

**EUE Proposal
FY2019**

Project ID#

19-12

Project Title

Developing a Business Geography Course that Teaches Techniques of Business Locational Analysis and Uses Free Open-Source Software

Project Director	ID Number	Telephone	Email
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Department	Campus Box	School College
Geography	1459	CAS

Course or Program

GEOG545

Project Co-Director	ID	Department	Email

Student Impact: 300+

Multiple Submission Priority:

Summary:

This proposal requests EUE funding to develop a new course Business Geography which teaches techniques in business locational analysis using free open source software. Currently, the Department of Geography offers several courses that involve some locational analysis. However, none of the courses directly teaches students business location decision-making, leaving a gap in business skill training with advanced technologies.

The proposed course teaches business locational analysis from a business decision making perspective. The course will be structured using established economic and business models including spatial interaction theory, location theory, location–allocation theory, and transport network analysis. It teaches five sets of techniques: market analysis using the spatial point process analysis techniques; market area analysis using various gravity models and area data; business catchment area analysis using attribute data and actual road networks; location-allocation analysis focusing on locating businesses and allocating customers to businesses; and road network analysis involving flow pattern analysis from road network and transport planning. While most of the techniques are commonly used for business locational analysis, the location-allocation and road network analyses are also important tools for government work.

To eliminate the cost burden on students and reduce resource access inequity, the new course will be taught entirely using free open source software.

A. Current Situation

This proposal requests EUE funding to develop a new course entitled Business Geography that incorporates techniques in business locational analysis using free open source software. Currently, the SIUE Department of Geography offers several courses which in one way or another involve analyzing business locations. The GEOG301 Economic Geography, which I teach, focuses on the spatial patterns of economic activities such as agriculture, industry, services, and some more detailed industrial and business sectors. This course emphasizes industry-wide or sector-wide geographical patterns and trends. For locational decision-making at the business firm level, the course covers locational factors such as costs of shipping, labor, various inputs, agglomeration economies, government policies, etc. However, the course is not designed to cover the techniques that bring the various locational factors together to make business location decisions for companies.

GEOG401 Geography of Development, which I also teach, covers broad development issues at the national level and draws attention to the reasons for the success and failure of national economic and social development. Behaviors of corporations and businesses are touched upon whenever they have broad impacts at the national level. For example, a Japanese car-maker may decide to invest in a developing country. The reasons for the decision, and the possible socioeconomic consequences of the investment in the developing country, are analyzed. However, in this development course, where exactly the Japanese car-maker would place the car making facility in the developing country is not the focus.

GEOG321 Quantative Techniques, a third course I teach covers statistical techniques to equip students to conduct sophisticated analysis in their research, especially within their senior

assignments. While some students analyze business locational issues in their research, statistical techniques can only offer partial solutions to their research problems.

The Department of Geography also offers various Geographic Information Systems (GIS) courses at both the introductory and more advanced levels. GIS as a field applies computing and telecommunication technologies in collecting, processing, storing, analyzing, mapping, and visualizing geographical information (i.e. data with geographical locations as an attribute). Some students have completed senior assignments that applies GIS techniques to locational analysis. Examples include analyzing the overlap of earthquake locations with oil and natural gas fracking sites; travel tracks of tornadoes; and risk assessments of mine subsidence. However, most SIUE geography faculty members who teach GIS courses are physical geographers who do not have systematic training in economic and business location models and locational factors. One result of this is that most senior assignments using GIS techniques focus on physical geography topics, rather than business location decision-making. Occasionally, there are senior assignments that involve public facilities (libraries) or real estate business and GIS. However, they are focused either on a single factor (travel routes) or on the GIS technical functionality, rather than seeing the process as involving business location decision-making. Another limitation is that these GIS-related senior assignments rely on the GIS software available in the Department. The software is mostly proprietary and requires a site license. Students can use the software when they are in school. When they leave the university and start working in a business, government agency, or non-profit organization with limited financial resources, the software may be too expensive to purchase by our alumni or their employers. They may have no way to apply what they have learned at SIUE in their workplace.

Students who graduate from SIUE should be equipped with techniques and skills that make them best suited for the career fields they choose to pursue. GIS has become an increasingly important decision-making tool for government and business, which explains the rapid rise of GIS specialists and spatial analysts as a job category in the last two decades. However, having only GIS skills without a sense of business location decision-making, or without affordable software to use, constitutes a major weakness for those students who aspire to enter into the field of business location analysis and decision-making.

