Lista 1

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1 Etap I

```
df <- read.csv('churn.txt')
dim(df)
```

```
## [1] 3333   21
```

```
head(df)
```

```
##   State Account.Length Area.Code    Phone Int.l.Plan VMail.Plan VMail.Message
## 1    KS            128       415 382-4657         no        yes            25
## 2    OH            107       415 371-7191         no        yes            26
## 3    NJ            137       415 358-1921         no         no             0
## 4    OH             84       408 375-9999        yes         no             0
## 5    OK             75       415 330-6626        yes         no             0
## 6    AL            118       510 391-8027        yes         no             0
##   Day.Mins Day.Calls Day.Charge Eve.Mins Eve.Calls Eve.Charge Night.Mins
## 1    265.1       110      45.07    197.4        99      16.78      244.7
## 2    161.6       123      27.47    195.5       103      16.62      254.4
## 3    243.4       114      41.38    121.2       110      10.30      162.6
## 4    299.4        71      50.90     61.9        88       5.26      196.9
## 5    166.7       113      28.34    148.3       122      12.61      186.9
## 6    223.4        98      37.98    220.6       101      18.75      203.9
##   Night.Calls Night.Charge Intl.Mins Intl.Calls Intl.Charge CustServ.Calls
## 1          91        11.01      10.0          3        2.70              1
## 2         103        11.45      13.7          3        3.70              1
## 3         104         7.32      12.2          5        3.29              0
## 4          89         8.86       6.6          7        1.78              2
## 5         121         8.41      10.1          3        2.73              3
## 6         118         9.18       6.3          6        1.70              0
##   Churn.
## 1 False.
## 2 False.
## 3 False.
## 4 False.
## 5 False.
## 6 False.
```

```
str(df)
```

```
## 'data.frame': 3333 obs. of  21 variables:
##  $ State         : Factor w/ 51 levels "AK","AL","AR",..: 17 36 32 36 37 2 20 25 19 50 ...
##  $ Account.Length: int  128 107 137 84 75 118 121 147 117 141 ...
```

```
##  $ Area.Code     : int  415 415 415 408 415 510 510 415 408 415 ...
##  $ Phone         : Factor w/ 3333 levels "327-1058","327-1319",..: 1927 1576 1118 1708 111 2254 1048 81
##  $ Int.l.Plan    : Factor w/ 2 levels "no","yes": 1 1 1 2 2 2 1 2 1 2 ...
##  $ VMail.Plan    : Factor w/ 2 levels "no","yes": 2 2 1 1 1 1 2 1 1 2 ...
##  $ VMail.Message : int  25 26 0 0 0 0 24 0 0 37 ...
##  $ Day.Mins      : num  265 162 243 299 167 ...
##  $ Day.Calls     : int  110 123 114 71 113 98 88 79 97 84 ...
##  $ Day.Charge    : num  45.1 27.5 41.4 50.9 28.3 ...
##  $ Eve.Mins      : num  197.4 195.5 121.2 61.9 148.3 ...
##  $ Eve.Calls     : int  99 103 110 88 122 101 108 94 80 111 ...
##  $ Eve.Charge    : num  16.78 16.62 10.3 5.26 12.61 ...
##  $ Night.Mins    : num  245 254 163 197 187 ...
##  $ Night.Calls   : int  91 103 104 89 121 118 118 96 90 97 ...
##  $ Night.Charge  : num  11.01 11.45 7.32 8.86 8.41 ...
##  $ Intl.Mins     : num  10 13.7 12.2 6.6 10.1 6.3 7.5 7.1 8.7 11.2 ...
##  $ Intl.Calls    : int  3 3 5 7 3 6 7 6 4 5 ...
##  $ Intl.Charge   : num  2.7 3.7 3.29 1.78 2.73 1.7 2.03 1.92 2.35 3.02 ...
##  $ CustServ.Calls: int  1 1 0 2 3 0 3 0 1 0 ...
##  $ Churn.        : Factor w/ 2 levels "False.","True.": 1 1 1 1 1 1 1 1 1 1 ...
```

```
df$Area.Code <- as.factor(df$Area.Code)
```

```
sapply(df, function(x) sum(is.na(x)))
```

```
##          State Account.Length      Area.Code          Phone     Int.l.Plan
##              0              0              0              0              0
##     VMail.Plan  VMail.Message       Day.Mins      Day.Calls     Day.Charge
##              0              0              0              0              0
##       Eve.Mins      Eve.Calls     Eve.Charge     Night.Mins    Night.Calls
##              0              0              0              0              0
##   Night.Charge      Intl.Mins     Intl.Calls    Intl.Charge CustServ.Calls
##              0              0              0              0              0
##         Churn.
##              0
```

```
df <- subset(df, select=-Phone)
```

```
sapply(df[, sapply(df, is.factor)], levels)
```

```
## $State
##  [1] "AK" "AL" "AR" "AZ" "CA" "CO" "CT" "DC" "DE" "FL" "GA" "HI" "IA" "ID" "IL"
## [16] "IN" "KS" "KY" "LA" "MA" "MD" "ME" "MI" "MN" "MO" "MS" "MT" "NC" "ND" "NE"
## [31] "NH" "NJ" "NM" "NV" "NY" "OH" "OK" "OR" "PA" "RI" "SC" "SD" "TN" "TX" "UT"
## [46] "VA" "VT" "WA" "WI" "WV" "WY"
##
## $Area.Code
## [1] "408" "415" "510"
##
## $Int.l.Plan
## [1] "no"  "yes"
##
```

```
## $VMail.Plan
## [1] "no"  "yes"
##
## $Churn.
## [1] "False." "True."
```

```
summary(df)
```

```
##      State      Account.Length  Area.Code  Int.l.Plan VMail.Plan
##  WV     : 106   Min.   :  1.0   408: 838   no :3010   no :2411
##  MN     :  84   1st Qu.: 74.0   415:1655   yes: 323   yes: 922
##  NY     :  83   Median :101.0   510: 840
##  AL     :  80   Mean   :101.1
##  OH     :  78   3rd Qu.:127.0
##  OR     :  78   Max.   :243.0
##  (Other):2824
##  VMail.Message       Day.Mins       Day.Calls       Day.Charge
##  Min.   : 0.000   Min.   :  0.0   Min.   :  0.0   Min.   : 0.00
##  1st Qu.: 0.000   1st Qu.:143.7   1st Qu.: 87.0   1st Qu.:24.43
##  Median : 0.000   Median :179.4   Median :101.0   Median :30.50
##  Mean   : 8.099   Mean   :179.8   Mean   :100.4   Mean   :30.56
##  3rd Qu.:20.000   3rd Qu.:216.4   3rd Qu.:114.0   3rd Qu.:36.79
##  Max.   :51.000   Max.   :350.8   Max.   :165.0   Max.   :59.64
##
##     Eve.Mins       Eve.Calls       Eve.Charge      Night.Mins
##  Min.   :  0.0   Min.   :  0.0   Min.   : 0.00   Min.   : 23.2
##  1st Qu.:166.6   1st Qu.: 87.0   1st Qu.:14.16   1st Qu.:167.0
##  Median :201.4   Median :100.0   Median :17.12   Median :201.2
##  Mean   :201.0   Mean   :100.1   Mean   :17.08   Mean   :200.9
##  3rd Qu.:235.3   3rd Qu.:114.0   3rd Qu.:20.00   3rd Qu.:235.3
##  Max.   :363.7   Max.   :170.0   Max.   :30.91   Max.   :395.0
##
##   Night.Calls     Night.Charge      Intl.Mins       Intl.Calls
##  Min.   : 33.0   Min.   : 1.040   Min.   : 0.00   Min.   : 0.000
##  1st Qu.: 87.0   1st Qu.: 7.520   1st Qu.: 8.50   1st Qu.: 3.000
##  Median :100.0   Median : 9.050   Median :10.30   Median : 4.000
##  Mean   :100.1   Mean   : 9.039   Mean   :10.24   Mean   : 4.479
##  3rd Qu.:113.0   3rd Qu.:10.590   3rd Qu.:12.10   3rd Qu.: 6.000
##  Max.   :175.0   Max.   :17.770   Max.   :20.00   Max.   :20.000
##
##   Intl.Charge    CustServ.Calls     Churn.
##  Min.   :0.000   Min.   :0.000   False.:2850
##  1st Qu.:2.300   1st Qu.:1.000   True. : 483
##  Median :2.780   Median :1.000
##  Mean   :2.765   Mean   :1.563
##  3rd Qu.:3.270   3rd Qu.:2.000
##  Max.   :5.400   Max.   :9.000
##
```

