

Health Data Study with Visualization

Reading training and testing dataset available in csv format

```
training_data = read.csv(file = 'ALS_TrainingData_2223.csv')
testing_data = read.csv(file = 'ALS_TestingData_78.csv')
```

First 6 rows of the training dataset

```
head(training_data)
```

ID	Age_m...	Albumin_...	Albumin_median	Albumin_min	Albumin_range	ALSFRS_sI...	AI
<int>	<int>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1 1	65	57	40.5	38	0.066202091	-0.9656085	
2 2	48	45	41.0	39	0.010452962	-0.9217172	
3 3	38	50	47.0	45	0.008928571	-0.9147870	
4 4	63	47	44.0	41	0.012111135	-0.5983607	
5 5	63	47	45.5	42	0.008291874	-0.4440389	
6 6	36	51	47.0	46	0.009057971	-0.1183528	

6 rows | 1-9 of 102 columns

Size of the training dataset

```
print(paste("No of columns in training data: ", ncol(training_data)))
```

```
## [1] "No of columns in training data: 101"
```

```
print(paste("No of rows in training data: ", nrow(training_data)))
```

```
## [1] "No of rows in training data: 2223"
```

Summary statistics of the training dataset

```
summary(training_data)
```

```

##          ID      Age_mean     Albumin_max     Albumin_median
##  Min.    : 1.0   Min.    :18.00   Min.    :37.00   Min.    :34.50
##  1st Qu.: 614.5 1st Qu.:47.00  1st Qu.:45.00  1st Qu.:42.00
##  Median  :1213.0 Median  :55.00  Median  :47.00  Median  :44.00
##  Mean    :1214.9 Mean    :54.55  Mean    :47.01  Mean    :43.95
##  3rd Qu.:1815.5 3rd Qu.:63.00  3rd Qu.:49.00  3rd Qu.:46.00
##  Max.    :2424.0 Max.    :81.00  Max.    :70.30  Max.    :51.10
##  Albumin_min     Albumin_range     ALSFRS_slope     ALSFRS_Total_max
##  Min.    :24.00  Min.    :0.000000  Min.    :-4.3452  Min.    :11.00
##  1st Qu.:39.00  1st Qu.:0.009042  1st Qu.:-1.0863  1st Qu.:29.00
##  Median  :41.00  Median  :0.012111  Median  :-0.6207  Median  :33.00
##  Mean    :40.77  Mean    :0.013779  Mean    :-0.7283  Mean    :31.69
##  3rd Qu.:43.00  3rd Qu.:0.015873  3rd Qu.:-0.2838  3rd Qu.:36.00
##  Max.    :49.00  Max.    :0.243902  Max.    : 1.2070  Max.    :40.00
##  ALSFRS_Total_median ALSFRS_Total_min ALSFRS_Total_range ALT.SGPT._max
##  Min.    : 2.5    Min.    : 0.00  Min.    :0.00000  Min.    : 10.00
##  1st Qu.:23.0    1st Qu.:14.00  1st Qu.:0.01404  1st Qu.: 32.00
##  Median  :28.0    Median  :20.00  Median  :0.02330  Median  : 45.00
##  Mean    :27.1    Mean    :19.88  Mean    :0.02604  Mean    : 54.44
##  3rd Qu.:32.0    3rd Qu.:27.00  3rd Qu.:0.03480  3rd Qu.: 65.00
##  Max.    :40.0    Max.    :40.00  Max.    :0.11765  Max.    :944.00
##  ALT.SGPT._median ALT.SGPT._min     ALT.SGPT._range     AST.SGOT._max
##  Min.    : 8.00   Min.    : 1.60  Min.    :0.002747  Min.    : 11.00
##  1st Qu.:22.00   1st Qu.:15.00  1st Qu.:0.030303  1st Qu.: 30.00
##  Median  :30.00   Median  :21.00  Median  :0.047619  Median  : 38.00
##  Mean    :32.99   Mean    :23.01  Mean    :0.071137  Mean    : 43.13
##  3rd Qu.:40.00   3rd Qu.:28.00  3rd Qu.:0.077539  3rd Qu.: 48.00
##  Max.    :193.00  Max.    :109.00  Max.    :2.383117  Max.    :911.00
##  AST.SGOT._median AST.SGOT._min     AST.SGOT._range     Bicarbonate_max
##  Min.    : 9.00   Min.    : 1.00  Min.    :0.00000  Min.    :20.0
##  1st Qu.:22.00   1st Qu.:17.00  1st Qu.:0.02352  1st Qu.:29.0
##  Median  :27.00   Median  :20.00  Median  :0.03502  Median  :31.0
##  Mean    :29.08   Mean    :21.54  Mean    :0.04919  Mean    :30.9
##  3rd Qu.:34.00   3rd Qu.:25.00  3rd Qu.:0.05243  3rd Qu.:32.0
##  Max.    :100.00  Max.    :86.00  Max.    :1.91667  Max.    :52.0
##  Bicarbonate_median Bicarbonate_min Bicarbonate_range
##  Min.    :19.50   Min.    : 2.50  Min.    :0.00000
##  1st Qu.:26.00   1st Qu.:22.00  1st Qu.:0.01266
##  Median  :27.00   Median  :23.00  Median  :0.01493
##  Mean    :26.96   Mean    :23.16  Mean    :0.01687
##  3rd Qu.:28.00   3rd Qu.:24.45  3rd Qu.:0.01815
##  Max.    :39.50   Max.    :34.00  Max.    :0.21429
##  Blood.Urea.Nitrogen..BUN._max Blood.Urea.Nitrogen..BUN._median
##  Min.    : 2.921           Min.    : 2.191
##  1st Qu.: 5.842           1st Qu.: 4.640
##  Median  : 6.937           Median  : 5.423
##  Mean    : 7.353           Mean    : 5.558
##  3rd Qu.: 8.210           3rd Qu.: 6.353
##  Max.    :25.192           Max.    :11.866
##  Blood.Urea.Nitrogen..BUN._min Blood.Urea.Nitrogen..BUN._range bp_diastolic_max
##  Min.    : 0.5842          Min.    :0.000000          Min.    : 70.00
##  1st Qu.: 3.2859          1st Qu.:0.004109          1st Qu.: 88.00
##  Median  : 4.0700          Median :0.005817          Median  : 90.00
##  Mean    : 4.1609          Mean   :0.007133          Mean   : 92.03
##  3rd Qu.: 5.0000          3rd Qu.:0.008353          3rd Qu.: 98.00

