FINAL REPORT:

LEADERSHIP WORKSHOP ON LOCATION ANALYTICS IN BUSINESS

Upham Hotel, Santa Barbara

January 31 to February 2 2018

Background

The motivation for this workshop originated in an effort by Esri to encourage greater use of location analytics in business, and to that end to engage with the discipline of information systems (IS) as a way of reaching an appropriate set of leaders in business education. Esri staff had made presentations at previous conferences of the Association for Information Systems (AIS) such as the Americas Conference on Information Systems (AMCIS), and had been encouraged by the level of interest they observed in location analytics. Michael Gould of Esri and three faculty of the University of California, Santa Barbara (UCSB; Michael Goodchild, emeritus; Werner Kuhn; and Krzysztof Janowicz) began the process of planning a workshop to be held in Santa Barbara in early December 2017, with the aim of further developing strategies and building bridges between the IS and GIScience communities. An open call was issued, and invitations were advanced to a number of key individuals.

In early December the Thomas Fire broke out and expanded rapidly across a wide area of Southern California, causing unhealthy levels of smoke in the Santa Barbara area, plus substantial risk that the fire would reach the city. The workshop had to be postponed at the last minute, and a new date of January 31 was announced. Unfortunately the new dates were impossible for some of the participants, leading to a workshop that was smaller than anticipated. However a very compelling set of presentations and extensive discussions occurred; this report is an account of the meeting and its conclusions.

The workshop was hosted by the Center for Spatial Studies at UCSB, and sponsored by Esri.

Objectives

As stated in the workshop announcement, “Location Analytics is the subset of Business Analytics that is concerned with gaining insights by analyzing the spatial component of business data. Leading retail, real estate, finance, manufacturing, and logistics firms, among others, implement location strategies to gain competitive advantage. Furthermore, a new generation of business researchers and educators is beginning to recognize location analytics as a distinctive professional specialty. The role of academics in this field can be to simplify location analysis, propose innovative new theories and methodologies, and educate business and technology leaders.” Although the case might appear compelling, there is evidence that location is rarely a major focus of programs in business analytics and data science for business, and the business sector has historically been slow to engage with GIS, especially in its academic programs.

With this objective in mind, the workshop was structured as a Specialist Meeting, a format that originated with the National Center for Geographic Information and Analysis, a consortium of UCSB, the University at Buffalo, and the University of Maine that was established in 1988 under

a cooperative agreement with the National Science Foundation. Specialist Meetings bring together participants interested in and in many cases actively pursuing research in a cutting-edge area of science, in order to initiate collaborative research, formulate a research agenda, and prioritize research topics. They feature stimulating presentations, abundant time for discussion in small groups, and plenary sessions aimed at building consensus.

This model was adapted to the specific needs of the workshop and its objectives. As stated in the workshop announcement, "Participants will interact with leading scholars in geographic information science and other related fields, and will lead breakout discussions on relevant subtopics. Benefits to participants include learning the current capabilities of a modern location analytics platform, gaining ideas and advice for implementing location analytics in next-generation business school curricula, and crossing disciplinary boundaries to network and collaborate with kindred scholars. Results may include a jointly-authored review and/or manifesto article for a peer-reviewed journal."

Narrative summary of the workshop

Opening keynotes

After opening words from the organizers, the program began with two complementary keynotes, one focused on GIScience and the other on the business curriculum, to stimulate thinking about how to encourage greater engagement. Krzysztof Janowicz led with a broad review of GIScience, emphasizing the foundational concepts and principles of the discipline. He distinguished between fields, which model the geographic world as a collection of layers, each providing a value for a spatial variable at every point on the Earth's surface, and objects, which model the world as an empty space littered with different types of entities, which may or may not overlap. He distinguished between *fiat* boundaries, such as the administrative boundaries that are imposed by governments, and the *bona fide* boundaries that are observed at sharp changes in the values of spatial variables. Finally, he reviewed notions such as spatial dependency and heterogeneity and related them to location analytics. These and many other basic spatial concepts were illustrated with the recent fire and flood events in Santa Barbara County, and the maps that were prepared as part of the emergency response and management. He also spoke to the typical geographies used in GIS. Do ZIP-code boundaries make sense for business? Which might be the more appropriate business geographies? And he asked if and how businesses and consumers can cope with the inherent uncertainty of data. He finished with a discussion of place versus space: "Place is space infused with human meaning."

GIScience emerged in the early 1990s in response to numerous comments that GIS was "non-intellectual expertise," a purely mechanical exercise in pushing the right buttons to create maps and other summaries from the analysis of geographic information. In the subsequent quarter century major advances have been made in the theory and principles of geographic information, in formalizing what had previously been a largely pragmatic field, and in identifying the distinctive nature of spatial thinking and spatial intelligence. The first opening keynote left participants in no doubt that "spatial is special," and far more than a simple addition of location variables to the contents of an information system.

Julio Rivera provided the second keynote. His presentation came straight to the point with its title, "Integrating GIS in the Business Curriculum." He began with his personal history, having started out as a geographer at the University of Florida and then Carthage College, and building a

GIS program designed to fit the needs of a small college that graduates many students into business careers. This path led to abundant consulting opportunities with corporations, and to an increasing familiarity with exactly why "where" matters in business. After advancing to the position of Provost, he saw the value of undergraduate research to a small liberal-arts college, and eventually left to become President of the Council on Undergraduate Research (an organization with 900 institutional members). All of this experience gave him a keen sense of the fundamental pressures and constraints of academia, and of the available options for introducing (or inducing) change. Back at Carthage College he has continued his commitment to building greater engagement between GIS and business.

Julio began his discussion of the core question with a quote from Joe Wall of Marquette University: "I think GIS should be part of every business program." Numerous publications have emphasized the importance of spatial thinking in business, and Julio quoted some of his former students who now work in business and understand the value of GIS first-hand. Yet a quick search of textbooks in marketing and business found almost no references to GIS or spatial thinking.

