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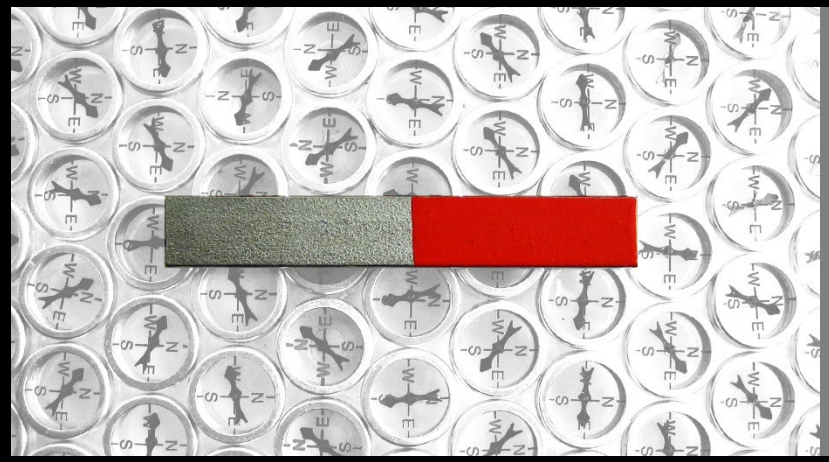
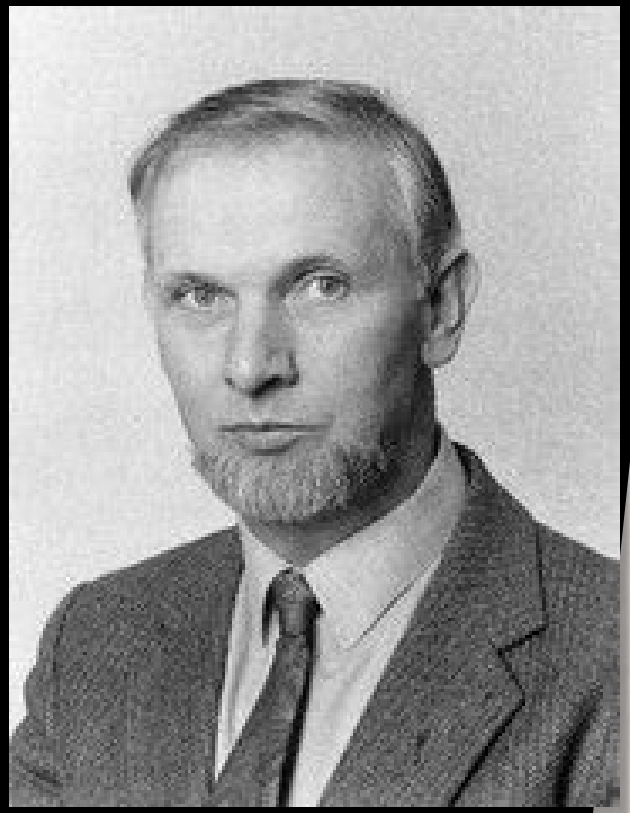


Can There Be a Spatial Data Science Ethics?

David DiBiase & Anthony Robinson

AutoCarto 2022 | November 3 | Redlands CA



J.B. Harley

(in 1985, looking more dour than usual.)

commentary

Can There Be a Cartographic Ethics?

J.B. Harley

In time you may discover all there is to discover — but your progress will only be progress away from mankind. The gulf between you and the people will become so great that one day you will cry out in jubilation over a new achievement — and be greeted by a cry of universal horror.

Bertholt Brecht, *The Life of Galileo*[1]

In an event little reported in the media during the recent Iraq war, a demonstration was held outside the U.S. Defense Mapping Agency in St. Louis. It concerned the crucial role of maps in our ability to wage modern warfare: official estimates stated that by 2nd January 1991 some 35 million maps had been shipped to some 300,000 U.S. troops stationed in the Persian Gulf area.[2] Whatever our views about the morality of war, the incident serves to remind us that the making of maps can raise profound ethical issues. In my case, it led me to reflect on the apparent lack of ethical discussion in the professional literature of cartography. Search long among the key words of periodical articles or books and "ethics" is usually missing. This means that in its failure to engage in a full and frank debate about ethics, cartography is out-of-step with other academic disciplines and professions. On the contrary, the discipline could be accused of complacency. Cartography seems to be uncritical of its own practices, and both their intentional and unintentional consequences. It certainly lacks a substantial literature in applied ethics comparable to that generated by many of its peer professions in science and technology. There is no group in cartography comparable to, for example, "Computer Professionals for Social Responsibility" founded in 1984. And there are no, or few features such as the "Legal and Ethical" case notes, now published in the *ACSM Bulletin*, in cartographic journals. In short, for many map-makers ethics remains a gray area, lost somewhere in the abyss that separates logic from the swamp of subjective opinion.

All this surely has to change in the next few years. I am writing this essay in response to a pioneering "roundtable commentary" on "Ethical Problems in Cartography" — the first of its kind — published in the Fall 1990 issue of *Cartographic Perspectives*.[3] Ethics was defined there as the "principles of conduct guiding the practices of an individual or professional group." Among the varied issues raised at the roundtable were some which may not immediately have struck all readers as obviously ethical problems. For instance, while the so-called "ethic" of being "precise, accurate, and exact" was plain enough, the moral aspects of the perennial copyright problem or the impact of new technology on the ability to maintain traditional standards and values raise finer points of definition. What, for a start, are the "traditional standards and values" and have they ever existed except as a social construction of cartographers? Or why should commercial cartographers feel threatened by copyright violations other than for reasons of profit which may or may not be an ethical question? Other issues considered are the claim that some aspects of cartographic practice — such as the design and choice of symbols — are ethically neutral, and that "the false impression" that is sometimes given "that cartography is a science, based on objective principles and criteria," is also ultimately a matter of ethics.

I did not find myself in agreement with all of the contributors and here I take issue with certain stated viewpoints. For example, the emphasis on the copyright question as a major ethical issue seems to be misplaced.

