60431 - Analysis, visualization and modelling of geological data

Información del Plan Docente

Academic Year	2017/18
Faculty / School	100 - Facultad de Ciencias
Degree	541 - Master's in Geology: Techniques and Applications
ECTS	10.0
Year	1
Semester	First semester
Subject Type	Compulsory
Module	---

1.General information

1.1.Introduction

1.2.Recommendations to take this course

1.3.Context and importance of this course in the degree

1.4.Activities and key dates

2.Learning goals

2.1.Learning goals

2.2.Importance of learning goals

3.Aims of the course and competences

3.1.Aims of the course

3.2.Competences

4.Assessment (1st and 2nd call)

4.1.Assessment tasks (description of tasks, marking system and assessment criteria)

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

Scientists and private-sector professionals in Geology make interpretations by using and combining many different types of data coming from a large variety of research methods. An especially appealing aspect for students of Earth Sciences is the ability to examine phenomena at different scales, ranging from global observations by satellites to atomic-scale material research. The geological investigations are based on a synthesis of both qualitative and quantitative information from fieldwork, experimental research and model construction of processes operating over a huge range of spatial and temporal scales. Computer simulations, using innovative numerical methods, are increasingly employed to integrate

different types of data and to test hypotheses quantitatively.

This course is designed to enable students to handle complex real-world problems and to develop a wide range of skills. A well-founded knowledge in diverse areas of data analysis, visualization and modelling will turn MSc students into appealing candidates for recruitment in research, private industry, or governmental institutions.

5.2.Learning tasks

This course (10 ECTS: 100 hours of lectures/practice sessions and 150 hours of autonomous work) is taught during the first semester. It is organised into three core modules (topics) that combine theory lectures and practice sessions using personal computers.

50% of the course grade comes from exams and the other 50% from coursework. The students have also the opportunity of taking an end-of-term examination to pass the course.

5.3.Syllabus

The course will address the following topics:

Topic 1: **Principles of modelling in Geology**

- Lecture 1 (0.5 ECTS) Scientific method in the natural sciences.
- Lecture 2 (0.5 ECTS) Fundamentals of geological modelling.
- Lecture 3 (0.5 ECTS) Conceptual modelling.
- Lecture 4 (0.5 ECTS) How to evaluate the quality of a model: validation and verification

Topic 2: **Digital analysis of geological data**

- Lecture 5 (0.4 ECTS) Global Positioning System (GPS).
- Lecture 6 (0.4 ECTS) Geographic Information System (GIS) and digital terrain models.
- Lecture 7 (1 ECTS) Software and utilities. QGis.
- Lecture 8 (0.2 ECTS) LIDAR technology.

Topic 3: **Databases and statistical methods in geology**

Section 3.1- Software applications for the management of geological data.

- Lecture 9 (0.5 ECTS) Spreadsheet applications. EXCEL.
- Lecture 10 (0.5 ECTS) Database applications. FileMaker Pro.

Section 3.2- Advanced statistical methods in geology

- Lecture 11 (1 ECTS) Experimental design and exploratory analysis in geology.
- Lecture 12 (1 ECTS) Use of multivariate methods in geological data analysis.
- Lecture 13 (0.5 ECTS) Trends and hidden patterns in the sequential data: an introduction.
- Lecture 14 (0.5 ECTS) Constructing and processing geological time series.
- Lecture 15 (1 ECTS) Geostatistics.
- Lecture 16 (1 ECTS) Morphometrics.

5.4.Course planning and calendar

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This course has 10 ECTS (100 hours of classes and 150 hours of autonomous work) and is taught during the first semester in 5-hour sessions (Monday and Wednesday afternoon).

The starting and finishing dates of the classes can be found in the website of the Faculty of Science (http://ciencias.unizar.es/).

During the first session, the coordinator of the course will hand out a detailed schedule of the coursework, including deadlines and assessment (workload, percentage of the grades).

This course will have a Moodle page where all course material will be uploaded and through which most of the communication between students and teachers will be conducted.

5.5.Bibliography and recommended resources

Caers, J. (2011). Modeling uncertainty in the earth sciences. Wiley-Blackwell, 229 pp.

Davis, J. C. 1986. Statistics and data analysis in geology. John Wiley & Sons.

DeMers, M.N., 2009. GIS For Dummies. Wiley Publishing Inc., 380 pp, ISBN: 978-0-470-23682-6.

Diggle, P.J.; Ribeiro Jr. P.J., 2007. *Model-based Geostatistics*. Series in Statistics, Springer, 228 pp. ISBN-10: 0-387-32907-2 ISBN-13: 978-0-387-32907-9

Dillon, R. y Goldstein M. 1984. Multivariate analysis: methods and applications. John Wiley & Sons.

Felsenstein, J. 2004. Inferring phylogenies. Sinauer Associates, Inc. 664 pp.

Gauch, Hugh G. 1982. Multivariate analysis in community ecology. Cambridge University Press.

Graser, A., 2013. *Learning QGIS 2.0*. Packt Publishing, 110 pp. ISBN 978-1-78216-748-8.

Hammer, Ø., Harper, D.A.T., and P. D. Ryan, 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica 4(1): 9pp.

Hammer, Ø. & Harper, D.A.T., 2006. Paleontological Data Analysis. Blackwell Publishing, 351 pp.

Harper, D.A.T. 1999. Numerical Paleobiology. Computer-based modelling and nalysis of fossils and their distributions. John Wiley & Sons. 468 pp.

Hengl, T., 2009. *A Practical Guide to Geostatistical Mapping*. University of Amsterdam, Second Edition, 291 pp. ISBN 978-90-9024981-0.

IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

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McKillup S & Dyar MD 2010, Geostatistics Explained. An Introductory Guide for Earth Scientist. Cambridge Univ. Press. 396 pp.

Middleton, G.V. y Wilcock, P.R. (1994). Mechanics in the Earth and Environmental Sciences. Cambridge University Press.

Reyment, R.A. 1991. Multidimensional Paleobiology. Pergamon Press.

Reyment, R.A. y Savazzi, E. Aspects of Multivariate Statistical Análisis in Geology. Elsevier. 285 p.

Rohlf, F.J. 1992. NTSYS-pc Numerical Taxonomy and Multivariate Analysis System. Version 1.70. Exeter Software, LTD., New York.

Shi, G.R. 1993. Multivariate data analysis in palaeoecology and palaeobiogeography -A review. Palaeogeography, Palaeoclimatology, Palaeoecology, 105: 199-234.

Walthan, D. 2000. Mathematics. A simple tool for Geologists. Blackwell Publishing.

Weedon G.P. 2003. Time-Series Análisis and Cyclostratigraphy. Examining stratigraphic records of environmental cycles. Cambridge University Press. 259 p.

Books, Manuals and free software:

QGIS http://www.qgis.org

PAST http://folk.uio.no/ohammer/past/

PSPP http://www.gnu.org/software/pspp/

R y R-Commander http://www.r-project.org/

Arriaza et al. 2008. Estadística Básica con R y R-Commander. Servicio de Publicaciones de la Universidad de Cádiz. ISBN: 978-84-9828-186-6 http://knuth.uca.es/ebrcmdr

Sutton, T., Dassau, O., y Sutton, M., 2009. A Gentle Introduction to GIS. http://docs.qgis.org/2.2/en/docs/gentle_gis_introduction/index.html