Take Home Final (S-520)

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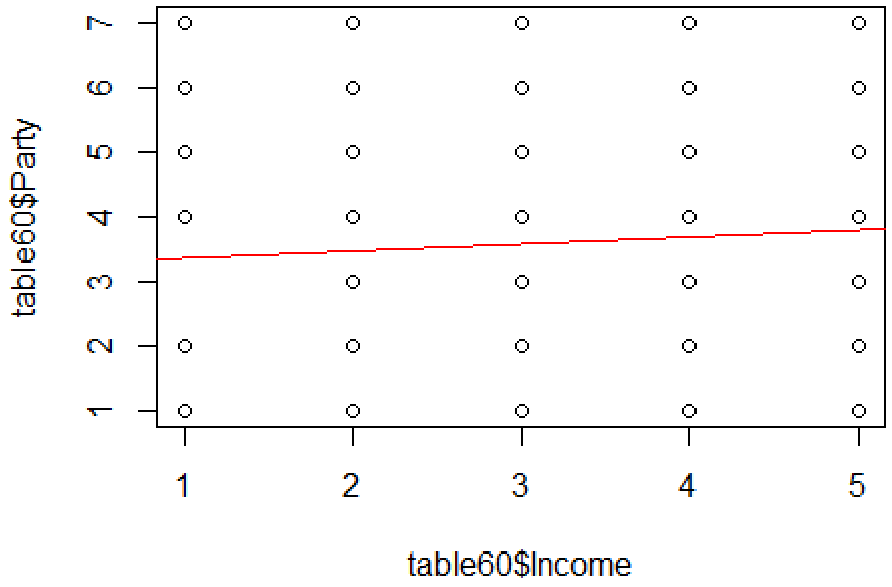
Solution 1

```
table60<- read.table('C:/Stats/TAKEHOME FINAL/election1960.txt',header=TRUE)
fit1<- lm(Party~Income,data = table60)
summary(fit1)
```

```
##
## Call:
## lm(formula = Party ~ Income, data = table60)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.7865 -1.6824 -0.6824  2.3176  3.6298
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  3.26610    0.20787   15.71   <2e-16 ***
## Income       0.10408    0.06386    1.63    0.103
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.263 on 1001 degrees of freedom
## Multiple R-squared:  0.002647,   Adjusted R-squared:  0.00165
## F-statistic: 2.656 on 1 and 1001 DF,  p-value: 0.1035
```

```
plot(table60$Income,table60$Party)
abline(fit1,col="red")
```



```
slope = cor(table60$Income,table60$Party) * sd(table60$Party) /
sd(table60$Income)
intercept = mean(table60$Party) - slope * mean(table60$Income)
```

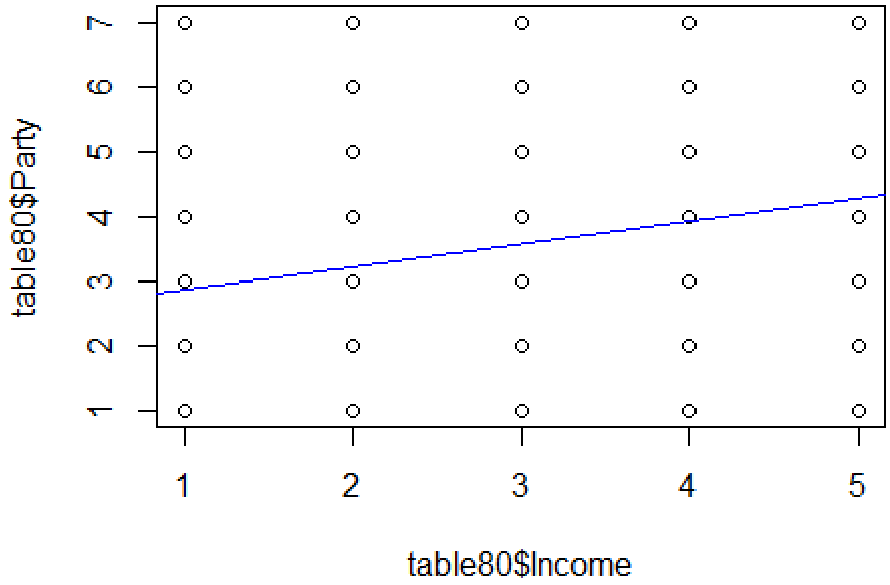
The equation of regression line is y=slope1* x + Intercept1 i.e. Party=0.104* Income + 3.266