J.B. Harley is a professor in the Department of Geography, University of Wisconsin — Milwaukee, Milwaukee, WI 53201

Agenda

1. Identify and characterize Masters programs branded as “Spatial” “Geospatial” or “Geographic” Data Science in August-September 2022
2. Assess prevalence of ethics-related content in academic program and course descriptions
3. Propose an “understatement factor” to help account for mismatches between course descriptions and actual course activities
4. Visualize and discuss variations among academic programs
5. Describe Penn State’s approach to ethics education

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Return to the blog

Space Skepticism, by Luc Anselin

by: Luc Anselin
Category: Fellows

Oct 24

When asked to write this column, the topic I suggested was "space skepticism." Space skepticism is the attitude/position that an explicit spatial perspective does not contribute in a meaningful way to the knowledge discovery process. In this view, (still) shared by many in academia, GIS and spatial technologies may be useful tools, but spatial thinking is not considered to be fundamental to the scientific process itself. Of course, this perspective is not shared by the UCGIS membership, but then among ourselves, we tend to preach to the choir. So, why do I set a negative tone in this first column in the series?

I hasten to add that I do not want to draw too dark a picture. Important progress has been made in terms of the adoption of a spatial perspective in mainstream science, policy and curriculum over the past two decades. This coincides with the establishment of UCGIS a little over 20 years ago. We have indeed come a long way. My dissertation advisor at Cornell University (the late Walter Isard) initially characterized my topic (spatial econometrics) as a "red herring" (he later came around). And one of my first submissions to an economics journal got the response from the (single) referee "what is this spatial autocorrelation?" Today, GIS(T) is increasingly common in the curriculum from high school to vocational and traditional higher education. Spatial questions are addressed in the mainstream science and social science journals, and both spatial statistics and spatial econometrics have become accepted subfields in the discipline.

However, all too often, GIS(T) is still considered mostly as a tool to create great visualizations, the so-called "GIS maps" as they are typically referred to. What is lacking is a true "spatial thinking" perspective, that not only uses the GIS to collect the data and present the results, but makes the spatial perspective an integral part of knowledge discovery.

This issue has become more relevant in the current setting of "big data," or, as I prefer to refer to it, "new" data, and the advent of data science as a new paradigm. The new data that have become

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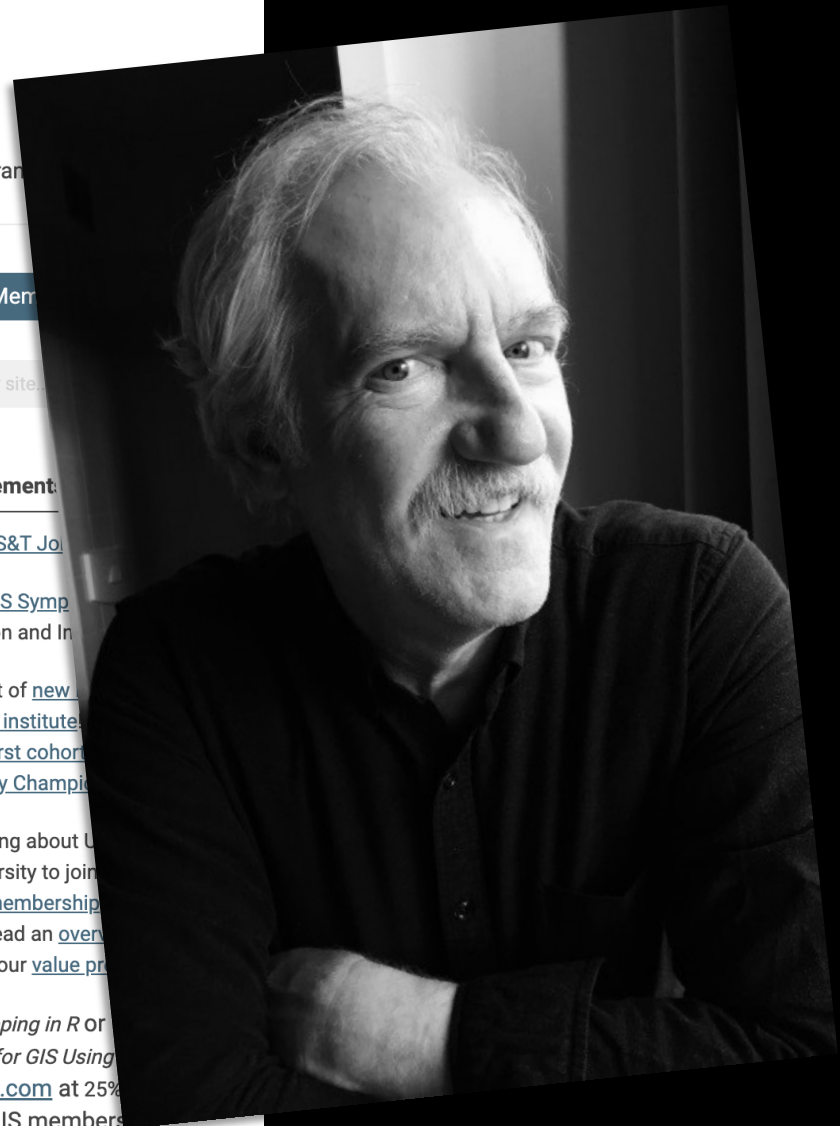

Luc Anselin
University of Chicago
(looking more cheerful than usual)

Alex Singleton
Professor of Geographic Information Science
University of Liverpool

geographical analysis

Geographical Analysis (2021) 53, 61–75

Special Issue

Geographic Data Science

Alex Singleton, Daniel Arribas-Bel

Department of Geography and Planning, University of Liverpool, Liverpool, L69 7ZT, U.K.

It is widely acknowledged that the emergence of "Big Data" is having a profound and often controversial impact on the production of knowledge. In this context, Data Science has developed as an interdisciplinary approach that turns such "Big Data" into information. This article argues for the positive role that Geography can have on Data Science when being applied to spatially explicit problems; and inversely, makes the case that there is much that Geography and Geographical Analysis could learn from Data Science. We propose a deeper integration through an ambitious research agenda, including systems engineering, new methodological development, and work toward addressing some acute challenges around epistemology. We argue that such issues must be resolved in order to realize a Geographic Data Science, and that such goal would be a desirable one.

