PRACTICAL GUIDE

Introduction

Geographical Information Science (GIS) is an academic discipline that has both theoretical and practical aspects. Practical GIS skills are useful in many research fields (social and scientific), may help you in your dissertation or project work, and are in great demand in the workplace. It is also generally easier to understand the theoretical side of GIS if you have practical experience. This guide is intended to accompany a series of practical exercises which are designed to give you practical skills and experience in GIS.

GIS Software

Two software applications presently dominate the GIS market, each with benefits and drawbacks:

1) **ESRI ArcGIS**: Consists of a suite of programs including ArcMap (standard GIS) and ArcScene (pseudo-3D GIS). ArcGIS has been the market leader for most of the development of GIS as a discipline since the 1990's, so it comes with a great legacy and is widely used.
   PROS: Well established in industry, and comes with a vast array of tools, algorithms, and online help.
   CONS: The user-interface is often un-intuitive, it is quite buggy, and is very expensive outside education.
2) **Quantum GIS**: Consists of a single program (QGIS). QGIS has undergone significant development in recent years and seems to be gaining market share from the competition, especially in the public sector.
   PROS: It is OPEN SOURCE software, free to install, and is rapidly catching up with ArcGIS in popularity.
   CONS: Lacks some of the more advanced functionality of ArcGIS, and may not be so sought after by employers.

Although ArcGIS is expensive, at Swansea both this and QGIS packages are installed on the Open Access computer system available to all staff and students. QGIS is adopted as the best tool for teaching GIS because its functionality has now reached a sufficiently advanced level, in my experience it is easier to use that ArcGIS, and crucially it is free for you to install on your own computers. I recommend that you do so (search *QGIS and install the latest stable release version*).

The overall functionality and user interface of these two software solutions are quite similar, and data files can be shared between them. However, they are both complex programs and differ in some respects. If you become keen on GIS and see a future in it for you, I recommend that you try to get the best of both worlds by exploring ArcGIS as well as QGIS, perhaps by also trying to complete the practical exercises in ArcMap.

Learning computer skills

The most effective way to learn a new software package is to sit down and use it to complete a set of tasks. The practical exercises are designed to lead you through a series of the most commonly used functions in GIS using QGIS. You will build up a range of skills and set of results that will be vital in your GIS coursework, project or dissertation. Once you have mastered the basics, it will be easier for you to explore more complex functionality. Here are some useful tips for effective development of your QGIS skills:

1) Expect to make mistakes, to get confused, to have to repeat many steps, and also for the software to hang or crash occasionally. The key to making progress is to develop strategies to rapidly recover from such setbacks. Most of your learning will be through making, and recovering from, such mistakes. Repeating steps many times is an effective way to remember how to get things done.
2) Save your work regularly, make sure you know where it is saved, and make copies of work that has taken a long time to achieve. Be tidy and structured in the way you handle computer files so that you can easily discriminate important from irrelevant files. GIS work tends to generate a large number of files, so it pays to be organized.
3) Do not expect to be spoon-fed a recipe for success. Simply following steps is usually boring and unproductive. You will learn more quickly if you have to be active in seeking out the next step. Be bold and experimental in exploring the functionality in all of the menus as you work out how to make progress. The practical exercises will expect you to find some things out for yourself.
4) If you get stuck, help is available in a number of places. These include the video demonstrations on Canvas, and the timetabled Zoom sessions. You are also encouraged to discuss the exercises with other

students to make joint progress with peers but beware that coursework must be carried out individually. Online help is also available from other sources (see *Getting help* later).

Swansea University Open Access computer network and Virtual Desktop

Software and data is provided through the Open Access computer network, which you can access in-person in one of the labs around campus, or via a virtual desktop on any computer with *Remote Desktop Protocol* installed (standard for most Windows PCs, available for most Macs and Linux computers). See elsewhere for instructions on how to access the virtual desktop, which will need Multi-Factor Authentication via a Smartphone App.

Applications are provided through the ZenWorks folder on your desktop. You will find QGIS (and ArcGIS) in the Science->Geography area. We use the latest stable release of QGIS.

Storage space is provided through OneDrive and network drives which appear identical regardless of which computer you are logged into and OneDrive should also be available to you on your own computer. You should save your own work on OneDrive to keep it secure and easy to access wherever you are. If you use the C:Drive (the local hard disk), then your work will not be available on other computers and may be deleted automatically overnight.

