ARCLG117
Spatial Analysis in Archaeology
(15 credits)

2015–2016

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Turnitin Password IoA1516
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This document and other resources are available from the course website: http://moodle.ucl.ac.uk/course/view.php?id=335
1 Overview

1.1 Short description

This course provides a working knowledge of the statistical theory and methods used to comprehend spatial patterns, whether the latter be distributions of settlements across a landscape, densities of artefacts across a site or region, or different kinds of archaeological sampling procedure. Students learn the fundamental differences between spatial and non-spatial statistics, the design of appropriate sampling strategies for fieldwork, geostatistical methods (e.g. kriging), predictive modelling through logistic regression and more spatially-sensitive versions (e.g. geographically-weighted regression) as well as the multi-scalar analysis of point patterns or processes (e.g. K functions and related methods). They develop practical familiarity with the R statistical package, which is perhaps the premier open source software environment for statistical analysis. The course is suitable for all those interested in more formal methods of spatial analysis, and hence assume a willingness to grapple with computational and quantitative methods. However, there are no pre-requisites and the course is open to those with no prior training in statistics or GIS.

It is taught using a combination of lectures, practical sessions and tutorials in the Institute’s AGIS laboratory and is assessed via a portfolio of analytical work and one essay. It would particularly benefit those who have an interest in statistically-supported approaches to spatial phenomena.

1.2 Week-by-week summary

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Session</th>
<th>Subject</th>
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<tbody>
<tr>
<td>1</td>
<td>11 Jan</td>
<td>1</td>
<td>A Rough Guide to spatial analysis</td>
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<tr>
<td>2</td>
<td>18 Jan</td>
<td>2</td>
<td>Archaeological sampling</td>
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<td>3</td>
<td>25 Jan</td>
<td>3</td>
<td>Statistical inference</td>
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<tr>
<td>4</td>
<td>01 Feb</td>
<td>3</td>
<td>Regression models</td>
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<td>5</td>
<td>08 Feb</td>
<td>4</td>
<td>Multivariate location models</td>
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<td>6</td>
<td>15 Feb</td>
<td>–</td>
<td>Reading week</td>
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<td>7</td>
<td>22 Feb</td>
<td>6</td>
<td>Challenges and opportunities with spatial datasets</td>
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<tr>
<td>8</td>
<td>29 Feb</td>
<td>7</td>
<td>Analysing point patterns</td>
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<td>9</td>
<td>07 Mar</td>
<td>8</td>
<td>Modelling point processes</td>
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<td>10</td>
<td>14 Mar</td>
<td>9</td>
<td>Spatial regression and kriging</td>
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<tr>
<td>11</td>
<td>21 Mar</td>
<td>10</td>
<td>Uncertainty in spatial analysis</td>
</tr>
</tbody>
</table>

1.3 Basic texts

In addition to the sessional readings below, some useful basic texts for this course are:


1.4 Methods of assessment

This course is assessed on the basis of two pieces of coursework: (i) a project, consisting of three individual practical assessments, the sum of which contribute 50% to your final grade; (ii) a written essay, no more than 3000 words in length, also worth 50% of your final mark. The topics and deadlines for each assessment are specified below. If you are unclear about the nature of an assignment, they should contact me. I will be willing to discuss an outline of your approach to the assessment, provided this is planned suitably in advance of the submission date.

1.5 Teaching methods

The course is taught by a mixture of lectures, practical sessions and group discussion. Students will be expected to have done the necessary tutorial revision in order to continue to follow the practical session in class and to contribute actively to discussion.

N.B. Participation in practical exercises is limited by the availability of suitably equipped computers, and is guaranteed only for those who are taking this course as an examined module for a Masters degree.

1.6 Workload

There will be 20 hours of dedicated lectures and practicals for this course, and students are expected to undertake around 70 hours of tutorial revision and further reading for the course, plus 60 hours preparing for and producing the assessed work. This adds up to a total workload of approximately 150 hours.