Introduction

There has never been a time in history with more abundant geographic data, offering great potential for the spatially enabled social sciences to advance understanding of a plethora of human and environmental problems (Elwood, Goodchild, and Sui 2012; Miller and Goodchild 2015). Such data are being generated by many sources including established and new earth observation technologies; the miniaturized and expanded mobile sensing platforms of smart phones (Batty 2013); wider sensor networks as part of a developing Internet of Things or other technologies related to the quantified self (Wilson 2015); and the warehousing, linkage and modeling of public and private sector consumer interactions (Miller 2015). The advance of such enabling instrumentation and those data that they generate have expanded both where and when points of computation and data collection can occur. Much of the resulting "data deluge" (Miller 2010; Kitchin 2014a, b) within this context have properties that can be argued as differentiating these new forms of data from those that have traditionally been the concern of the social sciences and geographers in particular (e.g., short- and long-form surveys or Censuses). Collectively, these new sources have been termed "Big Data," and although there is an array of different definitions (Kitchin 2014a), those properties that are most generally ascribed include being huge in *volume*, with high *velocity* (e.g., real time) and having diversity in *variety* (unstructured or structured) (Laney 2001).

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PNAS INAUGURAL ARTICLE | ENVIRONMENTAL SCIENCES COMPUTER SCIENCES

OPEN ACCESS

Accelerating ethics, empathy, and equity in geographic information science

T. A. Nelson[a,1,2], M. F. Goodchild[b,2], and D. J. Wright[a,c,1,2]

This contribution is part of the special series of Inaugural Articles by members of the National Academy of Sciences elected in 2021.

Contributed by D. J. Wright; received November 10, 2021; accepted February 22, 2022; reviewed by Sarah Elwood, Diana Liverman, and Nadine Schuurman

Science has traditionally been driven by curiosity and followed one goal: the pursuit of truth and the advancement of knowledge. Recently, ethics, empathy, and equity, which we term "the 3Es," are emerging as new drivers of research and disrupting established practices. Drawing on our own field of GIScience (geographic information science), our goal is to use the geographic approach to accelerate the response to the 3Es by identifying priority issues and research needs that, if addressed, will advance ethical, empathic, and equitable GIScience. We also aim to stimulate similar responses in other disciplines. Organized around the 3Es we discuss ethical issues arising from locational privacy and cartographic integrity, how our ability to build knowledge that will lead to empathy can be curbed by data that lack representativeness and by inadvertent inferential error, and how GIScientists can lead toward equity by supporting social justice efforts and democratizing access to spatial science and its tools. We conclude with a call to action and invite all scientists to join in a fundamentally different science that responds to the 3Es and mobilizes for change by engaging in humility, broadening measures of excellences and success, diversifying our networks, and creating pathways to inclusive education. Science united around the 3Es is the right response to this unique moment where society and the planet are facing a vast array of challenges that require knowledge, truth, and action.

ethics | empathy | equity GIScience | culture of science

Significance

There has been a groundswell in the support needed to center ethics, empathy, and equity in scientific thought and practice. Drawing on our experience from GIScience, our goal is to accelerate ethical, empathetic, and equitable scientific practices. Many of the opportunities and challenges we outline are broadly applicable and will stimulate the conversations needed to accelerate transformation of science practice and culture. With an emphasis on practical suggestions for reshaping science, we invite all scientists to join in a fundamentally different approach. This paper is a step toward mobilizing the scientific community toward ethics, empathy, and equity by inviting humility, broader measures of excellence and success, diversity in our networks, and the creation of pathways to inclusive education.

Most scientific research has traditionally been fueled by the innate curiosity of the researcher, by the desire to generate replicable and generalizable knowledge, and by the need to address practical problems. While there are, of course, less-noble drivers of science, most often researchers nobly aim their tools at knowledge creation and measure contributions through publications, awards, the support of funding agencies and our institutions, and various less-tangible forms of personal satisfaction. Yet, today we find a groundswell of support for complementary norms which have been percolating in science for some time. Here we focus on the "three Es"—ethics, empathy, and equity—which have scientists reflecting on and responding to questions such as the following:

- Given that we strive at all times for scientific practices to be ethical, how can science foster empathy and equity as well?
- Will our syllabi and courses attract and address the needs of all of our students?
- Does the culture of science that has evolved over the centuries truly reflect the needs and desires of all of humanity, or is science better at serving some segments of society than others?

These fundamental questions and many more like them are already the focus of long-standing initiatives such as the NSF's "Broader Impacts" criterion for research proposals. There are also professional development programs and networks seeking to accelerate progress in these areas, such as the GeoEthics project of the American Association of Geographers (https://aag-geoethics-series.secure-platform.com/a); the American Geophysical Society's EthicalGEO initiative (https://ethicalgeo.org/); the American Geophysical Union's LANDiNG (Leadership Academy and Network for Diversity and Inclusion in the Geosciences, https://www.agu.org/AGU-LANDInG); the University Consortium for Geographic Information Sciences' TRELIS-GS (Training and Retaining Leaders in STEM-Geospatial Sciences, https://www.ucgis.org/trelis); the American Association for the Advancement of Sciences' Project on Science, Technology, and Disability (https://www.aaas.org/programs/education-and-human-resources/project-science-technology-and-disability); and NorthStar, for increasing the representation, belonging, and inclusion of people of African descent in the geospatial industry and academia (https://gisnorthstar.org/). There are inclusive professional organizations such as the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science

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Author contributions: T.A.N., M.F.G., and D.J.W. wrote the paper.

Reviewers: S.E., University of Washington; D.L., The University of Arizona; and N.S., Simon Fraser University.

Competing interest statement: D.J.W. is an employee of the Environmental Systems Research Institute, which makes the software that was used in some of the studies cited in this work and depicted in Figs. 2 and 3.

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[2]T.A.N., M.F.G., and D.J.W. contributed equally to this work.

Published May 4, 2022.

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Esri

Trisalyn Nelson
Professor
University of California Santa Barbara

Mike Goodchild
Professor Emeritus
University of California Santa Barbara

Ethics Education *for* Current & Aspiring Geospatial Professionals

Open Educational Resources *for* Practical Ethics Education

Case Studies

Open Educational Resources for Practical Ethics Education

This project produced a set of case studies based on real and hypothetical scenarios experienced by geospatial professionals. The cases and associated instructor resources are freely available for use and reuse at other institutions. They have been successfully implemented in graduate curricula (both online and on campus) as well as in workshop settings.

The "case method" is a common pedagogical approach to ethics education in many fields. Through methodical analysis of case studies, students gain improved ethical sensitivity, knowledge, and judgment. Davis' "seven-step guide for ethical decision-making" helps students learn to analyze cases methodically.

