Geographic Information Systems 2023-2024

Exercise 13 - Modern GIS

Introduction

> **GOALS OF THE EXERCISE**
>
> - Obtain a sneak preview of the current advances on GIS
> - Identify trends and determinant technologies

In this exercise, we will try other ways, complementary to the GIS desktop software, to perform spatial analysis, in order to get insights on the subject under analysis.

With the advent of multiple data sources, including open data (e.g. satellite imagery, citizen science, data from government and administration, etc), there is an increase of data, that are available at different:

- formats:
  - geopackage (gpgk)
  - geojson
  - shapefile (shp)
  - csv
  - tiff
  - ...
- sources:
  - downloads
  - webservices Application Programming Interfaces (API)
  - web applications
  - devices (sensors, mobile phones, cameras, Internet of Things (IoT), GPS)

In addition, data gathering, processing and analysis can use multiple technologies and computational platforms. Often, the combination of these in a workflow is the most efficient way of performing a complex task.

As a result, as a modern GIS practitioner, you need to be prepared to work and combine different tools and resources. Often, you will perform part of your work using:

- a **web portal**, to get insight on the data and identification of problems and challenges
- a **cloud computing platform**, for example, Google Earth Engine, which is particularly powerful to facilitate access and process raster data
- a **scripting or programming tool/language**, for example, a Jupyter Notebook in python, to perform data processing or analysis
- a **web cloud service**, like ArcGIS Online to publish your data, and enable additional data services.

This exercise contains three parts:

- Use web applications to consult and analyze spatial data

- Publish data online
- Use code scripts to analyze spatial data

Part 1. Web applications

(You should use 30 min for completing this part of the exercise)

In this part of the exercise, you should visit several web applications, on different subjects, in order to identify multiple types of data visualization methods and data access and use. For each of the resources, click on the links suggested, or browse for more examples.

ESRI's Living Atlas

The ArcGIS Living Atlas is a spatial data repository and aggregator of data developed by ESRI and others that compiles data on multiple domains. The resources has different visualization and analysis tools, including:

- map viewer (online)
- scene viewer (online, for 3D, e.g. OpenStreetMap 3D Buildings)
- open in ArcGIS (requires an active license of ArcGIS Pro)
- dashboards (e.g. Coral Bleaching Locations)
- dynamic blog entries with dynamic data (e.g. USDA Census of Agriculture updates)
- web applications (e.g Sentinel-2 Land Cover Explorer)
- source code (e.g. Imagery Explorer Apps), which you can use to combine with your own code.
- Story maps: https://storymaps.com

Please check the examples linked above, or browse to the ArcGIS Living Atlas and find other examples. Note that most of the data layers can be directly accessed from your GIS desktop, and integrated in your GIS projects:

- in **ArcGIS Pro**, online resources are available at the pane **Catalog**, tab *Portal*.
- in QGIS, by adding as a new connection as ArcGIS REST servers.

Other Web GIS Viewers and data sources

Some global agencies or programmes of the United Nations (e.g. UNEP-WCMC, FAO) create and maintain extensive libraries of spatial data, many of global coverage. These can be valuable resources to get background data for our GIS projects.

You will find many other online platforms that provide domain specific spatial visualization and data access. These are often developed for specific purposes. Some examples:

- Seismological data: https://www.seismicportal.eu/
- Soil data: SoilGrids
- Birdwatchers lists data submissions: https://ebird.org/livesubs
- Cropland Data Layer of the USDA: CroplandCROS
- Map of Life: https://mol.org/
- Marine regions https://www.marineregions.org/downloads.php
- Worldclim https://worldclim.org/
- OpenStreetMap (Export): https://www.openstreetmap.org/export

Part 2. Publish data online

(This is mainly a reading part of the exercise)

You can publish and share your GIS projects and data online. The platform where your data will be available will depend on the desktop software you use, ArcGIS Pro or QGIS. In any case, your project, and the individual layers are published online, and can be accessed through a URL or database connection.

ArcGIS Pro

In the case of ArcGIS Pro, it integrates with ArcGIS Online.

After you finish preparing your GIS project on the desktop app, you can publish it online using the menu **Share --> Web map**. For an individual layer, you can use the tool **Web layer**. During the publication workflow, you will define the visibility of the layer online (public or private), and provide metadata to the resource being shared.

You can try to publish the results of your Ex07, or check the following example of our Ex07 project: https://ulisboa.maps.arcgis.com/home/item.html?id=767aa067dfc64531bb50aa687c3da595

Notice that each of the three vectorial layers integrated in the webmap - roads, parcels, boundary - have individual URL, meaning they can be accessed individually.

QGIS

The online publication of a QGIS GIS project is possible using the online service QGIS Cloud. This has several levels of service, with the free level allowing to publish and share public maps.

The integration with QGIS Desktop requires the installation of the **QGIS cloud** plugin in QGIS. Using the plugin, it is relatively easy to follow the steps to make the project shared online. in addition to the webmap, accessible online, it is also possible to create WMS and WFS services for the data layers. These can be later integrated in GIS projects. However, this service still displays some inconsistencies in data transfer/refresh.

The map for our Ex07 project can be viewed here: https://qgiscloud.com/ruifigueira/ex12_cloud

Part 3. Develop scripts to analyze spatial data

This part of the exercise is to demonstrate how spatial data can be accessed and analyzed using python in a Jupyter Notebook. In the analysis, we will determine the land use / land cover of the ISA's campus we edited on Exercise 07. The classification of the area is obtained from the ESA's WorldCover service https://esa-worldcover.org/en.

In order to perform this part of the exercise, you need to open a Jupyter Notebook hosted at the Google Collaboratory platform. This is a cloud service that provides a computing platform for python scripts.

You do not need to know python in order to run the exercise. All you need is to run all of the code cells, from top to bottom, by clicking on the play button that shows when you hover the code you your mouse, as indicated in the image bellow.

```
# import python modules
import numpy as np
import pandas as pd
import requests
import urllib.parse
import geopandas as gpd
import matplotlib.pyplot as plt
```

The Jupyter Notebook also contains cells of text that help to explain and document the analysis flow, and after running a code cell, results will appear with the output of that code.

To continue to the script code, link to the following: https://colab.research.google.com/drive/1E5GH_lnp_mjB-SrAcyrT3TR_un1Hcd0r?usp=sharing and follow the notebook by reading text, running code and analyzing outputs.