Practice 11

You need `R` packages `gee` and `MASS` for doing this practice. The question focuses on analysing the `OME` data stored in `MASS`. Type `help(OME)` and `help(gee)` to get details of the data and GEE solver.

The following are the description and background of data `OME`.

Tests of Auditory Perception in Children with OME

Description Experiments were performed on children on their ability to differentiate a signal in broad-band noise. The noise was played from a pair of speakers and a signal was added to just one channel; the subject had to turn his/her head to the channel with the added signal. The signal was either coherent (the amplitude of the noise was increased for a period) or incoherent (independent noise was added for the same period to form the same increase in power). The threshold used in the original analysis was the stimulus loudness needs to get 75% correct responses. Some of the children had suffered from otitis media with effusion (OME).

Format The `OME` data frame has 1129 rows and 7 columns:

- `ID`: Subject ID (1 to 99, with some IDs missing). A few subjects were measured at different ages.
- `OME`: "`low`" or "`high`" or "`N/A`" (at ages other than 30 and 60 months).
- `Age`: Age of the subject (months).
- `Loud`: Loudness of stimulus, in decibels.
- `Noise`: Whether the signal in the stimulus was "`coherent`" or "`incoherent`".
- `Correct`: Number of correct responses from `Trials` trials.
- `Trials`: Number of trials performed.

Background The experiment was to study otitis media with effusion (OME), a very common childhood condition where the middle ear space, which is normally air-filled, becomes congested by a fluid. There is a concomitant fluctuating, conductive hearing loss which can result in various language, cognitive and social deficits. The term 'binaural hearing' is used to describe the listening conditions in which the brain is processing information from both ears at the same time. The brain computes differences in the intensity and/or timing of signals arriving at each ear which contributes to sound localisation and also to our ability to hear in background noise.

Some years ago, it was found that children of 7–8 years with a history of significant OME had significantly worse binaural hearing than children without such a history, despite having equivalent sensitivity. The question remained as to whether it was the timing, the duration, or the degree of severity of the otitis media episodes during critical periods, which

affected later binaural hearing. In an attempt to begin to answer this question, 95 children were monitored for the presence of effusion every month since birth. On the basis of OME experience in their first two years, the test population was split into one group of high OME prevalence and one of low prevalence.

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The following commands are used to get the analysis results.

```
head(OME)
fm <- gee(cbind(Correct, Trials - Correct) ~ Loud + Age + OME + Noise, id = ID,
          data = OME, family = binomial, corstr = "exchangeable")
sfm <- summary(fm)
attributes(fm); attributes(sfm)
```

1. How many children were included in the data?

2. How many tests did the child with `ID=1` attend to in the data? Namely, what is the cluster size associated with child 1?

3. Let y_{it} and n_{it} be the number of correct responses and the number of trials, respectively, for the child with `ID=i` at test t. Define $y^*_{it} = y_{it}/n_{it}$. Write down the marginal model fitted by the GEE approach in this analysis. The model should include the following components: marginal means of y^*_{it}, marginal variances of y^*_{it}, and correlation between y^*_{ij} and y^*_{ik}.

4. Give the commands for finding the estimates and their robust variance matrix for the regression parameters in the marginal model.

5. Use the R output to estimate the mean and variance of y_{11}, and the covariance between y_{11} and y_{12}.