143 1144 1145 1147 1148 1149 1150 1152 1155 1158 1159 1160 1162 1165 1166 1168
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1169 1170 1171 1173 1179 1180 1181 1183 1184 1185 1186 1188 1189 1190 1191 1192
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1193 1194 1195 1196 1197 1198 1199 1200 1201 1203 1204 1206 1207 1210 1211 1213
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1215 1217 1218 1219 1220 1221 1222 1223 1224 1225 1227 1229 1230 1232 1233 1235
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1236 1238 1239 1241 1242 1243 1245 1246 1248 1251 1252 1253 1254 1255 1257 1258
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1259 1263 1264 1266 1267 1269 1270 1271 1272 1273 1275 1276 1278 1279 1281 1283
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1285 1288 1292 1294 1295 1299 1301 1304 1305 1309 1311 1312 1314 1315 1316 1317
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1319 1321 1322 1323 1325 1326 1327 1328 1329 1330 1331 1332 1336 1337 1339 1340
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1342 1344 1347 1348 1349 1350 1351 1354 1355 1356 1357 1358 1359 1360 1361 1363
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1364 1366 1367 1369 1370 1372 1373 1374 1375 1377 1378 1382 1384 1386 1388 1390
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1394 1395 1396 1397 1399 1401 1402 1404 1406 1407 1408 1409 1412 1413 1414 1415
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1417 1419 1420 1421 1422 1423 1425 1426 1427 1428 1429 1431 1432 1435 1436 1437
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1439 1440 1442 1443 1444 1445 1448 1449 1450 1451 1453 1455 1457 1458 1459 1460
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1461 1463 1464 1465 1468 1469 1470 1471 1472 1474 1475 1476 1479 1480 1483 1484
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1485 1486 1487 1488 1489 1491 1494 1496 1498 1501 1502 1505 1509 1513 1514 1515
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
## 1517 1518 1520 1521 1522 1523 1524 1526 1527 1532 1533 1534 1536 1537 1539 1541
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1542 1543 1545 1547 1548 1549 1550 1552 1556 1560 1561 1562 1563 1564 1566 1567
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1568 1569 1571 1573 1575 1576 1577 1579 1580 1582 1584 1585 1586 1587 1588 1589
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1590 1591 1592 1593 1595 1598 1599 1600 1602 1605 1606 1609 1610 1611 1612 1613
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1614 1616 1617 1619 1620 1622 1623 1624 1625 1626 1628 1629 1630 1631 1632 1633
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1636 1637 1638 1641 1643 1645 1649 1650 1652 1653 1658 1660 1662 1664 1666 1667
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1670 1671 1672 1674 1675 1676 1677 1678 1679 1680 1682 1683 1684 1685 1687 1688
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1689 1691 1693 1694 1695 1696 1703 1704 1705 1706 1709 1711 1712 1713 1714 1722
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1723 1727 1730 1731 1732 1734 1736 1737 1738 1739 1740 1741 1742 1743 1745 1747
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1750 1751 1752 1753 1754 1755 1756 1758 1759 1761 1762 1763 1764 1765 1767 1769
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1770 1771 1772 1773 1774 1775 1776 1777 1778 1780 1781 1783 1784 1785 1786 1787
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1788 1789 1790 1791 1794 1796 1797 1799 1801 1803 1804 1805 1807 1809 1810 1811
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1812 1813 1814 1815 1816 1818 1820 1821 1822 1823 1824 1825 1827 1828 1830 1831
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1832 1834 1835 1836 1837 1838 1839 1841 1842 1843 1844 1845 1846 1847 1848 1849
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1852 1853 1854 1855 1858 1859 1860 1861 1862 1865 1867 1869 1872 1873 1875 1876
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1879 1881 1883 1886 1887 1888 1889 1890 1891 1892 1894 1896 1897 1899 1900 1901
##    1    1    1    1    1    1    1    1    1    1    1    1    1    2    1    1
## 1902 1903 1904 1906 1912 1913 1914 1915 1916 1917 1919 1922 1923 1925 1926 1927
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1928 1929 1933 1934 1939 1940 1942 1944 1946 1947 1948 1950 1951 1952 1953 1955
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1957 1959 1960 1961 1962 1963 1965 1966 1967 1969 1971 1972 1975 1977 1979 1980
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1981 1982 1983 1984 1985 1986 1987 1988 1989 1991 1992 1993 1994 1995 1996 1997
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 1999 2000 2001 2002 2003 2006 2007 2008 2009 2010 2011 2012 2014 2015 2016 2018
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2020 2021 2022 2023 2026 2028 2029 2032 2034 2035 2037 2039 2040 2041 2042 2043
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2044 2046 2049 2050 2051 2052 2053 2054 2055 2056 2058 2059 2063 2064 2065 2066
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2068 2069 2070 2073 2075 2076 2078 2079 2083 2084 2086 2087 2092 2095 2096 2098
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2101 2104 2105 2107 2109 2111 2112 2114 2116 2117 2119 2120 2121 2123 2125 2126
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2130 2131 2133 2134 2135 2137 2139 2143 2146 2149 2152 2153 2155 2156 2157 2158
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2160 2162 2163 2164 2166 2168 2169 2170 2172 2173 2175 2176 2178 2183 2184 2187
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
## 2188 2189 2192 2193 2194 2195 2197 2198 2200 2201 2202 2204 2207 2208 2210 2211
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2213 2214 2215 2216 2217 2218 2220 2222 2223 2224 2225 2227 2229 2233 2234 2235
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2237 2239 2241 2242 2245 2246 2247 2248 2249 2250 2252 2253 2254 2255 2256 2257
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2258 2259 2261 2266 2270 2272 2273 2274 2275 2278 2279 2280 2281 2282 2283 2284
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2285 2286 2288 2289 2291 2292 2293 2296 2297 2298 2299 2300 2301 2302 2303 2304
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2306 2311 2312 2313 2314 2315 2316 2317 2319 2320 2321 2322 2326 2327 2328 2329
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2330 2331 2332 2333 2334 2336 2338 2339 2341 2342 2343 2345 2346 2348 2349 2350
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2354 2358 2360 2362 2363 2364 2365 2366 2367 2368 2370 2371 2372 2376 2377 2379
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2381 2382 2383 2384 2385 2386 2390 2391 2392 2393 2394 2395 2396 2397 2399 2400
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2401 2402 2403 2404 2406 2407 2408 2409 2410 2411 2413 2414 2415 2418 2419 2420
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2421 2422 2425 2427 2428 2429 2431 2433 2434 2435 2436 2437 2438 2439 2444 2446
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2447 2448 2450 2453 2454 2457 2458 2459 2460 2462 2464 2466 2468 2470 2471 2473
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2474 2476 2477 2479 2480 2482 2483 2485 2486 2488 2490 2492 2495 2497 2498 2499
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2500 2501 2502 2504 2507 2510 2512 2514 2515 2518 2520 2521 2522 2523 2524 2525
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2526 2527 2529 2530 2531 2532 2534 2535 2536 2537 2539 2542 2544 2546 2547 2549
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2550 2552 2553 2554 2556 2557 2558 2559 2561 2564 2566 2567 2568 2569 2570 2573
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2574 2576 2577 2578 2579 2581 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2593 2594 2595 2596 2600 2601 2602 2604 2609 2610 2611 2612 2613 2614 2615 2616
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2617 2619 2620 2622 2626 2628 2629 2630 2631 2634 2635 2636 2637 2638 2639 2640
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2641 2642 2643 2644 2645 2647 2648 2649 2650 2651 2653 2654 2657 2658 2661 2663
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2665 2666 2667 2668 2669 2670 2671 2672 2674 2675 2676 2677 2678 2679 2680 2681
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2683 2684 2685 2686 2687 2688 2690 2691 2692 2693 2694 2695 2696 2697 2698 2700
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2702 2703 2704 2705 2708 2710 2714 2715 2717 2718 2720 2721 2722 2723 2724 2725
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2742 2743 2744
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2745 2746 2750 2752 2754 2755 2757 2758 2759 2761 2762 2764 2766 2767 2768 2770
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2771 2773 2774 2775 2776 2777 2778 2779 2780 2782 2786 2787 2788 2789 2790 2792
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2793 2796 2799 2801 2802 2805 2806 2807 2809 2811 2815 2816 2817 2820 2821 2822
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

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## 2824 2825 2827 2828 2830 2831 2835 2839 2840 2841 2842 2844 2845 2846 2849 2850
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2854 2855 2856 2858 2859 2863 2864 2865 2866 2867 2868 2870 2871 2872 2873 2876
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2877 2878 2879 2880 2881 2882 2883 2884 2886 2887 2888 2892 2893 2894 2895 2897
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2898 2899 2900 2901 2902 2903 2904 2905 2906 2909 2911 2912 2914 2915 2916 2917
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2919 2920 2921 2922 2923 2924 2925 2926 2930 2932 2933 2935 2936 2937 2938 2940
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2941 2942 2944 2946 2947 2948 2950 2951 2953 2955 2957 2958 2961 2963 2964 2965
