

ADVANCED SPATIAL ANALYTICS

PLANA6232

Columbia University Graduate School of Arch., Planning and Preservation
114 Avery Hall | Wednesdays, 9 - 11AM

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book ahead at <http://vanky.co/officehours>

COURSE OVERVIEW

It goes without saying that the proliferation of technologies has brought a concomitant wealth of spatiotemporal data. Within the context of this wealth of data, and the tools by which we can explore the data, this course seeks to introduce students to advanced techniques in creating, utilizing, and critiquing methodologies for addressing questions relevant to urbanism. Aimed at covering a variety of topics in both practice and in research, the course operates with a two-fold mission: (1) to critically discuss the theories, concepts, and research methods involved in spatial analysis and (2) to learn the techniques necessary for engaging those theories and deploying those methods. The class will work to meet this mission with a dedicated focus on the urban environment and the spatial particularities and relationships that arise from the urban context.

This course will draw upon various disciplines to interrogate the state-of-the-discussion of GIScience as well as extend it to the realm of "social physics" and network science (as a subset of topics from complexity science), as the volume and velocity extends our opportunity to extract useful information from digital traces of human activity. This course will therefore also extend to teach algorithms to model and to characterize complex networks, as it is applied to questions of urbanism, planning and design within the domain of physical space. However, with the nascency of these practices, this course situates itself in the uncomfortable middle of providing both the methods for answering complex socio-spatial questions and critiquing them within a professional practice discourse.

tl;dr: We will critically explore and discuss advanced methods in analyzing spatiotemporal data within an urban contexts.

Topics Covered

The following is a non-exhaustive, yet non-exclusive list of topics we may cover in this course: remote sensing, spatial statistics, geostatistics, spatial clustering, transportation and land use, data visualization, network analysis and graph measures, eigenbehaviors, [really] big data, density, space syntax, gravity and radiation models, network structure, and even complexity science. Students will be able to propose additional topics as well.

Method of Instruction

This class marries several instructional formats to facilitate both an interrogation of these methods from a critical distance, but also by actively learning the methods

through use. In the first approach, seminar-styled, student-driven discussions and presentations will consider various approaches and techniques, as well as their opportunities, limitations, and implications on research, design and planning. In a practical approach, a research project will form the cornerstone by which we can engage in these conversations in an active sense, using the work as an anchor to the conversations surrounding these techniques and datasets. While certain class meeting sessions are planned for project development and discussion of research design and methods, students are expected to use their projects as additional discussion material throughout the semester.

Prerequisites

Students must have successfully completed Geographic Information Systems (PLANA4577), Introduction to Urban Data and Analytics (PLANA6201) or have similar experience to be eligible to enroll in Advanced Spatial Analysis. Other introductory GIS courses or related professional work will be considered as sufficient experience only with prior approval.

Although students will engage with mathematics at a linear algebra level, students are not required to have a working knowledge at this level. However, students should come with a certain amount of tenacity or bravery to actively engage the material.

Objectives

Upon successful completion of the class students will have:

- Built upon their familiarity with technical concepts of network analysis, spatial and behavioral modeling, decision support, and spatial statistics with more advanced analytical approaches;
- Understand the inputs, processing, biases, opportunities and outcomes of various methodological approaches to understanding socio-spatial, or spatiotemporal data;
- Accomplished the prior objectives through urban planning examples such as land use, transportation, environmental quality, accessibility, and public participation;
- Examined the recent history of common analytical approaches to prevalent urban issues, comparing their relative advantages, assumptions, and outcomes;
- Furthered visual and cartographic communication skills as well as textual and verbal communication skills for specialist as well as lay audiences; and
- Developed critical research design skills and processes.

ASSIGNMENTS + GRADING

Participation

20% of your cumulative grade. Fundamental to the interrogation of these tools, data and techniques is an engagement in conversation about their opportunities, limitations and implications. As such, students are required to be active participants in the readings, presentations and conversations about these methods.

