STAT 403 PROJECT

R Markdown

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When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
data=read.csv("Coffee.csv")
data
```

```
##    Island      City House              Name Age Gender                  Type
## 1       N    Helvig     2     Johana Bhinder  25      F  Coffee Espresso 60ml
## 2       N    Helvig     5      Abby Mccarthy  35      F  Coffee Espresso 60ml
## 3       N    Helvig     6       Corinna Khun  19      F  Coffee Espresso 60ml
## 4       N    Helvig    10      Erla Sorensen  32      F  Coffee Espresso 60ml
## 5       N    Helvig    12     Mathew Conolly  40      M  Coffee Espresso 60ml
## 6       N  Burjholm    30          Tyr Bager  32      M  Coffee Espresso 60ml
## 7       N  Burjholm    25       Nico Ekhlund  26      M  Coffee Espresso 60ml
## 8       N  Burjholm    28     Misaki Collins  29      F  Coffee Espresso 60ml
## 9       N  Burjholm    22       Bianka Jager  41      F  Coffee Espresso 60ml
## 10      N  Burjholm    41      Jhon Blomgren  36      M  Coffee Espresso 60ml
## 11      N  Burjholm    38       Tyr Sorenson  56      M  Coffee Espresso 60ml
## 12      N    Helvig    25  Rosemarrie Keller  32      F  Coffee Espresso 60ml
## 13      N    Helvig    12        Mohal Kumar  21      M  Coffee Espresso 60ml
## 14      N    Helvig   123        Riku kimura  37      F  Coffee Espresso 60ml
## 15      N  Burjholm   141      Elina Ekhlund  25      F  Coffee Espresso 60ml
## 16      N  Burjholm    41     Juhani Solberg  35      M  Coffee Espresso 60ml
## 17      N Helluland    23       Luke Conolly  21      M  Coffee Espresso 60ml
## 18      N Helluland    41       Adam Yamanda  37      F  Coffee Espresso 60ml
## 19      N Helluland    32       Juhani Bager  23      M  Coffee Espresso 60ml
## 20      N Helluland    29       Ole Sorenson  23      F  Coffee Espresso 60ml
## 21      N Helluland    22     Elias Sorenson  43      M  Coffee Espresso 60ml
## 22      N Helluland    22       Tom Albrecht  22      M  Coffee Espresso 60ml
## 23      N Helluland    32       Ishrat Mehta  27      F  Coffee Espresso 60ml
## 24      N Helluland    43       Raum Ekhlund  21      M  Coffee Espresso 60ml
## 25      N Helluland   345      lahar Chandra  52      M  Coffee Espresso 60ml
## 26      N Helluland   345     Sahana Chandra  37      F  Coffee Espresso 60ml
## 27      N Helluland   142         Jana Patel  21      f  Coffee Espresso 60ml
## 28      N Helluland   112        Nabhi Devar  19      M  Coffee Espresso 60ml
## 29      N Helluland    62  Sahana Schilinder  20      F  Coffee Espresso 60ml
## 30      N Helluland    70       Ryan Solberg  31      M  Coffee Espresso 60ml
## 31      N     Vardo    42     Anund Sorenson  30      M Coffee Espresso 120ml
## 32      N     Vardo    12       Manami Regan  24      F Coffee Espresso 120ml
## 33      N     Vardo    14 Alexander Sorenson  22      M Coffee Espresso 120ml
## 34      N     Vardo   322      Oriel Solberg  40      M Coffee Espresso 120ml
```