But curriculum change is difficult, and higher education is notoriously conservative. Change is glacially slow, and the crowded curriculum offers little opportunity to introduce new material. Resources are slim, new faculty lines hard to find and appropriate, and quoting F.G. Campbell, "In searches, faculty often try to replicate themselves rather than innovate."

Julio is a great believer in "the nudge," the potential for change in small increments that is induced by slow and modest but steady influence (Thaler and Sunstein, 2009). He offers extended examples of the use of GIS in three courses: Marketing Principles, Marketing Strategy, and Applied Statistics; and offers a three-week online module using Esri's Business Analyst tool. No curricular revision is needed, and the "nudge" is soft but supportive.

One of the strongest arguments for nudging students in the direction of GIS is that they in turn nudge the faculty; faculty are often highly responsive if students appear to know more than the faculty do about topics the faculty feel their students should understand. Students in business are often highly motivated, and keen to pursue new skills that offer certificates, or to enter contests that stimulate their competitive spirit. Julio sees the greatest challenge in getting students to recognize that GIS is not only cool but useful. He suggests a strategy composed of three stages: first, to deepen understanding of GIS and its potential to go beyond simple map-making to include analytics; second, to embed that understanding in the curriculum; and third, to institutionalize the practices of GIS and spatial thinking in business. He also discussed the issue of certification, and the different types and styles that are available, such as Microsoft certification (a rigorous technical exam) versus the free Esri MOOCs (which award a PDF certificate if the student completes the hours). And he suggested that business events and professional societies, which routinely run competitions, pitch sessions, and hackathons, might also be a good place to look for followers and leaders in location analytics.

Additional presentations

After a short discussion period and lunch, the workshop resumed with additional presentations. Dan Farkas of Pace University (Pleasantville, NY) made a short presentation on his work and the course sequence he offers in the Information Systems department of the computing school. He noted the variety of solutions to the challenge of introducing GIS into business schools. He has been a leader in the creation of a GIS special-interest group within AIS (SIGGIS), which

currently has roughly 50 members out of a total membership of 4500; he described the establishment of SIGGIS as "an uphill battle." SIGGIS runs short workshops on location analytics and similar topics, at the AMCIS and ICIS (international) events. He suggested that partnership with the library can often lead to positive outcomes, a strategy that UCSB and other universities have used successfully in the past. He also suggested facilities management as a significant GIS user on campus and thus a suitable partner to promote GIS.

This was followed by a series of presentations by Esri staff. Rebecca Woiteshek (marketing manager for commercial solutions) began with an overview of the company's main offerings in location intelligence. She showed a series of maps generated using Esri software and illustrating various issues of interest to business. She introduced the Tapestry product, a detailed classification of socioeconomic characteristics of neighborhoods down to the block-group level. A vast amount of information is now available, derived from census data, individual expenditure patterns, Web surfing patterns, and many other sources. Rebecca sees GIS as implementing "the science of where," and relevant to eight business areas: sales, finance, development, human resources, marketing, operations, supply chains, and the Internet of Things. She enumerated specific use cases for each of these areas, making a very compelling case.

Next, Jesus Chavez and John Preysner gave a joint demonstration of the power of a broad array of Esri tools for location analytics, emphasizing the ability to address a range of "where" questions of relevance to business, and demonstrating the vast quantities of data, at levels down to the individual, that are now available.

Day 2 presentations

Richard Church (UCSB) led off the second day with a keynote presentation titled "Location Analytics: Is it forging ahead without GIS?" He has published on many topics of interest to business, including spatial optimization (Church and Murray, 2009), and has consulted with many corporations. He began by contrasting systems analysis and location analytics. Systems analysis proceeds in a lock-step fashion, first finding a formulation of a problem, then building a model, solving the model, investigating the solution's sensitivity to uncertainties, and finally implementing the solution. Today's location analytics are much more pragmatic, combining existing tools with data to gain insights into business problems, without the grand design of systems analysis.

There are many possible objectives of location analytics, for example:

- Gain a competitive edge against competitors;
- Drive revenue growth by choosing the best location to do business;
- Reduce costs by accurately matching resources to distances;
- Manage risk by identifying threats of flood, crime and fire; or
- Increase customer satisfaction by delivering to the right place at the right time.

Many companies offer software products that address various business objectives, and many companies offer appropriately structured data. A quick survey of their promotional material shows the emphasis many of these companies place on simplicity, ease of use, and speed, properties that are largely absent in systems analysis. Some of their promotional material also tries to distance them from monolithic GIS: CARTO, for example, will allow its users to "escape

the GIS handcuffs" and "free (you the user) from reliance on legacy GIS products."

Rick's survey of location analytics led him to the following conclusions:

- The major focus is to access data from a disparate number of sources, in-house and out of house;
- Everyone takes the map for granted;
- Monolithic GIS takes a back seat;
- Many of the elements of map making, such as digitizing, are not of interest to those doing location analytics;
- Heavy use of market segmentation data;
- Most location analytics are point-based;
- Organized so that there can be lots of temporal data for customers;
- Ease of analysis is front and center (no programming required); and
- Drag and drop mentality, functionality at the user's fingertips.

He showed an informal demo of the Alteryx product, to highlight the good and bad, suggesting that it had a good level of customizability. The presentation then shifted to a discussion of location modeling, and its uses in business. Location models apply methods of spatial optimization to the solution of business problems, and rely on optimization codes, some of which are offered in GIS packages and others are available through the adaptation of general-purpose codes. Yet many course texts reduce these problems to extremely simple applications of weighted centroids, ignoring many complications, such as travel through networks rather than along straight lines, the effects of competition, and the availability of business sites.

