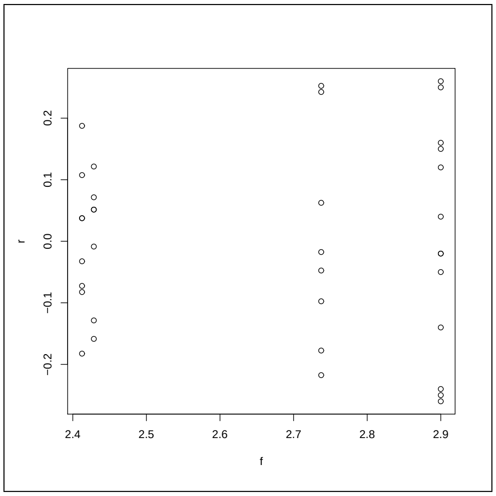
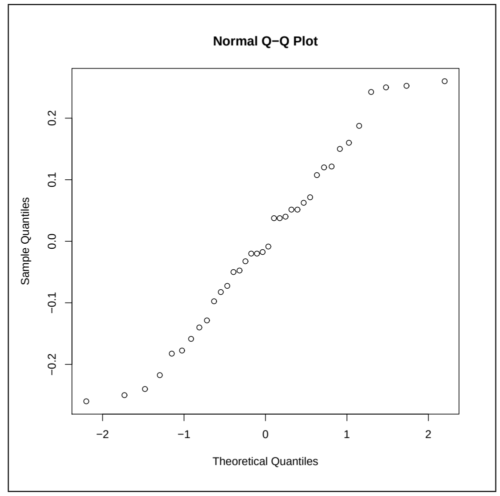
1. (a) The ANOVA model is

$$Y_{ijk} = \mu. + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

where $i = 0, 1$, $j = 0, 1$, and $k = 1, \ldots, n_{ij}$ with $n_{00} = 8$, $n_{01} = 7$, $n_{10} = 8$, and $n_{11} = 13$.

(b) Overall, the assumptions of constant variance and normality seem reasonable. The residual plot shows no major departure in vertical spread across the fitted values, and the QQ plot is fairly straight, with only a few points falling outside the trend.





(c) Without interaction, the reduced model is

$$Y_{ijk} = \mu. + \alpha_i + \beta_j + \varepsilon_{ijk}$$

and has $SSE = 0.83063$ with 33 degrees of freedom for error, compared with the full model of 0.78499 and 32, respectively. The test statistic for interaction is thus

$$\frac{.83063 - .78499}{33 - 32} \Big/ \frac{.78499}{32} = 1.86$$

which does *not* exceed $4.15 =$ `qf(.95,1,32)`. So, we cannot reject the assumption of no interaction.

(d) Without a significant interaction effect, we may drop the term $(\alpha\beta)_{ij}$ from the model and use the model in (c) as the full model. The reduced model for testing Factor A is then

$$Y_{ijk} = \mu. + \beta_j + \varepsilon_{ijk}$$

Using the same approach as above, the test statistic is

$$\frac{2.21870 - .83063}{34 - 33} \Big/ \frac{.83063}{33} = 55.15$$

which exceeds the critical value $4.14 =$ `qf(.95,1,33)`, so we have evidence for an effect due to discount price.

(e) Similar to above, the reduced model is

$$Y_{ijk} = \mu. + \alpha_i + \varepsilon_{ijk}$$

with test statistic

$$\frac{0.91672 - .83063}{34 - 33} \Big/ \frac{.83063}{33} = 3.42$$

which does not exceed the critical value $4.13 =$ `qf(.95,1,34)`, so we can't claim an effect due to package promotion.

2. (a) Since the retirement plans are the only ones of interest, they would be fixed.

   (b) Since the locations are randomly selected from a population of possible locations, they would be random.

3. (a) Letting Y_{ij} be the jth measured coil from the ith machine, then

$$Y_{ij} = \mu_i + \epsilon_{ij}$$

   where $\mu_i \sim N(\mu_{\cdot}, \sigma_\mu^2)$, and (independently) $\epsilon_{ij} \sim N(0, \sigma^2)$.

   (b) $H_0 : \sigma_\mu^2 = 0$ versus $H_a : \sigma_\mu^2 > 0$. The test statistic is $28.09 > 2.87$, so this is significant evidence for an effect due to machines.

   (c) With $\overline{y}_{\cdot\cdot} = 205.05$, $s\{\overline{Y}_{\cdot\cdot}\} = \sqrt{200.83/4(10)} = 2.24$, and $t_3(.05) = 2.35$, the 90% confidence interval for $\mu_{\cdot}$ is

$$205.05 \pm 2.35(2.35) = (199.79, 210.31)$$

   (d) From $MSE = 7.15$ and $MSTR = 200.83$, we have

$$\hat{\sigma}_\mu^2 = \frac{200.83 - 7.15}{10} = 19.37$$

   (e) With critical values $f_{3,36}(.05) = .116$ and $f_{3,36}(.95) = 2.87$, we first construct the interval (L, U) for σ_μ^2/σ^2:

$$L = \frac{1}{10}\left[\frac{200.83}{7.15}\left(\frac{1}{2.87}\right) - 1\right] = .879$$

   and

$$U = \frac{1}{10}\left[\frac{200.83}{7.15}\left(\frac{1}{.116}\right) - 1\right] = 24.11$$

   It follows that the intraclass correlation (ICC) $\sigma_\mu^2/(\sigma_\mu^2 + \sigma^2)$ falls within

$$\left(\frac{L}{L+1}, \frac{U}{U+1}\right) = (.47, .96)$$

   (f) The 90% confidence interval above represents all values for the ICC that would not be rejected in a (2-sided) test at level $\alpha = .1$. Since $H_0 : \sigma_\mu^2 = \sigma^2$ corresponds to an ICC of .5, we cannot reject that claim.