```
## 35      N     Vardo   322        Agda Jenson  35      F Coffee Espresso 120ml
## 36      N     Vardo   320       Erla Solberg  22      F Coffee Espresso 120ml
## 37      N     Vardo   120      Raphael Lund   26      M Coffee Espresso 120ml
## 38      N     Vardo   132       Megan Moore   34      F Coffee Espresso 120ml
## 39      N     Vardo   132      Mathew Satto   28      M Coffee Espresso 120ml
## 40      N     Vardo    76     Even Sorenson   19      M Coffee Espresso 120ml
## 41      N     Vardo    69    Mathew Solberg   28      M Coffee Espresso 120ml
## 42      N     Vardo    70    Hailey Yamanda   45      F Coffee Espresso 120ml
## 43      N Blonduous     2  Mathias Sorenson   23      M Coffee Espresso 120ml
## 44      N Blonduous    10   Thresa Carleson   32      F Coffee Espresso 120ml
## 45      N Blonduous    20     Sebatian Lund   28      F Coffee Espresso 120ml
## 46      N Blonduous    20       Kevin Price   30      M Coffee Espresso 120ml
## 47      N Blonduous    18       Rin Yamanda   22      F Coffee Espresso 120ml
## 48      N Blonduous    21     Alice Conolly   18      F Coffee Espresso 120ml
## 49      N Blonduous    22     Dahl Sorenson   20      M Coffee Espresso 120ml
## 50      N Blonduous   309         Sana Lund   37      F Coffee Espresso 120ml
## 51      N Blonduous   309    Anund Blomgren   32      F Coffee Espresso 120ml
## 52      N Blonduous   320   Krestin Ekhlund   24      F Coffee Espresso 120ml
## 53      N Blonduous   320    Kaito McCarthy   30      M Coffee Espresso 120ml
## 54      N Blonduous   320    Holly McCarthy   32      F Coffee Espresso 120ml
## 55      N Blonduous   362   Thurston Jenson   41      M Coffee Espresso 120ml
## 56      N Blonduous   360   Halmar Blomgren   38      M Coffee Espresso 120ml
## 57      N Blonduous   365     Kieran Morris   50      F Coffee Espresso 120ml
## 58      N Blonduous   220 Micheale Wantanbe   45      M Coffee Espresso 120ml
## 59      N Blonduous   210   Daniel Sorenson   34      M Coffee Espresso 120ml
## 60      N Blonduous   200     Olson Ekhlund   30      F Coffee Espresso 120ml
## 61      N      Hofn     2      Vera Schimdt   54      F           Water 120ml
## 62      N      Hofn    10       Marie Thorn   38      F           Water 120ml
## 63      N      Hofn    12       Alex Larsen   34      M           Water 120ml
## 64      N      Hofn    15       Jordan Hall   37      M           Water 120ml
## 65      N      Hofn    20         Adam Hall   40      M           Water 120ml
## 66      N      Hofn    18    Daniel Ericson   52      M           Water 120ml
## 67      N      Hofn    22        Malai Kaur   29      F           Water 120ml
## 68      N      Hofn    28      Haroon Ghosh   31      M           Water 120ml
## 69      N      Hofn    30       Sean Suzuki   24      M           Water 120ml
## 70      N      Hofn    50      Selina Thorn   84      F           Water 120ml
## 71      N     Vardo   488     Madison White   66      F           Water 120ml
## 72      N  Blonduos   625    Alex Soresnson   66      M           Water 120ml
## 73      N    Helvig   375   Selina Sorenson   61      F           Water 120ml
## 74      N    Helvig   637        Sten Olser   74      M           Water 120ml
## 75      N    Helvig   267     Sven Sorensen   45      M           Water 120ml
## 76      N  Bjurholm   195      Tyr Svendsen   48      M           Water 120ml
## 77      N      Hofn    55     Illona Jenson   22      F           Water 120ml
## 78      N     Vardo    73      Evan Collins   79      M           Water 120ml
## 79      N    Helvig   174   Henrik Sorenson   50      M           Water 120ml
## 80      N Helluland   481      Isobel burke   56      F           Water 120ml
## 81      N      Hofn   671      Maya Edwards   82      F           Water 120ml
## 82      N  Bjurholm   271    Matthew Kimura   63      M           Water 120ml
## 83      N      Hofn  1048     Hale Blomgren   58      F           Water 120ml
## 84      N Helluland   590  Thurston Solberg   48      M           Water 120ml
## 85      N  Blonduos   490      Lars Carlsen   19      M           Water 120ml
## 86      N  Blonduos   412    Hallen Ekhlund   22      M           Water 120ml
## 87      N    Helvig   532   Torsten Carlsen   49      M           Water 120ml
## 88      N    Helvig   586  Thurston Solberg   77      M           Water 120ml
```

```
## 89      N     Vardo  1011      Tyra Sorenson  52      F           Water 120ml
## 90      N  Blonduos    79    Harold Blomgren  73      M           Water 120ml
##    Treatment. Before After Change
## 1           1     19    17      2
## 2           1      4     6     -2
## 3           1     20    19      1
## 4           1     18    19     -1
## 5           1     12     9      3
## 6           1     16    16      0
## 7           1     13    11      2
## 8           1     20    19      1
## 9           1     20    19      1
## 10          1     19    16      3
## 11          1     20    14      6
## 12          1     16    20     -4
## 13          1     16    16      0
## 14          1     19    19      0
## 15          1     16    18     -2
## 16          1      2     6     -4
## 17          1     20    19      1
## 18          1     15    14      1
## 19          1     17    15      2
## 20          1     19    17      2
## 21          1     16    18     -2
## 22          1     20    18      2
## 23          1     18    17      1
## 24          1     18    14      4
## 25          1     18    15      3
## 26          1     18    18      0
## 27          1     12    11      1
## 28          1     15    15      0
## 29          1      7     5      2
## 30          1     10    12      2
## 31          2     19    18      1
## 32          2     17    16      1
## 33          2     20    14      6
## 34          2     20     8     12
## 35          2     20    15      5
## 36          2     20    18      2
## 37          2     20    12      8
## 38          2     15     9      6
## 39          2     18    12      6
## 40          2     16    16      0
## 41          2     19     8     11
## 42          2      7     5      2
## 43          2     13    13      0
## 44          2     15    13      2
## 45          2     17    14      3
## 46          2     14    12      2
## 47          2     19    12      7
## 48          2     17    14      3
## 49          2     14    12      2
## 50          2     17    11      6
## 51          2     18    10      8
```

