Q11

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```
mrcontract = expand.grid(agency=LETTERS[1:4], sup=c("local","travel"), scope=c("in-house", "subcontract
mrcontract$quality=c(124.3,120.6,120.7,122.6,112.7,110.2,113.5,108.6,115.1, 119.9,115.4,117.3,88.2,96,9
head(mrcontract)
```

```
##   agency    sup    scope  fee quality
## 1      A  local in-house high   124.3
## 2      B  local in-house high   120.6
## 3      C  local in-house high   120.7
## 4      D  local in-house high   122.6
## 5      A travel in-house high   112.7
## 6      B travel in-house high   110.2
```

```
names(mrcontract)
```

```
## [1] "agency"  "sup"     "scope"   "fee"     "quality"
```

(a) Regress quality on agency, fee and an interaction between sup and scope. State the estimated regression equation and use drop1 to test which terms are significant.

```
fit = lm(quality ~ as.factor(agency) + as.factor(fee) + as.factor(sup) : as.factor(scope), mrcontract)
drop1(fit, test = "F")
```

```
## Single term deletions
##
## Model:
## quality ~ as.factor(agency) + as.factor(fee) + as.factor(sup):as.factor(scope)
##                                Df Sum of Sq     RSS     AIC  F value Pr(>F)
## <none>                                      268.4 100.624
## as.factor(agency)               3       4.1   272.5  95.344   0.1964 0.8982
## as.factor(fee)                  2   10044.3 10312.7 271.757 729.7061 <2e-16
## as.factor(sup):as.factor(scope)  3    6241.2  6509.6 247.672 302.2756 <2e-16
##
## <none>
## as.factor(agency)
## as.factor(fee)                  ***
```

```
## as.factor(sup):as.factor(scope) ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(fit)
```