2 Etap II

```
library(ggplot2)
library(GGally)
library(tidyr)
library(dplyr)
library(EnvStats)
library(DescTools)
```

```
factors <- subset(df, select=sapply(df, is.factor))
numerics <- subset(df, select=sapply(df, function(x) !is.factor(x)))
```

a)

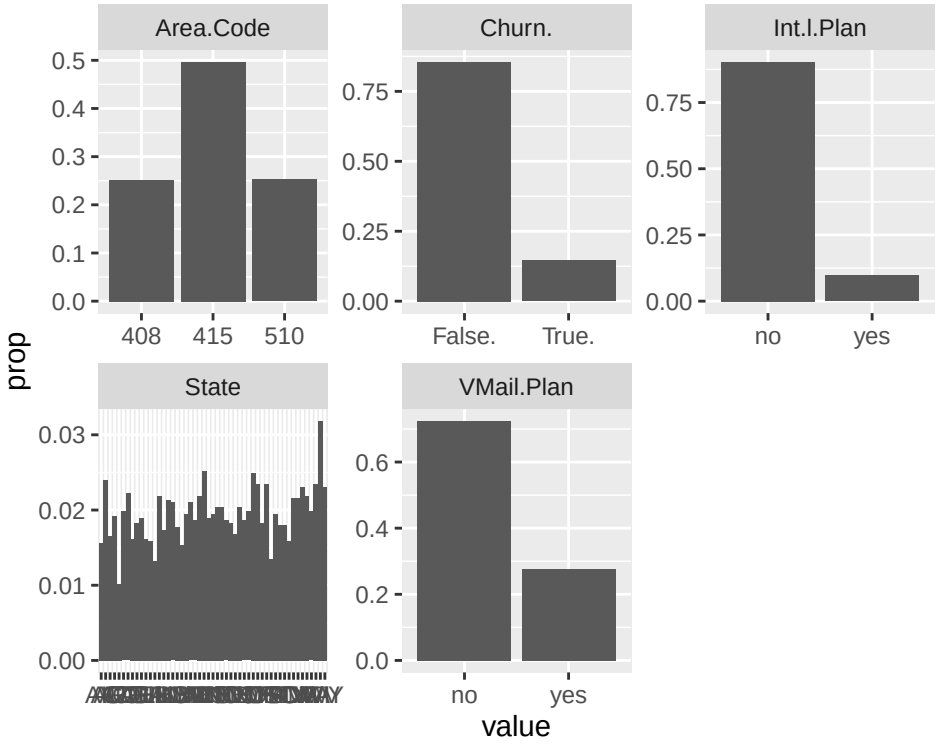
```
extended.summary <- function(X) {
    c(mean = mean(X), trimmed.mean = mean(X, trim=.0025), min = min(X), Q1 = quantile(X, .25, names=F)
}

sapply(numerics, extended.summary)
```

```
##              Account.Length VMail.Message  Day.Mins Day.Calls Day.Charge
## mean               101.06481       8.09901 179.77510 100.43564  30.562307
## trimmed.mean       101.00392       8.02050 179.80413 100.46850  30.567241
## min                  1.00000       0.00000   0.00000   0.00000   0.000000
## Q1                  74.00000       0.00000 143.70000  87.00000  24.430000
## median             101.00000       0.00000 179.40000 101.00000  30.500000
## Q3                 127.00000      20.00000 216.40000 114.00000  36.790000
## max                243.00000      51.00000 350.80000 165.00000  59.640000
## range1               1.00000       0.00000   0.00000   0.00000   0.000000
## range2             243.00000      51.00000 350.80000 165.00000  59.640000
## sd                  39.82211      13.68837  54.46739  20.06908   9.259435
## IQR                 53.00000      20.00000  72.70000  27.00000  12.360000
##                Eve.Mins Eve.Calls Eve.Charge Night.Mins Night.Calls Night.Charge
## mean           200.98035 100.11431  17.083540  200.87204   100.10771     9.039325
## trimmed.mean   201.00362 100.13205  17.085520  200.83841   100.10280     9.037814
## min              0.00000   0.00000   0.000000   23.20000    33.00000     1.040000
## Q1             166.60000  87.00000  14.160000  167.00000    87.00000     7.520000
## median         201.40000 100.00000  17.120000  201.20000   100.00000     9.050000
## Q3             235.30000 114.00000  20.000000  235.30000   113.00000    10.590000
## max            363.70000 170.00000  30.910000  395.00000   175.00000    17.770000
## range1           0.00000   0.00000   0.000000   23.20000    33.00000     1.040000
## range2         363.70000 170.00000  30.910000  395.00000   175.00000    17.770000
## sd              50.71384  19.92263   4.310668   50.57385    19.56861     2.275873
## IQR             68.70000  27.00000   5.840000   68.30000    26.00000     3.070000
##                Intl.Mins Intl.Calls Intl.Charge CustServ.Calls
## mean            10.23729   4.479448   2.7645815       1.562856
## trimmed.mean    10.24206   4.458245   2.7658728       1.551703
## min              0.00000   0.000000   0.0000000       0.000000
## Q1               8.50000   3.000000   2.3000000       1.000000
## median          10.30000   4.000000   2.7800000       1.000000
## Q3              12.10000   6.000000   3.2700000       2.000000
## max             20.00000  20.000000   5.4000000       9.000000
## range1           0.00000   0.000000   0.0000000       0.000000
## range2          20.00000  20.000000   5.4000000       9.000000
```

