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Q1

Exercise 64 on page 531.

Low dose gains:
$s_1 = 54\text{g}$, $m = 23$
Control gains:
$s_2 = 32\text{g}$, $n = 20$

Test statistic:
$f = \frac{s_1^2}{s_2^2} = \frac{54^2}{32^2} = 2.848$

Hypotheses:
$H_0 : \sigma_1^2 = \sigma_2^2$
$H_\text{a} : \sigma_1^2 > \sigma_2^2$ (low dose variability > control variability)

Rejection Region:
$f \geqslant F_{\alpha,m-1,n-1}$

$F_{\alpha,23-1,20-1} = 0.4799 < f$

The test statistic f is in the rejection region so the null hypothesis, which states that the variability of the control gains equals the variability of the low dose gains, can be rejected at the significance level $\alpha = 0.05$.

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Q2

Exercise 66 on page 532.

Epoxy
$s_1^2 = 0.02576$
$s_1 = 0.1605$
$m = 4$

MMA prepolymer
$s_2^2 = 0.005491$
$s_2 = 0.07411$
$n = 4$

For 90% confidence interval: $\alpha = 0.10$

Conidence Interval

$$\left(\frac{s_1}{s_2} \cdot \frac{1}{\sqrt{F_{\alpha/2,m-1,n-1}}}, \frac{s_1}{s_2} \cdot \sqrt{F_{\alpha/2,m-1,n-1}},\right)$$

$$\left(\frac{0.1605}{0.07411} \cdot \frac{1}{\sqrt{F_{0.05,3,3}}}, \frac{0.1605}{0.07411} \cdot \sqrt{F_{0.05,3,3}},\right)$$

$$(0.2335, 20.09)$$

Q3

Exercise 6 on page 564.

Source	df	Sum of squares	Mean square	f
Brand	$I-1$	SSTr	MSTr = SSTr$/(I-1)$	MSTr / MSE
Error	$I(J-1)$	SSE	MSE = SSE$/[I(J-1)]$	
Total	$IJ-1$	SST		

MSE = 14,713.69
SST = 310,500.76

Four brands are sparkplugs are tested $\implies I = 4$
Five of each brand are tested $\implies J = 5$

$$\text{MSE} = \frac{\text{SSE}}{I(J-1)} \implies \text{SSE} = \text{MSE}[I(J-1)] = 14,713.69 \cdot 4(5-1) = 235,419.04$$

$$\text{SST} = \text{SSTr} + \text{SSE} \implies \text{SSTr} = \text{SST} - \text{SSE} = 75,081.72$$

$$\text{MSTr} = \frac{\text{SSTr}}{I-1} = \frac{75,081.72}{4-1} = 25,027.24$$

$$f = \frac{MSTr}{MSE} = \frac{25,027.24}{14,713.69} = 1.7009$$

Source	df	Sum of squares	Mean square	f
Brand	3	75,081.72	25,027.24	1.7009
Error	16	235,419.04	14,713.69	
Total	19	310,500.76		

The null hypothesis is that all the spark plugs have the same mean performance, the alternative is that they are not all the same
$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$
H_a : at least two of the μ_i's are different
P value for a signficance level of $\alpha = 0.01$ is $F_{\alpha,I-1,I(J-1)=F_{0.01,3,16}} = 5.2922$

$f > F_{0.01,3,16}$ so reject the null hypotheiss at this signifigance level.

Q5

Exercise 18 on page 571.

a)

code:

```
m1 <- c(13, 17,  7, 14);     h1 <- rep("1", length(m1));
m2 <- c(21, 13, 20, 17);     h2 <- rep("2", length(m2));
m3 <- c(18, 15, 20, 17);     h3 <- rep("3", length(m3));
m4 <- c( 7, 11, 18, 10);     h4 <- rep("4", length(m4));
m5 <- c( 6, 11, 15,  8);     h5 <- rep("5", length(m5));

measure <- c(d1, d2, d3, d4, d5)
hormone <- c(h1, h2, h3, h4, h5)

vals <- data.frame(measure, hormone)

anova_result <- anova(lm(measure~ hormone, data=vals))
print(anova_result)
```

output:

```
Response: measure
          Df Sum Sq Mean Sq F value  Pr(>F)
hormone    4  200.3  50.075  3.4855 0.03336
Residuals 15  215.5  14.367
```

The F value is 3.4855 which which gives a P value of 0.03336, so the null hypothesis can be rejected.

b)

$\bar{x}_1 = 12.75$
$\bar{x}_2 = 17.75$
$\bar{x}_3 = 17.5$
$\bar{x}_4 = 11.5$
$\bar{x}_5 = 10$

$w = Q_{\alpha,I,I(J-1)} = Q_{0.05,5,5\cdot(4-1)}\sqrt{14.367/4} = 8.276$