Curriculum Vitae of SHASHI SHEKHAR

May 19, 2012

Contents

1 Brief Biography

Shashi Shekhar is currently a Mcknight Distinguished University Professor at the University of Minnesota, Minneapolis, MN, USA. He was elected and *AAAS*[1] *Fellow*, an *IEEE* [2] *Fellow* and received the *IEEE Computer Society Technical Achievement Award* for contributions to spatial database, spatial data mining, and geographic information systems(GIS). He is serving on the Future Work-force for Geospatial Intelligence Committee (2011) of the National Research Council of the National Academy of Sciences (NRC/NAS). Earlier he served on the NAS/NRC Mapping Sciences committee (2004-2009) and NAS/NRC committee on Priorities for GEOINT Research (2004-2005).

Shashi has co-authored over 260 research papers in peer-reviewed journals, books, and conferences, and workshops. Shashi co-edited an Encyclopedia of GIS (Springer, 2008, isbn 038730858X) and co-authored a textbook on Spatial Databases (Prentice Hall, 2003, ISBN 0-13-017480-7), which has been translated into multiple foreign languages and editions (isbn 7-111-13221-1 (Chinese), 5-93378-091-X (Russian), 978-81-317-2628-0 (Indian)). He received a Ph.D. degree in Computer Science and M.S. degrees in Business Administration as well as Computer Science from the University of California (Berkeley, CA).

Shashi is serving as a *co-Editor-in-Chief* of the Geo-Informatica: An International Journal on Advances in Computer Sc. for GIS (ISSN 1384-6175), a top-tier [3] journal in the interdisciplinary area of GIS. He is also serving as a series editor for the Springer-Briefs in GIS, a general co-chair of the Symposium on Spatial and Temporal Databases (2011), and a program co-chair for the International Conference on Geographic Information Science (2012). He is a member of the steering committee for the IEEE Workshop on Spatial and Spatio-temporal Data Mining. He served on the Board of Directors of University Consortium on GIS (2003-2004), the editorial boards of IEEE Transactions on Knowledge and Data Engineering, and the IEEE-CS Computer Science & Engineering Practice Board. He contributed via major service roles in many conferences and workshops including the ACM SIG-Spatial Intl. Conference on GIS, IEEE Intl. Conf. on Data Mining (ICDM), IEEE ICDM Intl. Workshop on Spatial and Spatio-temporal Data Mining, SIAM Intl. Conf. on Data Mining, etc. He served as a technical advisor to United Nations Development Program (UNDP), Environmental Systems Research Institute (ESRI), and other organizations. His research projects have been sponsored by the NSF, NGA, NASA, Army Research Laboratories, USDOT, FHWA, MN/DoT etc.

Shashi is a leading researcher in the area of spatial databases and spatial data mining, an interdisciplinary area at the intersection of Computer Science and GIS. A major goal of his research is to understand the computational structure of very large geo-spatial computations (e.g. data analysis via spatial querying and spatial data mining) needed by social, biological and physical sciences as well as engineering disciplines. Earlier his research developed core technologies behind in-vehicle navigation devices as well as web-based routing services, which revolutionized outdoor navigation in urban environment in the last decade. His research results played a critical role in evacuation route planning for homeland security and were recognized via the CTS Partnership Award (2006) for significant impact on transportation. He also contributed significantly to design of UMN map server, which is being used on tens of thousands of web-services publishing geographic information on the Internet. His recent geo-social media white-paper was discussed in many blogs, science forums, tweets and facebook postings.

[1] American Association for Advancement of Science

[2] Institution of Electrical and Electronics Engineers

[3] C. Caron et al, GIScience Journals Ranking and Evaluation: An International Delphi Study, Transactions in GIS, 12(3), 2008, Blackwell Publishing Ltd. (Table 5, pp. 308 provide a summary).

Shashi's general area of research is data and knowledge engineering, with a focus on storage, management and analysis of scientific and geographic data, information and knowledge. Major contributions in data engineering and database systems, includes the *Connectivity-Clustered Access Method (CCAM)*, a new storage and access method for spatial networks, which outperform traditional indexes (e.g. R-tree family) in carrying out network computations. Other contributions relate to with semantic query optimization and high performance geographic databases. In knowledge engineering, his work focuses on spatial data mining, and neural networks. Major contributions include the notion of *co-location* patterns in spatial datasets, characterization of the computational structure of *spatial outlier detection*, faster algorithms for estimating parameters for the spatial auto-regression model, as well one of the most scalable parallel formulation of the back-propagation learning algorithms for neural networks.