1.7 Prerequisites

There are no formal prerequisites for this course, but it is strongly recommended that students have at least some prior experience of GIS.

2 Aims, objectives and assessment

2.1 Aims

The course aims to provide:

- A working knowledge of non-spatial statistical methods that are widely used in conjunction with GIS;
- An understanding of the role of spatial sampling in archaeology
- A working knowledge of both basic and more advanced spatial statistics;

2.2 Objectives

The course objectives are that you will be able to:

- Evaluate the limitations of existing spatial data and devise appropriate spatial sampling strategies for the acquisition of additional data;
• Make statistically sound inferences as part of spatial analysis;
• Use spatial statistics to model the properties of spatial data;

2.3 Learning outcomes
In meeting these objectives you will also be able to demonstrate the following generic learning outcomes:

• An understanding of the differences between scientific and other forms of reasoning;
• The ability to use quantitative data to support an argument;
• The application of acquired knowledge.

2.4 Coursework
2.4.1 Assessment tasks
This course is assessed entirely by coursework consisting of the two assignments described here.

1. One 2,850-3,150 word essay (50%) giving you an opportunity to demonstrate your theoretical understanding of an important issue in archaeological spatial analysis. This essay is due on Thursday, 24 March 2016. You should choose one of the following questions:

• Discuss the factors that can cause archaeological data to be inadequate to support a spatial analysis, and the steps that might be taken to overcome them.
• What are the potential pitfalls when testing a hypothesis about the reasons for site location? Illustrate your answer using a published and/or hypothetical example.
• What are the future prospects for archaeological predictive modelling?
• To what extent can statistical techniques that rely on the concept of an underlying spatial process be used to analyse and/or predict archaeological processes or past human behaviour?

2. One written account of laboratory work (50%), comprising three practical assignments (assigned approximately every fortnight). This will provide an opportunity for you to demonstrate technical competence in a range of spatial analytic methods. You will be provided with further information about the exact form that the practical exercises should take. They will require you to include illustrations, such as maps and graphs. Please ensure that these are carefully presented. General guidance is available at: http://www.ucl.ac.uk/archaeology/handbook/common/illustrations.htm. All illustrations should have informative captions. Where appropriate, maps should include indicators of scale and orientation, as well as a legend (key) based on sensible ranges of data values. Graphs should include informative labels for the X- and Y-axes.

You are not permitted to re-write and re-submit coursework in order to try to improve your marks. However, the Course Co-ordinator is willing to discuss an outline of your approach to an assignment, provided this is planned suitably in advance of the submission date.
2.4.2 Word length

Strict new regulations with regard to word-length were introduced UCL-wide with effect from 2013:

3.1.7 Penalties for Over-length Coursework For submitted coursework, where a maximum length has been specified, the following procedure will apply: i) The length of coursework will normally be specified in terms of a word count ii) Assessed work should not exceed the prescribed length. iii) For work that exceeds the specified maximum length by less than 10% the mark will be reduced by ten percentage marks; but the penalised mark will not be reduced below the pass mark, assuming the work merited a pass. iv) For work that exceeds the specified maximum length by 10% or more, a mark of zero will be recorded. vii) In the case of coursework that is submitted late and is also overlength, the lateness penalty will have precedence.

The following should not be included in the word-count: title page, contents pages, lists of figure and tables, abstract, preface, acknowledgements, bibliography, captions and contents of tables and figures, appendices, and wording of citations.

2.4.3 Submission procedures

Students are required to submit hard copy of all coursework to the course co-ordinators pigeon hole via the Red Essay Box at Reception by the appropriate deadline. The coursework must be stapled to a completed coversheet (available from the web, from outside Room 411A or from the library)

Students should put their Candidate Number on all coursework. This is a 5 digit alphanumerical code and can be found on Portico: it is different from the Student Number/ ID. Please also put the Candidate Number and course code on each page of the work.