```
##
## Call:
## lm(formula = quality ~ as.factor(agency) + as.factor(fee) + as.factor(sup):as.factor(scope),
##     data = mrcontract)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.0208 -1.9292 -0.3406  1.8458  4.5167
##
## Coefficients: (1 not defined because of singularities)
##                                                 Estimate Std. Error t value
## (Intercept)                                      92.2208     1.1360  81.182
## as.factor(agency)B                                0.1250     1.0710   0.117
## as.factor(agency)C                                0.1500     1.0710   0.140
## as.factor(agency)D                               -0.5667     1.0710  -0.529
## as.factor(fee)med                                -0.9625     0.9275  -1.038
## as.factor(fee)low                               -31.1563     0.9275 -33.591
## as.factor(sup)local:as.factor(scope)in-house     30.2333     1.0710  28.229
## as.factor(sup)travel:as.factor(scope)in-house    19.2833     1.0710  18.005
## as.factor(sup)local:as.factor(scope)subcontract  24.7917     1.0710  23.148
## as.factor(sup)travel:as.factor(scope)subcontract      NA         NA      NA
##                                                 Pr(>|t|)
## (Intercept)                                       <2e-16 ***
## as.factor(agency)B                                 0.908
## as.factor(agency)C                                 0.889
## as.factor(agency)D                                 0.600
## as.factor(fee)med                                  0.306
## as.factor(fee)low                                 <2e-16 ***
## as.factor(sup)local:as.factor(scope)in-house      <2e-16 ***
## as.factor(sup)travel:as.factor(scope)in-house     <2e-16 ***
## as.factor(sup)local:as.factor(scope)subcontract   <2e-16 ***
## as.factor(sup)travel:as.factor(scope)subcontract      NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.623 on 39 degrees of freedom
## Multiple R-squared:  0.9838, Adjusted R-squared:  0.9805
## F-statistic: 295.9 on 8 and 39 DF,  p-value: < 2.2e-16
```

(b) Are there differences in quality between the agencies? To receive full credit state the null and alternative hypotheses, find the P value, state you decision (reject or not), and summarize your conclusion.

0.908 0.889 0.600 $>$ .05, cannot reject.

(c) Are there differences in quality between the fee values? To receive full credit state the null and alternative hypotheses, find the P value, state you decision (reject or not), and summarize your conclusion.

feemed: P-value(0.306) > .05, feelow: P-value <2e-16, reject.

(d) What does the coefficient for feemed tell you? Test whether it is different from 0 and discuss what the results of this tell you from a managerial perspective.

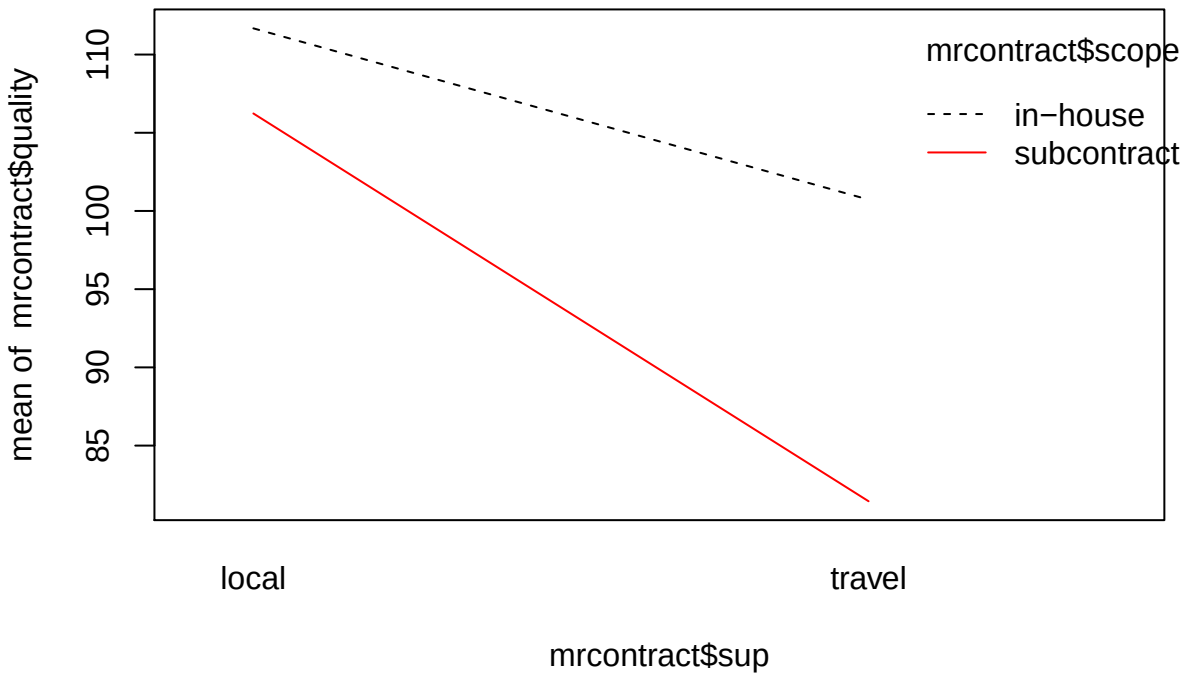
-0.9625, 0.306 > .05, cannot reject.

(e) Is the interaction between sup and scope significant? To receive full credit state the null and alternative hypotheses, find the P value, and state you decision (reject or not).

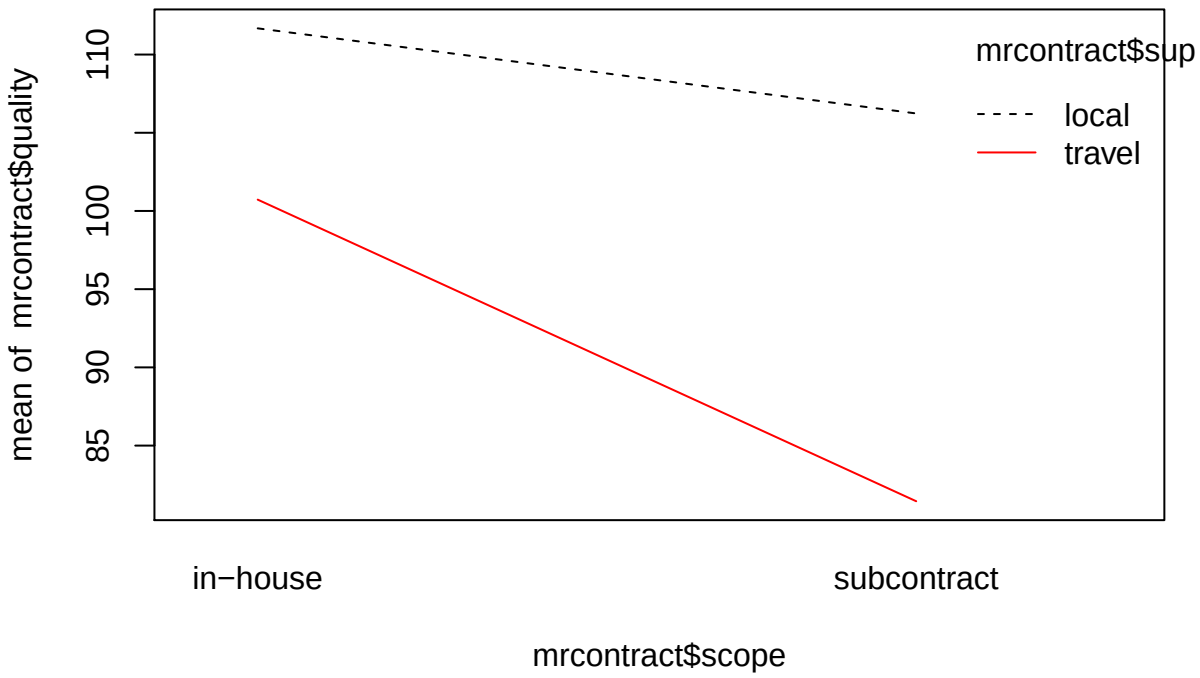
P-value < 2e-16, reject.

(f) Construct and interaction plot for sup and scope. Write one sentence summarizing what the interaction plot tells you.

```
interaction.plot(mrcontract$sup, mrcontract$scope, mrcontract$quality, col = 1:2)
```




```
interaction.plot(mrcontract$scope, mrcontract$sup, mrcontract$quality, col = 1:2)
```



non-parallel