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2966 2967 2970 2972 2973 2974 2975 2977 2979 2981 2982 2986 2987 2989 2992 2993
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 2995 2996 2997 2998 3001 3004 3005 3006 3007 3008 3010 3011 3012 3014 3016 3017
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3020 3021 3024 3025 3027 3032 3033 3034 3035 3036 3037 3040 3041 3042 3043 3044
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3045 3046 3047 3051 3054 3059 3060 3061 3062 3063 3064 3066 3067 3068 3070 3071
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3072 3073 3075 3076 3077 3078 3079 3080 3081 3082 3083 3084 3085 3086 3088 3090
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3091 3092 3093 3094 3095 3096 3097 3098 3100 3101 3103 3105 3106 3108 3113 3117
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3118 3122 3123 3124 3125 3126 3128 3130 3132 3135 3136 3138 3140 3144 3146 3148
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3151 3154 3155 3156 3162 3163 3164 3165 3168 3170 3171 3172 3173 3174 3175 3177
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3178 3179 3180 3181 3184 3185 3186 3187 3191 3193 3195 3196 3199 3200 3201 3202
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3203 3204 3205 3206 3207 3208 3210 3211 3212 3213 3214 3215 3217 3218 3219 3222
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3223 3224 3225 3227 3228 3229 3230 3233 3234 3235 3236 3238 3239 3240 3242 3244
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3246 3248 3249 3250 3251 3252 3253 3255 3256 3258 3259 3260 3262 3263 3266 3267
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3270 3272 3273 3274 3275 3276 3277 3278 3279 3280 3281 3282 3284 3287 3288 3289
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3293 3294 3295 3297 3298 3299 3301 3303 3305 3307 3308 3309 3312 3314 3316 3318
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3319 3321 3323 3324 3325 3326 3327 3329 3331 3333 3334 3335 3336 3339 3340 3344
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3346 3348 3349 3351 3352 3353 3354 3356 3357 3358 3360 3364 3366 3367 3369 3370
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## 3371 3372 3373 3374 3376 3377 3378 3380 3381 3383 3384 3385 3386 3387 3388 3389
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3390 3391 3392 3394 3395 3396 3397 3399 3401 3403 3404 3405 3406 3407 3408 3411
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3413 3414 3415 3416 3419 3420 3422 3425 3426 3427 3428 3429 3430 3432 3434 3436
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3438 3440 3441 3442 3443 3444 3445 3447 3448 3450 3451 3452 3454 3455 3456 3457
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3459 3460 3461 3462 3463 3464 3466 3469 3470 3472 3473 3474 3475 3477 3480 3482
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
## 3483 3484 3485 3487 3488 3489 3492 3493 3494 3495 3497 3499 3502 3504 3506 3508
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## 3509 3510 3512 3516 3518 3519 3520 3521 3522 3523 3524 3526 3528 3531 3532 3534
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3536 3539 3541 3542 3543 3544 3545 3548 3550 3552 3553 3554 3555 3557 3562 3563
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3566 3567 3569 3570 3571 3572 3573 3574 3575 3578 3580 3581 3582 3583 3587 3588
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3589 3590 3592 3593 3594 3596 3599 3601 3603 3604 3606 3612 3614 3615 3616 3617
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3618 3619 3620 3621 3622 3623 3624 3625 3627 3628 3629 3631 3632 3633 3636 3638
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3639 3642 3643 3644 3645 3646 3651 3652 3653 3657 3658 3659 3660 3661 3663 3664
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3666 3668 3669 3670 3671 3672 3675 3677 3678 3679 3681 3683 3685 3686 3689 3690
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3691 3692 3693 3694 3695 3696 3698 3699 3700 3701 3704 3705 3706 3707 3708 3710
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3711 3713 3714 3715 3717 3718 3719 3722 3725 3728 3729 3731 3732 3735 3736 3738
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3740 3742 3743 3744 3747 3749 3750 3751 3753 3754 3755 3757 3758 3759 3761 3762
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3763 3764 3766 3768 3769 3770 3771 3772 3773 3774 3775 3777 3779 3780 3784 3785
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3786 3789 3791 3792 3794 3795 3796 3797 3798 3801 3802 3803 3806 3807 3808 3809
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3812 3813 3814 3815 3816 3817 3818 3819 3820 3821 3822 3823 3824 3826 3828 3829
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3831 3832 3833 3834 3835 3837 3838 3839 3840 3841 3844 3847 3848 3854 3855 3857
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3858 3859 3860 3861 3862 3864 3865 3866 3867 3869 3871 3874 3875 3877 3879 3881
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3883 3887 3889 3890 3891 3892 3893 3894 3895 3896 3897 3898 3899 3900 3901 3902
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3903 3904 3905 3906 3908 3909 3911 3912 3914 3915 3916 3919 3921 3923 3925 3926
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3927 3930 3931 3932 3933 3935 3937 3938 3939 3940 3941 3942 3944 3945 3946 3947
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3948 3949 3950 3952 3953 3955 3956 3957 3959 3960 3962 3963 3965 3966 3967 3968
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3969 3972 3974 3975 3976 3978 3980 3982 3984 3985 3987 3988 3992 3993 3995 3997
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3998 3999 4000 4001 4002 4003 4004 4005 4006 4010 4011 4014 4015 4016 4017 4018
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4019 4020 4021 4022 4026 4029 4031 4032 4034 4035 4036 4038 4040 4041 4043 4044
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4045 4046 4048 4049 4051 4052 4054 4058 4059 4060 4063 4064 4065 4066 4068 4069
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4071 4073 4074 4076 4077 4078 4080 4081 4082 4083 4086 4087 4088 4089 4090 4095
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4096 4097 4098 4099 4102 4103 4105 4106 4107 4108 4110 4111 4113 4114 4117 4119
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4120 4121 4122 4124 4125 4126 4127 4131 4132 4133 4134 4138 4140 4143 4144 4145
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
## 4146 4147 4148 4149 4150 4151 4152 4153 4156 4158 4159 4161 4162 4163 4164 4165
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4166 4167 4169 4170 4171 4174 4175 4176 4177 4178 4182 4183 4189 4190 4192 4195
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4197 4198 4199 4200 4201 4202 4204 4205 4207 4208 4210 4211 4214 4215 4216 4218
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4219 4222 4223 4224 4225 4226 4230 4231 4234 4236 4240 4241 4243 4244 4246 4248
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4253 4254 4256 4257 4259 4262 4263 4264 4265 4266 4267 4268 4269 4270 4271 4272
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4273 4275 4276 4277 4278 4279 4282 4285 4286 4287 4289 4290 4291 4292 4293 4296
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4299 4300 4302 4303 4305 4308 4309 4310 4311 4312 4313 4315 4316 4318 4319 4320
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4321 4322 4325 4326 4328 4329 4330 4331 4332 4333 4334 4335 4339 4340 4343 4344
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4345 4348 4349 4351 4353 4354 4356 4358 4359 4360 4361 4362 4363 4365 4366 4367
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4368 4369 4372 4373 4374 4377 4378 4380 4381 4383 4384 4385 4386 4387 4388 4389
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4390 4391 4393 4394 4395 4396 4397 4398 4400 4401 4402 4403 4404 4405 4408 4409
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4410 4411 4412 4414 4415 4416 4417 4418 4419 4423 4425 4426 4427 4429 4433 4434
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4435 4436 4437 4440 4441 4443 4444 4449 4450 4451 4454 4455 4457 4458 4459 4460
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4461 4462 4463 4464 4466 4470 4471 4474 4475 4479 4481 4482 4483 4485 4486 4487
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4488 4489 4490 4491 4492 4493 4494 4495 4496 4497 4498 4500 4501 4504 4505 4506
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4511 4512 4513 4515 4517 4518 4519 4520 4522 4523 4524 4525 4526 4527 4528 4529
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4530 4531 4533 4534 4535 4536 4537 4538 4540 4541 4542 4543 4544 4545 4546 4548
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4549 4550 4551 4553 4554 4555 4556 4557 4558 4559 4560 4561 4562 4564 4565 4566
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4567 4568 4569 4570 4572 4574 4576 4577 4578 4579 4581 4582 4583 4584 4585 4586
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4587 4588 4590 4591 4593 4594 4596 4597 4598 4599 4600 4603 4604 4605 4607 4608
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4611 4612 4614 4615 4616 4620 4622 4623 4624 4625 4626 4627 4628 4629 4630 4631
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4633 4634 4635 4636 4637 4638 4640 4644 4645 4647 4648 4649 4650 4653 4654 4655
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4657 4659 4660 4661 4662 4663 4664 4665 4666 4668 4669 4670 4671 4672 4673 4674
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4675 4678 4681 4683 4684 4686 4687 4688 4691 4693 4694 4695 4696 4697 4699 4700
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4701 4702 4703 4704 4705 4706 4707 4708 4709 4711 4712 4713 4714 4715 4716 4717
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4719 4721 4723 4725 4727 4728 4729 4732 4733 4734 4735 4736 4738 4739 4741 4742
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4743 4744 4745 4746 4747 4748 4750 4751 4754 4755 4756 4759 4760 4763 4764 4765
