data analysis

2.Data cleaning

2.1 Data cleaning

```
## # A tibble: 6 x 28
##    First Second Third Class    Age AvgSleepTime LastNightSleep HoursAweak Fatigue
##    <dbl>  <dbl> <dbl> <chr>  <dbl>        <dbl>          <dbl>      <dbl> <ord>
## 1    734    684   783 Senior    22            8              8         13 Modera~
## 2    647    510   565 Sopho~    20            8              8         11 Modera~
## 3    779    608   566 Senior    21            7              8          9 Modera~
## 4    693    705   652 Junior    21            8              5          6 Slight~
## 5    310    292   298 Junior    21            7              6          3 Slight~
## 6    512    490   537 Senior    21           10             17          9 Not fa~
## # i 19 more variables: Stress <chr>, Distraction <chr>, NoiseLevel <dbl>,
## #   Temperature <chr>, VideoGamePlay <chr>, SportsPlay <chr>,
## #   ShootingGames <chr>, AvgHoursExercise <dbl>, Gamer <chr>,
## #   CaffeinIntake <chr>, AlcoholIntake <chr>, VisualAcuity <chr>,
## #   PrimarilyHand <chr>, UsePrimaryHand <chr>, Cautious <chr>,
## #   InputDevice <chr>, RefreshRate <chr>, DeviceOS <chr>, WiFi <chr>

## # A tibble: 6 x 29
##    First Second Third Class    Age AvgSleepTime LastNightSleep HoursAweak Fatigue
##    <dbl>  <dbl> <dbl> <chr>  <dbl>        <dbl>          <dbl>      <dbl> <ord>
## 1    734    684   783 Senior    22            8              8         13 Modera~
## 2    647    510   565 Sopho~    20            8              8         11 Modera~
## 3    779    608   566 Senior    21            7              8          9 Modera~
## 4    693    705   652 Junior    21            8              5          6 Slight~
## 5    310    292   298 Junior    21            7              6          3 Slight~
## 6    512    490   537 Senior    21           10             17          9 Not fa~
## # i 20 more variables: Stress <chr>, Distraction <chr>, NoiseLevel <dbl>,
## #   Temperature <chr>, VideoGamePlay <chr>, SportsPlay <chr>,
## #   ShootingGames <chr>, AvgHoursExercise <dbl>, Gamer <chr>,
## #   CaffeinIntake <chr>, AlcoholIntake <chr>, VisualAcuity <chr>,
## #   PrimarilyHand <chr>, UsePrimaryHand <chr>, Cautious <chr>,
## #   InputDevice <chr>, RefreshRate <chr>, DeviceOS <chr>, WiFi <chr>,
## #   Fatigue.3 <fct>

## # A tibble: 145 x 29
##     First Second Third Class    Age AvgSleepTime LastNightSleep HoursAweak Fatigue
##     <dbl>  <dbl> <dbl> <chr> <dbl>        <dbl>          <dbl>      <dbl> <ord>
## 1     734    684   783 Seni~    22            8              8         13 Modera~
## 2     647    510   565 Soph~    20            8              8         11 Modera~
## 3     779    608   566 Seni~    21            7              8          9 Modera~
## 4     693    705   652 Juni~    21            8              5          6 Slight~
## 5     310    292   298 Juni~    21            7              6          3 Slight~
## 6     512    490   537 Seni~    21           10             17          9 Not fa~
## 7     623    618   527 Juni~    20            8             10         12 Slight~
## 8     386    360   362 Juni~    21            6              8          6 Not fa~
```

```
## 9    473    402    391 Seni~     22            5                   5               2 Extrem~
## 10   588    549    514 Juni~     22            6.5                  10              4 Modera~
## # i 135 more rows
## # i 20 more variables: Stress <ord>, Distraction <chr>, NoiseLevel <fct>,
## #   Temperature <fct>, VideoGamePlay <chr>, SportsPlay <chr>,
## #   ShootingGames <chr>, AvgHoursExercise <dbl>, Gamer <fct>,
## #   CaffeinIntake <fct>, VisualAcuity <chr>, PrimarilyHand <chr>,
## #   UsePrimaryHand <chr>, Cautious <chr>, InputDevice <chr>, RefreshRate <chr>,
## #   DeviceOS <chr>, WiFi <chr>, Fatigue.3 <fct>, RH <fct>
```

2.2 descriptive statistics

```
##      First          Second          Third          Class
##  Min.   : 212.0  Min.   :292.0  Min.   :298.0  Length:145
##  1st Qu.: 512.0  1st Qu.:491.0  1st Qu.:490.0  Class :character
##  Median : 588.0  Median :561.0  Median :542.0  Mode  :character
##  Mean   : 592.3  Mean   :559.8  Mean   :548.7
##  3rd Qu.: 663.0  3rd Qu.:625.0  3rd Qu.:615.0
##  Max.   :1050.0  Max.   :868.0  Max.   :819.0
##
##       Age          AvgSleepTime   LastNightSleep    HoursAweak
##  Min.   :18.00  Min.   : 4.000  Min.   : 0.000  Min.   : 0.000
##  1st Qu.:20.00  1st Qu.: 6.500  1st Qu.: 6.000  1st Qu.: 4.000
##  Median :21.00  Median : 7.000  Median : 7.000  Median : 6.000
##  Mean   :20.88  Mean   : 7.248  Mean   : 7.159  Mean   : 7.445
##  3rd Qu.:21.00  3rd Qu.: 8.000  3rd Qu.: 8.000  3rd Qu.:10.000
##  Max.   :26.00  Max.   :11.000  Max.   :17.000  Max.   :24.000
##
##                  Fatigue         Stress    Distraction        NoiseLevel
##  Extremely fatigued : 2  Very Low :27  Length:145       3      :36
##  Very fatigued      :17  Low      :39  Class :character 2      :31
##  Moderately fatigued:49  Moderate :50  Mode  :character 1      :29
##  Slightly Fatigued  :53  High     :23                   5      :16
##  Not fatigued at all:24  Very High: 6                   4      :13
##                                                         7      :10
##                                                         (Other):10
##     Temperature  VideoGamePlay      SportsPlay      ShootingGames
##  Cold     : 14  Length:145      Length:145       Length:145
##  Neutral  :111  Class :character Class :character Class :character
##  Very Warm:  2  Mode  :character Mode  :character Mode  :character
##  Warm     : 18
##
##
##
##  AvgHoursExercise Gamer    CaffeinIntake VisualAcuity     PrimarilyHand
##  Min.   : 0.000  No :76  No :109  Length:145       Length:145
##  1st Qu.: 2.000  Yes:69  Yes: 36  Class :character Class :character
##  Median : 4.000                   Mode  :character Mode  :character
##  Mean   : 4.859
##  3rd Qu.: 6.000
##  Max.   :30.000
##
##  UsePrimaryHand       Cautious        InputDevice      RefreshRate
##  Length:145       Length:145       Length:145       Length:145
```
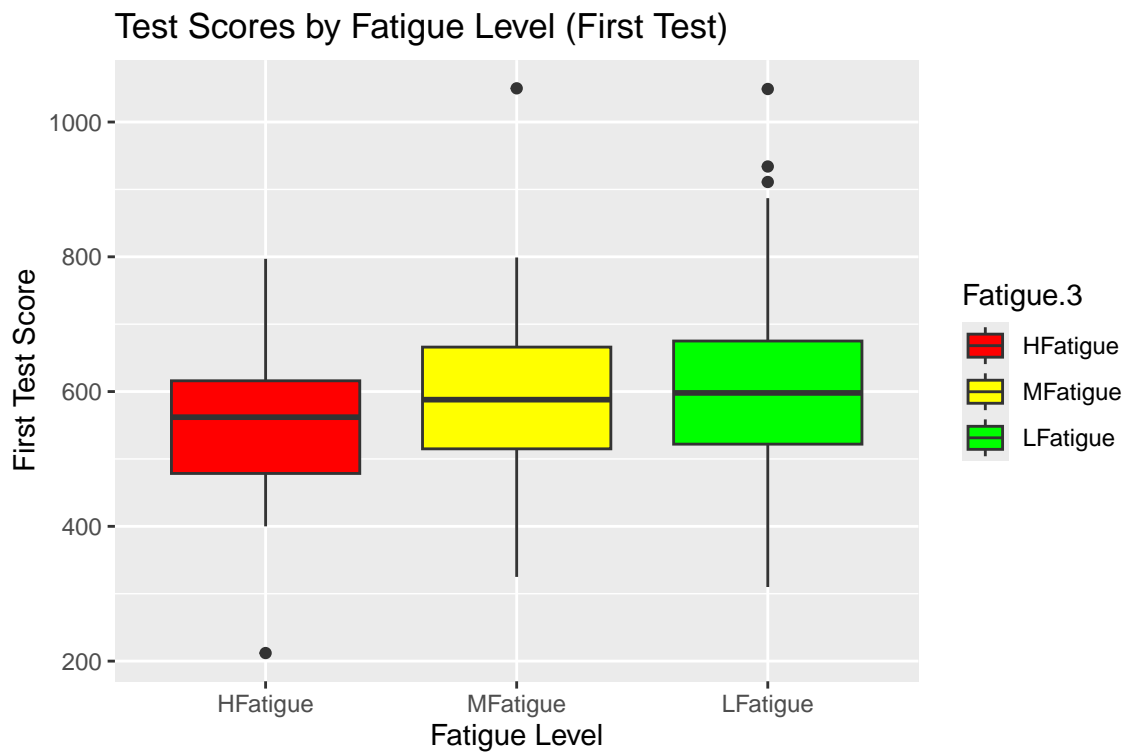
```
## Class :character   Class :character   Class :character   Class :character
## Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##    DeviceOS            WiFi             Fatigue.3 RH
## Length:145         Length:145         HFatigue:19  Y:133
## Class :character   Class :character   MFatigue:49  N: 12
## Mode  :character   Mode  :character   LFatigue:77
##
##
##
##
```
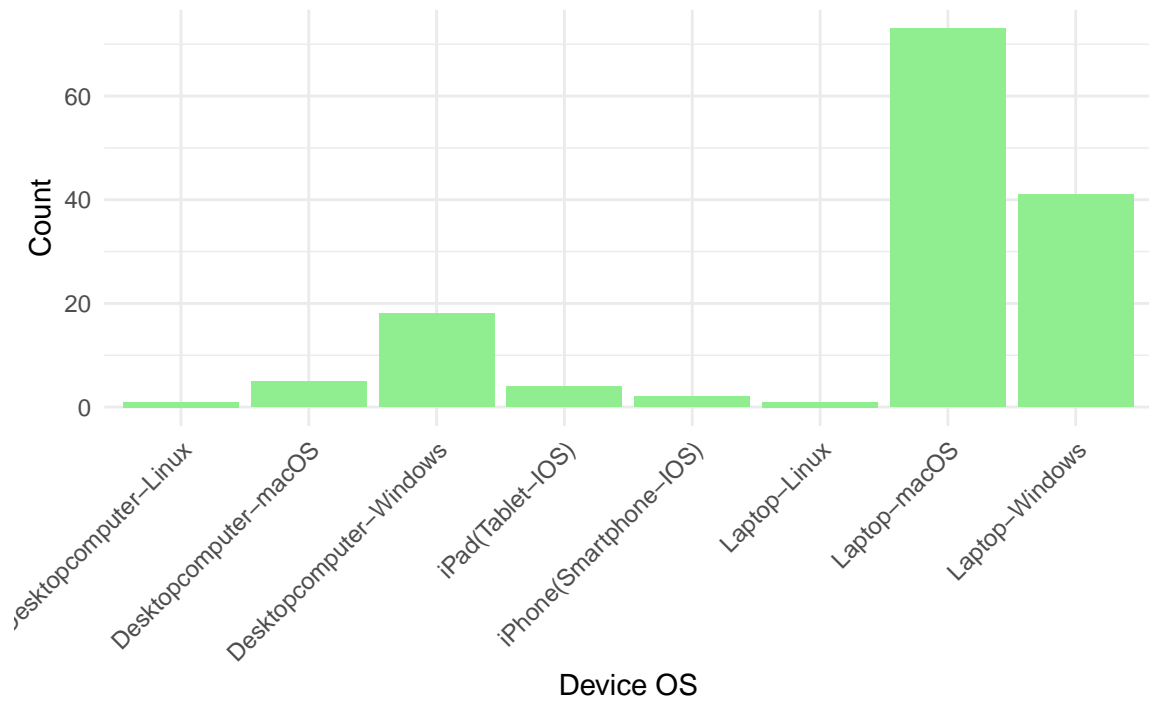
3.Exploratory data analysis

3.1 Fatigue level vs reaction time (first round)

3.2 Distribution of operating system types

Distribution of Device OS

3.3 Comparison of weekly exercise duration and first round reaction time

Avg Hours of Exercise vs Reaction Time (First Try)

4 model building

4.1 Multiple linear regression

```
##
## Call:
## lm(formula = First ~ Fatigue.3 + Stress + AvgSleepTime + LastNightSleep +
##     HoursAweak + VideoGamePlay + SportsPlay + AvgHoursExercise +
##     CaffeinIntake + RH + InputDevice + DeviceOS + RefreshRate +
##     WiFi, data = survey)
##
## Residuals:
##    Min     1Q  Median     3Q     Max
## -202.77  -62.07   -5.76   42.91  338.40
##
## Coefficients:
##                                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)                        582.3575   154.0334    3.781 0.000257 ***