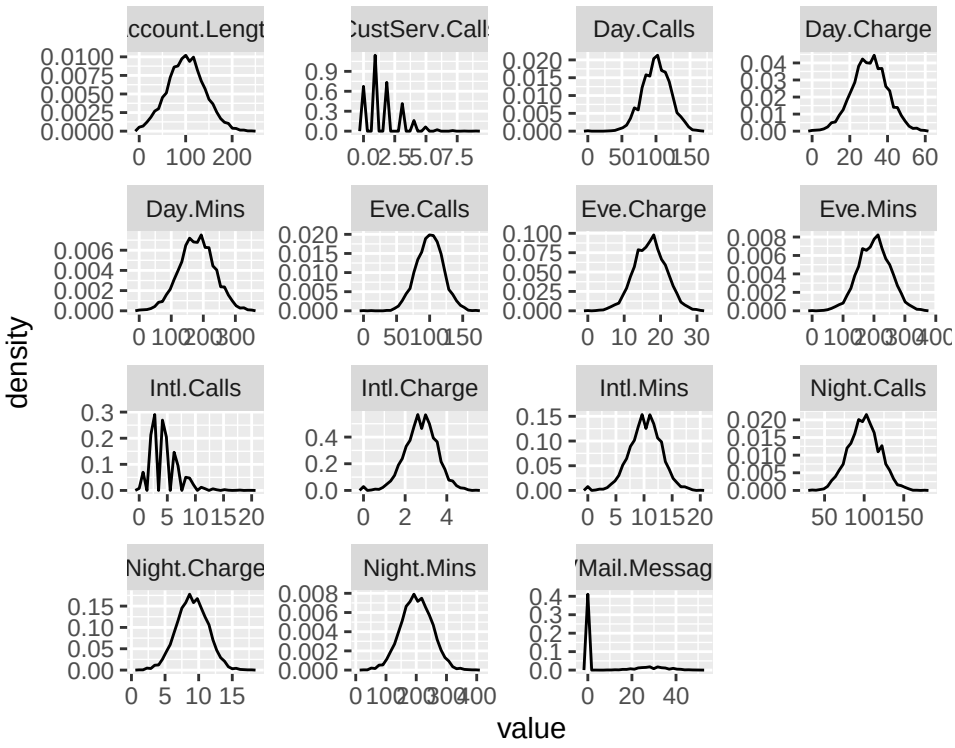
```
## sd              2.79184   2.461214   0.7537726       1.315491
## IQR             3.60000   3.000000   0.9700000       1.000000
```

b)

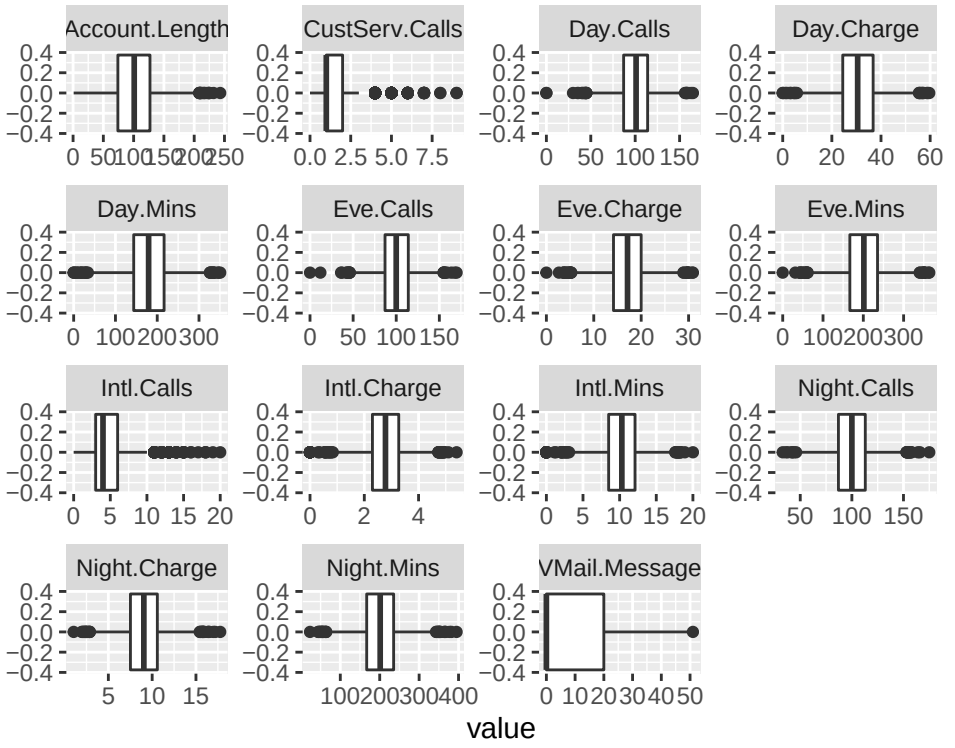
```
ggplot(gather(factors), aes(value)) +
  geom_bar(aes(y=..prop.., group=1)) +
  facet_wrap(~key, scales='free')
```




```
ggplot(gather(numerics), aes(value)) +
  geom_freqpoly(aes(y=..density..)) +
  facet_wrap(~key, scales='free')
```