```
## 52          2     20    19      1
## 53          2     12    10      2
## 54          2     19    19      0
## 55          2     17    15      2
## 56          2     16    12      4
## 57          2     19    20     -1
## 58          2     18     7     11
## 59          2     17    19     -2
## 60          2     10     8      2
## 61          3     18    17      1
## 62          3     20    20      0
## 63          3     15    13      2
## 64          3     12    15     -3
## 65          3     18    18      0
## 66          3     12    11      1
## 67          3     14    17     -3
## 68          3     18    17      1
## 69          3     14    14      0
## 70          3     18    16      2
## 71          3     19    19      0
## 72          3     18    12      6
## 73          3     20    20      0
## 74          3      5     8     -3
## 75          3     10     9      1
## 76          3     13     9      4
## 77          3     17    20     -3
## 78          3     20    18      2
## 79          3     18    19     -1
## 80          3     12    19     -7
## 81          3     14    13      1
## 82          3     17    14      3
## 83          3     19    12      7
## 84          3     19     9     10
## 85          3     20    12      8
## 86          3     12    10      2
## 87          3     11    10      1
## 88          3     12    18     -6
## 89          3     19    19      0
## 90          3     18    18      0
```

```
table1=data[1:30,]
table2=data[31:60,]
table3=data[61:90,]
```

```
##All 3 treatments
table1
```

```
##    Island      City House              Name Age Gender                 Type
## 1       N    Helvig     2    Johana Bhinder  25      F Coffee Espresso 60ml
## 2       N    Helvig     5     Abby Mccarthy  35      F Coffee Espresso 60ml
## 3       N    Helvig     6      Corinna Khun  19      F Coffee Espresso 60ml
## 4       N    Helvig    10     Erla Sorensen  32      F Coffee Espresso 60ml
## 5       N    Helvig    12    Mathew Conolly  40      M Coffee Espresso 60ml
```

```
## 6       N  Burjholm    30         Tyr Bager  32      M Coffee Espresso 60ml
## 7       N  Burjholm    25      Nico Ekhlund  26      M Coffee Espresso 60ml
## 8       N  Burjholm    28    Misaki Collins  29      F Coffee Espresso 60ml
## 9       N  Burjholm    22      Bianka Jager  41      F Coffee Espresso 60ml
## 10      N  Burjholm    41     Jhon Blomgren  36      M Coffee Espresso 60ml
## 11      N  Burjholm    38      Tyr Sorenson  56      M Coffee Espresso 60ml
## 12      N    Helvig    25 Rosemarrie Keller  32      F Coffee Espresso 60ml
## 13      N    Helvig    12       Mohal Kumar  21      M Coffee Espresso 60ml
## 14      N    Helvig   123       Riku kimura  37      F Coffee Espresso 60ml
## 15      N  Burjholm   141     Elina Ekhlund  25      F Coffee Espresso 60ml
## 16      N  Burjholm    41    Juhani Solberg  35      M Coffee Espresso 60ml
## 17      N Helluland    23      Luke Conolly  21      M Coffee Espresso 60ml
## 18      N Helluland    41      Adam Yamanda  37      F Coffee Espresso 60ml
## 19      N Helluland    32      Juhani Bager  23      M Coffee Espresso 60ml
## 20      N Helluland    29      Ole Sorenson  23      F Coffee Espresso 60ml
## 21      N Helluland    22    Elias Sorenson  43      M Coffee Espresso 60ml
## 22      N Helluland    22      Tom Albrecht  22      M Coffee Espresso 60ml
## 23      N Helluland    32      Ishrat Mehta  27      F Coffee Espresso 60ml
## 24      N Helluland    43      Raum Ekhlund  21      M Coffee Espresso 60ml
## 25      N Helluland   345     lahar Chandra  52      M Coffee Espresso 60ml
## 26      N Helluland   345    Sahana Chandra  37      F Coffee Espresso 60ml
## 27      N Helluland   142        Jana Patel  21      f Coffee Espresso 60ml
## 28      N Helluland   112       Nabhi Devar  19      M Coffee Espresso 60ml
## 29      N Helluland    62 Sahana Schilinder  20      F Coffee Espresso 60ml
## 30      N Helluland    70      Ryan Solberg  31      M Coffee Espresso 60ml
##    Treatment. Before After Change
## 1           1     19    17      2
## 2           1      4     6     -2
## 3           1     20    19      1
## 4           1     18    19     -1
## 5           1     12     9      3
## 6           1     16    16      0
## 7           1     13    11      2
## 8           1     20    19      1
## 9           1     20    19      1
## 10          1     19    16      3
## 11          1     20    14      6
## 12          1     16    20     -4
## 13          1     16    16      0
## 14          1     19    19      0
## 15          1     16    18     -2
## 16          1      2     6     -4
## 17          1     20    19      1
## 18          1     15    14      1
## 19          1     17    15      2
## 20          1     19    17      2
## 21          1     16    18     -2
## 22          1     20    18      2
## 23          1     18    17      1
## 24          1     18    14      4
## 25          1     18    15      3
## 26          1     18    18      0
## 27          1     12    11      1
## 28          1     15    15      0
```