```

```

## Max.    :10.2228          Max.    :0.069543          Max.    :140.00
## bp_diastolic_median bp_diastolic_min bp_diastolic_range bp_systolic_max
## Min.    : 56.00          Min.    : 20.00          Min.    :0.00000          Min.    :100.0
## 1st Qu.: 78.00          1st Qu.: 65.00          1st Qu.:0.03527          1st Qu.:138.0
## Median  : 80.00          Median  : 70.00          Median :0.04337          Median :145.0
## Mean    : 81.11          Mean    : 69.89          Mean    :0.04766          Mean    :147.1
## 3rd Qu.: 85.00          3rd Qu.: 75.00          3rd Qu.:0.05435          3rd Qu.:157.0
## Max.    :110.00          Max.    :100.00          Max.    :0.71429          Max.    :220.0
## bp_systolic_median bp_systolic_min bp_systolic_range Calcium_max
## Min.    : 90.0           Min.    : 72.0           Min.    :0.00000           Min.    :2.171
## 1st Qu.:120.0           1st Qu.:108.0           1st Qu.:0.05272           1st Qu.:2.400
## Median  :130.0           Median :110.0           Median :0.06494           Median :2.470
## Mean    :129.6           Mean   :113.4           Mean   :0.07118           Mean   :2.475
## 3rd Qu.:136.0           3rd Qu.:120.0           3rd Qu.:0.08190           3rd Qu.:2.530
## Max.    :190.0           Max.    :165.0           Max.    :0.40462           Max.    :9.460
## Calcium_median Calcium_min Calcium_range Chloride_max
## Min.    :2.046           Min.    :0.2438          Min.    :0.0000000           Min.    : 96.0
## 1st Qu.:2.283           1st Qu.:2.1707          1st Qu.:0.0003741           1st Qu.:106.0
## Median  :2.345           Median :2.2300          Median :0.0004739           Median :107.0
## Mean    :2.346           Mean   :2.2229          Mean   :0.0005407           Mean   :107.2
## 3rd Qu.:2.400           3rd Qu.:2.2977          3rd Qu.:0.0005893           3rd Qu.:109.0
## Max.    :2.800           Max.    :2.6500          Max.    :0.0129009           Max.    :119.0
## Chloride_median Chloride_min Chloride_range Creatinine_max
## Min.    : 90.0           Min.    : 76.00          Min.    :0.00000           Min.    : 22.00
## 1st Qu.:102.0           1st Qu.: 98.00          1st Qu.:0.01250           1st Qu.: 65.00
## Median  :104.0           Median :100.00          Median :0.01587           Median : 79.56
## Mean    :103.5           Mean   : 99.26          Mean   :0.01787           Mean   : 78.78
## 3rd Qu.:105.0           3rd Qu.:101.00          3rd Qu.:0.01990           3rd Qu.: 88.40
## Max.    :111.0           Max.    :109.00          Max.    :0.21429           Max.    :248.00
## Creatinine_median Creatinine_min Creatinine_range Gender_mean
## Min.    : 18.00          Min.    :  0.00          Min.    :0.00000           Min.    :1.000
## 1st Qu.: 53.04          1st Qu.: 39.00          1st Qu.:0.03824           1st Qu.:1.000
## Median  : 62.00          Median : 53.00          Median :0.04865           Median :2.000
## Mean    : 65.19          Mean   : 51.98          Mean   :0.05842           Mean   :1.637
## 3rd Qu.: 78.85          3rd Qu.: 61.88          3rd Qu.:0.07026           3rd Qu.:2.000
## Max.    :176.80          Max.    :167.96          Max.    :0.42095           Max.    :2.000
## Glucose_max Glucose_median Glucose_min Glucose_range
## Min.    : 4.160          Min.    : 3.497          Min.    : 0.000           Min.    :0.000000
## 1st Qu.: 5.827          1st Qu.: 4.911          1st Qu.: 4.051           1st Qu.:0.003051
## Median  : 6.500          Median : 5.300          Median : 4.440           Median :0.004695
## Mean    : 7.160          Mean   : 5.487          Mean   : 4.265           Mean   :0.006319
## 3rd Qu.: 7.600          3rd Qu.: 5.695          3rd Qu.: 4.800           3rd Qu.:0.007373
## Max.    :33.688          Max.    :26.196          Max.    :12.200           Max.    :0.097463
## hands_max hands_median hands_min hands_range
## Min.    :0.000          Min.    :0.000          Min.    :0.000           Min.    :0.000000
## 1st Qu.:5.000           1st Qu.:3.000           1st Qu.:0.000           1st Qu.:0.003610
## Median  :7.000           Median :5.500           Median :3.000           Median :0.006652
## Mean    :6.181           Mean   :4.905           Mean   :3.047           Mean   :0.006883
## 3rd Qu.:8.000           3rd Qu.:7.000           3rd Qu.:5.000           3rd Qu.:0.009513
## Max.    :8.000           Max.    :8.000           Max.    :8.000           Max.    :0.042857
## Hematocrit_max Hematocrit_median Hematocrit_min Hematocrit_range
## Min.    : 0.373          Min.    : 0.362          Min.    : 0.311           Min.    :0.000000
## 1st Qu.:42.300          1st Qu.:40.000          1st Qu.:37.000           1st Qu.:0.007164
## Median  :45.200          Median :42.600          Median :40.000           Median :0.009701
## Mean    :41.939          Mean   :39.467          Mean   :36.962           Mean   :0.011431
## 3rd Qu.:47.700          3rd Qu.:45.000          3rd Qu.:42.700           3rd Qu.:0.013579

```

```

## Max.    :81.000   Max.    :56.000   Max.    :52.900   Max.    :0.185714
## Hemoglobin_max Hemoglobin_median Hemoglobin_min  Hemoglobin_range
## Min.    :116.0    Min.    :106.0    Min.    : 6.204   Min.    :0.00000
## 1st Qu.:144.0    1st Qu.:136.0    1st Qu.:128.000  1st Qu.:0.02321
## Median  :152.0    Median  :145.0    Median  :136.000  Median  :0.03106
## Mean    :152.1    Mean    :144.3    Mean    :135.461  Mean    :0.03824
## 3rd Qu.:160.0    3rd Qu.:152.0    3rd Qu.:145.000  3rd Qu.:0.04205
## Max.    :280.0    Max.    :182.0    Max.    :180.000  Max.    :0.56180
## leg_max      leg_median      leg_min      leg_range
## Min.    :0.00    Min.    :0.00    Min.    :0.00000  Min.    :0.000000
## 1st Qu.:3.00    1st Qu.:2.50    1st Qu.:1.000   1st Qu.:0.003378
## Median  :5.00    Median  :3.00    Median  :2.000   Median  :0.005435
## Mean    :5.31    Mean    :4.05    Mean    :2.493   Mean    :0.006163
## 3rd Qu.:8.00    3rd Qu.:6.00    3rd Qu.:3.000   3rd Qu.:0.008718
## Max.    :8.00    Max.    :8.00    Max.    :8.000   Max.    :0.042017
## mouth_max     mouth_median     mouth_min     mouth_range
## Min.    : 1.00   Min.    : 0.000   Min.    : 0.000   Min.    :0.000000
## 1st Qu.:10.00   1st Qu.: 8.000   1st Qu.: 5.000   1st Qu.:0.001815
## Median  :12.00   Median  :11.000   Median  : 9.000   Median  :0.005329
## Mean    :10.74    Mean    : 9.703   Mean    : 7.778   Mean    :0.006595
## 3rd Qu.:12.00   3rd Qu.:12.000   3rd Qu.:11.000   3rd Qu.:0.010251
## Max.    :12.00   Max.    :12.000   Max.    :12.000   Max.    :0.036765
## onset_delta_mean onset_site_mean Platelets_max  Platelets_median
## Min.    :-3119   Min.    :1.000   Min.    : 84.0   Min.    : 73.0
## 1st Qu.: -887   1st Qu.:2.000   1st Qu.:239.0   1st Qu.:204.0
## Median  : -572   Median  :2.000   Median  :275.0   Median  :233.0
## Mean    : -683   Mean    :1.801   Mean    :285.3   Mean    :238.8
## 3rd Qu.: -374   3rd Qu.:2.000   3rd Qu.:320.0   3rd Qu.:270.0
## Max.    : -16    Max.    :3.000   Max.    :866.0   Max.    :526.0
## Platelets_min  Potassium_max  Potassium_median Potassium_min
## Min.    : 0.197   Min.    : 3.400   Min.    : 3.000   Min.    :2.400
## 1st Qu.:175.000  1st Qu.: 4.400   1st Qu.:4.000   1st Qu.:3.700
## Median  :204.000  Median  : 4.500   Median  :4.200   Median  :3.900
## Mean    :208.382  Mean    : 4.628   Mean    :4.189   Mean    :3.857
## 3rd Qu.:236.000  3rd Qu.: 4.800   3rd Qu.:4.300   3rd Qu.:4.000
## Max.    :476.000  Max.    :43.000   Max.    :5.100   Max.    :5.100
## Potassium_range pulse_max      pulse_median      pulse_min
## Min.    :0.000000  Min.    : 53.00   Min.    : 50.00   Min.    : 18.00
## 1st Qu.:0.001058  1st Qu.: 84.00   1st Qu.: 72.00   1st Qu.: 60.00
## Median  :0.001425  Median  : 90.00   Median  : 77.00   Median  : 64.00
## Mean    :0.001744  Mean    : 90.64   Mean    : 76.97   Mean    : 65.37
## 3rd Qu.:0.001913  3rd Qu.: 96.00   3rd Qu.: 81.00   3rd Qu.: 70.00
## Max.    :0.098674  Max.    :144.00   Max.    :115.00   Max.    :102.00
## pulse_range      respiratory_max respiratory_median respiratory_min
## Min.    :0.005425  Min.    : 2.00   Min.    :0.000   Min.    :0.000
## 1st Qu.:0.036755  1st Qu.: 4.00   1st Qu.:3.000   1st Qu.:2.000
## Median  :0.048821  Median  : 4.00   Median  :4.000   Median  :3.000
## Mean    :0.053587  Mean    : 3.91   Mean    :3.593   Mean    :2.791
## 3rd Qu.:0.062365  3rd Qu.: 4.00   3rd Qu.:4.000   3rd Qu.:4.000
## Max.    :0.500000  Max.    : 4.00   Max.    :4.000   Max.    :4.000
## respiratory_range Sodium_max  Sodium_median  Sodium_min
## Min.    :0.000000  Min.    :134.0   Min.    :128.0   Min.    :112.0
## 1st Qu.:0.000000  1st Qu.:142.0   1st Qu.:139.0   1st Qu.:135.0
## Median  :0.001828  Median  :143.0   Median  :140.0   Median  :137.0
## Mean    :0.002513  Mean    :143.4   Mean    :140.1   Mean    :136.8
## 3rd Qu.:0.003653  3rd Qu.:145.0   3rd Qu.:141.0   3rd Qu.:138.0