It is also essential that students put their Candidate Number at the start of the title line on Turnitin, followed by the short title of the coursework. eg YBPR6 Funerary practices

Please note the stringent UCL-wide penalties for late submission given below. Late submission will be penalized in accordance with these regulations unless permission has been granted and an Extension Request Form (ERF) completed.

Date-stamping will be via Turnitin (see below), so in addition to submitting hard copy, students must also submit their work to Turnitin by the midnight on the day of the deadline. Students who encounter technical problems submitting their work to Turnitin should email the nature of the problem to ¡a href="mailto:ioa-turnitin@ucl.ac.uk "¿ioa-turnitin@ucl.ac.uk¡/a¿ in advance of the deadline in order that the Turnitin Advisers can notify the Course Co-ordinator that it may be appropriate to waive the late submission penalty.

If there is any other unexpected crisis on the submission day, students should telephone or (preferably) e-mail the Course Co-ordinator, and follow this up with a completed ERF

Please see the Coursework Guidelines on the IoA website (or your Degree Handbook) for further details of penalties.

Further information is given on the IoA website. Turnitin advisors will be available to help you via email: ¡a href="mailto:ioa-turnitin@ucl.ac.uk "¿ioa-turnitin@ucl.ac.uk¡/a¿ if needed.

2.4.4 UCL-wide Penalties for Late Submission of Coursework

UCL regulation 3.1.6 Late Submission of Coursework Where coursework is not submitted by a published deadline, the following penalties will apply: i) A penalty of 5 percentage marks should be applied to coursework submitted the calendar day after the deadline (calendar day 1). ii) A penalty of 15 percentage marks should be applied to coursework submitted on calendar
day 2 after the deadline through to calendar day 7. iii) A mark of zero should be recorded for coursework submitted on calendar day 8 after the deadline through to the end of the second week of third term. Nevertheless, the assessment will be considered to be complete provided the coursework contains material that can be assessed. iv) Coursework submitted after the end of the second week of third term will not be marked and the assessment will be incomplete. vii) Where there are extenuating circumstances that have been recognised by the Board of Examiners or its representative, these penalties will not apply until the agreed extension period has been exceeded. viii) In the case of coursework that is submitted late and is also over length, only the lateness penalty will apply.

2.4.5 Timescale for return of marked coursework to students

You can expect to receive your marked work within four calendar weeks of the official submission deadline. If you do not receive your work within this period, or a written explanation from the marker, you should notify the IoA’s Academic Administrator, Judy Medrington.

2.4.6 Keeping copies

Please note that it is an Institute requirement that you retain a copy (this can be electronic) of all coursework submitted. When your marked essay is returned to you, you should return it to the marker within two weeks.

2.4.7 Citing of sources

Coursework should be expressed in your own words giving the exact source of any ideas, information, diagrams etc. that are taken from the work of others. Any direct quotations from the work of others must be indicated as such by being placed between inverted commas. Plagiarism is regarded as a very serious irregularity which can carry very heavy penalties. It is your responsibility to read and abide by the requirements for presentation, referencing and avoidance of plagiarism to be found in the IoA Coursework Guidelines at http://www.ucl.ac.uk/archaeology/handbook/common/cfp.htm. There are strict penalties for plagiarism. Further details are available on the IoA website.

2.4.8 Marking criteria

The marking criteria can be downloaded from http://www.ucl.ac.uk/archaeology/handbook/common/criteria/criteria.htm/.

3 Schedule and syllabus

3.1 Teaching schedule

The course will be taught in Term 2. Classes will be held on Mondays, commencing at 14:00 lasting until 17:00. All practicals will be held in room 322C (the AGIS lab). There will be no taught class in Reading Week. Except in the case of illness, the 70% minimum attendance requirement applies to all classes.
3.2 Detailed week-by-week syllabus

The following is an outline for the course as a whole, and identifies essential and supplementary readings relevant to each session. Information is provided as to where in the UCL library system individual readings are available; their location and status (whether out on loan) can also be accessed on the eUCLid computer catalogue system. Copies of individual articles and chapters identified as essential reading are in the Teaching Collection in the Institute Library (where permitted by copyright).

