14) $(M_1+M_2)/2 - M_3 \pm 2.064\left(\sqrt{0.64\left(\left(\frac{1}{9}+\frac{1}{12}\right)+\frac{1}{6}\right)}\right) \rightarrow (6.88+8.13)/2 - 9.2 \pm 2.064(0.481)$

$\rightarrow -1.695 \pm 0.992 \rightarrow \boxed{(-2.69, -0.703)}$

$\rightarrow$ There is a difference between group 3 and average of groups 1&2 because 0 is not included

15) Did not know how to do

16) Scheffe multiplier $= \sqrt{tF_{t,\nu_{RD}}} \rightarrow \sqrt{2\cdot(3.401)} = \boxed{2.609}$

$M_2 - M_1 \pm 2.609\sqrt{MSE\left(\frac{1}{9}+\frac{1}{12}\right)} \rightarrow 8.13 - 6.88 \pm 2.609\sqrt{0.64\left(\frac{1}{9}+\frac{1}{12}\right)}$

$\rightarrow 1.25 \pm 0.92 \rightarrow \boxed{(0.33, 2.18)}$

$M_3 - M_1 \pm 2.609\sqrt{MSE\left(\frac{1}{9}+\frac{1}{6}\right)} \rightarrow \boxed{(1.32, 3.52)}$

$M_2 - M_3 \pm 2.609\sqrt{MSE\left(\frac{1}{6}+\frac{1}{12}\right)} \rightarrow \boxed{(-2.11, -0.02)}$

17) $(M_1+M_2)/2 - M_3 \pm 2.609\sqrt{MSE\left(\frac{1}{9}+\frac{1}{12}+\frac{1}{6}\right)} \rightarrow \boxed{(-2.64, -0.74)}$

17) Yes, similar to 13, the multiplier would be smaller

11) $8.13 - 6.88 \pm 2.064\sqrt{\frac{1}{12}+\frac{1}{9}} = 1.25 \pm 2.064(0.44) =$

$\boxed{(0.345, 2.166)}$ → The true mean difference between μ_2 and μ_1 can be found (at a 95% level of confidence) between (0.345, 2.166), meaning because 0 is not included in the range, there is indeed a difference in group means

12) Using studentized range statistic q at df 24, k = 3 ⇒ 3.532

$3.532/\sqrt{2} = 2.498$

$\mu_2 - \mu_1 \pm 2.498\sqrt{MSE(\frac{1}{n_1}+\frac{1}{n_2})} \rightarrow 8.13 - 6.88 \pm 2.498(0.3528) \rightarrow 1.25 \pm 0.88$

↳ $\boxed{(0.37, 2.13)}$

$\mu_3 - \mu_1 \pm 2.498\sqrt{MSE(\frac{1}{n_3}+\frac{1}{n_1})} \rightarrow 9.2 - 6.88 \pm 2.498(0.422) \rightarrow 2.32 \pm 1.051$

↳ $\boxed{(1.27, 3.37)}$

$\mu_3 - \mu_2 \pm 2.498\sqrt{MSE(\frac{1}{n_2}+\frac{1}{n_3})} \rightarrow 9.2 - 8.13 \pm 2.498(0.4) \rightarrow 1.07 \pm 0.999$

↳ $\boxed{(0.07, 2.07)}$

Each are entirely different and increase

13) No, because n are all different, the value in the $\sqrt{MSE(\frac{1}{n_i}+\frac{1}{n_j})}$ would yield larger values and thus produce a larger multiplier. A Bonferroni may be more efficient and create smaller intervals.

6) $SSR = n\Sigma(\bar{x}_j - \bar{x})^2 = 9(6.88-8.07)^2 + 12(8.13-8.07)^2 + 6(9.2-8.07)^2$
$= 12.745 + 0.043 + 7.6614 \boxed{20.12}$

$SSE = \Sigma(x_{ij} - \bar{x}_j)^2 = (7.6-6.88)^2 + (8.2-6.88)^2 + \ldots + (6.0-6.88)^2$
$+ (6.7-8.13)^2 + (8.1-8.13)^2 + \ldots + (8.4-8.13)^2$
$+ (8.5-9.2)^2 + (9.7-9.2)^2 + \ldots + (9.5-9.2)^2$

$= \boxed{15.36}$

$df_j = 2$, $df_{resid} = 24$

$MST = 20.12/2 = \boxed{10.06}$
$MSE = 15.36/24 = \boxed{0.64}$
$F = 10.06/0.64 = \boxed{15.719}$
$\hookrightarrow \boxed{P = 0}$

	Df	SS	MS	F	P
j	2	20.12	10.06	15.72	0
Resid	24	15.36	0.64		

7) We see in the Anova table that the estimated P is $0 < \alpha = 0.05$, and therefore conclude that there is a difference in mean productivity according to the level of research and development expenditures

8) 0

9) Based on means at $j = 1, 2, 3$, we see an increase in M's as j increases, which can be assumed that higher research and development expenditures yields improved productivity

10) $9.2 \pm 1.96\left(\frac{0.7916}{\sqrt{6}}\right) = 9.2 \pm 0.633 \rightarrow \boxed{(8.567 - 9.833)}$

HW5 DUE 10/25/2022

1) $y_{jk} = \mu_{jk} + \epsilon_{jk}$, where μ_j is the mean for treatment j

$\hookrightarrow y_{jkl} = \mu + p_j + q_k + (pq)_{jk} + \epsilon_{jkl}$

2) $\mu_1 = \frac{7.6 + 8.2 + 6.8 \ldots + 6.0}{9} = \boxed{6.88}$

$\mu_2 = \frac{6.7 + 8.1 + 9.4 + \ldots + 8.4}{12} = \boxed{8.13}$ Overall $\mu = 8.07$

$\mu_3 = \frac{8.5 + 9.7 + 10.1 + \ldots + 9.5}{6} = \boxed{9.2}$

3) Residuals for $j=1 \rightarrow$ 0.72, 1.32, -0.08, -1.08, 0.02, -0.28, -0.58, 0.82, -0.88

$j=2 \rightarrow$ -1.41, -0.01, 1.29, 0.49, -0.31, -0.41, 0.79, -0.51, 0.19, 0.59, -1.01, 0.29

$j=3 \rightarrow$ -0.7, 0.5, 0.9, -1.4, 0.4, 0.3

It appears that the residuals are approximately homoscedastic

4) Yes, the normality assumption is reasonable

5) $Q^1_{3U} = 7.65$, $Q^1_{1U} = 6.15$ $\rightarrow$ $Q^1_{3E} = 7.55$, $Q^1_{1E} = 6.3$

$M^1_U = 6.84$ $M^1_E = 6.925$

$Q^2_{3U} = 8.6$, $Q^2_{1U} = 7.75$ $\rightarrow$ $Q^2_{3E} = 8.7$, $Q^2_{1E} = 7.1$

$M^2_U = 8.12$ $M^2_E = 8.14$

$Q^3_{3U} = 9.7$, $Q^3_{1U} = 7.8$ $\rightarrow$ $Q^3_{3E} = 10.1$, $Q^3_{1E} = 8.5$

$M^3_U = 9.03$ $M^3_E = 9.37$

$\hookrightarrow$ It does not appear that the anova model would benefit, at least not significantly, by adding location of home office, as the IQR indicates not enough consistent differences between US and Europe boxplots