hw4

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```
library(faraway)
```

3.2

```
data("cheddar")
summary(cheddar)
```

```
##      taste           Acetic           H2S             Lactic      
##  Min.   : 0.70   Min.   :4.477   Min.   : 2.996   Min.   :0.860  
##  1st Qu.:13.55   1st Qu.:5.237   1st Qu.: 3.978   1st Qu.:1.250  
##  Median :20.95   Median :5.425   Median : 5.329   Median :1.450  
##  Mean   :24.53   Mean   :5.498   Mean   : 5.942   Mean   :1.442  
##  3rd Qu.:36.70   3rd Qu.:5.883   3rd Qu.: 7.575   3rd Qu.:1.667  
##  Max.   :57.20   Max.   :6.458   Max.   :10.199   Max.   :2.010
```

a.

```
model_a <- lm(taste ~ ., cheddar)
summary(model_a)
```

```
##
## Call:
## lm(formula = taste ~ ., data = cheddar)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -17.390  -6.612  -1.009   4.908  25.449
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -28.8768    19.7354  -1.463  0.15540
## Acetic        0.3277     4.4598   0.073  0.94198
## H2S           3.9118     1.2484   3.133  0.00425 **
## Lactic       19.6705     8.6291   2.280  0.03108 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 10.13 on 26 degrees of freedom
## Multiple R-squared:  0.6518, Adjusted R-squared:  0.6116
## F-statistic: 16.22 on 3 and 26 DF,  p-value: 3.81e-06
```

At 5% level, H2S and Lactic are statistically significant predictors.

b.

```
model_b <- lm(taste ~ exp(Acetic) + exp(H2S) + Lactic, data = cheddar)
summary(model_b)
```

```
##
## Call:
## lm(formula = taste ~ exp(Acetic) + exp(H2S) + Lactic, data = cheddar)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -16.209  -7.266  -1.651   7.385  26.335
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.897e+01  1.127e+01  -1.684   0.1042
## exp(Acetic)  1.891e-02  1.562e-02   1.210   0.2371
## exp(H2S)     7.668e-04  4.188e-04   1.831   0.0786 .
## Lactic       2.501e+01  9.062e+00   2.760   0.0105 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.19 on 26 degrees of freedom
## Multiple R-squared:  0.5754, Adjusted R-squared:  0.5264
## F-statistic: 11.75 on 3 and 26 DF,  p-value: 4.746e-05
```

At 5% level, Lactic and exp(H2S) are statistically significant predictors.

c.

We can use F-test to compare these model because we want to compare between a base model (model_a) and a modified new model (model_b).

```
anova_test <- anova(model_a, model_b)
anova_test
```

```
## Analysis of Variance Table
##
## Model 1: taste ~ Acetic + H2S + Lactic
## Model 2: taste ~ exp(Acetic) + exp(H2S) + Lactic
##   Res.Df    RSS Df Sum of Sq F Pr(>F)
## 1     26 2668.4
## 2     26 3253.6  0    -585.2
```

The RSS of model_a is much lower (585.2) than that of model_b, hence model_a is better fit for the data.

d.

```
delta_H2S <- 0.01
predicted_change <- coef(model_a)["H2S"] * log(delta_H2S)
predicted_change
```

```
##       H2S
## -18.01469
```

Since H2S in model_a is in logarithmic form, when H2S increases by 0.01, the change in taste will be the previous coefficient times the log of the delta increase. The final result is -18.01469.

e.

```
delta_log_H2S <- 0.01
percentage_change <- (exp(delta_log_H2S) - 1) * 100
percentage_change
```

```
## [1] 1.005017
```

If H2S increases by 0.01, The percentage change in H2S is 1%.

4.

```
data("sat")
summary(sat)
```

```
##      expend          ratio           salary          takers
##  Min.   :3.656   Min.   :13.80   Min.   :25.99   Min.   : 4.00
##  1st Qu.:4.882   1st Qu.:15.22   1st Qu.:30.98   1st Qu.: 9.00
##  Median :5.768   Median :16.60   Median :33.29   Median :28.00
##  Mean   :5.905   Mean   :16.86   Mean   :34.83   Mean   :35.24
##  3rd Qu.:6.434   3rd Qu.:17.57   3rd Qu.:38.55   3rd Qu.:63.00
##  Max.   :9.774   Max.   :24.30   Max.   :50.05   Max.   :81.00
##      verbal           math           total
##  Min.   :401.0   Min.   :443.0   Min.   : 844.0
##  1st Qu.:427.2   1st Qu.:474.8   1st Qu.: 897.2
##  Median :448.0   Median :497.5   Median : 945.5
##  Mean   :457.1   Mean   :508.8   Mean   : 965.9
##  3rd Qu.:490.2   3rd Qu.:539.5   3rd Qu.:1032.0
##  Max.   :516.0   Max.   :592.0   Max.   :1107.0
```

