Final Project

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Import EDA packages

```
library(stats)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

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

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

```
library(ggplot2)
library(reshape2)
library(tidyr)
```

```
##
## Attaching package: 'tidyr'

## The following object is masked from 'package:reshape2':
##
##     smiths
```

```
library(randomForest)
```

```
## randomForest 4.6-14

## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:ggplot2':
##
##     margin

## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(caret)
```

```
## Loading required package: lattice
```

```
library(e1071)
```

```
## Warning: package 'e1071' was built under R version 4.0.4
```

```
library(ROSE)
```

```
## Warning: package 'ROSE' was built under R version 4.0.5

## Loaded ROSE 0.0-3
```

```
library(nnet)
```

```
## Warning: package 'nnet' was built under R version 4.0.4
```

```
library(NeuralNetTools)
```

```
## Warning: package 'NeuralNetTools' was built under R version 4.0.4
```

```
library(psych)
```

```
## Warning: package 'psych' was built under R version 4.0.5

##
## Attaching package: 'psych'

## The following object is masked from 'package:randomForest':
##
##     outlier

## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha
```

```
library(rpart)
```

```
## Warning: package 'rpart' was built under R version 4.0.4
```

```
library(rpart.plot)
```

```
## Warning: package 'rpart.plot' was built under R version 4.0.4
```

```
library(arules)
```

```
## Warning: package 'arules' was built under R version 4.0.4
```

```
## Loading required package: Matrix
```

```
##
## Attaching package: 'Matrix'
```

```
## The following objects are masked from 'package:tidyr':
##
##     expand, pack, unpack
```

```
##
## Attaching package: 'arules'
```

```
## The following object is masked from 'package:dplyr':
##
##     recode
```

```
## The following objects are masked from 'package:base':
##
##     abbreviate, write
```

Import dataframe as strokeData

```
filePath <- "D:/MS-ADS-502-02-SP21-Data Mining/Final Project/healthcare-dataset-stroke-data.csv"
strokeData <- read.csv(file = filePath)
```

Statistic summary of strokeData

```
summary(strokeData)
```

```
##        id            gender                age         hypertension
##  Min.   :   67   Length:5110        Min.   : 0.08   Min.   :0.00000
##  1st Qu.:17741   Class :character   1st Qu.:25.00   1st Qu.:0.00000
##  Median :36932   Mode  :character   Median :45.00   Median :0.00000
##  Mean   :36518                      Mean   :43.23   Mean   :0.09746
##  3rd Qu.:54682                      3rd Qu.:61.00   3rd Qu.:0.00000
##  Max.   :72940                      Max.   :82.00   Max.   :1.00000
##  heart_disease     ever_married        work_type         Residence_type
##  Min.   :0.00000   Length:5110        Length:5110        Length:5110
##  1st Qu.:0.00000   Class :character   Class :character   Class :character
##  Median :0.00000   Mode  :character   Mode  :character   Mode  :character
##  Mean   :0.05401
##  3rd Qu.:0.00000
##  Max.   :1.00000
##  avg_glucose_level     bmi            smoking_status         stroke
##  Min.   : 55.12    Length:5110        Length:5110        Min.   :0.00000
##  1st Qu.: 77.25    Class :character   Class :character   1st Qu.:0.00000
##  Median : 91.89    Mode  :character   Mode  :character   Median :0.00000
##  Mean   :106.15                                          Mean   :0.04873
##  3rd Qu.:114.09                                          3rd Qu.:0.00000
##  Max.   :271.74                                          Max.   :1.00000
```

Remove 'id' column from strokeData

```
strokeData$id <- NULL
```

Counting number of occurences

```
lapply(strokeData, table)
```

```
## $gender
##
## Female   Male  Other
##   2994   2115      1
##
## $age
##
## 0.08 0.16 0.24 0.32  0.4 0.48 0.56 0.64 0.72  0.8 0.88    1 1.08 1.16 1.24 1.32
##    2    3    5    5    2    3    5    4    5    4    5    5    8    4    8    8
##  1.4 1.48 1.56 1.64 1.72  1.8 1.88    2    3    4    5    6    7    8    9   10
##    3    6    4    8    6    9    8   55   46   34   65   24   32   58   38   35
##   11   12   13   14   15   16   17   18   19   20   21   22   23   24   25   26
##   36   45   57   54   45   52   60   60   50   59   47   45   64   55   57   62
##   27   28   29   30   31   32   33   34   35   36   37   38   39   40   41   42
##   55   54   51   55   79   71   57   68   54   52   76   72   71   74   73   71
##   43   44   45   46   47   48   49   50   51   52   53   54   55   56   57   58
##   70   75   85   62   75   66   79   83   86   90   85   87   83   77   95   68
##   59   60   61   62   63   64   65   66   67   68   69   70   71   72   73   74
```

```
##   80   72   76   74   74   53   62   60   49   47   54   45   61   45   46   40
##   75   76   77   78   79   80   81   82
##   53   50   42  102   85   70   60   56
##
## $hypertension
##
##    0    1
## 4612  498
##
## $heart_disease
##
##    0    1
## 4834  276
##
## $ever_married
##
##   No  Yes
## 1757 3353
##
## $work_type
##
##      children      Govt_job  Never_worked       Private Self-employed
##           687           657            22          2925           819
##
## $Residence_type
##
## Rural Urban
##  2514  2596
##
## $avg_glucose_level
##
##  55.12  55.22  55.23  55.25  55.26  55.27  55.28  55.32  55.34  55.35  55.39
##      1      1      1      1      1      1      1      1      2      1      1
##  55.41  55.42  55.46  55.47  55.51  55.57  55.58  55.59  55.61  55.62  55.64
##      1      1      1      1      1      1      1      1      1      1      1
##  55.67  55.72  55.78  55.79  55.83  55.84  55.86  55.93  55.96  56.07  56.08
##      1      1      1      1      1      1      1      1      1      2      2
##  56.11  56.12  56.13  56.18  56.21  56.23   56.3  56.31  56.32  56.33  56.34
##      4      2      1      1      1      1      2      1      1      2      1
##  56.37  56.42  56.43  56.47  56.48  56.51  56.63  56.64  56.67  56.71  56.74
##      1      2      1      1      2      1      1      1      1      1      1
##  56.75  56.77  56.79  56.84  56.85  56.87  56.89   56.9  56.94  56.95  56.96
##      2      1      1      1      2      1      1      2      1      1      1
##  56.99  57.02  57.06  57.08  57.09   57.1  57.15  57.17  57.26  57.27  57.28
##      1      3      1      1      1      1      1      1      1      1      2
##   57.3  57.33  57.37  57.38   57.4  57.42  57.43  57.46  57.47  57.51  57.52
##      1      2      1      1      1      2      1      1      1      2      1
##  57.56  57.57  57.59   57.6  57.76  57.77  57.79   57.8  57.82  57.83  57.89
##      2      2      1      1      1      1      1      1      1      1      1
##  57.92  57.93  57.94  57.95  57.96  58.01  58.02  58.03  58.09  58.14  58.19
##      2      2      1      1      1      2      1      1      1      1      2
##  58.23  58.24  58.25  58.26  58.29   58.3  58.35  58.37  58.38  58.39  58.41
##      1      1      1      1      1      1      2      1      1      2      1
##  58.42  58.47  58.48  58.51  58.55  58.57  58.63  58.64  58.65  58.66  58.69
```

```
##      2      1      1      1      1      1      2      1      2      2      1
##   58.7  58.71  58.72  58.81  58.86  58.87  58.88  58.89  58.95  58.96     59
##      1      1      1      1      1      1      1      1      1      1      1
##  59.05  59.07  59.11  59.14  59.15  59.17   59.2  59.26  59.28  59.31  59.32
##      2      1      1      1      1      1      2      1      2      1      1
##  59.35  59.36  59.43  59.48  59.49  59.52  59.54  59.61  59.62  59.63  59.67
##      1      1      1      1      2      2      1      2      2      1      2
##  59.68  59.74  59.76  59.78  59.82  59.83  59.85  59.86  59.87  59.89  59.91
##      1      2      1      1      1      1      1      1      1      1      2
##  59.93  59.99  60.01  60.02  60.05  60.06  60.09  60.13  60.17   60.2  60.22
##      1      1      1      1      1      1      1      1      1      1      3
##  60.26  60.32  60.34  60.35  60.36  60.37  60.39   60.4  60.41   60.5  60.53
##      1      2      1      1      1      1      2      1      1      1      1
##  60.56  60.57   60.6  60.61  60.64  60.67  60.69   60.7  60.73  60.74  60.77
##      1      1      2      2      1      2      1      2      1      1      2
##  60.84  60.91  60.94  60.96  60.98  60.99  61.01  61.04  61.07   61.1  61.11
##      1      2      1      1      4      1      1      1      1      2      2
##  61.13  61.27  61.29  61.32  61.34  61.36  61.38  61.42  61.45  61.47  61.53
##      1      1      2      1      1      1      1      2      1      1      1
##  61.54  61.57  61.61  61.67  61.68  61.75  61.78   61.8  61.81  61.83  61.87
##      2      1      1      1      1      1      1      1      2      1      1
##  61.88  61.94  61.96  61.98     62  62.02  62.08  62.12  62.13   62.2  62.21
##      2      3      1      1      2      1      1      1      2      1      1
##  62.25  62.27  62.32  62.37   62.4  62.41  62.44  62.46  62.47  62.48  62.49
##      1      1      1      1      1      1      2      1      2      3      1
##  62.52  62.54  62.55  62.56  62.57   62.6  62.61  62.62  62.63  62.64  62.66
##      1      1      1      2      3      3      2      1      1      1      2
##  62.67  62.68  62.69  62.78  62.81  62.89  62.91  62.93  62.99  63.01  63.08
##      1      2      1      1      1      2      1      1      2      1      1
##  63.16  63.18  63.19  63.22  63.26  63.27  63.28  63.32  63.33  63.37   63.4
##      1      1      1      1      1      1      2      1      1      1      1
##  63.41  63.42  63.43  63.45  63.47  63.49  63.53  63.56  63.57   63.6  63.61
##      1      1      1      1      1      1      1      1      1      1      1
##  63.63  63.64  63.65  63.69  63.71  63.72  63.73  63.74  63.78  63.82  63.86
##      1      1      1      1      2      1      2      1      2      1      1
##   63.9  63.94  63.95  63.98  64.02  64.06  64.07  64.08  64.09   64.1  64.14
##      1      1      1      3      1      1      1      1      1      1      1
##  64.15  64.17  64.18   64.2  64.27  64.29  64.37   64.4  64.41  64.44  64.45
##      1      1      1      1      1      1      1      2      1      2      2
##  64.51  64.55   64.6  64.62  64.64  64.66  64.68  64.84  64.85  64.87  64.92
##      2      1      1      1      1      2      1      1      1      1      2
##  64.94  64.99  65.01  65.04  65.05  65.07  65.08  65.09  65.12  65.15  65.16
##      1      1      2      1      1      1      1      1      3      1      1
##  65.21  65.22  65.24  65.25  65.28  65.29   65.3  65.32  65.33  65.34  65.36
##      2      1      1      1      1      2      2      1      2      1      3
##  65.38   65.4  65.41  65.42  65.43  65.44  65.45  65.46  65.47  65.48  65.49
##      2      1      2      2      1      1      1      1      2      2      1
##   65.5  65.51  65.52  65.58  65.59   65.6  65.61  65.63  65.66  65.67  65.68
##      1      2      1      1      1      1      1      1      2      2      1
##  65.69   65.7  65.71  65.77  65.78  65.79  65.81  65.82  65.84  65.85  65.87
##      1      1      1      2      1      1      1      1      2      1      1
##  65.88   65.9  65.91  65.93  65.95  65.96  65.98  66.01  66.03  66.06  66.07
##      1      1      1      1      1      2      3      1      1      1      1
##  66.08  66.11  66.12  66.13  66.16  66.17   66.2  66.22  66.24  66.25  66.29
```

```
##     1     2     1     1     2     1     1     1     1     1     1
##  66.3 66.32 66.33 66.36 66.42 66.46 66.47 66.51 66.55 66.59 66.61
##     2     2     1     1     1     2     1     1     3     1     1
## 66.67 66.69  66.7 66.71 66.72 66.85 66.96 67.02 67.03 67.06 67.07
##     2     1     1     1     1     1     1     2     1     3     2
## 67.08  67.1 67.21 67.26 67.27 67.28 67.29  67.3 67.33 67.38 67.39
##     1     2     1     1     1     1     2     1     1     1     1
## 67.41  67.5 67.53 67.55 67.56 67.66 67.68 67.73 67.75 67.76 67.78
##     1     2     1     2     1     1     2     1     1     1     1
## 67.79  67.8 67.81 67.84 67.87  67.9 67.92 67.96 67.97 67.99 68.01
##     1     1     1     2     2     1     4     1     3     2     1
## 68.02 68.07 68.09 68.12 68.13 68.17 68.18 68.19 68.24 68.27 68.34
##     1     1     1     1     1     1     1     2     2     2     3
## 68.35 68.37 68.38  68.4 68.41 68.42 68.43 68.44 68.48 68.49 68.52
##     3     2     2     3     1     1     1     1     2     1     2
## 68.53 68.56  68.6 68.61 68.62 68.66 68.68  68.7 68.72 68.76 68.78
##     2     1     1     1     1     3     1     1     1     1     1
## 68.79  68.8 68.84 68.86 68.88 68.91 68.94 68.96 68.98 68.99 69.01
##     1     2     1     1     1     1     2     1     1     1     2
## 69.04 69.06 69.09 69.11 69.12 69.15 69.16 69.17 69.18  69.2 69.21
##     1     1     1     1     2     1     1     1     1     2     1
## 69.22 69.23 69.24 69.25 69.26 69.28  69.3 69.34 69.35 69.37 69.38
##     1     1     4     1     1     1     1     2     1     2     2
##  69.4 69.42 69.45 69.46 69.47 69.48  69.5 69.52 69.53 69.54 69.58
##     2     1     1     1     1     1     1     2     1     1     1
## 69.61 69.67 69.68  69.7 69.72 69.74 69.76 69.77 69.79 69.82 69.84
##     1     1     1     1     2     1     1     2     1     1     1
## 69.87 69.88 69.89 69.91 69.92 69.94 69.97 69.99    70 70.01 70.02
##     1     3     1     1     2     2     1     1     2     1     1
## 70.03 70.04 70.06 70.07 70.08 70.09 70.11 70.13 70.15 70.16 70.18
##     2     1     1     2     1     1     1     2     2     2     1
## 70.19 70.21 70.22 70.23 70.25 70.28 70.29  70.3 70.31 70.32 70.33
##     1     1     1     2     1     2     1     1     1     1     1
## 70.34 70.35 70.37 70.38 70.43 70.45 70.48 70.51 70.52 70.53 70.54
##     1     1     1     1     1     1     1     3     1     2     2
## 70.55 70.56 70.58 70.59 70.61 70.65 70.66 70.67  70.7 70.71 70.73
##     1     2     1     1     1     1     1     1     1     1     2
## 70.75 70.78 70.87 70.89 70.91 70.92 70.93 70.94 70.96 70.98 71.02
##     1     1     2     1     1     1     2     1     2     1     1
## 71.06 71.08 71.12 71.15 71.16 71.18  71.2 71.22 71.25 71.26 71.29
##     4     2     1     1     1     1     2     2     2     1     1
##  71.3 71.31 71.32 71.34 71.37 71.38  71.4 71.42 71.43 71.44 71.46
##     1     1     1     1     1     2     2     1     1     1     1
##  71.5 71.58 71.59 71.63 71.66  71.7 71.71 71.73 71.77 71.79  71.8
##     2     1     1     2     1     1     1     1     1     1     2
## 71.81 71.88 71.89 71.91 71.92 71.93 71.94 71.97 71.98    72 72.01
##     3     2     1     1     1     2     1     2     1     1     1
## 72.02 72.03 72.04 72.06 72.07 72.08 72.09  72.1 72.12 72.13 72.16
##     1     1     1     1     1     1     2     1     1     1     1
## 72.17 72.18 72.19  72.2 72.28 72.29 72.33 72.34 72.35 72.36 72.39
##     1     1     1     2     1     1     1     1     1     2     1
## 72.42 72.49  72.5 72.52 72.53 72.54 72.55 72.56  72.6 72.61 72.62
##     1     5     1     2     1     1     1     2     1     2     1
## 72.63 72.64 72.65 72.67 72.71 72.73 72.75 72.76 72.79 72.81 72.84
```