```
## 29          1      7     5      2
## 30          1     10    12      2
```

```
table2
```

```
##    Island      City House               Name Age Gender                  Type
## 31      N     Vardo    42     Anund Sorenson  30      M Coffee Espresso 120ml
## 32      N     Vardo    12       Manami Regan  24      F Coffee Espresso 120ml
## 33      N     Vardo    14 Alexander Sorenson  22      M Coffee Espresso 120ml
## 34      N     Vardo   322      Oriel Solberg  40      M Coffee Espresso 120ml
## 35      N     Vardo   322        Agda Jenson  35      F Coffee Espresso 120ml
## 36      N     Vardo   320       Erla Solberg  22      F Coffee Espresso 120ml
## 37      N     Vardo   120       Raphael Lund  26      M Coffee Espresso 120ml
## 38      N     Vardo   132        Megan Moore  34      F Coffee Espresso 120ml
## 39      N     Vardo   132       Mathew Satto  28      M Coffee Espresso 120ml
## 40      N     Vardo    76      Even Sorenson  19      M Coffee Espresso 120ml
## 41      N     Vardo    69     Mathew Solberg  28      M Coffee Espresso 120ml
## 42      N     Vardo    70     Hailey Yamanda  45      F Coffee Espresso 120ml
## 43      N Blonduous     2   Mathias Sorenson  23      M Coffee Espresso 120ml
## 44      N Blonduous    10    Thresa Carleson  32      F Coffee Espresso 120ml
## 45      N Blonduous    20      Sebatian Lund  28      F Coffee Espresso 120ml
## 46      N Blonduous    20        Kevin Price  30      M Coffee Espresso 120ml
## 47      N Blonduous    18        Rin Yamanda  22      F Coffee Espresso 120ml
## 48      N Blonduous    21      Alice Conolly  18      F Coffee Espresso 120ml
## 49      N Blonduous    22      Dahl Sorenson  20      M Coffee Espresso 120ml
## 50      N Blonduous   309          Sana Lund  37      F Coffee Espresso 120ml
## 51      N Blonduous   309     Anund Blomgren  32      F Coffee Espresso 120ml
## 52      N Blonduous   320    Krestin Ekhlund  24      F Coffee Espresso 120ml
## 53      N Blonduous   320     Kaito McCarthy  30      M Coffee Espresso 120ml
## 54      N Blonduous   320     Holly McCarthy  32      F Coffee Espresso 120ml
## 55      N Blonduous   362    Thurston Jenson  41      M Coffee Espresso 120ml
## 56      N Blonduous   360    Halmar Blomgren  38      M Coffee Espresso 120ml
## 57      N Blonduous   365      Kieran Morris  50      F Coffee Espresso 120ml
## 58      N Blonduous   220  Micheale Wantanbe  45      M Coffee Espresso 120ml
## 59      N Blonduous   210    Daniel Sorenson  34      M Coffee Espresso 120ml
## 60      N Blonduous   200      Olson Ekhlund  30      F Coffee Espresso 120ml
##    Treatment. Before After Change
## 31          2     19    18      1
## 32          2     17    16      1
## 33          2     20    14      6
## 34          2     20     8     12
## 35          2     20    15      5
## 36          2     20    18      2
## 37          2     20    12      8
## 38          2     15     9      6
## 39          2     18    12      6
## 40          2     16    16      0
## 41          2     19     8     11
## 42          2      7     5      2
## 43          2     13    13      0
## 44          2     15    13      2
## 45          2     17    14      3
## 46          2     14    12      2
## 47          2     19    12      7
```