## Fatigue.3MFatigue                   58.3614    35.9464    1.624 0.107384
## Fatigue.3LFatigue                   82.1195    38.4976    2.133 0.035181 *
## Stress.L                            44.6655    37.5993    1.188 0.237465
## Stress.Q                            12.0160    30.8026    0.390 0.697234
## Stress.C                           -11.2298    25.8746   -0.434 0.665147
## Stress^4                            61.3190    20.3270    3.017 0.003188 **
## AvgSleepTime                         8.3588    10.1913    0.820 0.413915
## LastNightSleep                      -8.1584     5.5301   -1.475 0.143053
## HoursAweak                          -0.3191     2.5206   -0.127 0.899486
## VideoGamePlayNever                  79.2171    48.1440    1.645 0.102791
## VideoGamePlayOnce a week           -16.1496    47.7682   -0.338 0.735956
## VideoGamePlayRarely                 48.1585    37.9051    1.271 0.206636
## VideoGamePlaySeveral times a month  18.5972    37.7080    0.493 0.622879
## VideoGamePlaySeveral times a week   31.8182    35.3143    0.901 0.369592
## SportsPlayNever                     37.5837    53.3903    0.704 0.482984
## SportsPlayOnce a week                8.4121    58.2248    0.144 0.885393
## SportsPlayRarely                    25.1348    48.9353    0.514 0.608557
## SportsPlaySeveral times a month     43.2118    50.7336    0.852 0.396243
## SportsPlaySeveral times a week      33.5185    47.9672    0.699 0.486192
## AvgHoursExercise                    -4.7851     2.4451   -1.957 0.052931 .
## CaffeinIntakeYes                    20.4474    23.9229    0.855 0.394598
## RHN                                100.9457    37.5348    2.689 0.008294 **
## InputDeviceKeyboard                -78.6286   118.6915   -0.662 0.509086
## InputDeviceMouse                  -167.1352    84.1193   -1.987 0.049468 *
## InputDeviceTouch screen           -196.5561   101.8504   -1.930 0.056249 .
## InputDeviceTrackpad                -96.4346    84.7574   -1.138 0.257734
## DeviceOSDesktopcomputer-macOS       99.1543   143.7577    0.690 0.491842
## DeviceOSDesktopcomputer-Windows    -59.8443   128.7022   -0.465 0.642880
## DeviceOSiPad(Tablet-IOS)           -29.6079   156.2508   -0.189 0.850065
## DeviceOSiPhone(Smartphone-IOS)     102.4076   160.6011    0.638 0.525050
## DeviceOSLaptop-Linux               -42.7056   162.2346   -0.263 0.792872
## DeviceOSLaptop-macOS                12.3461   130.6508    0.094 0.924890
## DeviceOSLaptop-Windows               0.3998   129.7698    0.003 0.997548
## RefreshRateMid-Range                 7.4648    29.8668    0.250 0.803111
## RefreshRateStandard                 60.3629    29.7419    2.030 0.044860 *
## WiFiUnstable                       169.2559    87.0499    1.944 0.054454 .
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 105.4 on 108 degrees of freedom
## Multiple R-squared:  0.5285, Adjusted R-squared:  0.3713
## F-statistic: 3.362 on 36 and 108 DF,  p-value: 6.481e-07
```

4.2 ANOVA (Effects of Different Caffeine Intake and Game Duration on Sleep Duration)

```