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
## 4766 4767 4770 4771 4772 4773 4775 4777 4779 4780 4781 4782 4783 4784 4785 4786
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4787 4788 4789 4790 4791 4792 4793 4795 4796 4797 4799 4800 4801 4802 4805 4806
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4808 4809 4815 4816 4818 4820 4821 4822 4823 4824 4825 4826 4828 4830 4831 4832
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4836 4837 4838 4839 4841 4844 4845 4846 4847 4850 4851 4852 4853 4854 4857 4862
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4864 4866 4867 4868 4869 4870 4871 4873 4874 4876 4877 4878 4880 4881 4882 4883
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4884 4885 4886 4889 4890 4891 4892 4894 4895 4896 4898 4899 4901 4903 4904 4907
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4909 4910 4911 4912 4913 4914 4916 4918 4919 4920 4921 4922 4923 4924 4926 4930
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4931 4932 4933 4934 4935 4936 4937 4938 4939 4940 4943 4948 4952 4953 4955 4956
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4960 4961 4963 4964 4965 4967 4968 4969 4970 4971 4972 4975 4977 4978 4979 4982
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 4983 4985 4987 4988 4989 4990 4991 4992 4993 4994 4996 4997 5001 5002 5004 5006
##    1    1    1    1    1    1    1    1    1    1    1    1    2    2    2    2
## 5007 5008 5009 5010 5012 5013 5014 5017 5018 5019 5020 5021 5022 5023 5025 5027
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5028 5030 5031 5032 5033 5034 5036 5039 5040 5042 5043 5044 5045 5046 5049 5054
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5055 5057 5058 5059 5060 5061 5062 5064 5065 5066 5067 5068 5069 5070 5072 5073
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## 5077 5078 5080 5081 5082 5083 5084 5085 5088 5089 5090 5092 5093 5094 5095 5096
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5099 5101 5102 5103 5105 5106 5107 5109 5114 5117 5118 5119 5121 5122 5125 5126
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5127 5130 5131 5132 5133 5134 5135 5138 5139 5140 5142 5143 5144 5145 5148 5150
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5151 5154 5155 5156 5158 5159 5160 5161 5162 5163 5165 5166 5168 5169 5170 5171
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5172 5174 5175 5179 5180 5181 5183 5184 5185 5186 5187 5188 5190 5191 5192 5193
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5194 5195 5196 5197 5198 5199 5200 5202 5204 5206 5209 5210 5211 5212 5213 5215
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5217 5219 5220 5221 5222 5223 5224 5225 5227 5228 5229 5230 5233 5234 5236 5237
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5238 5239 5240 5241 5242 5243 5244 5245 5246 5247 5248 5249 5250 5251 5252 5255
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5256 5257 5258 5259 5260 5261 5262 5263 5265 5266 5268 5269 5271 5275 5276 5279
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5280 5284 5285 5286 5287 5288 5289 5291 5292 5293 5295 5296 5297 5298 5300 5302
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5303 5307 5311 5312 5314 5315 5316 5317 5319 5320 5321 5322 5323 5324 5325 5326
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5327 5328 5329 5335 5337 5339 5341 5343 5344 5346 5347 5350 5352 5353 5355 5356
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5358 5359 5362 5365 5366 5367 5368 5369 5370 5371 5372 5373 5375 5377 5378 5379
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5380 5383 5384 5385 5387 5392 5395 5396 5397 5398 5400 5401 5405 5407 5408 5410
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
## 5411 5412 5413 5414 5415 5417 5419 5420 5423 5424 5425 5426 5427 5428 5431 5433
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5434 5435 5436 5438 5439 5442 5443 5444 5445 5446 5447 5448 5450 5451 5452 5453
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5456 5457 5458 5459 5461 5462 5463 5466 5468 5469 5470 5471 5472 5473 5474 5476
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5477 5478 5479 5480 5482 5483 5484 5486 5487 5489 5491 5492 5493 5494 5495 5496
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5498 5499 5501 5505 5507 5510 5511 5512 5513 5514 5515 5517 5520 5523 5525 5526
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5527 5528 5530 5533 5534 5535 5536 5538 5539 5540 5543 5544 5545 5546 5548 5549
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5550 5551 5552 5555 5556 5557 5558 5559 5560 5561 5566 5567 5569 5570 5571 5572
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5573 5576 5577 5578 5579 5580 5581 5582 5585 5586 5587 5588 5589 5592 5594 5596
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5597 5599 5601 5607 5608 5610 5611 5612 5613 5614 5615 5616 5618 5619 5623 5624
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5626 5627 5628 5629 5630 5631 5632 5634 5637 5640 5641 5642 5643 5644 5645 5647
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5648 5652 5654 5655 5656 5657 5658 5659 5660 5661 5664 5666 5667 5668 5669 5670
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5672 5673 5676 5677 5682 5685 5686 5689 5691 5692 5693 5694 5695 5696 5697 5699
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5700 5701 5702 5703 5704 5705 5706 5707 5708 5710 5711 5712 5714 5715 5716 5718
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5719 5722 5723 5724 5725 5726 5727 5728 5729 5730 5733 5734 5735 5736 5737 5739
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5740 5741 5742 5743 5744 5747 5750 5751 5753 5754 5755 5756 5757 5758 5759 5762
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5763 5764 5765 5767 5768 5769 5771 5772 5773 5774 5775 5777 5781 5782 5784 5786
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5787 5791 5792 5793 5795 5797 5799 5800 5801 5803 5804 5805 5806 5808 5809 5810
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5811 5812 5814 5816 5817 5818 5820 5821 5822 5823 5824 5827 5828 5829 5830 5831
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5835 5836 5838 5839 5841 5842 5843 5844 5845 5846 5847 5848 5849 5850 5851 5852
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5855 5856 5857 5858 5859 5861 5862 5865 5866 5867 5868 5871 5872 5874 5877 5879
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5881 5883 5885 5887 5888 5889 5890 5891 5892 5893 5894 5895 5896 5897 5898 5899
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5904 5905 5906 5907 5909 5910 5911 5912 5913 5915 5916 5918 5920 5923 5928 5929
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5930 5931 5932 5933 5934 5935 5936 5938 5940 5941 5942 5943 5944 5948 5949 5950
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5951 5952 5954 5956 5958 5959 5961 5962 5964 5965 5968 5969 5971 5974 5975 5976
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 5978 5979 5982 5983 5984 5985 5986 5989 5991 5995 5996 5997 5998 5999 6000 6001
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6003 6005 6007 6008 6009 6010 6011 6012 6014 6015 6019 6022 6023 6024 6025 6027
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6028 6029 6030 6031 6032 6033 6036 6037 6039 6040 6042 6043 6044 6045 6048 6049
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
## 6050 6056 6059 6060 6061 6062 6063 6068 6069 6071 6073 6076 6077 6078 6079 6080
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6081 6082 6083 6085 6086 6087 6088 6089 6091 6092 6093 6095 6096 6097 6099 6100
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6102 6103 6104 6106 6108 6109 6112 6113 6114 6115 6116 6118 6119 6120 6121 6125
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6126 6127 6128 6129 6132 6134 6136 6139 6144 6145 6147 6148 6149 6151 6152 6153
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6154 6155 6157 6158 6159 6160 6161 6163 6164 6165 6166 6168 6169 6170 6172 6178
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6179 6181 6184 6185 6187 6188 6189 6190 6191 6192 6193 6194 6196 6198 6199 6200
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6202 6203 6204 6205 6207 6208 6209 6210 6212 6213 6214 6217 6218 6221 6222 6225
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6226 6227 6228 6229 6230 6231 6233 6234 6235 6236 6237 6238 6243 6244 6245 6247
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6248 6249 6250 6252 6253 6254 6255 6256 6257 6259 6260 6265 6266 6268 6269 6270
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6271 6274 6275 6276 6277 6278 6281 6282 6283 6284 6286 6287 6289 6291 6292 6293
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6294 6295 6296 6297 6299 6300 6303 6304 6306 6307 6308 6309 6311 6312 6314 6316
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6319 6320 6321 6324 6325 6326 6327 6328 6329 6330 6335 6336 6338 6339 6340 6343
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6344 6345 6346 6347 6348 6349 6352 6355 6358 6360 6361 6362 6363 6364 6367 6369
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6370 6371 6372 6373 6374 6375 6376 6377 6378 6381 6385 6386 6387 6390 6391 6393
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6395 6396 6397 6398 6399 6402 6403 6404 6405 6408 6409 6410 6411 6412 6413 6414
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6417 6418 6419 6423 6424 6427 6429 6431 6432 6433 6434 6435 6436 6437 6438 6439
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6441 6442 6443 6447 6449 6450 6451 6452 6453 6454 6458 6459 6461 6462 6465 6466
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6467 6468 6469 6470 6476 6477 6478 6480 6481 6482 6483 6485 6487 6488 6489 6490
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6491 6492 6493 6495 6496 6498 6499 6500 6501 6502 6503 6504 6505 6506 6507 6508
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6509 6511 6512 6514 6516 6517 6519 6521 6522 6523 6524 6527 6528 6529 6530 6531