```
model_a <- lm(total ~ expend + ratio + salary, data = sat)
summary(model_a)
```

```
##
## Call:
## lm(formula = total ~ expend + ratio + salary, data = sat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -140.911  -46.740   -7.535   47.966  123.329
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1069.234    110.925   9.639 1.29e-12 ***
## expend        16.469     22.050   0.747   0.4589
## ratio          6.330      6.542   0.968   0.3383
## salary        -8.823      4.697  -1.878   0.0667 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 68.65 on 46 degrees of freedom
## Multiple R-squared:  0.2096, Adjusted R-squared:  0.1581
## F-statistic: 4.066 on 3 and 46 DF,  p-value: 0.01209
```

a.

Test of beta of salary is 0:

```
t_test_salary <- coef(summary(model_a))["salary", "t value"]
p_value_salary <- coef(summary(model_a))["salary", "Pr(>|t|)"]

cat("T-Test for Salary Coefficient:\n")
```

```
## T-Test for Salary Coefficient:
```

```
cat("t-value:", t_test_salary, "\n")
```

```
## t-value: -1.878437
```

```
cat("p-value:", p_value_salary, "\n")
```

```
## p-value: 0.06666771
```

We don't reject the null, hence salary does not have an effect on the response variable.

Test of beta of salary, ratio, and expend all 0.

```
f_test_all <- anova(model_a)
cat("\nF-Test for All Coefficients:\n")
```

```
##
## F-Test for All Coefficients:
```

```
f_test_all
```

```
## Analysis of Variance Table
##
## Response: total
##           Df Sum Sq Mean Sq F value   Pr(>F)
## expend     1  39722   39722  8.4276 0.005658 **
## ratio      1   1143    1143  0.2424 0.624795
## salary     1  16631   16631  3.5285 0.066668 .
## Residuals 46 216812    4713
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

From the ANOVA table, only extend is a statistically significant predictor to the responses.

b.

```
model_b <- lm(total ~ expend + ratio + salary + takers, data = sat)
```

```
t_test_takers <- coef(summary(model_b))["takers", "t value"]
p_value_takers <- coef(summary(model_b))["takers", "Pr(>|t|)"]

cat("\nT-Test for Takers Coefficient:\n")
```

```
##
## T-Test for Takers Coefficient:
```

```
cat("t-value:", t_test_takers, "\n")
```

```
## t-value: -12.55937
```

```
cat("p-value:", p_value_takers, "\n")
```

```
## p-value: 2.606559e-16
```

Based on the p-value, we reject the null. Hence, takers is a statistically significant predictor.

```
anova_test_ab <- anova(model_a, model_b)
anova_test_ab
```

```
## Analysis of Variance Table
##
## Model 1: total ~ expend + ratio + salary
## Model 2: total ~ expend + ratio + salary + takers
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1     46 216812
## 2     45  48124  1    168688 157.74 2.607e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

From the ANOVA table, we can see that, as the difference between model_a and model_b is just the new predictor takers, and model_b shows a significant improvement in RSS from model_a, takers definitely contribute to the response, which is the same conclusion as the t-test above.

6.

```
data("happy")
summary(happy)
```

```
##      happy            money             sex              love
##  Min.   : 2.000   Min.   :  0.00   Min.   :0.0000   Min.   :1.000
##  1st Qu.: 5.000   1st Qu.: 42.50   1st Qu.:0.0000   1st Qu.:2.000
##  Median : 7.000   Median : 50.00   Median :1.0000   Median :3.000
##  Mean   : 6.744   Mean   : 62.15   Mean   :0.6923   Mean   :2.462
##  3rd Qu.: 8.000   3rd Qu.: 78.00   3rd Qu.:1.0000   3rd Qu.:3.000
##  Max.   :10.000   Max.   :175.00   Max.   :1.0000   Max.   :3.000
##       work
##  Min.   :1.000
##  1st Qu.:3.000
##  Median :4.000
##  Mean   :3.359
##  3rd Qu.:4.000
##  Max.   :5.000
```

a.