```

```

## Max.    :0.025424   Max.    :169.0   Max.    :146.5   Max.    :145.0
## Sodium_range      SubjectID       trunk_max      trunk_median
## Min.    :0.00000   Min.    : 533   Min.    :0.000   Min.    :0.000
## 1st Qu.:0.01058   1st Qu.:240826  1st Qu.:5.000   1st Qu.:3.000
## Median  :0.01312   Median :496835   Median :7.000   Median :5.000
## Mean    :0.01500   Mean   :498880   Mean   :6.204   Mean   :4.893
## 3rd Qu.:0.01728   3rd Qu.:750301  3rd Qu.:8.000   3rd Qu.:6.500
## Max.    :0.14286   Max.    :999482   Max.    :8.000   Max.    :8.000
## trunk_min        trunk_range     Urine.Ph_max  Urine.Ph_median
## Min.    :0.000   Min.    :0.000000  Min.    :5.00   Min.    :5.000
## 1st Qu.:1.000   1st Qu.:0.003643  1st Qu.:6.00   1st Qu.:5.000
## Median  :3.000   Median :0.006920   Median :7.00   Median :6.000
## Mean    :2.956   Mean   :0.007136   Mean   :6.82   Mean   :5.711
## 3rd Qu.:5.000   3rd Qu.:0.009639  3rd Qu.:7.00   3rd Qu.:6.000
## Max.    :8.000   Max.    :0.042017  Max.    :9.00   Max.    :9.000
## Urine.Ph_min
## Min.    :5.000
## 1st Qu.:5.000
## Median :5.000
## Mean   :5.183
## 3rd Qu.:5.000
## Max.   :8.000

```

First 6 rows of the testing data

```
head(testing_data)
```

ID	Age_m...	Albumin_...	Albumin_median	Albumin_min	Albumin_range	ALSFRS_si...	AI
	<int>	<dbl>	<dbl>	<dbl>	<int>	<dbl>	<dbl>
1	3	65.90685	46	44.0	43	0.024590164	-1.7673293
2	4	54.00000	39	36.0	33	0.013100437	-1.3518519
3	5	56.39452	46	43.0	39	0.009735744	-0.4124294
4	6	72.61918	50	42.5	41	0.092783505	-0.3834034
5	9	65.00000	45	42.0	36	0.021327014	0.0000000
6	10	67.00000	40	35.0	25	0.038860104	-1.4071768

6 rows | 1-9 of 132 columns

Size of the testing dataset

```
print(paste("No of columns in testing data: ", ncol(testing_data)))
```

```
## [1] "No of columns in testing data: 131"
```

```
print(paste("No of rows in testing data: ", nrow(testing_data)))
```

```
## [1] "No of rows in testing data: 78"
```

Summary statistics of the testing data

```
summary(testing_data)
```

```

##          ID      Age_mean     Albumin_max     Albumin_median
##  Min.   : 3.00   Min.   :24.58   Min.   :38.00   Min.   :35.00
##  1st Qu.: 27.25  1st Qu.:51.00  1st Qu.:43.00  1st Qu.:40.00
##  Median : 51.50  Median :57.00  Median :45.50  Median :42.25
##  Mean   : 51.59  Mean   :56.03  Mean   :45.26  Mean   :42.17
##  3rd Qu.: 74.75  3rd Qu.:62.18  3rd Qu.:47.00  3rd Qu.:44.00
##  Max.   :100.00   Max.   :77.00   Max.   :51.00   Max.   :49.00
##  Albumin_min    Albumin_range    ALSFRS_slope    ALSFRS_Total_max
##  Min.   :25.00   Min.   :0.004138   Min.   :-3.0417   Min.   :13.00
##  1st Qu.:36.25  1st Qu.:0.011006  1st Qu.:-1.3153  1st Qu.:26.00
##  Median :39.00  Median :0.013761  Median :-0.6797  Median :31.00
##  Mean   :38.91  Mean   :0.016753  Mean   :-0.8259  Mean   :29.81
##  3rd Qu.:41.00  3rd Qu.:0.018015  3rd Qu.:-0.3907  3rd Qu.:34.00
##  Max.   :47.00   Max.   :0.092784  Max.   : 0.3259  Max.   :40.00
##  ALSFRS_Total_median ALSFRS_Total_min ALSFRS_Total_range ALT.SGPT._max
##  Min.   : 2.00   Min.   : 0.00   Min.   :0.00000   Min.   : 20.00
##  1st Qu.:16.50   1st Qu.: 8.00   1st Qu.:0.01701   1st Qu.: 37.00
##  Median :22.00   Median :14.00   Median :0.02672   Median : 48.00
##  Mean   :21.54   Mean   :14.71   Mean   :0.02816   Mean   : 59.08
##  3rd Qu.:28.00   3rd Qu.:21.00   3rd Qu.:0.03591   3rd Qu.: 73.00
##  Max.   :39.00   Max.   :37.00   Max.   :0.06852   Max.   :194.00
##  ALT.SGPT._median ALT.SGPT._min ALT.SGPT._range AST.SGOT._max
##  Min.   :14.50   Min.   : 8.00   Min.   :0.01508   Min.   : 20.00
##  1st Qu.:23.50   1st Qu.:15.25   1st Qu.:0.04200   1st Qu.: 33.00
##  Median :29.25   Median :20.00   Median :0.05720   Median : 40.00
##  Mean   :32.40   Mean   :22.36   Mean   :0.10900   Mean   : 48.33
##  3rd Qu.:38.00   3rd Qu.:26.00   3rd Qu.:0.11424   3rd Qu.: 49.75
##  Max.   :108.00  Max.   :78.00   Max.   :0.91753   Max.   :272.00
##  AST.SGOT._median AST.SGOT._min AST.SGOT._range Basophils_max
##  Min.   :16.00   Min.   :12.00   Min.   :0.01345   Min.   :0.500
##  1st Qu.:23.00   1st Qu.:17.00   1st Qu.:0.02987   1st Qu.: 0.925
##  Median :26.50   Median :20.00   Median :0.04358   Median :1.300
##  Mean   :28.87   Mean   :21.09   Mean   :0.08234   Mean   :1.515
##  3rd Qu.:32.38   3rd Qu.:23.00   3rd Qu.:0.07066   3rd Qu.: 1.900
##  Max.   :71.00   Max.   :46.00   Max.   :0.61856   Max.   :4.200
##  Basophils_median Basophils_min Basophils_range Bicarbonate_max
##  Min.   :0.300   Min.   :0.0000   Min.   :0.0007003  Min.   :22.10
##  1st Qu.:0.500   1st Qu.:0.2000  1st Qu.:0.0014268  1st Qu.: 26.00
##  Median :0.650   Median :0.3000   Median :0.0025298  Median :27.05
##  Mean   :0.675   Mean   :0.3192   Mean   :0.0032847  Mean   :27.92
##  3rd Qu.:0.800   3rd Qu.:0.5000  3rd Qu.:0.0039944  3rd Qu.: 29.38
##  Max.   :1.450   Max.   :0.9000   Max.   :0.0234043  Max.   :38.00
##  Bicarbonate_median Bicarbonate_min Bicarbonate_range Bilirubin..total._max
##  Min.   :20.00   Min.   :16.10   Min.   :0.005208  Min.   : 5.00
##  1st Qu.:23.00   1st Qu.:19.70  1st Qu.:0.011352  1st Qu.: 9.00
##  Median :24.10   Median :21.00   Median :0.015560  Median :10.26
##  Mean   :24.49   Mean   :21.19   Mean   :0.018107  Mean   :12.27
##  3rd Qu.:25.80   3rd Qu.:23.00  3rd Qu.:0.021065  3rd Qu.:14.00
##  Max.   :31.50   Max.   :26.00   Max.   :0.090909  Max.   :39.33
##  Bilirubin..total._median Bilirubin..total._min Bilirubin..total._range
##  Min.   : 3.000   Min.   : 2.000   Min.   :0.003878
##  1st Qu.: 5.344   1st Qu.: 3.000   1st Qu.:0.010171
##  Median : 7.848   Median : 5.000   Median :0.014433
##  Mean   : 8.117   Mean   : 5.199   Mean   :0.022924
##  3rd Qu.: 9.500   3rd Qu.: 6.840   3rd Qu.:0.021508