Shashi has supervised 19 PhDs and a postdoctoral fellow; all are serving major universities (e.g. Virginia-Tech., Rutgers, Sydney, UT-Dallas), premier federal laboratories (ORNL/USDOE, NGA/USDOD), and industry (IBM-TJWatson, Microsoft-Bing, Oracle-Spatial, ESRI). Many play prominent roles in professional societies (e.g. Lu, Secretary; Huang, Treasurer at SIG-Spatial), and conferences (e.g., Ravada, Zhang, Program Co-chairs (PCs); Lu and Zhang, General Co-chairs at ACMGIS; Hamidzadeh, PC of IEEE TAI). In academia, Chawla is now chair of the CS Department at the University of Sydney. Coyle, ex-Vice-President, Ravada and Kohli, Directors at Oracle, are rising leaders in industry.

In 2010, Shashi was named a key difference-maker for the field of Geographic Information Science and Systems in 2010 by the most popular GIS textbook[4] co-authored by a member of National Academy of Science.

In 2012, Shashi was named a member of the Computing Community Consortium (CCC) Council (2012-2015). The CCC is an organization whose goal is to catalyze and empower the U.S. computing research community to pursue audacious, high-impact research.

[4]P. A. Longley, M. F. Goodchild, D. J. Maguire, D. W. Rhind, Geographic Information Systems and Science, 3rd Edition, Wiley, 2010, isbn 978-0-470-72144-5. http://www.wiley.com/WileyCDA/WileyTitle/productCd-EHEP001475.html.

2 BASIC INFORMATION

CONTACT INFORMATION

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Electronic:	shekhar@cs.umn.edu, http://www.cs.umn.edu/~shekhar

RESEARCH INTERESTS

Spatial databases, spatial data mining, geographic information systems.

EDUCATION

- 1989 , Ph.D., Computer Science, University of California, Berkeley. (Thesis: Cooperating Expert Systems.)
- 1989 , M.S., Business Administration, University of California, Berkeley. (Thesis: A Stochastic Learning Algorithm for Neural Networks.)
- 1987 , M.S., Computer Science, University of California, Berkeley. (Thesis: Intelli-Genesis: Software Engineering Environment for AI Programs)
- 1985 , B.S., Computer Science, Indian Inst. of Tech. (IIT), Kanpur (India). (Thesis: Implementation of a Programming Environment for 'C'.)

APPOINTMENTS

- 2005 – present, McKnight Distinguished University Professor, University of Minnesota, Minneapolis, Minnesota.
- 2005 – 07, Director, Army High Performance Computing Research Center, University of Minnesota, Minneapolis, Minnesota.
- 2001– present, Professor, University of Minnesota, Minneapolis, Minnesota.
- 1995– 01, Associate Professor, University of Minnesota, Minneapolis, Minnesota.
- 1989–95 , Assistant Professor, University of Minnesota, Minneapolis, Minnesota.
- 1985–99 , Research Asst. / Post graduate researcher, University of California, Berkeley, California. Worked on cooperating expert systems, reasoning under uncertainty, and neural networks.
- 1985 (summer) , Instructor, Regional Institute of Technology, Jamshedpur, India. Developed courses on programming paradigms.
- 1984 (summer) , Software Engineer, Taj Services Ltd., New Delhi, India. Designed and implemented a Report Generator Package for a Hotel Management System.

PROFESSIONAL MEMBERSHIPS

- IEEE Computer Society (Fellow)
- American Association for Advancement of Science (Fellow)
- Association for Computing Machinery
- University Consortium on Geographic Information Systems (Delegate).