```
model <- lm(happy ~ money + sex + love + work, data = happy)
summary(model)
```

```
##
## Call:
## lm(formula = happy ~ money + sex + love + work, data = happy)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.7186 -0.5779 -0.1172  0.6340  2.0651
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.072081   0.852543  -0.085   0.9331
## money        0.009578   0.005213   1.837   0.0749 .
## sex         -0.149008   0.418525  -0.356   0.7240
## love         1.919279   0.295451   6.496 1.97e-07 ***
## work         0.476079   0.199389   2.388   0.0227 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.058 on 34 degrees of freedom
## Multiple R-squared:  0.7102, Adjusted R-squared:  0.6761
## F-statistic: 20.83 on 4 and 34 DF,  p-value: 9.364e-09
```

At 1% level, love and work are statistically significant predictors.

b.

```
summary_table <- table(happy)
summary_table
```

```
## , , sex = 0, love = 1, work = 1
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##     2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##     2    0
##     3    0
##     4    0
##     5    0
##     6    0
##     7    0
##     8    0
##     9    0
##     10   0
##
## , , sex = 1, love = 1, work = 1
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##     2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0   0   0
##     4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##     2    0
##     3    0
##     4    0
##     5    0
##     6    0
##     7    0
##     8    0
##     9    0
```

```
##    10   0
##
## , , sex = 0, love = 2, work = 1
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 2, work = 1
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 3, work = 1
##
```

```
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##     2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##     2    0
##     3    0
##     4    0
##     5    0
##     6    0
##     7    0
##     8    0
##     9    0
##     10   0
##
## , , sex = 1, love = 3, work = 1
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##     2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     8  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##     2    0
##     3    0
##     4    0
##     5    0
##     6    0
##     7    0
##     8    0
##     9    0
##     10   0
##
## , , sex = 0, love = 1, work = 2
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##     2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##     3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
```

```
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 1, work = 2
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 2, work = 2
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
```

```
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 2, work = 2
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 3, work = 2
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
```

```
## happy 175
##    2   0
##    3   0
##    4   0
##    5   0
##    6   0
##    7   0
##    8   0
##    9   0
##    10  0
##
## , , sex = 1, love = 3, work = 2
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   1   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2   0
##    3   0
##    4   0
##    5   0
##    6   0
##    7   0
##    8   0
##    9   0
##    10  0
##
## , , sex = 0, love = 1, work = 3
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2   0
##    3   0
##    4   0
```

```
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 1, work = 3
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 2, work = 3
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
```

```
##    9    0
##    10   0
##
## , , sex = 1, love = 2, work = 3
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 3, work = 3
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 3, work = 3
```

```
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  1  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  1  0  0  0  0  1  0  0  0  0  0  0  0  1  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 1, work = 4
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 1, work = 4
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0
```

```
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##    4  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 2, work = 4
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 2, work = 4
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
```

```
##    7  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 3, work = 4
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 3, work = 4
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  1  0  1  0  0   0   0
##    9  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   1
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
```

```
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    1
##    9    1
##    10   0
##
## , , sex = 0, love = 1, work = 5
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 1, work = 5
##
##      money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##      money
## happy 175
##    2    0
##    3    0
```

```
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 2, work = 5
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 2, work = 5
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
```

```
##    8    0
##    9    0
##    10   0
##
## , , sex = 0, love = 3, work = 5
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  1  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
##
## , , sex = 1, love = 3, work = 5
##
##       money
## happy 0 31 35 36 40 41 44 45 47 50 53 55 56 60 62 65 70 75 81 85 88 90 112 115
##    2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##    10 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0
##       money
## happy 175
##    2    0
##    3    0
##    4    0
##    5    0
##    6    0
##    7    0
##    8    0
##    9    0
##    10   0
```

The questional assumption is that some predictors should not have numerical values in the real number domain e.g 'sex', but they instead should have had categorical values.

c.

Permutation Test

```
set.seed(123)  # Set a random seed for reproducibility
n_permutations <- 1000
permutation_results <- numeric(n_permutations)

for (i in 1:n_permutations) {
  happy_permuted <- happy
  happy_permuted$money <- sample(happy$money)
  model_permuted <- lm(happy ~ money + work + sex + love, data = happy_permuted)
  permutation_results[i] <- coef(model_permuted)["money"]
}
```

```
observed_coef <- coef(model)["money"]
p_value_permutation <- sum(abs(permutation_results) >= abs(observed_coef)) / n_permutations
cat("\nP-value from Permutation Test (money predictor):\n")
```

