Practicum - Consultation: 23.05.2024, 09-11

Please send your Group solutions to corneliafranziska.richter@vetpharm.uzh.ch on time.

What	File name	When
Group solutions	"06worksheet-Group-Name.zip"	27.05.2024 at 7 am.

Please upload all files to OLAT on time.

What	File name	When
Individual project	"06worksheet-Your-Name.zip"	27.05.2024 at 7 am.
Group contribution	"07contribution-Group-Name.zip"	28.05.2024 at 22 pm.

Individual tasks
Your 06worksheet-Your-Name.zip file contains reproducible code necessary to generate your results and your report together with the resulting pdf-file.

Exercise 1 (Individual project (Part 6))

The individual project of worksheets 1–5 investigated the Bayesian analysis provided by Baeten et al. (2013). You have learned different methods that are relevant for Bayesian study design, prior elicitation, and Bayesian data analysis.
Please put together all pieces (text and R code) from all individual exercises. It is recommended to follow a time line for an evolving project as if you were a statistician coaching the whole study. Assume that the project must pass several stages:

1. study design and sample size computation
2. priori elicitation for placebo and treatment groups
3. data collection
4. data analysis
5. interpretation of the results

Explain your approach to a client.

Remark: You can also use the diagram to structure introduction, methods, results, and discussion sections in your report.

Exercise 2 (Individual task: reflection)

Reflect upon the whole course and provide your answers in a separate file.

1. What have you learnt in this course? For example, review your answers in the survey you completed at the beginning of the course. What has changed?
2. Which tools for organizing group collaboration can you recommend to future students?
3. How much time did it take you to complete all the tasks?
4. What should be improved in this course and how?
5. What are the positive sides of this course? What did you like most?

Group tasks
Your 06worksheet-Group-Name.zip (one per group) file contains reproducible code necessary to generate your results and your report together with the resulting pdf-file, which can contain scans of your handwritten solutions. List the names of students who contributed to the solution of group tasks.

Exercise 3 (Bayesian meta-analysis with `bayesmeta`)

Use the description of the package `bayesmeta` provided by Röver (2020) to compute a Bayesian meta-analysis of $\log(OR)$ of treatment and placebo based on 8 historical studies to replicate the analysis shown in the script.
Total number of observations n_i in each study subject to placebo $i = 1, \ldots, 8$:
`pl_total←(107,44,51,39,139,20,78,35)`
Number of cases x_i in each study subject to placebo $i = 1, \ldots, 8$:
`pl_case←c(23,12,19,9,39,6,9,10)`
Total number of observations n_i in each study subject to a treatment $i = 1, \ldots, 8$:
`tr_total←(208,38,150,45,138,20,201,34)`
Number of cases x_i in each study subject to a treatment $i = 1, \ldots, 8$:
`tr_case←c(120,18,107,26,82,16,126,23)`
Note that these data extend the data used for the prior elicitation in the placebo group in the individual project Exercise 1 in Worksheet 5 by the treatment group (Adalimumab in studies 1 and 2, Etanercept in studies 3–6, Infliximab in studies 7 and 8). Explore and use plot functions provided by `bayesmeta` and report results obtained.

Exercise 4 (Bayesian meta-analysis with JAGS)

Run `R` code provided in the file `06worksheet_JAGSextension.R`. This model provides an alternative analysis of data considered in the Exercise 3 above. Discuss similarities and differences of the model provided in this R code and models that were used for Bayesian meta-analyses in the Exercise 3 above and in the individual project (Exercise 1 of Worksheet 5).

Exercise 5 (Moments of the Poisson-gamma distribution)

Let $Y \mid \lambda \sim \text{Po}(\lambda)$ with $\lambda \sim \text{G}(\alpha, \beta)$. Use the expressions for iterated expectation

$$\mathbb{E}(Y) = \mathbb{E}_\lambda[\mathbb{E}_Y(Y \mid \lambda)]$$

and variance (Held and Sabanés Bové, 2020, Section A.3.4)

$$\text{Var}(Y) = \text{Var}_\lambda[\mathbb{E}_Y(Y \mid \lambda)] + \mathbb{E}_\lambda[\text{Var}_Y(Y \mid \lambda)]$$

to derive both the expectation and the variance of the random variable Y.