2.1 Awards and Honors

- Resident Fellow, Institute on Environment, University of Minnesota (2011). The resident fellows program provides support for creative faculty members from a range of backgrounds who wish to work together across disciplines on innovative solutions to environmental problems.
- Fellow, American Association for Advancement of Science (2008 onwards). A Fellow is defined as "a Member whose efforts on behalf of the advancement of science or its applications are scientifically or socially distinguished." Examples of areas in which nominees may have made significant contributions are research; teaching; technology; services to professional societies; administration in academe, industry, and government; and communicating and interpreting science to the public. Fellows are elected annually by the AAAS Council.
- Technical Achievement Award, Institution of Electrical and Electronics Engineers (Computer Society), 2006. It recognizes outstanding and innovative contributions to the fields of computer and information science and engineering or computer technology, usually within the past ten, and not more than fifteen years.
- McKnight Distinguished University Professorship, University of Minnesota, 2005 onwards. It honors and rewards highest-achieving faculty, whose work has brought great renown and prestige to the University of Minnesota. Selectivity is less than one sixth of one percent.
- Fellow, Institution of Electrical and Electronics Engineers (Computer Society), 2003 onwards. the IEEE Grade of Fellow is conferred by the Board of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year does not exceed one-tenth percent of the total voting Institute membership.
- Fellow, Minnesota Supercomputing Institute, University of Minnesota, 2005 onwards.
- The Center for Transportation Studies (CTS) **2006 Research Partnership Award**, which recognizes research projects within the CTS program that have **resulted in significant impacts on transportation**, and rewards teams of individuals who have drawn on the strengths of their diverse partnerships to achieve those results.
- Designated as CTS Scholar, Center for Transportation Studies, University of Minnesota, 1999 onwards.
- Best paper award, ACM SIGKDD Workshop on Sensor Data Mining, 2007.
- One of 4 best papers, CoMoGIS 2006 - 3rd International Workshop on Conceptual Modeling for Geographic Information Systems.
- One of 4 best papers, IEEE Workshop on Spatial and Spatio-temporal Data Mining, 2006.
- One of 4 best papers, ACM Conference on Geographic Info. Systems, 2003.
- One of 4 best papers, ACM Conference on Geographic Info. Systems, 1998.
- One of the 4 best papers, Symposium on Spatial Databases, 1997.
- Bush Foundation Fellowship, Sabbatical Supplement Program Award, 1997-98.
- Excellence in Teaching Award, Bush Foundation 1992 - 93.
- Best paper award, Indian Computing Congress, 1991.
- Certificate of Appreciation, IEEE Computer Society, 1991.
- Pass with distinction, Qualifying Exam., (thesis proposal defense), 1988, U. C. Berkeley.
- Eugene C. and Mona Fay Gee Fellowship 1987, U. C. Berkeley.
- Best Graduating Student (among 250 students), B. Tech. Computer Sc., 1985, I. I. T., Kanpur, India.
- All India Rank *2* among 100,000 students, Joint Entrance Exam. 1981 for all Indian Institute of Technology, India.
- National Talent Search Scholarship, 1979 to 1985 from the Government of India.
- Silver medal for *2nd* rank in a merit list of 300,000 students, Bihar State Secondary School Examination 1979. Also awarded four gold medals for winning the competitions for debate, general knowledge, personality, and mental ability.

2.1.1 Honors

- Research results reported in major media including ReadWriteWeb (2011), NSF Science360.gov (2011), sciencenewsdaily (2011), sciencedaily.com (2011), scienceblog.com (2011), psychcentral.com (2011), gisandscience.com (2011), newwebmag.com (2011), machineslikeus.com (2011), milkeg.typepad.com (2011), gratis-jobs.blogspot.com (2011), etc. One of these articles generated 600+ facebook posts and 250+ tweets.

  It was also discussed in University of Minnesota news wire (2011), Minnesota Daily (2010, 2011), University of Minnesota Alumni magazine and website (2007), University of Minnesota bi-annual Research Magazine (2007) from the Office of Vice-President of Research.