```

```

## Max.    :17.955          Max.    :11.000          Max.    :0.319149
## Blood.Urea.Nitrogen..BUN._max Blood.Urea.Nitrogen..BUN._median
## Min.    : 4.600          Min.    : 3.200
## 1st Qu.: 6.100          1st Qu.: 4.600
## Median : 7.497          Median : 5.400
## Mean   : 7.720          Mean   : 5.752
## 3rd Qu.: 8.817          3rd Qu.: 6.426
## Max.    :16.200          Max.    :10.353
## Blood.Urea.Nitrogen..BUN._min Blood.Urea.Nitrogen..BUN._range
## Min.    :1.400          Min.    :0.001614
## 1st Qu.:3.213          1st Qu.:0.005588
## Median :4.106          Median :0.008761
## Mean   :4.205          Mean   :0.010031
## 3rd Qu.:4.998          3rd Qu.:0.011018
## Max.    :7.854          Max.    :0.056818
##     BMI_max      bp_diastolic_max bp_diastolic_median bp_diastolic_min
## Min.    :0.001800      Min.    :67.00   Min.    :59.00   Min.    :52.00
## 1st Qu.:0.002379      1st Qu.:85.00   1st Qu.:76.00   1st Qu.:62.00
## Median :0.002594      Median :90.00   Median :80.00   Median :68.00
## Mean   :0.002631      Mean   :90.56   Mean   :80.14   Mean   :67.55
## 3rd Qu.:0.002865      3rd Qu.:95.00   3rd Qu.:85.00   3rd Qu.:72.00
## Max.    :0.003635      Max.    :117.00  Max.    :100.00  Max.    :88.00
## bp_diastolic_range bp_systolic_max bp_systolic_median bp_systolic_min
## Min.    :0.01153       Min.    :110.0   Min.    :100.0   Min.    :80.0
## 1st Qu.:0.03638       1st Qu.:132.2   1st Qu.:117.0   1st Qu.:102.0
## Median :0.04901       Median :141.0   Median :124.8   Median :109.0
## Mean   :0.05733       Mean   :143.5   Mean   :125.4   Mean   :108.9
## 3rd Qu.:0.06293       3rd Qu.:154.8   3rd Qu.:134.5   3rd Qu.:117.8
## Max.    :0.23377       Max.    :184.0   Max.    :156.0   Max.    :134.0
## bp_systolic_range Calcium_max Calcium_median Calcium_min
## Min.    :0.01805       Min.    :2.100   Min.    :2.100   Min.    :1.875
## 1st Qu.:0.05541       1st Qu.:2.500   1st Qu.:2.381   1st Qu.:2.235
## Median :0.06927       Median :2.530   Median :2.428   Median :2.300
## Mean   :0.08626       Mean   :2.543   Mean   :2.420   Mean   :2.286
## 3rd Qu.:0.10654       3rd Qu.:2.600   3rd Qu.:2.450   3rd Qu.:2.350
## Max.    :0.28866       Max.    :2.850   Max.    :2.630   Max.    :2.500
## Calcium_range Chloride_max Chloride_median Chloride_min
## Min.    :0.0002083      Min.    :100.0   Min.    :97.0   Min.    :91.00
## 1st Qu.:0.0004194      1st Qu.:104.0   1st Qu.:101.0   1st Qu.:98.00
## Median :0.0005505      Median :105.0   Median :102.0   Median :100.00
## Mean   :0.0007201      Mean   :105.2   Mean   :102.3   Mean   :99.22
## 3rd Qu.:0.0007503      3rd Qu.:107.0   3rd Qu.:104.0   3rd Qu.:101.75
## Max.    :0.0078723      Max.    :110.0   Max.    :106.0   Max.    :104.00
## Chloride_range Creatinine_max Creatinine_median Creatinine_min
## Min.    :0.004484       Min.    :35.00   Min.    :27.00   Min.    :9.00
## 1st Qu.:0.010447       1st Qu.:62.00   1st Qu.:44.00   1st Qu.:35.00
## Median :0.014000       Median :71.00   Median :53.04   Median :44.00
## Mean   :0.016394       Mean   :76.72   Mean   :57.82   Mean   :44.09
## 3rd Qu.:0.018122       3rd Qu.:80.00   3rd Qu.:67.25   3rd Qu.:53.04
## Max.    :0.063830       Max.    :360.00  Max.    :106.08  Max.    :97.00
## Creatinine_range Eosinophils_max Eosinophils_median Eosinophils_min
## Min.    :0.01614        Min.    :0.900   Min.    :0.400   Min.    :0.0000
## 1st Qu.:0.04604        1st Qu.:2.900   1st Qu.:1.400   1st Qu.:0.4250
## Median :0.06516        Median :4.100   Median :1.925   Median :0.8500
## Mean   :0.08303        Mean   :4.365   Mean   :2.194   Mean   :0.9936
## 3rd Qu.:0.09373        3rd Qu.:5.475   3rd Qu.:2.900   3rd Qu.:1.3000

```

```

## Max.    :0.66523   Max.    :11.100   Max.    :5.400    Max.    :3.5000
## Eosinophils_range Gender_mean     Glucose_max   Glucose_median
## Min.    :0.001107  Min.    :1.000   Min.    : 4.100  Min.    : 3.950
## 1st Qu.:0.004352  1st Qu.:1.000   1st Qu.: 6.490  1st Qu.: 5.000
## Median  :0.006818  Median :2.000   Median : 7.200  Median : 5.300
## Mean    :0.009624  Mean   :1.615   Mean   : 7.786  Mean   : 5.467
## 3rd Qu.:0.010168  3rd Qu.:2.000   3rd Qu.: 8.185  3rd Qu.: 5.638
## Max.    :0.042553  Max.    :2.000   Max.    :16.700  Max.    :12.050
## Glucose_min   Glucose_range   hands_max    hands_median
## Min.    :2.700    Min.    :0.001973  Min.    :0.000   Min.    :0.00
## 1st Qu.:3.915    1st Qu.:0.004942  1st Qu.:5.000   1st Qu.:1.25
## Median  :4.400    Median :0.007186  Median :6.000   Median :4.00
## Mean    :4.352    Mean   :0.010322  Mean   : 5.782  Mean   : 3.75
## 3rd Qu.:4.700    3rd Qu.:0.011355  3rd Qu.:8.000   3rd Qu.:6.00
## Max.    :7.400    Max.    :0.093617  Max.    : 8.000  Max.    : 8.00
## hands_min    hands_range    Hematocrit_max Hematocrit_median
## Min.    :0.000    Min.    :0.000000  Min.    :39.0   Min.    :36.50
## 1st Qu.:0.000    1st Qu.:0.004356  1st Qu.:45.4   1st Qu.:41.56
## Median  :0.500    Median :0.006576  Median :48.0   Median :43.00
## Mean    :1.936    Mean   :0.007256  Mean   : 47.7  Mean   : 43.69
## 3rd Qu.:4.000    3rd Qu.:0.010302  3rd Qu.:51.0   3rd Qu.:45.74
## Max.    :7.000    Max.    :0.019656  Max.    : 55.2  Max.    : 52.75
## Hematocrit_min Hematocrit_range Hemoglobin_max Hemoglobin_median
## Min.    :31.70   Min.    :0.00600   Min.    :126.0  Min.    :119.0
## 1st Qu.:38.00   1st Qu.:0.01227   1st Qu.:147.2  1st Qu.:137.6
## Median  :40.00   Median :0.01682   Median :154.0  Median :143.0
## Mean    :40.14   Mean   :0.02045   Mean   : 154.7  Mean   : 144.3
## 3rd Qu.:42.55   3rd Qu.:0.02173   3rd Qu.:164.0  3rd Qu.:149.9
## Max.    :48.10   Max.    :0.10851   Max.    : 183.0  Max.    : 167.5
## Hemoglobin_min Hemoglobin_range leg_max    leg_median
## Min.    :100.0   Min.    :0.01435   Min.    :0.000   Min.    :0.000
## 1st Qu.:127.0   1st Qu.:0.03620   1st Qu.:3.000  1st Qu.:1.000
## Median  :133.5   Median :0.04724   Median :4.000  Median :2.500
## Mean    :133.7   Mean   :0.05733   Mean   : 4.718  Mean   : 3.032
## 3rd Qu.:140.8   3rd Qu.:0.06535   3rd Qu.:6.750  3rd Qu.:4.000
## Max.    :160.0   Max.    :0.27273   Max.    : 8.000  Max.    : 8.000
## leg_min    leg_range    Lymphocytes_max Lymphocytes_median
## Min.    :0.000   Min.    :0.000000  Min.    :15.90  Min.    :12.60
## 1st Qu.:0.000   1st Qu.:0.003252  1st Qu.:28.30  1st Qu.:21.52
## Median  :1.000   Median :0.004914  Median :32.45  Median :25.25
## Mean    :1.679   Mean   :0.005756  Mean   : 33.00  Mean   : 25.29
## 3rd Qu.:3.000   3rd Qu.:0.007767  3rd Qu.:37.90  3rd Qu.:29.07
## Max.    :8.000   Max.    :0.017131  Max.    : 58.00  Max.    : 46.05
## Lymphocytes_min Lymphocytes_range Monocytes_max  Monocytes_median
## Min.    : 4.00   Min.    :0.008414  Min.    : 4.800  Min.    : 3.850
## 1st Qu.:13.45  1st Qu.:0.023245  1st Qu.: 7.525  1st Qu.: 5.625
## Median  :17.05  Median :0.034018  Median : 8.450  Median : 6.375
## Mean    :17.38  Mean   :0.046605  Mean   : 9.458  Mean   : 6.560
## 3rd Qu.:21.45  3rd Qu.:0.048425  3rd Qu.:10.075 3rd Qu.: 6.975
## Max.    :29.20  Max.    :0.291489  Max.    : 43.900  Max.    :13.100
## Monocytes_min Monocytes_range mouth_max   mouth_median
## Min.    : 2.500  Min.    :0.004063  Min.    : 3.00   Min.    : 0.000
## 1st Qu.: 3.825  1st Qu.:0.007275  1st Qu.:10.00  1st Qu.: 6.000
## Median  : 4.450  Median :0.009031  Median :11.00  Median : 9.000
## Mean    : 4.587  Mean   :0.013009  Mean   :10.56  Mean   : 8.474
## 3rd Qu.: 5.000  3rd Qu.:0.013369  3rd Qu.:12.00  3rd Qu.:12.000

