Center for Geographic Analysis
Harvard University

SIGMA XI
HARVARD CHAPTER

Welcome

Workshop on Spatial-Temporal Modeling

its implications across disciplines

Date: Friday, April 10th, 2009
Time: 8:30am – 6:00pm
Location: Tsai Auditorium, CGIS Building South, Room S010
Address: 1730 Cambridge St., Cambridge, MA 02138

It has become a CGA tradition to host a spring workshop every year. Since 2006, the CGA workshop series have covered the topics of geographic analysis, remote sensing, and georeferencing. For the spring of 2009, we turn to a classical yet rapidly evolving topic – Spatial-Temporal Modeling.

All things happen along the axes of space and time, yet the ancient disciplines of history and geography have traditionally divided the two. The need for a more integrated understanding of the phenomena in our world suggests we should avoid isolating the temporal dimension from the spatial. Spatial-temporal modeling has long posed a challenge, from science fiction to scientific research. Although the technology is still far from being mature, recent advancements have given spatial-temporal modeling a new momentum, leading to a burst in the number of conferences and publications in recent years.

This workshop is aimed at providing a high-level overview of this field, from theoretical research to industrial solutions and multi-disciplinary applications; from 4-dimensional database construction, object manipulation, to simulation and visualization. The audience will come from many disciplines, some with and some without previous experience in spatial-temporal modeling. The keynote address will give a general overview of the field, and the subsequent presenters from Harvard and other local institutions will show-case a sampler of current work in various disciplines. The break-out sessions will give beginners a selection of hands-on learning opportunities while experienced researchers engage in an in-depth discussion of the subject. The workshop's poster session will display a larger collection of relevant research activities at Harvard.

8:30 AM - 9:00 AM

Registration and Breakfast

9:00 AM - 9:05 AM

Welcome

Peter Bol, Director of Center for Geographic Analysis, Harvard University

9:05 AM - 10:00 AM

Keynote Address:

Interdisciplinary Spatiotemporal Modelling: It's not where you take things from, it's where you take them to

George Christakos, San Diego State University

10:00 AM - 11:00 AM Moderator: Stephen Ervin

ScenarioCMS: Managing the Temporal Geography of Futures

Mike Flaxman, MIT

Synthesizing Interactive Visual Query Interfaces for Spatiotemporal Data Exploration and Analysis

Chris Weaver, University of Oklahoma

11:00 AM - 11:15 AM

Coffee Break

11:15 AM - 12:15 PM Moderator: Stephen Ervin

Virtual Cities of the Future and Past

Paul Cote, Harvard University Graduate School of Design

Mapping Africa: Exploring Culture Spatially

Suzanne Blier, FAS, Harvard University

Modeling and Visualizing Historical GIS Data

Lex Berman, FAS, Harvard University

12:15 PM - 1:15 PM

Lunch Break

1:15 PM - 2:25 PM Moderator: Paul Cote

Spatio-temporal Analysis of Disease Surveillance Data

Al Ozonoff, Boston University

Modeling the Ecology of Urban Inequality in Space and Time

Corina Graif, FAS, Harvard University

HunchLab: Spatial-temporal Data Mining for Large Public Safety Databases

Robert Cheetham, Avencia

2:25 PM - 2:40 PM

Coffee Break

2:40 PM - 4:00 PM Moderator: Sumeeta Srinivasan

The Earth Trends Modeler

Ronald Eastman, Clark University

Working with Temporal Data in ArcGIS

Nawajish Noman, ESRI

4:00 PM - 5:00 PM (Locations for the following tutorials and workshops will be announced around 4:00PM)

Tutorial: Building and Browsing Visual Query Tools in Improvise, *Chris Weaver*

Tutorial: The Earth Trends Modeler, *Ronald Eastman*

Tutorial: Learning to Work with Temporal Data in ArcGIS, *Nawajish Noman*

STARS: Space Time Analysis of Regional Systems, *Sumeeta Srinivasan*

5:00 PM - 6:00 PM (CGIS South Concourse Lobby)

