Teaching Guide				
Identifying Data				2020/21
Subject (*)	Resampling Techniques		Code	614493022
Study programme	Mestrado Universitario en Técnicas Estadísticas (Plan 2019)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	1st four-month period	First Second	Optional	5
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Matemáticas			
Coordinador		E-mail		
Lecturers		E-mail		
Web	dm.udc.es/profesores/ricardo/			
General description	It is intended that students acquire skills in identifying situations in which resampling methods are adequate to solve real problems with inferential tools. To do this students will have to know how the main resampling techniques can be used. This includes the bootstrap method and its applications in major areas in statistics. It is also intended that the student is able to design and implement in a computer appropriate resampling plans for a wide range of situations.			
Contingency plan	1. Modifications to the contents 2. Methodologies *Teaching methodologies that are maintained *Teaching methodologies that are modified 3. Mechanisms for personalized attention to students 4. Modifications in the evaluation *Evaluation observations: 5. Modifications to the bibliography or webgraphy			

Study programme competences	
Code	Study programme competences
A2	Capacidade para comprender, formular, formular e resolver aqueles problemas susceptibles de ser abordados a través de modelos da estatística e da investigación operativa.
A4	Coñecer algoritmos de resolución dos problemas e manexar o software axeitado.
A9	Obter os coñecementos precisos para unha análise crítica e rigorosa dos resultados.
B6	Capacidade para iniciar a investigación e para participar en proxectos de investigación que poden culminar na elaboración dunha tese doutoral.
B8	Capacidade de traballo en equipo e de forma autónoma
B10	Capacidade de identificar e resolver problemas
C1	Ser capaz de identificar un problema da vida real.
C2	Dominar a terminoloxía científica-metodolóxica para comprender e interactuar con outros profesionais.
C3	Habilidade para traballar os aspectos metodolóxicos da investigación en colaboración con outros colegas a través do Campus Virtual co foro.
C4	Habilidade para realizar a análise estatística con ordenador.
C5	Escoller o deseño máis axeitado para responder á pregunta de investigación.

C6	Utilizar as técnicas estatísticas máis axeitadas para analizar os datos dunha investigación.
C7	Planificar, analizar e interpretar os resultados dunha investigación considerando tanto os aspectos teóricos coma os metodolóxicos.
C8	Habilidade de xestión administrativa do proceso dunha investigación.
C9	Comunicación e difusión dos resultados das investigacións.
C10	Lectura con xuízo crítico de artigos científicos dende unha perspectiva metodolóxica.

Learning outcomes			
Learning outcomes	Study programme competences		
G1 - Capacidade para iniciar a investigación e para participar en proxectos de investigación que poden culminar na elabouración duhna teses de doutoramento.	AC2 AC4	BJ6 BJ8 BJ10	CJ1 CJ2 CJ3 CJ4 CJ5 CJ6 CJ7 CJ8 CJ9 CJ10
G2 - Capacidade de aplicación de algoritmos de resolución dos problemas e manexo do software adecuado.	AC4		
G3 - Capacidade de traballo en equipo e de xeito autónomo		BJ8	
G4 - Capacidade de formular problemas en termos estatísticos, e de resolvelos utilizando as técnicas axeitadas.	AC2 AC4		
G6 - Capacidade de identificar e resolver problemas		BJ10	
G10 - Capacidade de integrarse nun equipo multidisciplinar para a análise experimental		BJ8	
G11 - Adquirir destreza para o desenvolvemento de software	AC2 AC4		
G12 - Capacidade de análise estatística crítica das mostras, os plantexamentos e resultados	AC2 AC9		
G14 - Representar un problema real mediante un modelizado estatístico axeitado.	AC2		
G15 - Deseñar un plano de observación ou recollida de datos que permita abordar o problema de interese	AC4 AC9	BJ10	
E2 - A adquisición dos coñecementos de estatística e investigación de operacións necesarios para a incorporación en equipos multidisciplinares pertencentes a diferentes sectores profesionais.	AC2	BJ8	CJ1 CJ2 CJ3
E4 - Coñecer as aplicacións dos modelos da estatística e a investigación de operacións.	AC2		
E5 - Coñecer algoritmos de resolución dos problemas e manexar o software axeitado.	AC4		
E12 - Realizar inferencias respecto aos parámetros que aparecen no modelo.			CJ6
E19 - Tratamento de datos e análise estatística dos resultados obtidos.		BJ6	
E27 - Obter os coñecementos precisos para unha análise crítica e rigurosa dos resultados.	AC9		
E28 - Complementar a aprendizaxe dos aspectos metodolóxicos con apoio de software.	AC4		
E78 - Fomentar a sensibilidade cara os principios do pensamento científico, favorecendo as actitudes asociadas ao desenvovemento dos métodos matemáticos, como: o cuestionamento das ideas intuitivas, a análise crítica das afirmacións, a capacidade de análise e síntese ou a toma de decisións racionais	AC2		
E82 - O estudiante será capaz de comprender a importancia da Inferencia Estatística como ferramenta de obtención de información sobre a población en estudo, a partir do conxunto de datos observados dunha mostra representativa de esta. Para iso deberá recoñecer a diferenza entre estatística paramétrica e non paramétrica.			CJ4 CJ5
E84 - Ser quen de manexar diverso software (en particular R) e interpretar os resultados que proporcionan nos correspondentes estudos prácticos.	AC4		CJ4
E86 - Soltura no manexo da teoría da probabilidade e as variables aleatorias.	AC2		