  It was covered by FoxTV (2006), the Star Tribune (2006, 1999), the Pioneer Press (2006, 1996) and on public radio (1992). These were also highlighted by the Office of Vice President of Research (2006), University of Minnesota Foundation (2007), Office of Vice President of Public Engagement (2006), and Center of Transportation Studies (2005) within the University of Minnesota.
- Member, Member, Computing Community Consortium (CCC) Council (2012-2015). The CCC is an organization whose goal is to catalyze and empower the U.S. computing research community to pursue audacious, high-impact research. The CCC is governed by an 18-member Council on 3-year staggered terms, representing the diverse nature of the computing research field.
- Selected to participate in, Leadership in Science Policy Institute, Computing Community COnsortium, November 7th, 2011.
- Member, National Academy of Science - National Research Council (NAS/NRC) Committee on *Future Workforce for Geospatial Intelligence* 2011.
- Key difference-maker in Geographic Information Science and systems (2010): Biography highlighted in the most popular GIS textbok, namely, *Geographic Information Systems and Science, Wiley, 2009, isbn 978-0-470-72144-3*. It recognizes committed motivated individuals, whose contributions have made a difference to GIS. This textbook reaches hundreds of thousands of GIS academics, students and professionals around the world. It is co-authored by a member of the National Academy of Science.
- Member, Advisory Board,, Integrated Media System Center (IMSC), University of Southern California, Los Angeles, CA, 2011-onwards.
- Member, Review and Advisory Committee, Strategic Research Cluster in Advanced Geotechnologies, Science Foundation Ireland (ICT Division), Dublin, Ireland, 2010.
- Member, Dean's ad-hoc Committee, Division of Engineering and Applied Sciences, Harvard University, January, 2007.
- Member, DARPA IXO Panel on "Model the Planet" for the very large spatial database program, 2006.
- Selected to present at Congressional breakfast program on GIS and homeland security, University Consortium on GIS, 2/2004.
- Member, Mapping Science Committee, National Research Council of national academies, 2003-2009.
- Member, National Research Council (national academies) Committee to review basic and applied research at the National Geo-spatial Intelligence Agency, 2004-2005.
- Member, Committe to Review Geospatial Research Program of the Army Corps of Engineers, 2010.
- Member, Rand Committee to review Geo-knowledgebase prototype (GKB-p) project at the National Geo-spatial Intelligence Agency, July 2005.
- Board of Directors, University Consortium on GIS, 2003-4.
- Member, Review and Advisory Committee, Strategic Research Cluster in Advanced Geotechnologies, Science Foundation Ireland (ICT Division), Dublin, Ireland, 2007.
- Member, Review and Advisory Committee, GEOIDE: A national nesearch network of excellence on Geomatics, Canada, 2004.
- Member, FY 2008 Director's R&D Fund Review Committee, Laboratory Directed Research and Development (LDRD), Ultrascale Computing Initiative Oak Ridge National Laboratory, U.S. Department of Energy, 2007.

- Member, Review Committee, Pennsylvania Department of Health Final Performance Review, Oak Ridge Associated Universities (ORAU), 2008.
- Member, Review Committee, Florida Centers of Excellence proposals, Oak Ridge Associated Universities (ORAU), 2008.
- Member, Advisory Board, NSF IGERT in Sensor Science, Engineering and Informatics, University of Maine, 2008-2011.
- Member, Advisory Board, NSF IGERT in Geographic Information Science, SUNY Buffalo, 2004-2010.
- Member, Review Board, NSF EPSCoR Center in Geographic Information Science, U. Maine, 2003.
- Selected as a *site visitor* to review NSF research infra-structure grant proposals, May 1999 along with invitations to multiple panels at NSF and NASA.
- Selected as a delegate to represent the University of Minnesota in the University Consortium on GIS, 1999-2000.
- Selected as the Computer Science representative in the national Curriculum Committee of University Consortium on GIS, 1998-99.
- Selected as United Nations international advisor for UNDP projects 1997-98.
- Invited Expert, CalTrans/NCGIA Conference on Navigable Databases, 1996.

