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|                              | <ul style="list-style-type: none"> <li>• Part I: <ul style="list-style-type: none"> <li>• Basics of one-dimensional function optimization. Special case: the likelihood function.</li> <li>• Global vs local optima; numerical convergence and approximation errors.</li> <li>• Challenges of optimizing multi-dimensional functions. Special cases: linear and generalized linear models and computing the multivariate normal density (link with LSTAT2120, 2100, 2110, 2040).</li> <li>• Newton's method, Fisher scoring and IRLS.</li> <li>• Non-linear functions and numerical differentiation.</li> <li>• Case study: ?optim(), ?nlm(), ?deriv() and friends.</li> <li>• The EM algorithm. Special cases: missing data, normal mixture models and linear mixed models (link with LSTAT2210).</li> </ul> </li> <li>• Part II: <ul style="list-style-type: none"> <li>• Setting up controlled simulation studies: competitor selection, performance metrics and reproducibility.</li> <li>• Sampling from distributions and DGPs.</li> <li>• Case study I: Sample mean (mean, median, trimmed mean from normal and skewed distributions); German tank problem (estimators from slide LSTAT 2040) - mean, bias, MSE, RE.</li> <li>• Case study II: t-test (size, power, coverage and length for CIs) and Binomial test (Tables from slides LSTAT 2040).</li> <li>• Case study III: GLM variable selection (TPR, FPR, FDR).</li> <li>• Parallel computing in R: doParallel, foreach, mclapply and friends to illustrate Case study I-III.</li> </ul> </li> <li>• Part III: <ul style="list-style-type: none"> <li>• Bootstrap and resampling methods.</li> <li>• Bias and variance approximation based on resampling.</li> <li>• Bootstrap confidence intervals and hypothesis testing.</li> <li>• Other techniques: Permutation tests and Jackknife</li> </ul> </li> </ul> |
| Ressources en ligne          | <p>Slides and notes on Moodle.<br/> Site Moodle of the class :LSTAT2185 - Numerical Methods for Statistics: Optimization, Simulations and the Bootstrap<br/> <a href="https://moodle.uclouvain.be/course/view.php?id=5785">https://moodle.uclouvain.be/course/view.php?id=5785</a></p>  |
| Bibliographie                | <p>Givens, G.H. and Hoeting. J.A. (2013). Computational Statistics (2nd ed). Wiley.<br/> Rizzo, M.L. (2007). Statistical Computing with R (2nd ed). Chapman &amp; Hall /CRC.<br/> Gentle, J.E. (2009). Computational Statistics. Springer.<br/> Lange, K. (2010). Numerical Analysis for Statisticians (2nd ed). Springer.<br/> Peng, R.D. (2020+). Advanced Statistical Computing. Available at <a href="https://bookdown.org/rdpeng/advstatcomp/">https://bookdown.org/rdpeng/advstatcomp/</a><br/> Chernick, M.R. (2008). Bootstrap methods : a guide for practitioners and researchers, Wiley Series in Probability and Statistics.<br/> Davison, A.C. et Hinkley, D.V. (1997). Bootstrap Methods and their Applications, Cambridge University Press.<br/> Efron, B. et Tibshirani, R.J. (1993). An Introduction to the Bootstrap, Chapman and Hall.<br/> Hall, P. (1992). The Bootstrap and Edgeworth Expansion, Springer.<br/> Mammen, E. (1992). When does bootstrap work ? Springer.</p>  |
| Autres infos                 | Software: R   |
| Faculté ou entité en charge: | LSBA  |

| <b>Programmes / formations proposant cette unité d'enseignement (UE)</b>        |         |         |           |   |
|---|---------|---------|-----------|---|
| Intitulé du programme   | Sigle   | Crédits | Prérequis | Acquis d'apprentissage  |
| Master [120] en science des données, orientation statistique                    | DATS2M  | 5       |           |  |
| Master [120] en statistique, orientation biostatistiques                        | BSTA2M  | 5       |           |  |
| Master [120] en statistique, orientation générale                               | STAT2M  | 5       |           |  |
| Certificat d'université :<br>Statistique et science des données (15/30 crédits) | STAT2FC | 5       |           |  |