Examples of case study scenarios:

> A police department's plan to map potential terrorist enclaves brings charges of racial profiling.

> A GIS analyst is asked to exclude pertinent data from maps prepared for a public hearing.

> Researchers track mobile phone users' movements to derive predictive models of human mobility.

> A geospatial intelligence analyst predicts the civilian casualties likely to be caused by a preemptive missile attack.

> A sales representative is expected to withhold information that could affect availability of a data product.

> A scope of work statement and established mapping procedures prevent a GIS analyst from adding wetlands to a landuse planning database.

Pedagogy

Seven Step Process for Making Ethical Decisions in GIS&T

Davis, Michael (1999). *Ethics and the University*. London, England: Routledge.

A key objective of practical ethics education in GIS&T is to strengthen the moral reasoning skills of current and future geospatial professionals. Davis' "seven-step guide" is a useful framework for helping students acquire these skills.

Step 1: State problem. For example, "there's something about this decision that makes me uncomfortable" or "do I have a conflict of interest?"

Step 2: Check facts. Many problems disappear upon closer examination of the situation, while others change radically.

Step 3: Identify relevant factors. For example, persons involved, laws, professional code, other practical constraints.

Step 4: Develop list of options. Be imaginative, try to avoid "dilemma"; not "yes" or "no" but whom to go to, what to say.

Step 5: Test options. Use such tests as the following: **Harm test:** does this option do less harm than alternatives? **Publicity test:** would I want my choice of this option published in the newspaper? **Defensibility test:** could I defend choice of option before Congressional committee or committee of peers? **Reversibility test:** would I still think the choice of this option is good if I were adversely affected by it?

Step 6: Make a choice based on steps 1-5.

Step 7: Review steps 1-6. What could you do to make it less likely that you would have to make such a decision again?

ETHICS

Case Studies

Students develop ethical awareness and moral reasoning skills by analyzing and discussing realistic case studies. The cases in this curated collection pose some of the ethical challenges faced by geospatial professionals. Related educator resources are available on request for most cases.

Download the Case Studies

- **An Ethical Minefield** Should a surveying and mapping crew chief pay a bribe to acquire data needed to conduct field reconnaissance safely?
- **Bear Baiting** Should locations of controversial hunting stations be mapped?

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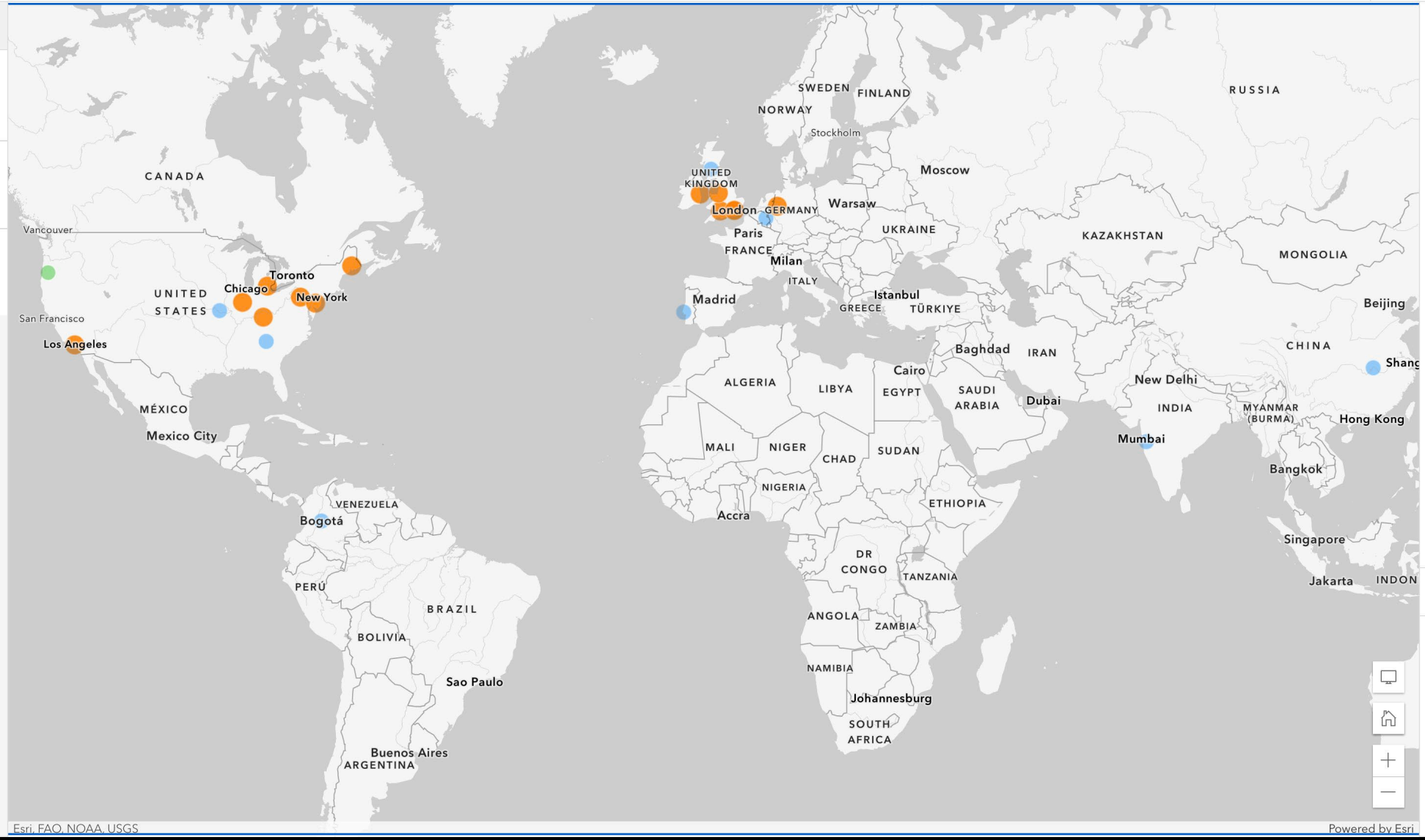

PeerJ Computer Science

Undergraduate data science degrees emphasize computer science and statistics but fall short in ethics training and domain-specific context

Jeffrey C. Oliver[1] and Torbet McNeil[1,2]