Seminar Presentation

30% of your cumulative grade. Teams of students will curate a methodological presentation and exercises that will allow us to engage in the inner workings of these models, toolsets and contexts. Students will be asked to meet with the instructor to aid in the shaping of these presentations.

Project

50% of your cumulative grade. To better understand the opportunities available with these datasets, including non-traditional ones from online, social and digital sources, teams will design, research, and execute a self-directed final project on a topic of their choosing. Students will engage in these analyses with vigor and criticality, with

emphasis on proper methodological approaches, as well as communicability to lay audiences. To facilitate this scale of project, there will be both group and individual intermediate deliverables.

SCHEDULE (OUTLINE)

MODULE A: (Re-)Introductions

These early weeks of the semester include topics and establish premises to which we will refer for the remainder of the course. These readings should serve as a basis for our discussions, and students are expected to return to them as relevant to our later topics.

01: 22 January

Class Plan: We will review of the syllabus, the scope and expectations of the course, and a discussion on spatial methods and methodologies as it pertains to the pedagogical approach of the course. The full description of the Methods Presentations assignment will be distributed and discussed.

Readings

Bettencourt LMA, Lobo J, Helbing D, et al. (2007) Growth, innovation, scaling, and the pace of life in cities. *Proceedings of the National Academy of Sciences* 104(17): 7301-7306.

Crampton, J. (1995). The ethics of GIS. *Cartography and Geographic Information Systems*, 22 (1), 84-89.

Chrisman, Nicholas R. (1987). "Design of Geographic Information Systems Based on Social and Cultural Goals." *Photogrammetric Engineering and Remote Sensing*.

Curry, M R. (1995). Rethinking rights and responsibilities in geographic information systems: beyond the power of the image. *Cartography and Geographic Information Systems* 22 (1), 58-69.

Goodchild, M F, et al (2000). Toward spatially integrated social science. *International Regional Science Review*, 23 (2), 139-159.

Goodspeed, Robert (2014). "Smart cities: moving beyond urban cybernetics to tackle wicked problems". In: *Cambridge Journal of Regions, Economy and Society* 8.1, pp. 79-92.

Graham, S. D. N. (2005). Software-sorted geographies. *Progress in Human Geography*, 29(5), 562-580.
<https://doi.org/10.1191/0309132505ph568oa>

Miller, H J. (2004). Tobler's First Law and Spatial Analysis. *Annals of the Association of American Geographers*, 94 (2), 284-289.

Miller, R P. (1995). Beyond methods, beyond ethics: integrating social theory into GIS and GIS into social theory. *Cartography and Geographic Information Systems*, 22 (1), 98- 103.

Stephens-Davidowitz, Seth (2017). *Everybody Lies: Big Data, New Data, and What the Internet Can Tell Us About Who We Really Are*. New York, NY: Harper Collins. ISBN: 978-0-06-249749-9.

02: 29 January

Project Plan: We discuss the methodological assignment (also known as the final assignment) in depth.

Seminar/Class Plan: "Data" and the computational imperative, if it exists. New data, new computational tools, who dis?

Readings

Bettencourt, L. M. A. (2013). The Uses of Big Data in Cities. *SFI WORKING PAPER*.

Boyd D and Crawford K (2012) Critical questions for big data. *Information, Communication and Society* 15(5): 662-679.

Dodge, M and R Kitchin. (2013). Crowdsourced cartography: mapping experience and knowledge. *Environment and Planning A*, 45 (1), 19-36.

de Albuquerque, J. P., Herfort, B., Brenning, A., & Zipf, A. (2015). A geographic approach for combining social media and authoritative data towards identifying useful information for disaster management. *International Journal of Geographical Information Science*, 29(4), 667-689.

Graham, Mark. 2012. "Big Data and the End of Theory?" *The Guardian*.
<http://www.theguardian.com/news/datablog/2012/mar/09/big-data-theory>.