Contents	
Topic	Sub-topic
1. Motivation of the Bootstrap principle.	Uniform bootstrap. Bootstrap distribution calculation: exact distribution and Monte Carlo approximation. Examples.
2. Some applications of the Bootstrap method.	Application of the Bootstrap to estimate the precision and the bias of an estimator. Examples.
3. Motivation of the Jackknife method.	Jackknife estimation of the precision and the bias of an estimator. Bootstrap/Jackknife relationship. Examples. Simulation studies.
4. Variations of the uniform Bootstrap.	Parametric Bootstrap, symmetrized Bootstrap, smoothed Bootstrap, weighted Bootstrap and biased Bootstrap. Discussion and examples. Validity of the Bootstrap approach. Examples.
5. Applications of Bootstrap to construct confidence intervals.	Percentile method, percentile-t method, symmetrized percentile-t method . Examples. Simulation studies.
6. Bootstrap and nonparametric density estimation.	Bootstrap approximation for the distribution of the Parzen-Rosenblatt estimator. The Bootstrap in the selection of the smoothing parameter.
7. Bootstrap and nonparametric estimation of the regression function.	Bootstrap approximation of the distribution of the Nadaraya-Watson estimator. Different resampling methods and results.
8. Bootstrap with censored data.	Introduction to censored data. Bootstrap resampling plans in the presence of censorship. Relations among them.
9. Bootstrap with dependent data.	Introduction to the usual conditions of dependency and dependent data models. Parametric models of dependence. General dependence situations: Moving Block Bootstrap, Stationary Bootstrap and Subsampling method.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Oral presentation	A2 A4 A9 B6 B10 C2 C3 C5 C6 C10	21	31.5	52.5
ICT practicals	A4 B8 C3 C4 C6 C8	14	28	42
Multiple-choice questions	A4 A9 B10 C2 C3 C5 C6 C7 C10	1	11.5	12.5
Problem solving	A4 A9 B8 B10 C1 C4 C5 C6 C7 C8 C9 C10	4	8	12
Personalized attention		6	0	6
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Oral presentation	Presentation with computer by videoconference to three campuses
ICT practicals	Resampling algorithm implementation
Multiple-choice questions	Multiple-choice test on concepts.
Problem solving	Design of resampling plans. Bias and variance calculation for the bootstrap analogues.

Personalized attention	
Methodologies	Description

ICT practicals Problem solving	Attendance and participation in lectures. Written multiple choice test. Participation in workshops and seminars. Practicals to be performed by the student.

Assessment			
Methodologies	Competencies	Description	Qualification
ICT practicals	A4 B8 C3 C4 C6 C8	Using the software R to implement the bootstrap method in some setup.	20
Problem solving	A4 A9 B8 B10 C1 C4 C5 C6 C7 C8 C9 C10	Original work on the bootstrap on some relevant setup.	40
Multiple-choice questions	A4 A9 B10 C2 C3 C5 C6 C7 C10	Comprehension Test.	40

Assessment comments
The assessment will be carried out using a written test on R labs, an individual student work, as well as a written concept test. The concept test score will be 40% of the total qualification, the test on R labs will correspond to 20% of the global score, while the remaining 40% will correspond to the individual student work, that has to be presented orally. To pass the subject is necessary to obtain a score of at least 5 out of 10 overall. On July opportunity, students could avoid those tests with scores of at least 4 out of 10 in January tests. Only students that didn't take any test will be qualified as NON ATTENDANT in the first opportunity (January-February). In July opportunity only students that didn't take the final exam will be qualified as NON ATTENDANT.

Sources of information	
Basic	Bibliografía básicaDavison, A.C. and Hinkley, D.V. (1999). Bootstrap Methods and their Application. Cambridge University Press.Efron, B. (1979). Bootstrap Methods: Another look at the Jackknife. Ann. Statist., 7, 1-26.Efron, B. and Tibshirani, R.J. (1993). An Introduction to the Bootstrap. Chapman and Hall.Shao, J. and Tu, D. (1996). The Jackknife and Bootstrap. Springer Verlag.