**Session 1: A Rough Guide to spatial analysis**

A brief introduction to the course followed by familiarisation with the principal software package that will be used throughout the course.

**Practical** You will be introduced to the R statistical programming language. You will learn how to start R, load libraries, import data, conduct basic exploratory data analysis and produce plots.

**Essential reading**


**Session 2: Archaeological sampling**

The role of sampling is fundamental to archaeological practice, at scales from the regional to the microscopic. Archaeologists either sample in a deliberate way or they do so by accident, but in either case, these sampling decisions have important implications for what we can and cannot then infer from the recovered archaeological record. In this session, we both introduce the general idea of sampling and use case studies to focus on the specific issues raises by spatial samples.

**Practical** Consideration of the impact on data analysis of different kinds of sampling regime.

**Essential reading**


**Session 3: Statistical inference**

We will explore the process of statistical inference using traditional non-spatial statistical methods such as one- and two-sample significance tests, as well as via the arguably more powerful methods offered by Monte Carlo simulation.
Practical  Use of R to perform t-tests, Kolmogorov-Smirnov tests and Monte Carlo simulation.

Essential reading


Session 4: Regression models

This week we begin a series of more analytical sessions by reviewing the use of linear regression to explore the relation between two variables, including measures of correlation and the distribution of residuals. We then introduce linear logistic regression, which is widely used for the construction of GIS-based predictive models.

Practical  Use of R for linear regression analysis, including the study of residuals.

Essential reading


Session 5: Multivariate location models

This week is entirely devoted to a practical exercise in which you will use multivariate logistic regression to build a predictive model of archaeological site location.

Practical  Use of R and GRASS GIS to build a predictive model.

Essential reading


Session 6: Challenges and opportunities with spatial datasets

This week we consider how space complicates statistical analysis of archaeological datasets, but also opens up new opportunities for insight. Topics covered include different types of spatial data (point, areal and continuous), the key concepts of spatial stationarity and autocorrelation, and the difference between the first- and second-order properties of spatial data.

Practical Use of global and local statistics to understand patterns of spatial autocorrelation.

Essential reading


Session 7: Analysing point patterns

This week, we consider a variety of methods for analysing data comprising the point locations, a common kind of evidence best-known to archaeologists in the form of ‘distribution maps’. The simplest, nearest-neighbour and quadrat-based methods have been around in archaeology for nearly 50 years, while more complicated, multi-scalar methods such as K functions have only been introduced into archaeology more recently. We also consider the analysis of point distributions where there are likely to be directional patterns present, as well as the treatment of point distributions of multiple types or involving cases-and-controls.

Practical Use of R to analyse point patterns.

Essential reading


**Session 8: Modelling point processes**

Modern approaches to point distributions do not just consider whether and how a pattern departs from a null hypothesis of complete spatial randomness. Instead, there is increasing emphasis on fitting different kinds of model to observed point patterns with a view to understand when external variables might affect the overall density of points across a study area, as well as what kinds of interaction between points might be involved. Joint models of ‘first-order’ and ‘second-order’ characteristics are now possible and of great use in archaeology.

**Practical** Use of R to build an inhomogeneous point process model.

**Essential reading**


**Session 9: Spatial regression and kriging**

In many cases, we are not dealing with a pattern of unmarked points (i.e. without attributes), but instead wish to analyse a spatial relationship between one continuously-measured variable and a range of others across a study area. Some of the simple forms of regression analysis introduced earlier in this course assume that the relations between independent variables are constant throughout space, but this is not always—perhaps not even usually—the case. This week we explore geographically weighted regression, which allows the parameters of the model to vary in space. We also consider an advanced method, kriging, for inferring about the degree of spatial autocorrelation present in continuously-measured variables, as well as how this technique can be combined with a regression-based approach.