```
##      1      1      1      1      2      1      1      2      2      2      2
##  72.88  72.93  72.94  72.96  72.99     73  73.01  73.02  73.04  73.06  73.07
##      1      1      1      2      1      5      1      2      1      1      1
##  73.08  73.18  73.19   73.2  73.24  73.27  73.28  73.29  73.31  73.32  73.33
##      1      2      1      3      1      3      1      3      1      1      1
##  73.36  73.37  73.39   73.4  73.41  73.44  73.48  73.49   73.5  73.54  73.56
##      2      1      1      1      1      1      3      1      2      2      2
##  73.57  73.58   73.6  73.62  73.63  73.65  73.66  73.67  73.69   73.7  73.71
##      1      1      1      2      1      1      1      1      2      1      2
##  73.72  73.73  73.74  73.75  73.76  73.78  73.81  73.83  73.87  73.89  73.92
##      2      1      1      2      2      1      1      1      3      2      1
##  73.94  73.98  73.99     74  74.01  74.02  74.04  74.05  74.06  74.08  74.09
##      1      1      1      2      1      2      1      1      1      1      1
##   74.1  74.11  74.12  74.14  74.15  74.16  74.17  74.19   74.2  74.22  74.23
##      1      2      1      1      1      1      1      1      1      1      1
##  74.24  74.26  74.28  74.29  74.32  74.33  74.34  74.35  74.36  74.39  74.42
##      1      1      1      2      1      1      1      3      2      1      1
##  74.43  74.44  74.46   74.5  74.51  74.52  74.53  74.54  74.55  74.58  74.61
##      2      1      1      2      2      1      1      1      1      1      1
##  74.63  74.64  74.65  74.66   74.7  74.72  74.79   74.8  74.81  74.82  74.83
##      3      2      1      1      1      1      2      2      1      1      1
##  74.85  74.86  74.88   74.9  74.91  74.96  74.98  74.99     75  75.02  75.03
##      1      2      2      2      1      2      1      1      1      1      1
##  75.04  75.05  75.06  75.07  75.08  75.09   75.1  75.13  75.15  75.16  75.18
##      1      1      3      1      1      2      1      1      1      1      1
##  75.19  75.22  75.23  75.25  75.27  75.28  75.29   75.3  75.32  75.34  75.39
##      2      3      1      2      1      1      1      1      1      1      1
##   75.4  75.41  75.42  75.43  75.46  75.47   75.5  75.52  75.53  75.56  75.62
##      1      1      1      1      1      1      2      1      2      1      1
##  75.64  75.67  75.69   75.7  75.73  75.74  75.77  75.78  75.79  75.82  75.84
##      1      1      1      1      1      1      3      2      1      1      1
##  75.85  75.86  75.87  75.88   75.9  75.91  75.92  75.93  75.94  75.95  75.98
##      1      1      1      2      1      1      1      1      1      1      1
##     76  76.03  76.04  76.05  76.08  76.09   76.1  76.11  76.12  76.13  76.15
##      1      2      1      1      1      1      1      2      3      1      1
##  76.19   76.2  76.21  76.22  76.25  76.26  76.28   76.3  76.31  76.34  76.35
##      2      1      1      1      1      2      1      1      1      3      1
##  76.36  76.42  76.43  76.44  76.45  76.46  76.47   76.5  76.51  76.52  76.55
##      1      2      1      1      1      1      1      1      2      1      2
##  76.56  76.57  76.58  76.62  76.63  76.64  76.66  76.68   76.7  76.72  76.74
##      1      2      1      1      2      2      2      1      2      2      3
##  76.77  76.78  76.79  76.81  76.82  76.83  76.88  76.89  76.92  76.93  76.98
##      1      1      1      1      1      1      1      1      1      1      1
##  76.99  77.01  77.04  77.06  77.07  77.08   77.1  77.12  77.16  77.19   77.2
##      1      1      2      1      1      2      1      3      2      2      1
##  77.23  77.24  77.26  77.28  77.29   77.3  77.32  77.33  77.35  77.37  77.42
##      1      1      1      1      2      1      1      1      1      1      2
##  77.43  77.44  77.45  77.46  77.48  77.49   77.5  77.51  77.52  77.53  77.54
##      1      1      1      3      1      1      1      1      3      1      2
##  77.55  77.57  77.59   77.6  77.63  77.65  77.66  77.67  77.68  77.72  77.73
##      4      2      2      1      1      1      1      4      1      1      1
##  77.75  77.76  77.77  77.79  77.82  77.83  77.86  77.87  77.88  77.91  77.92
##      1      1      1      1      3      1      1      1      1      3      2
##  77.93  77.94  77.95  77.96  77.99     78  78.02  78.03  78.04  78.05  78.08
```

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##      3      2      1      1      2      1      1      1      2      3      1
##  78.09  78.11  78.12  78.14  78.16  78.18  78.23  78.24  78.26  78.28  78.29
##      1      2      1      1      2      2      1      4      2      1      3
##   78.3  78.32  78.34  78.35  78.38   78.4  78.42  78.43  78.44  78.45  78.46
##      1      2      2      1      1      1      1      3      1      1      2
##  78.48  78.49   78.5  78.52  78.53  78.57  78.59  78.65  78.68   78.7  78.73
##      3      1      1      1      1      1      2      1      2      2      1
##  78.74  78.75  78.76  78.78  78.79   78.8  78.81  78.85  78.88   78.9  78.91
##      1      1      1      1      3      2      1      2      1      2      1
##  78.92  78.93  78.94  78.96  78.97  78.98  78.99     79  79.02  79.03  79.05
##      1      3      2      1      1      2      1      1      1      3      2
##  79.08  79.09  79.13  79.14  79.15  79.16  79.17  79.18   79.2  79.21  79.22
##      1      1      1      1      1      2      2      2      3      1      1
##  79.25  79.26  79.27   79.3  79.33  79.34  79.35  79.36  79.39  79.42  79.44
##      1      1      1      2      3      1      2      1      2      1      2
##  79.47  79.49  79.51  79.53  79.54  79.55  79.56  79.57  79.58  79.59   79.6
##      1      1      1      2      1      2      1      2      2      2      2
##  79.61  79.62  79.63  79.64  79.66  79.69   79.7  79.73  79.76  79.77  79.79
##      1      1      2      1      1      1      1      1      1      1      2
##   79.8  79.81  79.82  79.83  79.84  79.85  79.87  79.89  79.91  79.92  79.94
##      2      3      1      1      1      1      1      4      1      2      2
##  79.95  79.96  79.98  79.99     80  80.01  80.05  80.06  80.07  80.08  80.09
##      1      1      1      1      2      1      1      1      2      4      1
##   80.1  80.13  80.15  80.17  80.18  80.19   80.2  80.21  80.22  80.24  80.25
##      1      1      1      1      1      1      1      1      1      1      1
##  80.27  80.28   80.3  80.33  80.34  80.35   80.4  80.42  80.43  80.44  80.47
##      1      2      1      1      1      1      1      2      2      2      2
##  80.48  80.51  80.54  80.55  80.57  80.59  80.63  80.67  80.72  80.73  80.74
##      1      1      1      2      3      1      4      1      4      1      1
##  80.75  80.76  80.77  80.79   80.8  80.81  80.82  80.83  80.84  80.85  80.86
##      1      1      1      1      2      2      2      2      1      2      2
##  80.88  80.89  80.92  80.93  80.94  80.96  80.97  80.98  80.99     81  81.02
##      2      1      3      2      1      1      1      2      1      2      1
##  81.03  81.05  81.06   81.1  81.11  81.13  81.15  81.18   81.2  81.21  81.24
##      1      2      1      1      2      2      1      2      1      2      1
##  81.25  81.26  81.28  81.31  81.32  81.33  81.36  81.38  81.42  81.43  81.44
##      2      2      1      2      2      2      1      2      2      1      1
##  81.51  81.53  81.54  81.58  81.59   81.6  81.64  81.66  81.68  81.71  81.73
##      4      1      3      1      2      1      2      2      3      1      2
##  81.74  81.76  81.77  81.78  81.84  81.87  81.88   81.9  81.92  81.94  81.95
##      1      2      3      2      1      1      1      1      2      2      1
##  81.96  81.99     82  82.01  82.02  82.05  82.06  82.07  82.08  82.09   82.1
##      3      1      1      1      1      1      1      2      2      2      2
##  82.12  82.13  82.14  82.15  82.18  82.19   82.2  82.21  82.24  82.25  82.26
##      1      1      1      1      2      1      1      2      2      1      2
##  82.27  82.28   82.3  82.31  82.32  82.33  82.34  82.35  82.36  82.37  82.38
##      2      1      2      2      1      1      2      2      1      1      2
##  82.39   82.4  82.41  82.42  82.43  82.44  82.46  82.47  82.48  82.49  82.53
##      3      1      3      1      1      3      1      1      1      1      1
##  82.56  82.57  82.58  82.59  82.61  82.62  82.63  82.64  82.67  82.68  82.69
##      2      3      1      3      1      2      1      3      1      1      1
##  82.71  82.72  82.73  82.77  82.81  82.83  82.84  82.85  82.86  82.88  82.89
##      1      2      1      1      3      2      1      3      1      1      1
##   82.9  82.91  82.93  82.94  82.95  82.99  83.01  83.02  83.03  83.06  83.07
```

```
##      1      2      2      1      1      1      1      1      1      1      2
##  83.09   83.1  83.12  83.13  83.14  83.15  83.16   83.2  83.23  83.24  83.26
##      1      2      2      2      2      1      5      1      1      1      2
##  83.27  83.28   83.3  83.33  83.34  83.37  83.41  83.42  83.43  83.44   83.5
##      2      1      2      1      1      2      2      1      1      1      2
##  83.51  83.52  83.53  83.55  83.56  83.57  83.58  83.59   83.6  83.61  83.62
##      3      2      1      2      2      1      1      1      1      1      1
##  83.64  83.65  83.66  83.68   83.7  83.73  83.74  83.75  83.76  83.78  83.79
##      1      1      1      1      2      1      1      3      1      1      2
##   83.8  83.82  83.83  83.84  83.85  83.86  83.88  83.89  83.91  83.93  83.94
##      1      1      2      2      1      1      2      2      3      1      1
##  83.95  83.97  84.02  84.03  84.04  84.06  84.07  84.08  84.09   84.1  84.11
##      1      1      1      3      2      1      2      2      1      5      1
##  84.12  84.13  84.14  84.16  84.17  84.18  84.19   84.2  84.21  84.25  84.27
##      2      2      1      1      1      2      1      2      2      1      1
##   84.3  84.31  84.35  84.37  84.38   84.4  84.41  84.42  84.43  84.44  84.46
##      2      3      1      1      1      4      1      1      2      1      3
##  84.47  84.48  84.49   84.5  84.54  84.56  84.58  84.59   84.6  84.62  84.63
##      1      2      2      1      1      1      1      2      2      1      1
##  84.66  84.68  84.69   84.7  84.75  84.78  84.79  84.81  84.84  84.85  84.86
##      1      2      1      1      1      1      3      1      1      2      4
##  84.88   84.9  84.91  84.92  84.93  84.94  84.96  84.99     85  85.02  85.03
##      2      2      1      1      3      1      1      1      2      1      2
##  85.04  85.06  85.07  85.08  85.12  85.13  85.15  85.16  85.17  85.18  85.22
##      2      1      3      1      2      1      1      2      2      1      1
##  85.23  85.27  85.28  85.29  85.33  85.35  85.37  85.38  85.46  85.48  85.51
##      1      2      1      2      2      1      1      1      1      1      1
##  85.52  85.53  85.54  85.55  85.57  85.59   85.6  85.62  85.64  85.65  85.66
##      2      1      1      1      2      2      3      2      1      1      2
##  85.68  85.77  85.79  85.81  85.82  85.83  85.84  85.86  85.87  85.88   85.9
##      1      2      2      4      3      1      4      1      1      1      1
##  85.91  85.92  85.96  85.97  85.98  85.99     86  86.03  86.04  86.05  86.06
##      1      2      1      1      1      1      3      1      1      2      4
##  86.07  86.09   86.1  86.11  86.15  86.19  86.21  86.23  86.24  86.25  86.26
##      2      2      1      2      1      1      3      1      2      2      1
##   86.3  86.32  86.33  86.34  86.35  86.36  86.37  86.38  86.39   86.4  86.46
##      2      1      1      1      1      2      1      1      1      2      1
##  86.49  86.51  86.53  86.55  86.57  86.58   86.6  86.61  86.62  86.67  86.68
##      1      1      2      2      2      1      2      1      1      2      1
##   86.7  86.73  86.74  86.75  86.78  86.84  86.85  86.86  86.87  86.91  86.92
##      1      1      1      1      2      1      1      2      1      1      1
##  86.93  86.94  86.95  86.96  86.97  86.99     87  87.01  87.03  87.06  87.08
##      1      1      1      3      2      2      2      1      1      2      1
##  87.09   87.1  87.11  87.12  87.15  87.16  87.17  87.18   87.2  87.21  87.23
##      1      2      1      1      3      2      1      1      1      1      1
##  87.24  87.25  87.26  87.27  87.29  87.33  87.34  87.39   87.4  87.41  87.43
##      1      1      1      1      1      1      1      2      2      1      1
##  87.44  87.47  87.49   87.5  87.51  87.52  87.54  87.56  87.62  87.66  87.69
##      1      1      1      1      2      2      2      1      2      1      2
##   87.7  87.71  87.72  87.74  87.77  87.78  87.79   87.8  87.81  87.82  87.84
##      1      1      4      2      2      1      1      1      2      1      1
##  87.85  87.86  87.87  87.88  87.91  87.92  87.93  87.94  87.95  87.96  87.98
##      1      1      1      1      1      2      1      2      1      2      2
##     88  88.02  88.04  88.05  88.06   88.1  88.11  88.13  88.17  88.18  88.19
```

```
##      1      1      2      1      1      1      1      1      1      1      2
##   88.2  88.23  88.24  88.27  88.29  88.31  88.32  88.33  88.34  88.38  88.39
##      3      2      1      2      1      1      1      1      1      2      1
##  88.41  88.43  88.44  88.47  88.48  88.49   88.5  88.51  88.52  88.53  88.54
##      1      1      1      2      1      1      1      3      1      1      1
##  88.56  88.57   88.6  88.62  88.63  88.65  88.66  88.68  88.69  88.75  88.78
##      1      2      2      1      1      3      1      1      1      1      1
##  88.79  88.81  88.82  88.83  88.85  88.88  88.89   88.9  88.92  88.97  88.98
##      3      2      1      4      2      1      1      1      1      3      1
##     89  89.01  89.02  89.03  89.04  89.05  89.06  89.11  89.13  89.14  89.16
##      1      1      1      2      1      1      2      4      1      2      1
##  89.17  89.18  89.21  89.22  89.24  89.28  89.29   89.3  89.31  89.32  89.33
##      1      2      1      2      2      2      1      3      1      3      1
##  89.37  89.38  89.41  89.42  89.43  89.44  89.45  89.52  89.53  89.57  89.58
##      1      1      1      1      1      2      2      1      2      2      1
##  89.59  89.61  89.63  89.68   89.7  89.72  89.73  89.74  89.75  89.77  89.81
##      1      3      1      4      1      1      1      1      1      1      1
##  89.83  89.84  89.85  89.86  89.87  89.88  89.93  89.95  89.96  89.98  89.99
##      1      1      1      1      1      1      1      1      3      1      1
##     90  90.01  90.04  90.06  90.07   90.1  90.11  90.12  90.15  90.16  90.19
##      3      2      1      2      2      1      2      1      1      2      2
##  90.21  90.22  90.26  90.28  90.29   90.3  90.31  90.35  90.36  90.38  90.39
##      1      2      2      1      1      2      2      3      1      1      1
##   90.4  90.42  90.43  90.44  90.46  90.49  90.51  90.52  90.54  90.55  90.57
##      2      4      3      1      1      1      2      1      2      2      1
##  90.58   90.6  90.61  90.62  90.65  90.66  90.67  90.68  90.69  90.71  90.73
##      2      2      1      1      2      1      1      1      1      1      1
##  90.74  90.77  90.78  90.84  90.87   90.9  90.91  90.92  90.95  90.96  90.97
##      1      3      2      1      1      2      1      2      1      1      1
##     91  91.01  91.02  91.04  91.05  91.08  91.09  91.13  91.16  91.18  91.19
##      1      1      2      2      2      3      1      1      1      1      1
##  91.21  91.23  91.25  91.28   91.3  91.32  91.34  91.35  91.36  91.44  91.45
##      2      1      2      2      1      1      2      2      1      1      2
##  91.46  91.47  91.53  91.54  91.56  91.57  91.58   91.6  91.61  91.63  91.65
##      1      1      2      2      1      1      1      1      1      2      3
##  91.68  91.69  91.71  91.72  91.81  91.82  91.85  91.88  91.89   91.9  91.92
##      5      1      1      1      1      3      5      1      2      1      1
##  91.93  91.95  91.96  91.97  91.98     92  92.02  92.04  92.06  92.08  92.11
##      2      1      1      1      2      1      1      2      1      1      2
##  92.13  92.14  92.15  92.16  92.17   92.2  92.21  92.22  92.23  92.24  92.26
##      1      3      1      1      1      1      2      2      2      1      2
##  92.27   92.3  92.32  92.34  92.35  92.37  92.39   92.4  92.43  92.44  92.48
##      1      1      2      1      1      1      1      1      1      1      1
##  92.49  92.56  92.59  92.62  92.64  92.65  92.67   92.7  92.71  92.72  92.73
##      2      1      3      2      1      3      1      1      2      1      2
##  92.74  92.75  92.76  92.77  92.78  92.81  92.82  92.86  92.87   92.9  92.95
##      1      1      1      1      1      2      4      3      3      1      2
##  92.96  92.97  92.98  92.99     93  93.02  93.03  93.04  93.05  93.07  93.11
##      1      1      2      1      1      1      1      2      1      1      1
##  93.13  93.14  93.15  93.17  93.18   93.2  93.21  93.23  93.24  93.25  93.28
##      2      1      1      1      1      2      2      1      2      1      2
##  93.29   93.3  93.34  93.36  93.47  93.48  93.51  93.52  93.55  93.58   93.6
##      1      3      1      1      1      2      3      2      4      2      2
##  93.61  93.62  93.64  93.67  93.68  93.71  93.72  93.73  93.74  93.76  93.77
```

```
##      1      1      1      3      1      1      2      1      4      1      1
##  93.78  93.79   93.8  93.81  93.85  93.88  93.89   93.9  93.93  93.96  93.97
##      1      1      1      1      2      6      1      1      2      1      2
##  93.99     94  94.03  94.04  94.06  94.07  94.09  94.11  94.12  94.14  94.15
##      1      1      1      1      1      1      1      1      3      1      2
##  94.18  94.19   94.2  94.22  94.23  94.24  94.25  94.26  94.27  94.29   94.3
##      1      2      1      1      1      2      1      1      1      1      2
##  94.33  94.34  94.37  94.38  94.39   94.4  94.44  94.45  94.47  94.48  94.49
##      1      1      1      1      2      1      1      1      1      1      1
##  94.53  94.59  94.61  94.62  94.63  94.64  94.65  94.66  94.67  94.68  94.69
##      1      1      1      2      2      1      1      1      2      1      1
##  94.71  94.75  94.76  94.77  94.78  94.88  94.89  94.92  94.96  94.98  95.01
##      2      2      1      3      1      1      2      3      3      1      3
##  95.02  95.04  95.05  95.07  95.08   95.1  95.12  95.16  95.18  95.19   95.2
##      1      2      1      1      2      2      2      2      1      1      1
##  95.23  95.24  95.25  95.27  95.28  95.29  95.31  95.32  95.33  95.36  95.37
##      1      1      1      1      1      1      1      1      1      3      2
##  95.38  95.39   95.4  95.42  95.43  95.44  95.46  95.47  95.49   95.5  95.52
##      1      1      2      1      1      2      1      1      3      1      1
##  95.57  95.58  95.59  95.62  95.66   95.7  95.75  95.79   95.8  95.81  95.82
##      1      1      1      2      1      1      1      1      1      1      1
##  95.84  95.85  95.86  95.87  95.88  95.89  95.93  95.94  95.98     96  96.01
##      1      1      1      3      2      1      1      2      1      1      2
##  96.02  96.03  96.04  96.06   96.1  96.14  96.15  96.16  96.17  96.18  96.19
##      3      1      2      2      1      1      1      1      1      1      1
##   96.2  96.21  96.24  96.25  96.26  96.28  96.29   96.3  96.35  96.37  96.42
##      1      1      1      1      2      1      1      1      1      1      1
##  96.43  96.47  96.52  96.57  96.58  96.59  96.62  96.63  96.69   96.7  96.73
##      1      2      1      1      1      1      2      1      2      1      1
##  96.75  96.77  96.78  96.79  96.81  96.82  96.84  96.85  96.86  96.88  96.91
##      1      2      1      1      1      1      3      2      2      1      1
##  96.93  96.95  96.97  96.98  96.99  97.04  97.05  97.06  97.08  97.12  97.14
##      1      1      1      1      1      1      1      3      1      1      1
##  97.16  97.22  97.23  97.24  97.25  97.26  97.27  97.28  97.31  97.32  97.34
##      1      1      2      3      1      1      1      1      1      1      1
##  97.35  97.37  97.39   97.4  97.41  97.43  97.46  97.47  97.49   97.5  97.51
##      1      2      2      1      1      1      2      2      1      1      1
##  97.52  97.53  97.55  97.57  97.58  97.59   97.6  97.61  97.64  97.65  97.68
##      1      1      2      1      2      1      2      1      1      1      1
##  97.73  97.76  97.78  97.81  97.84  97.86  97.87  97.89   97.9  97.92  97.93
##      1      1      2      1      1      1      1      2      1      2      1
##  97.95  97.96  97.97  97.99  98.01  98.02  98.03  98.05  98.07  98.09   98.1
##      3      1      1      1      1      2      1      2      2      2      1
##  98.12  98.14  98.22  98.23  98.24  98.27   98.3  98.34  98.35  98.37  98.39
##      2      2      1      1      1      1      1      1      1      1      1
##  98.41  98.42  98.44  98.45  98.46  98.52  98.53  98.54  98.55  98.56  98.57
##      1      2      2      1      1      1      1      1      2      1      1
##  98.58  98.61  98.65  98.66  98.67  98.69   98.7  98.71  98.73  98.74  98.76
##      1      1      1      1      1      1      1      1      1      2      1
##  98.84  98.85   98.9  98.91  98.92  98.99     99  99.01  99.06  99.07   99.1
##      1      1      2      1      2      1      2      1      1      3      1
##  99.12  99.13  99.14  99.15  99.16   99.2  99.21  99.23  99.29   99.3  99.33
##      1      1      1      1      1      1      1      2      2      1      1
##  99.34  99.35  99.36   99.4  99.44  99.47  99.48  99.49  99.58   99.6  99.64
```

