101a_hw6_Jinah_Weon

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2020 2 10

1) Iowa City is the home of the university of Iowa. Do schools in Iowa City out perform the rest? Answer, and provide supporting statistics and graphics (a graphic is required.)

```
options(repos=structure(c(CRAN="http://cran.r-project.org")))
install.packages("dplyr")
```

```
##
## The downloaded binary packages are in
##  /var/folders/xg/yr22qmtn1zdb_f5hxty72c7c0000gn/T//RtmphPriBU/downloaded_packages
```

```
library(dplyr)
```

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

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

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

```
#Supporting with graphic
iowatest <- read.delim("iowatest.txt")
new <- group_by(iowatest, City) %>%
  summarise(
    test_score= mean(Test, na.rm = TRUE)
  )
install.packages("ggpubr")
```

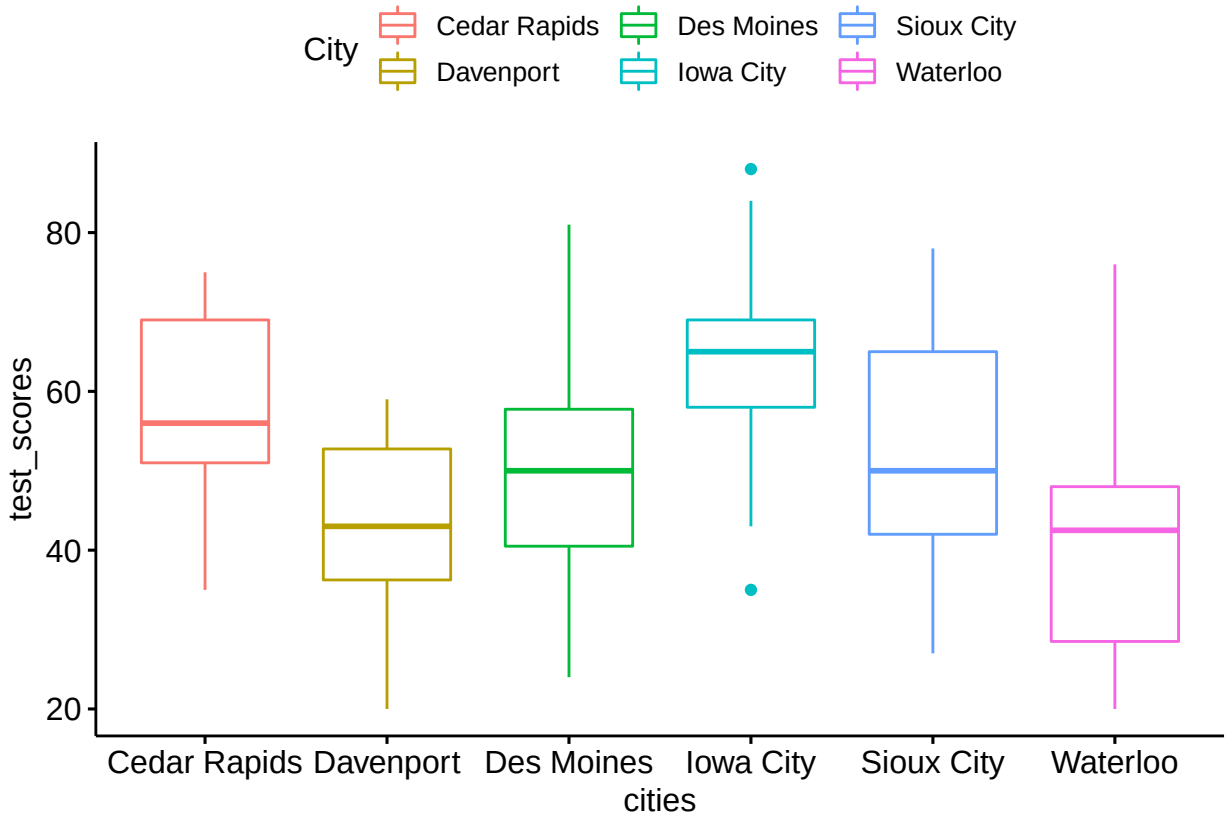
```
##
##   There is a binary version available but the source version is
##   later:
##        binary source needs_compilation
## ggpubr  0.2.4  0.2.5             FALSE

## installing the source package 'ggpubr'
```

```
library("ggpubr")
```

```
## Loading required package: ggplot2
```

```
## Loading required package: magrittr
```

```
ggboxplot(iowatest, x = "City", y = "Test",
          color = "City", ylab = "test_scores", xlab = "cities")
```



