Design and methodology for a Remote Sensing course

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Abstract

Remote sensing offers Geographic Information Systems specialists the possibility of integrating useful and powerful information into their analyses. As at least a basic knowledge of remote sensing principles and methodologies are desirable for anyone working in the geospatial industry, we include this competence as a mandatory subject in the curricula of our online master's degree in GIS analysis.

The topics of this remote sensing course have been selected based on our experience in the sector, but also with the support of tools like the body of knowledge developed by the GI2NK and EO4GEO projects. These applications can be very useful for anyone starting with the creation of new courses, as they take into consideration the recommendations of experts related to different sectors: from university to private companies, and also from the public sector.

The course is fundamentally based on practical work, but since it is introductory and most of the students are not familiar with the principles of remote sensing, it is essential for them to start understanding basic concepts such as electromagnetic radiation, electromagnetic spectrum, spectral signature, bands, etc. After that, they are prepared to start searching the best images for a specific project, perform image enhancements and corrections, compute indices and apply supervised and unsupervised classifications.

During the course, students are encouraged to use open-source software to develop the mandatory activities and the optional ones. Most of the tutorials are based on QuantumGIS and some of its main extensions to work with raster data and remote sensing images, but there are also tutorials based on GRASS Gis and SNAP. Nevertheless, students have total freedom to choose any available software (open-source or not) to perform the mandatory activities, and the tutor is open to resolving doubts about them.

Finally, the module is designed to practice with Copernicus and Landsat images. The use of these free catalogues offers the possibility to analyse phenomena from all over the world without cost, and it empowers students to carry out their own projects more economically. Also, the historical series of Landsat Images is very useful to evaluate changes over long periods of time.

Keywords
Remote sensing, GIS, e-learning, open-source, open data

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Acronyms/Abbreviations

BoK *Body of Knowledge*

CDT *Curriculum Design Tool*

GIS *Geographic Information System*

LST *Land Surface Temperature*

SCP *Semiautomatic Classification Plugin*

1. Introduction

The use of remote sensing data is very useful for Geographic Information Systems (GIS) specialists, as it provides powerful information for their analyses.

It is for that reason that the UNIGIS Girona master's degree in GIS includes a subject about remote sensing, in which students understand the basic principles of this discipline and also learn how to obtain, process, analyse and extract information from satellite datasets.

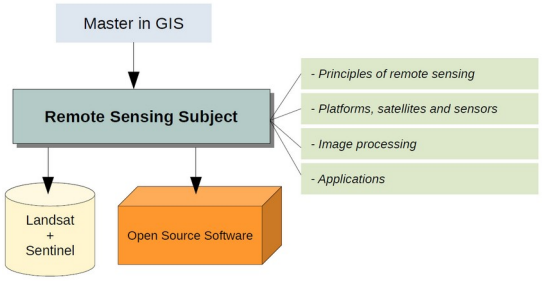

Figure 1. Remote sensing subject in the framework of a Master's degree in GIS.

Designing this kind of subject requires a knowledge of the needs of the sector, and tools like the Body of Knowledge (BoK) developed in the framework of the GiN2K and EO4GEO projects can be of great help.

Access to open datasets, like Copernicus or Landsat, are a very valuable resource for this course. Students can access these catalogues for free, and obtain images to analyse a great variety of study cases.

Open-source software is also a recommendation for students in order to visualize and analyse the images. During the course, they are provided with tutorials and guided activities about QGIS and the Semiautomatic Classification Plugin (SCP), SNAP and GRASS GIS.

2. Discussion

The methodology based on the learning-by-doing approach is adopted in all the subjects of the UNIGIS-Girona master's degree. And the remote sensing subject is not an exception in that sense.

Students must solve some practical activities that will help them to acquire the competences of the course.

In order to complete the mandatory activities, students have some resources at their disposal:

- Learning materials

- Self-study activities

- Webinars

- Lectures and online resources

Also the **forums** are a very valuable part of the learning methodology of the subject. Through these channels the tutor can answer student's questions, and also mentor them on how to complete the activities.

2.1 Subject structure

The remote sensing subject is structured in four different units.

The first one, **introduction to remote sensing**, is just an introduction to some basic concepts of remote sensing such as electromagnetic radiation, electromagnetic spectrum, spectral signature or bands. Since most of our students have never used processed remote sensing images, they need to be familiar with these basic concepts, which will help them later to complete the mandatory activities.

A questionnaire is used to verify if students have learnt these theoretical concepts.

The second unit, **platforms, satellites and sensors**, refers to the different types of available platforms and sensors, the missions which provide remote sensing images (Copernicus, Landsat, Spot, Ikonos, Aqua and Terra, etc.) and the different ways to obtain these data.

In this unit students are also introduced to the different types of resolutions: spatial, spectral, radiometric and temporal.

The third unit, **image processing**, introduces the steps to perform image processing. The unit also deals with the application of

geometric and radiometric correction techniques and image enhancements.

Finally, the image processing unit shows how to apply the different techniques to analyse the images visually and statistically.

The last unit, **applications of remote sensing images**, shows the applications of remote sensing in different areas: forest, agriculture, oceans and water, ice, cartography, geology and land use. It is also the unit where students learn how to extract information from satellite data, applying indexes, classifications and algorithms to obtain Land Surface Temperature (LST) from thermal bands.

In order to evaluate the competences acquired by the students, they have to work on two different practical activities. Both of them try to emulate a real study case, and are designed to perform the following tasks:

- Search and download images from a public catalog.