Huang, Q., & Wong, D. W. S. (2016). Activity patterns, socioeconomic status and urban spatial structure: what can social media data tell us? *International Journal of Geographical Information Science*, 30(9), 1873-1898.

Lee, J.-G., & Kang, M. (2015). Geospatial Big Data: Challenges and Opportunities. *Big Data Research*, 2(2), 74-81.

Li, S., et al. (2016). Geospatial big data handling theory and methods: A review and research challenges. *ISPRS Journal of Photogrammetry and Remote Sensing*, 115, 119-133.

Shelton, T, A Poorthuis, and M Zook. (2015). Social media and the city: Rethinking urban socio-spatial inequality using user-generated geographic information. *Landscape and Urban Planning*, 142, 198-211.

Shelton, T. (2017). Spatialities of data: mapping social media 'beyond the geotag.' *GeoJournal*, 82, 721-734

Sui, D., & Goodchild, M. (2011). The convergence of GIS and social media: challenges for GIScience. *International Journal of Geographical Information Science*, 25(11), 1737-1748.

Tsou, M.-H. (2015). Research challenges and opportunities in mapping social media and Big Data. *Cartography and Geographic Information Science*, 42(sup1), 70-74.

Voigt, C, S Dobner, and M Schmidt. (2016). Collaborative mapping and the reliability of volunteered data. [conference paper] Sixth International Conference on Advanced Collaborative Networks, Systems and Applications (COLLA16). Barcelona, Spain: Xpert Publishing Services.

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...But for planners?

Crawford, Kate, and Jason Schultz. 2014. "Big Data and Due Process: Toward a Framework to Redress Predictive Privacy Harms." *BCL Rev.* 55: 93.

Kitchin, Rob (2016). "The Ethics of Smart Cities and Urban Science". In: *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences* 374.2083. ISSN: 1364-503X. DOI: 10.1098/rsta.2016.0115.

Koonin, Steven E. and Michael Holland. 2014. "The Value of Big Data for Urban Science." Pp. 137-152 in *Privacy, Big Data, and the Public Good*. New York: Cambridge University Press.

Zwitter, A. 2014. "Big Data Ethics." *Big Data & Society* 1 (2). doi:10.1177/2053951714559253.

03: 05 February

Project Plan: Topic Paragraphs are due via the Canvas [Discussion Board](#) by the start of class. Post one submission per group (postings should include all group members' names).

Seminar/Class Plan: Algorithms, analyses, positionality. What is the role of measurement and quantification, and what are the implications involved?

Readings

Alonso, William and Paul Starr, ed. (1989). *The politics of numbers*. Russell Sage Foundation.

Batty, Michael. 2013. "Building a Science of Cities." Chapter 1, pp.13-45 in *The New Science of Cities*. Cambridge, MA: MIT Press. (available as an e-book via CLIO)

Harley, J.Brian. "Maps, knowledge, and power" (Chapter 8). In Henderson, George and Waterstone, Marvin. *Geographic thought: a praxis perspective*, 1988. 129-148.

Dolores Hayden. Part I - Chapter 2 and Chapter 10. *The Power of Place: Urban Landscapes as Public History*. MIT Press, 1995.

Kitchin, Rob (2014). "The real-time city? Big data and smart urbanism". In: *GeoJournal* 79.1, pp. 1- 14. ISSN: 1572-9893. DOI: 10.1007/s10708-013-9516-8. <https://doi.org/10.1007/s10708-013-9516-8>

Klosterman, R E. (1994). Large-scale urban models retrospect and prospect. *Journal of the American Planning Association*, 60 (1), 3-6.

Klosterman, R E. (2012). Simple and complex models. *Environment and Planning B: Planning and Design*, 39 (1), 1-6.

Kwan, M-P. (2016). Algorithmic geographies: big data, algorithmic uncertainty, and the production of geographic knowledge. *Annals of the American Association of Geographers*, 106 (2), 274-282.

"Why is it so Difficult to Trace the Social?" in Latour, B. (2005). *Reassembling the Social* (Vol. 7). Oxford, UK: Oxford University Press.