Yes, its mean is much higher than any other cities' scores mean.

```
# Using t test
the null hypothesis will be Iowa City's mean test score (iu) is less than the rest. And the alternative
H0 : iu < ou
H1 : iu >= ou
```

```
iu <- iowatest %>% filter(City == "Iowa City") %>% mutate(group = 1)
iu
```

```
##        School Poverty Test      City group
## 1  Coralville      20   65 Iowa City     1
## 2       Hills      42   35 Iowa City     1
## 3      Hoover      10   84 Iowa City     1
```

```
## 4        Horn       5   83 Iowa City     1
## 5    Kirkwood      34   49 Iowa City     1
## 6       Lemme      17   69 Iowa City     1
## 7     Lincoln       3   88 Iowa City     1
## 8     Longfel      24   63 Iowa City     1
## 9       Lucas      21   65 Iowa City     1
## 10       Mann      34   58 Iowa City     1
## 11       Penn      24   52 Iowa City     1
## 12     Roosev      35   61 Iowa City     1
## 13     Shimek       4   81 Iowa City     1
## 14      Twain      57   43 Iowa City     1
## 15      Weber      24   66 Iowa City     1
## 16    Wickham      10   62 Iowa City     1
## 17       Wood      31   65 Iowa City     1
```

```
ou <- iowatest %>% filter(City != "Iowa City") %>% mutate(group = 2)
ou
```

```
##        School Poverty Test         City group
## 1    Black Hk      35   46     Waterloo     2
## 2      Edison      62   41     Waterloo     2
## 3     Elk Run      56   48     Waterloo     2
## 4       Grant      81   36     Waterloo     2
## 5      Irving      45   52     Waterloo     2
## 6      Jewett      50   44     Waterloo     2
## 7    Kingsley      15   76     Waterloo     2
## 8    Kittrell      40   48     Waterloo     2
## 9     Lincoln      74   30     Waterloo     2
## 10    Longfel      99   27     Waterloo     2
## 11     Lowell      82   28     Waterloo     2
## 12    McKinst      81   20     Waterloo     2
## 13     Orange      38   56     Waterloo     2
## 14      Roose      80   23     Waterloo     2
## 15     Arthur      13   75 Cedar Rapids     2
## 16  Cleveland      27   55 Cedar Rapids     2
## 17   Coolidge      10   72 Cedar Rapids     2
## 18    Erskine      25   67 Cedar Rapids     2
## 19   Garfield      39   46 Cedar Rapids     2
## 20    Grant W      44   55 Cedar Rapids     2
## 21   Harrison      55   35 Cedar Rapids     2
## 22   Hiawatha      27   56 Cedar Rapids     2
## 23     Hoover      30   66 Cedar Rapids     2
## 24    Jackson       7   69 Cedar Rapids     2
## 25    Johnson      59   51 Cedar Rapids     2
## 26    Kenwood      41   75 Cedar Rapids     2
## 27    Madison      16   70 Cedar Rapids     2
## 28      Nixon      21   62 Cedar Rapids     2
## 29     Pierce       3   75 Cedar Rapids     2
## 30       Polk      80   54 Cedar Rapids     2
## 31     Taylor      78   36 Cedar Rapids     2
## 32     Truman      10   57 Cedar Rapids     2
## 33    Van Bur      52   43 Cedar Rapids     2
## 34     Wilson      39   41 Cedar Rapids     2
## 35     Wright      27   53 Cedar Rapids     2
```

```
## 36      Adams      17   52    Davenport     2
## 37   Blue Gra       9   53    Davenport     2
## 38     Buchan      57   37    Davenport     2
## 39    Buffalo      31   43    Davenport     2
## 40      Eisen      40   58    Davenport     2
## 41   Fillmore      57   39    Davenport     2
## 42   Garfield      49   43    Davenport     2
## 43      Grant      38   47    Davenport     2
## 44   Harrison      22   56    Davenport     2
## 45      Hayes      61   30    Davenport     2
## 46    Jackson      58   34    Davenport     2
## 47  Jefferson      89   21    Davenport     2
## 48    Johnson      53   40    Davenport     2
## 49    Lincoln      59   56    Davenport     2
## 50    Madison      87   29    Davenport     2
## 51   McKinley      50   49    Davenport     2
## 52     Monroe      73   36    Davenport     2
## 53      Perry      51   20    Davenport     2
## 54     Truman      40   48    Davenport     2
## 55    Walcott      23   59    Davenport     2
## 56       Wash      71   38    Davenport     2
## 57     Wilson      39   53    Davenport     2
## 58      Adams      50   58   Des Moines     2
## 59     Brooks      79   32   Des Moines     2
## 60    Cattell      49   50   Des Moines     2
## 61    Douglas      37   54   Des Moines     2
## 62    Edmunds      77   28   Des Moines     2
## 63    Findley      61   51   Des Moines     2
## 64     Garton      55   27   Des Moines     2
## 65    Granger      47   49   Des Moines     2
## 66    Greenwd      32   67   Des Moines     2
## 67   Hanawalt      12   79   Des Moines     2
## 68      Hills      31   57   Des Moines     2
## 69       Howe      50   50   Des Moines     2
## 70    Hubbell      22   81   Des Moines     