Geographic Data Science

We live in an era of increasingly abundant data and as always the challenge is to turn these into information. Geospatial data adds substantially to this challenge, and as presented by Dony, Nara, Rey, Solem and Herman (this issue), this is pointing to the increasing need for educating a workforce trained in both geography and computational thinking, or geo-computational thinking. Geographers worldwide have been at the forefront of geographic data science research, but as these authors present, we need to do a better job preparing our students, while increasing diversity in the geospatial workforce. Given our prominent role in preparing professionals in California, the CSU should be a leader.

Geographic data are rapidly increasing in abundance and availability. Location data can come from many sources, such as GPS or other location services built into smart phones and other devices or interpreted from Twitter feeds, to add to the existing wealth of data with traditional locational sources. On top of our well-established and continually advancing ArcGIS tools, recent developments in R such as the Tidyverse (Wickham & Grolemund 2017), especially coupled with linked advances in spatial structures such as Simple Features (Pebesma 2018), have improved the accessibility and capabilities of structuring data in logical ways as well as enhancing our ability to explore and present our data in informative graphs and maps.

Geographers and others who use geospatial data are discovering new ways to approach the wealth of data sources. Big Data is one thing; big geographic data adds to the challenge, but provides opportunities. Chen, Tsou and Nara (this issue) define big data as having a size or complexity "too big to be processed effectively by traditional software." Government sources at multiple levels remain a key source for the data used in this issue, whether it's data water quality, land-cover and feed-lot permits (Alford & Perez); transportation (Chen, Tsou & Nara); or health (Huh, Abdullah & Williams) and as these authors show these can be related to business data from the fast food industry. And of course, as we've increasingly reported in this journal, we're creating our own data challenges by collecting our own imagery from drones (Wells, Monak & Patsch) and (DaSilva & Patsch), but these sources clearly help us communicate our stories graphically and journalistically.

The CSU is a big system, and as the annual issues of the CSU Geospatial Review shows, we are finding many ways to address geospatial research, in the field and in the lab. But are we doing enough to meet the challenge to prepare the next generation of geo-computational scholars?

Jerry Davis, *Director,* CSU GIS Specialty Center
San Francisco State University

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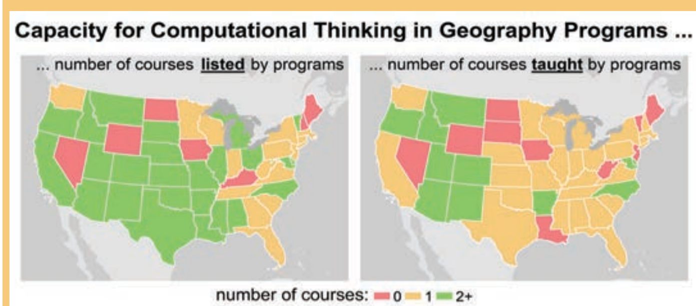
San Diego



Cartography by Hannah Ellingson
(Date: 2 April 2018 | Source: AAG Guide to Geography Programs)

Encoding Geography: Building Capacity for Inclusive Geo-Computational Thinking with Geospatial Technologies

The value and intelligence gained from geospatial innovations such as mobile Global Positioning System (GPS) is such that, in recent years, the geospatial services industry created approximately 4 million direct jobs and generated 400 billion U.S. dollars globally in revenue per year (AlphaBeta, 2017). This is the main reason for the increased demand for graduates with training in both geography and computational thinking (geo-computational thinking), but such students are hard to find. As a consequence, employers across the public and private sectors are constrained and forced to choose between hiring a geographer with limited

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or no computational skills, or a computer science graduate with limited or no expertise in geography and geographic information.

The recent democratization of manufacturing geospatial hardware (Baiocchi & Welser, 2015) is a sign that the geospatial services industry continues to innovate and grow. More importantly, these innovations will generate enormous volumes of geospatial data at even higher rates than we are already facing. We argue that the value of these spatial data will hinge on a workforce that is (1) equipped with geo-computational thinking skills and (2) is diverse and inclusive.

At the K-12 levels, we are still facing long-standing challenges with geography education. In 2015, the Government Accountability Office raised concerns that "throughout the country, K-12 students may not be acquiring adequate skills in and exposure to geography, which are needed to meet workforce needs in geospatial and other geography-related industries". At the college level, geography departments are starting to offer courses that involve computational thinking (Bowlick, Goldberg & Bednarz, 2017), but only a handful have built capacity for certificates or a specialty in geo-computation.

A collaborative effort between the American Association of Geographers (AAG), San Diego State University, UC Riverside, California Geographic Alliance, and Sweetwater Union High School District, will engage in exploratory research to help institutions understand the capacity they need to modernize geography education and to broaden the participation of underrepresented minorities in geo-computational curriculum. This two-year NSF funded project (2018-2020) will initiate the formation of a researcher-practitioner partnership (RPP) to articulate PreK-14 pathways that will expand opportunities for all students to develop spatial and computational (i.e., geo-computational) thinking skills. This pilot RPP is composed of geographers, computer science educators, social science educators and geospatial technology specialists experienced in serving underrepresented minority students and communities. Building capacity for inclusive pathways in computational geography will contribute to key instructional goals in K-12 and postsecondary institutions and increase the potential of all students to contribute to the national innovative ecosystem.

The maps on the previous page show the result of preliminary research conducted by the AAG on a selection of college geography programs to assess their offerings of courses involving computational thinking. The map on the left shows the average number of such courses in each state that are listed on a geography program's website. However, some of the courses listed in geography programs are courses offered by a computer science (or related) program. The map on the right shows the same average but only taking into account courses offered by the geography departments. These maps indicate that, although students have access to courses supporting computational thinking, they are not often taught by a geography professor. On the one hand, this may indicate barriers experienced by geography professors to teach such courses in their department. On the other hand, this may indicate barriers to learning computational thinking if it is not taught in way that would be meaningful to geography students.

This RPP will initiate the design of a long-term mixed-methods approach combining surveys with qualitative data collection to allow other regions or states to design, develop, and implement geo-computational curriculum at all educational levels. The main questions driving further research are: (1) What are barriers experienced by students, teachers, schools or departments in teaching and learning geo-computational thinking? (2) How can RPPs expand access to geo-computational education in K-12 schools?

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AUTHORS

Coline Dony
Senior Geography Researcher
Association of American Geographers
cdony@aag.org

Atsushi Nara
Assistant Professor, Geography
Associate Director, Center for Human Dynamics in the Mobile Age (HDMA)
San Diego State University
anara@sdsu.edu

Sergio Rey
Founding Director, Center for Geospatial Sciences
Professor, School of Public Policy
University of California, Riverside
sergio.rey@ucr.edu

Michael Solem
Research Professor, Department of Geography, and Director of Research, Grosvenor Center for Geographic Education
Texas State University, San Marcos
Senior Adviser for Geography Education and Co-Director of the National Center for Research in Geography Education
American Association of Geographers
msolem@aag.org

Thomas Herman
Director, California Geographic Alliance (CGA)
Adjunct Faculty/Instructor, Department of Geography
San Diego State University
therman@sdsu.edu