Poster Session and Reception

Interdisciplinary Spatiotemporal Modelling: It's not where you take things from, it's where you take them to

George Christakos, Distinguished Professor at Department of Geography, San Diego State University

Abstract: *Spatiotemporal modelling in an interdisciplinary context is based on the synthesis of core scientific knowledge, case-specific information, multi-sourced uncertainty and "agent-system" associations. Following a critical discussion of current views, certain possibilities are considered. A fusion of ideas from brain and neuropsychological sciences can lead to novel concepts and tools of spatiotemporal analysis and mapping that integrate technical "proof" (symbolic and numerical data processing) with every-day "truth" (contextual meaning and space-time interpretation) in the living experience sense. Accordingly, in real-world applications spatiotemporal modelling is conceived as a network of data bases, theories, beliefs, purposes and thinking modes in which any string in the net pulls and is pulled by the others in an interconnected way that can change the configuration of the whole. Applications include the integration of knowledge bases in fields such as human exposure, health effects, environmental assessment, risk analysis, space-time epidemiology and medical history.*

George Christakos is Distinguished Prof. at Department of Geography, SDSU-CA. His research focuses on spatiotemporal modelling of interdisciplinary systems in environmental science, human exposure, health risk effects, epidemiology, temporal GIS and space-time statistics. He worked on major projects in US, Spain, Italy, UK, Belgium, Greece, Russia, China, India, Bangladesh and Egypt. He authored/co-authored 7 books and over 150 papers on scientific/engineering topics. His laboratory has developed the SEKS-GUI software library of spatiotemporal analysis and mapping used worldwide.

ScenarioCMS: Managing the Temporal Geography of Futures

Michael Flaxman, Assistant Professor of Planning, MIT

Abstract: *Scenario planning is a form of contingency planning. Multiple designs or simulations of future conditions are generated, each reflecting key unknowns or strategic choices,. These are known as "alternative futures." Each alternative is considered from a variety of perspectives, typically using both formal and informal impact evaluations. Finally, a decision process is organized based on the comparison of alternative futures and their impacts. While alternative futures planning has proven to be an effective means of planning under uncertainty, its use is often restricted by the complexity of the underlying formulation and the lack of supporting tools and methods. Because a typical scenario study generates a half dozen alternatives, each of which is evaluated using several impact metrics, the propagation of scenario-impact sets can involve dozens to hundreds of files.*

ScenarioCMS (scenario content management system), is a new web-based tool for organizing and displaying spatiotemporal information about alternative futures. Its goal is to democratize interactive exploratory access to the results of alternative futures studies, in order to encourage substantive public engagement. The outputs of such studies have previously been available largely in two formats: paper reports (which are not interactive and thus difficult to query) or GIS files (which require substantial software training to utilize effectively). ScenarioCMS is composed of a front-end user interface, designed in Adobe Flex and presented on a web page, an XML-based scenario description language, and a back-end spatial information server, ESRI's ArcGIS Server.

This talk will focus on the representation of time within ScenarioCMS, and discuss how current alternative futures planning work in the Florida Everglades is challenging our research team to develop novel spatiotemporal representations and user interfaces.

Michael Flaxman is an assistant professor in the Urban Information Systems Group of MIT's Department of Planning. His primary research interest is in the development of tools for scenario-based planning of large landscapes. He has practiced GIS-based planning in 14 countries, including one year as a Fulbright fellow in Canada. Before coming to MIT, Dr. Flaxman served as Industry Manager for Design at Environmental Systems Research Incorporated (ESRI), the world's largest maker of geographic information systems (GIS). Michael received his Doctorate in Design from Harvard in 2001, and holds a Master's in Community and Regional Planning from the University of Oregon, and a Bachelor's in Biology from Reed College.