```
##
## P-value from Permutation Test (money predictor):
```

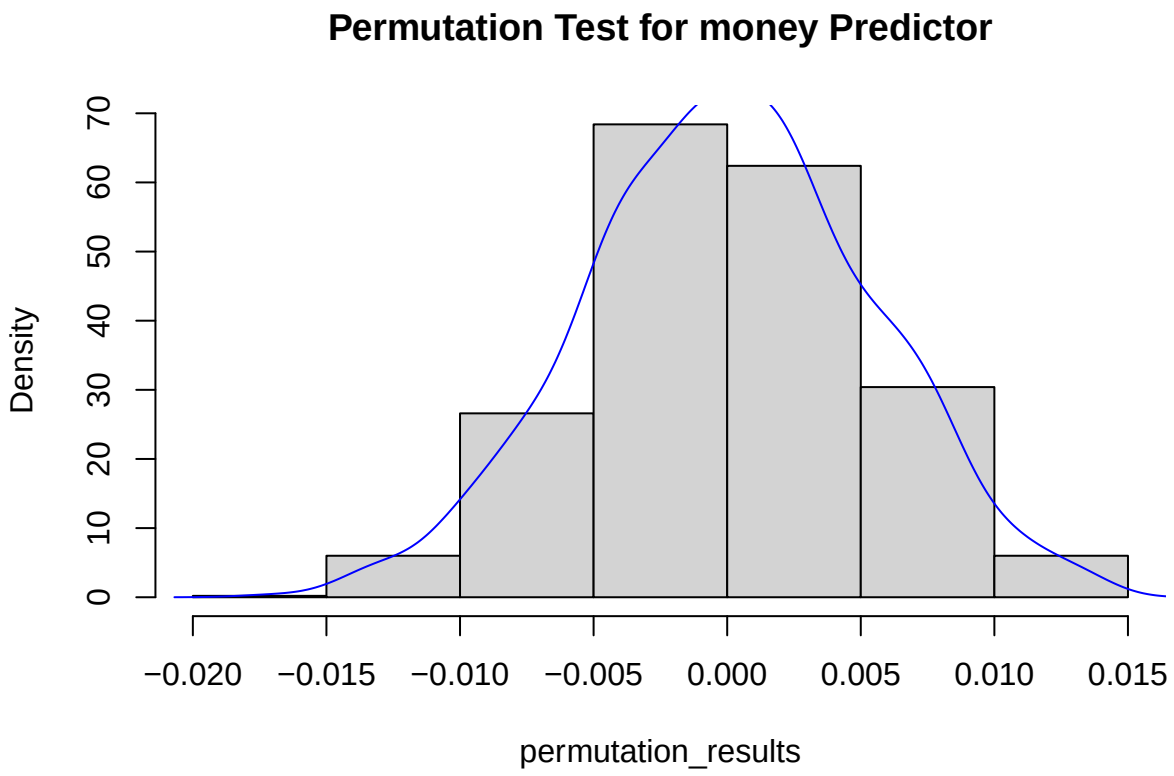
```
cat("p-value:", p_value_permutation, "\n")
```

```
## p-value: 0.073
```

Based on the p-value, 'money' is not a statistically significant predictor at 5% level.

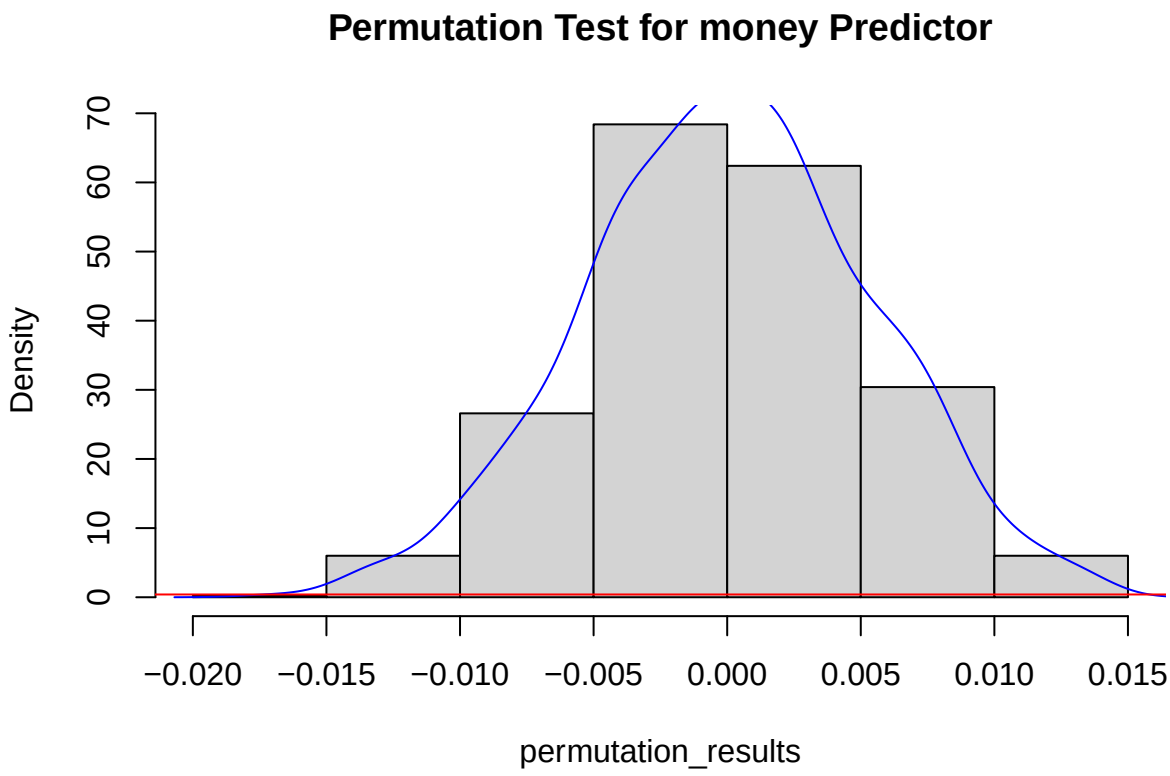
d.