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##      1      1      1      1      3      1      1      2      1      1      1
##  99.65  99.67  99.68  99.69  99.71  99.72  99.73  99.75  99.76  99.78  99.79
##      1      1      2      1      1      1      1      1      3      1      1
##   99.8  99.82  99.83  99.84  99.87  99.91  99.92  99.94  99.96  99.97 100.01
##      1      1      2      1      2      1      1      1      2      1      1
## 100.02 100.03 100.05 100.06 100.08 100.09 100.12 100.15 100.16 100.19  100.2
##      1      1      1      1      1      2      1      1      2      1      1
## 100.22 100.26 100.29 100.31 100.33 100.35 100.39 100.41 100.42 100.47 100.49
##      1      1      1      2      2      1      1      1      1      2      1
## 100.52 100.54  100.6 100.61 100.65 100.66 100.71 100.74 100.75  100.8 100.81
##      2      4      1      2      1      1      1      1      1      3      1
## 100.82 100.83 100.84 100.85 100.88 100.91 100.93 100.96 100.97 100.98 101.02
##      1      1      1      2      1      1      1      1      1      2      1
## 101.05 101.06 101.07 101.09 101.12 101.13 101.15 101.19 101.22 101.24 101.25
##      1      1      1      1      1      2      1      2      1      1      1
## 101.26 101.28  101.3 101.31 101.32 101.34 101.35 101.37 101.41 101.43 101.45
##      1      1      2      2      1      1      1      1      1      2      2
## 101.46  101.5 101.52 101.53 101.56 101.57 101.58  101.6 101.61 101.65 101.66
##      2      1      2      1      1      1      1      1      1      1      1
## 101.75 101.76 101.79 101.81 101.83 101.85 101.87 101.89 101.92 101.93 101.95
##      1      1      1      2      1      1      2      1      1      2      1
## 101.96 101.98 101.99    102 102.01 102.03 102.04 102.05 102.06 102.07 102.08
##      1      1      1      2      1      1      1      1      1      2      1
##  102.1 102.11 102.13 102.15 102.16 102.21 102.27 102.28  102.3 102.34 102.35
##      2      1      1      1      1      1      2      1      1      2      1
## 102.36 102.37 102.39  102.4 102.42 102.46 102.47 102.48  102.5 102.51 102.53
##      1      1      2      1      1      1      1      1      3      2      1
## 102.54 102.58 102.61 102.64 102.71 102.73 102.76 102.77 102.84 102.87 102.88
##      1      1      1      2      1      1      1      1      1      2      1
## 102.89  102.9 102.91 102.92 102.96 102.97    103 103.01 103.06 103.08 103.09
##      2      1      1      1      1      3      1      1      1      2      1
## 103.11 103.12 103.15 103.17 103.21 103.22 103.25 103.26 103.28 103.29 103.34
##      1      1      1      1      1      1      2      1      1      1      1
## 103.35 103.37 103.43 103.44 103.45 103.46 103.48  103.5 103.51 103.55 103.56
##      1      1      2      3      1      1      1      1      1      1      1
## 103.58  103.6 103.61 103.62 103.65 103.66 103.68 103.69 103.72 103.73 103.76
##      1      1      2      1      1      1      1      1      1      1      2
## 103.78 103.79 103.81 103.86 103.89 103.92 103.94    104 104.02 104.03 104.04
##      3      1      1      1      1      1      2      1      2      2      1
## 104.05 104.07 104.08 104.09 104.12 104.16 104.21 104.23 104.24 104.26  104.3
##      1      1      1      1      3      1      2      1      1      1      1
## 104.33 104.34 104.36 104.37 104.38  104.4 104.42 104.45 104.47 104.48 104.51
##      1      1      2      1      1      1      1      1      1      2      2
## 104.55 104.62 104.64 104.66  104.7 104.72 104.75 104.77 104.79 104.86  104.9
##      3      1      1      1      2      1      1      1      1      2      1
## 104.92 104.95 105.05 105.08 105.18 105.19 105.22 105.26 105.28 105.29 105.34
##      1      1      1      1      1      1      3      1      2      2      1
## 105.36 105.47 105.48 105.49 105.51 105.52 105.55 105.59 105.61 105.63 105.72
##      1      1      1      1      1      2      1      1      1      3      1
## 105.73 105.74 105.75 105.76 105.77 105.88  105.9 105.91 105.92 105.93 105.95
##      2      1      1      2      2      1      2      1      1      1      1
## 105.99 106.01 106.02 106.03 106.08  106.1 106.11 106.13 106.18 106.22 106.23
##      1      1      1      2      1      1      1      1      1      2      1
## 106.24 106.27 106.33 106.35  106.4 106.41 106.43 106.47 106.51 106.52 106.53
```

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##      1      1      1      2      1      3      1      1      2      1      1
## 106.54 106.56 106.58 106.59 106.65 106.68 106.69  106.7 106.73 106.74 106.76
##      2      2      1      1      1      2      1      1      1      2      1
##  106.8 106.83 106.84 106.85 106.95 106.97 106.98 107.02 107.06 107.11 107.17
##      1      1      1      1      1      1      1      1      1      1      1
## 107.18 107.21 107.22 107.25 107.26 107.27 107.29 107.33  107.4 107.41 107.42
##      3      1      1      1      1      1      2      1      2      1      2
## 107.43 107.45 107.46 107.47 107.49  107.5 107.52 107.55 107.58 107.59 107.61
##      1      1      1      3      1      1      2      1      1      2      1
## 107.69 107.72 107.74 107.78 107.82 107.83 107.84 107.91 107.97 107.98 107.99
##      1      1      2      1      1      2      1      2      1      1      1
## 108.03 108.06 108.08  108.1 108.12 108.14 108.18  108.2 108.23 108.32 108.33
##      2      1      2      1      1      1      1      1      2      1      1
## 108.34 108.35 108.38 108.43 108.47 108.51 108.53 108.56 108.61 108.62 108.63
##      1      1      1      1      1      2      1      2      1      2      2
## 108.64 108.65 108.68 108.71 108.72 108.75 108.79  108.8 108.82 108.87 108.89
##      2      1      1      1      1      1      1      2      1      1      1
## 108.96    109 109.02 109.03 109.09  109.1 109.12 109.16 109.19 109.22 109.23
##      1      1      1      2      1      1      1      1      1      1      1
## 109.27  109.3 109.32 109.33 109.39  109.4 109.46 109.47 109.51 109.52 109.56
##      1      1      1      1      1      1      1      1      4      1      3
## 109.59 109.65 109.68 109.69 109.73 109.78 109.81 109.82 109.85 109.88 109.97
##      1      1      1      1      1      1      1      1      1      1      1
## 110.07  110.1 110.14 110.15 110.16 110.17 110.18  110.2 110.23 110.25 110.28
##      1      1      1      1      1      1      2      1      1      1      1
## 110.32 110.33 110.36 110.38 110.41 110.42 110.47 110.52 110.53 110.55  110.6
##      1      2      1      3      2      2      1      1      1      1      1
## 110.63 110.66 110.68 110.69  110.7 110.72 110.73 110.76 110.78 110.84 110.85
##      1      1      2      1      1      1      1      1      1      1      1
## 110.87 110.89 110.91 110.92 110.96 110.97 110.99 111.02 111.04 111.08  111.1
##      1      1      1      1      1      1      1      2      2      2      2
## 111.13 111.15 111.19 111.21 111.22 111.24 111.27 111.32 111.33 111.36 111.37
##      1      2      1      1      1      1      2      1      2      1      1
## 111.38 111.41 111.43 111.47 111.48 111.61 111.64 111.65 111.68 111.71 111.73
##      2      1      1      1      3      1      2      2      1      1      1
## 111.76 111.77 111.78 111.79 111.81 111.84 111.85 111.92 111.93 111.94 111.96
##      1      1      1      1      3      1      1      1      1      2      1
## 111.98 111.99 112.02 112.06 112.07 112.08 112.09 112.11 112.12 112.16 112.17
##      1      1      2      1      1      2      2      1      1      2      1
## 112.19  112.2 112.22 112.23 112.24 112.25 112.29  112.3 112.31 112.33 112.34
##      3      1      1      1      1      1      1      1      1      1      1
## 112.35 112.37 112.38 112.39 112.41 112.43 112.44 112.46 112.47 112.54 112.55
##      1      1      1      1      1      1      1      1      1      2      1
## 112.62 112.64 112.66 112.69  112.7 112.72 112.75 112.77 112.79 112.83 112.92
##      1      1      1      1      1      1      1      1      1      1      1
## 112.94 112.95 112.96 112.98 113.01 113.05 113.08  113.1 113.11  113.2 113.21
##      1      1      2      2      2      1      1      1      1      1      2
## 113.24 113.25 113.26 113.28 113.34  113.4 113.41 113.45 113.47 113.57 113.63
##      1      1      1      1      1      2      1      1      1      1      2
## 113.64 113.65 113.68 113.74  113.8 113.84 113.85 113.86 113.87 113.95 113.96
##      1      1      2      1      1      1      2      1      1      1      1
## 114.01 114.02 114.05 114.09 114.16 114.18 114.21 114.25 114.32 114.33 114.34
##      1      1      1      2      2      1      1      1      4      1      2
## 114.37 114.41 114.45 114.46 114.47  114.5 114.53 114.54 114.61 114.71 114.76
```

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##      1      1      1      1      1      1      1      2      1      2      1
## 114.77 114.79 114.82 114.84 114.88 114.89 114.92 114.94 114.99 115.03 115.07
##      1      1      1      1      2      1      1      1      1      1      1
## 115.12 115.13 115.16 115.21 115.22 115.23 115.29  115.4 115.42 115.43 115.46
##      1      1      1      1      1      1      1      1      1      1      1
## 115.47 115.52 115.54 115.68 115.69 115.71 115.79 115.83 115.86 115.91 115.92
##      2      2      1      1      1      1      1      1      1      1      1
## 115.93 115.98 115.99 116.02 116.04 116.06  116.1 116.12 116.14  116.2 116.21
##      1      2      1      1      2      1      1      1      1      2      1
## 116.23 116.25 116.38 116.44 116.49  116.5 116.55  116.6 116.62 116.64 116.66
##      1      1      1      2      1      1      1      1      1      1      1
## 116.67 116.68 116.69 116.76 116.78 116.84 116.85 116.93 116.95 116.98 117.03
##      1      1      1      1      1      1      1      1      1      2      2
## 117.04 117.31 117.34 117.45 117.59 117.63 117.69 117.75 117.77 117.92 117.98
##      1      1      1      1      1      2      1      1      1      1      1
## 118.03 118.14 118.21 118.22 118.41 118.44 118.46 118.51 118.55 118.61 118.62
##      1      1      1      1      1      1      1      1      3      1      1
## 118.66 118.69  118.7 118.75 118.81 118.82 118.85 118.87 118.88 118.89 118.93
##      2      1      1      1      2      2      1      1      1      1      1
## 119.01 119.03 119.04 119.13  119.3 119.32 119.34  119.4 119.52 119.58 119.61
##      1      1      1      1      1      1      1      1      1      2      1
## 119.62 119.67 119.77 119.88  119.9 119.96 120.03 120.05 120.06 120.07 120.09
##      1      1      1      1      2      1      1      1      1      1      1
## 120.15 120.22 120.23 120.25 120.27 120.31 120.43 120.44 120.46 120.56 120.58
##      1      1      1      1      1      1      1      1      2      1      2
## 120.77 120.85 120.94 120.96 121.04 121.11 121.14 121.15 121.17 121.19 121.27
##      2      1      1      1      1      1      1      1      1      1      1
## 121.32 121.39 121.43 121.44 121.46  121.6 121.66 121.71  121.8 121.83 121.99
##      1      1      1      1      1      1      2      1      1      1      1
## 122.01 122.04  122.1 122.19 122.22 122.23 122.25 122.26 122.31 122.32 122.38
##      1      1      1      1      1      1      2      1      1      1      1
## 122.39 122.41 122.43 122.46 122.48  122.5 122.73 122.74 122.75 122.83 122.91
##      1      1      1      1      1      1      1      1      1      1      1
##    123 123.04 123.08  123.1 123.15 123.21 123.23 123.36 123.39 123.47 123.49
##      1      2      1      2      1      1      1      1      1      1      2
## 123.61 123.65 123.66 123.79 123.81 123.83 123.87 123.89 123.94 123.95 123.98
##      1      1      2      1      1      1      2      1      1      1      1
## 124.01 124.06 124.08 124.13 124.16 124.26 124.31 124.34 124.35 124.37 124.38
##      1      1      1      1      2      1      1      1      1      2      2
## 124.39 124.45 124.48 124.49  124.5 124.54  124.6 124.61 124.64 124.66 124.78
##      1      1      1      1      2      1      1      1      1      1      1
## 124.92 125.03 125.09 125.11 125.14  125.2 125.26 125.29  125.3 125.32 125.33
##      1      1      1      1      1      1      1      1      1      1      1
## 125.38 125.43 125.63 125.68 125.74 125.87 125.89 125.98 126.04 126.09 126.12
##      1      1      1      1      1      1      2      1      1      1      1
## 126.18 126.32 126.34 126.35 126.39 126.57 126.67 126.68 126.82 126.85 126.96
##      1      1      2      2      1      1      1      1      1      1      1
## 126.99 127.13 127.18  127.2 127.21 127.23 127.25 127.28 127.29 127.32  127.4
##      1      1      1      1      1      1      1      1      2      1      1
## 127.42 127.57 127.71 127.75 127.78 128.04 128.17 128.23 128.28 128.61 128.63
##      1      1      1      1      1      1      1      1      1      1      2
## 128.72 128.97 129.01 129.07 129.16 129.19 129.31 129.43 129.53 129.54 129.66
##      2      1      2      1      3      1      2      2      1      1      1
## 129.73 129.97 129.98    130 130.07 130.15 130.34 130.37 130.54 130.56 130.61
```

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##      1      1      1      1      2      1      1      1      1      1      1
## 131.05 131.19 131.23 131.28  131.3  131.4 131.41 131.42 131.43 131.51 131.63
##      1      1      1      1      1      1      1      1      2      1      1
## 131.77  131.8 131.81 131.85 131.89 131.99 132.08 132.41 132.46 132.85 132.88
##      1      1      1      1      1      1      1      1      1      1      1
## 133.13 133.19  133.2 133.24 133.58 133.62 133.63 133.76 133.82 134.12 134.23
##      1      1      1      2      1      1      1      1      1      1      1
## 134.24 134.29 134.33 134.39 134.45 134.59 134.61 134.65 134.76  134.8 135.19
##      1      1      1      1      1      1      1      1      1      2      2
## 135.32 135.63 135.64 135.74 135.75 135.79 135.82 135.84 135.89  136.1 136.18
##      1      1      1      1      1      1      1      1      1      1      1
##  136.2 136.23  136.8 136.81 136.96 137.22 137.27  137.3 137.45 137.74 137.77
##      1      1      1      1      1      1      1      1      1      1      1
## 137.91 137.94 137.96 138.02 138.06 138.07 138.16 138.29 138.44 138.47 138.51
##      1      1      1      1      1      1      1      1      1      1      1
## 138.55  139.2 139.43 139.48 139.67 139.72 139.77 139.81 139.87  139.9 140.07
##      1      1      1      1      1      1      1      1      1      1      1
## 140.08  140.1 140.14 140.28 140.39  140.4 140.52 140.93 140.96 141.09 141.15
##      1      2      1      1      1      1      1      1      1      1      1
## 141.16 141.23 141.24 141.37  141.8 141.84 142.02 142.12 142.31 142.38 142.57
##      1      1      1      1      1      1      1      2      2      1      1
## 142.63 142.64 142.68 142.82 143.15 143.33 143.43 143.45 143.47 143.97 144.08
##      1      1      1      1      1      1      1      2      1      1      1
##  144.1 144.14 144.15 144.16  144.2 144.23 144.33 144.48  144.9 145.03 145.15
##      2      1      1      1      1      1      1      1      1      1      1
## 145.18 145.22 145.23 145.25 145.26 145.37 145.46  145.5 145.71 145.94 146.01
##      1      1      1      1      1      1      1      1      1      1      1
## 146.08  146.1 146.21 146.44 146.59 146.61 146.97 147.04 147.12 147.14 147.42
##      1      1      1      1      1      1      1      1      1      1      1
## 147.48  147.5 147.74 148.24 148.37 148.52 148.72 148.91 149.13 149.15 149.17
##      1      1      1      1      1      1      1      1      1      1      1
## 149.42 149.62 149.68 149.75  149.8  149.9 149.95    150 150.03  150.1 150.27
##      1      1      1      1      1      1      1      1      1      1      1
## 150.45 150.74 151.16 151.23 151.25 151.26  151.3 151.33 151.56 152.02 152.38
##      1      1      1      1      2      1      1      1      1      1      1
## 152.56 152.81 152.84 152.87 153.08 153.24 153.31 153.34 153.38 153.48  153.6
##      1      1      1      1      1      1      1      1      1      1      1
## 153.76 154.03 154.08  154.6 154.67 154.75 155.14 155.17 155.23 155.32 155.43
##      1      1      1      1      1      1      1      1      1      1      1
## 155.86 156.18 156.43 156.45 156.57 156.69  156.7 156.82 157.01 157.57 157.67
##      1      1      1      1      1      1      1      1      2      1      1
## 157.77 158.31 158.33 158.48 158.89  158.9 158.93 159.39 159.67  159.7 159.79
##      1      1      1      1      1      1      1      2      1      1      1
##    160 160.64 160.76 160.83 160.87 160.94    161 161.28 161.57 161.95 162.14
##      1      1      1      1      1      1      1      1      1      1      1
## 162.23 162.24  162.3 162.72 162.93 162.96 163.02 163.17 163.56  163.7 163.82
##      1      1      1      1      1      1      1      1      1      1      1
## 164.67  164.7 164.77 165.11 165.31 165.36 165.47 165.99 166.29 166.38 167.13
##      1      1      1      1      1      1      1      1      1      1      1
## 167.16 167.31 167.41 167.59 167.66 168.06 168.15 168.68 169.43 169.49 169.67
##      1      1      1      1      1      1      2      1      1      1      1
## 169.74 169.97 170.05 170.22 170.76 170.88 170.93 170.95 171.23 172.27 172.33
##      1      1      1      1      1      1      1      1      1      1      1
## 172.86 173.14 173.43  173.9 173.96 173.97 174.12 174.37 174.43 174.54 175.29
```