Synthesizing Interactive Visual Query Interfaces for Spatiotemporal Data Exploration and Analysis

Chris Weaver, Assistant Professor at School of Computer Science and the Center for Spatial Analysis, University of Oklahoma

Abstract: *Visualization of multidimensional data increasingly involves rich combination of representation and interaction. However, synthesis of visualization tools remains largely craft, typically involving months of ad hoc design and implementation effort. Application of visualization is limited in practice to a small fraction of potentially useful and usable forms, presenting a significant hurdle for widespread adoption in the social and natural sciences and beyond.*

In this talk I will describe Improvise, a software architecture and user interface for building and browsing multidimensional visualizations interactively. By coupling interaction with a declarative query language, user-designers gain precise control over data appearance and behavior across multiple views. Interactive synthesis makes it practical to design, implement, and refine rich visual query interfaces in a matter of days or even hours. Improvise has been so used to explore and analyze spatial+temporal+abstract information sources as diverse as historic hotel guest registries, political events in international newswire stories, health and census demographics, caribou migration patterns, a simulated health facility evacuation, and the Internet Movie Database. Drawing from such examples, I will present for consideration some ideas and initial steps toward identifying compounds and formulating principles for a "science of visualactive synthesis" aimed at serving broad needs through visual computing.

Chris Weaver is an assistant Professor in the School of Computer Science and Associate Director of the Center for Spatial Analysis at the University of Oklahoma. He holds a B.S. in Chemistry and Mathematics from Michigan State University and an M.S. and Ph.D. in Computer Science from the University of Wisconsin-Madison. He was recently a Research Associate with the GeoVISTA Center in the Department of Geography at Penn State, where he helped to found the North-East Visualization and Analytics Center. His research in information visualization and visual analytics focuses on synthesis of visual query interfaces for exploring and analyzing heterogeneous multidimensional data sets.

Virtual Cities of the Future and Past

Paul Cote, GIS Specialist and Lecturer at the Harvard University Graduate School of Design

Abstract: *The problem with developing and maintaining information about the three dimensional form of cities is that they are always changing. This presentation discusses a database model that maintains past and proposed future city design scenarios and yields a logically consistent three dimensional visualization of the state of the city at a user-specified time. This database design is scalable and could provide a basis for an open source metropolitan virtual city model built upon the ongoing data management efforts of many independent jurisdictions.*

Paul Cote is GIS Specialist and Lecturer at the Harvard University Graduate School of Design. He teaches courses on the Fundamentals of GIS and Three Dimensional Modeling of Urban Landscapes. He has been active in developing standards integrating the information models of the Architecture Engineering and Construction industries with Geospatial Web Services.

Mapping Africa: Exploring Culture Spatially

Suzanne Preston Blier, Professor of Fine Arts and Professor of African and African American Studies, Harvard University

Abstract: *This paper explores several case studies that address the ways in which GIS can be used to study historical questions related to city planning, architecture, and art in Africa. Among the factors that are addressed are the use of GIS to address changes in class dynamics and land ownership over time, the importance of topography to socio-political and religious dynamics in urban spatial use, and the use of GIS to address questions of creativity and innovation in broader regional contexts.*

Suzanne Preston Blier, the Allen Whitehill Clowes Professor of Fine Arts and professor of African and African American studies at Harvard University, is an art and architectural historian specializing in the cultures and history of Africa who has published an array of books and articles on this subject. She is co-Chair of Africamap at Harvard, and previously edited Baobab: Sources and Studies in African Visual Culture, an online database. Blier received her BA from the University of Vermont, taking time off to work with the Peace Corps. She earned an MA, MPhil, and PhD from Columbia

University, where she later became professor. Blier has held fellowships from the National Gallery, National Endowment for the Humanities, the John Simon Guggenheim Memorial Foundation, and the Institute for Advanced Study in Princeton, New Jersey. Most recently, she published Art of the Senses: African Masterpieces from the William and Bertha Teel Collection (Boston Museum of Fine Arts Publications, 2004) and Butabu: Adobe Architecture from the Western Sudan (with James Morris, Princeton Architectural Press, 2004).