Rick concluded with a set of desiderata: good case studies, involving the opening and closing of stores and the mixing of online and bricks-and-mortar retailing; and good textbooks covering such topics as Web scraping and other data-collection sources, market segmentation, data integration and conflation, applications of artificial intelligence, location models and how to solve them, and the roles that GIS can and should play.

Indy Hurt (Gap Inc) followed, and provided the perspective of someone with a strong background in GIS who is currently working in a retail company where there is little awareness of location analytics or of GIS, despite a recognition of its importance. After completing her PhD at UCSB she first worked at Apple in their mapping team, then moved to the open-source start-up MapZen, and when it folded moved to Gap Inc. She described the skills needed to survive and prosper in this latest environment. In her own words, "It requires a lot of collaboration if you land one of these jobs without the skills to work with big data and also if you're not a subject-matter expert. I may be a subject-matter expert with respect to GIS, but certainly not retail, so I can't just throw useful things together without insight. There's a lot of collaboration necessary, and effective communication to get leadership onboard when you need resources to do an effective job." She ended with a plea for more attention to such skills (as well as programming and working with large data sets) while in graduate school, and noted that her work has begun to receive awards, despite her short history to date with the company.

Day 2 afternoon groups

The afternoon of the second day was spent in small-group and plenary discussions. Julio suggested that four general questions (such as those he has frequently aimed at statistics students), or their spatial equivalents, might serve to spark discussion:

- Are these two things different?
- Is there a relationship between two or more things?
- How good is your estimate? and
- Did you observe what you expected?
- And more broadly, what did each of the small groups feel would be the four key questions for location analytics?

Following are some of the major points discussed.

1. **What to call it?** The announcement of the workshop used the phrase "location analytics," but significant time was devoted to considering the alternatives. "Location science" has a history as the title of a journal with a strong orientation to location modeling and spatial optimization. The journal was subsequently merged into *Computers and Operations Research*. "Location analytics" sounds like a subset of data analytics, but as noted earlier it is hard to find much attention to location in the curricula or textbooks of courses in data analytics. Concern was also expressed that an effort termed "location analytics" would be absorbed, and perhaps buried, in departments responsible for data analytics. "Location intelligence" was discussed, and the consensus in the group seemed to tilt in that direction. "Intelligence" sounds more comprehensive than "analytics," as it extends to any kind of information that is useful in decision-making, and it was noted that many students choose to study IS in business schools with the goal of becoming decision-makers rather than analysts.. On the other hand it implies a subset of business intelligence (BI), and might therefore be buried in departments responsible for BI. If the name needs to be distinctive and independent, then GIS or one of its equivalents (*e.g.*, geoinformatics, geomatics) might be better, though these terms do not suggest an immediate relevance to business. "Science of where" is attractive for many reasons, but its status as an Esri trademark would be problematic. "Quantitative geography" and "applied geography" each have a long history, and the latter has strong associations with business, but neither is meaningful to non-geographers. "Business geographics" is also attractive, and might miss some of the negative baggage often associated with "geography."
2. **Does location matter?** The participants felt that there will always be situations in which the case for location needs to be made, and often made quickly and in compelling fashion. Despite widespread belief in the business importance of the "three Ls" (location, location, location), it is clear from a review of curricula and textbooks that often location is not perceived as mattering very much as a theme in business education. Questions such as "what determines business success *at this location*?" may appear trivial and fall far short of justifying a focus on location *per se*. A more fundamental question might be "do our observations vary with location?" or "How will business processes vary with location?" Business analysts tend to regard the base map as a given, with no need for concern about digitizing, scale, map projection, or any of the issues that typically concern a GIScientist. On the other hand topics such as location modeling or spatial interaction modeling, steeped as they are in a concern for location and in parameters derived from

location, such as distance or travel time, may appear too complex to be used as the basis for quick elevator speeches or management decisions. A set of well-chosen elevator speeches, along with well-chosen and compelling examples, must be an essential part of any effort to promote location analytics in business schools. Such an approach recognizes the diminishing returns of making spatial models more sophisticated, or of trying to promote location analytics because "it is harder than you thought."

3. **What is the significance of proximity?** While location *per se* may not be especially enlightening in all circumstances, it is the properties derived from location, including distance and travel time, which come much closer to mattering in a business context. Placing customer locations or business locations on a map immediately invites the eye to see clusters and gaps, and to search the mind for possible explanations. Thus it is not so much the addition of a pair of coordinates to a record, as what one can do once that pair of coordinates has been added, that justifies a belief in the importance of location.
4. **Is the context of location important?** Geographers have long distinguished between *site* and *situation*. In business, a site has properties that may well determine business success, including such factors as land cost, visibility, volume of drive-by traffic, or parking. In addition a site's situation may determine the number of consumers with easy access, as well as the strength of local competition. In GIScience site is sometimes termed *vertical context* because it implies access to other layers that contain information about the site, and situation is termed *horizontal context* because it implies access to layers of information about nearby locations.
5. **Are core issues in GIScience relevant to business?** This question was stimulated in part by Krzysztof Janowicz's opening keynote, which led participants into discussions of various core concepts and their relevance to location analytics. Scale is clearly relevant, for example in Esri's presentation of Tapestry data, and begs the question of the appropriate scale at which to aggregate demographics in order to understand the market potential of a proposed location. The Modifiable Areal Unit Problem (MAUP) is closely related to scale, and might be adapted to the needs of location analytics as "The results of any business analysis depend on the choice of geographic units used to report or aggregate data." For example, an analysis of the market potential of a site will depend on whether ZIP codes, census tracts, block groups, or school districts have been used in the site's analysis. Uncertainty is another issue that prompted discussion, and how it might be possible to come up with estimates of the uncertainty associated with any use of location analytics, or to absorb uncertainty through decisions about scale. While new data sources such as social media may well lead to improvement in spatial and temporal resolution, they are likely to lack the kinds of rigorous sampling and completeness that we associate with the decennial census, the American Community Survey, and other traditional sources of data for location analysis. As a result uncertainties may be more important, and more difficult to estimate.