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##      1      1      1      1      1      1      1      1      1      1      1
## 175.74 175.92 176.25 176.34 176.38 176.42 176.48 176.71 176.78 177.56 177.91
##      1      1      1      1      1      1      1      1      1      1      1
## 178.29 178.33 178.76 178.89 179.12 179.14 179.38 179.67 180.45 180.63 180.76
##      1      1      1      1      1      1      1      1      1      1      1
##  180.8 180.93 181.23  181.3  182.2 182.22 182.52 182.86  182.9 182.99    183
##      1      1      2      1      1      1      1      1      1      1      1
##  183.1 183.34 183.43 183.45 183.87 184.15 184.25  184.4    185 185.17 185.27
##      1      1      1      1      1      1      1      1      1      1      1
## 185.28 185.31 185.49 185.71 186.17 186.21 186.32  186.4 186.45 186.54 186.95
##      1      1      1      1      1      1      1      1      1      1      1
## 187.22 187.47 187.52 187.87 187.88 187.99 188.11 188.13 188.69 189.44 189.45
##      1      1      1      1      1      1      1      1      1      1      1
## 189.49 189.57 189.82 189.84 189.88 190.13 190.14 190.32  190.4 190.67  190.7
##      1      1      1      1      1      1      1      1      1      1      1
## 190.89 190.92 191.15 191.33 191.47 191.48 191.61 191.66 191.78 191.79 191.82
##      1      1      1      1      1      1      1      1      1      1      1
## 191.94 192.16 192.37 192.39 192.47  192.5 193.22 193.45 193.61  193.8 193.81
##      1      1      1      1      1      1      1      1      1      1      1
## 193.83 193.87 193.88 193.94 194.04 194.37 194.53 194.62 194.75 194.98 194.99
##      1      1      1      1      1      1      2      1      1      1      1
## 195.03 195.04 195.16 195.23 195.25 195.43 195.61 195.71 195.74 196.01 196.08
##      1      1      1      1      1      1      1      1      1      1      1
##  196.2 196.25 196.26 196.33 196.36  196.5 196.58 196.61 196.71 196.81 196.91
##      1      1      1      1      1      1      1      1      1      1      1
## 196.92 197.06 197.09  197.1 197.11 197.28 197.36 197.54 197.58 197.69 197.79
##      1      1      1      1      1      1      1      1      1      1      1
## 198.02 198.12 198.21 198.24  198.3 198.32 198.33 198.36 198.69 198.79 198.84
##      1      1      1      1      1      1      1      1      1      2      1
## 199.14 199.18  199.2 199.38 199.42 199.78 199.83 199.84 199.86 199.88 199.96
##      1      1      1      1      1      1      1      1      1      1      1
## 200.14 200.16 200.25 200.28 200.46 200.49 200.59 200.62 200.66 200.68 200.73
##      1      1      1      2      1      1      1      1      1      1      1
##  200.8 200.91 200.98 201.01 201.07 201.25 201.38 201.45 201.58 201.76 201.96
##      1      1      1      1      1      1      1      1      1      1      1
## 202.05 202.06 202.21 202.38 202.51 202.55 202.57 202.66 202.67 202.98 203.01
##      1      1      2      1      1      1      1      2      1      1      1
## 203.04 203.16 203.27 203.36 203.44 203.57 203.76 203.81 203.87 204.05 204.17
##      2      1      1      1      1      1      1      2      2      1      1
##  204.5 204.57 204.63 204.77 204.86 204.92 204.98    205 205.01 205.23 205.26
##      1      1      1      1      1      1      1      1      1      2      1
## 205.33 205.35  205.5 205.77 205.78 205.84 205.97 206.09 206.15 206.25 206.33
##      1      1      1      2      1      1      1      1      1      2      1
##  206.4 206.49 206.52 206.53 206.59 206.62 206.66 206.72 206.98 207.28 207.32
##      1      1      1      2      1      1      1      1      1      1      1
## 207.37 207.45 207.58  207.6 207.62 207.64 207.71 207.79 207.84 207.95 207.96
##      1      1      1      1      1      1      1      1      1      1      1
## 208.05 208.06 208.17  208.2  208.3 208.31 208.39 208.65 208.69 208.78 208.85
##      2      1      1      1      1      1      1      1      1      1      1
## 208.99 209.06 209.15 209.26  209.5 209.58 209.86  209.9    210 210.23  210.4
##      1      1      1      1      2      1      1      1      2      1      1
## 210.48 210.78 210.94 210.95 210.96 211.03 211.06 211.12 211.35 211.49 211.58
##      1      1      1      1      1      1      1      1      1      1      1
## 211.78 211.83 211.88 212.01 212.02 212.08 212.19 212.62 212.87 212.92 212.97
```

```
##      1      1      1      1      1      1      1      1      1      1      1
## 213.03 213.11 213.22 213.33 213.37 213.38 213.43 213.54  213.8 213.87 213.92
##      1      1      1      1      1      1      1      1      1      1      1
## 214.05 214.09 214.42 214.43 214.45 214.51 214.73 214.77 215.07 215.33  215.6
##      1      1      1      1      1      1      1      2      1      1      1
## 215.64 215.69 215.72 215.81  215.9 215.92 215.94    216 216.07 216.19 216.38
##      1      1      1      1      1      1      1      1      1      1      1
##  216.4 216.58 216.64  216.7 216.71 216.88  216.9 216.92 216.94 216.96    217
##      1      1      1      1      1      2      1      1      1      1      1
## 217.08 217.11  217.3 217.39  217.4 217.55 217.57 217.66 217.71 217.74 217.75
##      1      1      1      1      1      1      1      1      1      1      1
## 217.79 217.84 217.94    218  218.1 218.46 218.54  218.6 218.65 219.17 219.38
##      1      1      1      1      1      2      1      1      1      1      1
## 219.39  219.5 219.53 219.67  219.7 219.72 219.73  219.8 219.81 219.82 219.84
##      1      1      1      1      1      1      1      1      1      1      1
## 219.91 219.92 219.96 219.97 220.24 220.26 220.36 220.47 220.49 220.52 220.64
##      1      1      1      1      1      1      1      2      1      1      1
## 221.06 221.08 221.24 221.29 221.43 221.58 221.79  221.8 221.83 221.89 222.21
##      1      1      1      1      1      1      1      1      1      1      1
## 222.29 222.46 222.52 222.58  222.6 222.66 222.85 223.14 223.16 223.26 223.35
##      2      1      1      1      1      1      1      1      1      1      1
## 223.36 223.58 223.64 223.68 223.78 223.83  223.9  224.1 224.63 224.71 225.35
##      1      1      1      1      1      1      1      1      1      1      1
## 225.47  225.6 226.11 226.28 226.38  226.7 226.73 226.75 226.84 226.88 226.93
##      1      1      1      1      1      1      1      1      1      1      1
## 226.98 227.04  227.1 227.16 227.23 227.28 227.51 227.68 227.74 227.81 227.89
##      1      1      1      1      1      1      1      1      1      1      1
## 227.91 227.94 227.96 227.98 228.05 228.08  228.2 228.26 228.42  228.5 228.56
##      1      1      1      1      1      1      1      1      1      1      1
## 228.69  228.7 228.92  229.2 229.21 229.58 229.73 229.86 229.92 229.94 230.59
##      1      2      1      1      1      1      1      1      1      1      1
## 230.68 230.74 230.78 231.15 231.19 231.31 231.43  231.5 231.54 231.56 231.61
##      1      1      1      1      1      1      1      1      1      1      1
## 231.69 231.71 231.72 231.76 231.95 232.12 232.29 232.64 232.78 232.81 232.89
##      1      1      1      1      1      1      1      1      1      1      1
## 233.29  233.3 233.47 233.52 233.59 233.71 233.94 234.06 234.27 234.35 234.45
##      1      1      1      1      1      1      1      1      1      1      1
##  234.5 234.51 234.58 234.82 235.06 235.45 235.54 235.63 235.85 236.04 236.14
##      1      1      1      1      1      1      1      1      1      1      1
## 236.79 236.84 237.15 237.17 237.21 237.58 237.74 237.75 238.27 238.53 238.78
##      1      1      1      1      1      1      1      1      1      1      1
## 239.07 239.19 239.21 239.28 239.52 239.64 239.82 239.95 240.09 240.59 240.69
##      1      1      1      1      1      1      1      1      1      1      1
## 240.71 240.81 240.86  242.3 242.52 242.62 242.84 242.94  243.5 243.52 243.53
##      1      1      1      1      1      1      1      1      1      1      1
## 243.58 243.59 243.73 244.28  244.3 246.34 246.53 247.48 247.51 247.69 247.87
##      1      1      1      1      1      1      1      1      1      1      1
## 247.97 248.24 248.37 249.29 249.31  250.2  250.8 250.89 251.46  251.6 251.99
##      1      1      1      1      1      1      1      1      1      1      1
## 252.72 253.16 253.86 253.93  254.6 254.63 254.95 255.17 256.74 259.63 260.85
##      1      1      1      1      1      1      1      1      1      1      1
## 261.67 263.32 263.56 266.59  267.6 267.61 267.76 271.74
##      1      1      1      1      1      1      1      1
##
```

```
## $bmi
##
## 10.3 11.3 11.5   12 12.3 12.8   13 13.2 13.3 13.4 13.5 13.7 13.8 13.9   14 14.1
##    1    1    1    1    1    1    1    1    1    1    1    2    2    1    1    5
## 14.2 14.3 14.4 14.5 14.6 14.8 14.9   15 15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8
##    4    3    2    2    4    4    1    2    8    4    4    3    5    3    3    5
## 15.9   16 16.1 16.2 16.3 16.4 16.5 16.6 16.7 16.8 16.9   17 17.1 17.2 17.3 17.4
##    5    8    8   10   10   11    4    8   11    7    7   10   12   11    9   13
## 17.5 17.6 17.7 17.8 17.9   18 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9   19
##    7   16   13    7    7   16   12    9   17   10   12   19   13   15    8    7
## 19.1 19.2 19.3 19.4 19.5 19.6 19.7 19.8 19.9   20 20.1 20.2 20.3 20.4 20.5 20.6
##   11   13    9   14   21    7    8   17    9   17   25   16   17   23   18   15
## 20.7 20.8 20.9   21 21.1 21.2 21.3 21.4 21.5 21.6 21.7 21.8 21.9   22 22.1 22.2
##   12   17   13   17   16   16   21   22   27   16   14   18   14   15   22   30
## 22.3 22.4 22.5 22.6 22.7 22.8 22.9   23 23.1 23.2 23.3 23.4 23.5 23.6 23.7 23.8
##   18   22   13   18   25   25   16   27   21   20   19   36   31   24   16   22
## 23.9   24 24.1 24.2 24.3 24.4 24.5 24.6 24.7 24.8 24.9   25 25.1 25.2 25.3 25.4
##   24   28   28   29   26   23   26   22   22   31   27   27   34   18   28   26
## 25.5 25.6 25.7 25.8 25.9   26 26.1 26.2 26.3 26.4 26.5 26.6 26.7 26.8 26.9   27
##   33   21   15   24   24   25   37   27   23   34   30   29   37   21   34   35
## 27.1 27.2 27.3 27.4 27.5 27.6 27.7 27.8 27.9   28 28.1 28.2 28.3 28.4 28.5 28.6
##   28   24   36   22   29   37   37   23   28   28   29   25   30   38   27   27
## 28.7 28.8 28.9   29 29.1 29.2 29.3 29.4 29.5 29.6 29.7 29.8 29.9   30 30.1 30.2
##   41   26   31   26   29   26   22   30   26   26   27   23   26   27   26   20
## 30.3 30.4 30.5 30.6 30.7 30.8 30.9   31 31.1 31.2 31.3 31.4 31.5 31.6 31.7 31.8
##   30   17   24   18   23   21   27   22   26   19   21   30   27   21   14   24
## 31.9   32 32.1 32.2 32.3 32.4 32.5 32.6 32.7 32.8 32.9   33 33.1 33.2 33.3 33.4
##   22   21   24   20   28   19   21   19   21   25   13   15   25   17   15   16
## 33.5 33.6 33.7 33.8 33.9   34 34.1 34.2 34.3 34.4 34.5 34.6 34.7 34.8 34.9   35
##   23   11   19   13   13   17   15   17   18   18   21   11   20   15   11   12
## 35.1 35.2 35.3 35.4 35.5 35.6 35.7 35.8 35.9   36 36.1 36.2 36.3 36.4 36.5 36.6
##   10   16   12    9   13   15   13   24   18   11    7   12   13   10    4   14
## 36.7 36.8 36.9   37 37.1 37.2 37.3 37.4 37.5 37.6 37.7 37.8 37.9   38 38.1 38.2
##   15    8   13   10    7    9   13   11    9    9    7   10   11   13   10    9
## 38.3 38.4 38.5 38.6 38.7 38.8 38.9   39 39.1 39.2 39.3 39.4 39.5 39.6 39.7 39.8
##    2    6    7    9   11   10    8    7    8   10    6   10    8    9    8    5
## 39.9   40 40.1 40.2 40.3 40.4 40.5 40.6 40.7 40.8 40.9   41 41.1 41.2 41.3 41.4
##    5    6   10   10    8    9    7    1    1    7    6    3    7    8    6    3
## 41.5 41.6 41.7 41.8 41.9   42 42.1 42.2 42.3 42.4 42.5 42.6 42.7 42.8 42.9   43
##    8    5    7   11    5    3    3    8    5    5    2    4    4    3    3    8
## 43.1 43.2 43.3 43.4 43.6 43.7 43.8 43.9   44 44.1 44.2 44.3 44.4 44.5 44.6 44.7
##    4    4    5    6    4    7    9    8    4    1    4    3    1    4    2    6
## 44.8 44.9   45 45.1 45.2 45.3 45.4 45.5 45.7 45.8 45.9   46 46.1 46.2 46.3 46.4
##    4    2    5    2    3    4    4    4    2    1    2    4    2    2    1    1
## 46.5 46.6 46.8 46.9 47.1 47.3 47.4 47.5 47.6 47.8 47.9   48 48.1 48.2 48.3 48.4
##    2    1    1    2    1    2    1    3    3    2    1    1    1    1    2    1
## 48.5 48.7 48.8 48.9 49.2 49.3 49.4 49.5 49.8 49.9 50.1 50.2 50.3 50.4 50.5 50.6
##    2    1    2    3    1    3    1    2    3    1    2    4    2    1    1    2
## 50.8 50.9   51 51.5 51.7 51.8 51.9 52.3 52.5 52.7 52.8 52.9 53.4 53.5 53.8 53.9
##    1    1    1    1    1    1    2    1    1    2    3    1    2    1    2    1
##   54 54.1 54.2 54.3 54.6 54.7 54.8   55 55.1 55.2 55.7 55.9   56 56.1 56.6 57.2
##    1    1    1    1    2    3    1    2    1    1    4    2    1    1    2    2
## 57.3 57.5 57.7 57.9 58.1 59.7 60.2 60.9 61.2 61.6 63.3 64.4 64.8 66.8 71.9   78
##    1    1    1    1    1    1    1    2    1    1    1    1    1    1    1    1
```

```
##   92 97.6  N/A
##    1    1  201
##
## $smoking_status
##
## formerly smoked    never smoked          smokes         Unknown
##             885            1892             789            1544
##
## $stroke
##
##    0    1
## 4861  249
```

Convert BMI from character to numeric, and check for missing values.

```
strokeData$bmi <- as.numeric(strokeData$bmi)
```

```
## Warning: NAs introduced by coercion
```

```
colSums(is.na(strokeData))
```

```
##            gender               age      hypertension     heart_disease
##                 0                 0                 0                 0
##      ever_married         work_type    Residence_type avg_glucose_level
##                 0                 0                 0                 0
##               bmi    smoking_status            stroke
##               201                 0                 0
```

Drop na in bmi because bmi varies with height and weight, so the average would not best represent the data set. Height and weight are also unknown so bmi cannot be calculated. 201 observations will be deleted, and should not affect the dataset when removing the rows with NA values for bmi.