2.2 List of Invited Presentations

- Invited Speaker, Spatial Big Data, Army Research Office Workshop on Big Data at Large Workshop, June 14-15, 2012, near Duke University Durham, NC, USA.
- **Keynote speech**, Spatial Big Data, 11th ACM SIGMOD International Workshop on Data Engineering for Wireless and Mobile Access (MobiDE), May 20th, 2012, Phoenix, AZ, USA.
- Invited Speaker, Spatial Big Data, NSF Workshop on Big Data Benchmarking, Brocade Executive Briefing Center, San Jose, CA, USA, May 7-9, 2012.
- Invited Speaker, Spatial Data Mining, NIH-AAG Symposium on Geospatial Frontiers in Health and Social Environments (Spatiotemporal Analysis for Health Research), April 27-28, 2012.
- Invited Speaker, Evacuation Route Planning, NSF/CCC Workshop on Computing for Disaster Management, April 24-25, 2012.
- **Distinguished Colloquium**, Management Science and Information Systems Department, Rutgers University, Newark, NJ, USA, March 30th, 2012.
- **Distinguished Colloquium**, Computer Science Department, Iowa State University, Des Moines, IA, USA, March 8th, 2012.
- Invited Panelist, Panel on Mobility and Cloud Computing, NSF Workshop on Social Networks and Mobility in the Cloud, February 23-24, 2012.
- **Distinguished Seminar**, Evacuation Route Planning: Scalable Methods, Operations Research Center, University of Florida, Gainesville, FL, USA, November 18th, 2012.
- Invited Panelist, Panel on Challenges and opportunities in High-performance and Distributed GIS (HPDGIS), ACM SIG-Spatial Intl. Conference on GIS, November 1-3, 2011.
- Invited talk, Geo-Social Computing, CDC/FDA Workshop on Food Safety Biosurveillance, Michigan State University, October 24-26th, 2011.
- Invited talk, Eco-Routing: Computational Challenges, USDOE ORNL Symposium on Virtualizing Energy, US Department of Energy ORNL, Fall-Creek Falls, Gatlinburg, TN, September 14-16th, 2011.
- **Keynote speech**, ISPRS Symposium on Spatial-Temporal Analysis and Data Mining, July 18-20th, 2011, University College, London, U.K.
- **Panelist**, Plenary Panel on Sustainability, SECON 2011 : IEEE Communications Society Conference on Sensor, Mesh and Ad-Hoc Communications and Networks, June 28th, 2011, Salt Lake City, Utah, USA.
- **Invited talk**, NSF Workshop on Information and Communication Technologies for Sustainability (WICS), June 27th, 2011, Salt Lake City, Utah, USA.
- **Keynote speech**, Twentieth International Conference on Software Engineeing and Data Engineering, Intl. Society for Computers and their Applications, June 20th-22nd, 2011, Las Vegas, NV.
- Colloquium Speaker, What is Special about Mining Spatial Data, Computer Science Department, Montana State University, April 29th, 2011, Bozeman, MT.
- **Distinguished Colloquium Speaker**, Evacuation Route Planning: Scalable Approaches, College of Engineering, Montana State University, April 29th, 2011, Bozeman, MT.
- Invited talk, Geo-Social Media Revolution: Hype or Reality?, Meeting of the Social Computing Collaborative: an interdisciplinary research community at the University of Minnesota, March 31st, 2011, Minneapolis, MN.
- Invited talk, Geo-Social Media Revolution: Hype or Reality?, annual retreat of the Integrated Media Systems Center (an NSF ERC), University of Southern California, February 17th, 2011, Los Angeles, CA.