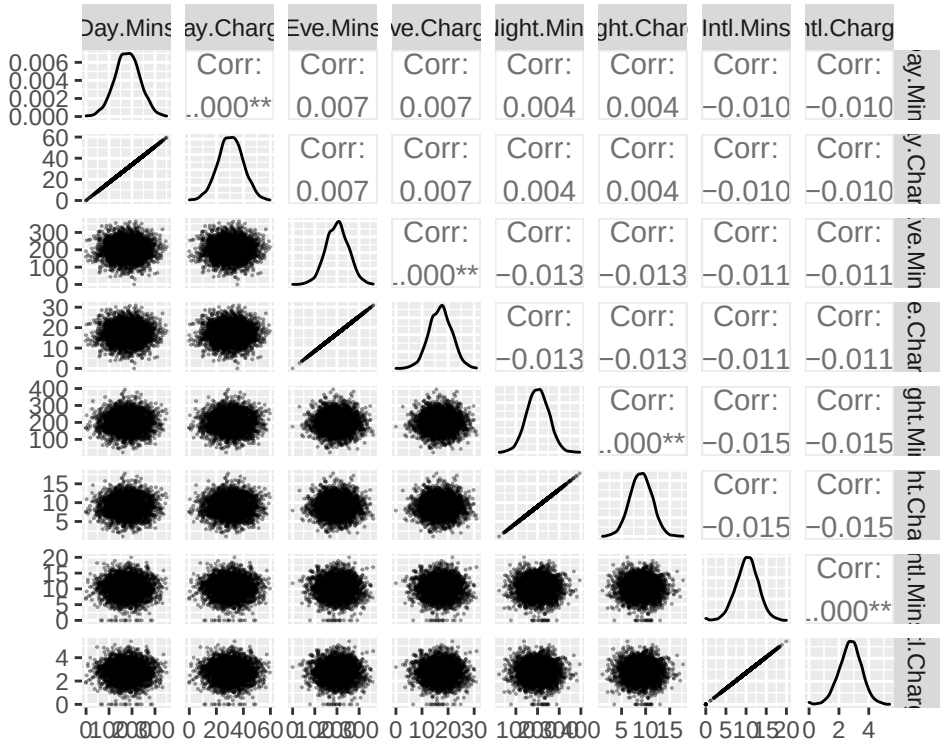



```
ggplot(gather(numerics), aes(value)) +
  geom_boxplot(aes(x=value)) +
  facet_wrap(~key, scales='free')
```



c)

```
continuous <- subset(numerics, select=sapply(numerics, function(x) !is.integer(x)))
ggpairs(continuous,
        lower=list(continuous=wrap("points", alpha=.4, size=.01)))
```



d)

```
sapply(numerics, Range)
```

```
## Account.Length  VMail.Message       Day.Mins      Day.Calls     Day.Charge
##         242.00          51.00         350.80         165.00          59.64
##       Eve.Mins      Eve.Calls     Eve.Charge     Night.Mins    Night.Calls
##         363.70         170.00          30.91         371.80         142.00
##   Night.Charge      Intl.Mins     Intl.Calls    Intl.Charge CustServ.Calls
##          16.73          20.00          20.00           5.40           9.00
```

```
sapply(factors, levels)
```

```
## $State
##  [1] "AK" "AL" "AR" "AZ" "CA" "CO" "CT" "DC" "DE" "FL" "GA" "HI" "IA" "ID" "IL"
## [16] "IN" "KS" "KY" "LA" "MA" "MD" "ME" "MI" "MN" "MO" "MS" "MT" "NC" "ND" "NE"
## [31] "NH" "NJ" "NM" "NV" "NY" "OH" "OK" "OR" "PA" "RI" "SC" "SD" "TN" "TX" "UT"
## [46] "VA" "VT" "WA" "WI" "WV" "WY"
##
## $Area.Code
## [1] "408" "415" "510"
##
```

```
## $Int.l.Plan
## [1] "no"  "yes"
##
## $VMail.Plan
## [1] "no"  "yes"
##
## $Churn.
## [1] "False." "True."
```

```
sapply(numerics, skewness)

## Account.Length  VMail.Message       Day.Mins      Day.Calls     Day.Charge
##    0.096606294    1.264823634   -0.029077067   -0.111786639   -0.029083268
##       Eve.Mins      Eve.Calls     Eve.Charge     Night.Mins    Night.Calls
##   -0.023877456   -0.055563139   -0.023857989    0.008921291    0.032499570
##   Night.Charge      Intl.Mins     Intl.Calls    Intl.Charge CustServ.Calls
##    0.008886237   -0.245135939    1.321478166   -0.245286508    1.091359482

sapply(numerics, cv)

## Account.Length  VMail.Message       Day.Mins      Day.Calls     Day.Charge
##      0.3940255      1.6901282      0.3029752      0.1998203      0.3029691
##       Eve.Mins      Eve.Calls     Eve.Charge     Night.Mins    Night.Calls
##      0.2523324      0.1989988      0.2523287      0.2517715      0.1954755
##   Night.Charge      Intl.Mins     Intl.Calls    Intl.Charge CustServ.Calls
##      0.2517746      0.2727127      0.5494459      0.2726534      0.8417223
```

3 Etap III

a)

