

# COMPUTATIONAL STATISTICS I: R and Simulation (16h)

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## Outline

- R fundamentals and programming (approx 6 hours): RStudio as a useful IDE - Basic commands - Statistical tools - ggplot2 graphics - Hints and tips for simulations with R (memory issues, object sizes, efficient handling of complex data structures, integration with other languages, . . .) - Writing R functions - LaTeX and RStudio: Brief introduction to Sweave/knitr integration in RStudio (Generation of reports and scientific papers within RStudio) - R Markdown;
- Pseudo-random numbers and variates generation (approx 4 hours): Historical remarks on use of simulation methods in Statistics and Random Numbers Generation - Generating from a Uniform distribution: linear congruential generators - Goodness of Pseudo-RNG algorithms - Empirical evaluation and statistical testing - Generating from arbitrary distributions: Inverse Transform, Mixture Representation, Accept-Reject Algorithm, ad-hoc methods;
- Monte Carlo methods for numerical integration (approx 4 hours): Historical remarks - Classic Monte Carlo Integration - Importance Sampling and other Variance Reduction methods;
- Special Topics (approx 2 hours): Introduction to MCMC in R: Metropolis-Hastings Algorithms and Gibbs sampler.

## References

- [1] Albert, J. & M. Rizzo (2012). *R by Example*. Springer.
- [2] Golemund, G. (2014). *Hands-On Programming with R: Write Your Own Functions and Simulations*. O'Reilly Media, Inc.
- [3] Geweke, J. (2005). *Contemporary Bayesian econometrics and statistics*. John Wiley & Sons.
- [4] Matloff, N.S. (2011). *The art of R programming: tour of statistical software design*. No Starch Press, San Francisco.
- [5] Matsumoto, M. and Nishimura, T. (1998). Mersenne Twister: A 623-dimensionally equidistributed uniform pseudo-random number generator, *ACM Transactions on Modeling and Computer Simulation*, 8, 3–30. Source code at <http://www.math.keio.ac.jp/~matumoto/emt.html>.
- [6] Rizzo, M. L. (2019). *Statistical computing with R*. CRC Press.
- [7] Robert, C.P. and Casella, G. (2010). *Introducing Monte Carlo Methods with R*. Springer-Verlag, New York. <https://link.springer.com/book/10.1007/978-1-4419-1576-4>
- [8] Van Ravenzwaaij, D., Cassey, P., & Brown, S. D. (2018). *A simple introduction to Markov Chain Monte-Carlo sampling*. *Psychonomic bulletin & review*, 25(1), 143-154.
- [9] Xie, Y., Allaire, J. J., & Golemund, G. (2018). *R markdown: The definitive guide*. Chapman and Hall/CRC.