UNSW
THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF SCIENCE

SCHOOL OF BEES

GEOS3821

GEOGRAPHIC DATA ANALYSIS

AND

GEOS9017

Advanced GIS

T1, 2021

Faculty of Science - Course Outline - 2017

Contents:

Faculty of Science - Course Outline - 2019

1. Information about the courses

NB: Some of this information is available on the UNSW Virtual Handbook[1]

Year of Delivery	2021
Course Codes	GEOS3821 GEOS9017
Course Name	Geographic Data Analysis Advanced GIS
Academic Unit	School of BEES
Level of Course	3rd year & postgraduate
Units of Credit	6UOC
Session(s) Offered	T1
Assumed Knowledge	A knowledge of GIS principles and ArcGIS 10
Hours per Week	4
Number of Weeks	10
Dates	Weeks 1-10

Summary of Course Structure (for details see 'Course Schedule')

Component	Hours	Time	Day	Location
Lectures	13		Mon, Tues	Online
Labs	20	14:00-16:00	Tuesday & Wednesday	Bioscience G29 and online

2. Staff involved

Staff	Name	Contact Details	Consultation Times
Course Convener and lecturer	Prof Shawn Laffan	Shawn.Laffan@unsw.edu.au +61 2 9065 5607	By appointment outside scheduled contact times

[1] UNSW Virtual Handbook: http://www.handbook.unsw.edu.au/current/index.html

3. Course details

Course Description[2] (Handbook Entry)

GEOS3821:

The field of Geographic Information Systems has expanded considerably over the past decade and the world has become very much richer in digital geographic information. Vast amounts of geographic data are routinely collected, with approximately 80% of all data collected having geographic attributes. This course explores a toolbox of conceptual approaches and methods to model and analyse a range of highly complex, often non-deterministic, geographic problems. It explores a true enabling technology for the natural sciences in addition to a rich source of computational and representational challenges for the computer sciences. This course emphasises a range of GIS and spatial data analysis approaches via a disparate selection of real-world applications.

GEOS9017:

Geographic information systems have improved considerably over the past decade in response to a world that has become very much richer in digital geographic information. The requirement to build complex applications and simulations has become more urgent with the need to plan for a changing climate, to feed an increasing population and to provide pinpoint marketing analysis for business. This course explores a toolbox of conceptual approaches and methods to model and analyse a range of highly complex, often non-deterministic problems. It provides a true enabling technology for the natural sciences and a rich source of computational and representational challenges for the computer sciences. Topics covered include spatial dynamic spatio-temporal modelling; geostatistics; error analysis and data accuracy; network analysis; and machine learning and artificial intelligence methods in GIS.

Course Aims

The main objective of this course is to provide you with experience in the analysis of spatial data. Through this approach, you will be better equipped to deal with the enormous variety of different applications you will encounter in the workforce.

Student Learning Outcomes

By the end of this course you will be expected to understand how and when you should use spatial analysis approaches to address geographic problems. You will also be expected to understand the advantages and limitations of such approaches, as all such analyses are simplifications of reality.

[2] UNSW Handbook: http://www.handbook.unsw.edu.au/current/index.html

Graduate Attributes Developed in this Course

Science Graduate Attributes	***FOCUS*** *0 = NO FOCUS* *1 = MINIMAL* *2 = MINOR* *3 = MAJOR*	**Activities / Assessment**
1. Research, inquiry and analytical thinking abilities	3	All will be achieved through the main project
2. Capability and motivation for intellectual development	3	
3. Ethical, social and professional understanding	1	
4. Communication	2	
5. Teamwork, collaborative and management skills	3	
6. Information literacy	3	

Major Topics (Syllabus Outline)	See the lecture sequence
Relationship to Other Courses within the Program	This course explores the application of cutting-edge conceptual approaches and techniques to model and analyse a range of highly complex, often non-deterministic spatial problems. Such approaches are essential for the modern study of many different components of the environmental and geosciences. It provides examples of what can be done using such spatial data, as well as a grounding in how to effectively use such data.

4. Rationale and strategies underpinning the course

Rationale for learning and teaching in this course – How this course is taught

Spatial analysis is technical in nature, in that one needs to use software to achieve one's aims. However, this course is not about teaching software. It is about the principles of GI Science and spatial analysis (software changes rapidly while principles do not).