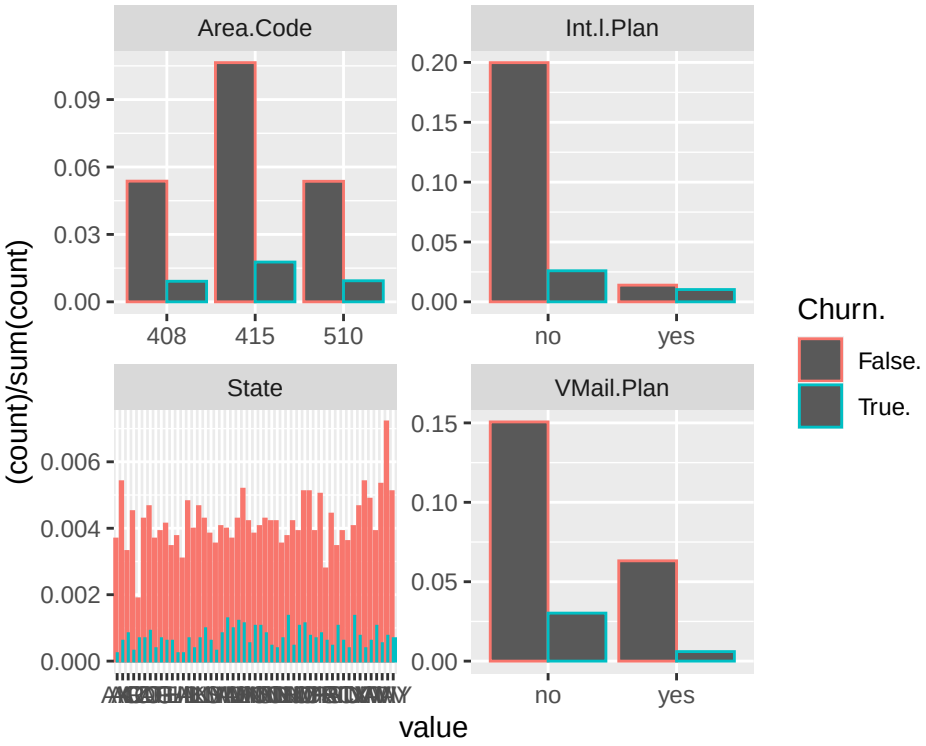
```
numerics <- data.frame(numerics, Churn. = df$Churn.)
```

```
aggregate(. ~ Churn., numerics, extended.summary)

##   Churn. Account.Length.mean Account.Length.trimmed.mean Account.Length.min
## 1 False.           100.79368                   100.73202            1.00000
## 2  True.           102.66460                   102.62162            1.00000
##   Account.Length.Q1 Account.Length.median Account.Length.Q3 Account.Length.max
## 1          73.00000             100.00000         127.00000          243.00000
## 2          76.00000             103.00000         127.00000          225.00000
##   Account.Length.range1 Account.Length.range2 Account.Length.sd
## 1               1.00000             243.00000          39.88235
## 2               1.00000             225.00000          39.46782
##   Account.Length.IQR VMail.Message.mean VMail.Message.trimmed.mean
## 1           54.00000           8.604561                   8.526446
## 2           51.00000           5.115942                   5.037422
##   VMail.Message.min VMail.Message.Q1 VMail.Message.median VMail.Message.Q3
## 1          0.000000         0.000000             0.000000        22.000000
## 2          0.000000         0.000000             0.000000         0.000000
```

