

Open Source Geospatial Software: Challenges and Opportunities

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A key challenge facing academic open source geospatial software is that it faces stiff competition for new students who are critical to the future growth of the field. Increasingly, private sector companies with deep pockets can attract the brightest graduate and post-doctoral students by offering productive working environments and the promise of challenging/interesting geospatial problems. At the same time, tenure track positions in academia are on the decline and the expectations for career advancement within academia continue to rise. Additionally, the talented individual who has the rare combination of scientific training and open source software experience/skills faces the reality that only their scientific contributions will be given recognition in the promotion process. Their time spent contributing to open source projects is still woefully underrewarded in the current system. The increasing competition from the private sector together with the institutional inertia within academia have created a first-order brain drain problem for academic open source geospatial software.

A related challenge is the emerging trend in the explosion of open source spatial analysis software that is being developed **outside** of academia. Companies like Mapbox and Carto have been at the forefront of making locational data and web based geovisualization available to open source developers, in arguably more agile ways than the giants Google and ESRI. The widespread adoption of these services by the broader development community has led to a perception that academic research on spatial analytical software is being crowded out to the point where spatial data science and the products of these agile companies are viewed as one and the same.

There are real dangers in these developments. Leading open source contributors in the private sector have a different perspective on the field of spatial software. For example, Sean Gilles, a prominent figure in the Python geospatial world, now at Mapbox, has recently stated that:

"All the problems in GIS software have been solved." (Podcast. `__init__` episode 80).

This stands in stark contrast to the discussions at academic conferences such as GiScience, Geocomputation, and ACM-SIGSPATIAL, where an embarrassment of riches of interesting problems being addressed by researchers can be found. Clearly there is a disconnection between what is going on inside these new open source geospatial companies and the world of academic research. This disconnection poses problems for both communities. By taking the innovation inside private companies, there are deep tensions that arise from a scientific perspective as the closing up of open source software inside proprietary API dampens scientific innovation. A parallel siloing in a sense may arise in academia where research advances are circulated among academic peers at conferences and through journals but their impact on society are blunted because of the private sector-academic disconnect.

The newly formed Center for Geospatial Sciences at the University of California, Riverside is bringing together GIScientists with expertise in open source spatial analysis software, its development, implementation, application and dissemination. Members of CGS work in

different areas of spatial analysis from high performance geocomputation, geovisualization, ESDA, to big spatial data and spatial optimization, and both develop new analytical methods as well as collaborate in their implementation in open source software. CGS expertise can help inform responses to these challenges from three angles: (1) It will bridge different scientific worlds, for example, geospatial analysis and big spatial data management, which will potentially accelerate innovations and advances in open source GIS software and shows the impact of the academic world as an on-going stream of innovations rather than a set of historical achievements. (2) It stimulates interdisciplinary research as a core value which helps in advancing the GIS software capabilities in terms of detecting gaps and innovating new solutions via collaborating with researchers from different disciplines. (3) It gives a boost for more rewarding evaluation for open source software contributions within the academic system, having people hired with primary focus on computational geospatial research. This is a baby step towards a large reform on how open source software contributions are valued and encouraged in the community. Finally, we feel strongly that a community wide discussion that harnesses the energies across institutions (North Carolina State University, Ohio State University, UC Santa Barbara, UMaryland, U Chicago, U Illinois, among others) will also be a vital component in responding to these, and other, challenges.