Final discussion on Day 3

The final plenary discussion was devoted to a number of questions, most of them forward-looking and intended to maintain the momentum generated by the meeting.

1. **Has this meeting advanced our thoughts on why this is hard?** Although many of the participants have been involved in promoting GIS in one way or another for many years,

the participants as a whole tended to agree that the problem of advancing location analytics in business schools was indeed hard, for a host of reasons. Not least is the dilemma anyone faces in choosing between presenting an oversimplified case (which invites the response that location is easily addressed and not worthy of much attention) and an overly complex one (which may overwhelm and lose the attention of the listener). The GIScientists present appreciated the thoughts and experience of participants who have been "in the trenches" on this issue, in some cases for decades.

2. **Is location analytics a new academic discipline?** As noted earlier, the academic world is conservative at times and resistant to change. On the other hand "data science," "data analytics," and "data mining" are all of recent coinage, and are the focus of many new programs and even new departments. "GIScience" and "geoinformatics" have also been the subject of new programs and the renaming of existing programs, departments, and journals. Perhaps it would be better to reframe the question; for example, "Is location analytics a recognized field with its own technology and well-defined set of issues, and worthy as such of attention in textbooks and education programs?" Insertion into existing disciplines and programs was deemed more promising than the invention of new ones.
3. **What should a curriculum in location analytics contain?** Various examples of curricula were discussed during the workshop, ranging from small modules that could be inserted into existing courses, to entire courses and programs. A curriculum should contain discussion of core concepts, a review of the types of data that can support location analytics, and compelling examples. Numerous related questions arise: What should be the prerequisites for studying location analytics? What might be suitable metrics of success in the introduction of location analytics? What might be the role of case studies, and how might they be generated?
4. **What next steps might be taken to continue the momentum of this workshop?** The group discussed possible participation in two upcoming IS meetings: the AMCIS (Americas Conference on Information Systems) meeting in New Orleans in August and the ICIS meeting in San Francisco in December. The AMCIS meeting has the theme "digital disruption," which several participants found compelling. Several participants will attend AGILE in Sweden in June and GIScience in Australia in September. Other directions include academic papers and a possible book. Meeting with key individuals was also mooted: perhaps Doug Richardson, Executive Director of AAG, might be approached given his history of engagement with the commercial GIS sector.
5. **How might location analytics inform the wider GIS community?** Location analytics is already well-established within the discipline of geography, under a variety of names: applied geography, quantitative geography, spatial analysis, or spatial optimization. All of the core concepts of GIScience are relevant to location analytics, which begs the interesting question: are there core concepts of GIScience that will emerge first from the application of location analytics in business? And conversely, are there developments in GIScience, such as the extension of data models to time and the third spatial dimension, which will empower location analytics in business? Inserting location intelligence into business programs may in time put more business thinking into spatial modeling and analysis.
6. **The nudge or the moonshot?** Reference was made earlier to Julio's belief in the nudge

as the way to effect change in academia. Alternatively we might think of a moonshot, that is, a future target that might motivate change. Various future dates and formulations were discussed: for example, “To fully realize the benefits of location analytics in business by 2025” or “To take location analytics to the level of individuals by 2025 (while protecting and respecting privacy).” A moonshot might be based on broader societal objectives, such as the use of location analytics to promote equity of access or the reduction of emissions.

7. **On-campus initiatives.** Many of the perspectives presented at the meeting were broad in scope, but thoughts turned from time to time to the question of what might be achieved on an individual campus. Many campuses are members of the University Consortium for Geographic Information Science (UCGIS), and membership requires a campus-wide inventory of interest in GIScience. On many campuses the business school or similar entity is not an active participant, even though it may offer courses and programs in data analytics. An initiative through UCGIS in which each member campus reached out to its business school equivalent through personal contact might be successful at nudging the appropriate faculty in the direction of greater engagement with location analytics. Esri might identify one or more target schools where this kind of outreach could be encouraged and facilitated.

Conclusion

The meeting ended with a sense that many issues had been identified and clarified, participants had been exposed to a wide variety of perspectives, consensus had been reached on many questions, and a clear path forward had emerged. Although its purpose was not to make recommendations to its Esri sponsors, nevertheless clear ideas emerged of how Esri might be more successful at promoting its own implementations of location analytics. The group recognized the importance of direct engagement with analysts and data scientists, and felt that a continued push to gain allies and collaborators within business schools and departments was needed and achievable in the short to medium term.

References

Church, R.L. and A.T. Murray, 2009. *Business Site Selection, Location Analysis, and GIS*. Wiley.

Thaler, R.H. and C.R. Sunstein, 2009. *Nudge: Improving Decisions about Health, Welfare, and Happiness*. Penguin.

Participant bios (including last-minute cancelations)

Jesus Chavez is an Esri technical consultant, assisting new and existing users in the adoption/expansion of location analytics best practices at their respective organizations. Chavez supports Esri users in the Commercial sector, and focuses on both technical implementation and business application of Esri's technology. Jesus also advises a team of Esri business consultants working across a number of verticals, and has developed location analytics industry expertise in retail, real estate, financial services, and healthcare. Chavez is most interested in the computational and statistical models being used by location analytics practitioners. He appreciates opportunities to work with companies who have made an investment in their data science operations, and believes that organizations who do this have a leg up on their competitors at a time of rapid digital transformation.