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[2] Department of Educational Policy Studies and Practice, University of Arizona, Tucson, AZ, USA

ABSTRACT

The interdisciplinary field of data science, which applies techniques from computer science and statistics to address questions across domains, has enjoyed recent considerable growth and interest. This emergence also extends to undergraduate education, whereby a growing number of institutions now offer degree programs in data science. However, there is considerable variation in what the field actually entails and, by extension, differences in how undergraduate programs prepare students for data-intensive careers. We used two seminal frameworks for data science education to evaluate undergraduate data science programs at a subset of 4-year institutions in the United States; developing and applying a rubric, we assessed how well each program met the guidelines of each of the frameworks. Most programs scored high in statistics and computer science and low in domain-specific education, ethics, and areas of communication. Moreover, the academic unit administering the degree program significantly influenced the course-load distribution of computer science and statistics/mathematics courses. We conclude that current data science undergraduate programs provide solid grounding in computational and statistical approaches, yet may not deliver sufficient context in terms of domain knowledge and ethical considerations necessary for appropriate data science applications. Additional refinement of the expectations for undergraduate data science education is warranted.

Subjects Computer Education, Data Science
Keywords Education, Machine learning, Ethics, Statistics, Computer science, Curricula, Data science

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Academic editor
Harry Hochheiser

Additional Information and Declarations can be found on page 13

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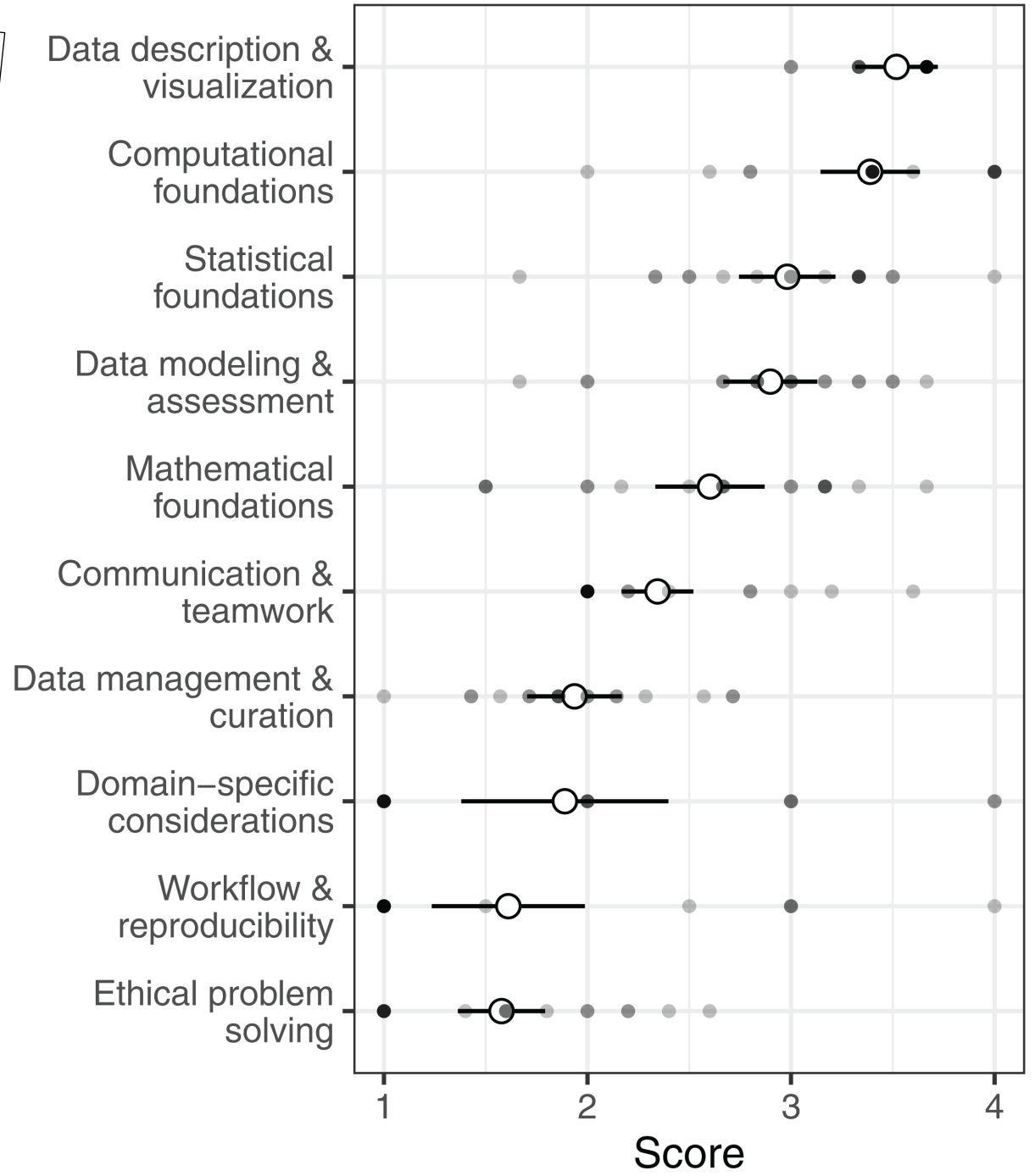
BACKGROUND

Data-intensive work and the desire for data-driven decisions increasingly fuel interest in the field of data science. According to the *National Academies of Sciences, Engineering & Medicine (2018)*, employers across disciplines are demanding that employees have skills in working with and extracting knowledge from data. Additionally, the report suggests every undergraduate student should graduate with at least beginning competency for working with data. However, many undergraduates are not obtaining the necessary training to prosper in the new economy. College administrators have reacted, and the number of undergraduate data science programs has multiplied. In 2014, there were



10. Ethical Problem Solving

- **Ethical precepts for data science and codes of conduct**
  4: Required course(s) covering ethical precepts for data science and codes of conduct.
  3: Required course(s) introducing ethical precepts for data science and codes of conduct, but not at the level necessary to receive a 4.
  2: Optional course covering ethical precepts for data science and codes of conduct.
  1: No course covering material.
- **Privacy and confidentiality**
  4: Required course(s) covering privacy, confidentiality, or ethics of data.
  3: Required course(s) introduced privacy, confidentiality, or ethics of data, but not at the level necessary to receive a 4.
  2: Optional course covering privacy, confidentiality, or ethics of data.
  1: No course covering material.
- **Responsible conduct of research**
  4: Required course description specifically mentioning responsible conduct of research or something similar.
  3: Required course description mentioning responsible conduct of research or something similar, but not at the level necessary to receive a 4.
  2: Optional course description specifically mentioning responsible conduct of research or something similar.
  1: No course covering material.
- **Ability to identify "junk" science**
  4: Required course description specifically mentioning junk science or pseudoscience.
  3: Required course description including language like "critically evaluating the quality of prior published work."
  2: Required course description explicitly mentioning the scientific method; or optional course description including language like "critically evaluating the quality of prior published work."
  1: No course covering material.
- **Ability to detect algorithmic bias**
  4: Required course description explicitly mentioning algorithmic bias, ethics of algorithm development/application, or something of that ilk.
  2: Optional course description explicitly mentioning algorithmic bias, ethics of algorithm development/application, or something of that ilk.
  1: No course covering material.