2
## 71    Jackson      40   45   Des Moines     2
## 72  Jefferson       3   74   Des Moines     2
## 73    Longfel      80   50   Des Moines     2
## 74    Lovejoy      62   40   Des Moines     2
## 75    Madison      52   45   Des Moines     2
## 76       Mann      65   32   Des Moines     2
## 77      McKee      57   31   Des Moines     2
## 78   McKinley      78   36   Des Moines     2
## 79   Mitchell      54   46   Des Moines     2
## 80     Monroe      45   53   Des Moines     2
## 81      Moore      40   53   Des Moines     2
## 82    Moulton      83   30   Des Moines     2
## 83   Oak Park      52   49   Des Moines     2
## 84   Park Ave      42   36   Des Moines     2
## 85    Perkins      65   51   Des Moines     2
## 86   Phillips      29   61   Des Moines     2
## 87   Pleasant      17   68   Des Moines     2
## 88      Stowe      53   47   Des Moines     2
## 89       Stud      25   53   Des Moines     2
```

```
## 90    Wallace      77   24   Des Moines     2
## 91    Watrous      39   47   Des Moines     2
## 92    Willard      84   42   Des Moines     2
## 93    Windsor      32   62   Des Moines     2
## 94       Wood      35   59   Des Moines     2
## 95     Wright      28   60   Des Moines     2
## 96     Bryant      32   56   Sioux City     2
## 97      Clark       4   78   Sioux City     2
## 98   Crescent      49   65   Sioux City     2
## 99    Emerson      53   40   Sioux City     2
## 100   Everett      79   48   Sioux City     2
## 101     Grant      50   45   Sioux City     2
## 102      Hunt      72   43   Sioux City     2
## 103    Irving      86   27   Sioux City     2
## 104       Joy      33   65   Sioux City     2
## 105     Leeds      46   42   Sioux City     2
## 106   Lincoln      14   76   Sioux City     2
## 107   Longfel      34   40   Sioux City     2
## 108    Lowell      54   57   Sioux City     2
## 109  McKinley      84   37   Sioux City     2
## 110   Nodland      10   74   Sioux City     2
## 111 Riverview      60   59   Sioux City     2
## 112    Roosev      48   50   Sioux City     2
## 113     Smith      72   39   Sioux City     2
## 114   Sunnysd      14   73   Sioux City     2
## 115      Wash      20   57   Sioux City     2
## 116  Whittier      39   48   Sioux City     2
```

```
compare <- rbind(iu,ou)
compare
```

```
##         School Poverty Test         City group
## 1   Coralville      20   65    Iowa City     1
## 2        Hills      42   35    Iowa City     1
## 3       Hoover      10   84    Iowa City     1
## 4         Horn       5   83    Iowa City     1
## 5     Kirkwood      34   49    Iowa City     1
## 6        Lemme      17   69    Iowa City     1
## 7      Lincoln       3   88    Iowa City     1
## 8      Longfel      24   63    Iowa City     1
## 9        Lucas      21   65    Iowa City     1
## 10        Mann      34   58    Iowa City     1
## 11        Penn      24   52    Iowa City     1
## 12      Roosev      35   61    Iowa City     1
## 13      Shimek       4   81    Iowa City     1
## 14       Twain      57   43    Iowa City     1
## 15       Weber      24   66    Iowa City     1
## 16     Wickham      10   62    Iowa City     1
## 17        Wood      31   65    Iowa City     1
## 18    Black Hk      35   46     Waterloo     2
## 19      Edison      62   41     Waterloo     2
## 20     Elk Run      56   48     Waterloo     2
## 21       Grant      81   36     Waterloo     2
## 22      Irving      45   52     Waterloo     2
```

```
## 23      Jewett      50   44     Waterloo     2
## 24    Kingsley      15   76     Waterloo     2
## 25    Kittrell      40   48     Waterloo     2
## 26     Lincoln      74   30     Waterloo     2
## 27     Longfel      99   27     Waterloo     2
## 28      Lowell      82   28     Waterloo     2
## 29     McKinst      81   20     Waterloo     2
## 30      Orange      38   56     Waterloo     2
## 31       Roose      80   23     Waterloo     2
## 32      Arthur      13   75 Cedar Rapids     2
## 33   Cleveland      27   55 Cedar Rapids     2
## 34    Coolidge      10   72 Cedar Rapids     2
## 35     Erskine      25   67 Cedar Rapids     2
## 36    Garfield      39   46 Cedar Rapids     2
## 37     Grant W      44   55 Cedar Rapids     2
## 38    Harrison      55   35 Cedar Rapids     2
## 39    Hiawatha      27   56 Cedar Rapids     2
## 40      Hoover      30   66 Cedar Rapids     2
## 41     Jackson       7   69 Cedar Rapids     2
## 42     Johnson      59   51 Cedar Rapids     2
## 43     Kenwood      41   75 Cedar Rapids     2
## 44     Madison      16   70 Cedar Rapids     2
## 45       Nixon      21   62 Cedar Rapids     2
## 46      Pierce       3   75 Cedar Rapids     2
## 47        Polk      80   54 Cedar