Topics for Primary seminar, 2021-22

1. Welch two-sample t-test and beyond
Explaining the standard (exact as well as asymptotic) two-sample t-test – the model, the null and the alternative hypothesis, construction of the test statistic.
Introducing the Welch version of the t-test
A detailed explanation of the choice of the degrees of freedom.
Illustrating on the real data set, implementation in R software.
Generalization to more than two samples.

Literature:
Anděl J.: Statistické metody, Matfyzpress, Praha, 1998.
Poznámky k přednášce NMSA331,
http://msekce.karlin.mff.cuni.cz/~omelka/Soubory/nmsa331/ms1.pdf
Kurková M (2006). Dvouvýběrový t-test v případě nestejných rozptylů. Bachelor thesis. Faculty of mathematics and physics. Charles University.
Miller Jr, R. G. (1997). Beyond ANOVA: basics of applied statistics. Chapman and Hall/CRC. Chapter 2.3
Satterthwaite F. E.: An Approximate Distribution of Estimates of Variance Components, Biometrics Bulletin 2 (1946), 110–114.
Welch B. L.: The Significance of the Difference Between Two Means when the Population Variances are Unequal, Biometrika 29 (1938), 350– 362.

2. Two sample Wilcoxon test and beyond
Explaining the standard two sample Wilcoxon test – the model, the null and the alternative hypothesis, construction of the test statistic.
Mann-Whitney rank test
Generalizing Mann-Whitney rank test to more general hypothesis
Illustrating what happens if under the alternative hypothesis the distribution does not change only in location.
Dealing with ties

Literature:
Chung, E., & Romano, J. P. (2016). Asymptotically valid and exact permutation tests based on two-sample U-statistics. Journal of Statistical Planning and Inference, 168, 97-105.
Šlampiak, T. (2016). Wilcoxonův dvouvýběrový test. Bachelor thesis. Faculty of mathematics and physics. Charles University.

3. Q-Q plots
Normal Q-Q plot – construction, implementation in R, examples of normal distributions as well distributions that are not normal. Comparison with histogram. Use in linear regression.
General Q-Q plots
Q-Q plots to compare two samples

Literature:
Zvára: Regrese, kapitola 8.7, MATFYZPRESS, 2008 (in Czech),

Wilk, M.B., Gnanadesikan, R. (1968), "Probability plotting methods for the analysis of data", Biometrika, 55 (1): 1–17

4. Permutation tests
Two sample permutation tests (comparision with t-test and Wilcoxon test)
K-sample permutation tests (comparision with ANOVA and Kruskall-Wallis test)
Test of independence

Literature:
Course notes for NMST434, Chapter 8.6, Available at
http://msekce.karlin.mff.cuni.cz/~omelka/Soubory/nmst434/nmst434_course-notes.pdf
Davison, A. C. and Hinkley, D. V. (1997). Bootstrap Methods and their Application. Cambridge University Press, New York. Chapter 4.3.
Efron, B. and Tibshirani, R. J. (1993). An Introduction to the Bootstrap. Chapman & Hall. Chapter 15.

5. Confidence interval, predictive interval and tolerance limits
Introducing and expaling various confidence intervals in the context of a normal distribution
Literature:
Krishnamoorthy, K., Mathew, T.: Statistical tolerance regions. John Wiley, New Jersey, 2009. Chapters 2.2 and 2.3
Otava, M. (2017). Stručný průvodce statistickými intervaly. *Pokroky matematiky, fyziky a astronomie*, *62*(1), 7-16. https://dml.cz/handle/10338.dmlcz/146719

6. Fisher's exact test and Barnard's test
Explanation of the test, calculation of the p-values (possible different approaches)
Implementation in R software (explaining the R-output).
Comparison with the chi-square test of independence
Illustration on interesting examples

Literature:
Agresti, A.: Categorical data analysis, Second Edition, Wiley, 2002, Chapter 3.5
Anděl, J.: *Statistické metody.* Matfyzpress, Praha, 1998.
Anděl, J.: *Základy matematické statistiky.* Matfyzpress, Praha, 2002.
Kulich, M.: *NMSA 331, Poznámky k přednášce*,
http://msekce.karlin.mff.cuni.cz/~omelka/Soubory/nmsa331/ms1.pdf

7. McNemar test, Stuart test, test of symmetry
Explanation of the test, calculation of the p-values
Implementation in R software.
Illustration on interesting examples
Explaining the relationships between the tests
Literature:
Agresti, A.: Categorical data analysis, Second Edition, Wiley, 2002, Chapter 10.1, 10.3
Anděl, J.: *Statistické metody.* Matfyzpress, Praha, 1998.
Anděl, J.: *Základy matematické statistiky.* Matfyzpress, Praha, 2002.
Prášková, Z.: *Kontingenční tabulky.* Univerzita Karlova. Skripta MFF UK, 1985.

Míchal, P.: *Testy pro párová kategoriální data*, MFF UK, bakalářská práce, 2017.

8. Some tests for random blocks
Friedman test, Anderson-Kannemann test
Explanation of the test, calculation of the p-values
Implementation in R software.
Illustration on interesting examples
Comparison of the tests

Literature:
Anděl, J.: *Statistické metody.* Matfyzpress, Praha, 1998.
Anděl, J.: *Základy matematické statistiky.* Matfyzpress, Praha, 2002.
Anderson, R. L. (1959). Use of contingency tables in the analysis of consumer preference studies. *Biometrics*, 15(4), 582-590.
Friedman, M. (1937). The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association*, 32 (200): 675–701.
Friedman, M. (1939). A correction: The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association*. 34 (205): 109.
Kloke, J., and McKean, J. W. (2014). *Nonparametric statistical methods using R*. CRC Press. Chapter 8.2

9. Copulas - introduction.
Sklar's Theorem and its use
Basic properties
Association based on copulas - Spearman's correlation coefficient, Kendall correlation coefficient

Literature: Nelsen, R. B.: An Introduction to Copulas, Second Edition, Springer, 2007, Chapters 2 and 5;
Embrechts, P., Frey, R., & McNeil, A. (2005). Quantitative risk management. Princeton Series in Finance, Princeton, 10. Chapter 5.2

10. Quantile regression
Characterization of quantiles
Regression quantiles with special attention to median regression (LAD)
Using quantiles to illustrate heteroscedastisticity
Comparison with the least squares method

Literature:
Course notes for NMST434, Chapter 5, Available at http://msekce.karlin.mff.cuni.cz/~omelka/Soubory/nmst434/nmst434_course-notes.pdf
Koenker, R. (2005). Quantile Regression. Cambridge University Press, New York.