Richard Church is a Professor of Geography and Associate Dean of the Sciences at the University of California, Santa Barbara. He received his PhD in Environmental Engineering from The Johns Hopkins University. Before joining the faculty at UCSB, he was an Associate Professor of Civil Engineering at the University of Tennessee. He has taught courses in Geography, Business, Industrial Engineering, and Civil Engineering. Church's research is concentrated on spatial optimization and geographic information science applied to transportation systems, location and logistics, urban systems and environmental natural resource protection. He has published more than 250 papers in Regional Science, Geography, Transportation, Operations Research, Environmental Modeling, and Engineering. Church has served as a consultant to a number of companies and governmental agencies on a wide variety of problems (logistics, environmental management, site selection, and transportation) and is a co-inventor on a US Patent on estimating manpower needs for emergency medical systems from computerized data systems. He is a Fellow of the Regional Science Association International and a Fellow of the American Association for the Advancement of Science (AAAS). He received the outstanding Graduate Mentor Award from the University of California, Santa Barbara in 2013, the Lifetime Achievement in Location Award (from the Section on Location Analysis of INFORMS) in 2012, and the University Consortium for Geographic Information Science Research Award in 2014. In 2015, he served as the President of the North American Regional Science Council and as President of the Section on Location Analysis of INFORMS from 2015 to 2017.

Subhasish Dasgupta is Associate Professor of Information Systems in Information Systems and Technology Management in the School of Business at George Washington University in Washington, DC. He served as Department Chair from 2010–2015, and Program Director of the Master of Science program in Information Systems Technology from 2004–2010. He is Editor-in-Chief of the *International Journal of Virtual Communities and Social Networking*. Dasgupta received his BS (Physics) and MBA (MIS and Operations Research) degrees from the University of Calcutta, India, and PhD (Information Systems) from Baruch College, The City University of New York. His research interests include information technology adoption and diffusion, global information systems, virtual communities and social media, and open source architectures. Dasgupta has published his research in journals such as *Journal of Strategic Information Systems, European Journal of Information Systems, Journal of Global Information Management,* and *Journal of Information Education and Research* (now *Journal of Information Systems Education*). He has presented many papers at international, national and regional conferences. Dasgupta is an expert in software development methodologies, and open source software

development.

Dan Farkas is a Professor of Information Systems in the Seidenberg School of Computer Science and Information Systems at Pace University. He is the founder and current Chair of the AIS Special Interest group on GIS (SIGGIS). Working with SIGGIS colleagues, he has been active in growing SIG membership and impact through the development of workshops and minitracks at AIS conferences. At Pace, he has been innovative in developing curriculum in Computer Networking and Geographic Information Systems. Farkas has given tutorials and workshops on Networking, Linux Administration, and GIS concepts nationally and nternationally for more than 35 years. Interdisciplinary at heart, Farkas holds a BA in History, an MS in Computer Science and a PhD in Educational Technology from New York University. Supporting his interest and research in Environmental Conservation, he has an MS in Environmental Science and Policy from Johns Hopkins University.

Michael F. Goodchild (B.A., Physics, Cambridge University; Ph.D., Geography, McMaster University) is Professor Emeritus of Geography and former director of the Center for Spatial Studies (spatial@ucsb) at the University of California, Santa Barbara. After 19 years at the University of Western Ontario, including three years as Chair, he moved to Santa Barbara in 1988. Since then, he has served as Director of the National Center for Geographic Information and Analysis (NCGIA); Associate Director of the Alexandria Digital Library Project; and Director of the Center for Spatially Integrated Social Science. Goodchild retired from academia in June 2012. Goodchild's research publications, including more than 400 scientific papers and a dozen authored and edited books, have laid a foundation for geographic information science and spatial analysis, extended the development of geo-libraries, contributed to understanding uncertainty in geographic data, and advanced capabilities in location-allocation modeling. He was Editor of *Geographical Analysis* for three years and of the "Methods, Models, and Geographic Information Sciences" section of the *Annals of the Association of American Geographers* for six years. Goodchild is an elected member of the National Academy of Sciences and the American Academy of Arts and Sciences, and is a Foreign Fellow of the Royal Society of Canada. He has received honorary doctorates from Laval University, Keele University, Ryerson University, and McMaster University. He is a recipient of the Canadian Association of Geographers' Award for Scholarly Distinction, Association of American Geographers' Award for Outstanding Scholarship, Canadian Cartographic Association's Award of Distinction for Exceptional Contributions to Cartography, Educator of the Year Award from the University Consortium for Geographic Information Science, the Founder's Medal of the Royal Geographical Society, a Lifetime Achievement Award from Environmental Systems Research Institute, Inc., the American Society of Photogrammetry and Remote Sensing Intergraph Award, and the Horwood Critique Prize (twice) of the Urban and Regional Information Systems Association (URISA). In 2007 Goodchild was inducted into the GIS Hall of Fame of URISA and received the prestigious international Prix Vautrin Lud, in St Dié-des-Vosges, France. More recently, Goodchild received the Peter A. Burrough Medal, International Spatial Accuracy Research Association, 2012.

Michael Gould received a Ph.D. from the State University of New York at Buffalo, and has been teaching and researching in the field of GIS since 1991, when he moved to Spain. In 2008 he joined Esri (Redlands, CA) as director of education and now is back in Spain as Esri's global education manager. In this capacity, he works on diverse educational projects in collaboration with Esri's 84 international offices and with almost 11,000 universities.

Indy Hurt is a data scientist at Gap Inc. She leads all spatial analysis for the global real estate team. Her academic achievements include a Ph.D. in Geography from the University of California, Santa Barbara, a Masters of Science in GIS from the University of Redlands, and a Bachelors of Arts in Geography from the University of California, Los Angeles. Prior to Gap Inc., Hurt was one of the coordinators for geospatial research at Apple and later provided spatial data analysis and outreach for open source mapping startup, Mapzen. Between graduate degrees, she was an instructor for Esri. When she's not analyzing data, her hobbies include singing, sewing, hiking, and traveling.