Rapids     2
## 48      Taylor      78   36 Cedar Rapids     2
## 49      Truman      10   57 Cedar Rapids     2
## 50     Van Bur      52   43 Cedar Rapids     2
## 51      Wilson      39   41 Cedar Rapids     2
## 52      Wright      27   53 Cedar Rapids     2
## 53       Adams      17   52    Davenport     2
## 54    Blue Gra       9   53    Davenport     2
## 55      Buchan      57   37    Davenport     2
## 56     Buffalo      31   43    Davenport     2
## 57       Eisen      40   58    Davenport     2
## 58    Fillmore      57   39    Davenport     2
## 59    Garfield      49   43    Davenport     2
## 60       Grant      38   47    Davenport     2
## 61    Harrison      22   56    Davenport     2
## 62       Hayes      61   30    Davenport     2
## 63     Jackson      58   34    Davenport     2
## 64   Jefferson      89   21    Davenport     2
## 65     Johnson      53   40    Davenport     2
## 66     Lincoln      59   56    Davenport     2
## 67     Madison      87   29    Davenport     2
## 68    McKinley      50   49    Davenport     2
## 69      Monroe      73   36    Davenport     2
## 70       Perry      51   20    Davenport     2
## 71      Truman      40   48    Davenport     2
## 72     Walcott      23   59    Davenport     2
## 73        Wash      71   38    Davenport     2
## 74      Wilson      39   53    Davenport     2
## 75       Adams      50   58   Des Moines     2
## 76      Brooks      79   32   Des Moines     2
```

```
## 77     Cattell      49   50   Des Moines     2
## 78     Douglas      37   54   Des Moines     2
## 79     Edmunds      77   28   Des Moines     2
## 80     Findley      61   51   Des Moines     2
## 81      Garton      55   27   Des Moines     2
## 82     Granger      47   49   Des Moines     2
## 83     Greenwd      32   67   Des Moines     2
## 84    Hanawalt      12   79   Des Moines     2
## 85       Hills      31   57   Des Moines     2
## 86        Howe      50   50   Des Moines     2
## 87     Hubbell      22   81   Des Moines     2
## 88     Jackson      40   45   Des Moines     2
## 89   Jefferson       3   74   Des Moines     2
## 90     Longfel      80   50   Des Moines     2
## 91     Lovejoy      62   40   Des Moines     2
## 92     Madison      52   45   Des Moines     2
## 93        Mann      65   32   Des Moines     2
## 94       McKee      57   31   Des Moines     2
## 95    McKinley      78   36   Des Moines     2
## 96    Mitchell      54   46   Des Moines     2
## 97      Monroe      45   53   Des Moines     2
## 98       Moore      40   53   Des Moines     2
## 99     Moulton      83   30   Des Moines     2
## 100   Oak Park      52   49   Des Moines     2
## 101   Park Ave      42   36   Des Moines     2
## 102    Perkins      65   51   Des Moines     2
## 103   Phillips      29   61   Des Moines     2
## 104   Pleasant      17   68   Des Moines     2
## 105      Stowe      53   47   Des Moines     2
## 106       Stud      25   53   Des Moines     2
## 107    Wallace      77   24   Des Moines     2
## 108    Watrous      39   47   Des Moines     2
## 109    Willard      84   42   Des Moines     2
## 110    Windsor      32   62   Des Moines     2
## 111       Wood      35   59   Des Moines     2
## 112     Wright      28   60   Des Moines     2
## 113     Bryant      32   56   Sioux City     2
## 114      Clark       4   78   Sioux City     2
## 115   Crescent      49   65   Sioux City     2
## 116    Emerson      53   40   Sioux City     2
## 117    Everett      79   48   Sioux City     2
## 118      Grant      50   45   Sioux City     2
## 119       Hunt      72   43   Sioux City     2
## 120     Irving      86   27   Sioux City     2
## 121        Joy      33   65   Sioux City     2
## 122      Leeds      46   42   Sioux City     2
## 123    Lincoln      14   76   Sioux City     2
## 124    Longfel      34   40   Sioux City     2
## 125     Lowell      54   57   Sioux City     2
## 126   McKinley      84   37   Sioux City     2
## 127    Nodland      10   74   Sioux City     2
## 128  Riverview      60   59   Sioux City     2
## 129     Roosev      48   50   Sioux City     2
## 130      Smith      72   39   Sioux City     2
```

```
## 131    Sunnysd      14   73   Sioux City     2
## 132       Wash      20   57   Sioux City     2
## 133   Whittier      39   48   Sioux City     2
```

```r
# Supporting with statistics
t.test(Test~group, data = compare, alternative = "greater")
```

```
##
##  Welch Two Sample t-test
##
## data:  Test by group
## t = 3.9071, df = 20.99, p-value = 0.0004058
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  8.228843      Inf
## sample estimates:
## mean in group 1 mean in group 2
##        64.05882        49.35345
```

