Livestock Breeding and Genomics - Exercise 10

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Problem 1: Marker Effect Model

We are given the dataset that is shown in the table below. This dataset contains gentyping results of 10 for 2 SNP loci.

Animal	SNP A	SNP B	Observation
1	0	0	156
2	1	0	168
3	0	1	161
4	1	0	164
5	-1	0	128
6	-1	1	124
7	0	-1	143
8	1	1	178
9	1	0	163
10	0	0	151

The above data can be read from:

```
## https://charlotte-ngs.github.io/lbgfs2022/data/geno_data.csv
```

Your Task

- The goal of this problem is to estimate SNP marker effects using a `marker effect model`. Because we have just 2 SNP loci, you can use a fixed effects linear model with the 2 loci as fixed effects. Furthermore you can also include a fixed intercept into the model.
- Specify all the model components including the vector of observations, the design matrix X, the vector of unknowns and the vector of residuals.
- You can use the R-function `lm()` to get the solutions for estimates of the unknown SNP effects.

Problem 2: Breeding Value Model

Use the same data as in Problem 1 to estimate genomic breeding values using a `breeding value model`.

Hints

- The only fixed effect in this model is the mean μ which is the same for all observations.
- You can use the following matrix as the genomic relationship matrix

$$
G = \begin{bmatrix}
0.093 & -0.125 & -0.125 & -0.125 & 0.292 & 0.083 & 0.292 & -0.333 & -0.125 & 0.083 \\
-0.125 & 0.718 & -0.333 & 0.708 & -0.958 & -1.167 & 0.083 & 0.5 & 0.708 & -0.125 \\
-0.125 & -0.333 & 0.718 & -0.333 & 0.083 & 0.917 & -0.958 & 0.5 & -0.333 & -0.125 \\
-0.125 & 0.708 & -0.333 & 0.718 & -0.958 & -1.167 & 0.083 & 0.5 & 0.708 & -0.125 \\
0.292 & -0.958 & 0.083 & -0.958 & 1.552 & 1.333 & 0.5 & -1.167 & -0.958 & 0.292 \\
0.083 & -1.167 & 0.917 & -1.167 & 1.333 & 2.177 & -0.75 & -0.333 & -1.167 & 0.083 \\
0.292 & 0.083 & -0.958 & 0.083 & 0.5 & -0.75 & 1.552 & -1.167 & 0.083 & 0.292 \\
-0.333 & 0.5 & 0.5 & 0.5 & -1.167 & -0.333 & -1.167 & 1.343 & 0.5 & -0.333 \\
-0.125 & 0.708 & -0.333 & 0.708 & -0.958 & -1.167 & 0.083 & 0.5 & 0.718 & -0.125 \\
0.083 & -0.125 & -0.125 & -0.125 & 0.292 & 0.083 & 0.292 & -0.333 & -0.125 & 0.093
\end{bmatrix}
$$

Your Tasks

- Specify all model components of the linear mixed model, including the expected values and the variance-covariance matrix of the random effects.