```
hist(permutation_results, probability = TRUE, main = "Permutation Test for money Predictor")
lines(density(permutation_results), col = "blue")
```



e.

```
hist(permutation_results, probability = TRUE, main = "Permutation Test for money Predictor")
lines(density(permutation_results), col = "blue")
grid <- seq(-3, 3, length = 300)
t_density <- dt(grid, df = length(permutation_results) - 1)
lines(grid, t_density, col = "red")
```



f.

```r
set.seed(123)
n_bootstrap <- 1000
bootstrap_results <- numeric(n_bootstrap)

for (i in 1:n_bootstrap) {
  sample_indices <- sample(1:length(happy$money), replace = TRUE)
  bootstrap_sample <- happy[sample_indices, ]
  model_bootstrap <- lm(happy ~ money + love + sex + work, data = bootstrap_sample)
  bootstrap_results[i] <- coef(model_bootstrap)["money"]
}
```

```r
# Calculate bootstrap confidence intervals
conf_interval_90 <- quantile(bootstrap_results, c(0.05, 0.95))
conf_interval_95 <- quantile(bootstrap_results, c(0.025, 0.975))

# Check if zero falls within these confidence intervals
zero_in_interval_90 <- conf_interval_90[1] <= 0 && conf_interval_90[2] >= 0
zero_in_interval_95 <- conf_interval_95[1] <= 0 && conf_interval_95[2] >= 0

# Output the results
cat("\nBootstrap Confidence Intervals for money:\n")
```

```
##
## Bootstrap Confidence Intervals for money:
```

```
cat("90% Confidence Interval:", conf_interval_90, "\n")
```

```
## 90% Confidence Interval: 0.001322696 0.02432515
```

```
cat("95% Confidence Interval:", conf_interval_95, "\n")
```

```
## 95% Confidence Interval: 0.0001812671 0.02748471
```

```
cat("Zero within 90% Confidence Interval:", zero_in_interval_90, "\n")
```

```
## Zero within 90% Confidence Interval: FALSE
```

```
cat("Zero within 95% Confidence Interval:", zero_in_interval_95, "\n")
```

```
## Zero within 95% Confidence Interval: FALSE
```

ZERO does NOT fall within these confidence intervals. This is consistant with the result from the permutation test above as we will reject the null that money is a statistically significant predictor at 5% level.

4.1

a.

```
data("prostate")
summary(prostate)
```

```
##      lcavol           lweight           age             lbph
##  Min.   :-1.3471   Min.   :2.375   Min.   :41.00   Min.   :-1.3863
##  1st Qu.: 0.5128   1st Qu.:3.376   1st Qu.:60.00   1st Qu.:-1.3863
##  Median : 1.4469   Median :3.623   Median :65.00   Median : 0.3001
##  Mean   : 1.3500   Mean   :3.653   Mean   :63.87   Mean   : 0.1004
##  3rd Qu.: 2.1270   3rd Qu.:3.878   3rd Qu.:68.00   3rd Qu.: 1.5581
##  Max.   : 3.8210   Max.   :6.108   Max.   :79.00   Max.   : 2.3263
##       svi              lcp             gleason          pgg45
##  Min.   :0.0000   Min.   :-1.3863   Min.   :6.000   Min.   :  0.00
##  1st Qu.:0.0000   1st Qu.:-1.3863   1st Qu.:6.000   1st Qu.:  0.00
##  Median :0.0000   Median :-0.7985   Median :7.000   Median : 15.00
##  Mean   :0.2165   Mean   :-0.1794   Mean   :6.753   Mean   : 24.38
##  3rd Qu.:0.0000   3rd Qu.: 1.1786   3rd Qu.:7.000   3rd Qu.: 40.00
##  Max.   :1.0000   Max.   : 2.9042   Max.   :9.000   Max.   :100.00
##       lpsa
##  Min.   :-0.4308
##  1st Qu.: 1.7317
##  Median : 2.5915
##  Mean   : 2.4784
##  3rd Qu.: 3.0564
##  Max.   : 5.5829
```

