Fundamentals of Precision Agriculture

Module: Sensors

Prof. Paolo Dosso

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The main objective of this module is to provide students with a basic knowledge of the use of geospatial techniques and related equipment and instruments in agriculture, in order to consciously plan and adopt precision agricultural strategies based on remote and/or proximal monitoring techniques and variable rate technologies. The specific characteristics, theoretical and methodological foundations, methods of use, costs and expected benefits will be analysed for each available technology.

Intended learning outcomes: at the end of the course, students will possess a basic mastery in the use of the main geospatial techniques introduced during the course; from among these, moreover, students will be able to choose, with knowledge of the facts, which would be effectively useful in the implementation of precision agricultural activities in relation to both herbaceous and arboreal crops.

COURSE CONTENT

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| Topics | ECTS |
| Introduction to geomatics |  |
| Introduction to geomatics: elements of Cartography, Topography, Aerial Photogrammetry and Geostatistics. | 0.5 |
| Positioning systems |  |
| Global positioning systems (GNSS). | 0.5 |
| Computer information systems |  |
| GIS/TIS (Geographic Information System/Territorial information System) theory, techniques and instruments. | 0.5 |
| Remote Sensing |  |
| Theoretical principles, tools and techniques of Remote Sensing. | 0.5 |
| Drones and Robotics |  |
| Unmanned aerial vehicles (UAV) and robotic platforms for crop monitoring and management. | 0.5 |
| Proximal Sensing |  |
| Theoretical principles, tools and techniques behind the Proximal Sensing of soil and crop properties. | 0.5 |

READING LIST

Casa R. (Ed.), *Agricoltura di precisione. Metodi e tecnologie per migliorare l'efficienza e la sostenibilità dei sistemi colturali*, Edagricole-New Business Media, Bologna, 2017.

TEACHING METHOD

Frontal lectures that will address both the theoretical aspects underlying the different disciplines of geomatics, and the possible practical application of the technologies presented, in the field of precision agriculture, with examples taken directly from concrete professional experiences; in-depth meetings with experts and professionals in the sector may also be arranged.

The lectures will be conducted with the aid of multimedia materials prepared ad hoc by the lecturer; these will be made available to students for download via the e-learning platform (Blackboard).

ASSESSMENT METHOD AND CRITERIA

An oral exam. Students will have to answer three general questions, each carrying a maximum mark of 10/30. If a student shows particular completeness, mastery and confidence in the presentation of their arguments, it will be possible to grant up to a further 3/30, so as to reach the maximum mark of 30/30 with honours.

Students will have to demonstrate their mastery of the main geospatial techniques introduced during the course, in terms of theoretical knowledge acquired (knowing) and the ability to apply this knowledge to concrete operational contexts (know-how); they will also be assessed on their general competence in knowingly determining which geomatic technologies, among those illustrated in the course, can be effectively used in the practical implementation of precision agriculture in relation to herbaceous and arboreal crops.

NOTES AND PREREQUISITES

Being an introductory module, the course requires no prerequisites for its contents; however, we will assume a degree of interest and curiosity regarding technological innovation in general, and a healthy predisposition towards technical-engineering matters.

In the event that limitations related to pandemic contingencies persist, as experienced in recent years, remote teaching will still be guaranteed in a synchronous or asynchronous manner; this will be communicated in good time to students.

Information on office hours available on the teacher's personal page at http://docenti.unicatt.it/.

Module: IT tools for land analysis

Prof. Paolo Dosso

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The main objective of this module is to teach students the usage fundamentals of the main IT tools for analysing the territory and managing territorial and environmental data, which normally constitute one of the fundamental building blocks of precision agriculture strategies that can be fielded today with relative ease. As a representative example of many of the features available in the various systems on the market, a specific open source (and, therefore, freely usable) GIS software tool has been identified, namely QGIS, the knowledge and practical use of which will also be explored in depth through interactive sessions in the computer science room.

Intended learning outcomes: at the end of the course, students will possess a basic mastery in the use of the main features typical of a GIS tool, introduced during the course; from among these, moreover, students will be able to choose, with knowledge of the facts, which would be effectively useful in the implementation of precision agricultural activities in relation to both herbaceous and arboreal crops.

COURSE CONTENT

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| --- | --- |
| Topics | ECTS |
| Introduction to GIS |  |
| Introduction to GIS type software tools. | 0.5 |
| Data models in a GIS environment |  |
| The different data models commonly used in GIS software environments: the *raster* and *vector* models; 2-D and 3-D data; terrain elevation models (DTM, DSM, TIN). | 0.5 |
| Coordinate systems in GIS |  |
| Management of data, reference surfaces, SRS/CRS (Spatial Reference System / Coordinate Reference System), transformation of coordinates with/without passage of data in GIS environment. | 0.5 |
| Editing GIS data |  |
| Specific techniques and functionalities for spatial editing of vector data in a GIS environment.  Specific techniques and features for editing vector data attributes in a GIS environment.  Specific techniques and features for editing raster data in a GIS environment. | 0.5 |
| Spatial analysis of GIS data |  |
| Vector geoprocessing, raster map algebra, reprojection in another coordinate system, rasterisation/vectorisation in a GIS environment. | 0.5 |
| Image processing functionality within GIS software |  |
| Image enhancement (histogram stretching), band composites, calculation of indices through band composites, vegetation indices, classification of images in the GIS environment. | 0.5 |
| Tutorials |  |
| Seminars, educational visits and classroom tutorials. | 0.0 |

READING LIST

Casa R. (Ed.), *Agricoltura di precisione. Metodi e tecnologie per migliorare l'efficienza e la sostenibilità dei sistemi colturali*, Edagricole-New Business Media, Bologna, 2017.

TEACHING METHOD

The teaching of the course will be divided into:

* frontal lectures that will illustrate both the potential, features and techniques offered by software for the management of territorial and environmental data, as well as the possible practical applications of the technologies presented in the field of precision agriculture, with examples taken directly from actual professional experiences;
* interactive lectures conducted in the computer science room and based on the practical use of GIS software tools, with a focus on the techniques and tools most suitable for dealing with data processing cases that typify the problems dealt with in the theoretical lectures.

The lectures will be conducted with the aid of multimedia materials prepared ad hoc by the lecturer; these will be made available to students for download via the e-learning platform (Blackboard).

ASSESSMENT METHOD AND CRITERIA

The exam will be carried out orally, and will consist of the presentation and discussion of a project carried out independently by the student using the QGIS software. The following assessment criteria will be applied to the work presented:

* ability to select/thematicise vector data;
* ability to select/thematicise raster data;
* ability to process vector and/or raster data;
* level of complexity and elements of originality of the work carried out.

The first three criteria will each be given a score of 10/30, while the fourth criterion will contribute with an additional 3/30, thus allowing the student to reach a maximum mark of 30/30 with honours.

Students will also be given the opportunity to present the aforementioned project on an ongoing basis, thus taking advantage of the possibility for greater discussion with the lecturer during the course of the lectures themselves.

Students will have to demonstrate their mastery of the main techniques for managing territorial and environmental data introduced during the course, in terms of theoretical knowledge acquired, and ability to apply this knowledge to concrete operational contexts (know-how); they will also be assessed on their general competence in knowingly determining which technologies, among those illustrated in the course, can be effectively used in the practical implementation of precision agriculture in relation to herbaceous and arboreal crops.

NOTES AND PREREQUISITES

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