```
## 48          2     17    14      3
## 49          2     14    12      2
## 50          2     17    11      6
## 51          2     18    10      8
## 52          2     20    19      1
## 53          2     12    10      2
## 54          2     19    19      0
## 55          2     17    15      2
## 56          2     16    12      4
## 57          2     19    20     -1
## 58          2     18     7     11
## 59          2     17    19     -2
## 60          2     10     8      2
```

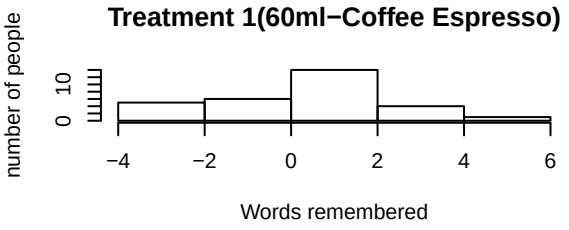
```
table3
```

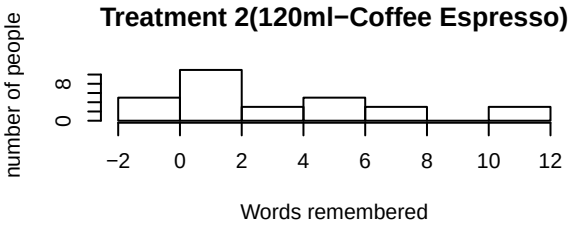
```
##    Island      City House             Name Age Gender        Type Treatment.
## 61      N      Hofn     2     Vera Schimdt  54      F Water 120ml          3
## 62      N      Hofn    10      Marie Thorn  38      F Water 120ml          3
## 63      N      Hofn    12      Alex Larsen  34      M Water 120ml          3
## 64      N      Hofn    15      Jordan Hall  37      M Water 120ml          3
## 65      N      Hofn    20        Adam Hall  40      M Water 120ml          3
## 66      N      Hofn    18   Daniel Ericson  52      M Water 120ml          3
## 67      N      Hofn    22       Malai Kaur  29      F Water 120ml          3
## 68      N      Hofn    28     Haroon Ghosh  31      M Water 120ml          3
## 69      N      Hofn    30      Sean Suzuki  24      M Water 120ml          3
## 70      N      Hofn    50     Selina Thorn  84      F Water 120ml          3
## 71      N     Vardo   488    Madison White  66      F Water 120ml          3
## 72      N  Blonduos   625   Alex Soresnson  66      M Water 120ml          3
## 73      N    Helvig   375  Selina Sorenson  61      F Water 120ml          3
## 74      N    Helvig   637       Sten Olser  74      M Water 120ml          3
## 75      N    Helvig   267    Sven Sorensen  45      M Water 120ml          3
## 76      N  Bjurholm   195     Tyr Svendsen  48      M Water 120ml          3
## 77      N      Hofn    55    Illona Jenson  22      F Water 120ml          3
## 78      N     Vardo    73     Evan Collins  79      M Water 120ml          3
## 79      N    Helvig   174  Henrik Sorenson  50      M Water 120ml          3
## 80      N Helluland   481     Isobel burke  56      F Water 120ml          3
## 81      N      Hofn   671     Maya Edwards  82      F Water 120ml          3
## 82      N  Bjurholm   271   Matthew Kimura  63      M Water 120ml          3
## 83      N      Hofn  1048    Hale Blomgren  58      F Water 120ml          3
## 84      N Helluland   590 Thurston Solberg  48      M Water 120ml          3
## 85      N  Blonduos   490     Lars Carlsen  19      M Water 120ml          3
## 86      N  Blonduos   412   Hallen Ekhlund  22      M Water 120ml          3
## 87      N    Helvig   532  Torsten Carlsen  49      M Water 120ml          3
## 88      N    Helvig   586 Thurston Solberg  77      M Water 120ml          3
## 89      N     Vardo  1011    Tyra Sorenson  52      F Water 120ml          3
## 90      N  Blonduos    79  Harold Blomgren  73      M Water 120ml          3
##    Before After Change
## 61     18    17      1
## 62     20    20      0
## 63     15    13      2
## 64     12    15     -3
## 65     18    18      0
## 66     12    11      1
```

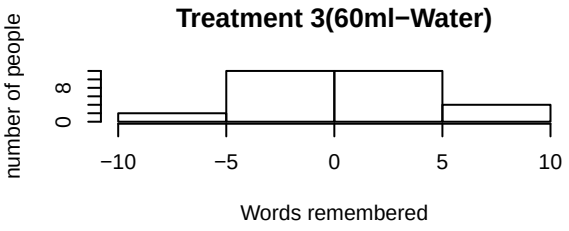
```
## 67     14    17     -3
## 68     18    17      1
## 69     14    14      0
## 70     18    16      2
## 71     19    19      0
## 72     18    12      6
## 73     20    20      0
## 74      5     8     -3
## 75     10     9      1
## 76     13     9      4
## 77     17    20     -3
## 78     20    18      2
## 79     18    19     -1
## 80     12    19     -7
## 81     14    13      1
## 82     17    14      3
## 83     19    12      7
## 84     19     9     10
## 85     20    12      8
## 86     12    10      2
## 87     11    10      1
## 88     12    18     -6
## 89     19    19      0
## 90     18    18      0
```

```r
data$DType = factor(data$Type)
data$Change = as.numeric(as.character(data$Change))

Mean=tapply(data$Change,data$DType,mean)
SD = tapply(data$Change,data$DType, sd)
SampleSize=tapply(data$Change,data$DType,length)
Min=tapply(data$Change,data$DType,min)
Max=tapply(data$Change,data$DType,max)
Median=tapply(data$Change,data$DType,median)
summary.df=data.frame(SampleSize,Mean,Median,SD,Min,Max)
```

```r
###Histograms
par(mfrow=c(3,2))

hist(table1$Change,xlab = "Words remembered",ylab="number of people",main = "Treatment 1(60ml-Coffee Esp

hist(table2$Change,xlab = "Words remembered",ylab="number of people",main = "Treatment 2(120ml-Coffee Es

hist(table3$Change,xlab = "Words remembered",ylab="number of people",main = "Treatment 3(60ml-Water)")
```








```
##Summary Statistics Table
print("Summary Statistics table")
```

```
## [1] "Summary Statistics table"
```

```
summary.df
```

```
##                         SampleSize      Mean Median       SD Min Max
## Coffee Espresso 120ml          30 3.7333333      2 3.657145  -2  12
## Coffee Espresso 60ml           30 0.8333333      1 2.182743  -4   6
## Water 120ml                    30 0.8666667      1 3.692801  -7  10
```

