UCLouvain

lstat2460

2023

Asymptotic Statistics

4.00 credits	15.0 h + 5.0 h	Q1

Teacher(s)	Segers Johan ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	Concepts and tools equivalent to those taught in teaching units LSTAT2190 Concepts et traitement de vecteurs aléatoires LSTAT2140 Statistique nonparamétrique: méthodes de base LSTAT2040 Inférence statistique et vraisemblance • Linear algebra: vectors and matrices • Calculus, univariate and multivariate: limits, continuity, differentiability, Taylor's theorem, deterministic o and O calculus, norms, partial derivatives, Jacobian
Main themes	The course focuses on mathematical techniques to establish large-sample distributions of common estimators and test statistics arising in statistical methodology
Learning outcomes	**At the end of this learning unit, the student is able to :** To select and use the proper mathematical tools to establish the asymptotic distribution of a sequence of statistics (estimators, test statistics). With regard to the AA reference framework of the Master's programme in Statistics, general orientation, this activity contributes to the development and acquisition of the following AAs: 1.4, 4.1, 4.3.
Evaluation methods	Each student will be given an assignment similar to those in the course. The examination is oral and is based on the submitted project. The assignments to be made during the year are worth bonus points.
Teaching methods	In the lectures, the teacher will explain each technique in general and work out an example. The students will then be given an assignment to apply the technique in a similar situation and write out the mathematical developments in some detail in a text (format: LATEX or R Markdown) to be submitted for detailed feedback to both the other students and the teacher. The practice sessions will focus on theoretical and numerical examples.

Content	• Basics: Convergence in distribution and in probability, continuous mapping theorem, Slutsky's lemma, stochastic op and Op calculus
	• Univariate and multivariate central limit theorems (also Lindeberg–Feller)
	  • Examples: sample variance, t-statistic (also multivariate, i.e., Hotelling?), Pearson chi-square tests, linear regression, . . .
	• Delta-method (with proof)
	  • Examples: sample skewness/curtosis, sample correlation, central order statistics (via quantile transform), variance-stabilizing transformations, . . .
	• Sample moments and moment estimators
	  • Example: parameter estimates in full-rank exponential families, . . .
	• M- and Z-estimators, consistency and asymptotic normality under classical conditions
	  • Examples: maximum likelihood estimators in smooth single-parameter models, robust estimators
	• U-statistics via Hájek projection (conditional expectation as an L2-projection)
	  • Examples: Wilcoxon's signed rank statistic, Kendall's tau
	  • Optional: two-sample U-statistics, such as Mann–Whitney statistic and Mann– Kendall trend test
	Attention will also be paid to verifying the accuracy of asymptotic approximations in finite samples via Monte Carlo simulation experiments in R.
	Note: Given the modest prerequisites and the limited time available, the course will not venture into empirical process techniques (Glivenko–Cantelli and Donsker theorems).

Inline resources	Course material (literature, explanations, exercises) available on Moodle.

Bibliography	Optional bibliography: [1] Hunter, D. R. (2014). Notes for a graduate-level course in asymptotics for statisticians. Penn State University, http://personal.psu.edu/drh20/asymp/lectures/asymp.pdf. [2] Lehmann, E. L. (1999). Elements of Large-Sample Theory. Springer Texts in Statistics. New York: Springer-Verlag. 2 [3] Polansky, A. M. (2011). Introduction to Statistical Limit Theory. Texts in Statistical Science Series. CRC Press, Boca Raton, FL. [4] Segers, J. (2017). Théorie des probabilités. UCLouvain, syllabus LMAT1371. [5] Serfling, R. J. (1980). Approximation Theorems of Mathematical Statistics. John Wiley & Sons, Inc., New York. Wiley Series in Probability and Mathematical Statistics. [6] van der Vaart, A. W. (1998). Asymptotic Statistics. Cambridge: Cambridge University Press
Faculty or entity in charge	LSBA

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Mathematics	MATH2M	4		
Master [120] in Statistics: General	STAT2M	4		
Certificat d'université : Statistique et science des données (15/30 crédits)	STAT2FC	4		