Solution 2

```
table80<- read.table('C:/Stats/TAKEHOME FINAL/election1980.txt',header=TRUE)
fit2<- lm(Party~Income,data = table80)
summary(fit2)

## 
## Call:
## lm(formula = Party ~ Income, data = table80)
## 
## Residuals:
##    Min     1Q Median     3Q    Max 
## -3.291 -1.881 -0.586  2.061  4.119 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept)  2.52803    0.16971  14.896  < 2e-16 ***
## Income       0.35265    0.05479   6.436 1.85e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.037 on 1058 degrees of freedom
## Multiple R-squared:  0.03768,    Adjusted R-squared:  0.03677
## F-statistic: 41.43 on 1 and 1058 DF,  p-value: 1.852e-10
```

```
slope2 = cor(table80$Income,table80$Party) * sd(table80$Party) /
sd(table80$Income)
intercept2 = mean(table80$Party) - slope2 * mean(table80$Income)
plot(table80$Income,table80$Party)
abline(fit2,col="blue")
```



The equation of regression line is y=slope2* x + Intercept2 i.e. Party=0.352* Income + 2.528

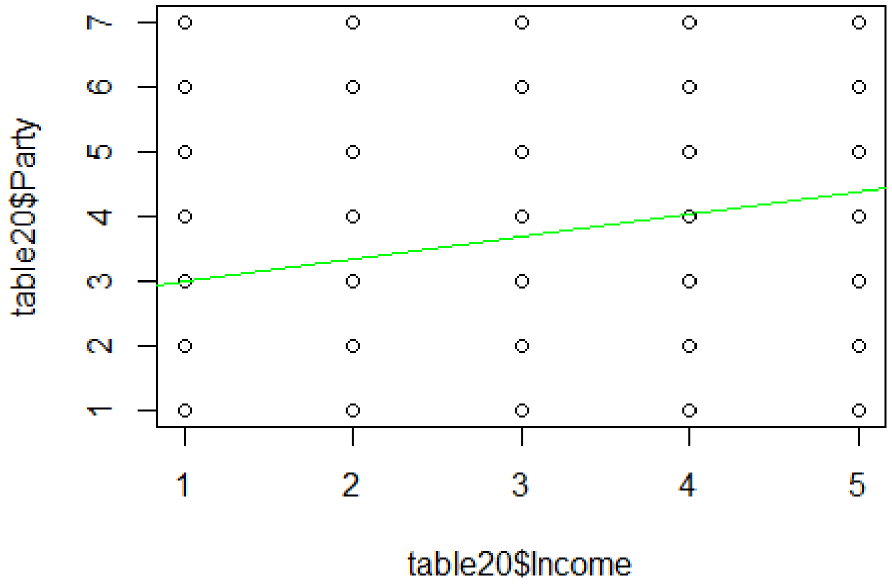
Solution 3

```
table20<- read.table('C:/Stats/TAKEHOME FINAL/election2000.txt',header=TRUE)
fit3<- lm(Party~Income,data = table20)
summary(fit3)
```

```
##
## Call:
## lm(formula = Party ~ Income, data = table20)
##
## Residuals:
```

```
##     Min      1Q  Median      3Q     Max 
## -3.3710 -1.9999 -0.3426  1.9718  4.0001 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept)  2.65710    0.16983  15.646  < 2e-16 ***
## Income       0.34277    0.05495   6.238 6.17e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 2.134 on 1174 degrees of freedom
## Multiple R-squared:  0.03208,    Adjusted R-squared:  0.03126 
## F-statistic: 38.91 on 1 and 1174 DF,  p-value: 6.17e-10
```

```
slope3 = cor(table20$Income,table20$Party) * sd(table20$Party) / 
sd(table20$Income)
intercept3 = mean(table20$Party) - slope3 * mean(table20$Income)
plot(table20$Income,table20$Party)
abline(fit3,col="green")
```