```
###before transformation
#Regression
fit=lm(data$Change ~ data$DType,data)
summary(fit)
```

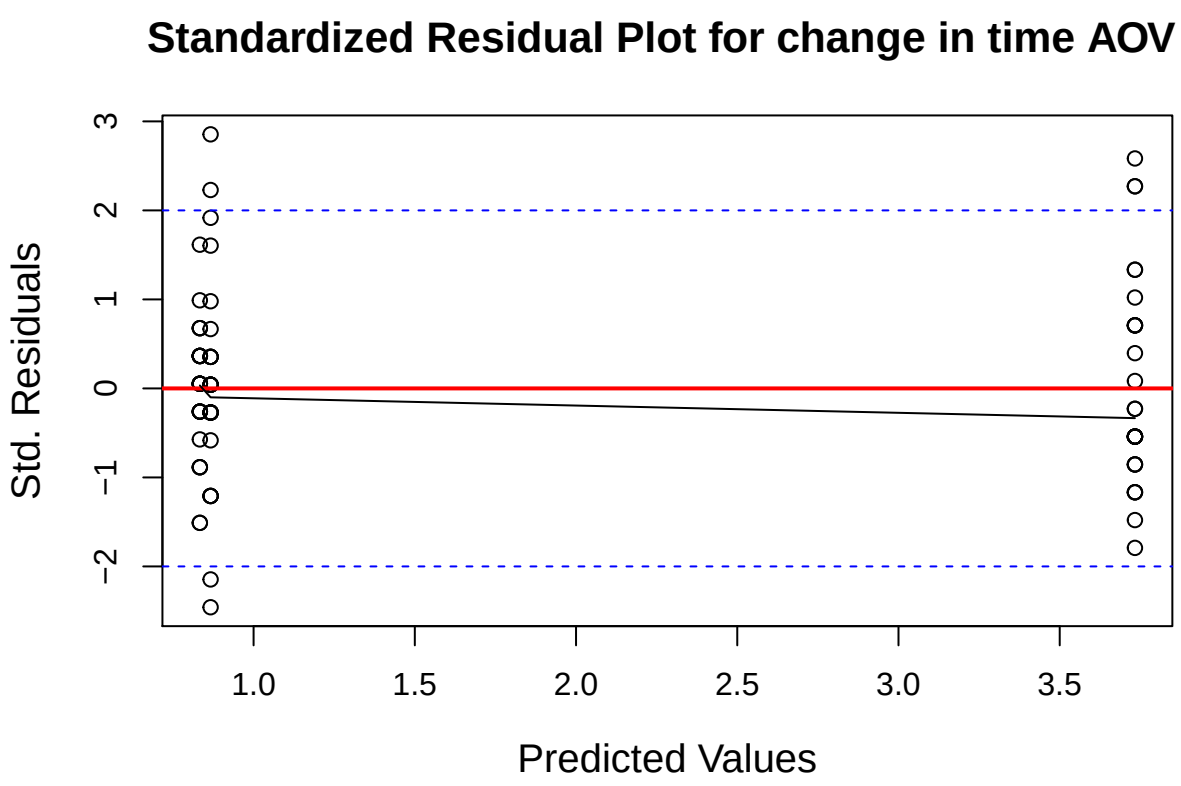
```
##
## Call:
## lm(formula = data$Change ~ data$DType, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.8667 -1.7333  0.1333  1.1667  9.1333
```

```
##
## Coefficients:
##                                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)                       3.7333     0.5942   6.283 1.27e-08 ***
## data$DTypeCoffee Espresso 60ml   -2.9000     0.8403  -3.451 0.000864 ***
## data$DTypeWater 120ml            -2.8667     0.8403  -3.411 0.000982 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.255 on 87 degrees of freedom
## Multiple R-squared:  0.1529, Adjusted R-squared:  0.1334
## F-statistic:  7.85 on 2 and 87 DF,  p-value: 0.0007343
```

```
fitness_aov = aov( data$Change~ data$DType,data)
summary(fitness_aov)
```

```
##              Df Sum Sq Mean Sq F value   Pr(>F)
## data$DType    2  166.3   83.14    7.85 0.000734 ***
## Residuals    87  921.5   10.59
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