I will provide data for the exercises and project via the ***Student Common L:drive*** (L:/College of Science/Geography/GIS/data). If you prefer to work on your own computer, then you will need to transfer these datasets. You can achieve this via OneDrive which should be available to you on both.

Occasionally your disk space can become completely full and this will adversely affect the software. To test if a drive is full, see the notification panel on your desktop or query the ***Properties*** of the *Drive* in Windows Explorer (right click), or go to the top level of folder tree where information about all attached disks can be found. It is often possible to make space by deleting unwanted or temporary files.

If you have problems with a persistently full disk, software unavailability, logging in, or any other computer-related issues, please refer to the HelpDesk in the Library.

QGIS basics

Windows

QGIS is based primarily around two desktop windows: the *Main Project Window* and the *Print Composer Window*. In addition, *Attribute Tables* can be opened to show data associated with map elements. You need to become familiar with opening and interacting with these main program elements.

Layers

All GIS software uses the concept of data *Layers*. A layer is a self-contained data source of a single type (point, line, polygon, or continuous field) that has one or more other data files associated with it. Layers are opened together within the software and visualized within a map or processed in some way individually or together to produce new layers. The choice of ordering of layers is important as layers on top may obscure those beneath.

Projects

A QGIS *Project* is a *container* which allows you to collect together and organize all of the data layers associated with a single geographical location. Projects are saved with a filename extension *.qgz. It is advisable to start a new project frequently, especially when the geographic focus of your work changes or you move onto a new assignment. The critical idea to grasp is that a QGIS project file DOES NOT contain the data associated with the project. Instead it contains virtual links to all of the data layer files that you have opened, as well as instructions to the software as to how they should appear. This leads to three important considerations:

1) Copying or transmitting a complete QGIS project from one computer system to another would require copying the project file AND all of the data layers in such a way as to maintain all of the relative file paths. This is sometimes difficult to achieve. If you change your computer environment (e.g. from the University system to your laptop) it is often easier simply to copy all of the layer files and start a new project from scratch, opening and arranging each of the layer files again.

2) Moving or renaming data layer files (or the folders in which they are kept) will mean that a project file can no longer find them and will not open cleanly. It is possible to recover from this situation, but better to avoid it. All data files on the L: drive will remain where they are. Make sure that all data files that you put on your OneDrive (or memory stick or laptop disk) are named sensibly and placed in an appropriate folder structure so that you don't accidentally move, rename or delete them. You will probably generate many hundreds of data files by downloading (e.g. from the internet), copying (e.g. from the L: drive), or creating in the course of GIS processing.
3) When you create a new GIS layer, for instance by performing a geoprocessing function on an existing layer, you are normally presented with the option of creating a temporary layer or saving the new layer to disk (following the … icon). Creating temporary layers is a quick way of exploring GIS, but when you close the project, these layers will no longer be available. I recommend that use temporary layers for experimentation, and choose a permanent name, location, and type for any layer that you will need later on.

In general, it is more important to protect (backup) your data layer files (which may have involved many processing steps) than your QGIS project files (which can normally be recreated swiftly, and which in doing so will help you to learn by repetition).

Plugins

The basic installation of QGIS is adequate for many purposes but the GIS practical exercises go a bit beyond this basic functionality. Many QGIS add-ons have been developed through Open Source software development and made freely available through the *Plugins* interface (*Main Menu->Plugins->Manage and install Plugins*). Plugins are installed in the user part of the computer storage so require no administrator privileges. You are encouraged to explore all available plugins. The practical exercises will explain which Plugins need to be installed for the practical exercises (on the University system and/or on your own computer):

Printing and exporting maps from QGIS

When you come to print or to export a map from QGIS, the software does not simply send what is visible on-screen to the printer but uses the map item settings to select what is printed and how it should appear. Thus, if you have made changes to one part of the composition since you last refreshed the screen, the map might not be printed as you expect. This is particularly noticeable if you have used one layer or layers for two or more different map items. Making a layer visible in one map item will automatically make it visible (on printing or refreshing) in another, unless you choose to lock the layers.

To make sure that you print (or export) only what you intend to, **for each map item**:

1. Compose the map item using the layers you need and their properties as you choose.
2. Check the tickbox "***lock layers for map item***" which you will find under the *Item Properties* tab
3. Refresh the screen (View->Refresh) to make sure that everything looks as you want it to
4. Only then should you print or export.