```

```

## Max.    :10.100   Max.    :0.080921   Max.    :12.000   Max.    :12.000
## mouth_min      mouth_range      onset_delta_mean  onset_site_mean
## Min.    : 0.000   Min.    :0.000000   Min.    :-1031.0   Min.    :1.000
## 1st Qu.: 2.000   1st Qu.:0.002305   1st Qu.: -637.5   1st Qu.:2.000
## Median : 6.500   Median :0.007066   Median : -505.5   Median :2.000
## Mean    : 6.244   Mean    :0.007931   Mean    : -516.6   Mean    :2.603
## 3rd Qu.:10.000   3rd Qu.:0.011799   3rd Qu.: -340.2   3rd Qu.:4.000
## Max.    :12.000   Max.    :0.023316   Max.    : -144.0   Max.    :4.000
## Platelets_max  Platelets_median Platelets_min    Potassium_max
## Min.    :192.0    Min.    :171.0     Min.    :132.0    Min.    :3.600
## 1st Qu.:257.0    1st Qu.:235.8    1st Qu.:215.0    1st Qu.:4.400
## Median :294.5    Median :264.5     Median :242.5    Median :4.600
## Mean    :311.9    Mean    :282.7     Mean    :261.2    Mean    :4.644
## 3rd Qu.:358.5    3rd Qu.:329.1    3rd Qu.:302.2    3rd Qu.:4.800
## Max.    :581.0    Max.    :499.0     Max.    :499.0    Max.    :5.800
## Potassium_median Potassium_min  Potassium_range  pulse_max
## Min.    :3.400    Min.    :2.800     Min.    :0.0006897  Min.    : 72.00
## 1st Qu.:4.062    1st Qu.:3.625    1st Qu.:0.0015365 1st Qu.: 86.50
## Median :4.200    Median :3.800     Median :0.0019149  Median : 91.50
## Mean    :4.169    Mean    :3.774     Mean    :0.0022789  Mean    : 95.96
## 3rd Qu.:4.300    3rd Qu.:3.900    3rd Qu.:0.0025891 3rd Qu.:106.75
## Max.    :4.600    Max.    :4.400     Max.    :0.0068182  Max.    :128.00
## pulse_median    pulse_min     pulse_range    Red.Blood.Cells..RBC._max
## Min.    : 57.50   Min.    :48.00    Min.    :0.02306   Min.    :4100
## 1st Qu.: 72.00   1st Qu.:60.00   1st Qu.:0.04831   1st Qu.:4760
## Median : 78.00   Median :64.00    Median :0.05989   Median :5100
## Mean    : 78.77   Mean    :64.71    Mean    :0.07628   Mean    :5071
## 3rd Qu.: 85.00   3rd Qu.:69.00   3rd Qu.:0.08227   3rd Qu.:5300
## Max.    :106.00   Max.    :95.00    Max.    :0.23770   Max.    :6300
## Red.Blood.Cells..RBC._median Red.Blood.Cells..RBC._min
## Min.    :3800      Min.    :3140
## 1st Qu.:4472      1st Qu.:4110
## Median :4700      Median :4400
## Mean    :4716      Mean    :4360
## 3rd Qu.:4900      3rd Qu.:4700
## Max.    :5600      Max.    :5200
## Red.Blood.Cells..RBC._range respiratory_max respiratory_median respiratory_min
## Min.    : 0.5202   Min.    :2.000    Min.    :0.00     Min.    :0.000
## 1st Qu.: 1.2334   1st Qu.:4.000    1st Qu.:2.00    1st Qu.:1.000
## Median : 1.5982   Median :4.000    Median :3.75    Median :2.000
## Mean    : 1.9944   Mean    :3.846    Mean    :3.00    Mean    :1.897
## 3rd Qu.: 2.0800   3rd Qu.:4.000    3rd Qu.:4.00    3rd Qu.:3.000
## Max.    :17.8723   Max.    :4.000    Max.    :4.00    Max.    :4.000
## respiratory_range Sodium_max  Sodium_median  Sodium_min
## Min.    :0.000000   Min.    :139.0   Min.    :137.0   Min.    :130.0
## 1st Qu.:0.001045   1st Qu.:142.0   1st Qu.:140.0   1st Qu.:137.0
## Median :0.002890   Median :143.0   Median :140.0   Median :138.0
## Mean    :0.003678   Mean    :143.2   Mean    :140.3   Mean    :137.4
## 3rd Qu.:0.005994   3rd Qu.:144.0   3rd Qu.:141.0   3rd Qu.:138.0
## Max.    :0.010345   Max.    :150.0   Max.    :145.0   Max.    :142.0
## Sodium_range      SubjectID    trunk_max     trunk_median
## Min.    :0.003587   Min.    :55888   Min.    :0.000   Min.    :0.000
## 1st Qu.:0.010262   1st Qu.:310523  1st Qu.:4.250   1st Qu.:1.500
## Median :0.013158   Median :549915   Median :6.000   Median :3.250
## Mean    :0.015560   Mean    :523970   Mean    :5.667   Mean    :3.532
## 3rd Qu.:0.018291   3rd Qu.:743966  3rd Qu.:7.000   3rd Qu.:6.000

```

```

## Max.    :0.063830   Max.    :978851   Max.    :8.000   Max.    :8.000
## trunk_min      trunk_range      Urine.Ph_max   Urine.Ph_median
## Min.    :0.000   Min.    :0.000000   Min.    :6.000   Min.    :5.500
## 1st Qu.:0.000   1st Qu.:0.004490   1st Qu.:6.500   1st Qu.:5.812
## Median  :1.000   Median  :0.006365   Median  :7.000   Median  :6.000
## Mean    :1.872   Mean    :0.007133   Mean    :7.077   Mean    :6.192
## 3rd Qu.:3.000   3rd Qu.:0.009639   3rd Qu.:7.500   3rd Qu.:6.500
## Max.    :7.000   Max.    :0.019048   Max.    :9.000   Max.    :7.500
## Urine.Ph_min  Urine.Ph_range  White.Blood.Cell..WBC._max
## Min.    :5.000   Min.    :0.000000   Min.    : 4.110
## 1st Qu.:5.000   1st Qu.:0.002278   1st Qu.: 7.768
## Median  :5.500   Median  :0.003390   Median  : 8.750
## Mean    :5.564   Mean    :0.004544   Mean    : 9.342
## 3rd Qu.:6.000   3rd Qu.:0.004715   3rd Qu.:10.690
## Max.    :7.000   Max.    :0.034483   Max.    :22.490
## White.Blood.Cell..WBC._median White.Blood.Cell..WBC._min
## Min.    : 3.240           Min.    :1.430
## 1st Qu.: 5.879           1st Qu.:4.330
## Median  : 6.720           Median :5.320
## Mean    : 6.789           Mean    :5.286
## 3rd Qu.: 7.730           3rd Qu.:6.125
## Max.    :11.795           Max.    :9.500
## White.Blood.Cell..WBC._range
## Min.    :0.003078
## 1st Qu.:0.005658
## Median  :0.008402
## Mean    :0.012203
## 3rd Qu.:0.012471
## Max.    :0.092045