```r
model <- lm(lpsa ~ ., data = prostate)
summary(model)
```

```
##
## Call:
## lm(formula = lpsa ~ ., data = prostate)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.7331 -0.3713 -0.0170  0.4141  1.6381
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.669337   1.296387   0.516  0.60693
## lcavol       0.587022   0.087920   6.677 2.11e-09 ***
## lweight      0.454467   0.170012   2.673  0.00896 **
## age         -0.019637   0.011173  -1.758  0.08229 .
## lbph         0.107054   0.058449   1.832  0.07040 .
## svi          0.766157   0.244309   3.136  0.00233 **
## lcp         -0.105474   0.091013  -1.159  0.24964
## gleason      0.045142   0.157465   0.287  0.77503
## pgg45        0.004525   0.004421   1.024  0.30886
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7084 on 88 degrees of freedom
## Multiple R-squared:  0.6548, Adjusted R-squared:  0.6234
## F-statistic: 20.86 on 8 and 88 DF,  p-value: < 2.2e-16
```

a.

```r
new_patient <- data.frame(
  lcavol = 1.44692,
  lweight = 3.62301,
  age = 65.00000,
  lbph = 0.30010,
  svi = 0.00000,
  lcp = -0.79851,
  gleason = 7.00000,
  pgg45 = 15.00000
)

predicted_lpsa <- predict(model, newdata = new_patient, interval = "prediction", level = 0.95)

cat("Predicted lpsa:", predicted_lpsa[1], "\n")
```

```
## Predicted lpsa: 2.389053
```

```r
cat("95% Confidence Interval for lpsa:", predicted_lpsa[2], "to", predicted_lpsa[3], "\n")
```

```
## 95% Confidence Interval for lpsa: 0.9646584 to 3.813447
```

b.

```
new_patient_age_20 <- data.frame(
  lcavol = 1.44692,
  lweight = 3.62301,
  age = 20.00000,  # Updated age
  lbph = 0.30010,
  svi = 0.00000,
  lcp = -0.79851,
  gleason = 7.00000,
  pgg45 = 15.00000
)

predicted_lpsa_age_20 <- predict(model, newdata = new_patient_age_20, interval = "prediction", level =

cat("Predicted lpsa (age = 20):", predicted_lpsa_age_20[1], "\n")
```

```
## Predicted lpsa (age = 20): 3.272726
```

```
cat("95% Confidence Interval for lpsa (age = 20):", predicted_lpsa_age_20[2], "to", predicted_lpsa_age_
```

```
## 95% Confidence Interval for lpsa (age = 20): 1.538744 to 5.006707
```

The CI is wider for the patient with age = 20 compared to the patient with age = 65 because at 5% level, age is one of the predictors in the regression model. When age is set to 20, it results in a prediction that is further away from the mean response value of the model compared to when age is 65. This increased deviation from the mean response leads to greater uncertainty in the prediction, resulting in a wider CI.

c.

```
significant_predictors_model <- lm(lpsa ~ lcavol + lweight + age + lbph + svi, data = prostate)
summary(significant_predictors_model)
```

```
##
## Call:
## lm(formula = lpsa ~ lcavol + lweight + age + lbph + svi, data = prostate)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.83505 -0.39396  0.00414  0.46336  1.57888
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.95100    0.83175   1.143 0.255882
## lcavol       0.56561    0.07459   7.583 2.77e-11 ***
## lweight      0.42369    0.16687   2.539 0.012814 *
## age         -0.01489    0.01075  -1.385 0.169528
## lbph         0.11184    0.05805   1.927 0.057160 .
## svi          0.72095    0.20902   3.449 0.000854 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7073 on 91 degrees of freedom
## Multiple R-squared:  0.6441, Adjusted R-squared:  0.6245
## F-statistic: 32.94 on 5 and 91 DF,  p-value: < 2.2e-16
```