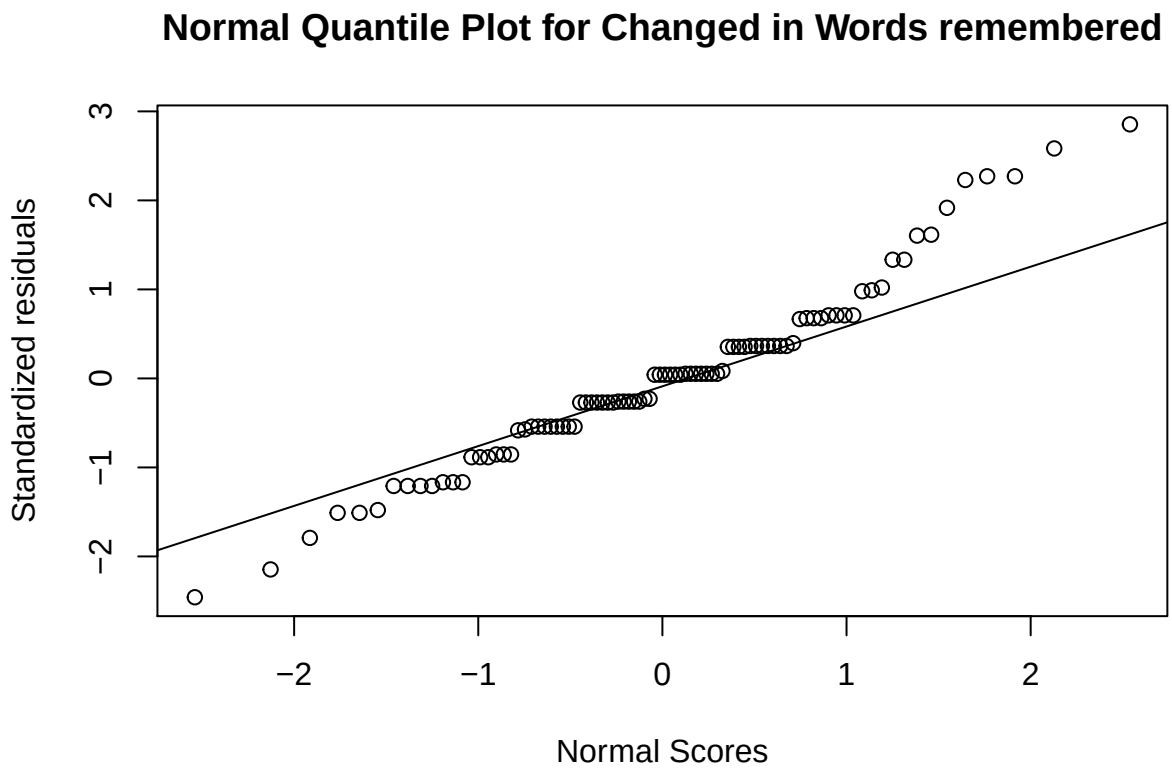
```
stdres = rstandard(fitness_aov) #obtain standardized residuals from aov object
pred = predict(fitness_aov)  #obtain predicted

plot(pred, stdres,
     main="Standardized Residual Plot for change in time AOV ",
     xlab="Predicted Values", ylab="Std. Residuals", cex.main = 1.3, cex.lab = 1.25)
abline(h=0, col="red", lwd=2)
abline(h = 2 , col="blue", lty=2)
abline(h = -2, col="blue", lty=2)

lines(lowess(pred,stdres))
```




```
#Normality Test
shapiro.test(data$Change)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  data$Change
## W = 0.93876, p-value = 0.0003607
```

```
# normal quantile plot
qqnorm(stdres, ylab="Standardized residuals", xlab="Normal Scores",
       main="Normal Quantile Plot for Changed in Words remembered")
qqline(stdres)
```




```
## Test for Variance
#Before transformation SD TEST
library(car)
```

```
## Loading required package: carData
```

```
SD = tapply(data$Change,data$DType, sd)
SD
```

```
## Coffee Espresso 120ml  Coffee Espresso 60ml           Water 120ml
##              3.657145              2.182743              3.692801
```

```
##ratio is less than 2 so constant variance condition is met

#Before Transformation Levene Test
leveneTest(data$Change~data$DType,data)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  2  2.1482 0.1228
##       87
```

```
##p-values greater than 0.05 then constant variance met
```

Transformations

```
fit_transform=lm(1/(data$Change+0.16)~ data$DType,data)
summary(fit_transform)
```

```
##
## Call:
## lm(formula = 1/(data$Change + 0.16) ~ data$DType, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.8217 -1.1683 -0.7660 -0.3927  5.3944
##
## Coefficients:
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                      0.8556     0.4188   2.043   0.0441 *
## data$DTypeCoffee Espresso 60ml   0.4289     0.5923   0.724   0.4709
## data$DTypeWater 120ml            0.7756     0.5923   1.310   0.1938
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.294 on 87 degrees of freedom
## Multiple R-squared:  0.0194, Adjusted R-squared:  -0.003141
## F-statistic: 0.8607 on 2 and 87 DF,  p-value: 0.4264
```

```
fitness_aov_transform = aov(1/(data$Change+0.16)~ data$DType,data)
summary(fitness_aov_transform)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## data$DType   2    9.1   4.529   0.861  0.426
## Residuals   87  457.8   5.262
```