There are three elements that you should use for learning in the course. The textbooks provide an overview of the subject, and are a key reference source. In the case of the software, there are detailed online manuals that should be referred to. These include both command references and tutorials. Finally, there are your colleagues in the course. You are all working on similar problems, and you should be learning together. The Moodle discussion forum is provided to assist in this.

As described above, you are expected to do much of the learning both by yourself and with your colleagues. Given the level of this course is third year and postgraduate you should have a broad understanding of geographic processes to which you can relate the course material (even if you have not formally studied it). Much of the learning is done as part of your assessment tasks, and I encourage you to delve further into the topics we cover, particularly as they relate to other fields of endeavour and applications you are interested in.

Teaching Strategies

The primary teaching strategy used in this course will be interactive "chalk and talk", supported by other media. I expect students to interact in the class. This is a less structured approach than used in standard lectures and provides a better learning environment. Lecture and laboratory notes will be provided on Moodle as support material, as will a discussion forum. More importantly, student learning is structured such that it is done through the practical application of the analysis techniques and applications covered in the course.

How the assessment supports and assists the learning

The assessment tasks are a learning exercise. One of the best ways to learn geospatial analysis is to actually do it, and this includes the process of making mistakes and repeating your work without these mistakes. This can be frustrating, but is a normal part of the learning process – you should expect to make many errors as part of your learning process so don't panic.

Access to the lecturer

I am available immediately after lectures, and the labs are devoted to the major project. If you encounter a problem outside of the scheduled contact periods, then what you should do depends on the nature of the problem.

If your problem is conceptual then please contact me by email or telephone to arrange a time to discuss it. I often have other meetings or am away from the university, so this will save you long periods of waiting around or trying to find me. Please provide a short summary of the area or topic you need help with to allow me to prepare for the meeting. Writing it in an email can also help you find the solution yourself.

Many of the challenges in this course are technical in nature. In turn, many of these technical problems are common to the entire course. So, **if your problem is technical and related to the software**, then please follow these five steps.

1. **Stop and think**. You will often be able to solve the problem with a little of your own brain power. I have found that walking away from the computer and doing something else for half an hour is a very effective approach. (Let your subconscious mind do some work).

2. **Read the manual**. The manuals have detailed explanations of much of what we need to do. They should be your next port of call. It will take a bit of time initially while you get used to the mindset of the software developers, but once learnt they are very useful. The ArcGIS software also has an extensive online database of bug reports and solutions. http://www.esri.com/

3. **Ask someone else in the course** if they have encountered the same problem – they may know the answer (and it is good to talk to people…)

4. **Post a question to the course Moodle discussion board or email the lecturer**. Read the list of postings first, in case someone has already answered the question. The discussion board will be regularly checked to post answers and check factual accuracy of other answers. Email queries relevant to the whole course will be anonymously copied to Moodle with a response.

5. **If your problem has still not been solved, then please contact the lecturer to make an appointment.** Don't stew on the problem forever.

The five steps are actually the approach you will need to use in the workforce, so it is a good learning exercise in itself.

5. Course schedule

Week	Lectures & topics	Labs	Assignment and Submission dates
1	1. Course introduction 2. Course overview 3. Spatial analysis concepts: Local & global; autocorrelation, dependence, structure; MAUP; geographic neighbourhoods	Explore data sets and select which you will use for the course. Try some initial analyses. Tuesday only	
2	Univariate spatial analysis of continuous field data 6. Local: Gi* hotspots, Moran's I autocorrelation 7. Global: Semivariograms, correlograms and related indices	Univariate analysis methods Tues & Wed	
3	Spatial analysis of discrete object/entity data; Point pattern analysis. 8. Kernel density analysis; Ripley's K Multivariate spatial analysis of continuous field data 9. Covariograms, bivariate Moran's I and related indices	Continue univariate analyses, start on multivariate as appropriate Tues & Wed	Quiz 1 during Wednesday lab.
4	10. Geographically Weighted Regression (GWR) Spatio-temporal 11. Space-time clustering	Start space-time analyses as appropriate Tues & Wed	
5	12. Applications 13. Revision	Tues & Wed	Quiz 2 during Wednesday lab
6	No lectures	Tuesday only	Project proposal due
7	No lectures	Tuesday only	
8	No lectures	Tuesday only	
9	No lectures	Tuesday only	Major report due
10	No lectures	No labs	

6. Additional resources and support

Text Books

O'Sullivan, D and Unwin, D.J., 2010. Geographic Information Analysis, second edition. Wiley, New York.