```
new_patient_age_20 <- data.frame(
  lcavol = 1.44692,
  lweight = 3.62301,
  age = 20.00000,  # Updated age
  lbph = 0.30010,
  svi = 0.00000,
  lcp = -0.79851,
  gleason = 7.00000,
  pgg45 = 15.00000
)

# Predict lpsa for the new patient with age = 20 using the model with significant predictors
predicted_lpsa_age_20_significant <- predict(significant_predictors_model, newdata = new_patient_age_20

# Output the prediction and 95% confidence interval for lpsa with age = 20 using the model with signifi
cat("Predicted lpsa (age = 20, significant predictors only):", predicted_lpsa_age_20_significant[1], "\n
```

```
## Predicted lpsa (age = 20, significant predictors only): 3.040145
```

```
cat("95% Confidence Interval for lpsa (age = 20, significant predictors only):", predicted_lpsa_age_20_s
```

```
## 95% Confidence Interval for lpsa (age = 20, significant predictors only): 1.340103 to 4.740187
```

The CIs for the predictions made with the model containing only significant predictors are narrower than the CIs from the previous model because the model's predictions are based on fewer variables, resulting in reduced uncertainty.

5.

```
data("fat")
summary(fat)
```

```
##      brozek           siri          density           age
##  Min.   : 0.00   Min.   : 0.00   Min.   :0.995   Min.   :22.00
##  1st Qu.:12.80   1st Qu.:12.47   1st Qu.:1.041   1st Qu.:35.75
##  Median :19.00   Median :19.20   Median :1.055   Median :43.00
##  Mean   :18.94   Mean   :19.15   Mean   :1.056   Mean   :44.88
##  3rd Qu.:24.60   3rd Qu.:25.30   3rd Qu.:1.070   3rd Qu.:54.00
##  Max.   :45.10   Max.   :47.50   Max.   :1.109   Max.   :81.00
##      weight          height          adipos           free
##  Min.   :118.5   Min.   :29.50   Min.   :18.10   Min.   :105.9
##  1st Qu.:159.0   1st Qu.:68.25   1st Qu.:23.10   1st Qu.:131.3
##  Median :176.5   Median :70.00   Median :25.05   Median :141.6
```

```
##  Mean   :178.9   Mean   :70.15   Mean   :25.44   Mean   :143.7
##  3rd Qu.:197.0   3rd Qu.:72.25   3rd Qu.:27.32   3rd Qu.:153.9
##  Max.   :363.1   Max.   :77.75   Max.   :48.90   Max.   :240.5
##       neck            chest            abdom             hip
##  Min.   :31.10   Min.   : 79.30   Min.   : 69.40   Min.   : 85.0
##  1st Qu.:36.40   1st Qu.: 94.35   1st Qu.: 84.58   1st Qu.: 95.5
##  Median :38.00   Median : 99.65   Median : 90.95   Median : 99.3
##  Mean   :37.99   Mean   :100.82   Mean   : 92.56   Mean   : 99.9
##  3rd Qu.:39.42   3rd Qu.:105.38   3rd Qu.: 99.33   3rd Qu.:103.5
##  Max.   :51.20   Max.   :136.20   Max.   :148.10   Max.   :147.7
##      thigh            knee            ankle           biceps         forearm
##  Min.   :47.20   Min.   :33.00   Min.   :19.1   Min.   :24.80   Min.   :21.00
##  1st Qu.:56.00   1st Qu.:36.98   1st Qu.:22.0   1st Qu.:30.20   1st Qu.:27.30
##  Median :59.00   Median :38.50   Median :22.8   Median :32.05   Median :28.70
##  Mean   :59.41   Mean   :38.59   Mean   :23.1   Mean   :32.27   Mean   :28.66
##  3rd Qu.:62.35   3rd Qu.:39.92   3rd Qu.:24.0   3rd Qu.:34.33   3rd Qu.:30.00
##  Max.   :87.30   Max.   :49.10   Max.   :33.9   Max.   :45.00   Max.   :34.90
##      wrist
##  Min.   :15.80
##  1st Qu.:17.60
##  Median :18.30
##  Mean   :18.23
##  3rd Qu.:18.80
##  Max.   :21.40
```

```
full_model <- lm(brozek ~ ., data = fat)
smaller_model <- lm(brozek ~ age + weight + height + abdom, data = fat)
```

```
summary(smaller_model)
```

```
##
## Call:
## lm(formula = brozek ~ age + weight + height + abdom, data = fat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -11.5105  -2.9346   0.0087   2.8942   9.4179
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -32.769636   6.541902  -5.009 1.04e-06 ***
## age          -0.007051   0.024342  -0.290    0.772
## weight       -0.123722   0.025046  -4.940 1.44e-06 ***
## height       -0.116694   0.082727  -1.411    0.160
## abdom         0.889704   0.067267  13.226  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.126 on 247 degrees of freedom
## Multiple R-squared:  0.7211, Adjusted R-squared:  0.7166
## F-statistic: 159.7 on 4 and 247 DF,  p-value: < 2.2e-16
```