```
strokeData <- na.omit(strokeData)
```

Check if na values have been removed

```
colSums(is.na(strokeData))
```

```
##            gender               age      hypertension     heart_disease
##                 0                 0                 0                 0
##      ever_married         work_type    Residence_type avg_glucose_level
##                 0                 0                 0                 0
##               bmi    smoking_status            stroke
##                 0                 0                 0
```

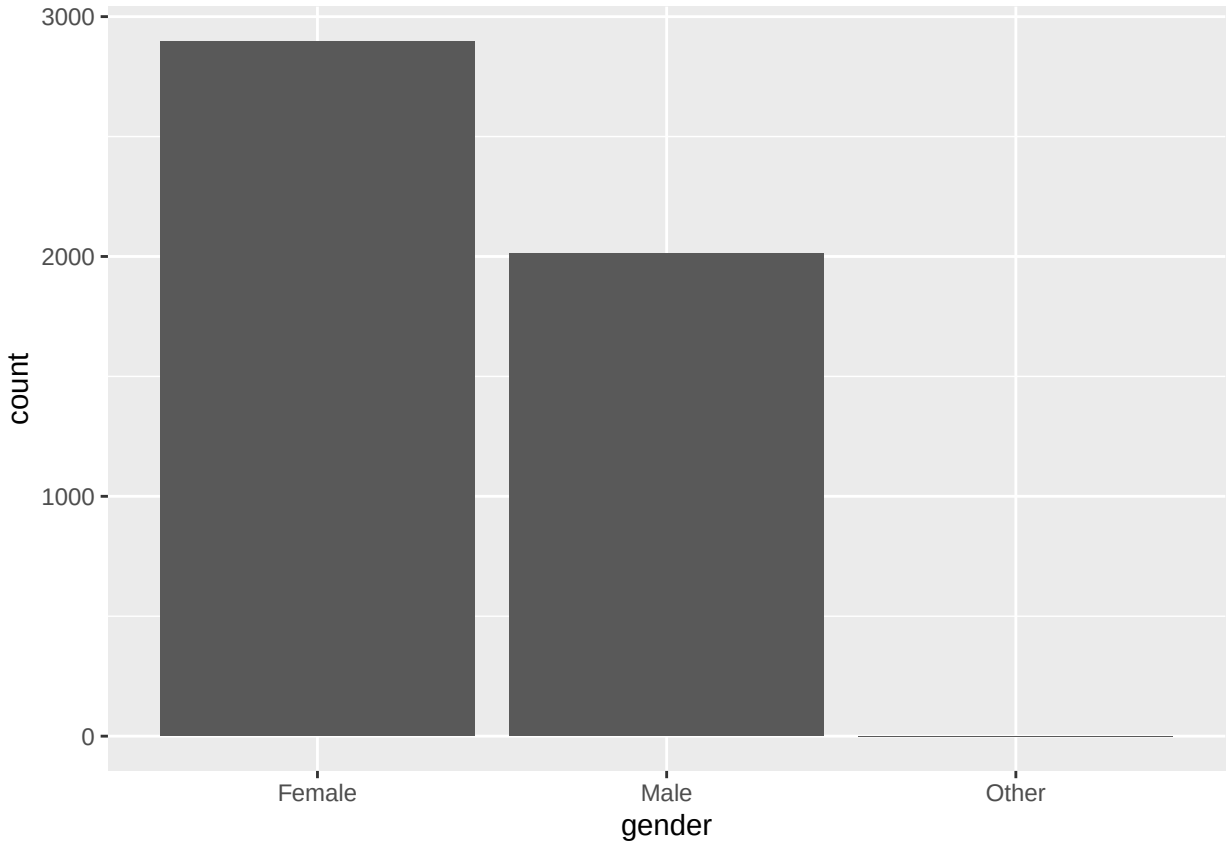
View the summary statistics.

```
describe(strokeData)
```

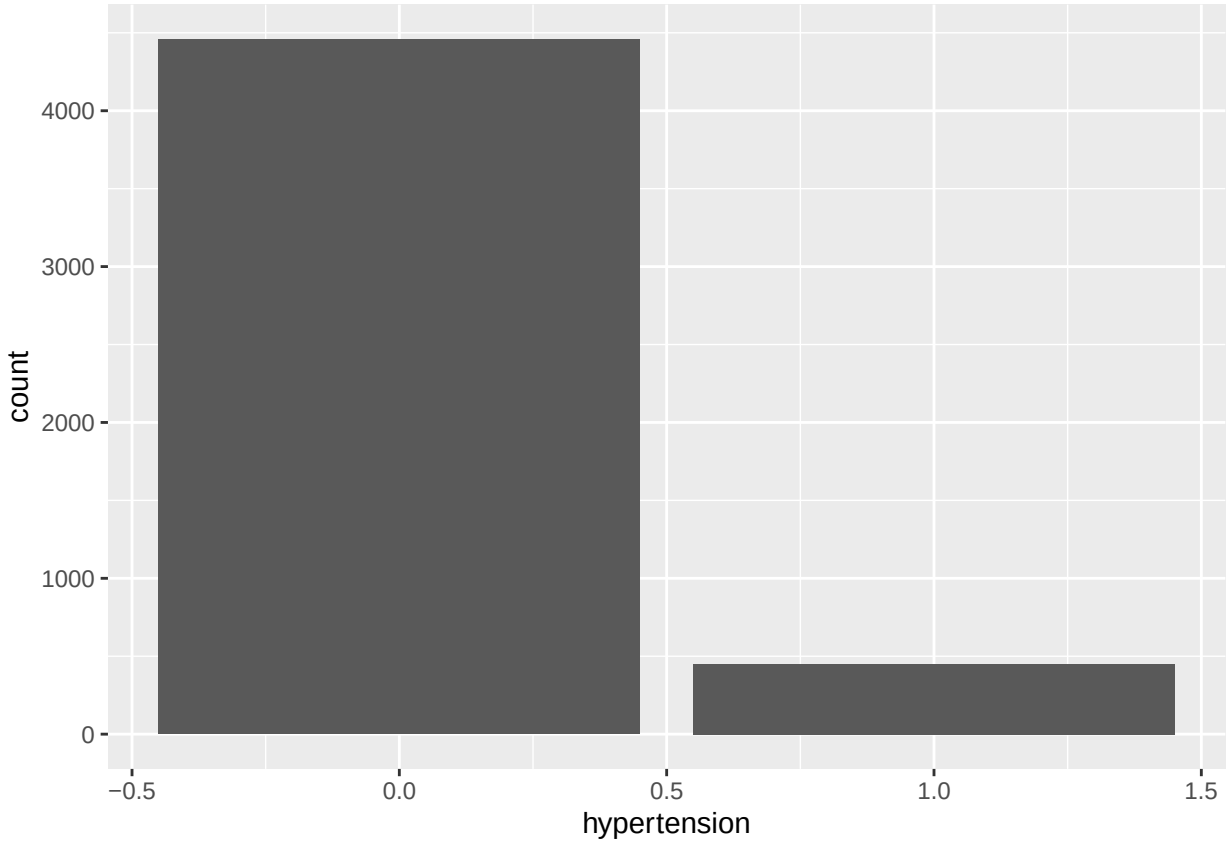
```
##                    vars    n   mean    sd median trimmed   mad   min    max
## gender*               1 4909   1.41  0.49   1.00    1.39  0.00  1.00   3.00
## age                   2 4909  42.87 22.56  44.00   43.17 26.69  0.08  82.00
## hypertension          3 4909   0.09  0.29   0.00    0.00  0.00  0.00   1.00
## heart_disease         4 4909   0.05  0.22   0.00    0.00  0.00  0.00   1.00
## ever_married*         5 4909   1.65  0.48   2.00    1.69  0.00  1.00   2.00
## work_type*            6 4909   3.49  1.28   4.00    3.61  0.00  1.00   5.00
## Residence_type*       7 4909   1.51  0.50   2.00    1.51  0.00  1.00   2.00
## avg_glucose_level     8 4909 105.31 44.42  91.68   97.02 25.86 55.12 271.74
## bmi                   9 4909  28.89  7.85  28.10   28.34  6.97 10.30  97.60
## smoking_status*      10 4909   2.58  1.09   2.00    2.60  1.48  1.00   4.00
## stroke               11 4909   0.04  0.20   0.00    0.00  0.00  0.00   1.00
##                     range  skew kurtosis   se
## gender*              2.00  0.37    -1.85 0.01
## age                 81.92 -0.12    -0.99 0.32
## hypertension         1.00  2.83     5.98 0.00
## heart_disease        1.00  4.15    15.25 0.00
## ever_married*        1.00 -0.64    -1.59 0.01
## work_type*           4.00 -0.90    -0.51 0.02
## Residence_type*      1.00 -0.03    -2.00 0.01
## avg_glucose_level  216.62  1.61     1.90 0.63
## bmi                 87.30  1.05     3.36 0.11
## smoking_status*      3.00  0.09    -1.35 0.02
## stroke               1.00  4.53    18.52 0.00
```

Plotting the categorical data plots.

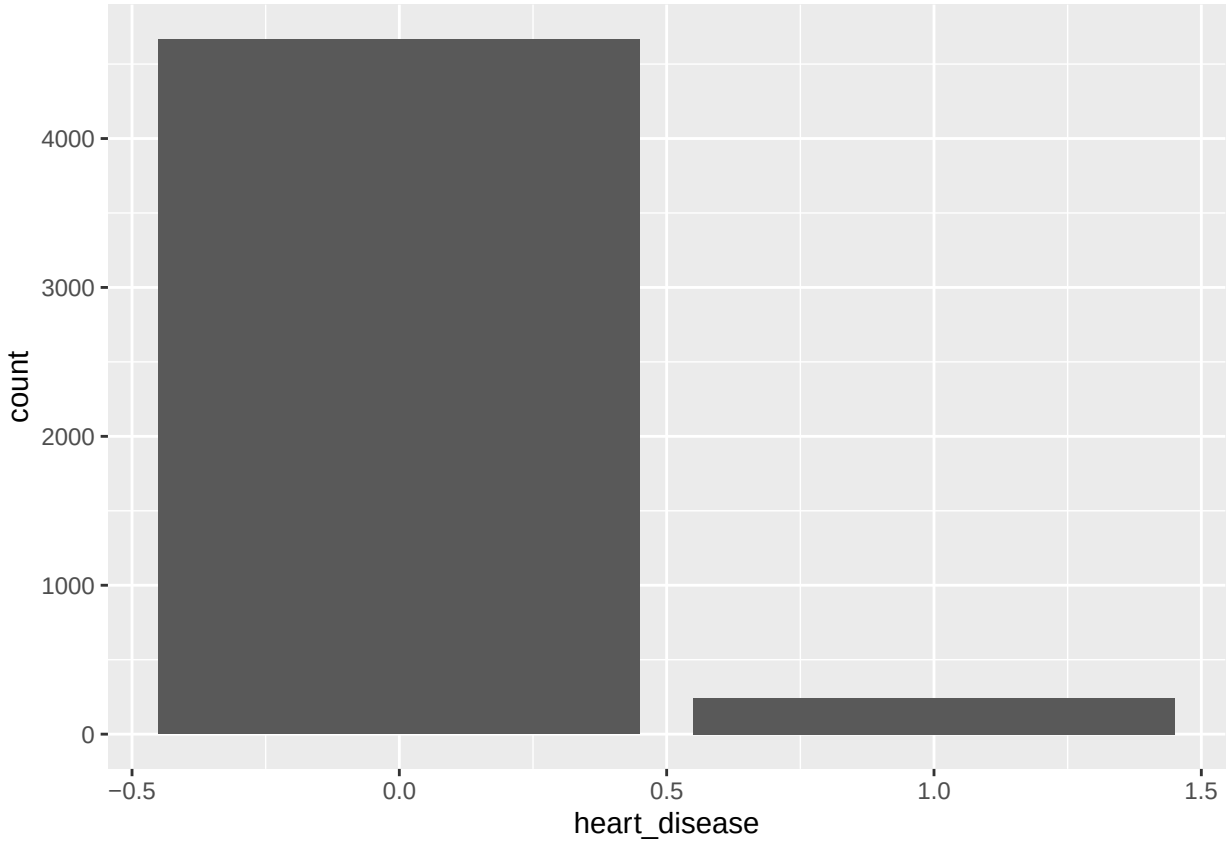
```
#gender bar plot
genderPlot <- ggplot(data = strokeData) + geom_bar(mapping = aes(x = gender))
genderPlot
```



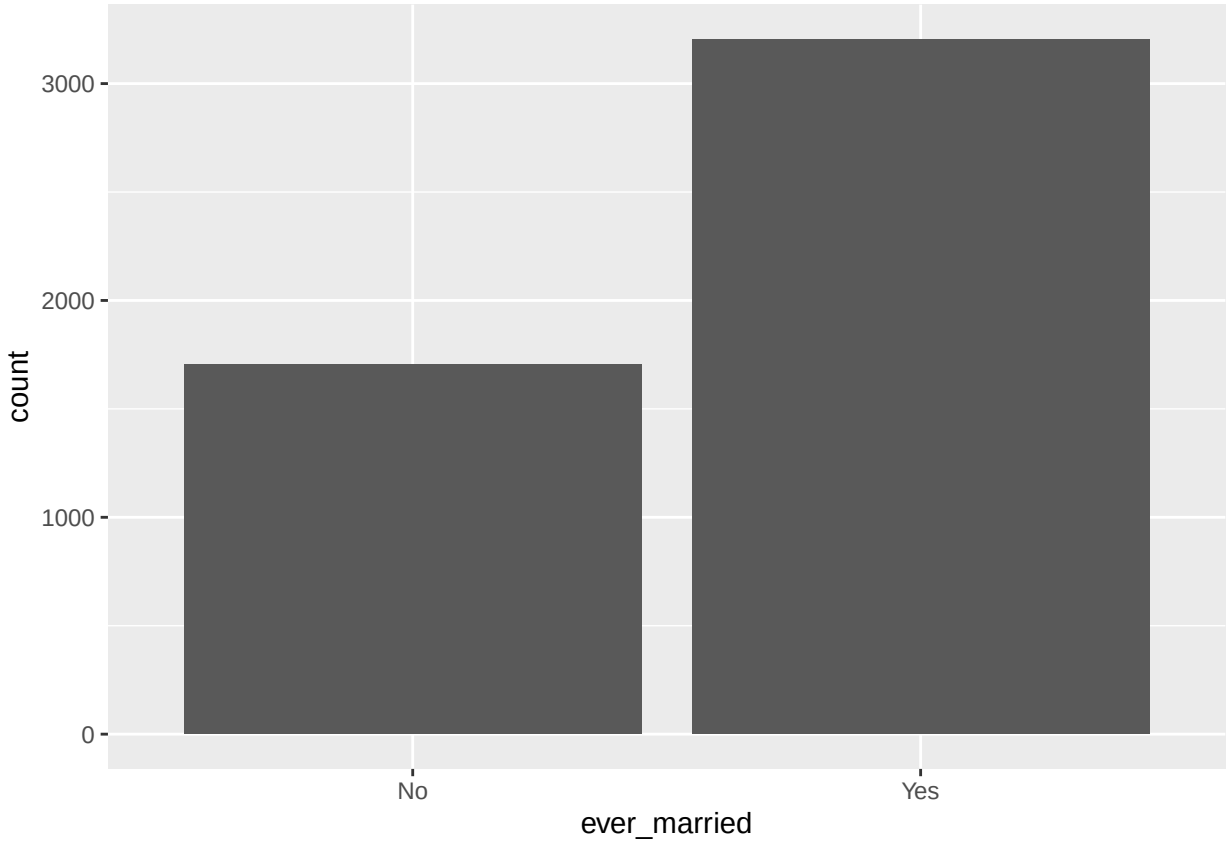

```
#hypertension bar plot
hypertensionPlot <- ggplot(data = strokeData) + geom_bar(mapping = aes(x = hypertension))
hypertensionPlot
```



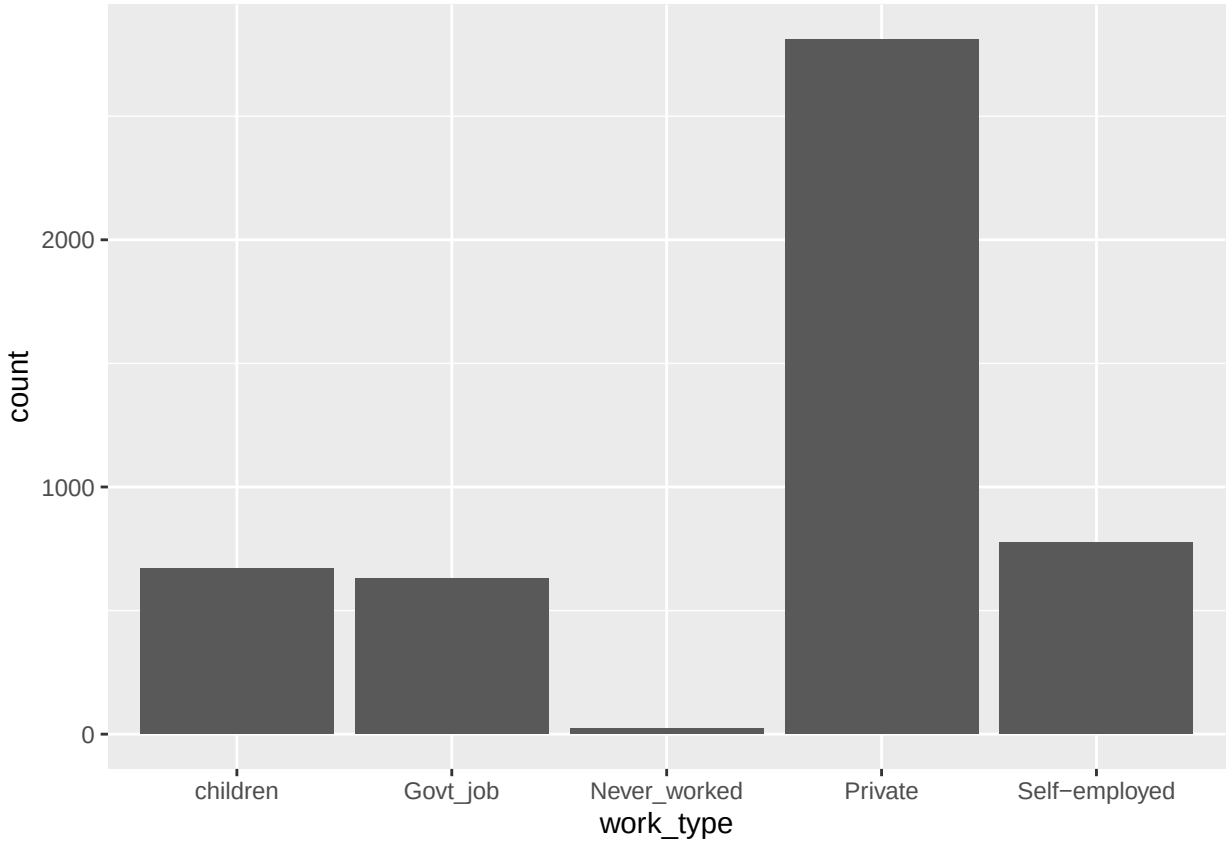