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6533 6535 6536 6537 6539 6540 6541 6543 6546 6549 6551 6552 6554 6555 6560 6562
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6563 6564 6566 6567 6568 6569 6570 6571 6573 6574 6575 6576 6580 6584 6585 6586
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6589 6591 6592 6593 6597 6598 6600 6601 6602 6604 6605 6607 6608 6609 6612 6616
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6617 6619 6620 6622 6623 6625 6626 6627 6628 6630 6631 6633 6634 6635 6636 6638
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6639 6640 6641 6642 6645 6647 6648 6649 6651 6652 6653 6654 6655 6656 6657 6658
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6659 6660 6664 6665 6666 6667 6668 6670 6671 6673 6675 6677 6678 6679 6680 6681
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6683 6684 6685 6687 6688 6689 6691 6692 6694 6695 6696 6697 6698 6701 6703 6705
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
## 6706 6707 6708 6709 6710 6712 6714 6715 6716 6718 6719 6720 6722 6723 6724 6725
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6727 6728 6729 6730 6732 6733 6734 6736 6738 6739 6743 6744 6745 6747 6748 6749
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6750 6751 6752 6753 6754 6755 6756 6758 6759 6760 6763 6764 6765 6769 6770 6771
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6773 6774 6776 6777 6778 6780 6781 6782 6783 6784 6785 6786 6787 6789 6790 6792
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6793 6794 6795 6796 6797 6798 6799 6800 6801 6803 6805 6806 6807 6810 6811 6812
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6813 6814 6815 6816 6817 6818 6819 6820 6822 6823 6824 6825 6826 6827 6828 6829
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6833 6834 6836 6837 6839 6840 6841 6842 6843 6844 6846 6847 6848 6851 6854 6855
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6856 6857 6858 6859 6860 6861 6863 6865 6866 6867 6868 6869 6871 6872 6873 6876
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6877 6879 6880 6881 6882 6883 6884 6885 6886 6888 6889 6890 6895 6897 6898 6899
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6900 6901 6902 6904 6906 6907 6908 6910 6911 6912 6915 6916 6919 6920 6926 6928
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6933 6934 6939 6941 6942 6943 6944 6946 6947 6948 6950 6951 6952 6953 6954 6955
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6956 6958 6959 6961 6962 6963 6964 6966 6967 6968 6969 6970 6971 6972 6973 6976
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6977 6978 6980 6981 6982 6983 6984 6986 6987 6989 6990 6991 6992 6994 6995 6996
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6997 6998 6999 7002 7003 7004 7008 7010 7011 7012 7017 7018 7019 7020 7021 7022
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7024 7025 7026 7028 7030 7032 7034 7035 7036 7037 7038 7039 7040 7042 7044 7045
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7046 7047 7049 7050 7051 7052 7053 7056 7061 7063 7064 7066 7069 7070 7072 7073
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7075 7076 7077 7078 7079 7080 7083 7084 7086 7087 7089 7090 7091 7092 7093 7094
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7096 7100 7101 7102 7103 7104 7105 7108 7109 7110 7112 7113 7114 7115 7116 7118
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7121 7123 7124 7125 7126 7127 7128 7130 7132 7133 7136 7137 7138 7139 7140 7141
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7142 7144 7146 7148 7151 7153 7154 7155 7159 7160 7161 7162 7163 7164 7166 7167
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7168 7172 7173 7174 7175 7176 7177 7182 7183 7184 7186 7187 7188 7189 7191 7193
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7202 7204 7205 7206 7207 7210 7211 7212 7213 7214 7215 7217 7220 7221 7222 7223
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7224 7229 7232 7234 7237 7238 7239 7240 7241 7242 7244 7245 7246 7248 7249 7250
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7251 7252 7253 7254 7255 7256 7257 7258 7259 7260 7261 7262 7263 7265 7266 7268
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7269 7271 7272 7274 7276 7278 7279 7280 7282 7283 7285 7286 7287 7288 7289 7290
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7292 7297 7301 7304 7305 7307 7314 7315 7317 7318 7319 7320 7321 7322 7323 7324
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7325 7326 7327 7329 7331 7332 7333 7334 7335 7336 7337 7339 7341 7346 7348 7349
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
## 7350 7351 7353 7354 7356 7357 7358 7360 7361 7362 7365 7366 7367 7368 7369 7370
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7372 7373 7374 7377 7380 7381 7384 7385 7388 7389 7390 7391 7392 7393 7394 7396
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7398 7399 7401 7402 7403 7404 7409 7410 7412 7413 7415 7418 7419 7420 7423 7424
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7425 7427 7428 7429 7430 7431 7432 7433 7434 7435 7436 7437 7438 7439 7440 7441
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7442 7445 7446 7447 7448 7449 7450 7452 7453 7455 7456 7457 7459 7460 7461 7462
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7463 7464 7466 7467 7468 7469 7470 7471 7473 7474 7475 7476 7478 7480 7482 7483
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7484 7485 7488 7489 7490 7491 7493 7494 7495 7496 7497 7498 7500 7501 7504 7505
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7507 7508 7511 7512 7513 7514 7515 7516 7518 7519 7520 7521 7525 7528 7529 7530
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7531 7532 7533 7534 7535 7536 7540 7541 7543 7544 7546 7547 7548 7549 7551 7552
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7553 7555 7556 7557 7558 7559 7561 7562 7564 7565 7566 7567 7568 7569 7571 7573
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7574 7575 7576 7577 7579 7580 7581 7584 7585 7587 7588 7589 7590 7591 7592 7593
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7594 7595 7597 7602 7603 7604 7605 7606 7607 7608 7609 7611 7612 7613 7614 7615
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7616 7618 7620 7621 7623 7624 7625 7626 7627 7631 7633 7637 7638 7639 7640 7641
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7642 7643 7644 7646 7649 7650 7651 7655 7656 7657 7658 7659 7660 7661 7662 7663
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7665 7666 7667 7670 7671 7675 7676 7680 7681 7682 7683 7684 7686 7688 7691 7692
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7695 7701 7703 7704 7705 7707 7708 7709 7710 7711 7712 7713 7714 7715 7716 7717
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7718 7722 7724 7725 7726 7727 7729 7731 7732 7733 7734 7735 7736 7737 7738 7739
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7740 7741 7742 7744 7745 7747 7749 7750 7751 7753 7754 7755 7759 7760 7763 7764
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7765 7766 7768 7769 7770 7773 7774 7775 7776 7778 7779 7780 7781 7784 7785 7788
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7789 7790 7791 7792 7793 7794 7795 7796 7797 7798 7799 7800 7801 7803 7804 7806
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7807 7808 7809 7810 7811 7812 7813 7814 7815 7816 7817 7818 7819 7820 7823 7825
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7827 7829 7830 7831 7833 7834 7835 7838 7841 7844 7845 7848 7849 7850 7851 7852
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7853 7858 7859 7860 7862 7863 7864 7865 7866 7867 7868 7869 7870 7871 7872 7873
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7876 7877 7878 7881 7883 7884 7886 7888 7889 7890 7892 7893 7894 7896 7898 7900
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7903 7905 7906 7907 7908 7912 7914 7917 7921 7924 7926 7927 7929 7931 7932 7933
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7934 7935 7937 7938 7939 7940 7941 7943 7944 7945 7946 7948 7949 7951 7953 7955
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 7956 7957 7959 7961 7962 7965 7966 7967 7969 7970 7972 7973 7976 7977 7978 7980
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

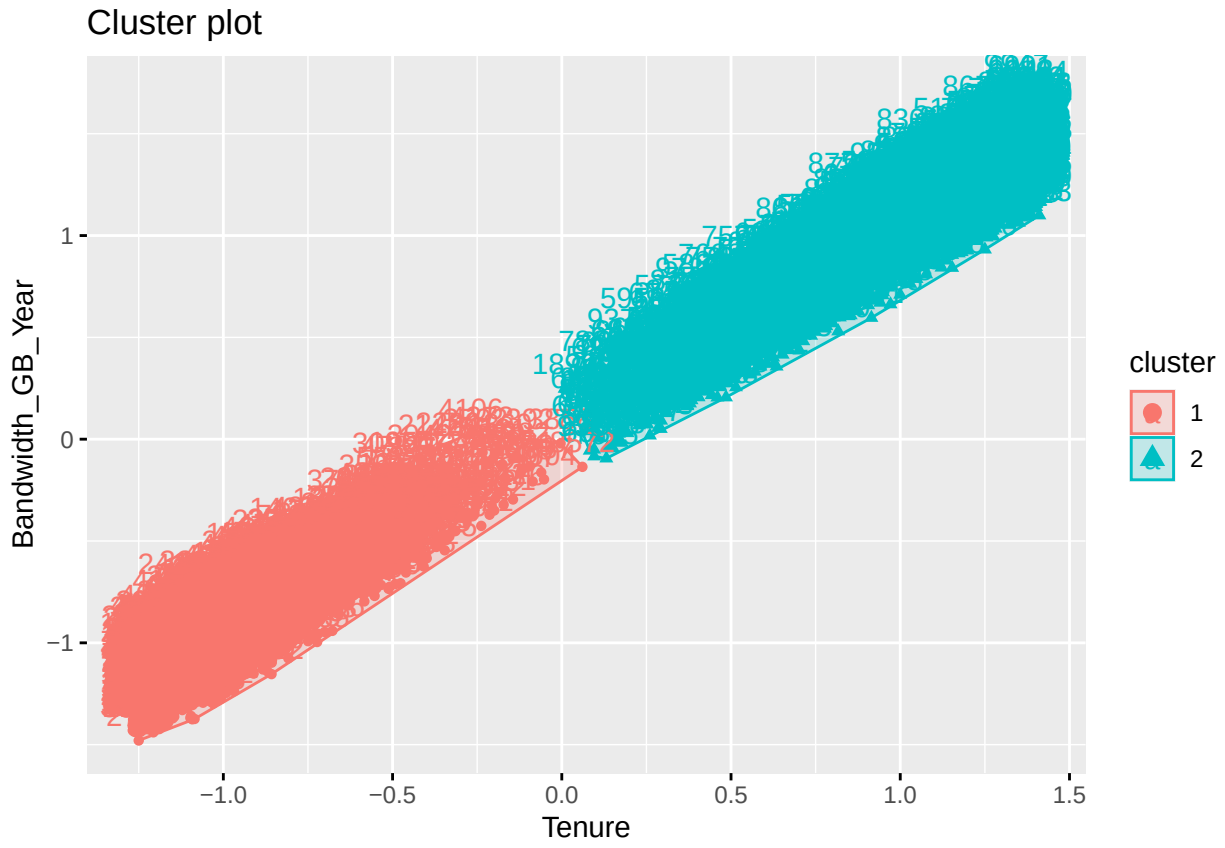
```
## 7981 7982 7984 7985 7986 7987 7988 7989 7991 7993 7994 7996 7997 7998 8002 8004
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8006 8007 8008 8009 8010 8012 8014 8017 8019 8020 8021 8024 8025 8026 8027 8028
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8029 8030 8031 8033 8035 8038 8040 8042 8043 8044 8045 8046 8048 8049 8050 8052
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8053 8054 8057 8060 8061 8062 8063 8065 8066 8067 8068 8069 8070 8071 8072 8073
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8075 8076 8077 8079 8080 8081 8083 8084 8085 8088 8089 8090 8091 8092 8094 8095
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8097 8098 8099 8100 8101 8102 8107 8108 8109 8110 8111 8112 8113 8115 8116 8117
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8118 8119 8120 8121 8123 8126 8128 8129 8130 8131 8135 8136 8137 8138 8140 8141
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8142 8143 8145 8147 8148 8149 8150 8153 8154 8155 8156 8159 8160 8161 8162 8163
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8164 8165 8167 8168 8171 8172 8175 8179 8181 8186 8187 8189 8190 8193 8194 8196
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8197 8199 8201 8202 8204 8205 8206 8207 8208 8210 8211 8212 8213 8214 8215 8216
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8217 8221 8225 8226 8227 8229 8230 8232 8233 8235 8239 8241 8243 8245 8246 8248
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8249 8250 8252 8253 8254 8257 8260 8262 8264 8265 8266 8267 8270 8272 8273 8274
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8277 8278 8280 8282 8283 8285 8286 8287 8289 8290 8291 8292 8294 8295 8296 8297