Rose-Redwood, R S. (2006). Governmentality, geography, and the geo-coded world. *Progress in Human Geography*, 30 (4), 469-486.

Sayer, A. (1985). Mathematical Modelling in Regional Science and Political Economy: Some Comments. *Antipode*, 10 (2), 79-86.

Winner, L. (1986). Do Artifacts have Politics? In *The whale and the reactor: a search for limits in an age of high technology*. (pp. 19-39). Chicago: University of Chicago Press.

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...What about positionality?

Campbell, Heather. 2012. "Planning to Change the World: Between Knowledge and Action Lies Synthesis." *Journal of Planning Education and Research* 32: 135-146. <http://www.columbia.edu/cgi-bin/cul/resolve?AH-J7Q2212VPAG0819>

Becker, Howard. 1967. "Whose Side are we On?" *Social Problems* 14(3): 239-47. <http://www.columbia.edu/cgi-bin/cul/resolve?AH-J7Q2212VPAG0545>

Brown, Michael and Larry Knopp (2008). "Queering the map: the productive tensions of colliding epistemologies". In: *Annals of the Association of American Geographers* 98.1, pp. 40-58.

Fischer, F. and Forester, (1993) J. Editors' Introduction, in *The Argumentative Turn in Policy Analysis and Planning*. Duke University Press. <https://doi-org.ezproxy.cul.columbia.edu/10.1215/9780822381815>

Forsyth, Ann. 2012. "Alternative Cultures in Planning Research—From Extending Scientific Frontiers to Exploring Enduring Questions."

Journal of Planning Education and Research 32: 160-168.
<http://www.columbia.edu/cgi-bin/cul/resolve?AH-J7Q2212VPAG0751>

Thomas S. Kuhn, *Structure of Scientific Revolutions* (1962), The University of Chicago Press, pp.1-210.

A good technical reference:

DeMers, M N. (2017). Chapter 9: Constructing Models. *Geographic Information Systems in Action*. New York: John Wiley & Sons.

04: 12 February

Project Plan: Peer feedback on Topic Paragraphs is due by the start of class, submitted by commenting on the Canvas discussion board.

Seminar/Class Plan: Good science, big data? In the last of the introductory weeks, we pivot to thinking about methodologies and mechanisms by which we can marry good research methodologies to spatial data and modeling.

Readings

Becker, Howard. 1967. "Whose Side are we on?" *Social Problems* 14(3): 239-47. <http://www.columbia.edu/cgi-bin/cul/resolve?AH-J7Q2212VPAG0545>

Singleton, Royce A. and Bruce C. Straits. 2009. Chapter 1 in *Approaches to Social Research, Fifth Edition*. Oxford: Oxford University Press. (On Reserve. <https://clio.columbia.edu/catalog/1232883>)

Steinberg, S. L., & Steinberg, S. J. (2010). Chapter 3. Research Design. In *GIS Research Methods: Incorporating Spatial Perspectives*. Redlands, Calif: ESRI Press.

Yee, Albert. 1996. "The Causal Effects of Ideas on Policies." *International Organization* 50(1): 69-109.
<http://www.columbia.edu/cgi-bin/cul/resolve?AH-J7Q2212VPAG3528>

MODULE B: Mode d'Empoi

05: 19 February

Project Plan: Precedent bibliography is due by the start of class via the Canvas discussion board. We will briefly discuss what you found as a means of sharing information with your colleagues.

Presentation Plan: Methodological Presentation (See Supplement)

Seminar Plan: Modeling Urban Phenomena

Readings

Badham J. 2008 A Compendium of Modeling Techniques. Integration Insight. Australian National University

Grimm, V., Revilla, E., Berger, U., Jeltsch, F., Mooij, W.M., Railsback, S.F., Thulke, H.H., Weiner, J., Wiegand, T., DeAngelis, D.L., 2005. Pattern-oriented modeling of agent-based complex systems: lessons from ecology. *Science* 310 (5750), 987e991.

