MAS6003(2)/MAS474 Extended Linear Models

Exercises 2

1. Below is an exam question from 2011. The R package command has changed a little since then, but you should be able to get the gist. For example, the command

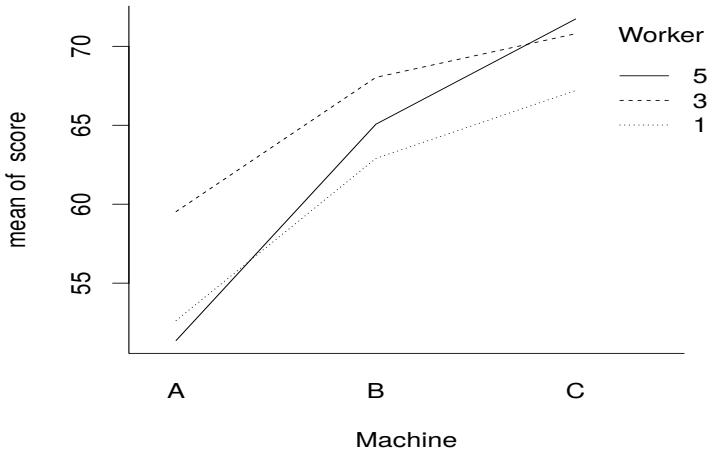
```
lme(score~Machine, random = ~1 |Worker)
```

is the same as

```
lmer(score ~ Machine +(1 |Worker))
```

1 Figure 1 shows mean productivity scores for each of three randomly chosen workers tested on each of three types of machine. Each worker used each machine three times giving three sets of replicates at each set of conditions.

Figure 1



Below is annotated output from an `R` session in which linear mixed effects models were investigated.

```
mach1.lme=lme(score~Machine, random = ~1 |Worker)
mach2.lme=lme(score~Machine, random = ~1 |Worker/Machine)

anova(mach1.lme,mach2.lme)
    Model    df      logLik     Test     L.Ratio   p-value
mach1.lme     5  -55.44817
mach2.lme     6  -44.83272   1 vs 2    21.23089    <.0001

mach3.lme=lme(score~Machine,random=pdCompSymm(~Worker))
```

(i) Write down the algebraic specification of the model `mach2.lme` stating clearly all assumptions and defining any terms that you use. ***(7 marks)***

(ii) Justify the choice of random and fixed effects in model `mach2.lme` ***(3 marks)***

(iii) Describe how you would check the normality assumptions within the `mach2.lme` model. State the value that the `levels` option would take in `R` for each set of residuals you'd check. ***(3 marks)***

(iv) Describe what is being tested by the `anova(mach1.lme,mach2.lme)` command in the `R` output above specifying the null hypothesis and state what the conclusion of the test is. ***(3 marks)***

(v) For the `mach3.lme` model state the algebraic form for the covariance matrix of the worker random effects that is being specified. How does it differ to that fitted in the `mach2.lme` model? ***(4 marks)***

2. Label the following missing data mechanisms as either MCAR, MAR or NMAR. Which ones are ignorable?

   (i) $\mathbb{P}(M_{i2} = 1|y, \psi) = \begin{cases} \psi & \text{if } y_{i1} > 2 \\ 0 & \text{otherwise} \end{cases}$

   (ii) $\mathbb{P}(M_{ij} = 1|Y, \psi) = \psi$

   (iii) $\mathbb{P}(M_{i2} = 1|y, \psi) = \psi y_{i2} + (1 - \psi)y_{i1}$

3. Describe how you could test whether a missing data mechanism was MCAR or MAR. Explain why it is impossible to test whether a missing data mechanism is MAR or NMAR.