Since the t.test show us the p-value is less than 0.05, it means we have enough evidence to reject the null; thus the alternative is true which means that iowa city performs better than other cities.

2) Test scores are meant to reflect the success of a school's academic program. But many critics point out that factors other than academic success can influence a score. In particular, a school's score might be merely a reflection of the wealth of the student body. Address this issue by fitting a regression line to predict school test score from poverty score. Is there evidence that poverty is associated with the test score?

```r
# t test
ml <- lm(Test~Poverty, iowatest)
summary(ml)
```

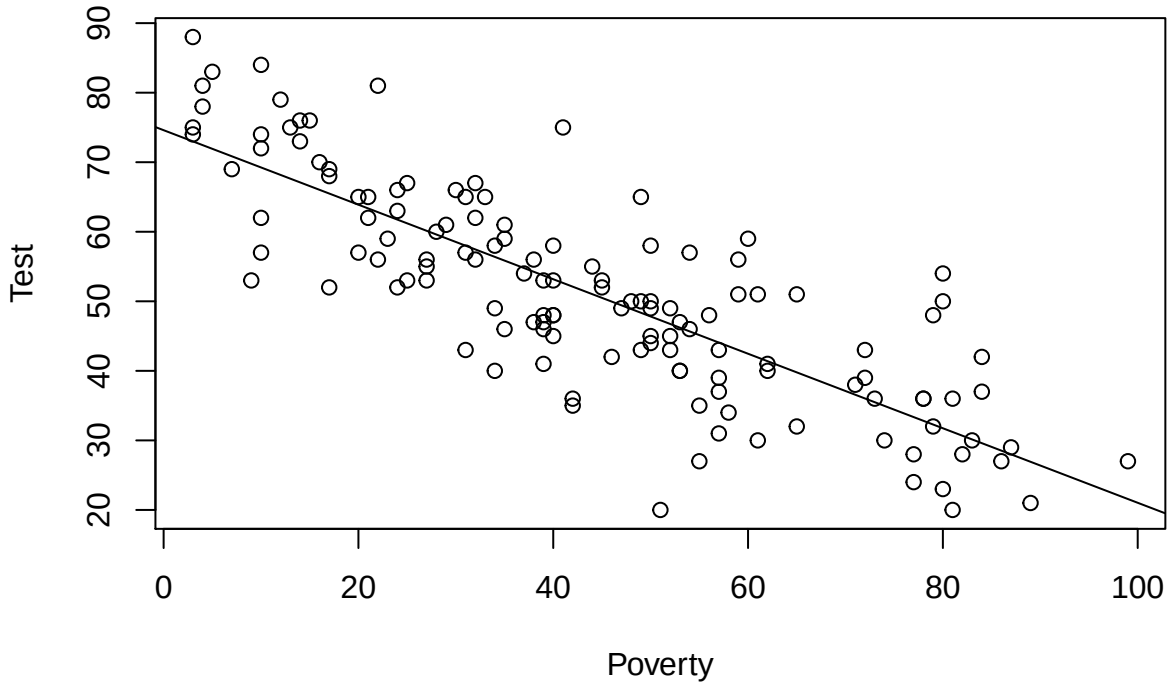
```
##
## Call:
## lm(formula = Test ~ Poverty, data = iowatest)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -27.2812  -6.2097   0.5058   4.8252  22.3610
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 74.60578    1.61325   46.25   <2e-16 ***
## Poverty     -0.53578    0.03262  -16.43   <2e-16 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.766 on 131 degrees of freedom
## Multiple R-squared:  0.6731, Adjusted R-squared:  0.6707
## F-statistic: 269.8 on 1 and 131 DF,  p-value: < 2.2e-16
```

We look at the t test and p value. Since we used t-test, null hypothesis would be: slope is 0 and the alternative would be: slope is not zero, which means they are in association. We check the P value which is two-sided and it is lower than 0.05. Therefore, we reject the null hypothesis and declare that they have association.

The formula will be this: Test = 74.6058-0.5358*x We can see negative trend from the graph as we can see from the graph, as poverty rate increases, Test scores decreases.

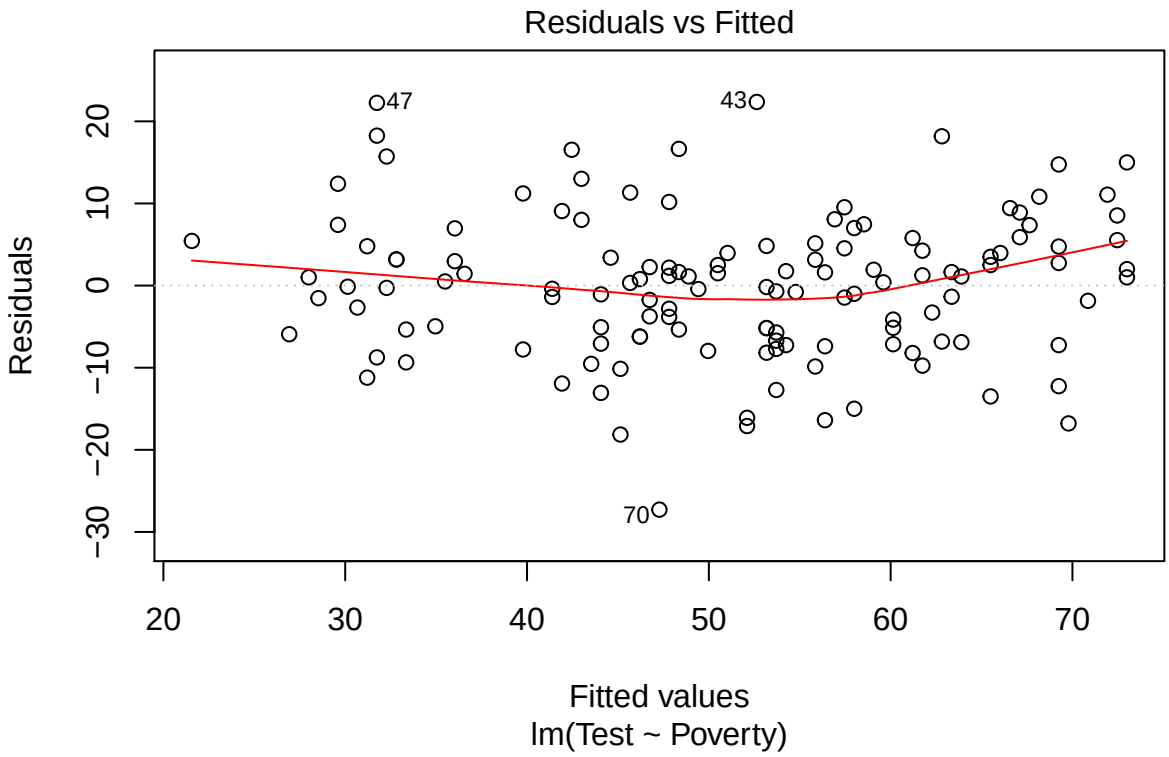
```
# Regression line
plot(Test~Poverty, iowatest)
abline(ml)
```