http://onlinelibrary.wiley.com.wwwproxy1.library.unsw.edu.au/book/10.1002/9780470549094

Fortin, M-J. & Dale, M., **2005**. Spatial Analysis: A guide for ecologists. Cambridge University Press, Cambridge.

http://www.unsw.eblib.com.wwwproxy1.library.unsw.edu.au/patron/FullRecord.aspx?p=228304&echo=1

Additional material will be from:

O'Sullivan, D and Perry, G, 2014. Spatial Simulation: Exploring Pattern and Process. Wiley-Blackwell, Oxford, UK.

http://primoa.library.unsw.edu.au/UNSWS:SearchFirst:UNSW_ALMA51172222780001731

Course Manual

Lab instructions and lecture notes are available through Moodle.

Required Readings

See the Leganto link under the course Moodle page.

Additional Readings

Useful Journals:

International Journal of Geographical Information Science
Transactions in GIS
Geographical Analysis
Environment and Planning, Series A
Computers and Geosciences
Journal of Geographical Systems
Mathematical Geology
Ecological Modelling
Environmental Modelling and Software
Remote Sensing of Environment
Photogrammetric Engineering and Remote Sensing
International Journal of Remote Sensing
Environmental Modelling and Software

You should also become familiar with the use of citation tracking in the Scopus, Web of Science and Google Scholar databases. These are available via the library http://www.library.unsw.edu.au/. Citation tracking allows you to see who has been citing articles, and who is cited in articles. It is a very good way of seeing if an idea or method has been critiqued or further developed by subsequent researchers.

Recommended Internet Sites

Geocomputation conference series: http://www.geocomputation.org/

MODSIM conference series: http://www.mssanz.org.au/

Computer Laboratories or Study Spaces

Bioscience G29

7. Required Equipment, Training and Enabling Skills

Required equipment	Provided in the computer labs.
Enabling skills - training which may be required to complete this course	Working knowledge of ArcGIS version 10.

8. Assessment Tasks and Feedback

Task	% of total mark	Submission date	Feedback	
			When	**How**
Quiz 1	10	Week 3	Feedback immediately following quiz	Marked exams
Quiz 2	10	Week 5	Feedback immediately following quiz	Marked exams
Project proposal	GEOS3821: 20 GEOS9017: 25	Week 6	One week later	Marks and annotated documents
Major report	GEOS3821: 60 GEOS9017: 55	Week 9	One week later	Marks and annotated documents

For GEOS3821 students: if your mark for the major report is higher than the project proposal, then the weightings will be 10% for the proposal and 70% for the report.

9. Course Evaluation and Development

Mechanisms of Review	**Last Review Date**	**Comments or Changes Resulting from Reviews**
Student surveys	2011	This course has been conducted in various forms since 2004. It has been continuously adapted and modified on the basis of student feedback during that time. Prior to 2021 it was run in five day intensive mode.

10. Administrative Matters

Expectations of Students

You are expected to attend all lectures and laboratories. All assessable items are compulsory.

Assignment Submissions

Assignments are to be submitted using the Moodle assignment submission system. Extensions will not be granted unless supported by documentation (e.g. doctor's certificate) or through UNSW Student Central (see https://student.unsw.edu.au/special-consideration).

Occupational Health and Safety[3]

Information on relevant Occupational Health and Safety policies and expectations can be found at https://safety.unsw.edu.au/.

Examination Procedures

The quizzes will be online and held during the course.

Equity and Diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services unit (https://student.unsw.edu.au/els).

Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

Grievance Policy[4]

Grievance Officer / Designated Officer	School Student Ethics Officer	University Contact
A/Prof Scott Mooney School of BEES s.mooney@unsw.edu.au Tel: 9385 8036	A/Prof Stephen Bonser School of BEES s.bonser@unsw.edu.au Tel: 9385 3863	University Counselling Services https://student.unsw.edu.au/counselling

[3] UNSW Occupational Health and Safety: https://safety.unsw.edu.au/ /

[4] UNSW Grievance Policy: https://student.unsw.edu.au/complaint

11. UNSW Academic Honesty and Plagiarism

What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.
*Examples include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne.

BEES Academic Honesty and Plagiarism

Please note:

In addition to the UNSW Policy on Academic Honesty and Plagiarism, the School of Biological, Earth and Environmental Sciences (BEES), also considers any work submitted that has been produced outside of a given course in a given year to be plagiarism i.e:

- Work produced for a third party e.g. your place of employment, is considered intellectual property of the third party, and as such if such work is submitted in place of a required course work, it is deemed plagiarism.