Oliver Jeffrey C. and Torbet McNeil (2021). Undergraduate data science degrees emphasize computer science and statistics but fall short in ethics training and domain-specific context. *PeerJ ComputerScience* 7:e441 https://doi.org/10.7717/peerj-cs.441

	A	B	C	D	E	F	G
1	PENN STATE UNIVERSITY **M.S. in Spatial Data Science**				Assessed program		
2	Program site: https://geospatial.psu.edu/degree-programs/master-of-science-in-			Perma CC: https://perma.cc/8LCV-F7VE	Date Assessed: 26 August 2022 (Reviewed 19 October 2022)		
3	Ethics education information: https://geospatial.psu.edu/ethics						
4							
5	**Ethical precepts for data science and codes of conduct**		**Scores**	**Courses**	**Notes**		
6	4	Required course(s) covering ethical precepts for data science and codes of conduct.					
7	3	Required course(s) introducing ethical precepts for data science and codes of conduct, but not at the level necessary to receive a 4.	3	Responsible Scholarship and Professional Practice (RSPP) workshop https://geospatial.psu.edu/RSPP_Workshop	"The Responsible Scholarship & Professional Practice (RSPP) workshop involves approximately twelve hours of instructor-led student activity. Activities include online (CITI) training in the responsible conduct of research, online discussions, readings, and formal analysis of geospatial ethics case studies. Students who successfully complete the RSPP workshop will be prepared to: vPractice academic integrity and responsible conduct of research; Demonstrate ability to write English prose at a graduate level; Demonstrate moral reasoning skills through methodical analysis of ethical case studies; and Demonstrate familiarity with and understanding of pertinent ethical codes and rules of conduct"	Note: MS-SDS students required to take either the RSPP workshop or GEOG 581: Spatial Data Science Ethics.	
8	2	Optional course covering ethical precepts for data science and codes of conduct.		GEOG 581: Spatial Data Science Ethics https://geospatial.psu.edu/geog581	"GEOG 581 is a graduate seminar for students who are concerned about the ethical implications and social impacts of geospatial technologies and methods. It traces the roots of Spatial Data Science Ethics in moral philosophy, professional ethics frameworks, and critical studies in the geospatial field. Students analyze ethical case studies and compare and critique relevant legal and policy issues. They evaluate the organizational ethics of firms and agencies (including current or potential employers) that provide spatial data science products and services, and they discuss a proposed “ethics of digital care” for leading balanced digital lives"		
9	1	No course covering material.					
10							
11	**Privacy and confidentiality**						
12	4	Required course(s) covering privacy, confidentiality, or ethics of data.					
13	3	Required course(s) introduced privacy, confidentiality, or ethics of data, but not at the level necessary to receive a 4.	3	RSPP workshop			
14	2	Optional course covering privacy, confidentiality, or ethics of data.		GEOG 581: Spatial Data Science Ethics			
15	1	No course covering material.					

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Curriculum Mapping Project Nov 2021 – Jan 2022

Instructors asked to rate their courses in relation to each of 9 competency areas

Application	Communication	Creation	Critical Thinking	Cultural Competence	Ethics	Knowledge	Professional	Research
Apply knowledge of spatial relationships, technology, and geospatial information for the creation of maps, databases, and software applications to address challenges in the private, commercial and societal sectors.	Communicate the nuances of complex spatial relationships with text, voice, and visual products to broadly inform professional and non-technical audiences in a range of contexts.	Create viable solutions using maps, applications and analytical tools to address new challenges in a variety of domains.	Objectively analyze and evaluate a situation in the context of spatial relationships to enable further analysis in support of problem solving and decision making.	Demonstrate knowledge of cultural norms that are respectful of diversity and inclusion to establish a positive and professional work environment.	Demonstrate ethical conduct by producing quality work, contributing to the community, managing professional relationships by establishing honest and respectful interactions among individuals and organizations.	Apply knowledge of spatial information and relationships using appropriate geographic information technologies in a variety of contexts to educate, solve problems and make decisions.	Demonstrate conduct in alignment with professional standards in interpersonal communication, mediation, and respect for diversity while recognizing appropriate team roles in professional, community and education-based activities.	Combine accepted geospatial techniques and prior knowledge of spatial relationships to create new solutions for previously unencountered situations.

Ratings: “1 for Introductory, 2 for Practice, or 3 for Mastery … or X if not applicable”

1 Introductory	2 Practice	3 Mastery
Students are receivers of knowledge, and demonstrate comprehension and ability to apply knowledge within the field of study	Students expand abilities to apply knowledge in the discipline. Foundation concepts and abilities are reinforced through practice.	Students demonstrate mastery of knowledge domain and proficiency in using what they have learned