Hoyle, R. H. (1995). The structural equation modeling approach: Basic concepts and fundamental issues.

Polhill, J.G., T. Filatova, M. Schlüter, A. Voinov. Modelling systemic change in coupled socio-environmental systems. *Environmental Modelling and Software* doi:10.1016/j.envsoft.2015.10.017

Sun, H., Forsythe, W., & Waters, N. (2007). Modeling Urban Land Use Change and Urban Sprawl: Calgary, Alberta, Canada. *Networks and Spatial Economics*, 7(4), 353-376.

Wong, D W S. (1993). Spatial Indices of Segregation. *Urban Studies*, 30 (3), 559-572. Wong, D

W S and W K Chong. (1998) Using spatial segregation measures in GIS and statistical modeling packages. *Urban Geography*, 19 (5), 477-485.

06: 26 February

Project Plan: Students should post to the discussion board their question and dataset drafts by the start of the class, and be prepared to informally present their thinking in today's session.

Presentation Plan: Methodological Presentation (See Supplement)

07: 04 March

Project Plan: Methodology statement is due.

Presentation Plan: Methodological Presentation (See Supplement)

Seminar Plan: Methodological Discussion: Sampling, Observations and Evaluations. (We will use your work from the previous two weeks as fodder for discussion.)

08: 11 March

AV in UK

##: 18 March

Spring Recess

09: 25 March

Project Plan: Teams should have preliminary findings their analyses, sufficient to discuss the basis for comparing results from different

methods and approaches. Emphasis will be on the findings of the individual studies, as well as across them. Teams should prepare their remarks, expecting short "report out".

Presentation Plan: Methodological Presentation (See Supplement)

10: **01 April**

Project Plan: Communicating Process and Outcomes. Students should upload their draft statements onto the Discussion Boards. Teams should also be ready to informally present their initial findings and process for discussion.

Presentation Plan: Methodological Presentation (See Supplement)

11: **08 April**

Project Plan: Mappings/Cartographies, graphics and layout drafts are due via the Discussion Board.

Presentation Plan: Methodological Presentation (See Supplement)

Readings

Gliner, J.A., Morgan G. A., and N. L. Leech Research Methods in Applied Settings: An Integrated Approach to Design Ch. 8. *

Judea Pearl (2000) Causality: Models Reasoning, and Inference. Chp. 2 A Theory of Inferred Causation.

12: **15 April**

Project Plan:

- Peer feedback on mappings/cartographies, graphics and layouts are due, submitted via the comments on the Discussion Board.
- Teams should upload their conclusion statements onto the Discussion Board.

Seminar Plan: Defensible Conclusions. We conclude the seminar sessions with a discussion on the methodological questions raised during the course of the semester. We will also discuss and workshop the final deliverables as time allows.

MODULE C: FIN

13: **22 April**

Show and Tell: Internal Project Presentations (work-in-progress, but comprehensive none-the-less). We will end our meetings together by presenting a summation of our work before the final poster session.

14: **29 April**

Final Poster Session! 🏆 🏆

##: 06 May

There is no class. All submissions due by 09:01am.

LiPS Lectures Several lectures this semester will be of interest to students taking this course. I draw your attention to the following in particular:

Jan 21 -- Ben Green
Feb 02 -- Michael Batty
Mar 31 -- Dani Arribas-Bel
Apr 21 -- Catherine d'Ignazio

COURSE TEXTS

All course texts should be easily found with CLIO or a quick search on Google Scholar. All texts in this course are neither optional, nor are they required. Students are expected to engage with the readings as a whole as they provide context, precedents and theoretical underpinnings in conversation or debate amongst themselves. Students are expected to synthesize their thoughts for discussion in each session.

There are several readings that are presented in addition, that may be of help more broadly in the course:

Robert Alford (1998), *The Craft of Inquiry: Theories, Methods, Evidence*, Oxford University Press.