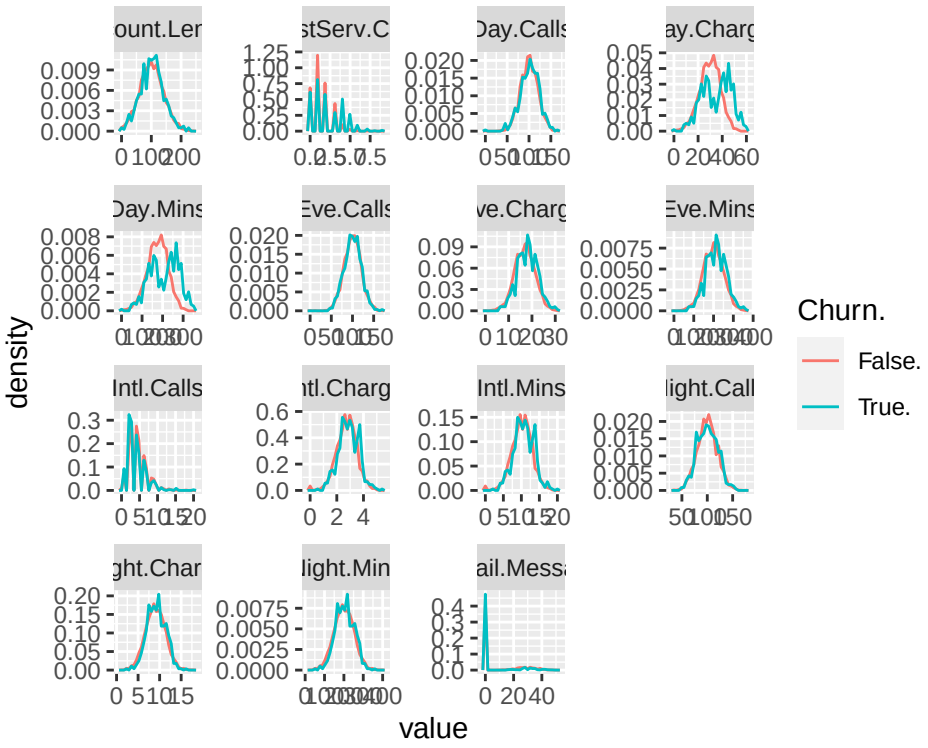
```
##   VMail.Message.max VMail.Message.range1 VMail.Message.range2 VMail.Message.sd
## 1         51.000000             0.000000            51.000000        13.913125
## 2         48.000000             0.000000            48.000000        11.860138
##   VMail.Message.IQR Day.Mins.mean Day.Mins.trimmed.mean Day.Mins.min
## 1         22.000000     175.17575             175.25127      0.00000
## 2          0.000000     206.91408             207.04511      0.00000
##   Day.Mins.Q1 Day.Mins.median Day.Mins.Q3 Day.Mins.max Day.Mins.range1
## 1   142.82500       177.20000   210.30000    315.60000         0.00000
## 2   153.25000       217.60000   265.95000    350.80000         0.00000
##   Day.Mins.range2 Day.Mins.sd Day.Mins.IQR Day.Calls.mean
## 1       315.60000    50.18166     67.47500      100.28316
## 2       350.80000    68.99779    112.70000      101.33540
##   Day.Calls.trimmed.mean Day.Calls.min Day.Calls.Q1 Day.Calls.median
## 1              100.30959       0.00000     87.00000        100.00000
## 2              101.41372       0.00000     87.50000        103.00000
##   Day.Calls.Q3 Day.Calls.max Day.Calls.range1 Day.Calls.range2 Day.Calls.sd
## 1    114.00000     163.00000          0.00000        163.00000     19.80116
## 2    116.50000     165.00000          0.00000        165.00000     21.58231
##   Day.Calls.IQR Day.Charge.mean Day.Charge.trimmed.mean Day.Charge.min
## 1      27.00000       29.780421               29.793262       0.000000
## 2      29.00000       35.175921               35.198191       0.000000
##   Day.Charge.Q1 Day.Charge.median Day.Charge.Q3 Day.Charge.max
## 1     24.282500         30.120000     35.750000      53.650000
## 2     26.055000         36.990000     45.210000      59.640000
##   Day.Charge.range1 Day.Charge.range2 Day.Charge.sd Day.Charge.IQR
## 1          0.000000         53.650000      8.530835      11.467500
## 2          0.000000         59.640000     11.729710      19.155000
##   Eve.Mins.mean Eve.Mins.trimmed.mean Eve.Mins.min Eve.Mins.Q1 Eve.Mins.median
## 1     199.04330             199.07831      0.00000   164.50000       199.60000
## 2     212.41014             212.38981     70.90000   177.10000       211.30000
##   Eve.Mins.Q3 Eve.Mins.max Eve.Mins.range1 Eve.Mins.range2 Eve.Mins.sd
## 1   233.20000    361.80000         0.00000       361.80000    50.29217
## 2   249.45000    363.70000        70.90000       363.70000    51.72891
##   Eve.Mins.IQR Eve.Calls.mean Eve.Calls.trimmed.mean Eve.Calls.min Eve.Calls.Q1
## 1     68.70000       100.03860              100.06488       0.00000     87.00000
## 2     72.35000       100.56108              100.53015      48.00000     87.00000
##   Eve.Calls.median Eve.Calls.Q3 Eve.Calls.max Eve.Calls.range1 Eve.Calls.range2
## 1        100.00000    114.00000     170.00000          0.00000        170.00000
## 2        101.00000    114.00000     168.00000         48.00000        168.00000
##   Eve.Calls.sd Eve.Calls.IQR Eve.Charge.mean Eve.Charge.trimmed.mean
## 1     19.95841      27.00000       16.918909               16.921890
## 2     19.72471      27.00000       18.054969               18.053243
##   Eve.Charge.min Eve.Charge.Q1 Eve.Charge.median Eve.Charge.Q3 Eve.Charge.max
## 1       0.000000     13.980000         16.970000     19.820000      30.750000
## 2       6.030000     15.055000         17.960000     21.205000      30.910000
##   Eve.Charge.range1 Eve.Charge.range2 Eve.Charge.sd Eve.Charge.IQR
## 1          0.000000         30.750000      4.274863       5.840000
## 2          6.030000         30.910000      4.396762       6.150000
##   Night.Mins.mean Night.Mins.trimmed.mean Night.Mins.min Night.Mins.Q1
## 1       200.13319               200.09041       23.20000     165.90000
## 2       205.23168               205.24865       47.40000     171.25000
##   Night.Mins.median Night.Mins.Q3 Night.Mins.max Night.Mins.range1
## 1         200.25000     234.90000      395.00000          23.20000
## 2         204.80000     239.85000      354.90000          47.40000
```

```
##   Night.Mins.range2 Night.Mins.sd Night.Mins.IQR Night.Calls.mean
## 1         395.00000      51.10503       69.00000        100.05825
## 2         354.90000      47.13282       68.60000        100.39959
##   Night.Calls.trimmed.mean Night.Calls.min Night.Calls.Q1 Night.Calls.median
## 1                100.05430        33.00000       87.00000           100.00000
## 2                100.38669        49.00000       85.00000           100.00000
##   Night.Calls.Q3 Night.Calls.max Night.Calls.range1 Night.Calls.range2
## 1      113.00000       175.00000            33.00000          175.00000
## 2      115.00000       158.00000            49.00000          158.00000
##   Night.Calls.sd Night.Calls.IQR Night.Charge.mean Night.Charge.trimmed.mean
## 1       19.50625        26.00000          9.006074                  9.004150
## 2       19.95066        30.00000          9.235528                  9.236299
##   Night.Charge.min Night.Charge.Q1 Night.Charge.median Night.Charge.Q3
## 1         1.040000        7.470000             9.010000       10.570000
## 2         2.130000        7.705000             9.220000       10.795000
##   Night.Charge.max Night.Charge.range1 Night.Charge.range2 Night.Charge.sd
## 1        17.770000             1.040000           17.770000        2.299768
## 2        15.970000             2.130000           15.970000        2.121081
##   Night.Charge.IQR Intl.Mins.mean Intl.Mins.trimmed.mean Intl.Mins.min
## 1         3.100000      10.158877              10.163999      0.000000
## 2         3.090000      10.700000              10.698753      2.000000
##   Intl.Mins.Q1 Intl.Mins.median Intl.Mins.Q3 Intl.Mins.max Intl.Mins.range1
## 1     8.400000        10.200000    12.000000     18.900000         0.000000
## 2     8.800000        10.600000    12.800000     20.000000         2.000000
##   Intl.Mins.range2 Intl.Mins.sd Intl.Mins.IQR Intl.Calls.mean
## 1        18.900000     2.784489      3.600000        4.532982
## 2        20.000000     2.793190      4.000000        4.163561
##   Intl.Calls.trimmed.mean Intl.Calls.min Intl.Calls.Q1 Intl.Calls.median
## 1                4.512341       0.000000      3.000000          4.000000
## 2                4.137214       1.000000      2.000000          4.000000
##   Intl.Calls.Q3 Intl.Calls.max Intl.Calls.range1 Intl.Calls.range2
## 1      6.000000      19.000000          0.000000         19.000000
## 2      5.000000      20.000000          1.000000         20.000000
##   Intl.Calls.sd Intl.Calls.IQR Intl.Charge.mean Intl.Charge.trimmed.mean
## 1      2.441984       3.000000        2.7434035                2.7447920
## 2      2.551575       3.000000        2.8895445                2.8892100
##   Intl.Charge.min Intl.Charge.Q1 Intl.Charge.median Intl.Charge.Q3
## 1       0.0000000      2.2700000          2.7500000      3.2400000
## 2       0.5400000      2.3800000          2.8600000      3.4600000
##   Intl.Charge.max Intl.Charge.range1 Intl.Charge.range2 Intl.Charge.sd
## 1       5.1000000          0.0000000          5.1000000      0.7517843
## 2       5.4000000          0.5400000          5.4000000      0.7541521
##   Intl.Charge.IQR CustServ.Calls.mean CustServ.Calls.trimmed.mean
## 1       0.9700000            1.449825                    1.440056
## 2       1.0800000            2.229814                    2.220374
##   CustServ.Calls.min CustServ.Calls.Q1 CustServ.Calls.median CustServ.Calls.Q3
## 1           0.000000          1.000000              1.000000          2.000000
## 2           0.000000          1.000000              2.000000          4.000000
##   CustServ.Calls.max CustServ.Calls.range1 CustServ.Calls.range2
## 1           8.000000              0.000000              8.000000
## 2           9.000000              0.000000              9.000000
##   CustServ.Calls.sd CustServ.Calls.IQR
## 1          1.163883           1.000000
## 2          1.853275           3.000000
```