```
#heart_disease bar plot
heart_diseasePlot <- ggplot(data = strokeData) + geom_bar(mapping = aes(x = heart_disease))
heart_diseasePlot
```



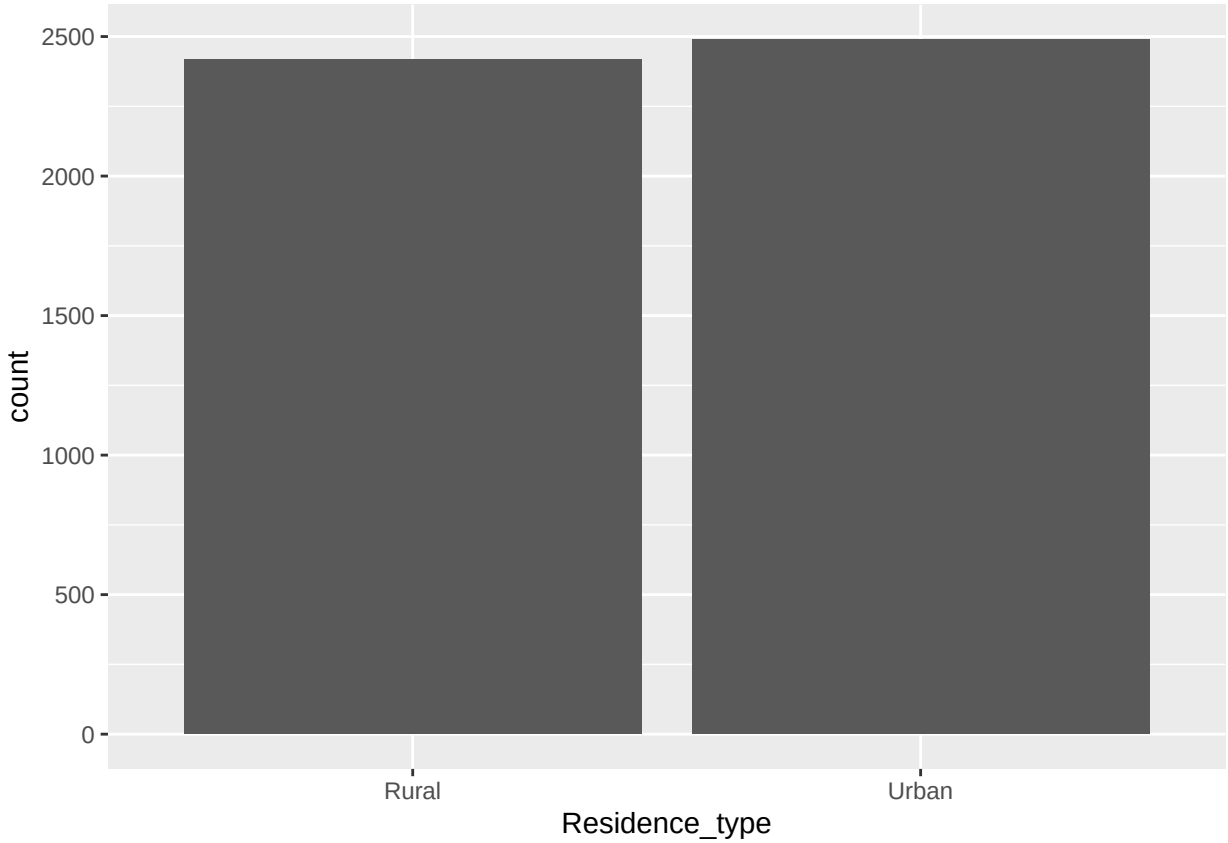

```
#ever_married bar plot
ever_marriedPlot <- ggplot(data = strokeData) + geom_bar(mapping = aes(x = ever_married))
ever_marriedPlot
```



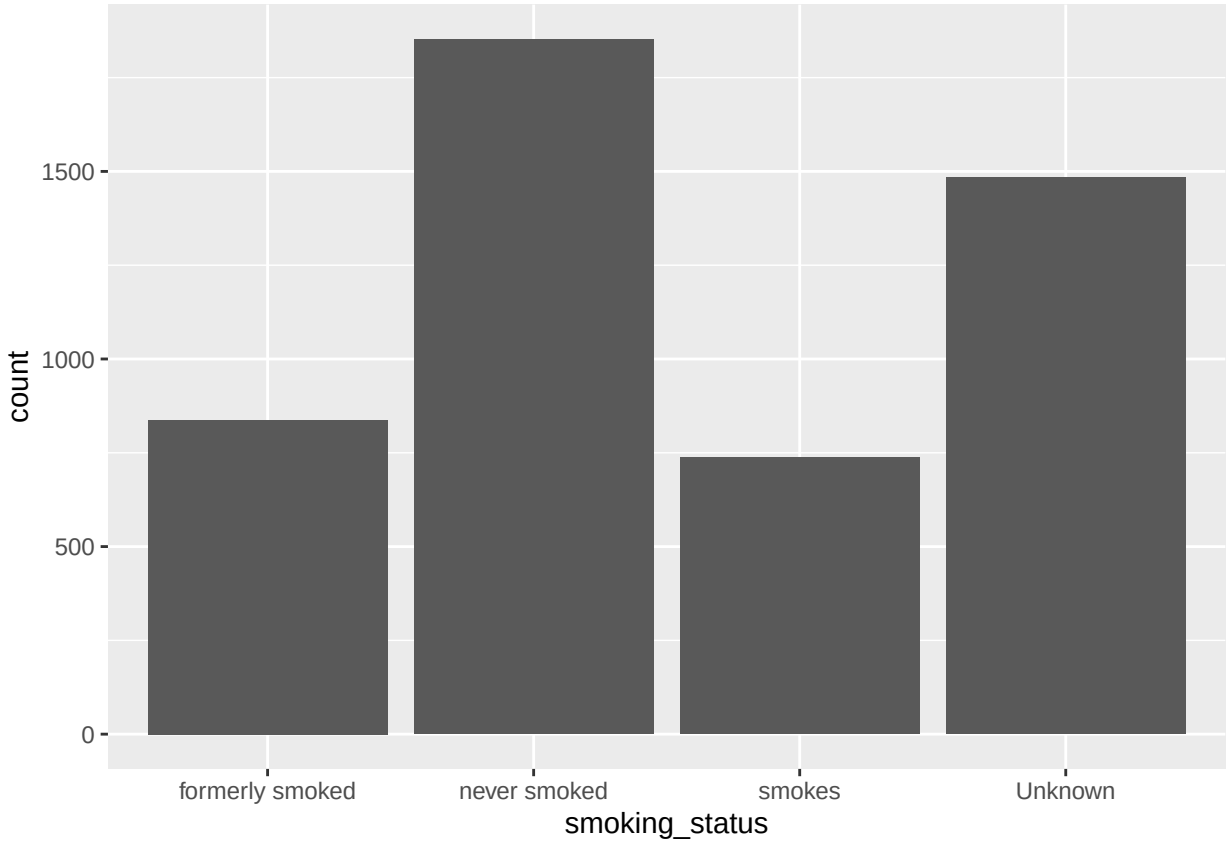

```
#work_type bar plot
work_typePlot <- ggplot(data = strokeData) + geom_bar(mapping = aes(x = work_type))
work_typePlot
```



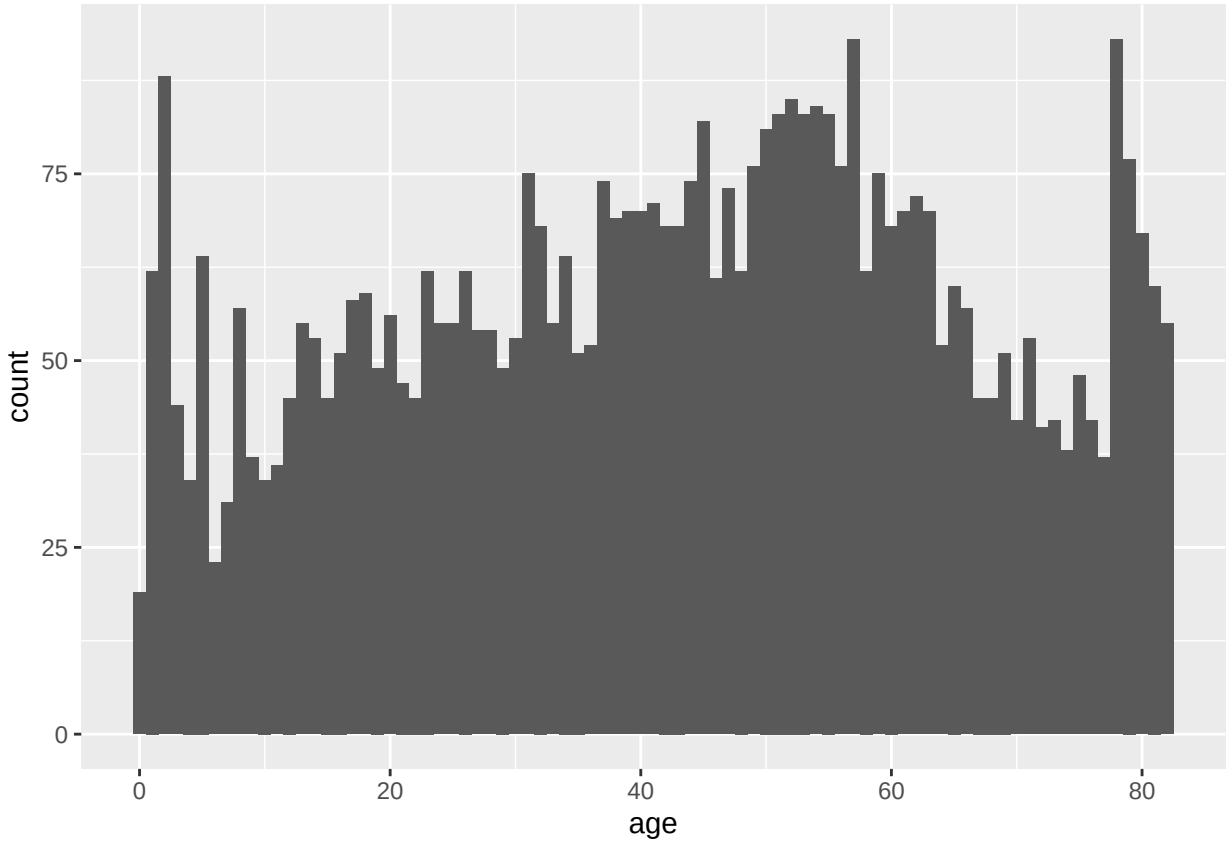

```
#Residence_type bar plot
Residence_typePlot <- ggplot(data = strokeData) + geom_bar(mapping = aes(x = Residence_type))
Residence_typePlot
```



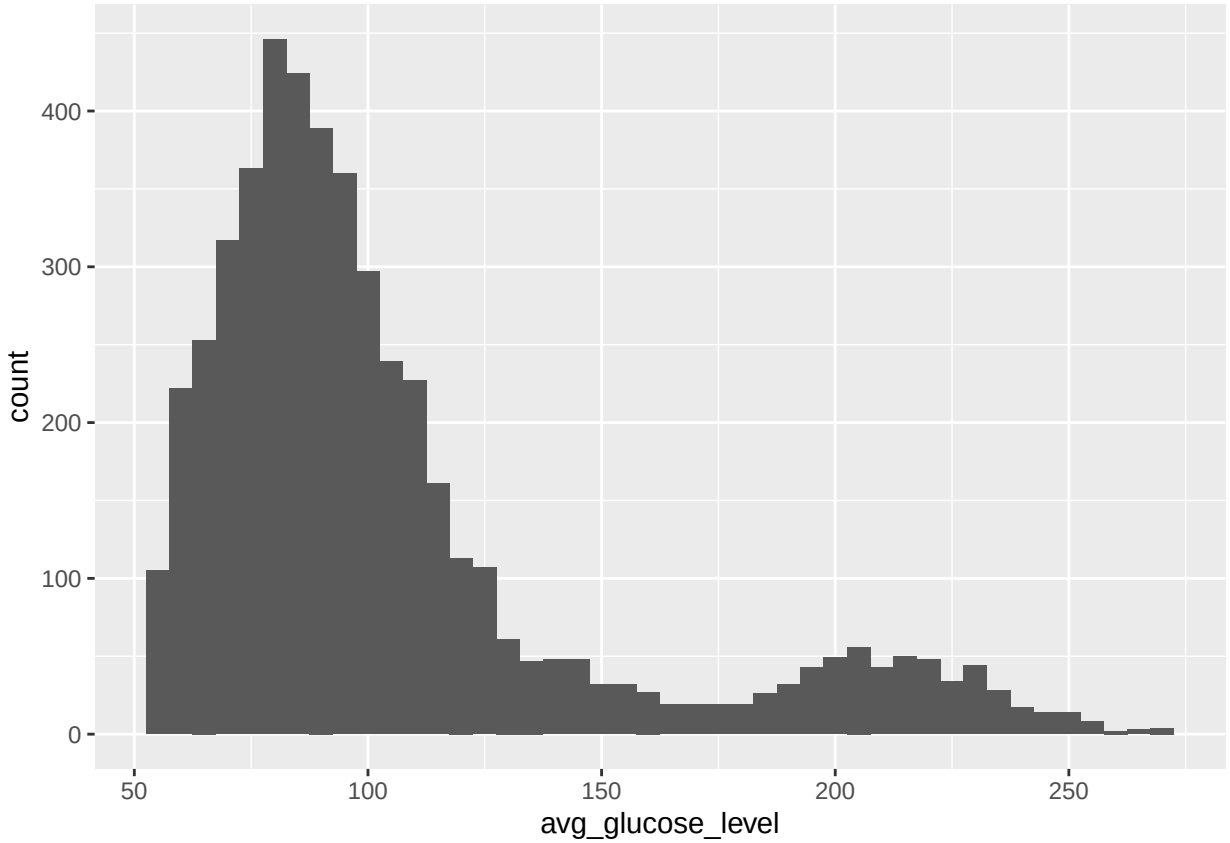

```
#smoking_status bar plot
smoking_statusPlot <- ggplot(data = strokeData) + geom_bar(mapping = aes(x = smoking_status))
smoking_statusPlot
```



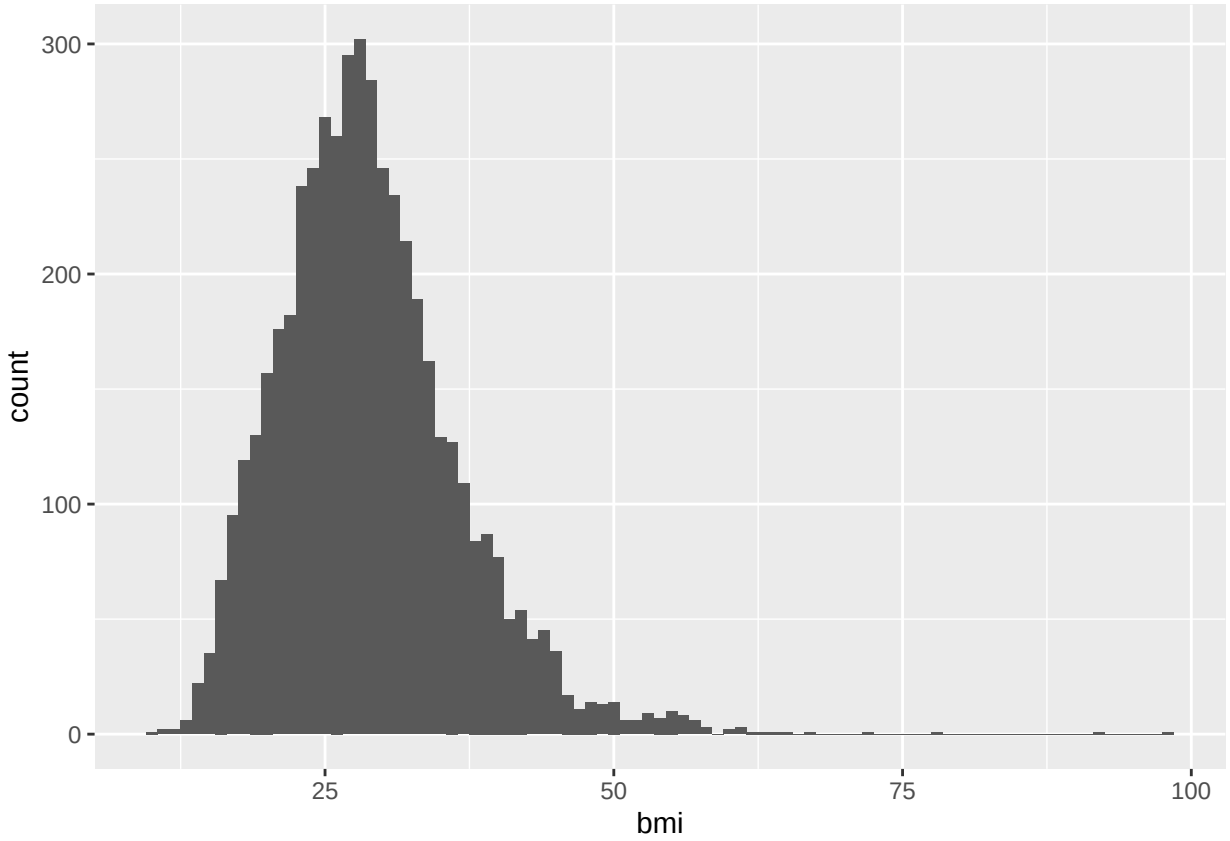

```
#CONTINUOUS DATA PLOTS
#age, avg_glucose_level, bmi
#age plot
agePlot <- ggplot(data = strokeData) + geom_histogram(mapping = aes(x = age), binwidth = 1)
agePlot
```