- All work submitted for assessment must be created specifically for the given assessment task in the given year. Work produced in previous years or for other assessments is not acceptable.

12. Major Project Proposal and Report, and Marking Criteria

Synopsis

The major project consists of the application of a set of spatial analysis methods to one or more data sets. Which specific analyses you use should be discussed with the lecturer, but should incorporate two of the main types of analysis discussed in the course (e.g. (1) a univariate analysis followed by a multivariate analysis, or (2) a univariate analysis followed by a spatio-temporal). Attempting more than two types will be too large an endeavour for a course of this scope and is discouraged.

The project proposal is an early version of the major project report and will describe preliminary analyses, results, conclusions and remaining work. It is used to provide feedback before the major report is written. The major report itself will describe the full set of analysis results.

The project proposal should be written in the style of an extended abstract for a conference. Length should be a maximum of 1500 words, excluding references, captions and tables of contents. Page length should not exceed 5 pages.

The major report should be written as a manuscript for an academic journal. Length should be 4500-6000 words, excluding abstract, references, captions and tables of contents.

Available data

The choice of which data set(s) to use is up to you, but this should be decided by the start of Week 2 to optimise your time. We have a collection of data sets you can use (see below). You can use your own data if you have some, but these must be approved before the end of week 1 to ensure the approaches covered in the course will be appropriate. Generally speaking, you need a high spatial density of observations relative to the variation of the phenomenon or phenomena they represent or sample.

Data sets:

1. Census of the Australian population (2001, 2006, 2011, 2016). Whole of Australia
2. Geochemical data, Cyprus Geochemical Atlas survey
3. Hurricanes in the Caribbean
4. Earthquakes in Australia
5. Crime data (see http://crimetool.bocsar.nsw.gov.au/bocsar/)

The first four are available on the N: drive, most in subfolders within N:\GIS_courses or N:\GIS_data.

Note that the N:\ drive is only accessible from the BEES computer lab machines.

See also data via the AURIN data portal and its plethora of urban population and other data sets. https://portal.aurin.org.au/

Another source is the ecocloud data explorer.
https://app.ecocloud.org.au/explorer

Question

The specific details of the question you address are up to you, and will depend on which data set you use. As a guide you should first analyse your data using univariate local and global analyses. If you are using time series data (e.g. earthquakes and hurricanes) then you should then use spatio-temporal tools. If you do not have time series data then you should use multivariate spatial analyses such as GWR.

As a guide, if you are using the Census, Crime or Cyprus data then the question will be based around two or more variables and be like: “What is the spatial distribution of variable a and of variable b? How do their distributions correspond and how do they differ?”

If you are using the hurricane or earthquake data then it will be spatio-temporal and something like: “Where are the spatial clusters of events? What is their temporal distribution?”

Please ensure you focus on the spatial analysis aspects of the problem, as that is what this course is about. You should show an understanding of the application domain, but it is not the primary focus of the work.

Software

Most of the data manipulation and preparation will be conducted using ArcGIS. The software to use for analyses themselves depends on what you are doing. Again, many of the analyses can be done within ArcGIS, using the Spatial Statistics and Spatial Analyst extensions. Additionally, point pattern analyses can be done using CrimeStat (substantially faster than ArcGIS for Ripley’s K). Spatio-temporal analyses can use SaTScan (or DBScan if we can get it working). OpenGeoDA is also available, and there are RStudio notebooks for some analyses if you prefer to use R.

These are already on the computers in either the start menu or under N:\GIS_courses\software, but can also be accessed through these sites:

CrimeStat: http://www.icpsr.umich.edu/CRIMESTAT/

SaTScan: http://www.satscan.org/

GeoDA: https://geodacenter.asu.edu/projects/opengeoda

RStudio Notebooks:
https://github.com/shawnlaffan/geographic_data_analysis

An access code for the ArcGIS student edition will be provided if you do not already have one.

Remote access to the G29 desktops will be enabled so you can use the software stack on those machines out of hours. ArcGIS can also be accessed directly through the MyAccess system, although it can be cripplingly slow. https://www.myaccess.unsw.edu.au/

Access to the ArcGIS Pro system will also be provided. ArcGIS Pro is a properly 64 bit application with a slightly simpler user interface than ArcGIS Desktop, albeit with some kinks that need to be ironed out.