##                            Df Sum Sq Mean Sq F value Pr(>F)
## CaffeinIntake               1   0.35  0.3493   0.281 0.5968
## VideoGamePlay               5  15.61  3.1219   2.513 0.0329 *
## CaffeinIntake:VideoGamePlay 5   5.23  1.0467   0.843 0.5217
## Residuals                 133 165.20  1.2421
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = AvgSleepTime ~ CaffeinIntake * VideoGamePlay, data = survey)
##
## $CaffeinIntake
##            diff        lwr       upr      p adj
## Yes-No 0.1136086 -0.3101443 0.5373614 0.5967928
##
## $VideoGamePlay
##                                               diff        lwr         upr
## Never-Daily                            -0.81704128 -2.0652149  0.43113238
## Once a week-Daily                      -1.28257390 -2.5307476 -0.03440024
## Rarely-Daily                           -0.90874226 -1.8878902  0.07040572
## Several times a month-Daily            -0.48164798 -1.5194787  0.55618273
## Several times a week-Daily             -0.51515545 -1.4908977  0.46058678
## Once a week-Never                      -0.46553262 -1.7812232  0.85015794
## Rarely-Never                           -0.09170097 -1.1555783  0.97217634
## Several times a month-Never             0.33539331 -0.7827287  1.45351528
## Several times a week-Never              0.30188583 -0.7588578  1.36262947
## Rarely-Once a week                      0.37383165 -0.6900457  1.43770896
## Several times a month-Once a week       0.80092593 -0.3171960  1.91904790
## Several times a week-Once a week        0.76741845 -0.2933252  1.82816209
## Several times a month-Rarely            0.42709428 -0.3797453  1.23393381
## Several times a week-Rarely             0.39358680 -0.3316513  1.11882494
## Several times a week-Several times a month -0.03350748 -0.8362105  0.76919557
##                                            p adj
## Never-Daily                            0.4110882
## Once a week-Daily                      0.0402477
## Rarely-Daily                           0.0853311
## Several times a month-Daily            0.7610371
## Several times a week-Daily             0.6477431
## Once a week-Never                      0.9094319
## Rarely-Never                           0.9998663
## Several times a month-Never            0.9535735
## Several times a week-Never             0.9628186
## Rarely-Once a week                     0.9118488
## Several times a month-Once a week      0.3086665
## Several times a week-Once a week       0.2977757
```
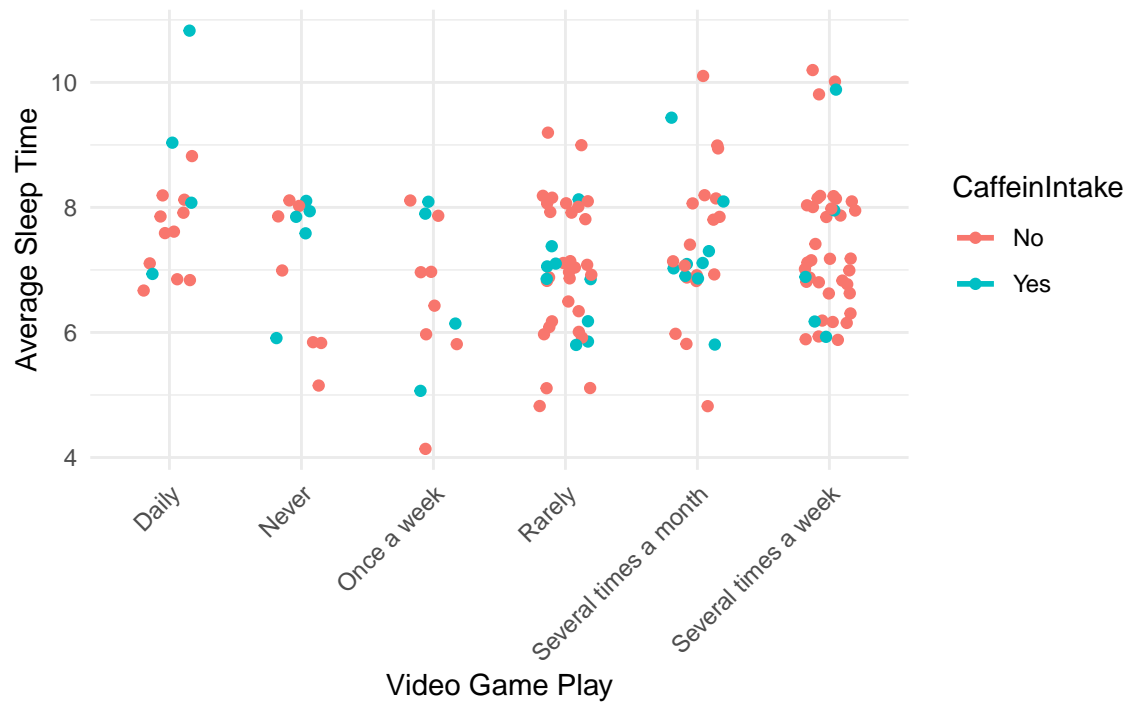
```
## Several times a month-Rarely              0.6451699
## Several times a week-Rarely               0.6200932
## Several times a week-Several times a month 0.9999963
##
## $`CaffeinIntake:VideoGamePlay`
##                                                diff        lwr
## Yes:Daily-No:Daily                        1.15909091 -1.0059416
## No:Never-No:Daily                        -0.77662338 -2.5694406
## Yes:Never-No:Daily                       -0.09090909 -2.0908804
## No:Once a week-No:Daily                  -1.02840909 -2.7513905
## Yes:Once a week-No:Daily                 -0.84090909 -3.0059416
## No:Rarely-No:Daily                       -0.55757576 -1.8645893
## Yes:Rarely-No:Daily                      -0.75757576 -2.4242185
## No:Several times a month-No:Daily        -0.11868687 -1.5377821
## Yes:Several times a month-No:Daily       -0.25757576 -1.9242185
## No:Several times a week-No:Daily         -0.22662338 -1.5083449
## Yes:Several times a week-No:Daily        -0.19090909 -2.1908804
## No:Never-Yes:Daily                       -1.93571429 -4.2598552
## Yes:Never-Yes:Daily                      -1.25000000 -3.7374329
## No:Once a week-Yes:Daily                 -2.18750000 -4.4582052
## Yes:Once a week-Yes:Daily                -2.00000000 -4.6219845
## No:Rarely-Yes:Daily                      -1.71666667 -3.6904249
## Yes:Rarely-Yes:Daily                     -1.91666667 -4.1449251
## No:Several times a month-Yes:Daily       -1.27777778 -3.3274774
## Yes:Several times a month-Yes:Daily      -1.41666667 -3.6449251
## No:Several times a week-Yes:Daily        -1.38571429 -3.3428161
## Yes:Several times a week-Yes:Daily       -1.35000000 -3.8374329
## Yes:Never-No:Never                        0.68571429 -1.4854952
## No:Once a week-No:Never                  -0.25178571 -2.1708819
## Yes:Once a week-No:Never                 -0.06428571 -2.3884266
## No:Rarely-No:Never                        0.21904762 -1.3374066
## Yes:Rarely-No:Never                       0.01904762 -1.8496320
## No:Several times a month-No:Never         0.65793651 -0.9937585
## Yes:Several times a month-No:Never        0.51904762 -1.3496320
## No:Several times a week-No:Never          0.55000000 -0.9852769
## Yes:Several times a week-No:Never         0.58571429 -1.5854952
## No:Once a week-Yes:Never                 -0.93750000 -3.0514115
## Yes:Once a week-Yes:Never                -0.75000000 -3.2374329
## No:Rarely-Yes:Never                      -0.46666667 -2.2578231
## Yes:Rarely-Yes:Never                     -0.66666667 -2.7349160
## No:Several times a month-Yes:Never       -0.02777778 -1.9022879
## Yes:Several times a month-Yes:Never      -0.16666667 -2.2349160
## No:Several times a week-Yes:Never        -0.13571429 -1.9084994
## Yes:Several times a week-Yes:Never       -0.10000000 -2.4451743
## Yes:Once a week-No:Once a week            0.18750000 -2.0832052
## No:Rarely-No:Once a week                  0.47083333 -1.0046398
## Yes:Rarely-No:Once a week                 0.27083333 -1.5309532
## No:Several times a month-No:Once a week   0.90972222 -0.6658944
## Yes:Several times a month-No:Once a week  0.77083333 -1.0309532
## No:Several times a week-No:Once a week    0.80178571 -0.6513305
## Yes:Several times a week-No:Once a week   0.83750000 -1.2764115
## No:Rarely-Yes:Once a week                 0.28333333 -1.6904249
## Yes:Rarely-Yes:Once a week                0.08333333 -2.1449251
## No:Several times a month-Yes:Once a week  0.72222222 -1.3274774
```

```
## Yes:Several times a month-Yes:Once a week              0.58333333 -1.6449251
## No:Several times a week-Yes:Once a week                0.61428571 -1.3428161
## Yes:Several times a week-Yes:Once a week               0.65000000 -1.8374329
## Yes:Rarely-No:Rarely                                  -0.20000000 -1.6092743
## No:Several times a month-No:Rarely                     0.43888889 -0.6666369
## Yes:Several times a month-No:Rarely                    0.30000000 -1.1092743
## No:Several times a week-No:Rarely                      0.33095238 -0.5916342
## Yes:Several times