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8299 8300 8301 8302 8303 8306 8307 8309 8312 8313 8314 8315 8317 8318 8319 8320
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8321 8323 8326 8328 8330 8331 8332 8333 8334 8336 8337 8338 8339 8341 8342 8343
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8344 8345 8346 8348 8353 8354 8356 8357 8358 8359 8360 8361 8364 8365 8366 8367
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8368 8369 8370 8371 8372 8373 8374 8375 8383 8384 8385 8386 8387 8388 8389 8390
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8391 8392 8393 8394 8396 8398 8399 8401 8403 8404 8406 8407 8408 8409 8410 8414
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8415 8416 8417 8421 8423 8424 8426 8427 8428 8429 8431 8433 8434 8435 8436 8437
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8438 8439 8440 8441 8443 8450 8451 8452 8453 8454 8455 8456 8457 8459 8460 8461
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8462 8468 8469 8470 8472 8473 8474 8477 8478 8479 8480 8481 8483 8484 8485 8488
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8490 8493 8494 8495 8497 8498 8500 8502 8503 8507 8508 8510 8512 8517 8518 8519
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8520 8523 8524 8525 8528 8529 8530 8532 8535 8536 8538 8539 8542 8543 8544 8546
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8547 8548 8549 8550 8553 8554 8557 8560 8561 8563 8564 8566 8568 8569 8570 8571
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8572 8574 8577 8578 8580 8587 8588 8589 8592 8593 8596 8597 8599 8601 8604 8605
##    1    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8608 8609 8610 8611 8613 8615 8616 8617 8619 8620 8621 8622 8628 8630 8632 8633
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8639 8640 8641 8642 8643 8645 8646 8647 8648 8649 8653 8657 8658 8660 8661 8662
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
## 8663 8667 8668 8669 8670 8672 8673 8676 8678 8679 8680 8681 8682 8683 8684 8685
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8687 8688 8689 8690 8691 8692 8693 8694 8695 8696 8697 8699 8700 8701 8705 8706
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8710 8711 8712 8713 8714 8715 8717 8719 8721 8723 8725 8726 8727 8729 8730 8732
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8734 8735 8736 8737 8739 8741 8742 8746 8747 8749 8751 8754 8755 8756 8757 8758
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8762 8764 8765 8766 8767 8768 8769 8770 8772 8774 8775 8776 8777 8778 8779 8780
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8781 8785 8787 8788 8791 8792 8793 8795 8796 8797 8798 8799 8801 8804 8805 8808
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8810 8812 8813 8814 8817 8818 8819 8822 8824 8825 8827 8829 8832 8833 8836 8837
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8838 8839 8841 8842 8843 8846 8847 8848 8849 8850 8851 8852 8853 8855 8856 8857
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8859 8862 8864 8865 8866 8868 8869 8871 8872 8873 8876 8877 8878 8879 8881 8882
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8883 8887 8890 8894 8895 8896 8898 8899 8902 8904 8905 8907 8908 8909 8910 8911
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8912 8914 8915 8917 8924 8925 8927 8928 8929 8930 8931 8932 8934 8935 8937 8938
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8942 8943 8945 8948 8949 8950 8951 8952 8953 8955 8958 8959 8961 8962 8964 8965
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8966 8968 8972 8973 8974 8975 8976 8978 8980 8981 8982 8983 8984 8985 8986 8990
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 8991 8993 8994 8995 8996 8998 8999 9001 9002 9003 9005 9006 9007 9008 9009 9011
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9012 9013 9014 9015 9017 9019 9021 9023 9024 9026 9027 9028 9029 9030 9031 9034
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9035 9036 9038 9040 9042 9043 9044 9046 9048 9050 9051 9052 9053 9054 9055 9056
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9057 9058 9059 9060 9061 9062 9064 9065 9066 9067 9068 9069 9071 9073 9074 9075
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9076 9079 9081 9082 9085 9087 9089 9090 9093 9095 9096 9097 9098 9100 9102 9103
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9104 9106 9110 9112 9114 9115 9116 9117 9118 9121 9122 9123 9124 9129 9130 9131
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9132 9133 9137 9138 9139 9140 9142 9143 9144 9146 9149 9150 9151 9152 9154 9155
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9157 9159 9160 9163 9165 9166 9169 9171 9172 9174 9178 9184 9185 9188 9189 9191
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9193 9194 9196 9197 9199 9200 9201 9202 9204 9205 9206 9207 9208 9209 9210 9211
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9214 9216 9217 9218 9219 9220 9222 9223 9225 9226 9228 9229 9230 9231 9232 9236
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9237 9239 9242 9243 9244 9245 9246 9248 9251 9252 9253 9255 9256 9258 9260 9261
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9262 9263 9264 9266 9267 9268 9269 9270 9271 9272 9273 9274 9275 9277 9278 9279
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9281 9282 9283 9284 9285 9288 9289 9290 9291 9292 9293 9294 9296 9297 9298 9300
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9302 9304 9306 9307 9308 9309 9310 9311 9312 9313 9314 9316 9318 9319 9322 9323
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

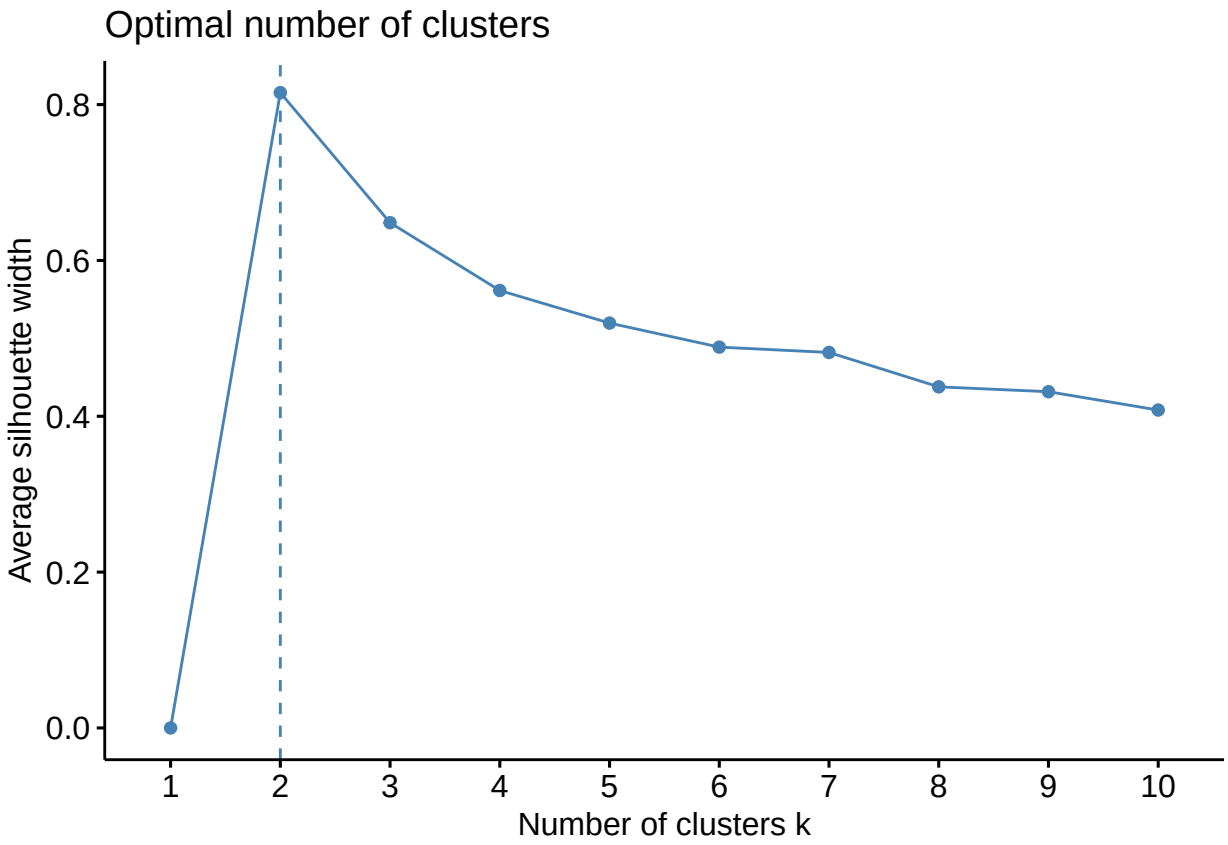
```
## 9324 9326 9327 9328 9329 9330 9331 9333 9334 9335 9336 9338 9341 9342 9347 9350
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9351 9352 9354 9355 9356 9357 9359 9360 9361 9362 9363 9364 9365 9367 9369 9370
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9371 9372 9373 9374 9375 9376 9377 9378 9379 9381 9382 9383 9384 9385 9388 9391
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9392 9393 9394 9395 9398 9399 9400 9401 9402 9407 9409 9410 9411 9413 9416 9417
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9418 9419 9420 9421 9423 9425 9428 9434 9436 9437 9438 9439 9440 9441 9443 9448
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9449 9450 9452 9454 9458 9460 9461 9462 9464 9465 9466 9467 9468 9471 9472 9473
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9475 9478 9479 9480 9481 9484 9486 9487 9489 9490 9491 9494 9495 9498 9501 9503
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9504 9507 9509 9510 9511 9513 9514 9515 9517 9518 9519 9520 9522 9523 9525 9526
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9527 9528 9531 9532 9533 9534 9535 9536 9537 9538 9539 9540 9542 9543 9545 9546
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9548 9550 9553 9554 9559 9560 9561 9563 9564 9565 9567 9568 9569 9570 9572 9573
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9576 9577 9578 9579 9580 9581 9582 9584 9585 9588 9589 9591 9594 9596 9598 9599
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9600 9601 9602 9605 9606 9608 9609 9611 9613 9614 9615 9617 9619 9621 9622 9626
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9627 9629 9630 9632 9634 9635 9636 9637 9638 9641 9645 9646 9647 9648 9651 9652
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9654 9656 9658 9659 9660 9662 9663 9665 9666 9668 9669 9670 9671 9672 9673 9674
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9675 9676 9679 9680 9681 9683 9689 9692 9693 9694 9695 9696 9698 9700 9703 9704
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9706 9708 9709 9710 9711 9712 9716 9717 9719 9721 9723 9724 9725 9728 9729 9730
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9731 9732 9733 9734 9735 9736 9737 9738 9740 9741 9743 9744 9745 9746 9747 9748
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9749 9750 9752 9753 9754 9755 9756 9757 9758 9763 9764 9765 9766 9767 9768 9770
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9771 9772 9773 9774 9775 9776 9777 9779 9780 9784 9788 9789 9791 9793 9794 9795
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9796 9797 9798 9799 9800 9801 9802 9803 9804 9805 9806 9807 9808 9809 9811 9813
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9814 9816 9818 9819 9820 9821 9822 9824 9829 9830 9832 9834 9837 9838 9839 9840
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9841 9846 9847 9849 9851 9852 9853 9854 9856 9857 9858 9859 9861 9863 9864 9868
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9869 9870 9871 9872 9874 9875 9876 9879 9881 9882 9883 9884 9885 9886 9890 9891
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9893 9894 9895 9896 9897 9898 9899 9900 9903 9904 9905 9907 9908 9909 9910 9911
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9912 9914 9916 9917 9918 9920 9923 9924 9925 9926 9927 9928 9930 9933 9934 9935
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9936 9937 9938 9939 9940 9942 9943 9944 9945 9947 9949 9950 9952 9954 9955 9956
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
## 9957 9958 9959 9961 9962 9963 9964 9966 9967 9968 9969 9971 9972 9973 9974 9975
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
## 9977 9979 9980 9981 9982 9984 9985 9986 9987 9989 9990 9991 9993 9996 9997
##    2    2    2    2    2    2    2    2    2    2    2    2    2    2    2
##
## Within cluster sum of squares by cluster:
## [1] 46.14259 85.59264
##  (between_SS / total_SS =  91.6 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
fviz_cluster(object=clusters2TrainFinal, data=dfTrainFinal)
```




```
dfTestFinal <- dfTestNorm[c('Tenure', 'Bandwidth_GB_Year')]
fviz_nbclust(dfTestFinal, FUNcluster = kmeans, method = "silhouette")
```




```
clusters2TestFinal <- kmeans(dfTestFinal, centers=2, n=50)
clusters2TestFinal
```

```