B. Proposed Project

A new Business Geography course which teaches students techniques in business location analysis using free open-source software would prepare SIUE graduates for the workforce. This course will teach business locational analysis as a business decision-making process, rather than a purely technical process. This requires the course to be guided by economic and business literature systematically so that the decision outcome meets current business standards. In addition, a course on business locational analysis should include the conceptual basis of business location decision making, rather than only seeing it as a technical process. Furthermore, the course should use best practice approaches, which requires software users to be able to write computer programs to alter the computing algorithm to meet the specific demand. Finally, this new course is designed to use the free open source software throughout, which should help eliminate the cost burden, increase education resource access equity, and facilitate life-long learning for SIUE graduates.

Three components of the new course. The first component is the conceptual basis of business location decision-making. This includes important economic and business geography theories such as spatial interaction theory and variants of the gravity model; location theory

including industrial location theory, agricultural location theory, urban land use theory, public utilities location theory, and central place theory (retail and service location), market delineation and catchments; location-allocation theory; and transport network analysis. These theories are at the heart of some of the most important computer software designed to conduct locational analysis.

The second component includes the following techniques to be taught in the course.

Market area analysis using spatial point process analysis. This is to use point data to analyze the market area of a business and market penetration (percent of the population who are the customers of the business).

Market area delineation using variants of the gravity model. This is to determine how fast the market area of a business changes with increasing distance, and the impacts of a new business on the existing businesses; the techniques can use area data and incorporate attributes of businesses and locations (size of a business, quality of a product, the population or total sales of a market).

Business catchment area analysis. This is to determine how markets are allocated among competing businesses for a set of business locations and road networks; this study is more realistic since the actual road networks are used rather than Euclidean distance (the straight line distance between any two points).

Location-allocation analysis. This is to locate a set of businesses and allocate customers to businesses according to some rules such as the minimum travel costs or the maximum market areas of certain businesses. The analysis is conducted using point data or area data, and incorporate locational attributes (demand sizes and supply capacities) and road networks.

Road network analysis. This is to analyze the flow pattern in a road network and attributes of vertices (points) and edges (lines), and make transportation planning. Transportation planning involves predicting population growth at various locations and making traffic assignments to various modes of transportation (cars, buses, etc.) in order to accommodate the future growth.

While most of the above five sets of techniques are commonly used for business locational analysis, the location-allocation analysis and road network analysis are also important tools for government work to determine the optimal locations for fire departments, libraries, government offices, etc.

The third component of the course involves the free open source software. Many free open source software programs can be used for business location analysis. While it is a continuing process to identify additional free software for the course, the software that has been identified so far can collectively achieve the analyses stated above. The main software includes:

R. This software requires program writing skills and has the flexibility to alter how commercial computing programs are run. For example, it can be used to alter the intermediate output from some menu-driven software, which, when re-entered back into the menu-driven software, changes how the software is run. Students can also acquire script writing ability by using it and thus enhance their job-related skills. R has many different packages that can implement the required functionalities for the course. The important packages are: *spatstat* and *splanr* for spatial point process analysis; *spatstat*, *sp*, and *shp2graph* for spatial lines and road network analysis; *huff_tools*, *gravity*, and *spatialposition* for market area analysis; *orcola* and *tbar* for location-allocation analyses; *network* and *stplanr* for road network and transportation planning analysis; *rgeos*, *GIStools*, *rgdal*, *raster*, *sp*, *shapefiles* and *maptools* for various GIS functions; and *tmap* and *ggplot2* for mapping.

GRASS GIS and **QGIS**. These GIS programs can be menu-driven or run through syntax. They carry many of the functionalities of proprietary GIS software such as ArcGIS, including network analysis and location-allocation analysis.

FLOWMAP. This software can be used to conduct flow analysis on networks and location-allocation analysis.

C. Evaluation and Dissemination

A direct way to evaluate the project is to see whether the new course will help students widen the topic choice and better design their senior assignments. There has been some initial evidence that this might be the case. This past fall semester I directed a senior assignment for which a student used spatial point process analysis techniques to analyze market area and market penetrations of his uncle's hardware store business. His uncle was quite impressed when he saw the market area that his business impacted after a few decades of business operation. He actually plans to increase advertisements for his business in nearby communities after realizing the impacts of his business there. Many faculty members also thought it was a successful research project. I believe projects like this will increase when the new course systematically trains students in business location analysis.

Dissemination of the project involves two steps. The first is the launch of the new course in Spring Semester 2019 as a special topics course GEOG454 (techniques course). The long-term plan is to convert "Business Geography" to a permanent 400-level course by going through the formal curricular approval process. The course will be open not only to geography majors, but also to business majors, and to all who have an interest in knowing more about doing locational analysis using GIS techniques. Given the nature of SIUE as a rising regional university structured on a teacher-scholar model, students need training that gives them the competitive

skills for employment and future career development. There has never been a single course at SIUE that systematically trains students in business location analysis, while American companies are increasingly adopting advanced technologies in business decision-making, including location decision-making. The proposed course should fill the gap and equip students with the necessary skills for their career success.

