Multivariate statistics: Assignment 1

Team B: **Kendall Brown** *r0773111* **Raïsa Carmen** *s0204278*
Stefan Velev *r0924289* **Adhithya Unni Narayanan** *r0776057*

1 Data trichotomization

To trichotomize the data, suitable cut-off points need to be found. The cutoff points are often chosen based on either expert knowledge or so as to optimize predictive power. An easy, often used method for dichotomization is a median-split since it assures that there are an equal amount of observation at either side of the cut-off value. Similarly, for trichotomization, we could aim for approximately 33.33% of the observations in each of the three categories. That would result in the following three categories: [-12,4], (4,11], (11,70].

It is quite common in literature to dichotomize hearing loss into normal hearing (≤25 dB) and hearing loss (>25 dB) (see Garinis et al. 2017; Gallagher et al. 2019; Ju et al. 2022, for example). However, thichotomization is less common and it should be noted that it is generally not advised to discretize continuous data since some information is inevitably lost (Nelson et al. 2017; MacCallum et al. 2002).

The Centers for Disease Control and Prevention distinguishes the following levels of hearing loss, based on Clark (1981):

- ≤25 dB: Normal hearing
- 26 - 40 dB: Mild hearing loss
- 41 - 55 dB: Moderate hearing loss
- 56 - 70 dB: Moderate / severe hearing loss
- 71 - 90 dB: Severe hearing loss
- ≥91 dB: Profound hearing loss

Table 1: Number of observations in each pre-defined categories from Clark (1981).

Category	Nb observations	Percentage	Cumulative percentage	Nb subjects	Avg age
(-13,25]	4148	93.87	93.87	536	56.12
(25,40]	239	5.41	99.28	91	71.85
(40,55]	22	0.50	99.77	14	75.70
(56,70]	10	0.23	100.00	1	70.18

Table 1 shows that, in this dataset, there is no one in the severe hearing loss categories and the large majority has normal hearing (93.87%). The median for all observation with normal hearing (≤25dB) is 6 dB. We therefor suggest to trichotomize the data into the following categories:

- ≤6 dB: Excellent hearing

- 7 - 25 dB: Normal hearing
- ≥25 dB: Hearing loss

Table 2: Number of observations in each category.

Category	Nb observations	Percentage	Cumulative percentage	Nb subjects	Avg age
Excellent	2192	49.60	49.60	400	50.10
Normal	1956	44.26	93.87	414	62.88
Hearing loss	271	6.13	100.00	93	72.10

2 Methodology

All analysis was done in R. All scripts are freely available at this git repository.