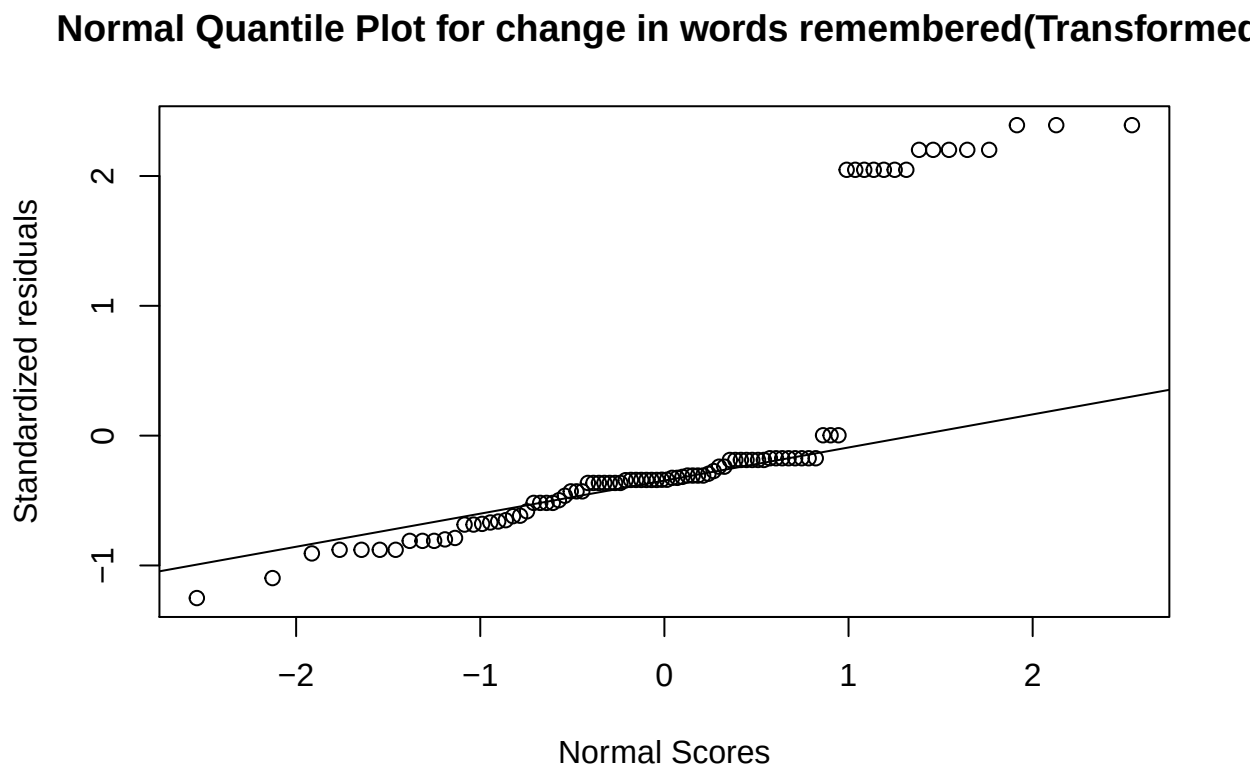
```
#Constatnt Variance tests

#After transformation SD TEST

SD = tapply(1/(data$Change+0.16),data$DType, sd)
SD
```

```
## Coffee Espresso 120ml  Coffee Espresso 60ml           Water 120ml
##              1.869493              2.314414              2.633446
```

```
leveneTest(1/(data$Change+0.16)~data$DType,data)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  2  1.2953  0.279
##       87
```

```r
fitness_aov_transform_Normality = aov(1/(data$Change+0.16)~ data$DType,data)

stdres_transform_Normality = rstandard(fitness_aov_transform_Normality) #obtain standardized residuals


# normal quantile plot
qqnorm(stdres_transform_Normality, ylab="Standardized residuals", xlab="Normal Scores",
       main="Normal Quantile Plot for change in words remembered(Transformed)")
qqline(stdres_transform_Normality)
```




```r
print("Using tukey HSD to reduce family-wise error rate")
```

```
## [1] "Using tukey HSD to reduce family-wise error rate"
```

```r
# Generate ANOVA table. Need this for input into Tukey function.
Time_aov = aov(1/(data$Change+0.16)~data$DType,data)
summary(Time_aov)
```

```
##              Df Sum Sq Mean Sq F value Pr(>F)
## data$DType    2    9.1   4.529   0.861  0.426
## Residuals    87  457.8   5.262
```

```r
# Tukey's HSD - this gives the adjusted p-values
TukeyHSD(Time_aov)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = 1/(data$Change + 0.16) ~ data$DType, data = data)
##
## $`data$DType`
##                                                diff        lwr      upr
## Coffee Espresso 60ml-Coffee Espresso 120ml 0.4288985 -0.9834147 1.841212
## Water 120ml-Coffee Espresso 120ml          0.7756371 -0.6366762 2.187950
## Water 120ml-Coffee Espresso 60ml           0.3467385 -1.0655747 1.759052
##                                                p adj
## Coffee Espresso 60ml-Coffee Espresso 120ml 0.7498963
## Water 120ml-Coffee Espresso 120ml          0.3937384
## Water 120ml-Coffee Espresso 60ml           0.8282836
```

```r
# Tukey's HSD - chart of confidence intervals
plot(TukeyHSD(Time_aov))
```