- Apply an image correction process over the images.

- Create RGB band combinations.

- Calculate indexes, such as NDVI, NDWI, NBR.

- Apply cloud masks.

- Create image mosaics.

- Obtain LST from thermal bands.

- Execute a supervised classification process.

2.2 The software

The objective of a subject like this is to learn how to deal with remote sensing images and apply the correct methodologies in order to extract useful information from them, but not how to use a specific software, library or toolbox.

Nonetheless, it is obvious that students will perform the activities with a specific tool, and they need to be instructed on that.

Our first approach is to let the students to choose their preferred tools, although we offer some recommendations and materials (lectures, tutorials, manuals and self-study activities) related to specific software.

In that sense, our priority is to recommend the use of open-source tools. So, students are encouraged to use tools like QGIS with the SCP plugin, GRASS Gis and SNAP. With these technologies, they can complete all the mandatory activities, and we consider that are very useful for acquiring the mandatory competences of the subject.

For those students who choose other options, like ArcGis Pro, ENVI, Erdas, etc., we don't offer support materials, but if necessary we can give advice through the forums.

2.3 The data

Nowadays there are lots of missions providing remote sensing images.

It is in fact one of the main competences of the second unit of the course (**platforms, satellites and sensors)** to be familiar with some of these missions and know their main characteristics in order to choose the best one for a specific project.

As it would be completely impossible to design activities to work with data from all the available missions, we can select only some of them.

Due to its impact on the industry, historical series and open access, **Landsat** data are widely used during the course. Students can easily obtain the images from Landsat catalogues using applications like Earth Explorer [1] or through the SCP plugin. Also, Landsat data formats can be directly used by our recommended software solutions and are offered in different processing levels.

Data from the **Copernicus** programme are also used during the course, especially the images offered by the **Sentinel** missions. In the same way as with Landsat images, Sentinel data can be obtained for free through applications like Sentinel Open Access Hub [2] or also the SCP plugin.

In the case of Sentinel datasets, we mainly work with the images provided by the optical sensor on board Sentinel 2. But we've also prepared a non-mandatory activity where students can practice with the radar images provided by Sentinel 1.

2.4 EO4GEO

Our experience developing projects in the geospatial sector is fundamental for designing a programme for a subject like this. We can

easily identify the skills that student must acquire in order to successfully join a team involved in the use and processing of remote sensing images.

However, beyond the experience, there are some tools that can be very useful in order to help in the design of such a programme.

EO4GEO[3] is a co-funded project of the Erasmus+ Programme of the European Union which aims to bridge the skills gap between the supply and demand of education and training in the space/geospatial sectors.

In the framework of EO4GEO, a set of tools based on the GIS&T body of knowledge [4] have been developed.

For example, the '**Bok Visualization and Search**' [5] tool allows users to navigate and visualize the EO4GEO BoK in a graphical and textual way. Starting from higher level concepts representing areas of knowledge in the field, one can browse down to more detailed concepts. So, this tool is specially indicated to identify the knowledge areas and concepts that the subject should integrate.

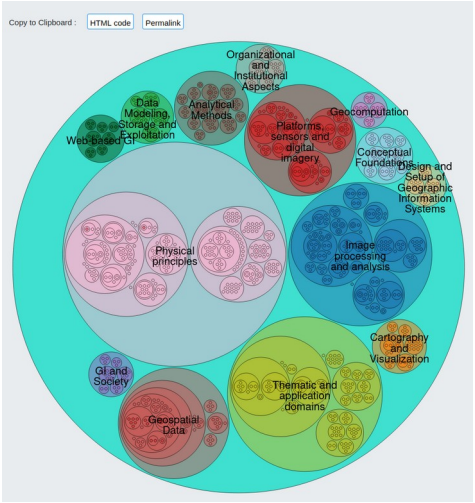

Figure 2. BoK Visualization and Search tool.

The 'BoK Visualization and Search' tool is public, and no registration is required.

The '**Curriculum Design Tool**' [6] (CDT) allows users to create, edit and find educational offers in the field of Earth Observation and Geographic Information. The tool could be useful to define the remote sensing subject programme re-using descriptions of related BoK concepts and link specific EO/GI BoK concepts and skills.

3. Conclusions

Remote sensing is a very valuable source of information for GIS projects. So, from our point of view, a master's degree in GIS must include a course about remote sensing.

A subject like this should guarantee that students have learnt the basic principles of remote sensing, and have also acquired competences in order to search and download remote sensing images, perform enhancements and corrections over them, and also extract information by applying some processes like RGB band combinations, index calculations, band maths or classifications.

Open-source tools like QGIS and the SCP plugin, GRASS or SNAP are good candidates to use during the course.

Despite the wide variety of providers, the open catalogues form Landsat and Sentinel are very useful for acquiring the skills of the course.

Finally, the GIS&T BoK and tools developed in the framework of projects like EO4GEO can help in the design of the course topics.

References

[1] Earth Explorer Website: https://earthexplorer.usgs.gov/, last visited: 25th February 2022.

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[4] GIS&T Body of Knowledge: http://www.gi-n2k.eu/wp-content/uploads/2014/01/UCGIS_GISandT_BoK_DigRelssue2012.pdf

[5] BoK Visualization and Search: http://www.eo4geo.eu/tools/bok-visualization-and-search/, last visited: 7th March 2022.

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