3 Results

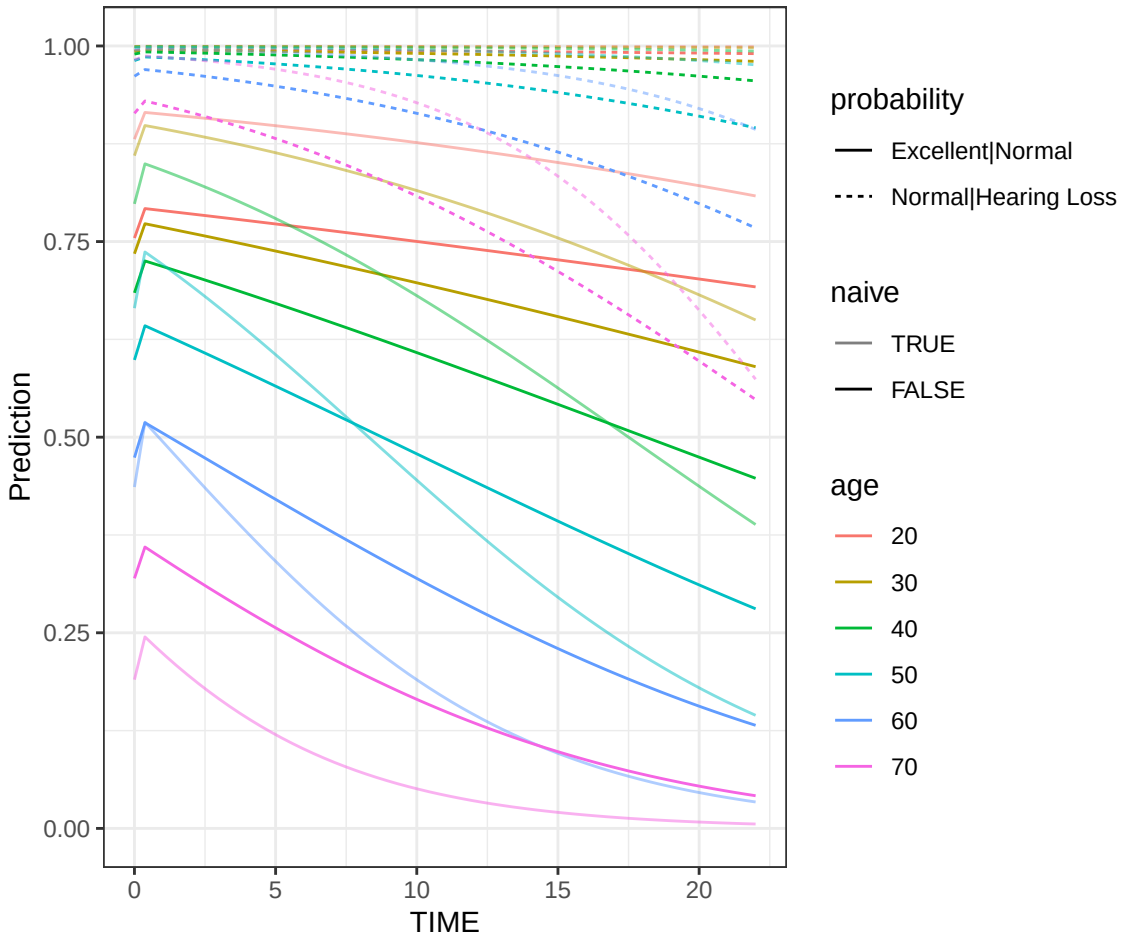
3.1 Marginal model

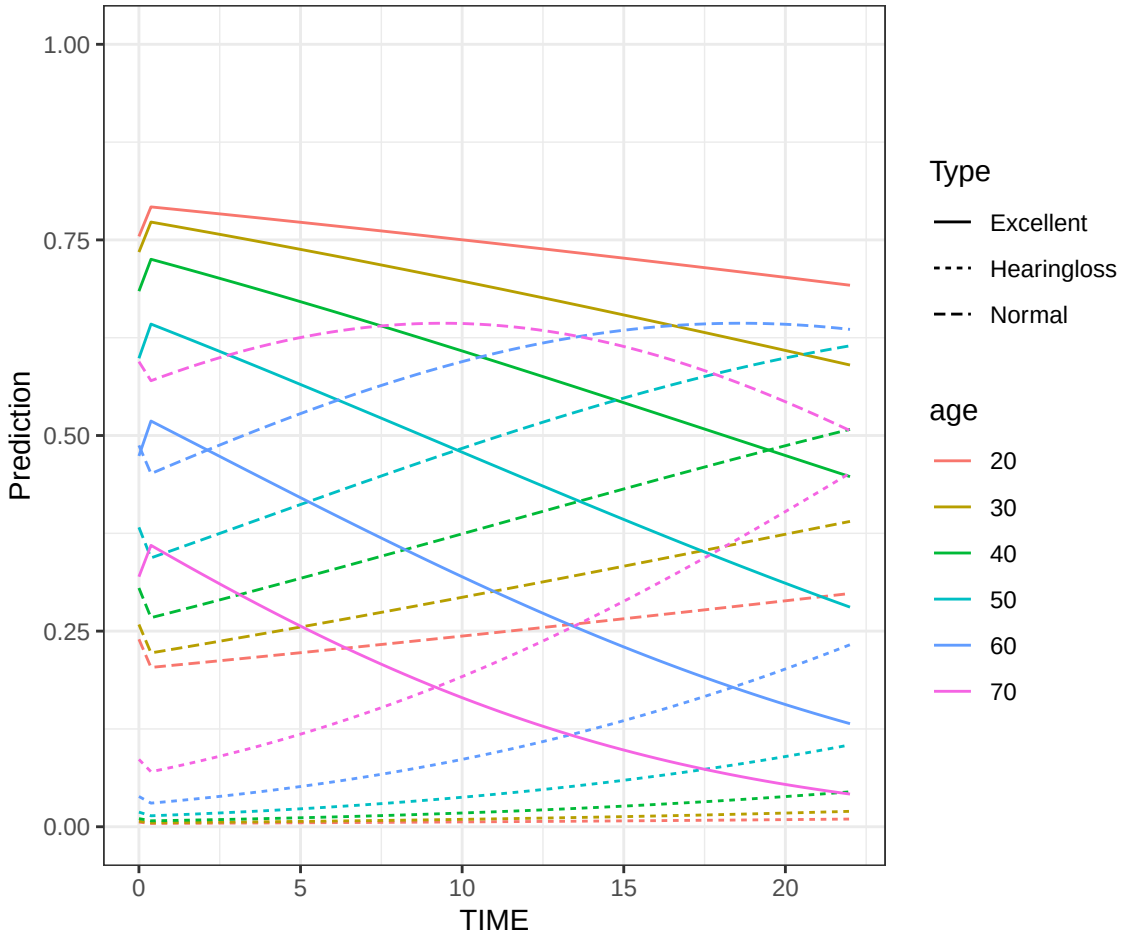
First, we fit a marginal model with the *ordLORgee* from the **multgee**. This function allows for an ordinal dependent variable which is appropriate for our data.

