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**Grant McKenzie** is an assistant professor in the Department of Geography at McGill University in Montré'al, Canada where he leads the Platial Analysis Lab, an interdisciplinary research group that works at the intersection of data science and behavioral geography. Much of Dr. McKenzie's work examines how human activities vary within and between local neighborhoods and global communities. This has driven his applied interests in financial accessibility, geoprivacy, and micro-mobility services as well as the broader role that spatial data science plays at the intersection of information technologies and society. Grant is a founding member of the Seattle-based start-up consultancy Spatial Development International and has worked as a data scientist and software developer for a range of NGOs and leading technology companies.

## The World Outside GIScience

In the 1960s the discipline of Geography went through a paradigm shift in what is often called the *Quantitative Revolution*. Spurred by seminal work such as Bunge's *Theoretical Geography*<sup>[1]</sup>, this movement is frequently attributed with giving rise to *Geographical Information Science*<sup>[3]</sup> as a discipline. We are in the midst of a similar scientific paradigm shift today with the rise of data-driven scientific discovery or what has been termed the *fourth paradigm* of science<sup>[6]</sup>. This move towards data-driven e-science is built on the emergence of *big*, heterogeneous datasets contributed from a range of sources analyzed through high-performance computing resources using various artificial intelligence approaches. While the rise of data-driven science has altered most scientific disciplines, it is having a profound impact on the discipline of Geography, arguably in much the same way as the Quantitative Revolution fifty years prior.

It is within this context that I envision the emergence of Spatial Data Science (SDS) as a discipline. As a geographic information scientist, I see Spatial Data Science as a logical, yet large, next step beyond Geographic Information Science. The key differences here being that Spatial Data Science is truly inclusive, looks outwards towards other disciplines, using spatial reference systems (in many facets) as the foundation on which to explore patterns within complex and multi-dimensional data. In discussing an agenda for this new field of Spatial Data Science, I outline three important items.

### Stepping outside the walls of GIScience

Geographic Information Science began as a field that drew from a range of disciplines such as Geography, Statistics, Cartography, etc. Over the last few years, however, GIScience, like many disciplines, has become introspective, building on existing, well-established GIScience research topics.

While this is not always a bad thing, it has unfortunately come at the expense of many new ideas, often contributed from researchers outside of the field. In fact, his introversion is well documented in the GIScience literature<sup>[5, 7, 2]</sup>. Spatial Data Science offers an opportunity to step outside the walls of GIScience, and truly look across many different disciplines.

Spatial Data Science represents a clean slate, an opportunity to be truly discipline agnostic. SDS should encompass naturally interdisciplinary fields such as remote sensing, information science, human-computer interaction, and the broader computer sciences as well as less obvious fields such as bioinformatics, psychology, sociology and communication studies, disciplines that often rely heavily on spatial information and have their own techniques and approaches for analyzing these data. This is not to say that GIScience as a field of research is no longer relevant, indeed it is, but rather that it has a leading role to play in the much broader interdisciplinary (super-)field of Spatial Data Science. In much the same way that Computer Science had a foundational role in the emergence of Information Science, GIScience has the opportunity to be a leading architecture of Spatial Data Science.

### **Data, Data . . . and More Data**

Spatial Data Science represents a shift from domain-specific thinking towards data-centric thinking. Data is at the center<sup>1</sup> of this discipline and it is important to keep in mind that it is predominantly focused on methods and techniques applied to extract pattern and mean from spatial *data*. The fourth paradigm of science is a catalyst which has assigned a label to the data-intensive scientific discovery process and it is through this lens that Spatial Data scientists explore the world.

It is not an oversight that the first word is *Spatial* and not *Geospatial*. The important distinction here is that SDS research is not necessarily aimed at data referenced to a geoid, but also includes analyses based on alternative spatial reference systems, such as the brain, or chemical bonds. A Geoinformatics researcher is a potential SDScientist that applies her techniques and methods to issue in the domain of Geography whereas an individual in Bioinformatics is a SDScientist applying similar techniques and methods to Biology, DNA sequences, etc. The agenda item here is to shift one's thinking from purely domain specific regions (e.g., Geography [Geo-] and Biology [Bio-]) to the data and the similarity of methods that are employed. This is where collaborative opportunities emerge and where shared interest and cooperation lead to new discoveries.

### **Building a Brand**

This last item is more focused on marketability than the previous two agenda items, but nevertheless I strongly believe it to be an important item in setting the Spatial Data Science agenda. When the term *Geographical Information Science* was coined, it put a label on an idea. The instantiation of that label was fresh, exciting, and gave rise to an entire new direction in geographic science. Not only was it a term for academics but it also became a tangible discipline through which

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<sup>1</sup> Literally from a linguistic sense.

Universities could bring in funds, students could enroll in courses and establish careers, and a pivotal term for industry (e.g., Esri)<sup>[4]</sup>.

While GIScience is now a well-established scientific field and a billion dollar industry, the branding behind GIScience is still very much associated with Geography as a discipline, often at the expense of being included in other fields of study (e.g., Information Science). Not surprisingly given its roots, the term is still associated with GISystems to many outside of the field. To some (including many private academic institutions) it is seen purely as an applied science or a tool to be wielded by domain experts. While researchers in this area have fought hard to escape these definitions, Spatial Data Science offers an opportunity to step outside of this label and bring together multiple disciplines under an umbrella term that reflects the interest of all stakeholders.

In summary, we are currently standing at the precipice of a new revolution in science, one brought to us through advanced computational capabilities, and large heterogeneous data. Data science has emerged as a burgeoning new field of research that spans disciplines and domains. We, as spatial scientists, now have the opportunity to establish Spatial Data Science as its own field of research focused on the spatial relationships within and between these data. We are faced with the monumental task of looking across disciplines to bring together scientists, industry, and governments with the common goal of speaking the same methodological languages, educating, collaborating, and pushing the boundaries of science. I, for one, look forward to the challenge.

## References

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