UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

GEOSPATIAL DATA PROCESSING

Anno immatricolazione	2019/2020
Anno offerta	2020/2021
Normativa	DM270
SSD	ING-INF/03 (TELECOMUNICAZIONI)
Dipartimento	DIPARTIMENTO DI INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE
Corso di studio	COMPUTER ENGINEERING
Curriculum	Data Science
Anno di corso	2°
Periodo didattico	Primo Semestre (28/09/2020 - 22/01/2021)
Crediti	6
Ore	45 ore di attività frontale
Lingua insegnamento	English
Tipo esame	ORALE
Docente	DELL'ACQUA FABIO (titolare) - 6 CFU
Prerequisiti	Basic-level knowledge of: computer science, data processing and mathematical analysis
Obiettivi formativi	Nowadays, a vast array of satellite-mounted sensors creates several TeraBytes of fresh data every day. This deluge of data comes with geospatial information attached, i.e. specific information about the location where each datum was acquired. In order to make the most of this “Big Space Data” it is crucial to understand both the spatial and the spectral and radiometric information contained in it. This know-how lets one make sense of geospatial data and harness the big-data power of Earth observation satellites. In this course, we will start from an introductory level to dive into this massive stream of data, in order to understand their features, their meaning, and their offer of information – from the obvious to the best concealed elements. The students will learn the concepts of “geospatial information” and “geospatial

processing", the type of data produced by different sensing systems, how to best select them, how to analyse and process such data in a geospatial environment. The course will illustrate a range of processing and analysis techniques, commonly applied in various contexts to achieve the desired geospatial information - out of massive geospatial "data lakes". Special attention will be devoted to the European Copernicus Programme, a major source of big, open data, with a remarkable impact potential – not fully deployed yet.

Programma e contenuti

Basic concepts of satellite geospatial data and geospatial information
In this chapter, the different sources of geospatial data will be introduced and discussed, with special regards to spaceborne remote sensing systems. With specific reference to Earth observation sensors, the physical principles underpinning remote sensing will be briefly revisited, in order to make better sense of the data generated by satellite systems.

Data characterization
In this section, we will describe and characterize geospatial data, starting from their preparation and enhancement, to then describe their standards. The most common standard formats for geospatial data will be discussed, including those by the International Standard Organization (ISO), the Open Geospatial Consortium, such as the ISO 14721:2003 OAIS (Open Archival Information System) reference model, and related standards such as the emerging CCSDS/ISO XFDU (XML Formatted Data Units) packaging format. Special attention will be given to the SAFE format (the Standard Archive Format for Europe) designed by the European Space Agency to frame satellite data.

Data mining in geospatial data
This section will discuss various approaches to the analysis of remotely sensed data, with special reference to statistical analysis, spatial analysis and spectral analysis. Each approach is described, and characterized in terms of what it can tell about the analysed dataset. Moreover, in this part of the course the notions of "big data" and "big geospatial data mining", will be introduced and discussed. Several possible ways to implement (big) geospatial data mining will be also presented with reference to applications such as classification, clustering, contextual and object-based processing, as well as target detection and temporal pattern detection.

Advanced geospatial interpretation techniques
In this part of the course, some advanced procedures for geospatial data interpretation are presented, with an emphasis on processing efficiency and accuracy of the results. An example is graph-based data processing, such as the "PROMODE" approach, for the extraction of spatio-temporal patterns in temporal geospatial data series. A second example is the use of artificial intelligence (AI) in satellite data processing, considering machine learning in geospatial data processing . Human-like gaze on satellite images .

The EU-ESA Copernicus programme
A multi-billion-euro initiative to thrust Europe all the way to the forefront

	of space-based innovation. Big data from space as a trigger of a societal change. Geospatial processing: exercises The open source Python programming language and QGIS, theory and practice.
Metodi didattici	The course is based on classroom lectures, possibly integrated with seminars. Whenever possible, hands-on sessions will be organized on processing of spaceborne radar datasets.
Testi di riferimento	Various authors (2015) Remotely Sensed Data Characterization, Classification and Accuracies. In: P. S. Thenkabail, Remote Sensing Handbook. CRC Press. ISBN 978-1-4822-1786-5. Li Z., Gui Z., Hofer B., Li Y., Scheider S., Shekhar S. (2020) Geospatial Information Processing Technologies. In: Guo H., Goodchild M., Annoni A. (eds) Manual of Digital Earth. Springer, Singapore Downey, A.B. (2016) Think Python: How to Think Like a Computer Scientist. O'Reilly Media; 2nd edition. ISBN-10: 1491939362; ISBN-13: 978-1491939369. See at https://greenteapress.com/wp/think-python-2e/ and note there exists an Italian version of the previous edition of the book. Various authors (2020) QGIS Training Manual. Online. Available at: https://docs.qgis.org/testing/en/docs/training_manual/
Modalità verifica apprendimento	The exam consists of an oral test, aimed at assessing the student's knowledge on the topics presented during the course and the hands-on exercises. Upon request, the teacher can assign an individual exercise whose discussion and analysis can form an integral part of the test. The maximum possible mark is 30 out of 30 with honours.
Altre informazioni	
Obiettivi Agenda 2030 per lo sviluppo sostenibile	Gli obiettivi