3.2 Random-effects model

The random effects model only includes a random intercept since it did not converge with random slopes included.

The random intercept has a variance (standard deviation) of 5.68 (2.38).


1.00
0.75
0.50
0.25
0.00
Prediction
0
5
10
15
20
TIME
probability
Excellent|Normal
Normal|Hearing Loss
naive
TRUE
FALSE
age
20
30
40
50
60
70


1.00
0.75
0.50
0.25
0.00
Prediction
0
5
10
15
20
TIME
Type
Excellent
Hearingloss
Normal
age
20
30
40
50
60
70

3.2.1 Empirical Bayes prediction

Q3

3.3 Transition model

Q4

4 Discussion

Bibliography

Clark, JG. 1981. "Uses and Abuses of Hearing Loss Classification." *ASHA* 23 (7): 493–500.

Gallagher, Nicola E., Chris C. Patterson, Charlotte E. Neville, John Yarnell, Yoav Ben-Shlomo, Anne Fehily, John E. Gallacher, Natalie Lyner, and Jayne V. Woodside. 2019. "Dietary Patterns and Hearing Loss in Older Men Enrolled in the Caerphilly Study." *British Journal of Nutrition* 121 (8): 877–86. https://doi.org/10.1017/S0007114519000175.

Garinis, Angela C, Campbell P Cross, Priya Srikanth, Kelly Carroll, M Patrick Feeney, Douglas H Keefe, Lisa L Hunter, et al. 2017. "The Cumulative Effects of Intravenous Antibiotic Treatments on Hearing in Patients with Cystic Fibrosis." *Journal of Cystic Fibrosis* 16 (3): 401–9.

Ju, Min Jae, Sung Kyun Park, Sun-Young Kim, and Yoon-Hyeong Choi. 2022. "Long-Term Exposure to Ambient Air Pollutants and Hearing Loss in Korean Adults." *Science of The Total Environment* 820: 153124.

MacCallum, Robert C, Shaobo Zhang, Kristopher J Preacher, and Derek D Rucker. 2002. "On the Practice of Dichotomization of Quantitative Variables." *Psychological Methods* 7 (1): 19.

Nelson, S. L. Prince, V. Ramakrishnan, P. J. Nietert, D. L. Kamen, P. S. Ramos, and B. J. Wolf. 2017. "An Evaluation of Common Methods for Dichotomization of Continuous Variables to Discriminate Disease Status." *Communications in Statistics - Theory and Methods* 46 (21): 10823–34. https://doi.org/10.1080/03610926.2016.1248783.