Krzysztof Janowicz is an Associate Professor for Geographic Information Science and Geoinformatics at the Geography Department of the University of California, Santa Barbara. He is the program chair of the Cognitive Science Program, one of two Editors-in-Chief of the *Semantic Web* journal, a Faculty Research Affiliate of the Center for Information Technology and Society, and the community leader of the 52° North semantics community. He currently runs the STKO Lab, which investigates the role of space and time for knowledge organization. Prior to coming to UCSB, Janowicz was an Assistant Professor at the GeoVISTA Center, Department of Geography at The Pennsylvania State University. Before moving to the United States, he worked as a postdoctoral researcher at the Institute for Geoinformatics (ifgi), University of Münster, Germany, for the international research-training group on Semantic Integration of Geospatial Information and the Münster Semantic Interoperability Lab (MUSIL). Methodologically, his niche is the combination of theory-driven (e.g., semantics) and data-driven (e.g., data mining) techniques.

Mehrdad Koohikamali is an Assistant Professor of IS/GIS in the School of Business, University of Redlands. Mehrdad received his Ph.D. in Information Systems at the University of North Texas. He holds an M.S. in Applied GIS from the University of North Texas and an M.S. in GIS from the University of Tehran. His research and professional interests include location intelligence for business, big data analytics, social media analytics, and information privacy. He is a member of the Association for Information Systems and the Decision Sciences Institute. His work appears in journals such as *Decision Support Systems*, *Computers in Human Behavior*, *Informing Science*, and *Lecture Notes in Business Information Processing*. He is currently working on several projects, including spatial big data analytics, spatial accuracy and privacy challenges, locational privacy issues in US cities and counties, sharing economy in mega cities, and location-based sentiment mining during social crises. His teaching interests include spatial big data analytics, global business spatial analytics, business intelligence and analytics, GIS for business, visual display of business information, and introduction to GIS. He has recently received an IT innovation award in teaching where he integrated location-based social media with teaching materials. Mehrdad has several years of working experience in the field of GIS, ranging from GIS consultant, analyst, and programmer, to GIS manager.

Werner Kuhn holds the Jack and Laura Dangermond Endowed Chair in Geography at the University of California, Santa Barbara, where he is professor of Geographic Information Science. He is also the director of the Center for Spatial Studies at UCSB. His main research and teaching goal is to make spatial information and computing accessible across domains and disciplines. Before joining UCSB in late 2013, Kuhn was a professor of Geoinformatics at the University of Munster, Germany, where he led MUSIL, an interdisciplinary semantic interoperability research lab. Kuhn is described as a leading expert in the area of geospatial semantics and especially known for his work on Semantic Reference Systems as well as his work

on interaction metaphors for geographic information systems. Recent research projects include the Linked Open Data University of Muenster (together with the university library), and a series of EU projects on geospatial services in the semantic web. Kuhn holds a doctorate from ETH Zurich (1989) and was a post-doctoral researcher with the National Center for Geographic Information and Analysis (1989–1991) as well as with the Vienna University of Technology (1991–1996). He is a co-founder of the COSIT Conference Series (since 1993) and of the Vespucci Initiative for Advancing Science through Geographic Information. He has been a visiting scientist at UCSD's Meaning and Computation Lab (2002/03), the UK eScience Center at Edinburgh (2007), and the Brazilian Institute for Space Research, INPE (2011). His publications range from GIScience and usability engineering through cognitive science to formal ontology. Kuhn was an elected member of the Council of AGILE (Association of Geographic Information Laboratories in Europe, from 1998 to 2002), the international member of the Research Management Committee of the Canadian GEOIDE network (2001 to 2003), the Technical Director Europe of the Open GIS Consortium (1998 to 2001), and an Austrian delegate to CEN TC 287 on Geographic Information (1992 to 1995). He is a member of several editorial boards of peer-reviewed international journals, such as the *International Journal of Geographical Information Science* (IJGIS), the *Semantic Web Journal* (SWJ), *Applied Ontology* (AO), *Spatial Cognition and Computation* (SCC), the *International Journal of Spatial Data Infrastructures Research* (IJSDIR) and the *Journal of Spatial Information Science* (JoSIS).

Selwyn Piramuthu is Professor of Information Systems at the University of Florida in Gainesville. He received his Ph.D. from the University of Illinois at Urbana-Champaign. His research interests include machine learning and cryptography as well as their applications in various domains that include manufacturing scheduling, sensor networks, supply chains, among others.

John Preysner is a business consultant at Esri focused on introducing Location Analytics to new Esri users in the Commercial sector. This often takes the form of identifying and partnering with an analytics champion within each prospective user's organization, and working with this champion to demonstrate to a larger department- or company-wide audience how location impacts business outcomes. While focused on the Commercial sector broadly, Preysner has a particular interest in introducing location analytics to mid-market companies and has worked with companies in the financial services, real estate, agriculture, professional services, and healthcare verticals. Preysner is particularly interested in how companies understand and target customers, and enjoys working with new Esri users to show them how location analytics can help them reach these ends. He has found that companies that have a concrete strategy for deriving and applying location-based insights find the most success—whether they are working with simple demographic overlays of a given market or detailed customer loyalty program data.

Julio Rivera (Professor of Management, Marketing and Geospatial Science at Carthage College) is focused on helping students understand and research "Big Data" problems in business by applying different methodologies to their work. His current work focuses on embedding research widely into the undergraduate curriculum, particularly in business. Rivera is an international leader in the in the undergraduate research movement and is Emeritus President of the Council on Undergraduate Research (CUR, www.cur.org), where he was President and served on its executive board. Rivera serves as a consultant to government, business and higher education. Rivera was the recipient of the 2002 Carthage College Distinguished Teaching Award. He served Carthage as Provost and Vice President of Academic Affairs. He was Chair of the Department of

Geography and Earth Science where he founded and developed the Geographic Information Science (GIS) program. Rivera earned his Ph.D. in Geography from the University of Wisconsin-Milwaukee, and completed a post-doctorate in Management and Marketing at the Hough Graduate School of Business at the University of Florida.

