

Exam 2 - Question 4

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Problem 4 - Do problem 7.7 on page 289 - Refers to the commercial realstate data from above

Part A. Obtain an analysis of variance table for decomposing the regression sum of squares into extra sums of squares associated with the following scenarios:

- X4
- X1 given X4
- X2 given X4
- X2 given X1 and X4
- X3 given X1 and X2 and X4

For this I have created a full (detailed) regression anova table

```
fullRegressionAnova <- function(lm_anova){
  VariationSource <- c("Regression", rownames(lm_anova), "Total")
  SSR <- sum(lm_anova$"Sum Sq"[1:(length(lm_anova$"Sum Sq")-1)])
  SST <- sum(lm_anova$"Sum Sq")
  DFReg <- sum(lm_anova$"Df"[1:(length(lm_anova$"Df")-1)])
  MSE <- lm_anova$"Mean Sq"[length(lm_anova$"Mean Sq")]
  MSR <- SSR / DFReg

  SS <- c(SSR,lm_anova$"Sum Sq",SST)
  MS <- c(MSR, lm_anova$"Mean Sq", NA)
  DF <- c(DFReg, lm_anova$"Df", sum(lm_anova$"Df"))
  F_stat <- MSR / MSE
  F_stats <-c(F_stat, lm_anova$"F value",NA)
  df_out <- data.frame(VariationSource, DF,SS, MS, F_stats)
  print(df_out)
  return(df_out)
}
```

Load Data Set and Recode the Variables

```
setwd("C:\\Users\\AdamMcQuistan\\Documents\\ISQA 8340\\Exam 2")
df <- read.csv("data/6.18.csv")
names(df)
```

```
## [1] "Case"      "Rental"    "Age"       "Expense"   "Vacancy"   "Footage"
```

```
names(df)[2:6] = c("Y", "X1", "X2", "X3", "X4")
names(df)
```

```
## [1] "Case" "Y"     "X1"    "X2"    "X3"    "X4"
```

X4

```
resultX4 <- lm(Y ~ X4, data=df)
resultX4_aov <- fullRegressionAnova(anova(resultX4))
```

##	VariationSource	DF	SS	MS	F_stats
## 1	Regression	1	67.7751	67.775098	31.7227
## 2	X4	1	67.7751	67.775098	31.7227
## 3	Residuals	79	168.7824	2.136486	NA
## 4	Total	80	236.5575	NA	NA

X1 given X4

```
resultX1_X4 <- lm(Y ~ X4 + X1, data=df)
resultX1_X4_aov <- fullRegressionAnova(anova(resultX1_X4))
```

##	VariationSource	DF	SS	MS	F_stats
## 1	Regression	2	110.04967	55.024833	33.92625
## 2	X4	1	67.77510	67.775098	41.78759
## 3	X1	1	42.27457	42.274568	26.06492
## 4	Residuals	78	126.50783	1.621895	NA
## 5	Total	80	236.55750	NA	NA

X2 given X4

```
resultX2_X4 <- lm(Y ~ X4 + X2, data=df)
resultX2_X4_aov <- fullRegressionAnova(anova(resultX2_X4))
```

##	VariationSource	DF	SS	MS	F_stats
## 1	Regression	2	77.066085	38.533043	18.84476
## 2	X4	1	67.775098	67.775098	33.14572
## 3	X2	1	9.290987	9.290987	4.54380
## 4	Residuals	78	159.491415	2.044762	NA
## 5	Total	80	236.557500	NA	NA

X2 given X1 and X4

```
resultX2_X1nX4 <- lm(Y ~ X1 + X4 + X2, data=df)
resultX2_X1nX4_aov <- fullRegressionAnova(anova(resultX2_X1nX4))
```

##	VariationSource	DF	SS	MS	F_stats
## 1	Regression	3	137.90716	45.969053	35.88043
## 2	X1	1	14.81852	14.818520	11.56637
## 3	X4	1	95.23115	95.231147	74.33120
## 4	X2	1	27.85749	27.857493	21.74374
## 5	Residuals	77	98.65034	1.281173	NA
## 6	Total	80	236.55750	NA	NA

X3 given X1, X2, and X4

```
resultX3_X1nX2nX4 <- lm(Y ~ X1 + X2 + X4 + X3, data=df)
resultX3_X1nX2nX4_aov <- fullRegressionAnova(anova(resultX3_X1nX2nX4))
```

##	VariationSource	DF	SS	MS	F_stats
## 1	Regression	4	138.3269061	34.5817265	26.7555260
## 2	X1	1	14.8185198	14.8185198	11.4649363
## 3	X2	1	72.8020109	72.8020109	56.3261669
## 4	X4	1	50.2866291	50.2866291	38.9062476
## 5	X3	1	0.4197463	0.4197463	0.3247534
## 6	Residuals	76	98.2305939	1.2925078	NA
## 7	Total	80	236.5575000	NA	NA

Part B. Test whether X3 can be dropped from the model give X1, X2, X3. Use F statistic and state p-value for leve $\alpha = 0.01$

To test if a singel β_k can be dropped from a multiple regression model, use the following formal test

$$H_0 : \beta_k = 0$$

$$H_a : \beta_k \neq 0$$

Use the test statistics

partial F test Note the partial F test is different in that it only tests whether one $\beta_k = 0$ not whether all $\beta_k = 0$ - if $F^* \leq F$ critical conclude H_0

Test if X3 should be removed from the model at an $\alpha = 0.01$

```
F_stat <- resultX3_X1nX2nX4_aov$F_stats[5]
F_crit <- qf(0.99, resultX3_X1nX2nX4_aov$DF[5], resultX3_X1nX2nX4_aov$DF[6])
p_val <- 1-pf(q=F_stat, df1=resultX3_X1nX2nX4_aov$DF[5], df2=resultX3_X1nX2nX4_aov$DF[6])
conclusion <- ifelse(F_stat <= F_crit, "Conclude Null Hypthosis", "Reject Null Hypthosis")
cat("F* =", F_stat, ", F crit (0.99,", resultX3_X1nX2nX4_aov$DF[5],
    ",", resultX3_X1nX2nX4_aov$DF[6], ") =", F_crit, "\n", conclusion,", Pvalue = ", p_val, sep=" ")

## F* = 0.3247534 , F crit (0.99, 1 , 76 ) = 6.980578
## Conclude Null Hypthosis , Pvalue = 0.5704457
```