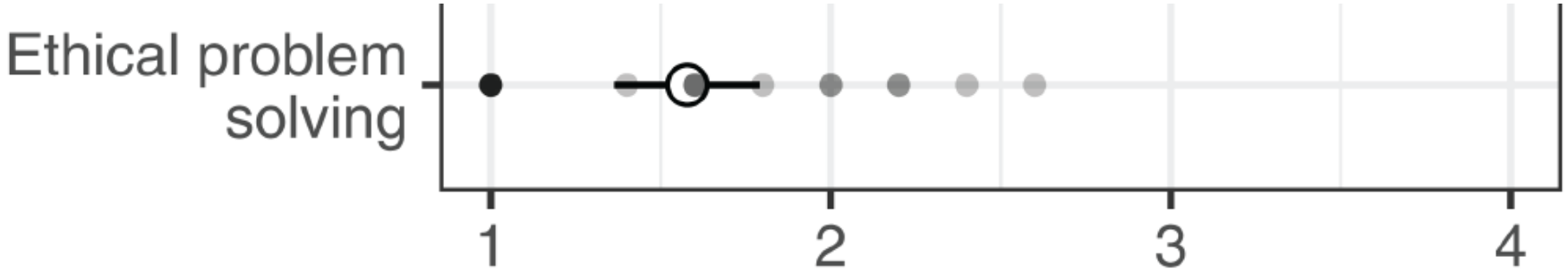
Course #	Title	Course map respondent	Instructor Ethics rating in Course Map	Ethics (or privacy, confidentiality, bias, truth, propaganda) mentioned in Course Description or Syllabus?	Statement in description
479	Spatial Data Science of Cyber and Human Social Networks	Giannakis	1	yes	"compare expectations and rights of individuals and governments related to the use of geolocation technologies, data, and privacy from various perspectives"
480	Exploring Imagery and Elevation Data in GIS Applications	Schuckman	2	no	"use acquired knowledge and critical thinking skills"
481	Topographic Mapping with Lidar	Schuckman	2	no	
482	Making Maps that Matter with GIS	DiBiase	1	yes	"Relevant ethical, legal, and policy issues such as locational privacy"
485	GIS Programming and Software Development	Giannakis	X	no	
484	GIS Database Development	Giannakis	2	no	
486	Cartography and Visualization	Kessler	X	no	Map critiques
489	Advanced Python Programming for GIS	O'Brien	1	no	
571	Intelligence Analysis, Cultural Geography, and Homeland Security	Thomas	1	no	
581	Spatial Data Science Ethics	DiBiase	3	yes	Spatiial Data Science Ethics
583	Geospatial System Analysis and Design	Bacastow	3	no	
585	Open Web Mapping	Giannakis	X	no	(implied)
586	Geographic Information Analysis	Kessler	X	no	"Discuss the merits of point pattern analysis versus cluster detection, and outline the issues involved in real-world applications of these methods."
589	Emerging Trends in Remote Sensing	Schuckman	2	no	
591	GIS for Analysis of Health	Beaty	2	yes	"Explain the privacy concerns associated with mapping and using health and disease data"
594a	Culminating Experiences in Geospatial Intelligence	Thomas	2	no	
596i	Independent Study in Geospatial Intelligence	Thomas	1	no	
858	Spatial Data Science for Emergency Management	Beaty	2	no	
861	Spatial Reference Systems in GIS	Kessler	X	no	
863	Web Application Development for the Geospatial Professional	Detwiler	X	no	
865	Cloud and Server GIS	Baxter	1	no	"This course will challenge you to exercise the critical thinking and technical skills needed to evaluate and develop successful cloud GIS projects"
868	Spatial Database Management	Detwiler	X	no	
882	Geographic Foundations of Geospatial Intelligence	Corson	2	yes	"critically assess ethical and social justice issues that arise in the application of geospatial intelligence analysis;"
883	Remote Sensing Image Analysis and Applications	Sharma	2	no	

589	Emerging Trends in Remote Sensing	Schuckman	2	no											
591	GIS for Analysis of Health	Beaty	2	yes	"Explain the privacy concerns associated with mapping and using health and disease data"										
594a	Culminating Experiences in Geospatial Intelligence	Thomas	2	no											
596i	Independent Study in Geospatial Intelligence	Thomas	1	no											
858	Spatial Data Science for Emergency Management	Beaty	2	no											
861	Spatial Reference Systems in GIS	Kessler	X	no											
863	Web Application Development for the Geospatial Professional	Detwiler	X	no											
865	Cloud and Server GIS	Baxter	1	no	"This course will challenge you to exercise the critical thinking and technical skills needed to evaluate and develop successful cloud GIS projects"										
868	Spatial Database Management	Detwiler	X	no											
882	Geographic Foundations of Geospatial Intelligence	Corson	2	yes	"critically assess ethical and social justice issues that arise in the application of geospatial intelligence analysis;"										
883	Remote Sensing Image Analysis and Applications	Sharma	2	no											
884	GIS for the Geospatial Intelligence Professional	Bacastow	3	no											
892	Unmanned Aerial Systems	Abdullah	2	yes	"3/2" "understanding rules and regulations governing operating a UAS in the United States"… "concerns surrounding UAS safety, security and privacy issues"… "D										
885	Advanced Analytic Methods in Geospatial Intelligence	Thomas	2	yes	"You'll also learn how to reduce personal and organizational bias"										
			Professional Practice rating in Course Map												
596A	Individual Studies - Peer Review	Kessler	3	no	(Implied: Responsible Conduct of Research)										
596B	Individual Studies = Capstone Project	Kessler	3	no	(Implied: Responsible Conduct of Research)										
		Instructor Ratings Summary		**Course Descriptions Summary**											
		X (Topic not addressed) =	7	22	No - Course descriptions don't mention ethics-related topics										
		1 (Introductory) =	6	7	Yes - Course descriptions mention ethics-related topics										
		2 (Practice) =	11												
		3 (Mastery) =	5												
		1, 2 or 3 (Some Ethics Content) =	22/29 = 77%	7/29 = 24%	Yes - Course descriptions mention ethics-related topics										