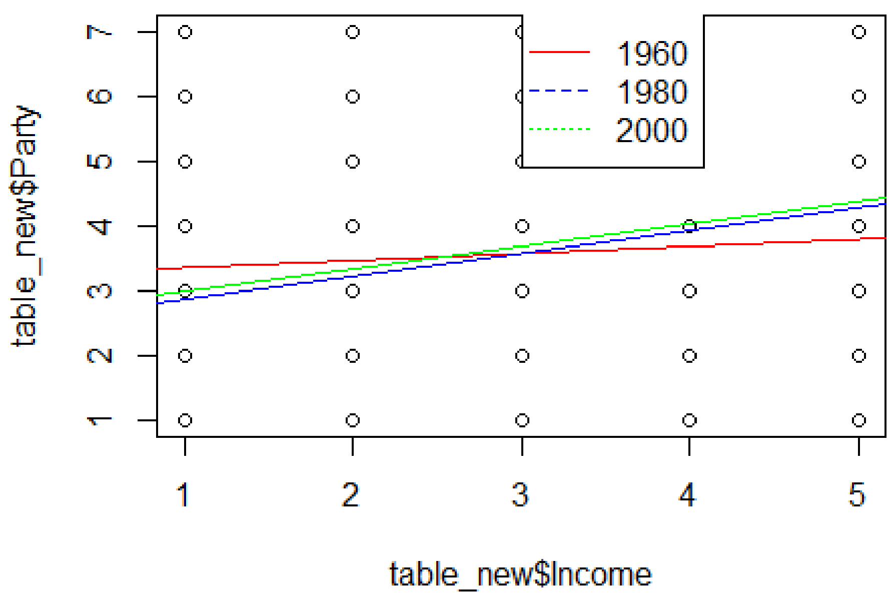


The equation of regression line is y=slope3* x + Intercept3

i.e. Party=0.342* Income + 2.657

Solution 4

```
table60$Year<-rep("1960",nrow(table60))
table80$Year<-rep("1980",nrow(table80))
table20$Year<-rep("2000",nrow(table20))
table_new<-rbind(table60,table80,table20)
plot(table_new$Income,table_new$Party)
abline(fit1,col="red")
abline(fit2,col="blue")
abline(fit3,col="green")
leg.line<- c("1960","1980","2000")
legend(list(x=3,y=7.3),legend=leg.line,col=c("red","blue","green"),lty=c(1,2,
3),merge=TRUE)
```



Solution 5

- In 1960, Most of the High Income people were in between Independent Democrat and true independent, even low class preferred the same.
- In 2000, Low Income people are either True independent or weak democrat whereas High Income people are Independent democrat or true Independent.

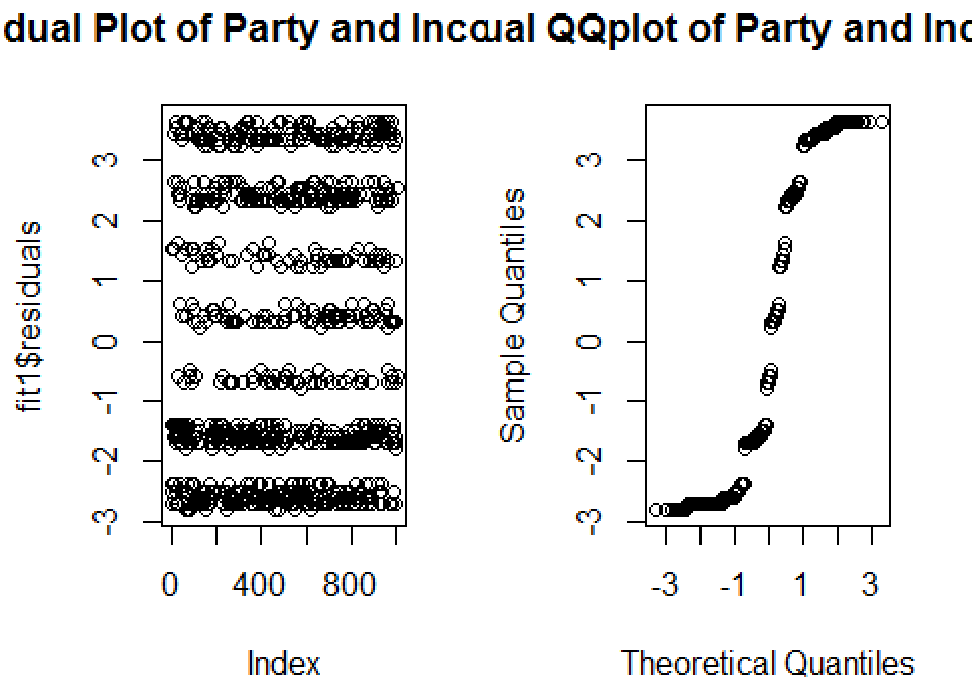
To summarize, People in 2000 are more inclined towards republicans compared to 1960's or earlier.