**Practical** Use of R to perform kriging and a spatially-weighted regression of an archaeological dataset.

**Essential reading**


Session 10: Uncertainty in Spatial Analysis

This session looks at the kinds of classificatory, temporal and/or positional uncertainties inherent in most archaeological analyses. In particular, it address the issue of how we manage, for purposes of spatial inference, the very fuzzy chronological evidence with which archaeologists regularly work.

**Practical** Handling temporal uncertainty via R scripting

**Essential reading**


4 Online resources

The full UCL Institute of Archaeology coursework guidelines are given here: [http://www.ucl.ac.uk/archaeology/handbook/common/](http://www.ucl.ac.uk/archaeology/handbook/common/). The full text of this handbook is available here (includes clickable links to Moodle and online reading lists if applicable) [http://www.ucl.ac.uk/silva/archaeology/course-info/](http://www.ucl.ac.uk/silva/archaeology/course-info/) and on the course website: [http://moodle.ucl.ac.uk/course/view.php?id=3477](http://moodle.ucl.ac.uk/course/view.php?id=3477).

5 Additional information

5.1 Libraries and other resources

In addition to the Library of the Institute of Archaeology (5th floor), other libraries in UCL with holdings of particular relevance to this course are the Science Library (D.M.S. Watson building on the central UCL site) and the Environmental Studies Library in Wates House on Gordon Street. You may also wish to consult the list of electronic journals available through UCL ([http://metalib-a.lib.ucl.ac.uk:8331/V?func=find-ej-1](http://metalib-a.lib.ucl.ac.uk:8331/V?func=find-ej-1)). A full list of UCL libraries and their opening hours is provided at [http://www.ucl.ac.uk/library/](http://www.ucl.ac.uk/library/).

The University of London Senate House Library ([http://www.ull.ac.uk/](http://www.ull.ac.uk/)) also has holdings which may be relevant to this course.

5.2 Attendance

A register will be taken at each class. If you are unable to attend a class, please notify the lecturer by email. Departments are required to report each student’s attendance to UCL Registry at frequent intervals throughout each term. Students are expected to attend at least 70% of classes.

5.3 Information for intercollegiate and interdepartmental students

Students enrolled in Departments outside the Institute of Archaeology should collect hard copy of the Institute’s coursework guidelines from the Academic Administrator’s office (Room 411A).
5.4 Dyslexia

If you have dyslexia or any other disability, please make your lecturers aware of this. Please discuss with your lecturers whether there is any way in which they can help you. Students with dyslexia are reminded to indicate this on each piece of coursework.

5.5 Feedback

In trying to make this course as effective as possible, we welcome feedback from students during the course of the year. All students are asked to give their views on the course in an anonymous questionnaire which will be circulated at one of the last sessions of the course. These questionnaires are taken seriously and help the Course Co-ordinator to develop the course. The summarised responses are considered by the Institute’s Staff-Student Consultative Committee, Teaching Committee, and by the Faculty Teaching Committee.

If you are concerned about any aspect of this course we hope you will feel able to talk to the Course Co-ordinator, but if you feel this is not appropriate, you should consult your Personal Tutor, the Academic Administrator (Judy Medrington), or the Chair of Teaching Committee (Dr. Karen Wright).

5.6 Health and safety

Students enrolled on this course are particularly reminded of the measures that should be taken to reduce possible discomfort arising from the extended use of computer workstations. See the advice provided on the web at http://www.ucl.ac.uk/efd/safety_services_www/guidance/dse/index.htm.

6 APPENDIX A: POLICIES AND PROCEDURES 2015-16 (PLEASE READ CAREFULLY)

This appendix provides a short précis of policies and procedures relating to courses. It is not a substitute for the full documentation, with which all students should become familiar. For full information on Institute policies and procedures, see the following website:
http://wiki.ucl.ac.uk/display/archadmin
For UCL policies and procedures, see the Academic Regulations and the UCL Academic Manual:
http://www.ucl.ac.uk/srs/academic-regulations
http://www.ucl.ac.uk/academic-manual/