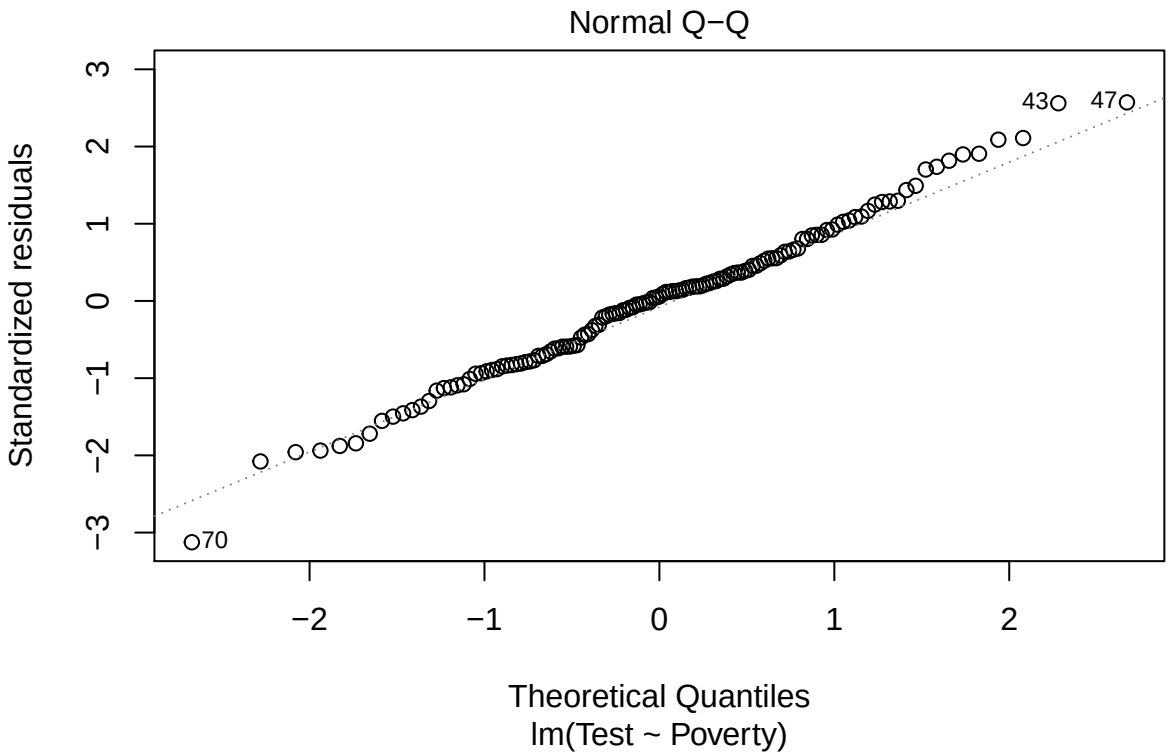


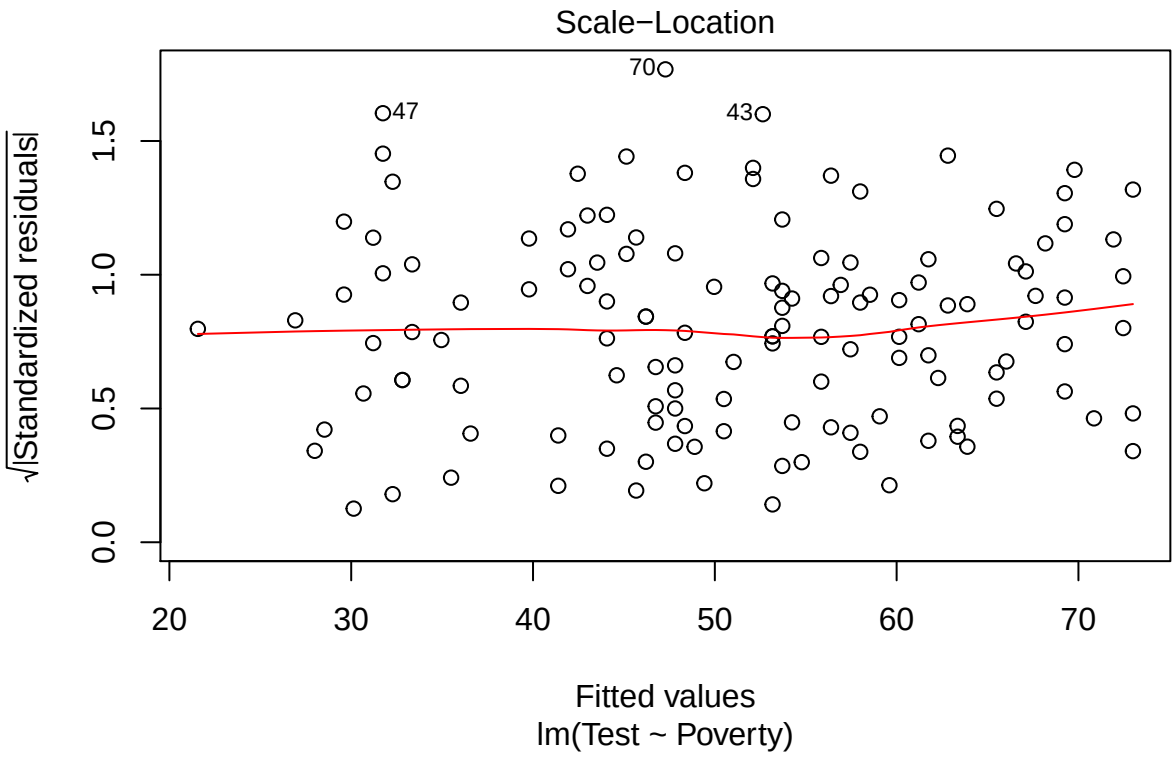
They are in straight linear line with moderate to strong association.

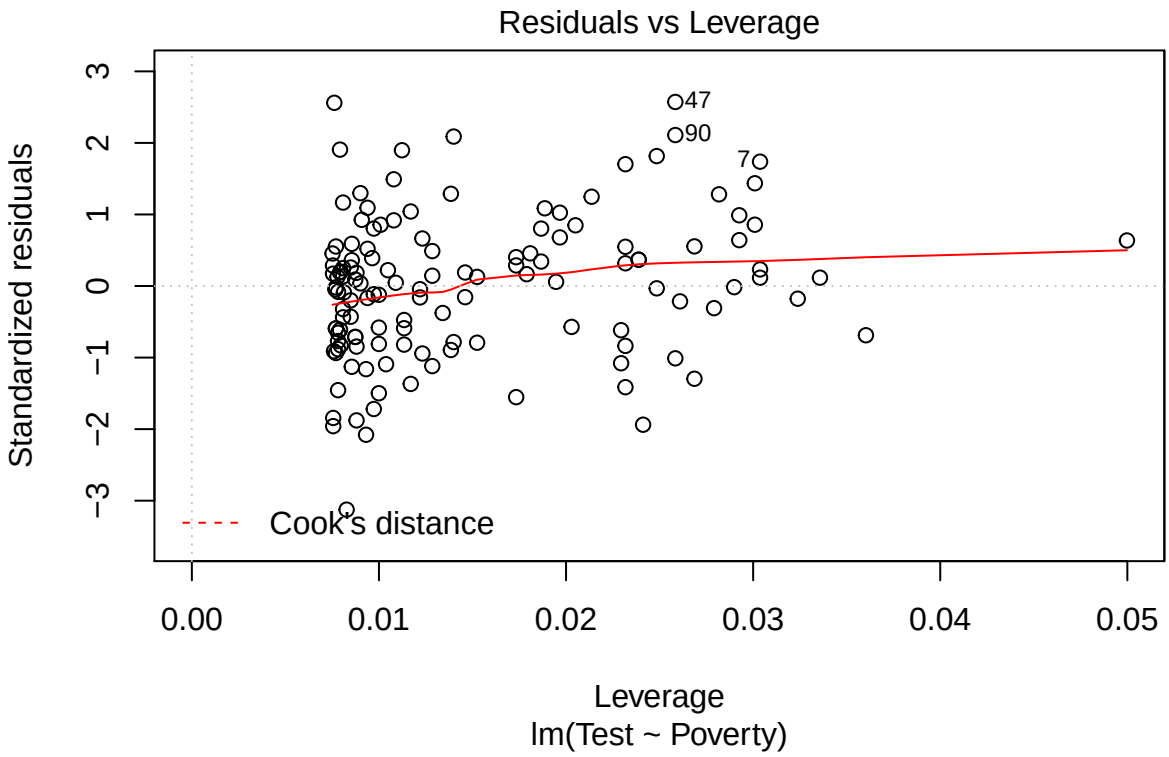
3) Describe any weaknesses in your model.

```
plot(lm(Test ~ Poverty, iowatest))
```


Residuals vs Fitted
Residuals
Fitted values
lm(Test ~ Poverty)
47
43
70
20
10
0
−10
−20
−30
20
30
40
50
60
70


Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(Test ~ Poverty)
43
47
70
−3
−2
−1
0
1
2
3


Scale−Location
70
47
43
√|Standardized residuals|
0.0
0.5
1.0
1.5
20
30
40
50
60
70
Fitted values
lm(Test ~ Poverty)



Residuals Plot: This plot has no trend which means it has linearity. However, the line is not horizontal and contains few outliers. Normal Q-Q Plot: This plot has left and right tail making the line not straight (normal). Scale-Location Plot: We use this plot to diagonose non-constant variance. A trend (increasing or decreasing) indicates failure in the constant variance condition and this graph have somewhat decreasing trend. Leverage Plot: It has some high leverages.