```

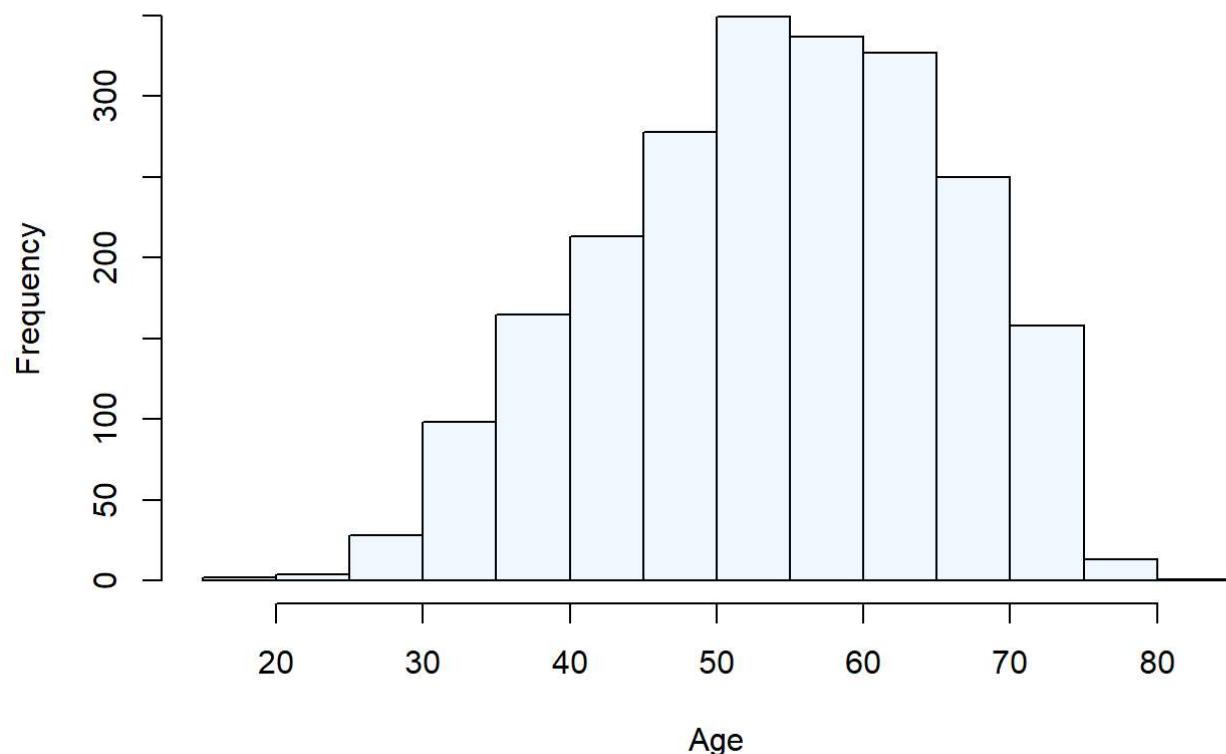
Histograms are a visual representation of a dataset.

It consists of x-axis, y-axis and various bars of different heights, where y-axis shows how frequently the values on x-axis occur in data.

Histogram of the age data in training dataset as below shows more data for the age between the range 45 to 65

```
hist(training_data$Age_mean, col = 'aliceblue', main = 'Histogram of Age in training data', xlab = 'Age')
```

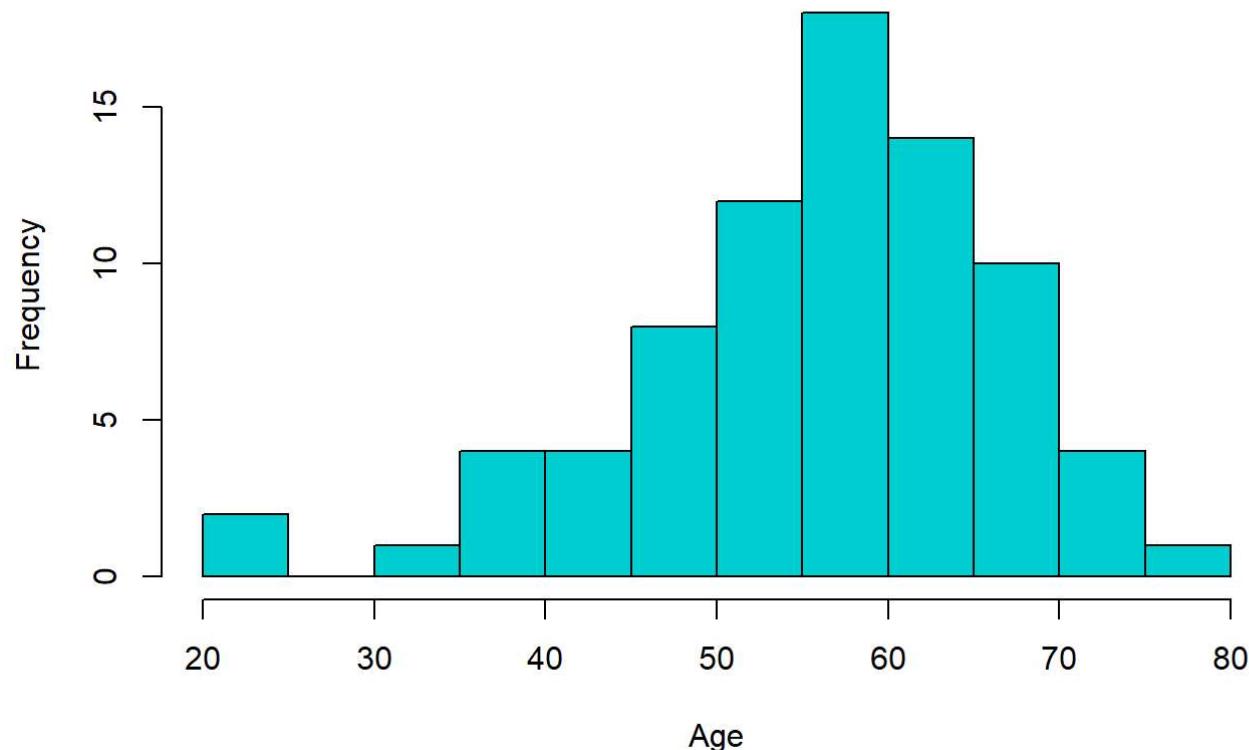
Histogram of Age in training data



Histogram of the age data in testing dataset as below shows more data for the age between the range 45 to 65

```
hist(testing_data$Age_mean, col = 'darkturquoise', main = 'Histogram of Age in testing data',  
xlab = 'Age')
```

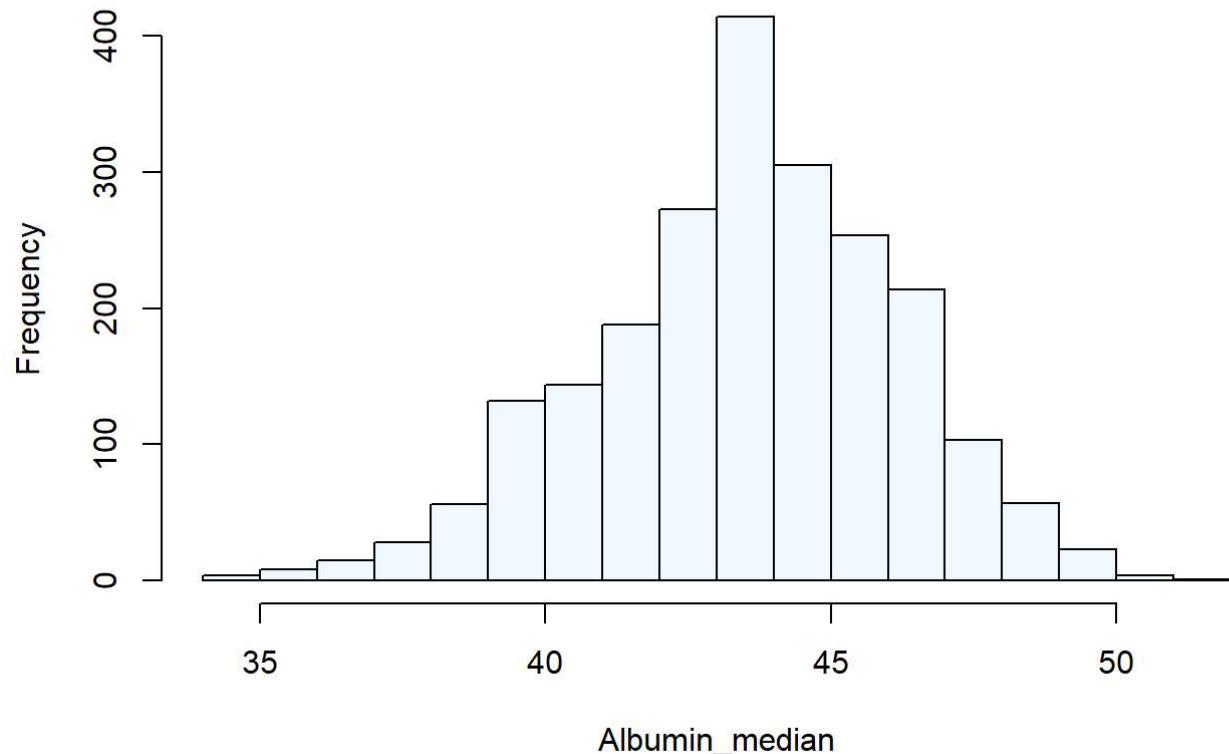
Histogram of Age in testing data



Majority of the data in training dataset has count of Albumin_median falling between 40 to 47

```
hist(training_data$Albumin_median, col = 'aliceblue', main = 'Histogram of Albumin in training data', xlab = 'Albumin_median')
```

