











5.00 credits

22.5 h + 7.5 h

Q2

Teacher(s)	Lambert Philippe ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	Concepts and tools equivalent to those taught in teaching units LSTAT2020 Logiciels et programmation statistique de base LSTAT2120 Linear models LSTAT2190 Concepts et traitement de vecteurs aléatoires
Main themes	- The Bayesian model: basic principles. - The likelihood function and its a priori specification. - One-parameter models: choice of the a priori distribution, derivation of the a posteriori distribution, summarizing the a posteriori distribution. - Multi-parameter models: choice of the a priori distribution, derivation of the a posteriori distribution, nuisance parameters. Special cases: the multinomial and the multivariate Gaussian models. - Large sample inference and connections with asymptotic frequentist inference. - Bayesian computation.
Learning outcomes	<b>At the end of this learning unit, the student is able to :</b>  By the end of the course, the student will be familiar with the principles and the basic techniques in Bayesian statistics. He or she will be able to use and to put forward the advantages and drawbacks of that paradigm in standard problems.  1
Evaluation methods	The assessment of this course will combine a written exam (on 15 points) and a project (on 5 points). This project will take the form of a written report submitted by each student before the beginning of the 1st exam session, without the possibility to submit it later on. However, the mark obtained for this work will be used in the same way during the two sessions to calculate the final mark.
Teaching methods	The course consists of lectures, possibly supplemented by podcasts made available to students on Moodle, and practicals. It is given on a weekly basis over 11 weeks starting at the beginning of the 2nd term.
Content	This course is an introduction to Bayesian statistics. After defining subjective probabilities, the basic principles underlying Bayesian inference are presented through the estimation of a proportion. The same principles are used to compare proportions and rates. The estimation of a mean (variance) in a normal distribution is also studied when the variance (mean) is unknown. Inference in multiparameter models is also tackled. The concepts of marginal and conditional posterior distributions, credible regions and predictive distributions are defined. It is first illustrated with the joint estimation of the mean and of the variance of a normal distribution. The comparison of two means of a normal distribution with known or unknown variance(s) is also tackled. A solution is obtained with the simulation of a random sample from the joint posterior distribution when the variances cannot be assumed equal. The multiple regression model and the ANOVA I model are also studied in a Bayesian framework. The basic algorithms enabling to generate a random sample from the posterior distribution are presented as these are fundamental to make inference in complex models. The course is concluded with a short introduction to hierarchical models.
Inline resources	Slides and podcasts are available to students on Moodle
Bibliography	Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A. and Rubin, D.B. (2013,3rd edition) Bayesian Data Analysis. Chapman and Hall - CRC Press. Bolstad, W.M. and J.M. Curran (2016) Introduction to Bayesian Statistics. Wiley.
Other infos	Prerequisites: It is assumed that students have a basic background in probability theory, statistical inference and the use of R software.
Faculty or entity in charge	LSBA

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Data Science : Statistic	DATS2M	5		
Master [120] in Biomedical Engineering	GBIO2M	5		
Master [120] in Statistics: Biostatistics	BSTA2M	5		
Master [120] in Mathematics	MATH2M	4		
Master [120] in Statistics: General	STAT2M	5		
Approfondissement en statistique et sciences des données	APPSTAT	5		
Master [120] in Mathematical Engineering	MAP2M	5		
Master [120] in Economics: General	ECON2M	5		
Master [120] in Data Science Engineering	DATE2M	5		
Certificat d'université : Statistique et science des données (15/30 crédits)	STAT2FC	5		
Master [120] in Data Science: Information Technology	DATI2M	5		