## K-means clustering with 2 clusters of sizes 1421, 1415
##
## Cluster means:
##      Tenure Bandwidth_GB_Year
## 1 0.8297110         0.7692332
## 2 0.1135891         0.1659293
##
## Clustering vector:
##     4     8     9    11    18    27    29    33    45    46    48    52    54
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##    58    65    71    73    84    89    94    97   108   109   117   119   121
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   129   135   136   143   145   149   151   153   158   160   167   171   172
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   173   174   176   181   188   191   193   198   199   202   204   205   206
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   208   209   211   212   214   217   222   223   225   231   237   242   251
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   260   265   269   275   276   278   283   286   291   296   298   302   306
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   307   308   310   312   313   314   316   317   319   320   329   333   340
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   347   352   357   358   359   361   363   364   366   370   379   380   384
##     2     2     2     2     2     2     2     2     2     2     2     2     2
```

```
##   385   387   389   390   391   392   399   400   402   404   405   406   411
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   416   421   423   425   438   441   446   448   449   450   456   464   467
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   468   469   472   473   480   486   490   497   501   505   506   515   516
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   519   522   523   525   529   531   533   536   538   540   542   545   555
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   558   562   564   565   566   569   575   576   577   578   580   582   589
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   592   594   595   597   598   601   605   611   616   620   625   627   628
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   629   638   639   642   650   652   656   661   662   667   669   671   677
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   679   680   684   687   688   694   696   697   698   706   710   711   716
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   717   720   725   734   736   738   739   742   744   745   749   753   767
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   769   770   774   778   780   790   797   800   801   806   809   814   817
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   821   822   823   825   828   834   838   839   844   848   849   852   855
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   860   875   881   887   889   892   893   895   899   902   907   908   912
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   914   916   920   922   927   936   942   944   948   950   953   956   957
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##   963   974   976   977   980   984   988   997   998   999  1004  1006  1007
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1013  1018  1024  1025  1027  1029  1034  1036  1040  1041  1042  1043  1046
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1050  1051  1052  1053  1055  1056  1060  1064  1074  1075  1077  1079  1087
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1089  1090  1095  1101  1108  1109  1112  1119  1120  1121  1123  1126  1128
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1129  1139  1146  1151  1153  1154  1156  1157  1164  1167  1172  1174  1175
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1176  1177  1178  1182  1202  1205  1208  1209  1214  1216  1228  1234  1237
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1240  1244  1249  1250  1256  1260  1261  1262  1265  1268  1274  1277  1280
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1282  1284  1286  1287  1290  1291  1293  1296  1297  1300  1303  1306  1308
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1310  1313  1318  1320  1324  1333  1334  1338  1341  1343  1345  1346  1352
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1353  1362  1365  1376  1379  1380  1381  1383  1385  1389  1391  1392  1393
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1398  1400  1403  1405  1411  1416  1418  1424  1430  1433  1434  1438  1446
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1447  1452  1456  1462  1466  1473  1478  1481  1482  1490  1493  1495  1499
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1500  1503  1504  1506  1507  1508  1510  1511  1512  1516  1519  1528  1529
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1531  1535  1538  1540  1544  1546  1551  1553  1555  1557  1558  1559  1565
##     2     2     2     2     2     2     2     2     2     2     2     2     2
```

```
##  1570  1572  1574  1578  1583  1594  1596  1597  1601  1603  1604  1607  1608
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1615  1618  1621  1634  1640  1642  1644  1646  1647  1648  1654  1655  1657
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1661  1663  1665  1668  1669  1673  1681  1686  1690  1692  1697  1698  1700
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1701  1702  1707  1708  1710  1716  1717  1718  1719  1720  1721  1724  1725
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1728  1729  1733  1735  1744  1748  1749  1757  1760  1766  1768  1779  1782
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1792  1793  1795  1798  1800  1802  1806  1808  1817  1819  1826  1829  1833
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1840  1850  1856  1857  1863  1864  1866  1868  1870  1871  1874  1877  1878
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1880  1884  1885  1893  1898  1907  1910  1911  1921  1924  1930  1931  1932
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1935  1936  1941  1943  1945  1954  1956  1958  1964  1968  1970  1973  1974
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  1976  1978  1990  2004  2005  2013  2017  2019  2024  2025  2027  2030  2031
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2033  2038  2047  2048  2060  2061  2062  2067  2071  2072  2077  2081  2082
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2085  2089  2090  2093  2094  2099  2100  2102  2103  2106  2108  2110  2118
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2122  2127  2128  2129  2132  2136  2138  2140  2141  2142  2144  2145  2147
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2148  2150  2151  2154  2159  2161  2165  2167  2174  2177  2179  2180  2181
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2182  2185  2186  2190  2196  2199  2205  2206  2209  2212  2219  2221  2228
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2230  2231  2232  2236  2238  2240  2243  2244  2260  2262  2263  2264  2265
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2267  2268  2271  2276  2277  2287  2290  2294  2305  2307  2308  2309  2310
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2318  2324  2325  2335  2337  2344  2347  2351  2352  2355  2357  2369  2373
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2374  2375  2378  2380  2387  2388  2389  2398  2405  2412  2417  2423  2424
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2426  2430  2432  2440  2441  2442  2443  2445  2451  2452  2455  2456  2461
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2463  2465  2467  2469  2472  2475  2481  2484  2487  2491  2493  2494  2503
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2505  2506  2508  2511  2513  2516  2517  2519  2528  2533  2538  2540  2541
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2543  2545  2548  2551  2560  2562  2563  2571  2575  2580  2582  2597  2598
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2599  2603  2605  2606  2607  2608  2618  2621  2623  2624  2625  2627  2632
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2646  2652  2655  2656  2660  2662  2664  2673  2682  2689  2699  2701  2706
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2709  2711  2712  2713  2716  2719  2726  2727  2741  2747  2748  2749  2751
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2760  2765  2769  2772  2781  2783  2784  2785  2791  2794  2795  2798  2800
##     2     2     2     2     2     2     2     2     2     2     2     2     2
```

```
##  2804  2808  2810  2812  2814  2819  2823  2826  2829  2832  2834  2836  2837
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2838  2843  2847  2848  2851  2853  2857  2860  2869  2874  2875  2889  2890
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2891  2896  2907  2908  2910  2918  2929  2931  2934  2939  2943  2945  2949
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  2952  2954  2959  2962  2969  2971  2976  2980  2983  2988  2990  2999  3000
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3003  3009  3013  3018  3022  3026  3028  3029  3031  3038  3039  3048  3049
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3050  3052  3053  3055  3056  3057  3058  3087  3089  3099  3102  3104  3107
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3109  3110  3111  3112  3114  3115  3116  3119  3120  3127  3129  3134  3139
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3141  3142  3143  3150  3152  3153  3157  3158  3159  3160  3161  3166  3169
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3176  3182  3188  3189  3190  3192  3197  3198  3209  3216  3221  3226  3231
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3237  3241  3243  3245  3247  3254  3257  3261  3264  3265  3268  3269  3271
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3283  3285  3286  3290  3291  3292  3296  3300  3304  3306  3311  3313  3315
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3317  3320  3322  3328  3330  3332  3337  3338  3341  3342  3343  3345  3347
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3350  3359  3361  3362  3363  3365  3368  3375  3379  3382  3393  3400  3402