Anagha Uppal is a first-year graduate student in the Geography department at UCSB. She received her BA in Computational Social Science from the University of Tennessee, Knoxville. She aims to use the technical skills she earns through her bachelor's and graduate degrees to adopt technology in the development of community-based solutions to local issues. Her passion is the food justice movement, and her research and activism is largely based around university organizations that promote a reduction of food waste, the consumption of better food, and the addressing of food insecurity. Her research interests fall at the intersection between technology, GIS and agent-based modeling, with social justice, computational social science, and food waste and food insecurity. She has served as the training director for the local non-profit organization East Tennessee Peace & Justice Center.

Shaohua Wang is Postdoctoral Fellow of Institute of Geographic Sciences and Natural Resources Research, CAS. He is Visiting Scholar of Department of Geography University of California, Santa Barbara. Wang received his PhD in Cartography and Geographical Information System from the University of Chinese Academy of Sciences, China. He also earned a BS in Mathematics from Beijing University of Chemical Technology. His research interests include spatial optimization, location analytics, logistics, spatial big data, machine learning and other critical geographic information technologies. His work has been published in journals such as ISPRS International Journal of Geo-Information, Bulletin of Surveying and Mapping, Journal of Resources and Ecology, Physica A: Statistical Mechanics and its Applications, Sensor Letters and Journal of Geo-Information Science. He was recognized with the 2015 Beijing science and technology award and 2014 scientific and technological progress award of Chinese Geographic information. He served as deputy director of SuperMap GIS Technology Institute in 2015. He obtained Beijing Training Funding for Excellent about location analytics in business. He got the international postdoctoral exchange fellowship program and Chinese government scholarship on location analytics as a visiting scholar of Department of Geography University of California, Santa Barbara.

Rebecca Woiteshek is the Director of Corporate Marketing—Location Intelligence at Esri where she focuses on helping companies and organizations across all industries better understand how The Science of Where™ can help them drive growth and strengthen data-based decision-making across all lines of business. Woiteshek began her career as a marketing and programs consultant in the non-profit sector where she specialized in utilizing demographic and market research to promote growth within lean operational budgets. She was recruited into the tech sector and began working within a variety of industries throughout Silicon Valley applying GIS to marketing and business development initiatives. Prior to joining Esri, Woiteshek worked on engagement marketing for Acrobat products at Adobe, deploying globally across North America, Latin America, Europe and Asia. Woiteshek graduated from Carthage College with a BA in Geography, specializing in marketing and demographic analysis. While at Carthage, Woiteshek published her thesis research, "Dire Straits: Using GIS to Better Identify and Serve the Urban Poor," which addressed the problem of identifying communities in dire economic straits and profound transition within densely populated urban space. Woiteshek's research was presented orally at The National Conference for Undergraduate Research and was one of 60 selected for

posters on the Hill presentation in the U.S. Capitol, based on a nationwide, multidisciplinary undergraduate research competition conducted by the Council on Undergraduate Research. Woiteshek's thesis was also one of five selected by CUR for President Obama's viewing.

POSITION PAPERS SUBMITTED IN ADVANCE OF THE MEETING

Dan Farkas: "Location Analytics Perspective"

In the environment at Pace University in which there was little if any geospatial research or teaching and excited by the possibility of interdisciplinary opportunities, I've been on a mission to introduce and expose GIS to different disciplines at Pace for many years. This has taken many forms including developing and delivering faculty development workshops, developing introductory graduate and undergraduate curricula in the IS program, guest lecturing in various departments and engaging researchers in a number of interdisciplinary projects including health care, ecology, and criminal justice. I have found that one of the hardest disciplines to engage is business. At Pace and in my experience as Chair of the AIS Special Interest Group on GIS (SIGGIS), there is a disconnect between how GIS is used in the business world (e.g., marketing, site selection, transportation or real estate) and the business school curricula designed to educate the next generation of leaders. This makes a workshop on Location Analytics most relevant (my department supports the Information Systems MBA). This year at Pace we are launching a Location Analytics and GIS Lab with the specific mission to be a resource for faculty from all disciplines. Additionally, we plan to have Location Analytics as part of the MS/IS Data Analytics concentration and are developing courses for a concentration in the MS degree. At the workshop, is my hope to network and broaden my perspective on geospatial thinking and Location Analytics.

Indy Hurt: "Position Statement"

I have had a lot of exposure to spatial analysis over the years, but never so tightly coupled with business. I see a profitable intersection between the domain of geographic information science and several big data methodologies advancing in computer science. Retail is inherently spatial with the coupling of demographic analysis for customer profiling, site suitability analysis, optimized distribution channels, and so much more. While it all seems intuitive, one can find complexity in the sheer volume of data and the rapidly changing landscape of retail. One or even several off-the-shelf solutions are rarely adequate. The ability to code solutions quickly and effectively is so valuable yet I find that most candidates strong in spatial analysis neglect their coding and communication skills. It may not be realistic to strengthen students in all areas at the same time, but collaborative projects at the undergrad and graduate level can bridge the gap.