Modeling and Visualizing Historical GIS Data

Merrick Lex Berman, Project Manager of China Historical GIS project, Harvard University

Abstract: *Spatial objects in Historical GIS are typically defined as either snapshots of a moment in time [time slices], or as a series of discrete objects that reflect changes [time series]. Here we examine ways to model a time series of asynchronous spatial objects, and visualization methods to show their changes over time, such as movements from point to point, and trails of previous instances that remain on-screen.*

Merrick Lex Berman, studied Asian Languages and Geosciences at UMASS Amherst, and spent a year as Fulbright Scholar at Academia Sinica, Taiwan. As Project Manager of the China Historical GIS project at Harvard University, Berman has developed a variety of database-centric tools for finding, visualizing, and sharing geographic information. Beginning in 2009, Berman will begin work on a permanent digital archive for the Hierarchical Regional Systems data developed by the late Prof. G. W. Skinner.

Spatio-temporal Analysis of Disease Surveillance Data

Al Ozonoff, Associate Professor of Biostatistics at the Boston University School of Public Health

Abstract: *Stephen Thacker of the CDC once wrote that 'surveillance is the cornerstone of public health practice.' Beyond playing a critical role in our public health infrastructure, disease surveillance systems offer a potentially valuable source of data to study dynamic patterns of disease. However, these data also suffer from some profound limitations. We will briefly review some characteristics of disease surveillance data that are relevant to spatio-temporal modeling, including a whirlwind tour of some seminal and recent research. We will then focus more closely on influenza, a disease which poses a unique set of modeling challenges.*

Al Ozonoff is Associate Professor of Biostatistics at the Boston University School of Public Health, and an adjunct faculty member at the Harvard School of Public Health. His research aims to improve and enhance the operation and performance of public health surveillance systems through the use of statistical methodology such as time series analysis and spatial statistics. His recent work has focused on dynamic patterns of influenza and other respiratory disease.

Modeling the Ecology of Urban Inequality in Space and Time

Corina Graif, Department of Sociology, Harvard University

Abstract: *In this presentation, I illustrate how spatially- and temporally-varying processes may be modeled to better understand the formation and long-term consequences of urban ecologies of social differentiation and spatial inequality. I analyze population, organizational, and survey data from urban neighborhoods and communities observed over time and at different levels of aggregation. Classical modeling approaches are complemented with spatial models, and a combination of multidimensional scaling, cluster analysis, and mapping of geographical and abstract spaces, to examine the extent to which neighborhood poverty, immigration, and racial-ethnic diversity systematically and differentially contribute over time to changes in the migration of the creative class and knowledge workers, and to changes in neighborhood social capital and crime rates.*

Corina Graif's research addresses questions related to migration and residential mobility, social and spatial stratification, neighborhood effects, crime, racial-ethnic and immigrant inequalities in neighborhood attainment and life-course outcomes. Her work also examines processes of social capital formation, social networks, mobility of the creative class, neighborhood migration flows, and the long-term consequences of poverty, segregation, immigration, and diversity on urban communities. Her dissertation analyzes systematic patterns in the geographic mobility pathways of socio-economically disadvantaged inner-city families in five major U.S. cities, and focuses in particular on racial and ethnic disparities in spatial attainment and neighborhood effects. Graif's

work is published in journals like Social Psychology Quarterly, Homicide Studies, and American Behavioral Scientist.