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3409  3410  3412  3417  3418  3421  3423  3431  3433  3435  3437  3439  3446
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3449  3453  3458  3465  3468  3471  3476  3478  3479  3481  3486  3490  3496
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3498  3501  3503  3505  3507  3511  3514  3515  3525  3527  3529  3530  3533
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3535  3537  3546  3547  3549  3551  3558  3559  3560  3564  3568  3576  3577
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3579  3584  3585  3586  3591  3595  3597  3598  3600  3605  3607  3608  3609
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3610  3611  3626  3634  3635  3637  3640  3641  3647  3648  3649  3650  3654
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3655  3656  3665  3667  3673  3674  3676  3680  3682  3684  3687  3697  3702
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3703  3709  3712  3716  3720  3723  3724  3726  3727  3730  3733  3734  3737
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3739  3741  3748  3756  3760  3765  3767  3776  3778  3781  3782  3788  3790
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3800  3804  3805  3810  3825  3827  3830  3836  3842  3843  3845  3849  3850
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3851  3852  3856  3863  3868  3872  3873  3878  3880  3882  3884  3885  3886
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3888  3907  3910  3917  3920  3922  3928  3929  3934  3936  3943  3951  3961
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  3964  3970  3973  3977  3979  3981  3983  3989  3991  3994  3996  4007  4008
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4012  4013  4023  4024  4025  4027  4028  4030  4037  4039  4042  4047  4050
##     2     2     2     2     2     2     2     2     2     2     2     2     2
```

```
##  4055  4056  4057  4061  4067  4070  4072  4084  4085  4091  4092  4093  4094
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4100  4101  4104  4109  4112  4116  4118  4123  4128  4135  4136  4137  4141
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4142  4154  4155  4157  4172  4179  4180  4181  4184  4186  4187  4188  4194
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4196  4203  4206  4212  4213  4217  4220  4221  4227  4228  4229  4232  4233
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4235  4237  4238  4239  4242  4245  4247  4249  4252  4258  4261  4274  4280
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4281  4283  4284  4288  4294  4295  4297  4298  4304  4306  4307  4317  4323
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4327  4336  4341  4342  4346  4347  4350  4352  4355  4357  4364  4370  4371
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4375  4379  4382  4392  4399  4406  4413  4420  4421  4422  4424  4430  4431
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4432  4438  4439  4442  4445  4446  4447  4448  4452  4453  4456  4467  4468
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4472  4477  4478  4480  4484  4499  4502  4503  4508  4509  4510  4514  4516
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4532  4539  4547  4552  4571  4573  4575  4580  4589  4592  4595  4601  4602
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4606  4609  4610  4617  4618  4621  4632  4639  4641  4642  4643  4646  4651
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4656  4658  4667  4676  4677  4679  4680  4682  4685  4689  4690  4692  4710
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4718  4720  4722  4724  4726  4730  4731  4737  4740  4749  4752  4753  4757
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4758  4761  4762  4768  4769  4774  4776  4778  4794  4798  4803  4804  4807
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4810  4811  4812  4813  4814  4817  4819  4827  4829  4833  4834  4835  4842
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4843  4848  4849  4855  4856  4858  4859  4860  4861  4865  4872  4879  4887
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4888  4893  4897  4900  4902  4906  4908  4915  4917  4925  4927  4928  4929
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4941  4942  4944  4945  4946  4947  4949  4951  4954  4957  4958  4959  4962
##     2     2     2     2     2     2     2     2     2     2     2     2     2
##  4966  4973  4974  4976  4980  4986  4995  4998  4999  5000  5003  5005  5011
##     2     2     2     2     2     2     2     2     2     2     1     1     1
##  5015  5016  5024  5026  5029  5035  5038  5041  5047  5048  5050  5051  5052
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5053  5056  5063  5071  5074  5075  5076  5079  5086  5087  5091  5097  5098
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5104  5108  5110  5112  5113  5115  5116  5120  5123  5124  5128  5129  5136
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5137  5141  5146  5147  5149  5152  5153  5157  5164  5167  5173  5176  5177
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5178  5182  5189  5201  5203  5205  5207  5208  5214  5216  5218  5226  5231
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5232  5235  5253  5254  5264  5270  5272  5273  5274  5277  5278  5281  5282
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5283  5290  5294  5299  5301  5304  5305  5306  5308  5309  5310  5313  5330
##     1     1     1     1     1     1     1     1     1     1     1     1     1
```

```
##  5331  5334  5336  5338  5340  5345  5348  5351  5354  5357  5360  5361  5363
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5374  5382  5386  5390  5391  5394  5399  5403  5404  5409  5416  5418  5421
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5422  5429  5430  5437  5441  5454  5455  5460  5464  5467  5475  5481  5488
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5490  5497  5500  5502  5503  5504  5506  5508  5509  5516  5518  5519  5521
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5524  5529  5531  5532  5537  5541  5542  5547  5553  5562  5563  5564  5565
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5574  5583  5590  5593  5595  5598  5602  5603  5605  5617  5620  5621  5622
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5625  5633  5635  5636  5638  5639  5646  5650  5651  5653  5662  5663  5665
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5671  5674  5675  5678  5680  5683  5684  5687  5690  5698  5717  5720  5721
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5731  5732  5738  5745  5746  5748  5749  5752  5760  5761  5766  5770  5776
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5778  5779  5783  5785  5788  5789  5790  5794  5796  5798  5807  5813  5815
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5819  5825  5826  5832  5833  5834  5837  5840  5860  5863  5864  5869  5873
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5875  5876  5878  5880  5882  5884  5900  5901  5902  5903  5914  5919  5921
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5922  5924  5926  5927  5937  5939  5945  5947  5953  5955  5957  5963  5966
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  5967  5972  5973  5977  5980  5981  5987  5988  5990  5992  5993  5994  6002
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6004  6006  6013  6016  6017  6020  6021  6026  6034  6038  6046  6047  6051
##     1     1     1     1     1     1     1     1     1     2     1     1     1
##  6052  6053  6054  6055  6057  6058  6064  6065  6066  6067  6070  6072  6074
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6075  6084  6090  6098  6105  6107  6111  6117  6122  6123  6124  6130  6135
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6140  6141  6142  6143  6146  6150  6162  6167  6174  6175  6176  6177  6180
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6182  6183  6186  6195  6197  6201  6206  6211  6215  6216  6219  6224  6232
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6239  6240  6241  6242  6246  6251  6261  6262  6263  6264  6272  6273  6279
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6280  6288  6290  6302  6310  6313  6315  6317  6318  6322  6323  6331  6332
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6333  6334  6341  6350  6353  6354  6356  6357  6359  6365  6366  6368  6379
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6380  6382  6383  6389  6392  6394  6400  6401  6406  6407  6415  6416  6420
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6422  6425  6426  6428  6430  6440  6445  6446  6448  6455  6456  6457  6460
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6463  6471  6473  6474  6475  6479  6484  6494  6497  6510  6515  6518  6520
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6525  6526  6532  6534  6538  6542  6544  6545  6547  6548  6550  6553  6557
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6559  6561  6565  6572  6577  6579  6582  6583  6587  6588  6590  6594  6596
##     1     1     1     1     1     1     1     1     1     1     1     1     1
```

```
##  6599  6603  6606  6610  6611  6613  6618  6621  6624  6629  6632  6643  6644
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6646  6661  6663  6672  6674  6686  6690  6693  6699  6700  6702  6704  6711
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6713  6717  6721  6726  6731  6735  6737  6740  6742  6746  6761  6762  6766
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6772  6775  6779  6791  6802  6804  6809  6821  6830  6831  6832  6835  6845
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6850  6852  6853  6862  6864  6870  6874  6875  6887  6891  6892  6893  6894
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6896  6903  6905  6909  6913  6914  6917  6918  6921  6922  6923  6924  6925
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6927  6929  6930  6932  6935  6936  6937  6938  6940  6945  6957  6965  6974