Complementary	Bibliografía complementariaAkritas, M. G. (1986). Bootstrapping the Kaplan--Meier estimator. J. Amer. Statist. Assoc. 81, 1032-1038.Bickel, P.J. and Freedman, D.A. (1981). Some asymptotic theory for the bootstrap. Ann. Statist. 12, 470-482.Bühlmann, P. (1997). Sieve bootstrap for time series. Bernoulli 3, 123-148.Cao, R. (1990). Órdenes de convergencia para las aproximaciones normal y bootstrap en la estimación no paramétrica de la función de densidad. Trabajos de Estadística, vol. 5, 2, 23-32.Cao, R. (1991). Rate of convergence for the wild bootstrap in nonparametric regression. Ann. Statist. 19, 2226-2231.Cao, R. (1993). Bootstrapping the mean integrated squared error. Jr. Mult. Anal. 45, 137-160.Cao, R. (1999). An overview of bootstrap methods for estimating and predicting in time series. Test, 8, 95-116.Cao, R. and González-Manteiga, W. (1993). Bootstrap methods in regression smoothing. J. Nonparam. Statist. 2, 379-388.Cao, R. and Prada-Sánchez, J.M. (1993). Bootstrapping the mean of a symmetric population. Statistics & Probability Letters 17, 43-48.Efron, B. (1981). Censored data and the bootstrap. J. Amer. Statist. Assoc. 76, 312-319.Efron, B. (1982). The Jackknife, the Bootstrap and other Resampling Plans. CBMS-NSF. Regional Conference series in applied mathematics.Efron, B. (1983). Estimating the error rate of a prediction rule: improvements on cross-validation. J. Amer. Stat. Assoc. 78, 316-331.Efron, B. (1987). Better Bootstrap confidence intervals (with discussion), J. Amer. Stat. Assoc. 82, 171-200.Efron, B. (1990). More Efficient Bootstrap Computations. J. Amer. Stat. Assoc. 85, 79-89.Efron, B. and Tibshirani, R. (1986). Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy. Statistical Science 1, 54-77.Freedman, D.A. (1981). Bootstrapping regression models. Ann. Statist. 9, 6, 1218-1228.García-Jurado, I. González-Manteiga, W., Prada-Sánchez, J.M., Febrero-Bande, M. and Cao, R. (1995). Predicting using Box-Jenkins, nonparametric and bootstrap techniques. Technometrics 37, 303-310.Hall, P. (1986). On the bootstrap and confidence intervals. Ann. Statist. 14, 1431-1452.Hall, P. (1988a). Theoretical comparison of bootstrap confidence intervals. Ann. Statist. 16, 927-953.Hall, P. (1988b). Rate of convergence in bootstrap approximations. Ann. Probab. 16, 4, 1665-1684.Hall. P. (1992). The Bootstrap and Edgeworth Expansion. Springer Verlag.Hall, P. and Martin, M.A. (1988). On bootstrap resampling and iteration. Biometrika 75, 661-671.Härdle, W. and Marron, J. S. (1991). Bootstrap simultaneous error bars for nonparametric regression. Ann. Statist. 19, 778-796.Künsch, H.R. (1989). The jackknife and the bootstrap for general stationary observations. Ann. Statist. 17, 1217-1241.Mammen, E. (1992). When does Bootstrap Work?. Springer Verlag.Navidi, W. (1989). Edgeworth expansions for bootstrapping regression models. Ann. Statist. 17, 4, 1472-1478.Politis, D.N. and Romano, J.R. (1994a). The stationary bootstrap. J. Amer. Statist. Assoc. 89, 1303-1313.Politis, D.N. and Romano, J.R. (1994b). Limit theorems for weakly dependent Hilbert space valued random variables with application to the stationary bootstrap. Statist. Sin. 4, 461-476.Politis, D.N., Romano, J.P. and Wolf, M. (1999). Subsampling. Springer Verlag.Reid, N. (1981). Estimating the median survival time. Biometrika 68, 601-608.Stine, R.A. (1987). Estimating properties of autoregressive forecasts. J. Amer. Statist. Assoc. 82, 1072-1078.Thombs, L.A. and Schucany, W.R. (1990). Bootstrap prediction intervals for autoregression. J. Amer. Statist. Assoc. 85, 486-492.Wu, C.-F. J. (1986). Jackknife, bootstrap and other resampling methods in regression analysis. Ann. Statist. 14, 1261-1350.

Recommendations
Subjects that it is recommended to have taken before
Estatística Matemática/614468102
Modelos de Probabilidade/614468103
Estatística Aplicada/614468104
Modelos de Regresión/614468105
Análise Exploratoria de Datos (data mining)/614468106
Estatística non Paramétrica/614468109
Simulación Estatística/614468113
Subjects that are recommended to be taken simultaneously
Series de Tempo/614427111
Fiabilidade e Modelos Biométricos/614427116
Subjects that continue the syllabus

Contrastes de Especificación/614468123
Datos Funcionais/614468124
Proxecto Fin de Carreira ou Traballo Tutelado/614468128
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.