HunchLab: Spatial-Temporal Data Mining for Large Public Safety Databases

Robert Cheetham, Founder and President of Avencia

Abstract: *HunchLab is a data mining software system that uses spatial statistics to identify changes in geographic clustering of space-time events and, when statistically significant changes are found, alert users via e-mail based on subscriptions with geographic filters. The system is capable of rapidly sifting through large numbers of geographic events and identifying locations that demonstrate statistically significant changes. A prototype version was developed in 2004 to supplement the CompStat process and to more rapidly provide alerts to command staff. With funding from the National Science Foundation, Avencia is currently developing a more generalized version of the software. The presentation will outline the concepts behind HunchLab and show the first implementation of the software, being carried out in Tacoma, Washington.*

Robert Cheetham is the founder and president of Avencia, a geospatial software design and development firm based in Philadelphia. Avencia develops geospatial analysis tools and services for government, non-profit, commercial and research organizations. Robert has an MLA in Landscape Architecture and Regional Planning from the University of Pennsylvania and a BA in Japanese Studies from the University of Michigan and has 14 years of experience developing geospatial software tools in a range of domains including: real estate, crime analysis, land conservation, cultural resources, economic development and elections. His current interests include geoprocessing, map algebra and distributed computing. Prior to founding Avencia, Robert served as a developer and analyst for the University of Pennsylvania, the City of Philadelphia and the Philadelphia Police Department. He founded Avencia to develop advanced visualization and analysis software for the web. Robert also serves as an occasional lecturer at the University of Pennsylvania, School of Design and collaborates with the University of Pennsylvania Cartographic Modeling Lab.

The Earth Trends Modeler

J. Ronald Eastman, Professor at Graduate School of Geography, Clark University

Abstract: *In response to dramatic changes in climate and land cover change, an extensive set of earth observing systems has been launched over the past three decades. This has led to the development of a wide range of image times series from which the dynamics of the earth system can be monitored. However, the development of software tools to analyze these archives has not kept pace. This presentation introduces the Earth Trends Modeler, an integrated suite of tools for image time series analysis that has been released as part of the Taiga Edition of the IDRISI software system. Analytical tools range from trend and seasonal trend (e.g., phenological) analysis, Principal Components (PCA) and Fourier PCA, Empirical Orthogonal Teleconnection analysis, Wavelets, and linear modeling tools. The application of these tools will be illustrated with a variety of environmental image series ranging from vegetation productivity to precipitation to atmospheric temperature.*

J. Ronald Eastman is Professor of Geography in the Graduate School of Geography at Clark University. He is also the Director of Clark Labs – a research unit at Clark that focuses on the development of spatial analysis tools. Dr. Eastman is best known as the developer and chief architect of the IDRISI GIS and Image Processing System and the Land Change Modeler which are distributed and supported by Clark Labs. He is also the author of numerous publications in the areas of GIS and Remote Sensing. His research is currently focused on the development of analytical tools for

Working with Temporal Data in ArcGIS

Nawajish Noman, Lead Product Engineer at ESRI

Abstract: *This session will provide an overview of functionality, techniques, and tips for visualization and query of temporal data in ArcGIS. ArcGIS has powerful capabilities for visualizing temporal data in ArcMap, ArcScene, and ArcGlobe. You can visualize temporal vector, raster, tabular and multidimensional data by changing layer visibility and by animating layer and graphs. This session will discuss the recommended vector and raster data structures for efficient visualization along with some common workflows to highlight the effectiveness of animation in analyzing your data. Multidimensional arrays are commonly used for storing temporal data and netCDF is a widely used data format for*

storing array-oriented scientific data. The basic structure of multidimensional netCDF data and how to work with them in ArcGIS will be covered as well. It will also touch on ArcGIS Tracking Analyst and ArcLogistics. Tracking Analyst provides tools for playback and analysis of time series data, and ArcLogistics lets you automate vehicle routing, create optimized routes, and solve scheduling problems to significantly improve your fleet efficiency. An overview of the considerations and best practices for storage and management of spatiotemporal data will be discussed throughout the session.