6.0.1 GENERAL MATTERS

ATTENDANCE: A minimum attendance of 70% is required, except in case of illness or other adverse circumstances which are supported by medical certificates or other documentation. A register will be taken at each class. If you are unable to attend a class, please notify the lecturer by email. DYSLEXIA: If you have dyslexia or any other disability, please discuss with your lecturers whether there is any way in which they can help you. Students with dyslexia should indicate it on each coursework cover sheet.
6.0.2 COURSEWORK

SUBMISSION PROCEDURES: You must submit a hardcopy of coursework to the Co-ordinator’s pigeon-hole via the Red Essay Box at Reception (or, in the case of first year undergraduate work, to room 411a) by stated deadlines. Coursework must be stapled to a completed cover-sheet (available from IoA website; the rack outside Room 411A; or the Library). You should put your Candidate Number (a 5 digit alphanumeric code, found on Portico. Please note that this number changes each year) and Course Code on all coursework. It is also essential that you put your Candidate Number at the start of the title line on Turnitin, followed by the short title of the coursework (example: YBPR6 Funerary practices).

LATE SUBMISSION: Late submission is penalized in accordance with UCL regulations, unless permission for late submission has been granted. The penalties are as follows: i) A penalty of 5 percentage marks should be applied to coursework submitted the calendar day after the deadline (calendar day 1); ii) A penalty of 15 percentage marks should be applied to coursework submitted on calendar day 2 after the deadline through to calendar day 7; iii) A mark of zero should be recorded for coursework submitted on calendar day 8 after the deadline through to the end of the second week of third term. Nevertheless, the assessment will be considered to be complete provided the coursework contains material than can be assessed; iv) Coursework submitted after the end of the second week of third term will not be marked and the assessment will be incomplete.

GRANTING OF EXTENSIONS: New UCL-wide regulations with regard to the granting of extensions for coursework have been introduced with effect from the 2015-16 session. Full details will be circulated to all students and will be made available on the IoA intranet. Note that Course Coordinators are no longer permitted to grant extensions. All requests for extensions must be submitted on a new UCL form, together with supporting documentation, via Judy Medringtons office and will then be referred on for consideration. Please be aware that the grounds that are now acceptable are limited. Those with long-term difficulties should contact UCL Student Disability Services to make special arrangements.

TURNITIN: Date-stamping is via Turnitin, so in addition to submitting hard copy, you must also submit your work to Turnitin by midnight on the deadline day. If you have questions or problems with Turnitin, contact ioa-turnitin@ucl.ac.uk.

RETURN OF COURSEWORK AND RESUBMISSION: You should receive your marked coursework within four calendar weeks of the submission deadline. If you do not receive your work within this period, or a written explanation, notify the Academic Administrator. When your marked essay is returned to you, return it to the Course Co-ordinator within two weeks. You must retain a copy of all coursework submitted.

WORD LENGTH: Essay word-lengths are normally expressed in terms of a recommended range. Not included in the word count are the bibliography, appendices, tables, graphs, captions to figures, tables, graphs. You must indicate word length (minus exclusions) on the cover sheet. Exceeding the maximum word-length expressed for the essay will be penalized in accordance with UCL penalties for over-length work.

CITING OF SOURCES and AVOIDING PLAGIARISM: Coursework must be expressed in your own words, citing the exact source (author, date and page number; website address if applicable) of any ideas, information, diagrams, etc., that are taken from the work of others. This applies to all media (books, articles, websites, images, figures, etc.). Any direct quotations from the work of others must be indicated as such by being placed between quotation marks. Plagiarism is a very serious irregularity, which can carry heavy penalties. It is your responsibility to abide by requirements for presentation, referencing and avoidance of plagiarism. Make sure
you understand definitions of plagiarism and the procedures and penalties as detailed in UCL regulations: http://www.ucl.ac.uk/current-students/guidelines/plagiarism

6.0.3 RESOURCES

MOODLE: Please ensure you are signed up to the course on Moodle. For help with Moodle, please contact Nicola Cockerton, Room 411a (nicola.cockerton@ucl.ac.uk).