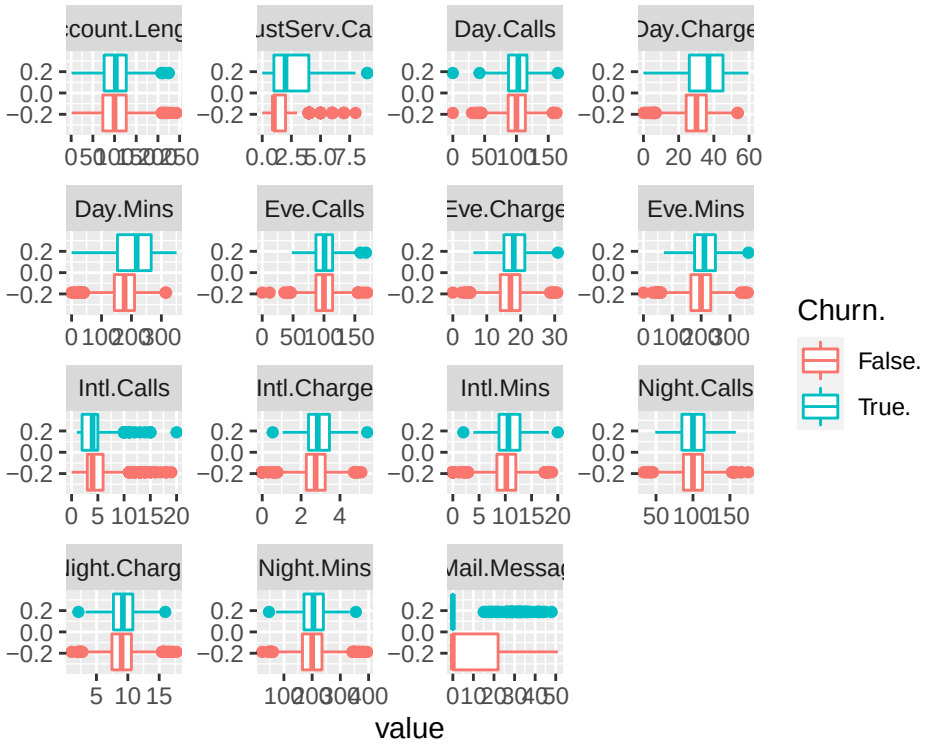
```
ggplot(gather(factors, "key", "value", -Churn.), aes(value, color=Churn.)) +
  geom_bar(position='dodge', aes(y=(..count..)/sum(..count..))) +
  facet_wrap(~key, scales='free')
```



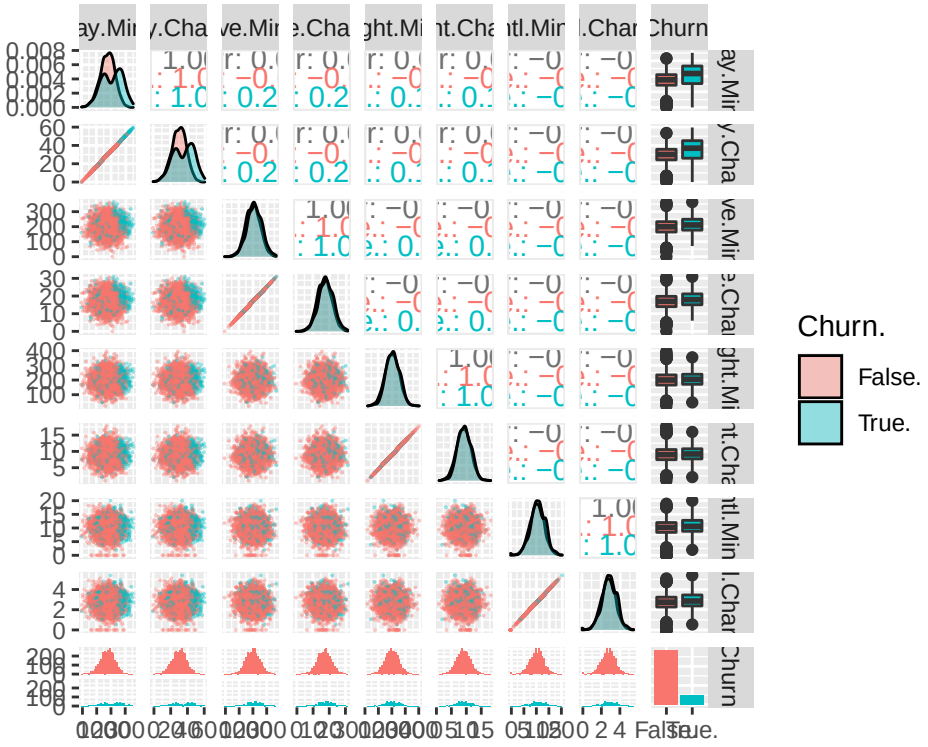

```
ggplot(gather(numerics, "key", "value", -Churn.), aes(value, color=Churn.)) +
  geom_freqpoly(aes(y=..density..)) +
  facet_wrap(~key, scales='free')
```