- Invited talk, National Academies Transportation Research Board, Workshop on Pervasive Data for Transportation: Innovations in Distributed and Mobile Information Discovery in ITS and LBS January 23rd, 2011, Washington D.C.
- Invited talk, An NSF/ARO Specialist Meeting on Spatio-Temporal Constraints on Social Networks, December 13th-14th, 2010, Santa Barbara, CA.
- **Keynote speech**, Workshop on High-Performance and Distributed Geographic Information Systems, ACM SIG-Spatial, November 2nd, 2010, San Jose, CA.
- **Keynote speech**, Annual GIS Day celeberatio, University of Notre Dame, South Bend, IN, November 19th, 2010.
- **Keynote speech** on Spatial Data Mining for Environmental Sciences, 21st International Conference on Modelling and Simulation, International Association for Science and Technology for Development (IASTED), July 15 - 17, 2010, Banff, Alberta, Canada.
- NSF Workshop on Socially Coupled Systems and Informatics: Decision Making, Science & Computing in a Complex Interdependent World, July 12th-14th, Old Town Alexandria, VA.
- Taiwan Academia Sinica, Taipei, Taiwan, May 5th, 2010.
- US-Taiwan Workshop Mega-City/Mega-Disaster Reduction, US NSF & National Science Council of Taiwan, National Center for Research in Earthquake Engineering, Taipei, Taiwan, May 6th-7th, 2010.
- Dagstuhl-Seminar on Computational Transportation Science, Schloss Dagstuhl, Leibniz-Zentrum for Informatik, Wadern, Germany, March 22nd-26th, 2010.
- International Workshop on Space-Time Modeling and Analysis, Environmental Systems Research Institute (GIS Week), Redlands, CA, February 22nd-23th, 2010.
- **Keynote Speech**, Indo-US Science & Technology Forum (IUSSTF) eorkshop on Geospatial Information for Developing Countries, Indian Institute of Technology, Bombay, India, December 16th-18th, 2009.
- **Keynote Speech**, Joint Smarter Planet University Research Day, IBM T.J. Watson Research Center, Yorktown Heights, NY, November 20th, 2009.
- DHS S&T Workshop on Emergency Management: Incident, Resource, and Supply Chain Management (EMWS09), University of California, Irvine, Center for Emergency Response Technologies, November 5-6, 2009.
- 19th Annual Minnesota Conference on Geographic Information Systems, Duluth Entertainment Convention Center (DECC), Duluth, Minnesota, October 21-23, 2009.
- NSF Next-Generation Data Mining Summit: Dealing with the Energy Crisis, Greenhouse Emissions, and Transportation Challenges, Columbia, MD, USA, October 1st-3rd, 2009.
- Bi-annual International Symposium on Spatial and Temporal Databases, Aalborg, Denmark, July, 2009.
- **Annual Dangermond Distinguished Lecture**, University of California, Santa Barabara, May 28th, 2009.
- Geospatial Technology Working Group, Mapping and Analysis for Public Safety, National Institue of Justice, U.S. Department of Justice, Annapolis, MD, April 16th, 2009.
- Innovision, National GeospatialIntelligence Agency (Reston, VA), Washington D.C., March 18th, 2009.
- Panel on GIScience and Computational Transportation Science, University Consortium on GIS, Winter Assembly, Jefferson Building (Library of Congress), Washington D.C., February 5th, 2009.
- **Keynote Speech**, Geospatial Science Forum (www.mapworldforum.org/2009/conference/gs.htm), Mapworld Forum, HICC Hyderabad, India February 12th13th, 2009.

- National Science Foundation Workshop on GeoSpatial and GeoTemporal Informatics, Washington D.C., January 89, 2009.
- Board on Earth Sciences and Resources, National Research Council, National Academy of Sciences Beckman Center, Irvine, CA, December 910, 2008.
- NATO NetworkofExperts Workshop Visualizing Network Dynamics, NATO Research Task Group "Visualisation Technologies for Network Analysis", QinetiQ Malvern Technology Centre, United Kingdom, 4th6h Nov. 2008.
- GIScience Journal Editors Panel, Biannual, Intl. Conference on Geographic Information Science, Salt Lake City, Utah, Sept. 2008
- Plenary Session on What have we learned? Suggestions for future IWCTS workshops? Intl. Workshop on Computational Transportation Science (IWCTS), Trinity College, Dublin, Ireland, July 2008.
- Education Plenary Session on Teaching GIScience: A Computational Perspective, University Consortium on GIS, Summer Assembly, Minneapolis, MN, June 2008.
- Informatics Workshop, Summer Institute and Science Advisory Meeting, NSFF IGERT on Sensor Science, Engineering and Informatics, University of Maine, Orono, June 2008.
- Panel on Cyberinfrastructure and Geographic Information Sciences at the "Annual Meeting of the American Association of Geographers", Boston, MA, April 2008.
- Minnesota Population Center, University of Minnesota, MN, February, 2007.
- **Keynote Speech** on "GIS in 2015" at at the "Research & New Venture Showcase: Geospatial Sciences", University of Texas, Dallas, TX, January 2008.
- Electrical Engineering and Computer Science Department, University of Tennessee, Knoxville, TN, December, 2007.
- National Geospatial Intelligence Agency, Workshop on Complicated Features, Airlie Conference Center, Virginia, Novemeber, 2007.
- NSF Workshop on Next Generation Data Mining (NGDM), Baltimore, October, 2007.
- National Geospatial Intelligence Agency PI Workshop, National Academies, Washington D.C., September, 2007.
- Transportation Research Board / Federal Highway Authority Workshop on Advanced Research in Geospatial Information Technologies for Transportation, National Academy of Science, Washington DC, September, 2007.
- China National Laboratory on Machine Perception, Center for Information Sciences, Peking/Beijing University, Beijing, China, August, 2007.
- China State Key Laboratory of Software Engineering, Wuhan University, Wuhan, China, August, 2007.
- China State Key Lab of Information Engineering in Surveying Mapping and Remote Sensing , (LIEMARS), Wuhan University, Wuhan, China, August, 2007.
- Computer Science Department, Fudan University, Shanghai, China, July, 2007.
- Spatial Database Group, Oracle Corporation, Nashua, NH, July, 2007.
- Volpe National Transportation Systems Center, USDOT Research and Innovative Technology Administration, MIT Campus, Cambridge, MA, July 2007.
- IEEE Computer Society President's Awards Banquet, Los Angeles, CA, May, 2007.
- **Keynote Speech**, NSF Workshop on Discrete Mathematical Problems in Computational Biomedicine, DIMACS Center, Rutgers University April, 2007.
- Computer Science Department, University of Houston, February, 2007.
- Workshop on Ubiquitous and Mobile Computing, National Center on Geographic Information and Analysis, January, 2007, Portland, Maine.
- **Keynote Speech** at the IEEE ICDM Workshop on Spatial and Spatiotemporal Data Mining (SSTDM), Dec. 18th, 2006, Hong Kong.