BIOGRAPHY

Sergio Rey is Professor in the School of Public Policy and Founding Director of the Center for Geospatial Sciences at UCR. Rey's research interests focus on the development, implementation, and application of advanced methods of spatial and space-time data analysis. His substantive foci include regional inequality, convergence and growth dynamics as well as neighborhood change, segregation dynamics, spatial criminology and industrial networks. Recent and current research projects include geodemographic approaches to neighborhoods in space-time contexts (NSF), new methods for spatial distribution dynamics (NSF), an analysis of the relationships between spatial linkages and urban economic dynamics (EDA), flexible geospatial visual analytics and simulation technologies to enhance criminal justice decision support systems (NIJ), spatial analytical framework for examining community sex offender residency issues over space and time (NSF), and cyberGIS software integration for sustained geospatial innovation (NSF). Rey is the creator and lead developer of the open source package STARS: Space-Time Analysis of Regional Systems as well as co-founder and lead developer of PySAL: A Python Library for Spatial Analysis. He is an elected fellow of the Regional Science Association International, a fellow of the Spatial Econometrics Association, and has served as the Editor of the International Regional Science Review from 1999-2014, editor of Geographical Analysis 2014-2017, and the president of the Western Regional Science Association. He is co-chair of the Scientific Computing with Python Meeting 2015-2018.

PUBLICATIONS

Selected Publications

- 2017 Clark, S.D. and S.J. Rey. "Temporal dynamics in local vehicle ownership in Great Britan." *Journal of Transport Geography*, 62: 30-37.
- 2017 Fan, C., S.W. Myint, S.J. Rey and W. Li. "Time series anaysis of urban dynamics using sequential Landsat imagery and spatial statistical modeling." *International Journal of Applied Earth Observation and Geoinformation*. Forthcoming.
- 2017 Rey, S.J. "Code as Text: Open Source Lessons for Geospatial Research and Education." In Thill, J-C. and S. Dragicevic (eds.) *Geocomputational Analysis and Modeling of Regional Systems*. Springer. In Press.
- 2017 Rey, S.J. "Python for GIS." In Wilson, J. (ed.) *Geographic Information Science & Technology Body of Knowledge*. University Consortium for Geographic Information Science. In Press.
- 2017 Arribas-Bel, D., T. de Graaff and S.J. Rey. "Looking at John Snow's cholera map from the XXIst century: a practical primer on reproducibility and open science. In R.W. Jackson and P. Schaeffer (eds.) *Regional Research Fontiers*. Springer. Page 283-306.

- 2017 Jackson, R., S.J. Rey and P. Jarosi. "Object orientation, open regional science, and cumulative knowledge building." In R.W. Jackson and P. Schaeffer (eds.) *Regional Research Frontiers*. Springer. Pages 259-282.
- 2017 Laura, J. and S.J. Rey "Spatial data analytics on heterogeneous multi- and many-core parallel architectures." In Shekhar, S. and H. Xiong (eds.) *Encyclopedia of GIS*. Springer. Pages 1972-1981.
- 2016 Fan, C., S.J. Rey, and S. Myint. "Spatially filtered ridge regression (SFRR): A regression framework to understanding impacts of land cover patterns on urban climate." *Transactions in GIS*. DOI: 10.1111/tgis.12240.
- 2016 Franklin, J. and S.J. Rey. "Heterogeneous tree recruitment following disturbance in insular tropical forest, Kingdom of Tonga." *Journal of Tropical Ecology*, 32(6): 536-542.
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- 2016 Rey, S.J., P. Stephens, and J. Laura. "An evaluation of sampling and full enumeration strategies for Fisher-Jenks classification in big data settings." *Transactions in GIS*, DOI: 10.1111/tgis.12236.
- 2016 Reyna, J., M. Chester, and S.J. Rey. "Defining geographical boundaries with social and technical variables to improve urban energy assessments." *Energy*, 112(1): 742-754.
- 2015 Rey, S.J. "Bells in space: The spatial dynamics of US interpersonal and interregional income inequality." *International Regional Science Review*. DOI: 10.1177/0160017615614899.
- 2015 Laura, J., W. Li, S.J. Rey and L. Anselin. "Parallelization of a regionalization heuristic in distributed computing platforms - A case study of parallel-p-compact-regions problem." *International Journal of Geographical Information Science*, 29: 536-555.
- 2015 Rey, S.J., L. Anselin, X. Li, R. Pahle, J. Laura, W. Li, J. Koshinsky. "Open Geospatial Analytics with PySAL." *International Journal of Geo-Information*, 4: 815-836.