Marking criteria

The approach used in marking is based on Biggs' (2003) Structure of the Observed Learning Outcome (SOLO) taxonomy (Table 1). There is also a set of words that describe the grades and marks (Table 2). Reading these tables should aid your understanding of what I am looking for in your projects in relation to the specific marking criteria.

Table 1. Biggs' SOLO taxonomy. This is a hierarchical taxonomy, listed from lowest to highest level. Achieving a higher level implies exceeding the lower levels. There is no direct translation between all grades and SOLO levels, as it depends on the level of the course and the nature of the assignment.

Level	*Verb examples*
Prestructural	Misses the point
Unistructural	Identify, do simple procedure
Multistructural	Enumerate, describe, list, combine, do algorithms
Relational	Compare/contrast, explain causes, analyse, relate, apply
Extended abstract	Theorise, generalise, hypothesise, reflect

Table 2. Grade and mark interpretation

Grade	*Mark*	*Description*
High Distinction	85+	Work of exceptional quality showing clear understanding of the subject matter and appreciation of issues; well formulated; arguments sustained; maps and diagrams where relevant; relevant literature referenced; marked evidence of creative ability; solid intellectual work.
Distinction	75-84	Work of very high quality showing strong grasp of subject matter and appreciation of dominant issues, though not necessarily of the finer points; arguments clearly developed; relevant literature referenced; evidence of creative ability; solid intellectual work.
Credit	65-74	Work of solid quality showing competent understanding of subject matter and appreciation of main issues, though possibly with some lapses and inadequacies; arguments clearly developed and supported by references, though possibly with minor red herrings and loose ends; some evidence of creative ability; well prepared and presented.
Pass	50-64	Adequate answers; reasonably relevant and accurate. Sufficient to merit a bare pass to safe pass mark.
Fail	<50	

References

Biggs, J. (2003) *Teaching for Quality Learning at University*, second edition. Society for Research into Higher Education & Open University Press, Buckingham, UK.

Specific criteria

In terms of Biggs' SOLO taxonomy, a High Distinction in the project represents Extended Abstract, while a Pass is Multistructural.

Postgraduate students will be assessed at a higher standard than undergraduate students.

Throughout your project reports you are expected to demonstrate an understanding of the meaning of your results, the rationale for doing it, and potential sources of error and their impact on your conclusions.

I will also be looking for:

Clarity

Clear, simple, grammatical language used. All terms are explained.

Argument and structure

Is the argument clearly and logically developed through the report? Are the points in the appropriate sequence (do your points build on previous points presented)? When discussing the limitations of your work, do not simply dump them at the end of the document. Note them as they become relevant, i.e. interweave them.

The wider scope

Do you place your work in the context of the broader literature? **You should cite at least ten peer-reviewed articles or book chapters.**

Be careful when using web sites as a source of information. If they summarise another piece of work, then you should read and cite the original piece of work (the primary reference). This particularly applies to Wikipedia. It is a secondary source – use it to locate primary sources. This rule also applies to lecture notes – use the references provided in them, not the lecture notes. In general, you should avoid direct use of web sites unless they are an official publication like a government report.

Map composition and diagrams

Are they clear and do they display the desired information? Are they used to support your arguments and not purely as decorative material? Do your maps have a scale bar, north pointer and legend? Are appropriate and consistent colour schemes used?

Innovation

This is the degree to which you develop your own ideas, moving beyond the instructions given in the lab handouts. Examples might be assessing analysis reliability or implementing more complex analyses.

Referencing

Appropriate use of the Harvard style referencing system[5]. There are several formatting variations with the Harvard system (have a look at a sample of journals, for example the *International Journal of Geographical Information Science*). I do not mind which one you use so long as it is consistent throughout the report. One exception to this is that you do not need to list all authors in the main text where there are three or more authors (eg. "Border et al., 1999" and not "Border, Taylor, Waugh, and Ponting, 1999"). Please see https://student.unsw.edu.au/referencing for a

[5] https://student.unsw.edu.au/harvard-referencing

good introduction, albeit their use of inverted commas around book and journal articles titles is tedious and unnecessary. It is far easier to use a style that does not require them. Please also note that the EndNote software is freely available to UNSW Staff and students. See http://www.it.unsw.edu.au. You can also consider the Mendeley or Zotero packages (http://www.mendeley.com; https://www.zotero.org). Learning how to use such software will make writing assignments considerably easier, and will solve most of your problems with building referencing lists (providing your database is correct). Most journal web sites also now support the direct export of citations into reference management software.