Budget and Justifications

I request one month summer salary of \$9,000 (my actual monthly pay is \$9,342. The requested \$9,000 is due to the EUE cap for salary request) for designing the new course. There will be a lot of work involved in developing this course, which is substantially beyond that required for a new more traditional class. First, there is currently no textbook with the focus on locational analysis for business. Thus there is no existing format to follow while designing the course. As a result, I have to come up with the overall design from the scratch. For each of the five set techniques, lectures and labs need to be designed and created. Lectures cover the conceptual basis and the labs involve student hands-on work. The hands-one projects for the labs will need example data or business cases. The data and cases will need be carefully screened and tested for the best results.

Secondly, I have to write R scripts for all five set techniques. Writing R scripts requires much trial-and-error effort. This is because the R scripts need to be designed and written to coordinate with other software used. For example, when conducting location-allocation analysis, a point file with supply and demand locations needs to be combined with a line file of road networks. In GRASS GIS, this process is done by adding lines to connect points to existing roads, extending the total length of the road network. In R, this is done by snapping points to the nearest lines. Which approach should be used depends on the purpose of the outcome product

and the actual distance between points and existing road lines. Too large a distance and too many points would artificially increase the network length and thus create large errors. These issues need to be dealt with on a case-by-case basis. Careful comparison and frequent experiments are the only way to get the best outcome. In addition, among different R packages, the file formats are not the same, and a file that is generated from one package may not be used in another package. Much effort has to be devoted to decoding and recoding so that files from different packages can be connected. This makes writing good R scripts a time consuming process. In addition, FLOWMAP uses an old version of map files BNA while today the most common map files are shapefiles. File transfer between the new format and the older one may cause errors, which requires significant effort to clean up the files for successful file transformation.

The time-line for the course development

The course design, lecture creation and script writing would run through the entire summer 2018 and complete during the Fall Semester, 2018. The planned stages of progress are as follows.

Now to the start of summer: location-allocation and transportation network analysis software integration, script writing, tests with data sets.

May to June: software integration, script writing, and tests for the gravity models and business catchment area analysis.

July to August: work on market area analysis, including the software interface, script writing, and tests with data sets. Begin to develop lectures.

Fall Semester, 2018: complete the course development.

SHORT VITAE: BIN ZHOU

A. Education and Work Experience at SIUE

Ph.D. 1990-1994 Geography, University of Georgia, Georgia, USA
2007 to Present: Department of Geography, Professor

B. Refereed Publications since 2000

2017. Changing market structure amid banking restructuring: a case of St. Louis. A chapter in *Location Intelligence: Research and Applications*. Ed by M.D. Rice and T. Hernandez. 249-264.

2017. Is retail banking service converging toward the market in Illinois: A general methodology. A chapter in *Location Intelligence: Research and Applications*. Ed by M.D. Rice and T. Hernandez. 233-248.

2016. Applying the Clique Percolation Method to analyzing cross-market branch banking network structure: the case of Illinois. *Social Network Analysis and Mining* (Springer) 6(11)

2016. A study of cross-market branch banking in Illinois: A multiple regression quadratic assignment procedure approach. *International Journal of Applied Geospatial Research* 7(1) 1-15.

2014. Does geography matter? A study of determinants of bank office size in Illinois. *International Journal of Applied Geospatial Research* 5(1) 38-59

2013. Distribution of Major Types of Industry in Southern Illinois: Afterword. *Illinois Geographer* 55: 30-33.

2010. Changing Retail Banking Supply-Demand Mismatch: A Tale of Two States. *International Journal of Applied Geospatial Research*

2009. Geographical Conditions and Economic Development. *Geography Online*.

2008. Learning Foreign Culture through Field Schools: A Case Study. *Papers of Applied Geography Conferences* Vol. 30 206-215. With Tom Lavallee.

2007. Regional Economic Integration and Economic Locations: A Note. *Geography Online*.

2006. A Comparative Study of Retail Banking Supply-Demand Mismatch: Illinois and New York. *Papers of the Applied Geography Conferences* 29:390-399

2005. Is Retail Banking Service Really Converging Toward the Market in Illinois? A General Methodology. *Papers and Proceedings of the Applied Geography Conferences* 28.