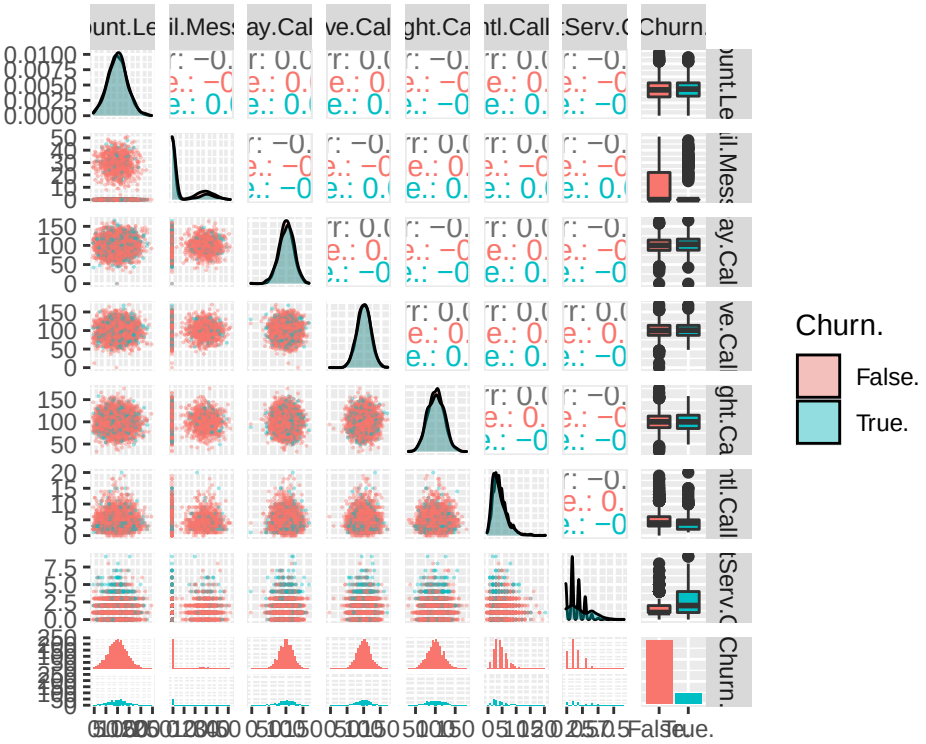

```
ggplot(gather(numerics, "key", "value", -Churn.), aes(value, color=Churn.)) +
  geom_boxplot(aes(x=value)) +
  facet_wrap(~key, scales='free')
```



```
continuous <- subset(numerics, select=sapply(numerics, function(x) !is.integer(x)))
integers <- subset(numerics, select=sapply(numerics, is.integer))
integers <- data.frame(integers, Churn. = continuous$Churn.)
continuous %>% ggpairs(.,
                mapping = ggplot2::aes(color=Churn.),
                legend=1,
                lower=list(continuous=wrap("points", alpha=.4, size=.01)),
                diag=list(continuous=wrap("densityDiag", alpha=.4)))
```




```
integers %>% ggpairs(.,
                mapping = ggplot2::aes(color=Churn.),
                legend=1,
                lower=list(continuous=wrap("points", alpha=.4, size=.01)),
                diag=list(continuous=wrap("densityDiag", alpha=.4)))
```




```
aggregate(. ~ Churn., numerics, Range)

##   Churn. Account.Length VMail.Message Day.Mins Day.Calls Day.Charge Eve.Mins
## 1 False.            242            51    315.6       163      53.65    361.8
## 2  True.            224            48    350.8       165      59.64    292.8
##   Eve.Calls Eve.Charge Night.Mins Night.Calls Night.Charge Intl.Mins Intl.Calls
## 1       170      30.75      371.8         142        16.73      18.9         19
## 2       120      24.88      307.5         109        13.84      18.0         19
##   Intl.Charge CustServ.Calls
## 1        5.10              8
## 2        4.86              9
```

```
aggregate(. ~ Churn., factors, levels)

##   Churn. State Area.Code Int.l.Plan VMail.Plan
## 1 False.  NULL      NULL       NULL       NULL
## 2  True.  NULL      NULL       NULL       NULL
```

```
aggregate(. ~ Churn., numerics, skewness)

##   Churn. Account.Length VMail.Message   Day.Mins  Day.Calls Day.Charge
## 1 False.     0.09052327      1.167435 -0.2263781 -0.0632955 -0.2264046
## 2  True.     0.13713205      2.040412 -0.1992228 -0.3533924 -0.1992087
##      Eve.Mins   Eve.Calls  Eve.Charge   Night.Mins Night.Calls Night.Charge
## 1 -0.04313957 -0.06921711 -0.04310337  0.017229862  0.02694851  0.017240153
## 2  0.03312938  0.02985619  0.03314373 -0.005073416  0.06149375 -0.005463696
##     Intl.Mins Intl.Calls Intl.Charge CustServ.Calls
```

```
## 1 -0.29377989   1.259044 -0.29390182      0.8868008
## 2  0.02139163   1.714231  0.02100866      0.7036041
```

```
aggregate(. ~ Churn., numerics, cv)

##   Churn. Account.Length VMail.Message  Day.Mins Day.Calls Day.Charge  Eve.Mins
## 1 False.      0.3956830      1.616948 0.2864646 0.1974525  0.2864579 0.2526695
## 2  True.      0.3844346      2.318271 0.3334611 0.2129789  0.3334585 0.2435331
##   Eve.Calls Eve.Charge Night.Mins Night.Calls Night.Charge Intl.Mins Intl.Calls
## 1 0.1995071  0.2526678  0.2553551   0.1949489    0.2553574 0.2740942  0.5387146
## 2 0.1961466  0.2435209  0.2296567   0.1987126    0.2296653 0.2610458  0.6128349
##   Intl.Charge CustServ.Calls
## 1   0.2740335      0.8027753
## 2   0.2609934      0.8311344
```

b)

4 Etap IV