Nawajish Noman is a Lead Product Engineer at ESRI. He works in the Spatial Analyst development team and is responsible for multidimensional data and hydrologic modeling related functionalities in ArcGIS. He graduated from Bangladesh University of Engineering & Technology (BUET), Bangladesh in 1991 as a Civil Engineer, completed Master of Engineering from Asian Institute of Technology (AIT), Thailand, and Ph.D. in Engineering from Brigham Young University, USA. His areas of interest include GIS-water resources integration, automated floodplain delineation, hydrologic and hydraulic dynamic modeling, and multidimensional data. Prior to joining ESRI in 2001, he worked as a consultant for Halcrow, Danish Hydraulic Institute, and other organizations.

Tutorial: Building and Browsing Visual Query Tools in Improvise, *Chris Weaver*

Improvise is a software architecture and user interface for building and browsing multidimensional visual query tools interactively. By coupling interaction with a declarative query language, users gain precise control over data appearance and behavior across multiple views. Interactive synthesis based on flexible coordination and expressive graphical encoding makes it practical to design, implement, and refine rich visualization interfaces in a matter of days or even hours. Improvise has been used to explore and analyze information sources as diverse as historic hotel guest registries, political events in international newswire stories, health and census demographics, caribou migration patterns, a simulated health facility evacuation, and the Internet Movie Database. In this tutorial, we will begin by browsing several existing Improvise visualizations. We will then discuss core features of the Improvise visualization architecture, including data access, visual encoding, and multiview coordination. Finally, we will use Improvise to build a modest visualization of a spatiotemporal data set (to be determined).

Tutorial: The Earth Trends Modeler, *J. Ronald Eastman*

(Please read the abstract of his presentation for details.)

Tutorial: Learning to Work with Temporal Data in ArcGIS, *Nawajish Noman*

This hands-on session will provide an overview of functionality, techniques, and tips for visualization and query of temporal data in ArcGIS. ArcGIS has powerful capabilities for visualizing temporal data. You can visualize temporal vector, raster, tabular and multidimensional data by changing layer visibility and by animating layer and graphs. This session will show you the recommended vector and raster data structures for efficient visualization and some common workflows to animate and analyze your data. Multidimensional arrays are commonly used for storing temporal data and netCDF is a widely used data format for storing array-oriented scientific data. This session will also cover how to work with multidimensional netCDF data in ArcGIS.

STARS: Space Time Analysis of Regional Systems, *Sumeeta Srinivasan*

Space-Time Analysis of Regional Systems (STARS) is an open source package designed for the analysis of areal data measured over time. STARS brings together a number of recently developed methods of space-time analysis into a user-friendly graphical environment offering an array of dynamically linked graphical views. It is intended to be used as an exploratory data analysis tool. STARS can also be used from the command line to support more flexible and specialized types of analyses by advanced users. It was developed by Sergio Rey and others at San Diego State University and was developed using Python. It consists of four core analytical modules: Anselin (1995) exploratory spatial data analysis; Anselin (2003) inequality measures; Carlino and Mills (1993) mobility metrics; and Christakos, Bogaert, and Serre (2001) spatial Markov.