Batty, M. (2013) *The New Science of Cities*. MIT Press, Cambridge, MA.

Jeffrey A. Gliner, George A. Morgan and Nancy L. Leech (2017), *Research Methods in Applied Settings*, Lawrence Erlbaum Associates, Publishers.

TECHNOLOGY

This course takes an all-of-the-above approach to the use of geographic information system software. Although there is a bias of the instructor toward non-monopolistic and/or open-source software, you are invited to use any tool that allows you to successfully, yet critically, address your research questions. In addition to ESRI's ArcGIS suite, QGIS, R, Python as well as other open-sourced programs should be available to you on GSAPP computers, and where available, you are invited to use these tools on your own device.

EDUCATIONAL RESOURCES

The Research Data Services is a great resource for you to use for GIScience, data-centered and technical questions. In addition to their spatial data collections, which may serve useful for your final project, they offer technical consultants available for questions regarding data as well as those related to performing certain operations in both the GIScience and data analytics domains. They are located in Lehman Library and more information can be found at

<https://library.columbia.edu/services/research-data-services/schedule.html>.

The strength of GSAPP and the urban planning program is the diversity of experiences among its community members. However, with the diversity of languages, academic writing in English is a difficult art to master. While you will gain practice in communicating to diverse audiences in this class, the writing center is a great resource that you should feel welcome (and excited!) to take advantage of:
<https://www.college.columbia.edu/core/uwp/writing-center>.

POLICIES

Grades	Although each grade will be given a numeric score, final grading will be consistent with GSAPP's grading system. Students who complete all assignments at a satisfactory level (75% average) will receive a "Pass". High-Pass is reserved for the top 2 students or 20%, whichever is lower, who deliver high quality deliverables, participate in class and demonstrate consistent and outstanding work across all aspects of the class.
Attendance	It does without saying students are expected to be at every class, on-time. Excessive absences or tardiness may lead to impacts on the student's grade. Students who may miss class due to religious or appropriate reasons should consult with the instructor in advance, when possible.
Late Assignments	No late assignments will be accepted, as to ensure progress on your final projects. In some cases, your peers will be responding to your submissions, and will need as much as time to complete their work.
Devices	Students are welcome to use electronic devices as long as they are being used for the strict and sole purpose of class-related material. Non-class related, on-screen materials during class time is strictly prohibited, unless given permission from the instructor. Penalties may include embarrassment, revoking of privileges or impacts to the student's grade.
Integrity	This course will strictly enforce the GSAPP honor code, which can be viewed at https://www.arch.columbia.edu/honor-system . Plagiarism, including the use of another's work in the class, is automatic grounds—at minimum—for failing. For more information, please refer to https://www.arch.columbia.edu/plagiarism-policy .
Accommodation	The School will make reasonable accommodations for persons with documented disabilities. Services are available only to students who have registered and submit appropriate documentation. As your instructor, I am happy to discuss specific needs with you as well. Please report any access related concerns about instructional material to Office of Disability Services and to me as your instructor.
Harassment and Violence Reporting	The University is committed to maintaining a safe environment for students. Because of this commitment and because of federal and state regulations, we must advise you that if you tell any of your instructors about sexual harassment or gender-based misconduct involving a member of the campus community, your instructor is required to report this information to the Title IX Coordinator, Margorie Fisher. While this information is considered private, it may lead to follow up. For more information on these policies, see https://www.arch.columbia.edu/discrimination-policy .

UNSOLICITED ADVICE ♥

Expect frustrating moments to come, and be prepared to persevere past them. Mastering a technology always involves learning how to seek help with problems that

exceed your understanding, even when Google or your chosen search engine fails you. It is worth noting that much of your learning will come through searching for answers, figuring out how to adapt what you found, and iterating until it works. **Use each other as resources and share resources amongst yourselves.**

The best advice I can offer is to start early, and ask for help. Should you feel that despite your perseverance and resourcefulness that you are still finding problems, you should not hesitate to contact the instructor.