Note also that printed colours may appear different to colours on your screen. If you need to print a map for any purpose (e.g. for inclusion within an essay or dissertation), you may want to check that you are happy with how your chosen screen colours translate onto the printer. The only way to do this is to print your work, inspect it carefully to see if you are happy that all map items can be read and discriminated from one another, then adjust the colours to improve the look. Sometimes multiple tests are advisable. Your work may be judged, in part, on its appearance. Fortunately, all of the coursework in GIS, and much of your assignments in other courses are submitted online.

Don't forget that printers hardly ever print right up to the end of the page. If you intend to print directly from QGIS, it is a good idea to leave a margin of at least ~0.5 cm around a map.

Use of Transparency

Choosing a level of *transparency* for GIS data layers can sometimes make it easier to visualize many layers together so that one layer does not obscure another so completely. HOWEVER, when you come to prepare a map of your work beware. The *Legend* (or Key) will explain to the user of your map (or the person giving it

a mark!) what each element of the map is and how it should appear – there is a fundamental and important process of conveying information which is dependent on the printed properties (colour, line width etc.) of a map item, and the printed properties of the legend. If you use transparency unwisely, the map items may no longer appear the same colour as your legend says they should, and the communication link is broken. I recommend that you avoid using layer transparency (other than fully transparent or fully opaque), especially when producing coursework.

GIS file types

There exist many different computer file-types associated with GIS data layers. For raster data I recommend ***GeoTIFF*** (filename extension *.tif or *.tiff; https://en.wikipedia.org/wiki/GeoTIFF) as a type for you to download where there is a choice, or to save raster layers to. For vector data (points, lines or polygons) I recommend the ***Shapefile*** format (filename extension *.shp; https://en.wikipedia.org/wiki/Shapefile) as it is the format most commonly used at present. The drawback with shapefiles is that what is referred to as an individual *shapefile* is actually stored on disk as a number of files (minimum of 3, norm of 5, maximum of 16) with the same root name but different filename extensions. This means that when you copy, transmit, backup or share a shapefile, you need to make sure that you include all of the files in the same folder that are associated with it.

GIS data sources

Sources of data compatible with GIS are myriad and growing very quickly. Using a search engine will rapidly make this clear. In the UK, detailed and authoritative GIS data associated with the landscape and built environment has traditionally been provided by the Ordnance Survey of Great Britain (OS). OS provide some data free (OS Open Data; https://www.ordnancesurvey.co.uk/opendatadownload/products.html), but other OS data products are restricted by licensing. As an educational institute Swansea University students and staff have access through the Digimap service (https://digimap.edina.ac.uk/).

In recent years, Open Data projects such as Open Street Map (OSM; https://www.openstreetmap.org) have been developed by the community to provide rival data free of licensing restrictions. These data are continuously improving in quality and coverage and anyone can get involved in the project. I have chosen to use only Open Data sources for the practical exercises and project so that there are no restrictions on sharing data.

Getting help

For general information please refer to Canvas. All documents associated with the course will be posted there, and I may use the Canvas Discussion Board for extra information. If you don't find what you are looking for, feel free to email me but please be patient for a reply. If I receive a query the answer to which might be useful for all students, I will post a reply on email or the Discussion Board or discuss it on Zoom.

Software-specific problems can often be solved by online help pages and forums. The QGIS manual can be found at https://www.qgis.org/en/docs/index.html, and useful forums include http://www.qgisforum.org/ and http://qgis.uk/. If you have a specific problem, a quick internet search using 'QGIS' and a description of your problem can often lead you to a solution.

Software Issues

QGIS is a robust and stable piece of software but can sometimes do strange things. Here are some tips:

- If a menu or menu-item are missing, try restarting the software
- If that doesn't work, explore the Plugins dialog to make sure that the basic processing tools are 'activated'
- If, when you open an existing project, you are presented with a table saying "Handle Bad Layers", then your QGIS project cannot connect to some or all of the data layers that you have opened previously. This can happen if you inadvertently move or delete data files that are part of your project. The only way to recover is to put things back as they were, or re-open the 'Bad Layers'.
- Another possible cause for 'Bad Layers' is that OneDrive or the L:drive did not connect properly to your computer when you logged in, and the best solution is to log out and in again.