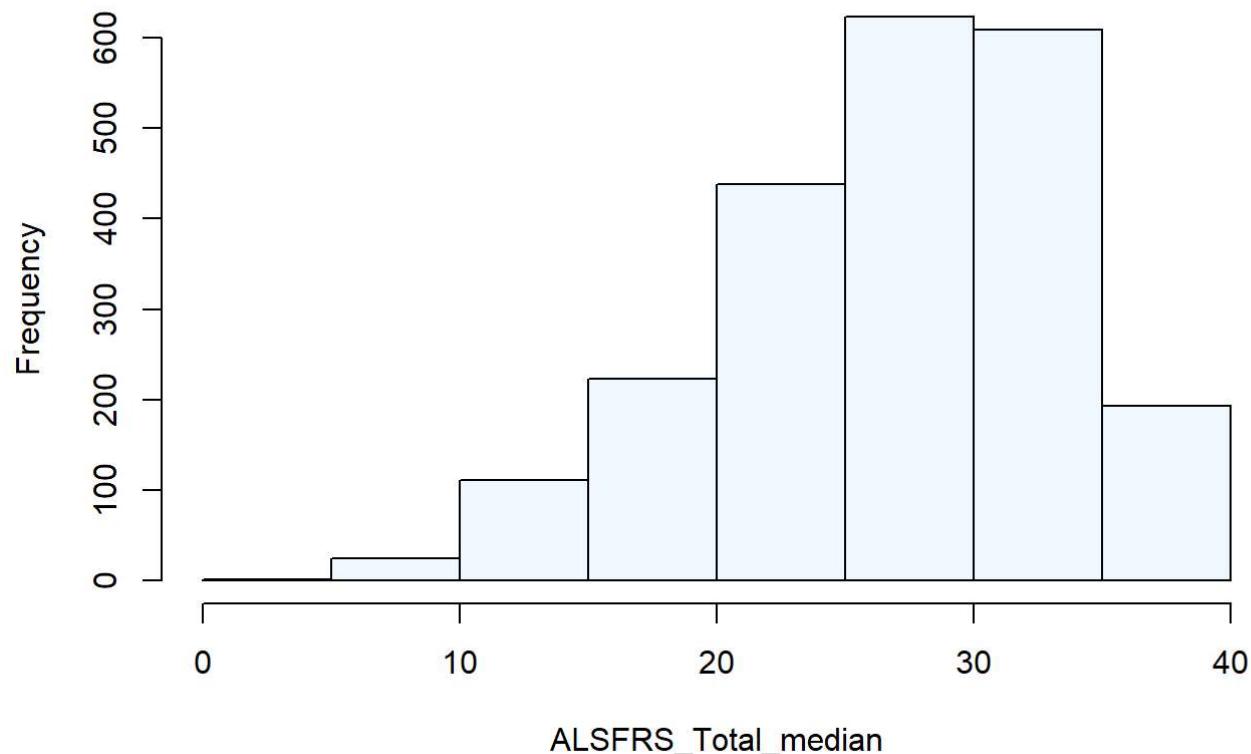
Histogram of Albumin in training data



Majority of the data in training dataset has count of ALSFRS_Total_median falling between 15 to 35

```
hist(training_data$ALSFRTS_Total_median, col = 'aliceblue', main = 'Histogram of ALSFRS in training data', xlab = 'ALSFRTS_Total_median')
```

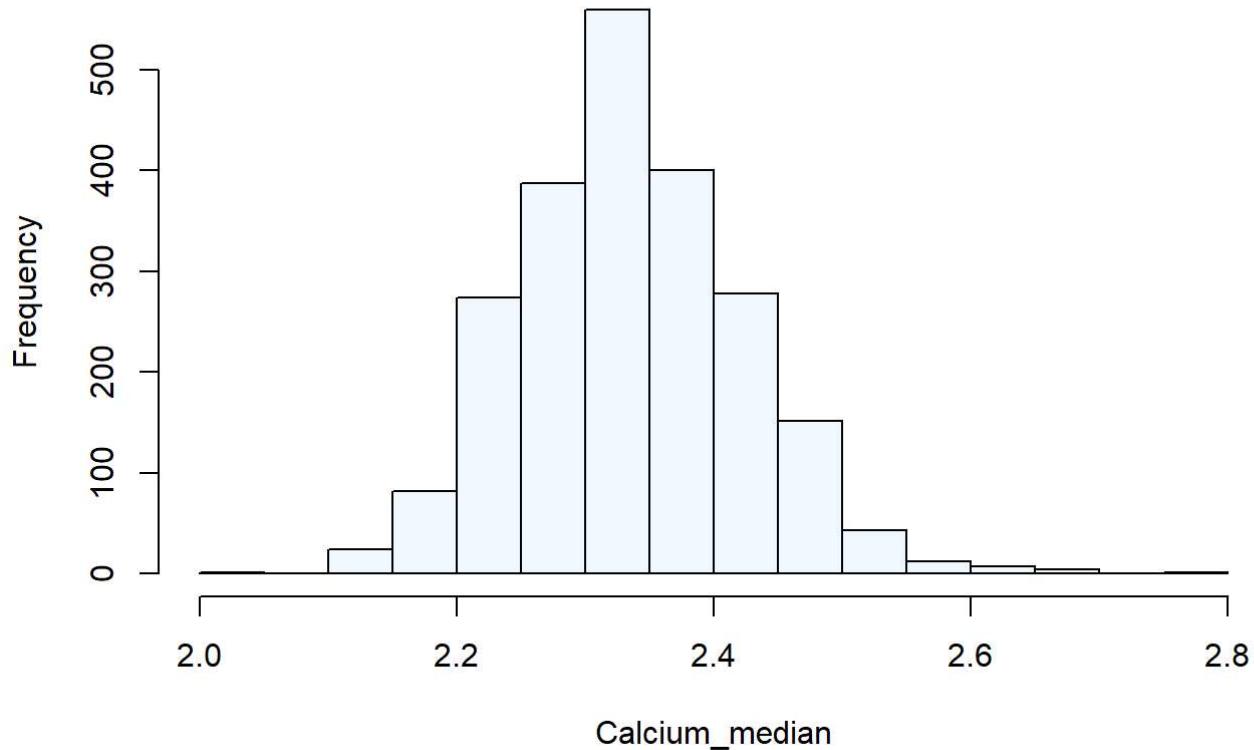
Histogram of ALSFRS in training data



Majority of the data in training dataset has count of Calcium_median falling between 2.2 to 2.5

```
hist(training_data$Calcium_median, col = 'aliceblue', main = 'Histogram of Calcium in training data', xlab = 'Calcium_median')
```