4) What would you consider to be a well-performing school among schools with an 80% poverty rating?

```
well <- iowatest %>% filter(Poverty == 80)
well
```

```
##    School Poverty Test         City
## 1   Roose      80   23     Waterloo
## 2    Polk      80   54 Cedar Rapids
## 3 Longfel      80   50   Des Moines
```

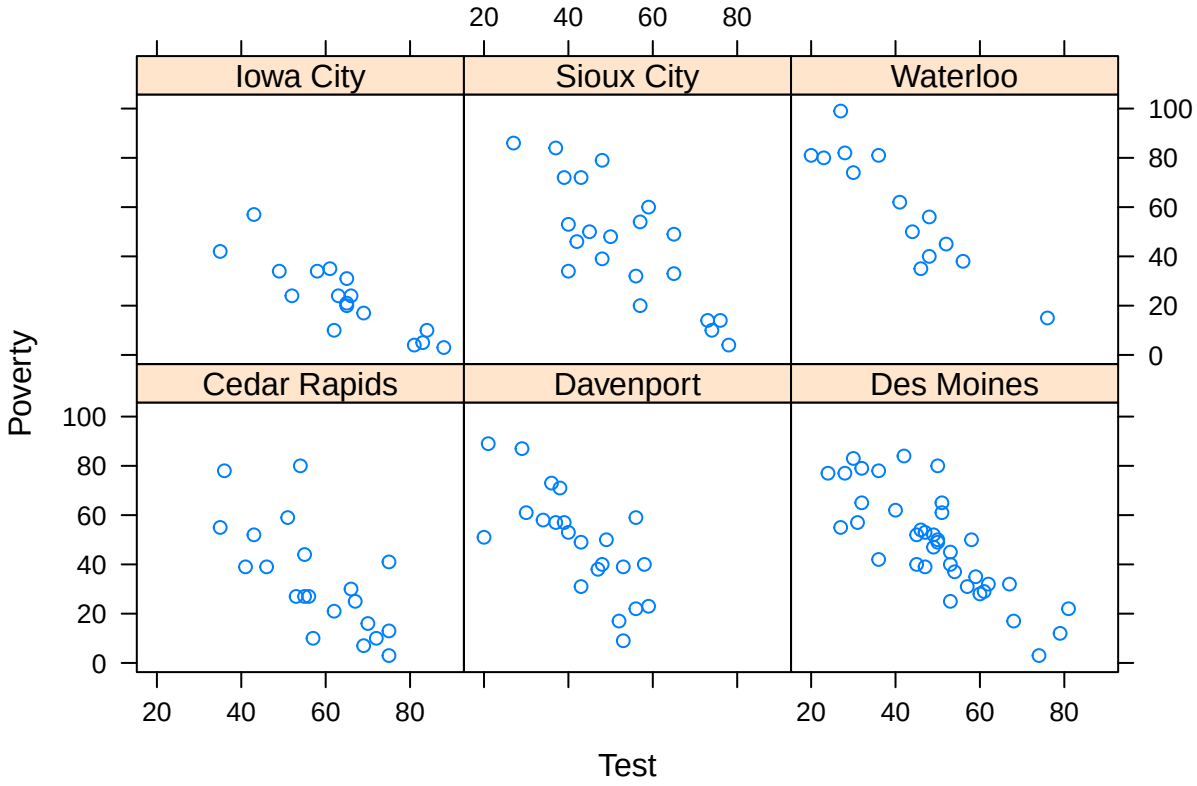
Among this 3 Schools with same Poverty rate(80%), we would consider the test score to be well-performing school because since they have same poverty rate, there is nothing to compare other than the test score to perform well. Thus, in this case, School name "Polk" would be the well-performing School with the highest Test score (54).

5) Create a statistical graphic that illustrates how the relationship between poverty and test scores varies by city.

```
install.packages("lattice")
```

```
##
## The downloaded binary packages are in
##  /var/folders/xg/yr22qmtn1zdb_f5hxty72c7c0000gn/T//RtmphPriBU/downloaded_packages
```

```
library("lattice")
xyplot(Poverty ~ Test|City, data =iowatest)
```



6) What hypothesis test is the F-test in the summary output for Question 2 testing? State the hypotheses and the conclusion from the test.

```
anova(ml)
```

```
## Analysis of Variance Table
```

```
##
## Response: Test
##            Df Sum Sq Mean Sq F value    Pr(>F)
## Poverty     1  20732 20731.5  269.79 < 2.2e-16 ***
## Residuals 131  10066    76.8
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

F-test: H0: E(Y|x) = B0 Ha: E(Y|x) = B0 + B1x

The P value is extremely small and the F value is big which results in rejecting the null hypothesis. In short, adding the slope was the good choice; Also, Poverty and Test score has association. ** From the summary output for Question 2 testing, t value and the f value are in relationship: the t-statistic that tests the slope is the square root of the F statistic that tests the slope.