Solution 6

```
summary(fit1)$coeff

##               Estimate Std. Error   t value     Pr(>|t|)
## (Intercept) 3.2660965 0.20787168 15.712080 6.859904e-50
## Income      0.1040787 0.06385869  1.629828 1.034525e-01

par(mfrow=c(1,2))
plot(fit1$residuals,main="Residual Plot of Party and Income 1960")
qqnorm(fit1$residuals,main="Residual QQplot of Party and Income 1960")
```



Slope=0.104 has confidence interval (-0.02,0.23)

We should not take it's meaning literally because:-

- As seen from Residual Plots there is no linearity between Party and Income. Linear Regression depends on assumptions like Linearity, Homoscedascity, Independence and Normality of errors.
- Linear Regression is not a good fit for categorical data,Both Party and Income are categorical data which should be fit using different model.

Solution 7

```
table60<- read.table('C:/Stats/TAKEHOME FINAL/election1960.txt',header=TRUE)
table80<- read.table('C:/Stats/TAKEHOME FINAL/election1980.txt',header=TRUE)
table20<- read.table('C:/Stats/TAKEHOME FINAL/election2000.txt',header=TRUE)
# Party Total in 1960
p160<- sum((table60$Party==1))
p260<- sum((table60$Party==2))
p360<- sum((table60$Party==3))
p460<- sum((table60$Party==4))
p560<- sum((table60$Party==5))
p660<- sum((table60$Party==6))
p760<- sum((table60$Party==7))

# Party Total in 1980

p180<- sum((table80$Party==1))
p280<- sum((table80$Party==2))
p380<- sum((table80$Party==3))
p480<- sum((table80$Party==4))
p580<- sum((table80$Party==5))
p680<- sum((table80$Party==6))
p780<- sum((table80$Party==7))

# Party Total in 2000

p120<- sum((table20$Party==1))
p220<- sum((table20$Party==2))
p320<- sum((table20$Party==3))
p420<- sum((table20$Party==4))
p520<- sum((table20$Party==5))
p620<- sum((table20$Party==6))
p720<- sum((table20$Party==7))

observed<- matrix(c(p160,p260,p360,p460,p560,p660,p760,p180,p280,p380
                    ,p480,p580,p680,p780,p120,p220,p320,p420,p520,p620
                    ,p720),ncol=3,nrow = 7)
colnames(observed)<- c("1960","1980","2000")
rownames(observed)<- c("1","2","3","4","5","6","7")
tt=as.table(observed,header=TRUE)
# Put my results in table
observed=read.table("C:/Stats/Assignment 11/Observed.txt")
observed
```

```
##   X1960 X1980 X2000
## 1   242   217   270
## 2   241   246   203
## 3    56   106   156
## 4    89   103    85
## 5    65   122   143
## 6   148   155   148
## 7   162   111   171
```

```
p60=sum(observed$X1960)/sum(observed)
p80=sum(observed$X1980)/sum(observed)
p20=sum(observed$X2000)/sum(observed)
p1= sum(observed[1,])
p2= sum(observed[2,])
p3= sum(observed[3,])
p4= sum(observed[4,])
p5= sum(observed[5,])
p6= sum(observed[6,])
p7= sum(observed[7,])
p11= p1*p60
p21= p2*p60
p31= p3*p60
p41= p4*p60
p51= p5*p60
p61= p6*p60
p71= p7*p60
#
p12= p1*p80
p22= p2*p80
p32= p3*p80
p42= p4*p80
p52= p5*p80
p62= p6*p80
p72= p7*p80
#
p13=p1*p20
p23=p2*p20
p33=p3*p20
p43=p4*p20
p53=p5*p20
p63=p6*p20
p73=p7*p20
expected<- matrix(c(p11,p21,p31,p41,p51,p61,p71,p12,p22,p32,p42,p52,p62
                  ,p72,p13,p23,p33,p43,p53,p63,p73),ncol=3,nrow=7)
expected
```

```
##           [,1]      [,2]     [,3]
## [1,] 225.74467 238.57363 264.6817
## [2,] 213.66780 225.81044 250.5218
## [3,]  98.47299 104.06916 115.4579
## [4,]  85.77678  90.65144 100.5718
## [5,] 102.18895 107.99630 119.8148
## [6,] 139.65823 147.59494 163.7468
## [7,] 137.49058 145.30411 161.2053
```

```
df=6*2
X2 = sum((observed - expected)^2 / expected)
1 - pchisq(X2, df=df)

## [1] 5.817569e-14
```