```
#avg_glucose_level plot
avg_glucose_levelPlot <- ggplot(data = strokeData) + geom_histogram(mapping = aes(x = avg_glucose_level
avg_glucose_levelPlot
```

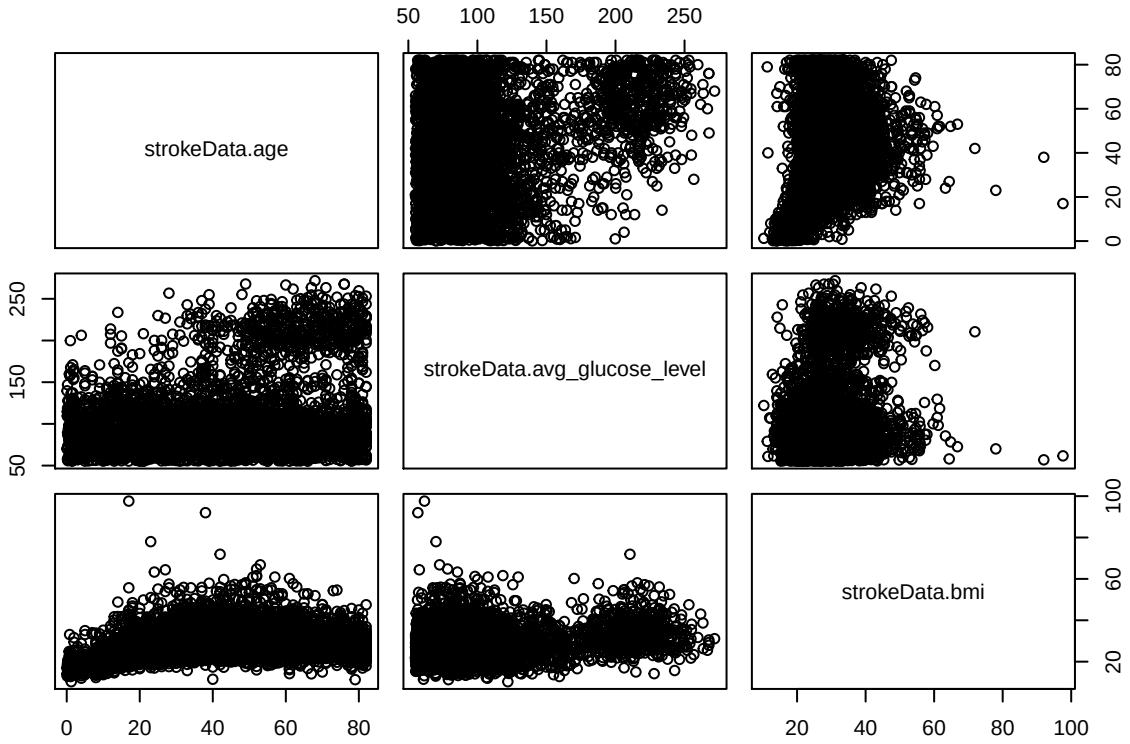



```
#bmi plot
bmiPlot <- ggplot(data = strokeData) + geom_histogram(mapping = aes(x = bmi), binwidth = 1)
bmiPlot
```



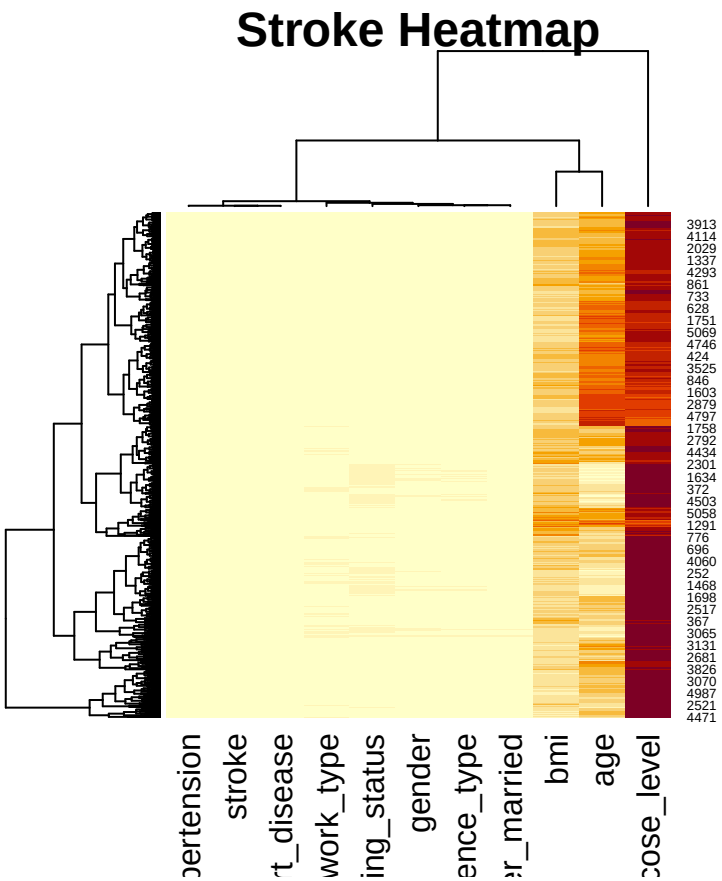
Pairwise comparisons

```
strokeDataNumeric <- data.frame(strokeData$age, strokeData$avg_glucose_level, strokeData$bmi)
pairs(strokeDataNumeric)
```



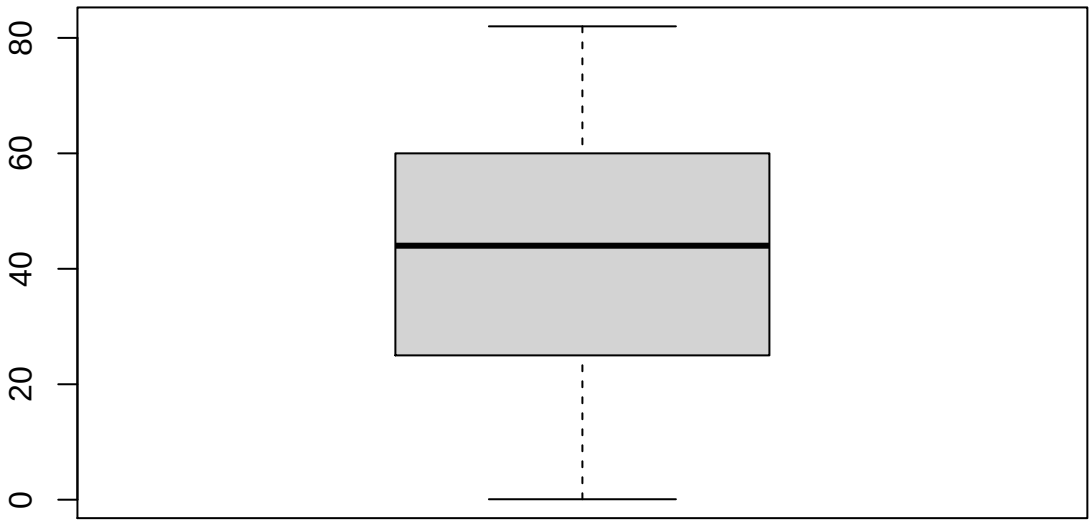
heatmap strokeData

```
y <- data.matrix(strokeData)
heatmap(y, main = 'Stroke Heatmap', cexRow = 0.5)
```

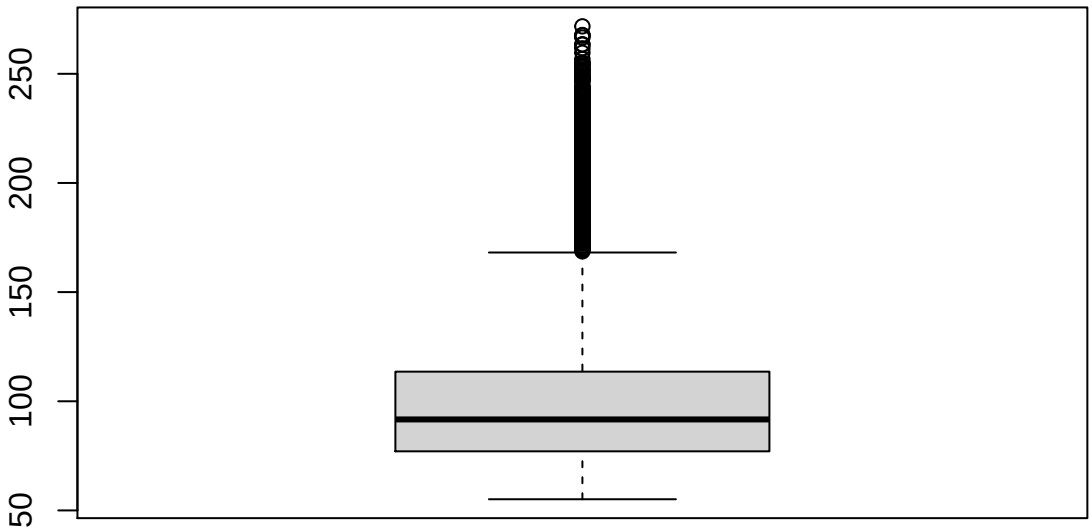


boxplots of age, avgGlucLevel, and bmi

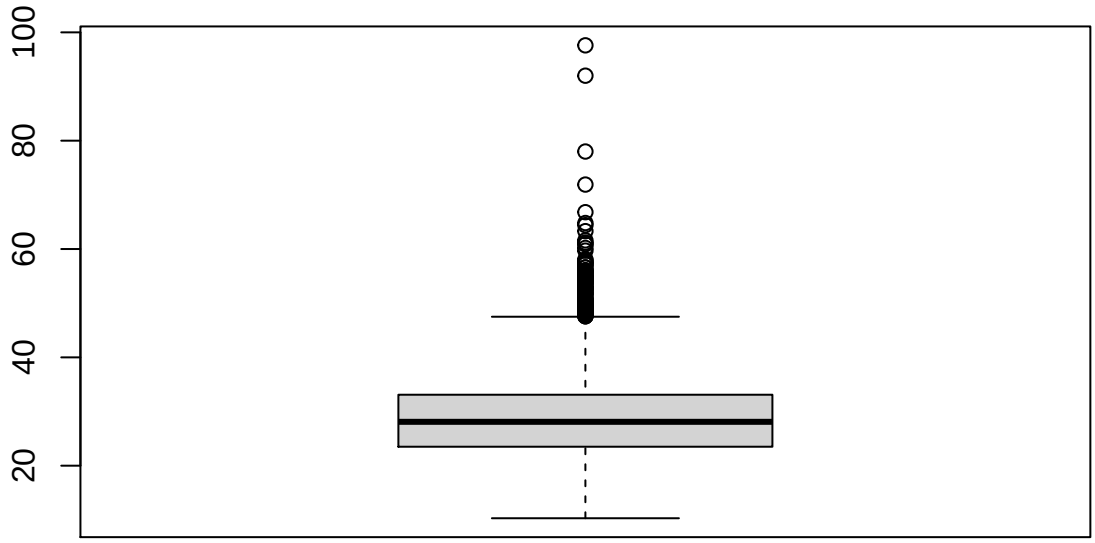
```
boxplot(strokeData$age, xlab = 'Age')
```




```
boxplot(strokeData$avg_glucose_level, xlab = 'Average Glucose Level')
```




```
boxplot(strokeData$bmi, xlab = 'BMI')
```



BMI

Standardizing the numeric fields (age, avg_glucose_level, bmi)

```
strokeData$age_z <- scale(x = strokeData$age)
strokeData$avg_glucose_level_z <- scale(x = strokeData$avg_glucose_level)
strokeData$bmi_z <- scale(x = strokeData$bmi)
```

Identifying outliers from numeric data

```
ageOutliers <- strokeData[ which(strokeData$age_z < -3 | strokeData$age_z > 3), ]
glucoseOutliers <- strokeData[ which(strokeData$avg_glucose_level_z < -3 | strokeData$avg_glucose_level
bmiOutliers <- strokeData[ which(strokeData$bmi_z < -3 | strokeData$bmi_z > 3), ]
```

Preparing the Data to Build Models

Partition the data into a training set and testing set

```r
set.seed(8)
n <- dim(strokeData)[1]
train_ind <- runif(n) < 0.75
strokeData_train <- strokeData[ train_ind, ]
strokeData_test <- strokeData[ !train_ind, ]
```

Balancing the training data.

Class imbalance problem for stroke. We would rather misclassify a stroke that won't occur over a stroke that will occur for a stroke that won't. We will need to balance the data so that we can more accurately predict the outcome.

```r
table(strokeData_train$stroke)
```

```
##
##    0    1
## 3497  157
```

```r
#increase yes's to 25% (from 4%) (resampling 1009 records)
```

```r
to.resample <- which(strokeData_train$stroke == 1)
our.resample <- sample(x = to.resample, size = 1009, replace = TRUE)
our.resample <- strokeData_train[our.resample, ]
strokeData_train_rebal <- rbind(strokeData_train, our.resample)
table(strokeData_train_rebal$stroke)
```

```
##
##    0    1
## 3497 1166
```

Logistic Regression for PCA

```r
#Create a data frame to store logistic regression data
strokeData_logReg <- strokeData_train_rebal
#Run the logistic regression algorithm
logReg01 <- glm(formula = stroke ~ gender + age + hypertension + heart_disease + ever_married + work_ty
summary(logReg01)
```

```
##
## Call:
## glm(formula = stroke ~ gender + age + hypertension + heart_disease +
##     ever_married + work_type + Residence_type + avg_glucose_level +
##     bmi + smoking_status, family = binomial, data = strokeData_logReg)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
```

```
## -2.1518  -0.6239  -0.2614   0.2063   2.6428
##
## Coefficients:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                 -4.938e+00  3.782e-01 -13.055  < 2e-16 ***
## genderMale                  -6.281e-02  8.512e-02  -0.738 0.460597
## genderOther                 -1.111e+01  8.827e+02  -0.013 0.989961
## age                          7.560e-02  3.451e-03  21.904  < 2e-16 ***
## hypertension                 6.782e-01  1.034e-01   6.560 5.37e-11 ***
## heart_disease                4.378e-01  1.256e-01   3.485 0.000493 ***
## ever_marriedYes              2.387e-02  1.457e-01   0.164 0.869905
## work_typeGovt_job           -1.557e+00  4.077e-01  -3.819 0.000134 ***
## work_typeNever_worked       -1.145e+01  2.430e+02  -0.047 0.962410
## work_typePrivate            -1.578e+00  4.014e-01  -3.931 8.45e-05 ***
## work_typeSelf-employed      -1.862e+00  4.168e-01  -4.467 7.93e-06 ***
## Residence_typeUrban          1.892e-02  8.217e-02   0.230 0.817908
## avg_glucose_level            5.190e-03  7.544e-04   6.880 5.99e-12 ***
## bmi                          1.551e-02  6.549e-03   2.368 0.017892 *
## smoking_statusnever smoked -3.788e-01  1.057e-01  -3.583 0.000340 ***
## smoking_statussmokes         2.937e-01  1.239e-01   2.370 0.017797 *
## smoking_statusUnknown       -3.620e-01  1.318e-01  -2.747 0.006015 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 5244.9  on 4662  degrees of freedom
## Residual deviance: 3686.4  on 4646  degrees of freedom
## AIC: 3720.4
##
## Number of Fisher Scoring iterations: 13
```

Validate the Logisitic regression model

```
strokeData_logRegTest <- strokeData_test
#Run the logistic regression algorithm
logReg01test <- glm(formula = stroke ~ gender + age + hypertension + heart_disease + ever_married + wor
summary(logReg01test)
```

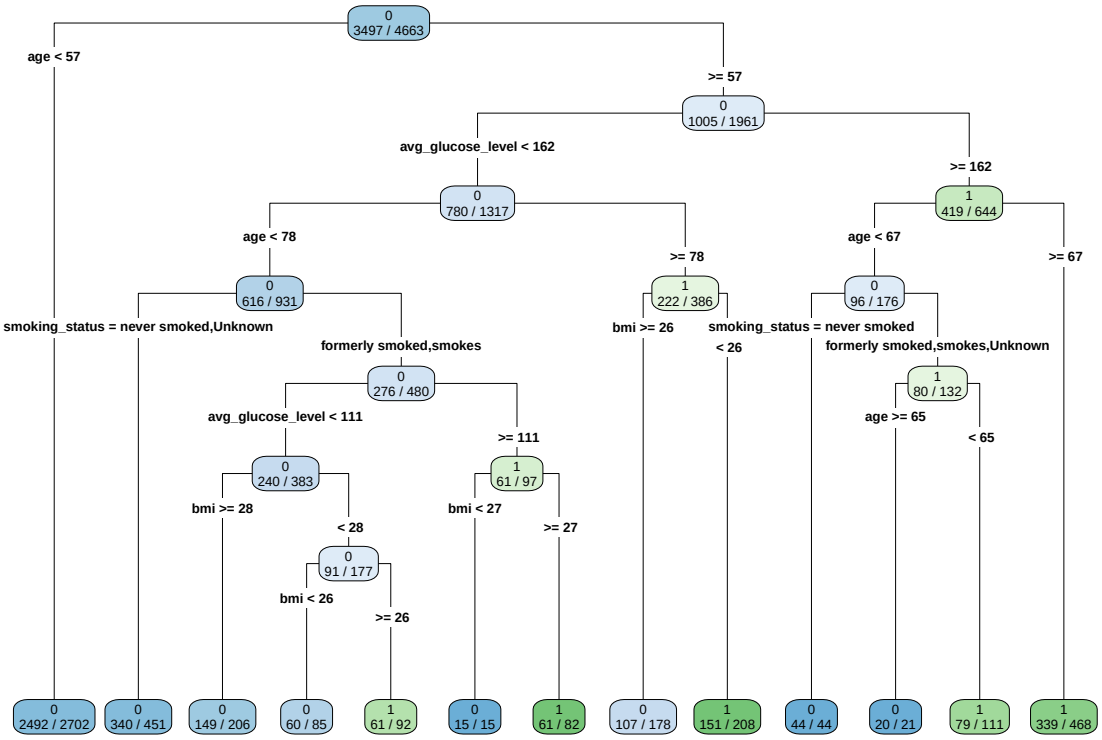
```
##
## Call:
## glm(formula = stroke ~ gender + age + hypertension + heart_disease +
##     ever_married + work_type + Residence_type + avg_glucose_level +
##     bmi + smoking_status, family = binomial, data = strokeData_logRegTest)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -1.15860  -0.27246  -0.14785  -0.07375   3.15712
##
## Coefficients:
##                               Estimate Std. Error z value Pr(>|z|)
```