Histogram of Calcium in training data

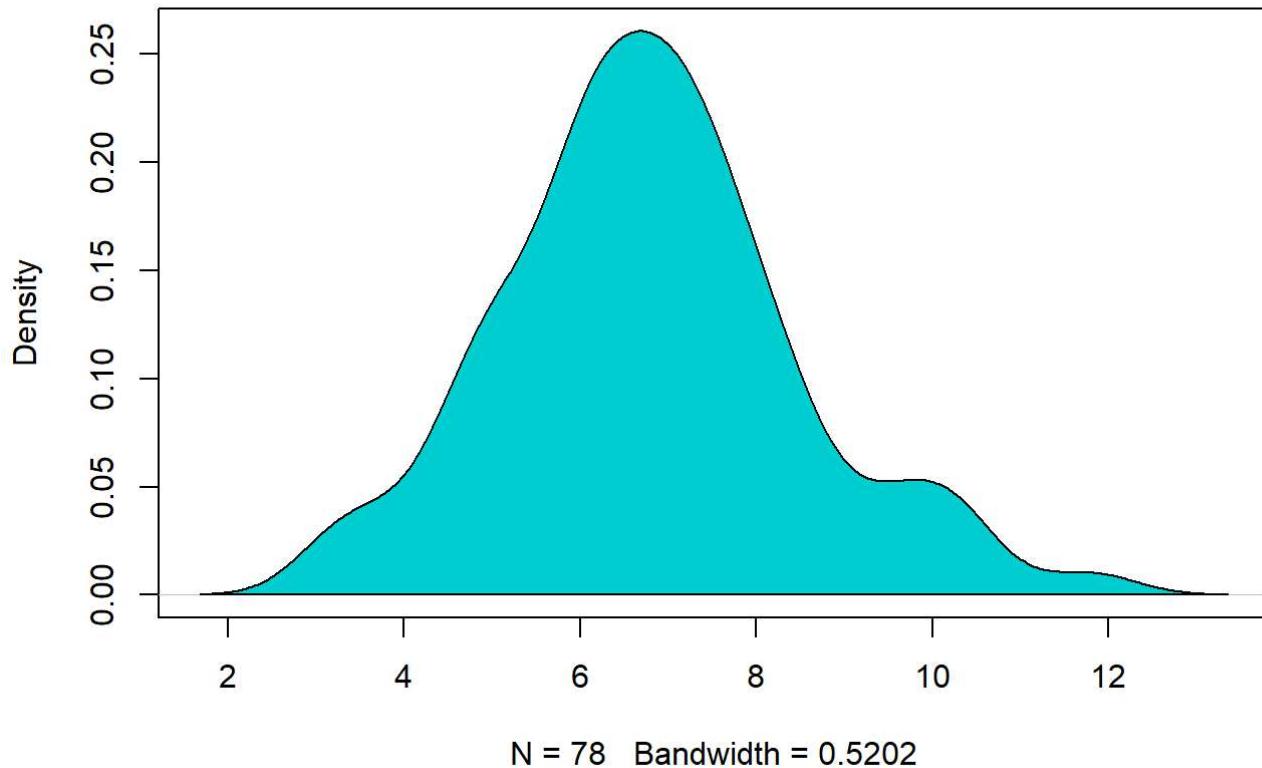


Density plots are used to view the distribution of a variable in a data

Below graph shows the density data of 'White.Blood.Cell..WBC._median' in testing dataset.

```
d <- density(testing_data$White.Blood.Cell..WBC._median)
plot(d, main = "Density of 'White Blood Cell' variable in testing data")
polygon(d, col="darkturquoise")
```

Density of 'White Blood Cell' variable in testing data



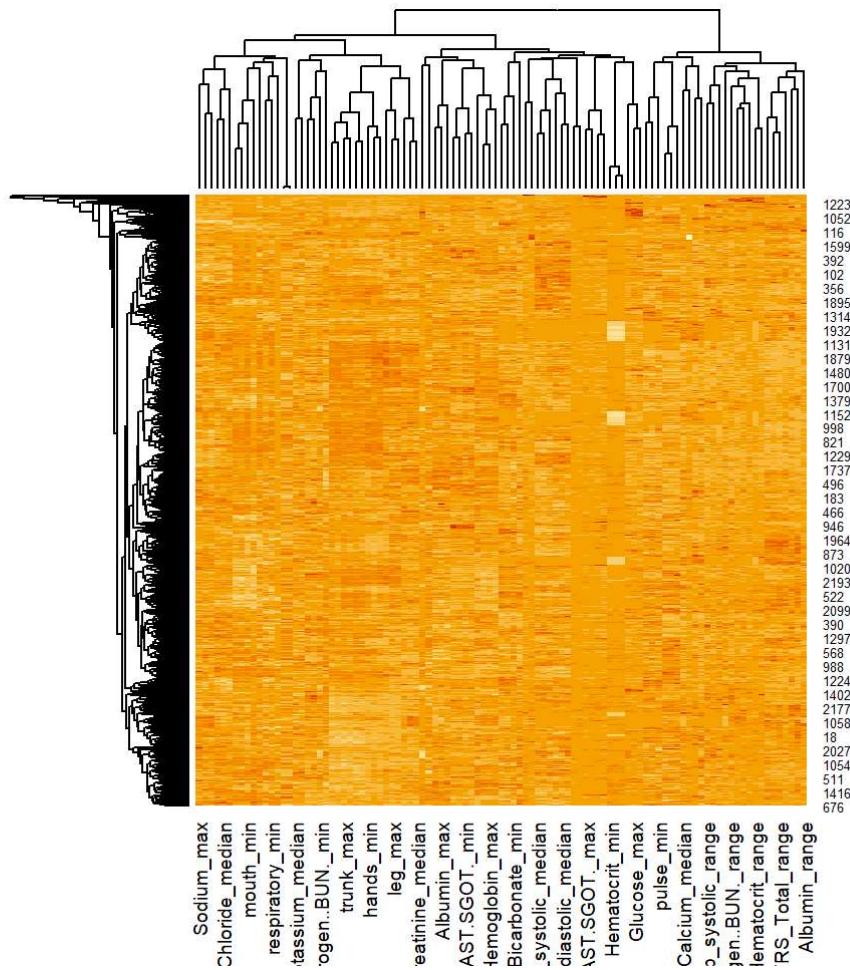
Heatmap is used to visualize hierarchical clustering, where data values are transformed to color scale.

First hierarchical clustering is done on both rows and columns of the data matrix, then data is re-ordered according to the hierarchical result, putting similar observations close to each other.

`heatmap()` is a base function in R to draw a simple heatmap, where the 'scale' attribute indicates if the values should be centered and scaled in either row or column direction, or none.

Below Heatmap of the training data

```
df <- scale(training_data)
heatmap(df, scale = "row")
```

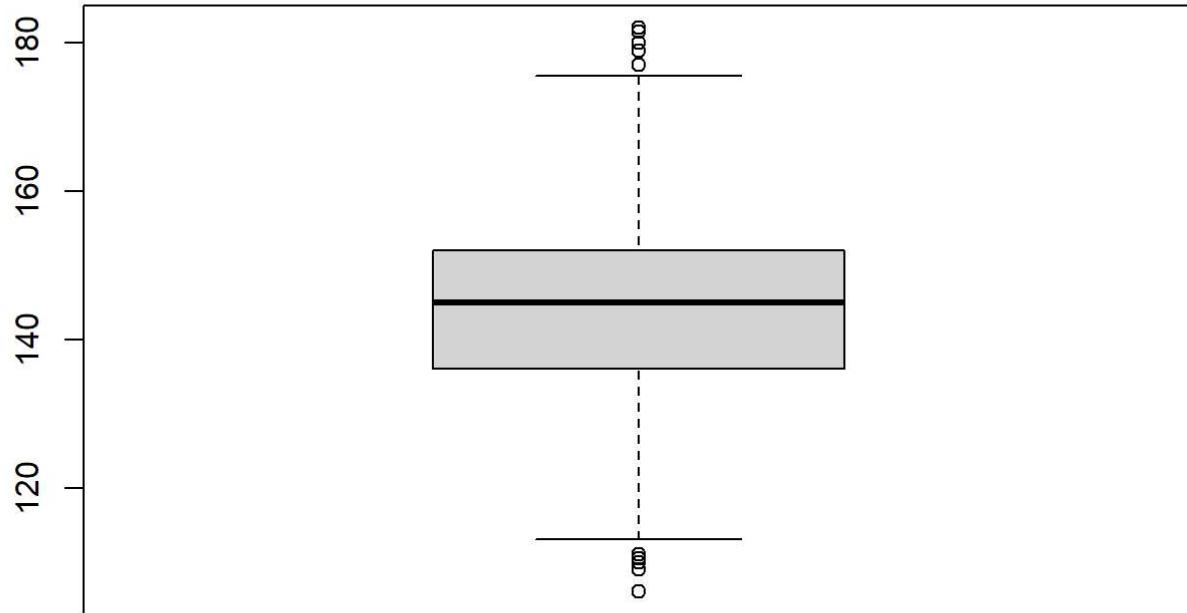


Boxplots are used to measure how well the data is distributed in the dataset.

It divides the data in three quartiles, the graph represents min, max, median, first quartile, third quartile in the dataset.

```
boxplot(training_data$Hemoglobin_median, xlab = "Hemoglobin_median", main = "Measurement of the Hemoglobin_median")
```

Measurement of the Hemoglobin_median



Hemoglobin_median

The below script will create a boxplot graph for the relation between pulse_median and bp_diastolic_median

```
boxplot(pulse_median ~ bp_diastolic_median, data = training_data, xlab = "bp_diastolic_media  
n", ylab = "pulse_median", main = "Relationship between bp_diastolic and pulse")
```

Relationship between bp_diastolic and pulse