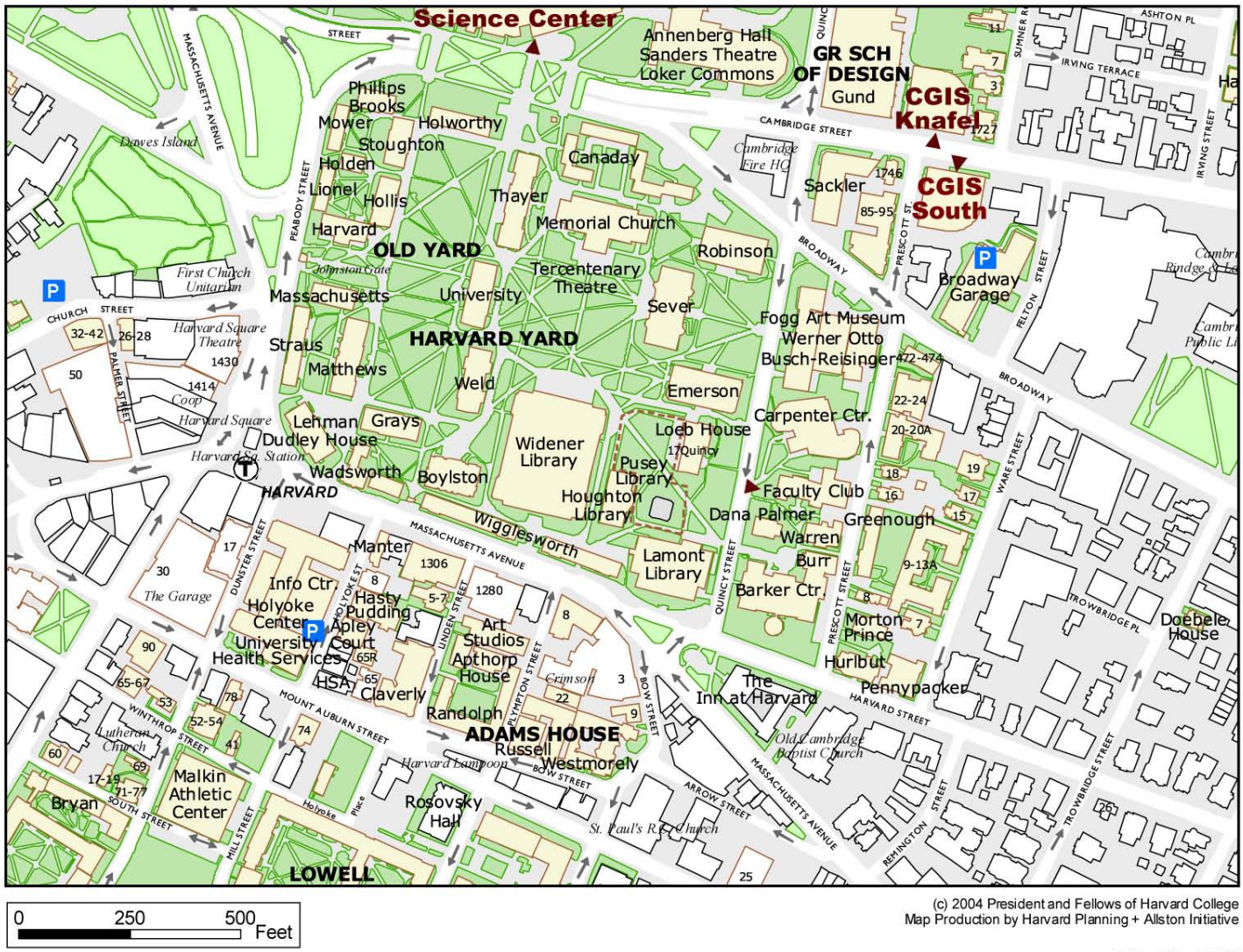
Sumeeta Srinivasan is a Preceptor in the Department of Government, Harvard University. She teaches courses on GIS, Spatial Analysis and Models. Her research interests include spatial models of environmental and urban systems. She received her Phd from MIT in Transportation Planning.

PARKING

Before planning to drive a car to Harvard Square, you should think about where you are going to park. If you do not have pre-arranged parking or you do not have time to search for a parking place, you should strongly consider arriving by subway or taxi. It is possible to purchase a one-day visitor's pass from the University Operations Services to park in the Broadway Garage for $9.00. The Broadway Garage is located on Felton Street, at the corner of Broadway. It is marked on the map below.

To purchase the visitor's pass on line, please visit:
https://www2.uos.harvard.edu/cgi-bin/permit/purchase.pl

MAP



Map Production by Harvard Planning + Allston Initiative

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