2004. The Rise and Fall of St. Louis as a Regional Interstate Banking Center in the United States. *Papers and Proceedings of the Applied Geography Conferences* 27:430-438

2004. Is the Geography of Banking Services Converging toward Markets? A Case of Illinois. *Industrial Geographer* 2:174-192
2004. Financial Transformation and Portfolio Reallocation: Impacts on House Mortgage Finance in the USA. *Housing Studies* 19:207-228. With W. Shaw.
2003. Race and American College Testing (ACT) Scores in Illinois. *The Geographical Bulletin* 45 121-134. With W. Shaw.
2003. ACT Scores in Illinois: Relationships to High School Grade Point Average and Gender. *Bulletin of the Illinois Geographical Society* 45: 16-30. With W. Shaw.
2003. A Simulation of the Hirfindahl-Herschman Index: Case of the St. Louis Banking Geographic Market. *Geography Online* 4.
2002. A Geographical View of ACT Scores in Illinois. *Bulletin of the Illinois Geographical Society* 44: 3-20. With W. Shaw.
2002. Trade Theory and Location Theory. *Geography Online* 3.
2001. A Note on Comparative Advantage and Money. *Geography Online*, 2.
2000. An Empirical Study of Institutional Characteristics of the Regional Financial Markets: Evidence from Kentucky. *Southeastern Geographer* 41: 209-224 With W. Shaw.
2000. The Community Reinvestment Act as a Policy Option for Enhancing Regional Money supply: Evidence from Kentucky. *Papers and Proceedings of the Applied Geography Conferences* 23: 64-71. With W. Shaw.

C. Grants Received

- 2006 SIUE Instructional Equipment grant \$3,315
- 2006 SIUE Seed Grant \$2,000
- 2006 SIUE Travel Fund \$4,000
- 2006 SIUE SRF \$8,000
- 2005 SIUE EGE grant \$3,450
- 2005 SIUE Instructional Equipment grant \$3,639
- 2005 SIUE \$9,000 Travel Study Fund
- 2005 SIUE \$150 Faculty Conversation
- 2004 SIUE EUE grant \$25,940 (with T. Lavalley)
- 2004 Beijing Normal University, China grant \$400
- 2003 SIUE Instructional Equipment grant \$1,500
- 2002 SIUE EUE grant \$3,750
- 2001 Illinois Education Research Council. ACT Analysis \$5,500 (with W. Shaw)
- 2001 SIUE Instructional Equipment grant \$3,750
- 2001 SIUE EUE grant \$4,500 (with W. Shaw)

SOUTHERN ILLINOIS UNIVERSITY
EDWARDSVILLE

Date: January 22, 2018

To: EUE Committee

From: Susan Hume, Chair, Department of Geography 

RE: EUE Proposal Support Statement

I strongly support Dr. Zhou's proposal to design a new 400-level course entitled "Business Geography" that would incorporate the use of free, open-source GIS software to teach SIUE undergraduate students business location decision-making and modeling. GIS is a valuable problem-solving technology for answering spatial questions, and it is widely used across academic disciplines, professions, industries, and government agencies. The focus of this course would appeal to SIUE students majoring in Geography, Business, and Economics, as well as students pursuing the interdisciplinary minor in Urban Studies. The proposed "Business Geography" course touches on three high-impact practices. First, Dr. Zhou's proposed curricular design weaves together theory and practice using cutting-edge technology to promote undergraduate research experience. Second, students enrolled in "Business Geography" can lay the groundwork for senior assignment capstone projects in Geography, Business, and Economics. Third, SIUE undergraduates completing this course will be well-equipped with workforce skills to pursue internships and entry-level positions in location decision-making and modeling in such diverse fields as agriculture, manufacturing, retail, transportation, and private/public/non-profit services. Dr. Zhou's commitment to teaching students how to use free, open-source software rather than proprietary software means that these SIUE graduates will be able to offer their skills even to small businesses and non-profit organizations. As chairperson, I support adding "Business Geography" to the Department of Geography's suite of GIS-related courses, and I am committed to scheduling it as a 400-level topics course in Spring Semester 2019.

If you need additional information, please do not hesitate to contact me at 650-2091 or shume@siue.edu.

COLLEGE OF ARTS AND SCIENCES, OFFICE OF THE DEAN

To: Excellence in Undergraduate Education

From: Greg Budzban, Dean, College of Arts and Sciences

Subject: Dean's Memo of Support

Date: 22 January, 2018



The College of Arts and Sciences supports the application of Dr. Zhou for an EUE grant to cover the salary costs to design a new course in business geography that incorporates techniques in business locational analysis using free open source software. The new course will help students widen senior assignment topic options, and build skills that will be transferable to their future workplaces. Course development will be labor intensive, but the resulting class should serve both Geography and Business majors. The project supports the focus of SIUE and the College of Arts and Sciences on expanding opportunities for experiential learning, and preparing students for 21st century careers.