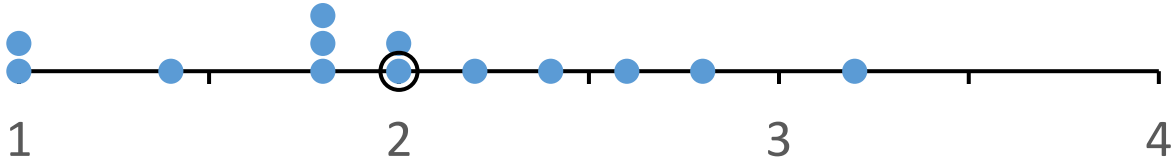
Sheet1

Spatial Data Science Ethics Education worksheet at https://bit.ly/3gy3cDP

INSTITUTION	MASTERS PROGRAMS ASSESSED	PROGRAM DESCRIPTION	DELIVERY
Birkbeck College	MSc in Geographic Data Science	https://perma.cc/5EQ2-ZRHT	On campus
University of Bristol	MSc in Geographic Data Science and Spatial Analytics	https://perma.cc/BU52-ZQ9P	On campus
University College Dublin	MSc in Geospatial Data Analysis	https://perma.cc/DQ8Q-ENV8	On campus
University of Illinois	MS in CyberGIS and Geospatial Data Science	https://perma.cc/7CBD-3HTK	Online
University of Kentucky	MS in Digital Mapping	https://perma.cc/6ESD-C6G5	Online
University of Liverpool	MSc in Geographic Data Science	https://perma.cc/6C8X-CD7F	On campus
London School of Economics	MSc Geospatial Data Science	https://perma.cc/W68W-P729	On campus
University of Maine	MS Spatial Information Science and Engineering MS Spatial Informatics	https://perma.cc/S29Y-R5JB	On Campus (MS SIS&E) Online (MS SI)
University of Michigan	MS in Spatial Data Science	https://perma.cc/C5NY-4F79	On Campus
Universität Münster	MSc in Geoinformatics and Spatial Data Science	https://perma.cc/Z7AE-PAXX	On campus
Pennsylvania State University	MS in Spatial Data Science	https://perma.cc/8LCV-F7VE	Online
Temple University	PSM in Geospatial Data Science	https://perma.cc/8LMM-FTCG	On campus/hybrid
University of Southern California	MS in Spatial Data Science	https://perma.cc/4PT8-DNG2	Online



Oliver & McNeil (2021)
Data Science BS programs



DiBiase & Robinson (2022)
Spatial Data Science MS

Rubric Scores Summary

	USC	Illinois	Michigan	Maine	Birkbeck	Temple	LSE	Dublin	Bristol	Penn State	Kentucky	Münster	Liverpool	Row means
Ethical precepts for data science and codes of conduct	1	1	1	1	1	4	1	1	1	3	3	3	3	1.8
Privacy and confidentiality	1	1	1	2	2	1	4	2	3	3	4	2	2	2.2
Responsible conduct of research	1	1	2	3	2	1	2	4	4	3	4	4	4	2.7
Ability to identify "junk" science	1	1	2	1	2	1	1	2	2	2	1	1	3	1.5
Ability to detect algorithmic bias	1	1	1	1	2	2	2	1	1	1	1	4	4	1.7
Column means	1	1	1.4	1.8	1.8	1.8	2	2	2.2	2.4	2.6	2.8	3.2	

Rubric Scores Summary

	USC	Illinois	Michigan	Maine	Birkbeck	Temple	LSE	Dublin	Bristol	Penn State	Kentucky	Münster	Liverpool	Row means
Ethical precepts for data science and codes of conduct	1	1	1	1	1	4	1	1	1	3	3	3	3	1.8
Privacy and confidentiality	1	1	1	2	2	1	4	2	3	3	4	2	2	2.2
Responsible conduct of research	1	1	2	3	2	1	2	4	4	3	4	4	4	2.7
Ability to identify "junk" science	1	1	2	1	2	1	1	2	2	2	1	1	3	1.5
Ability to detect algorithmic bias	1	1	1	1	2	2	2	1	1	1	1	4	4	1.7
Column means	1	1	1.4	1.8	1.8	1.8	2	2	2.2	2.4	2.6	2.8	3.2	

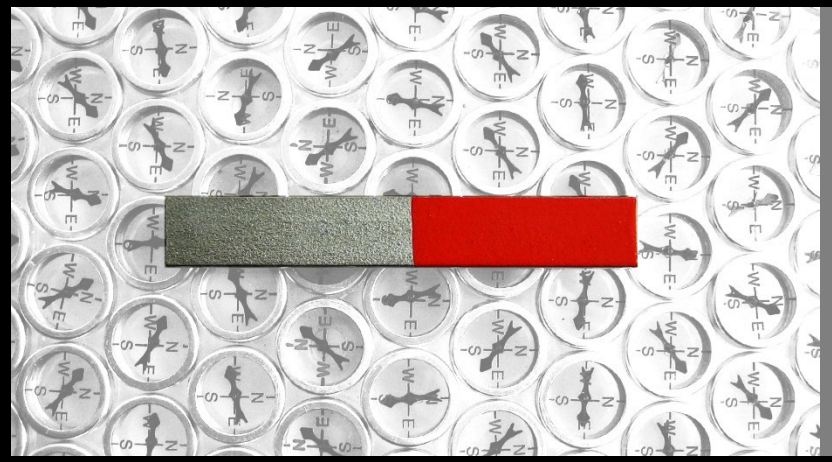
Data Quality

Commodification of Personal Data

Algorithmic Bias

Labor Exploitation and Workplace Automation

Cartographic Integrity



Penn State MS in Spatial Data Science

Spatial Data Science Ethics

Privacy

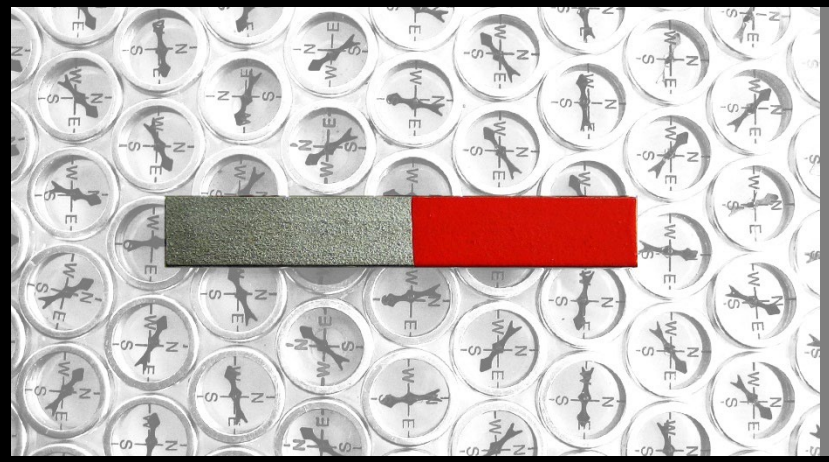
Inadequate Legal and Policy Frameworks

Surveillance Society

Environmental Impacts of Tech Manufacture and Operations

Analytical Integrity

PennState



Can There Be a Spatial Data Science Ethics?

David DiBiase & Anthony Robinson

AutoCarto 2022 | November 3 | Redlands CA