Hints:
Poisson distribution $X \sim \text{Po}(\lambda)$: $\text{E}(X) = \lambda, \text{Var}(X) = \lambda$
Gamma distribution $X \sim \text{G}(\alpha, \beta)$: $\text{E}(X) = \alpha/\beta, \text{Var}(X) = \alpha/\beta^2$

Exercise 6 (Empirical Bayes)

Consider observed numbers of lip cancer cases per district for each of 56 districts in Scotland:

```
y ← c(11, 5, 15, 9, 6, 9, 2, 3, 26, 39, 20, 31, 9, 16, 6, 16, 19, 17, 15, 11, 19,
7, 10, 0, 7, 7, 9, 2, 8, 8, 11, 6, 28, 4, 1, 1, 1, 8, 6, 3, 2, 1, 7, 10, 9, 11, 3,
11, 5, 8, 3, 7, 0, 8, 7, 13)
```

Assume that these observations are *i.i.d.* realisations of the model $Y \mid \lambda \sim \text{Po}(\lambda)$ with $\lambda \sim \text{G}(\alpha, \beta)$, where the district-specific parameter is denoted by λ_i, for $i = 1, \ldots, 56$. Apply and compare two different approaches to compute empirical Bayes estimates for each district $i = 1, \ldots, 56$:

(a) Numerical maximisation of the log-likelihood corresponding to the Poisson-gamma distribution as described by (Held and Sabanés Bové, 2020, p. 210–211 and Fig. 6.13) to obtain the marginal maximum likelihood estimator. Assume that $e_i = 1$, for $i = 1, \ldots, 56$.

(b) Matching of moments based on the Exercise 5 above, which provides the marginal moment estimator.

Compare means and the lengths of equi-tailed 95%CrI obtained by both approaches. Report your results.

Group contributions to the "Big picture"

Exercise 7 (Group contributions for the lecture on 30.05.2024)

Please prepare a group contribution, which your group will present (ca. 5 min) during the next lecture.

(7.1) Prior elicitation (O'Hagan, 2019; Hemming, Burgman, Hanea, McBride, and Wintle, 2018)

(7.2) History of the MATCH Uncertainty Elicitation Tool (`http://optics.eee.nottingham.ac.uk/match/uncertainty.php`) and the `SHELF` package in `R` (Morris, Oakley, and Crowe, 2014)

(7.3) Use the Roulette option of the online MATCH Uncertainty Elicitation Tool (`http://optics.eee.nottingham.ac.uk/match/uncertainty.php`) to elicit a normal prior for the height of adult Swiss females. Report the mean and the standard deviation of the elicited normal prior.

(7.4) Use the `SHELF` package in `R` to elicit a normal prior for the height of adult Swiss females. Report the mean and the standard deviation of the elicited normal prior.

Make sure that the file 07ontribution-Group-Name.zip (one per group) contains the file and the `R` code you want to present.

References

Baeten, D., X. Baraliakos, J. Braun, J. Sieper, P. Emery, D. van der Heijde, I. McInnes, J. van Laar, R. Landewé, P. Wordsworth, J. Wollenhaupt, H. Kellner, J. Paramarta, J. Wei, A. Brachat, S. Bek, D. Laurent, Y. Li, Y. Wang, A. Bertolino, S. Gsteiger, A. Wright, and W. Hueber (2013). Anti-interleukin-17A monoclonal antibody secukinumab in treatment of ankylosing spondylitis: a randomised, double-blind, placebo-controlled trial. *The Lancet 382*, 1705–1713.

Held, L. and D. Sabanés Bové (2020). *Likelihood and Bayesian Inference: With Applications in Biology and Medicine.* Springer (`https://link.springer.com/book/10.1007/978-3-662-60792-3`, `https://github.com/lheld/HSB`).

Hemming, V., M. Burgman, A. Hanea, M. McBride, and B. Wintle (2018). A practical guide to structured expert elicitation using the IDEA protocol. *Methods in Ecology and Evolution 9*(1), 169–180.

Morris, D., J. Oakley, and J. Crowe (2014). A web-based tool for eliciting probability distributions from experts. *Environmental Modelling & Software 52*, 1e–4.

O'Hagan, A. (2019). Expert knowledge elicitation: Subjective but scientific. *The American Statistician 73*(S1), 69–81.

Röver, C. (2020). Bayesian random-effects meta-analysis using the bayesmeta R package. *Journal of Statistical Software 93*(6), 1–51.