```r
summary(full_model)
```

```
##
## Call:
## lm(formula = brozek ~ ., data = fat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.11191 -0.04847  0.00277  0.04625  1.47542
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 12.1524013  4.1718589   2.913  0.00393 **
## siri         0.8884085  0.0111341  79.792  < 2e-16 ***
## density     -9.8456305  3.7471770  -2.627  0.00917 **
## age         -0.0005268  0.0012935  -0.407  0.68421
## weight       0.0084855  0.0036200   2.344  0.01991 *
## height      -0.0005459  0.0044439  -0.123  0.90234
## adipos      -0.0153248  0.0124778  -1.228  0.22062
## free        -0.0097388  0.0044270  -2.200  0.02880 *
## neck         0.0005002  0.0094279   0.053  0.95773
## chest        0.0021454  0.0043013   0.499  0.61840
## abdom        0.0014464  0.0044217   0.327  0.74388
## hip         -0.0044514  0.0058941  -0.755  0.45087
## thigh        0.0156926  0.0059507   2.637  0.00892 **
## knee        -0.0252126  0.0098531  -2.559  0.01113 *
## ankle        0.0027790  0.0089580   0.310  0.75667
## biceps      -0.0147134  0.0069201  -2.126  0.03454 *
## forearm      0.0149983  0.0080832   1.855  0.06478 .
## wrist        0.0326518  0.0218000   1.498  0.13554
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1706 on 234 degrees of freedom
## Multiple R-squared:  0.9995, Adjusted R-squared:  0.9995
## F-statistic: 3.046e+04 on 17 and 234 DF,  p-value: < 2.2e-16
```

```r
anova_test <- anova(full_model, smaller_model)
anova_test
```

```
## Analysis of Variance Table
##
## Model 1: brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
## Model 2: brozek ~ age + weight + height + abdom
##   Res.Df    RSS  Df Sum of Sq     F    Pr(>F)
## 1    234    6.8
## 2    247 4205.0 -13   -4198.2 11096 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

I don't think it's justificable to use the smaller model instead of the full model because the smaller model has a higher RSS, lower R-Squared, and we can see in the summary of the full model, there are statistically significant predictors we left out e.g 'siri', 'density'.

b.

```
median_values <- sapply(fat[, -1], median)
new_data_median <- data.frame(t(median_values))

pred_interval_smaller_median <- predict(smaller_model, newdata = new_data_median, interval = "predictio

pred_interval_full_median <- predict(full_model, newdata = new_data_median, interval = "prediction", le
```

```
pred_interval_smaller_median
```

```
##        fit      lwr      upr
## 1 17.84028 9.696631 25.98392
```

```
pred_interval_full_median
```

```
##        fit      lwr      upr
## 1 18.99539 18.65831 19.33247
```

The CIs differ by a practically importance amount. The CI in the full model is much smaller than that of in the smaller mode.

c.

```
anomalous_cases_smaller <- residuals(smaller_model)[25:50]

# Identify observations with particularly large residuals
outliers_smaller <- which(abs(anomalous_cases_smaller) > 1.5 * sd(anomalous_cases_smaller))

outliers_smaller
```

```
## 32 39
##  8 15
```

Observations 32 and 39 seems to be anomalous as they're 1.5 times standard deviation away from the mean.

d.

```
fat_cleaned <- fat[-outliers_smaller, ]
median_values <- sapply(fat_cleaned[, -1], median)
new_data_median <- data.frame(t(median_values))
```

```r
smaller_model_cleaned <- lm(brozek ~ age + weight + height + abdom, data = fat_cleaned)
full_model_cleaned <- lm(brozek ~ ., data = fat_cleaned)

pred_interval_smaller_cleaned <- predict(smaller_model_cleaned, newdata = new_data_median, interval = "
pred_interval_full_cleaned <- predict(full_model, newdata = new_data_median, interval = "prediction", le
```

```r
pred_interval_smaller_cleaned
```

```
##        fit      lwr      upr
## 1 17.84793 9.678289 26.01757
```

Look like removing the anomalous observations does not make much difference to the CI of the smaller model

```r
pred_interval_full_cleaned
```

```
##        fit      lwr      upr
## 1 18.99755 18.66048 19.33463
```

Similarly, look like removing the anomalous observations does not make much difference to the CI of the full model.