a week-No:Rarely                     0.36666667 -1.4244898
## No:Several times a month-Yes:Rarely                    0.63888889 -0.8749146
## Yes:Several times a month-Yes:Rarely                   0.50000000 -1.2479897
## No:Several times a week-Yes:Rarely                     0.53095238 -0.8548975
## Yes:Several times a week-Yes:Rarely                    0.56666667 -1.5015826
## Yes:Several times a month-No:Several times a month     -0.13888889 -1.6526924
## No:Several times a week-No:Several times a month       -0.10793651 -1.1834424
## Yes:Several times a week-No:Several times a month      -0.07222222 -1.9467323
## No:Several times a week-Yes:Several times a month       0.03095238 -1.3548975
## Yes:Several times a week-Yes:Several times a month      0.06666667 -2.0015826
## Yes:Several times a week-No:Several times a week        0.03571429 -1.7370708
##                                                            upr       p adj
## Yes:Daily-No:Daily                                   3.32412338 0.8251929
## No:Never-No:Daily                                    1.01619384 0.9529302
## Yes:Never-No:Daily                                   1.90906224 1.0000000
## No:Once a week-No:Daily                              0.69457231 0.7020267
## Yes:Once a week-No:Daily                             1.32412338 0.9788039
## No:Rarely-No:Daily                                   0.74943777 0.9577241
## Yes:Rarely-No:Daily                                  0.90906702 0.9347000
## No:Several times a month-No:Daily                    1.30040832 1.0000000
## Yes:Several times a month-No:Daily                   1.40906702 0.9999962
## No:Several times a week-No:Daily                     1.05509814 0.9999849
## Yes:Several times a week-No:Daily                    1.80906224 1.0000000
## No:Never-Yes:Daily                                   0.38842660 0.2047730
## Yes:Never-Yes:Daily                                  1.23743294 0.8775823
## No:Once a week-Yes:Daily                             0.08320522 0.0704029
## Yes:Once a week-Yes:Daily                            0.62198454 0.3263075
## No:Rarely-Yes:Daily                                  0.25709159 0.1553175
## Yes:Rarely-Yes:Daily                                 0.31159172 0.1672189
## No:Several times a month-Yes:Daily                   0.77192182 0.6418014
## Yes:Several times a month-Yes:Daily                  0.81159172 0.6128782
## No:Several times a week-Yes:Daily                    0.57138748 0.4433314
## Yes:Several times a week-Yes:Daily                   1.13743294 0.8120463
## Yes:Never-No:Never                                   2.85692376 0.9961013
## No:Once a week-No:Never                              1.66731046 0.9999993
## Yes:Once a week-No:Never                             2.25985517 1.0000000
## No:Rarely-No:Never                                   1.77550179 0.9999986
## Yes:Rarely-No:Never                                  1.88772720 1.0000000
## No:Several times a month-No:Never                    2.30963151 0.9743384
## Yes:Several times a month-No:Never                   2.38772720 0.9987608
## No:Several times a week-No:Never                     2.08527694 0.9887791
## Yes:Several times a week-No:Never                    2.75692376 0.9990531
## No:Once a week-Yes:Never                             1.17641151 0.9446612
## Yes:Once a week-Yes:Never                            1.73743294 0.9974034
## No:Rarely-Yes:Never                                  1.32448976 0.9993152
## Yes:Rarely-Yes:Never                                 1.40158263 0.9953504
## No:Several times a month-Yes:Never                   1.84673233 1.0000000
```