Mehrdad Koohikamali: "Location Analytics Themes: Spatial-Temporal Tapestry, Location Privacy, and Spatial Accuracy"

Location analytics is not only the intersection of GIS and data science. Location analytics is an emerging field of science where GIS is finally blooming to its full extent. At the root, location analytics is indeed still the application of traditional spatial analysis methods. The availability of new tools to work with spatial data upsurges the need for research and practice in specific areas of location intelligence. There are two main themes in location intelligence that businesses and researchers should put more time into:

- Validating the spatial accuracy of location information and its alignment with the business objectives, and

- Development of real-time and privacy-preserving data collection and location analytics methods to benefit different decision-making processes for businesses and individuals.

With some of the newest advancements in Internet of Things (IoT) including location-tracking devices, collection of information has gone too far into people's [former] private lives. Availability of spatial big data and the accessibility of tools to create fascinating graphics, has tremendously increased the importance of making true and useful interpretations for businesses and individuals. The goal of location analytics is not to create "beautiful graphics," but valid and meaningful insights. The question is whether an outcome of location analytics is really going to benefit the specific business process/decision-making? The need for validation of big data and the resulting outcome signals a new form of business practices and responsibilities to monitor the quality of information throughout the location analytics process. Today's businesses target individuals to personalize services and products. Tapestry segmentation is a great data source to enhance the location intelligence and analytics capabilities [1]. Current tapestry segmentation does not take into account the spatial-temporal patterns of people's behaviors. As a result, there is an opportunity to develop more detailed profiles of individuals at different locations and times to infuse neighborhood tapestry segmentation. With the availability of sensor data inside households (e.g., from smartphones, IoT devices, smart assistants) and valuable social media data [2], spatial-temporal segmentation can even go inside homes to see what people do (behavioral analysis) and how they feel (sentiment mining) at different locations within their private life. It may sound creepy and intimate, but people already give up some portion of their privacy in exchange for some benefits and incentives [3]. They even bring their smartphones to bed. Researchers and practitioners should find new ways to keep track of individuals' data and maximize business benefits, while still preserving individuals' privacy.

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Selwyn Piramuthu: "Position Statement"

I am interested in studying location-awareness as a concept, and have briefly studied the use of location information generated through sensors (e.g., GPS) for RFID/IoT authentication purposes and multichannel retailing. I have read about the use of location information for routing in supply chains. I want to learn more about location-related information, its use, and the state-of-the-art from experts at this event.

Anagha Uppal: "Position Paper"

Location analytics and business-oriented research are all about optimization. Although my experience with geography and GIS is limited, I have expressed interest in the topic of optimization since my introduction to geographic information systems. For my final project

during my introductory GIS course, I evaluated the efficiency of library placements in my county in terms of patronage and distance traveled by patrons. I later led a more extensive GIS project for the nutrition department at my university wherein I developed an interactive mapping tool of the food sources, public health indicators and demographic data in the 16 counties that make up East Tennessee for the use of any academician, policymaker or activist to study local trends in nutrition and health. This was to ensure that reliable methods are used to improve food access so that people are positively impacted and funds are not wasted. This intersection between social issues and GIS/GIScience would serve as my focus and my intended contribution to this workshop and to this emerging field. Specifically, I would hope to apply these questions, topics and technologies for nonprofit businesses that address UN Sustainable Development Goals. SDGs are valuable in condensing and prioritizing the most vital needs of the population today. In terms of food security and nutrition, for instance, the Huff Model—which is used to calculate the probability that a person from any given location will visit a particular store and predict the sales potential of potential store locations—has been applied alongside a number of other models to determine spatial rates of high food insecurity in the Minneapolis area. It would be fascinating to explore this and similar models further through this workshop. I am currently a first-year graduate (MA/PhD) student in the Department of Geography at UCSB in the STKO lab. I finished my undergrad in the spring, where I studied an interdisciplinary course titled Computational Social Science, for which I took classes in GIS, data mining and analytics using R and NCSS, database management, more advanced HTML skills, and network analysis using Gephi, as well as courses in sociology, political science, information science and the non-profit model. I graduated with a minor in Business Analytics. I therefore supply both an interdisciplinary perspective and prior knowledge of business analytics themes and goals, as well as strong communication skills and adaptability to new material and perspectives.

Shaohua Wang: “Comparative analysis for p-median problems: A Position Statement”

P-median problem is widely used for location analytics in business. The p-median problem has attracted more attentions. There are hundreds of methods for solving p-median problems. Heuristic methods can get approximate solution for p-median problems within short time. Integer linear programming and formulation method can be used for finding an optimal solution via linear programming solver over long time. It is important to analyze efficiency of different p-median problems. We explore a benchmark framework to comparative analysis for p-median problems. There are four types of methods were implemented for benchmark of comparative analysis for p-median problems, including open source linear programming solvers, commercial linear programming solvers, heuristic methods and formulation methods. In this study, we used open source solver (Google Or-Tools, Soplex, Qsopt), commercial solvers (Gurobi, Cplex 12.7.1) for get an optimal solution. Teiz_bart, Simulation Annealing, Variable neighborhood search and GRASP are tested as heuristic methods for approximate solution. BEAMR and Radius are used as formulation methods. 40 files test data set came from Beasley files (http://people.brunel.ac.uk/~mastjjb/jeb/orlib/pmedinfo.html).

Results show that Soplex works best from open source solvers, Gurobi performs much faster than Cplex, GRASP is the fastest algorithm among heuristic methods, BEAMR is better than Radius method. GRASP can be used for finding approximate solution for p-median problem. Gurobi is first choice to solve p-median problem as integer linear programming method. We can

use BEAMR to solve a huge p-median problem. GRASP can be used for finding approximate solution in the first phrase, Gurobi can be used for integer linear programming. In this research, the benchmark framework was able to provide comparative analysis of the efficiency for p-median problems. Further work in this area will implement methodology of BEAMR for solving huge p-median problem (over 10000 nodes). In addition, we can use hybrid parallel framework to improve performance for p-median problems. Pointer networks of machine learning framework for the p-median problem will be evaluated in the future work.

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