Since p-value is so low i.e. p-value<0.05, we reject our Null Hypothesis i.e Distribution of Party is independent of year and we conclude that Distribution of Party is dependent on year

Solution 8

H0:- Population average age is same between 3 years (Null Hypothesis)

H1:- Population average age is not same between 3 years (Alternate Hypothesis)

```
n1=nrow(table60)
n2=nrow(table80)
n3=nrow(table20)
N=n1+n2+n3
meana=mean(table60$Age)
meanb=mean(table80$Age)
meanc=mean(table20$Age)
grandmean=mean(table_new$Age)
SSB = n1*(meana-grandmean)^2 + n2*(meanb-grandmean)^2 + n3*(meanc-
grandmean)^2
between.df = 2
between.meansquare = SSB/2
SSW = sum( (table60$Age-meana)^2 ) + sum( (table80$Age-meanb)^2 ) + sum(
(table20$Age-meanc)^2 )
within.df = N - 3
within.meansquare = SSW/within.df
# F-test
F = between.meansquare/within.meansquare
P=1 - pf(F, df1=between.df, df2=within.df)
P

## [1] 0.003352559

fit<- lm(table_new$Age~table_new$Year)

# Alternatively to check our solution, we can use ANOVA
anova(fit)

## Analysis of Variance Table
##
## Response: table_new$Age
##                   Df Sum Sq Mean Sq F value   Pr(>F)
## table_new$Year     2   3033 1516.32  5.7081 0.003353 **
## Residuals       3236 859625  265.64
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value=0.003353<0.05 for 95% Confidence Interval hence we reject our Null Hypothesis i.e. Population average age is same for 3 years. We conclude that Population average age differs between 3 years.

Solution 9

H0:- Population proportion of women remained same in 2000. (Null Hypothesis)

H1:- Population proportion of women were not same in 2000 (Alternate Hypothesis)

```
female60<- nrow(table60[table60$Sex==2,])
femaleratio60<- female60/nrow(table60)
maleratio60<- 1-femaleratio60

female20<-nrow(table20[table20$Sex==2,])
male20<-nrow(table20[table20$Sex==1,])
observed<- c(female20,male20)
expfem20<- femaleratio60 *nrow(table20)
expmal20<- maleratio60 *nrow(table20)
expected<-c(expfem20,expmal20)

# Pearson's chi-squared
X2 = sum((observed - expected)^2 / expected)
1 - pchisq(X2, df=2-0-1)

## [1] 0.07546333

# Cross Check values with LR chi-squared test
G2 = 2 * sum(observed * log(observed/expected))
1 - pchisq(G2, df=2-0-1)

## [1] 0.07516072
```

p-value comes to 0.075 using both Pearson's or Chi-Squared test hence we cannot reject our Null Hypothesis since 0.075 > 0.05 for 95% Confidence Interval

Hence we conclude that Population proportion of women is same in 2000 as it was in 1960.