```
## Yes:Several times a month-Yes:Never                           1.90158263 1.0000000
## No:Several times a week-Yes:Never                             1.63707082 1.0000000
## Yes:Several times a week-Yes:Never                            2.24517426 1.0000000
## Yes:Once a week-No:Once a week                                2.45820522 1.0000000
## No:Rarely-No:Once a week                                      1.94630645 0.9957361
## Yes:Rarely-No:Once a week                                     2.07261986 0.9999972
## No:Several times a month-No:Once a week                       2.48533884 0.7440478
## Yes:Several times a month-No:Once a week                      2.57261986 0.9568685
## No:Several times a week-No:Once a week                        2.25490189 0.7952375
## Yes:Several times a week-No:Once a week                       2.95141151 0.9753630
## No:Rarely-Yes:Once a week                                     2.25709159 0.9999983
## Yes:Rarely-Yes:Once a week                                    2.31159172 1.0000000
## No:Several times a month-Yes:Once a week                      2.77192182 0.9901925
## Yes:Several times a month-Yes:Once a week                     2.81159172 0.9992839
## No:Several times a week-Yes:Once a week                       2.57138748 0.9963051
## Yes:Several times a week-Yes:Once a week                      3.13743294 0.9992959
## Yes:Rarely-No:Rarely                                          1.20927434 0.9999985
## No:Several times a month-No:Rarely                            1.54441464 0.9749813
## Yes:Several times a month-No:Rarely                           1.70927434 0.9999024
## No:Several times a week-No:Rarely                             1.25353900 0.9886568
## Yes:Several times a week-No:Rarely                            2.15782310 0.9999338
## No:Several times a month-Yes:Rarely                           2.15269237 0.9608303
## Yes:Several times a month-Yes:Rarely                          2.24798969 0.9983805
## No:Several times a week-Yes:Rarely                            1.91680225 0.9809198
## Yes:Several times a week-Yes:Rarely                           2.63491596 0.9989072
## Yes:Several times a month-No:Several times a month            1.37491459 1.0000000
## No:Several times a week-No:Several times a month              0.96756936 1.0000000
## Yes:Several times a week-No:Several times a month             1.80228789 1.0000000
## No:Several times a week-Yes:Several times a month             1.41680225 1.0000000
## Yes:Several times a week-Yes:Several times a month            2.13491596 1.0000000
## Yes:Several times a week-No:Several times a week              1.80849939 1.0000000
```

Effect of Caffeine Intake and Video Game Play on Average Sleep Tim

4.3 Residual Diagnosis Diagram

Normal Q–Q Plot