```
## (Intercept)                -2.021e+01  7.922e+02  -0.026   0.9796
## genderMale                  1.059e-01  3.229e-01   0.328   0.7430
## age                         7.783e-02  1.229e-02   6.332 2.43e-10 ***
## hypertension                9.166e-01  3.618e-01   2.533   0.0113 *
## heart_disease               7.846e-02  4.717e-01   0.166   0.8679
## ever_marriedYes            -5.028e-01  4.491e-01  -1.120   0.2629
## work_typeGovt_job           1.212e+01  7.922e+02   0.015   0.9878
## work_typeNever_worked      -8.773e-01  3.655e+03   0.000   0.9998
## work_typePrivate            1.287e+01  7.922e+02   0.016   0.9870
## work_typeSelf-employed      1.255e+01  7.922e+02   0.016   0.9874
## Residence_typeUrban         1.740e-01  3.145e-01   0.553   0.5802
## avg_glucose_level           3.656e-04  2.913e-03   0.126   0.9001
## bmi                        -2.046e-02  2.507e-02  -0.816   0.4146
## smoking_statusnever smoked  8.096e-01  4.538e-01   1.784   0.0744 .
## smoking_statussmokes        9.597e-01  5.518e-01   1.739   0.0820 .
## smoking_statusUnknown       2.457e-01  5.672e-01   0.433   0.6648
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 432.91  on 1254  degrees of freedom
## Residual deviance: 327.59  on 1239  degrees of freedom
## AIC: 359.59
##
## Number of Fisher Scoring iterations: 18
```

Per the results of logistic regression, the following fields will not be used in models: gender, ever_married, work_type, residence_type

Decision Trees

```
###Create a dataframe to store decision tree data.
strokeData_dt <- strokeData_train_rebal
#change categorical variables to factors (gender, hypertension, heart_disease, ever_married, work_type,
strokeData_dt$hypertension <- factor(strokeData_dt$hypertension)
strokeData_dt$heart_disease <- factor(strokeData_dt$heart_disease)
strokeData_dt$smoking_status <- factor(strokeData_dt$smoking_status)
#decision tree algorithm
dt01 <- rpart(formula = stroke ~ age + hypertension + heart_disease + avg_glucose_level + bmi + smoking
rpart.plot(dt01, type = 4, extra = 2)
```




```
#obtain the predicted values
predStrokeDT <- data.frame(age = strokeData_dt$age, hypertension = strokeData_dt$hypertension, heart_dis
predDt01 <- predict(object = dt01, newdata = predStrokeDT, type = "class")
#Evaluate the training model
trainTableDT <- table(strokeData_dt$stroke, predDt01)
row.names(trainTableDT) <- c("Actual: 0", "Actual: 1")
colnames(trainTableDT) <- c("Predicted: 0", "Predicted: 1")
trainTableDT <- addmargins(A = trainTableDT, FUN = list(Total = sum), quiet = TRUE); trainTableDT
```

```
##            predDt01
##             Predicted: 0 Predicted: 1 Total
##   Actual: 0         3227          270  3497
##   Actual: 1          475          691  1166
##   Total             3702          961  4663
```

Decision Tree Training Evaluation Metrics

Accuracy = 85.289% Error rate = 14.712% Sensitvity = 65.695% Specificity = 91.822% Precision = 72.814%

Validate the model on the test data

```r
strokeData_dtTest <- strokeData_test
#change categorical variables to factors (gender, hypertension, heart_disease, ever_married, work_type,
strokeData_dtTest$hypertension <- factor(strokeData_dtTest$hypertension)
strokeData_dtTest$heart_disease <- factor(strokeData_dtTest$heart_disease)
strokeData_dtTest$smoking_status <- factor(strokeData_dtTest$smoking_status)
#subset the predictors
predStrokeDTtest <- data.frame(age = strokeData_dtTest$age, hypertension = strokeData_dtTest$hypertensi
#Run the decision tree model on the test data
predDt01test <- predict(object = dt01, newdata = predStrokeDTtest, type = "class")
#Evaluate the training model on TEST data
testTableDT <- table(strokeData_dtTest$stroke, predDt01test)
row.names(testTableDT) <- c("Actual: 0", "Actual: 1")
colnames(testTableDT) <- c("Predicted: 0", "Predicted: 1")
testTableDT <- addmargins(A = testTableDT, FUN = list(Total = sum), quiet = TRUE); testTableDT
```

```
##            predDt01test
##             Predicted: 0 Predicted: 1 Total
##   Actual: 0         1097          106  1203
##   Actual: 1           35           17    52
##   Total             1132          123  1255
```

Decision Tree Training Evaluation Metrics Test Data

Accuracy = 87.649% Error rate = 12.351% Sensitvity = 30.769% Specificity = 90.108% Precision = 11.852%

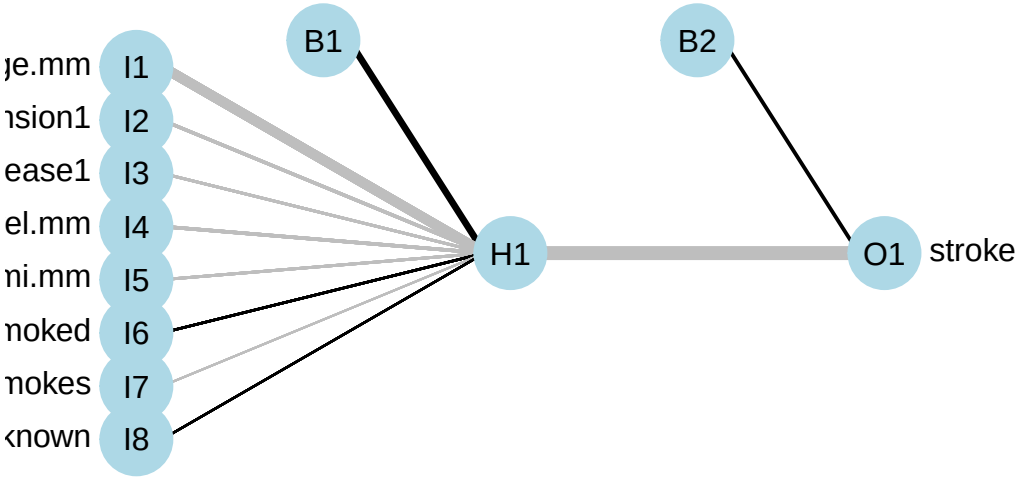
Neural Networks

```r
#create a dataframe to store neural network data
strokeData_nn <- strokeData_train_rebal
#Convert binary and categorical variables to factors (gender, hypertension, heart_disease, ever_married
strokeData_nn$hypertension <- factor(strokeData_nn$hypertension)
strokeData_nn$heart_disease <- factor(strokeData_nn$heart_disease)
strokeData_nn$smoking_status <- factor(strokeData_nn$smoking_status)
strokeData_nn$stroke <- factor(strokeData_nn$stroke)
#Perform min-max standardization on numeric variables (age, avg_glucose_level, bmi)
strokeData_nn$age.mm <- (strokeData_nn$age - min(strokeData$age)) / (max(strokeData_nn$age) - min(stroke
strokeData_nn$avg_glucose_level.mm <- (strokeData_nn$avg_glucose_level - min(strokeData_nn$avg_glucose_l
strokeData_nn$bmi.mm <- (strokeData_nn$bmi - min(strokeData$bmi)) / (max(strokeData_nn$bmi) - min(stroke
#Run the neural network algorithm
nn01 <- nnet(stroke ~ age.mm + hypertension + heart_disease + avg_glucose_level.mm + bmi.mm + smoking_s
```

```
## # weights:  11
## initial  value 3322.039889
## iter  10 value 2070.437480
## iter  20 value 1890.274614
## iter  30 value 1853.547502
## iter  40 value 1840.307884
## iter  50 value 1838.253264
```

```
## final  value 1838.252383
## converged
```

```
plotnet(nn01)
```




```
nn01$wts
```

```
##  [1]  2.7280373 -4.4834173 -0.8278710 -0.5615925 -0.9303020 -0.5769567
##  [7]  0.4342614 -0.1161438  0.2898360  1.1503330 -6.7509720
```

```
#obtain the predicted values
predStrokeNN <- data.frame(age.mm = strokeData_nn$age.mm, hypertension = strokeData_nn$hypertension, hea
predNn01 <- predict(object = nn01, newdata = predStrokeNN, type = "class")
#Evaluate the training model
trainTableNN <- table(strokeData_nn$stroke, predNn01)
row.names(trainTableNN) <- c("Actual: 0", "Actual: 1")
colnames(trainTableNN) <- c("Predicted: 0", "Predicted: 1")
trainTableNN <- addmargins(A = trainTableNN, FUN = list(Total = sum), quiet = TRUE); trainTableNN
```

```
##            predNn01
##             Predicted: 0 Predicted: 1 Total
##   Actual: 0         3090          407  3497
##   Actual: 1          529          637  1166
##   Total             3619         1044  4663
```

Neural Network Training Evaluation Metrics

Accuracy = 79.863% Error rate = 20.137% Sensitvity = 53.516% Specificity = 88.647% Precision = 61.117%

Validate the model on test data

```
#Test the model on the test data
strokeData_nnTest <- strokeData_test
#Convert binary and categorical variables to factors (gender, hypertension, heart_disease, ever_married
strokeData_nnTest$hypertension <- factor(strokeData_nnTest$hypertension)
strokeData_nnTest$heart_disease <- factor(strokeData_nnTest$heart_disease)
strokeData_nnTest$smoking_status <- factor(strokeData_nnTest$smoking_status)
strokeData_nnTest$stroke <- factor(strokeData_nnTest$stroke)
#Perform min-max standardization on numeric variables (age, avg_glucose_level, bmi)
strokeData_nnTest$age.mm <- (strokeData_nnTest$age - min(strokeData_nnTest$age)) / (max(strokeData_nnTes
strokeData_nnTest$avg_glucose_level.mm <- (strokeData_nnTest$avg_glucose_level - min(strokeData_nnTest$a
strokeData_nnTest$bmi.mm <- (strokeData_nnTest$bmi - min(strokeData_nnTest$bmi)) / (max(strokeData_nnTes
#obtain the predicted values
predStrokeNNtest <- data.frame(age.mm = strokeData_nnTest$age.mm, hypertension = strokeData_nnTest$hype
predNn01test <- predict(object = nn01, newdata = predStrokeNNtest, type = "class")
#Evaluate the training model
testTableNN <- table(strokeData_nnTest$stroke, predNn01test)
row.names(testTableNN) <- c("Actual: 0", "Actual: 1")
colnames(testTableNN) <- c("Predicted: 0", "Predicted: 1")
testTableNN <- addmargins(A = testTableNN, FUN = list(Total = sum), quiet = TRUE); testTableNN
```

```
##            predNn01test
##             Predicted: 0 Predicted: 1 Total
##   Actual: 0         1072          131  1203
##   Actual: 1           29           23    52
##   Total             1101          154  1255
```

Neural Network Training Evaluation Metrics Test Data

Accuracy = 87.091% Error rate = 12.908% Sensitvity = 44.231% Specificity = 88.944% Precision = 14.745%

Association Rules

```
#create a dataframe to store association rules data
strokeData_ar <- strokeData_train_rebal
#subset the data to only use variables we want rules for
min.strokeData_ar <- subset(strokeData_ar, select = c("age", "hypertension", "heart_disease", "avg_gluc
#Convert binary and categorical variables to factors (hypertension, heart_disease, smoking_status, stro
min.strokeData_ar$hypertension <- factor(min.strokeData_ar$hypertension)
min.strokeData_ar$heart_disease <- factor(min.strokeData_ar$heart_disease)
min.strokeData_ar$smoking_status <- factor(min.strokeData_ar$smoking_status)
```

```r
min.strokeData_ar$stroke <- factor(min.strokeData_ar$stroke)
#generate the association rules
all.rules <- apriori(data = min.strokeData_ar, parameter = list(supp = 0.01, target = "rules", conf = 0
```

```
## Warning: Column(s) 1, 4, 5 not logical or factor. Applying default
## discretization (see '? discretizeDF').
```

```
## Apriori
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport maxtime support minlen
##         0.4    0.1    1 none FALSE            TRUE       5    0.01      2
##  maxlen target  ext
##       2  rules TRUE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 46
##
## set item appearances ...[0 item(s)] done [0.00s].
## set transactions ...[19 item(s), 4663 transaction(s)] done [0.00s].
## sorting and recoding items ... [19 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2
```

```
## Warning in apriori(data = min.strokeData_ar, parameter = list(supp = 0.01, :
## Mining stopped (maxlen reached). Only patterns up to a length of 2 returned!
```

```
##  done [0.00s].
## writing ... [82 rule(s)] done [0.00s].
## creating S4 object  ... done [0.00s].
```

```r
#view the rules
inspect(head(all.rules, by = "lift", n = 10))
```

```
##      lhs                          rhs                              support
## [1]  {heart_disease=1}         => {stroke=1}                       0.05146901
## [2]  {heart_disease=1}         => {age=[61,82]}                    0.07076989
## [3]  {hypertension=1}          => {stroke=1}                       0.07034098
## [4]  {stroke=1}                => {age=[61,82]}                    0.17242119
## [5]  {age=[61,82]}             => {stroke=1}                       0.17242119
## [6]  {heart_disease=1}         => {avg_glucose_level=[110,272]} 0.05361355
## [7]  {hypertension=1}          => {age=[61,82]}                    0.08535278
## [8]  {age=[0.08,38)}           => {bmi=[10.3,26.1)}                0.18807635
## [9]  {bmi=[10.3,26.1)}         => {age=[0.08,38)}                  0.18807635
## [10] {smoking_status=Unknown} => {age=[0.08,38)}                   0.14711559
##      confidence coverage  lift     count
## [1]  0.6138107  0.0838516 2.454717 240
## [2]  0.8439898  0.0838516 2.442908 330
## [3]  0.5198098  0.1353206 2.078793 328
```

```
## [4]  0.6895369  0.2500536 1.995848 804
## [5]  0.4990689  0.3454857 1.995848 804
## [6]  0.6393862  0.0838516 1.917336 250
## [7]  0.6307448  0.1353206 1.825676 398
## [8]  0.5866221  0.3206090 1.765926 877
## [9]  0.5661717  0.3321896 1.765926 877
## [10] 0.5613748  0.2620630 1.750964 686
```

```
#determine the rules where stroke in antecedent
all.rules.ant.df <- as(as(attr(all.rules, "lhs"), "transactions"), "data.frame")
t1 <- all.rules.ant.df$items == "{stroke=1}"
t2 <- all.rules.ant.df$items == "{stroke=0}"
non.stroke.ant <- abs(t1 + t2 - 1)
good.rules <- all.rules[non.stroke.ant == 1]
inspect(head(good.rules, by = "lift", n = 25))
```

```
##      lhs                                   rhs
## [1]  {heart_disease=1}                  => {stroke=1}
## [2]  {heart_disease=1}                  => {age=[61,82]}
## [3]  {hypertension=1}                   => {stroke=1}
## [4]  {age=[61,82]}                      => {stroke=1}
## [5]  {heart_disease=1}                  => {avg_glucose_level=[110,272]}
## [6]  {hypertension=1}                   => {age=[61,82]}
## [7]  {age=[0.08,38)}                    => {bmi=[10.3,26.1)}
## [8]  {bmi=[10.3,26.1)}                  => {age=[0.08,38)}
## [9]  {smoking_status=Unknown}           => {age=[0.08,38)}
## [10] {age=[0.08,38)}                    => {smoking_status=Unknown}
## [11] {smoking_status=formerly smoked}   => {age=[61,82]}
## [12] {smoking_status=Unknown}           => {bmi=[10.3,26.1)}
## [13] {bmi=[10.3,26.1)}                  => {smoking_status=Unknown}
## [14] {hypertension=1}                   => {avg_glucose_level=[110,272]}
## [15] {age=[61,82]}                      => {avg_glucose_level=[110,272]}
## [16] {avg_glucose_level=[110,272]}      => {age=[61,82]}
## [17] {smoking_status=smokes}            => {age=[38,61)}
## [18] {hypertension=1}                   => {bmi=[31.5,92]}
## [19] {age=[0.08,38)}                    => {stroke=0}
## [20] {age=[38,61)}                      => {bmi=[31.5,92]}
## [21] {bmi=[31.5,92]}                    => {age=[38,61)}
## [22] {heart_disease=1}                  => {bmi=[26.1,31.5)}
## [23] {hypertension=1}                   => {smoking_status=never smoked}
## [24] {bmi=[31.5,92]}                    => {avg_glucose_level=[110,272]}
## [25] {avg_glucose_level=[110,272]}      => {bmi=[31.5,92]}
##      support    confidence coverage  lift     count
## [1]  0.05146901 0.6138107  0.0838516 2.454717  240
## [2]  0.07076989 0.8439898  0.0838516 2.442908  330
## [3]  0.07034098 0.5198098  0.1353206 2.078793  328
## [4]  0.17242119 0.4990689  0.3454857 1.995848  804
## [5]  0.05361355 0.6393862  0.0838516 1.917336  250
## [6]  0.08535278 0.6307448  0.1353206 1.825676  398
## [7]  0.18807635 0.5866221  0.3206090 1.765926  877
## [8]  0.18807635 0.5661717  0.3321896 1.765926  877
## [9]  0.14711559 0.5613748  0.2620630 1.750964  686
## [10] 0.14711559 0.4588629  0.3206090 1.750964  686
## [11] 0.11001501 0.5388655  0.2041604 1.559733  513
```

```
## [12] 0.13467725 0.5139116  0.2620630 1.547043  628
## [13] 0.13467725 0.4054229  0.3321896 1.547043  628
## [14] 0.06862535 0.5071315  0.1353206 1.520742  320
## [15] 0.16234184 0.4698945  0.3454857 1.409079  757
## [16] 0.16234184 0.4868167  0.3334763 1.409079  757
## [17] 0.07698906 0.4680574  0.1644864 1.401767  359
## [18] 0.06154836 0.4548336  0.1353206 1.356935  287
## [19] 0.31846451 0.9933110  0.3206090 1.324509 1485
## [20] 0.14775895 0.4425177  0.3339052 1.320192  689
## [21] 0.14775895 0.4408189  0.3351919 1.320192  689
## [22] 0.03667167 0.4373402  0.0838516 1.314840  171
## [23] 0.06433626 0.4754358  0.1353206 1.287432  300
## [24] 0.14089642 0.4203455  0.3351919 1.260496  657
## [25] 0.14089642 0.4225080  0.3334763 1.260496  657
```