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  6975  6985  6988  6993  7000  7005  7006  7007  7009  7013  7014  7015  7016
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7023  7027  7029  7031  7033  7043  7048  7054  7055  7058  7059  7060  7067
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7068  7074  7081  7082  7085  7088  7097  7098  7099  7106  7107  7111  7117
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7120  7122  7129  7131  7134  7135  7143  7145  7147  7149  7150  7152  7156
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7157  7158  7165  7169  7170  7171  7178  7179  7180  7185  7190  7194  7195
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7196  7197  7198  7199  7200  7201  7203  7208  7209  7216  7219  7225  7227
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7228  7230  7233  7235  7236  7243  7247  7264  7267  7270  7275  7277  7281
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7284  7291  7293  7294  7296  7298  7300  7302  7306  7308  7309  7310  7311
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7313  7316  7328  7330  7342  7343  7345  7347  7352  7355  7359  7363  7364
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7371  7375  7376  7379  7383  7386  7395  7397  7400  7405  7406  7407  7408
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7411  7414  7417  7421  7426  7443  7444  7451  7454  7458  7465  7472  7477
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7479  7481  7486  7492  7499  7502  7506  7509  7510  7517  7522  7523  7524
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7526  7527  7537  7538  7539  7542  7545  7550  7554  7560  7563  7570  7572
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7578  7583  7596  7598  7599  7600  7610  7617  7619  7622  7628  7629  7632
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7634  7635  7636  7645  7647  7648  7653  7654  7664  7668  7669  7672  7674
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7677  7678  7679  7687  7689  7690  7693  7694  7696  7697  7698  7699  7700
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7702  7706  7719  7720  7728  7730  7743  7746  7748  7752  7756  7757  7758
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7761  7762  7767  7771  7772  7777  7783  7786  7787  7802  7821  7822  7824
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7826  7832  7836  7837  7839  7840  7842  7843  7846  7847  7854  7855  7856
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7857  7861  7874  7875  7879  7885  7887  7897  7899  7901  7902  7904  7911
##     1     1     1     1     1     1     1     1     1     1     1     1     1
```

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##  7913  7915  7916  7918  7919  7920  7922  7923  7925  7928  7930  7936  7942
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  7950  7952  7958  7960  7963  7968  7971  7974  7975  7979  7983  7990  7992
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8000  8001  8003  8005  8011  8013  8015  8016  8022  8023  8032  8034  8036
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8037  8039  8051  8055  8056  8058  8059  8064  8078  8082  8087  8093  8096
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8103  8104  8105  8114  8122  8124  8125  8127  8132  8134  8144  8146  8151
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8152  8157  8166  8169  8170  8173  8176  8177  8178  8182  8183  8184  8185
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8188  8191  8192  8198  8200  8203  8209  8218  8219  8220  8222  8223  8224
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8228  8231  8234  8237  8240  8242  8244  8247  8251  8256  8258  8259  8261
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8263  8268  8269  8271  8275  8276  8279  8281  8284  8288  8293  8298  8304
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8305  8308  8310  8311  8322  8324  8325  8329  8335  8340  8347  8349  8350
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8351  8355  8362  8363  8376  8377  8378  8379  8381  8382  8397  8400  8402
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8405  8411  8412  8419  8420  8422  8425  8430  8432  8442  8444  8445  8446
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8447  8448  8449  8463  8464  8466  8467  8475  8476  8482  8486  8487  8489
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8492  8501  8504  8505  8506  8513  8514  8515  8516  8521  8522  8534  8537
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8541  8545  8551  8552  8556  8558  8559  8562  8565  8567  8573  8575  8576
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8579  8581  8582  8583  8584  8585  8586  8590  8591  8594  8595  8598  8600
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8602  8606  8607  8612  8618  8623  8624  8626  8627  8629  8631  8634  8635
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8636  8637  8638  8650  8651  8652  8654  8655  8656  8659  8664  8665  8666
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8674  8675  8677  8686  8698  8702  8703  8704  8707  8708  8709  8716  8718
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8720  8722  8724  8728  8731  8733  8738  8740  8743  8744  8748  8750  8752
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8753  8759  8760  8761  8763  8771  8773  8782  8783  8784  8786  8794  8800
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8802  8803  8806  8807  8809  8811  8816  8820  8821  8826  8828  8834  8835
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8840  8844  8845  8858  8860  8861  8863  8867  8870  8875  8880  8884  8885
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8886  8888  8889  8891  8892  8893  8897  8901  8903  8906  8916  8918  8919
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8920  8921  8922  8923  8926  8933  8936  8940  8941  8944  8947  8954  8956
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  8957  8960  8963  8967  8970  8971  8977  8979  8987  8988  8992  8997  9000
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9010  9016  9018  9020  9022  9025  9032  9037  9039  9041  9045  9049  9070
##     1     1     1     1     1     1     1     1     1     1     1     1     1
```
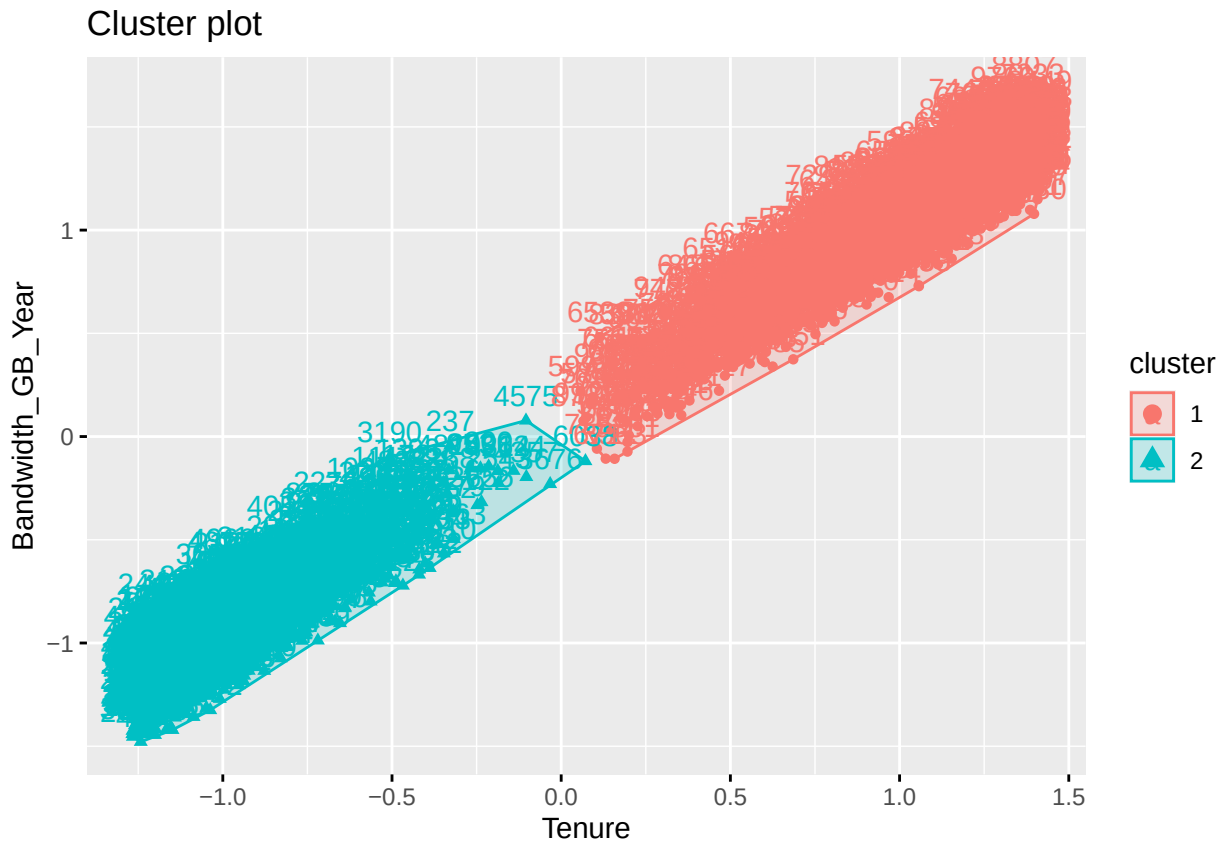

```
##  9072  9077  9080  9083  9084  9086  9088  9091  9092  9094  9099  9101  9105
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9107  9108  9109  9111  9113  9119  9120  9126  9127  9128  9134  9135  9136
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9141  9145  9147  9148  9153  9156  9161  9162  9164  9167  9170  9173  9175
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9176  9177  9179  9182  9187  9190  9192  9195  9198  9203  9212  9213  9215
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9224  9227  9233  9235  9238  9240  9241  9247  9249  9254  9257  9259  9265
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9276  9280  9286  9287  9299  9301  9303  9305  9315  9317  9320  9321  9325
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9332  9339  9340  9343  9344  9345  9348  9353  9358  9368  9380  9386  9387
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9389  9390  9396  9397  9404  9405  9406  9408  9412  9414  9422  9424  9426
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9427  9431  9432  9433  9435  9442  9444  9446  9447  9451  9455  9456  9457
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9459  9469  9470  9474  9476  9477  9482  9483  9485  9488  9492  9493  9496
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9497  9499  9500  9502  9505  9508  9512  9516  9521  9524  9529  9530  9541
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9547  9549  9551  9552  9555  9556  9557  9562  9566  9571  9574  9575  9583
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9586  9587  9590  9592  9593  9595  9597  9603  9604  9607  9610  9612  9618
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9620  9623  9624  9625  9628  9631  9633  9639  9642  9643  9644  9649  9650
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9653  9655  9661  9664  9677  9678  9682  9684  9685  9688  9690  9691  9699
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9701  9702  9705  9707  9713  9714  9715  9718  9720  9722  9726  9742  9760
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9761  9762  9769  9778  9781  9782  9783  9785  9786  9787  9790  9792  9810
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9812  9815  9817  9823  9825  9826  9827  9828  9831  9833  9835  9836  9842
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9843  9844  9845  9848  9855  9860  9862  9866  9867  9873  9878  9880  9887
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9888  9889  9901  9902  9906  9913  9915  9919  9921  9929  9931  9932  9941
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9946  9948  9951  9953  9960  9965  9970  9976  9983  9992  9994  9995  9998
##     1     1     1     1     1     1     1     1     1     1     1     1     1
##  9999 10000
##     1     1
##
## Within cluster sum of squares by cluster:
## [1] 36.69721 19.79456
##  (between_SS / total_SS =  91.7 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
fviz_cluster(object=clusters2TestFinal, data=dfTestFinal)
```




```
################################ FINAL COMPARISON ################################
# Centers
clusters2TrainFinal$centers
```

```
##      Tenure Bandwidth_GB_Year
## 1 0.1146104         0.1645299
## 2 0.8307966         0.7591695
```

```
clusters2TestFinal$centers
```

```
##      Tenure Bandwidth_GB_Year
## 1 0.8297110         0.7692332
## 2 0.1135891         0.1659293
```

```
# Ratio
clusters2TrainFinal$betweenss / clusters2TrainFinal$totss
```

```
## [1] 0.9159033
```

```
clusters2TestFinal$betweenss / clusters2TestFinal$totss
```

```
## [1] 0.9166966
```