- Computer Science Department, Hong Kong University, Hong Kong, December, 2006.
- Microsoft Virtual Earth Workshop (11/3012/1, 2006), Seattle, USA.
- Panel on Model the Planet, Defense Advanced Research Projects Agency, Summer, 2006.
- Defense Advanced Research Projects Agency, Information Exploitation Office, May, 2006.
- Army Research Laboratory, Computational Science Workshop on Future Directions, June, 2006, Aberdeen, MD.
- 38th Sympoium on the interfaces of statistics, computing science, and applications (Interfaces 2006: Massive Data Sets and Streams), Pasadena, CA, May, 2006.
- 2nd Intl. Statistical Challenges in ECommerce Research Symposium, Carlson School of Management, University of Minnesota, May 2223, 2006 (http://www.misrc.umn.edu/symposia/20060522/)
- IBM T. J. Watson Research Center, NY, March, 2006.
- Panel on Evacuation Planning for Twincities Metropolitan, Minnesota Intelligent Transportation Systems Conference, March, 2006.
- Computational Research Institute, Purdue University, January, 2006.
- Oakridge National Laboratory, TN, February, 2006.
- National Research Council, National Academy of Science, Committee on Confidentiality Issues in linking GeographicallyExplicit and SelfIdentifying Data, Washington DC, December, 2005.
- **Keynote Speech**, ISPRS International Workshop on Spatial Data Mining, Middle Eastern Technical University, Ankara, Turkey, Novemeber 2005.
- **Keynote Speech**, Brazilian National GeoInformation Conference, Campos dos Jordao, Brazil, Novemeber 2005.
- Topographic Engineering Center (an Army ERDC), Alexandria, VA, October 2005.
- IEEE Fellows Local Conference, University of Minnesota, October 2005.
- **Keynote Speech**, Ninth International Symposium on Spatial and Temporal Database, Angora dos Rias, Brazil, August 2005.
- PI Workshop on Sensor Networks for Homeland Defense, Oakridge National Laboratory and Office of Naval Research, Washington D.C., July 2005.
- **Keynote Speech**, NSF Workshop on National Phenology Network, University of Nebraska, Lincoln, May 2005.
- Workshop on Voter Registration Databases for Election Assistance Commission, Computer Science and Telecommunication Boards, National Research Council, National Academies, May 2005.
- Remote Sensing Center, Boston University, Boston, March 2005.
- Topographic Engineering Center, Army Core of Engineers, Alexandria, VA, Feb. 2005.
- National Geospatial Intelligence Agency (NGA) specialist workshop on spatial web, University of California, Santa Barbara, Dec. 2004.
- **Keynote Speech**, Biannual conference on Geographic Information Science, American Association of Geographers, Washington D.C., October 2004.
- Invited speaker, INFORMS annual conference, Denver, Oct. 2004.
- Invited testimony, Minnesota Senate Election Committee, Hearing on the voter registration database for the 2004 presidential election , Aug. 2004.
- Dagstuhl Workshop on Data Warehouses, Dagstuhl, Germany, August 2004.
- Presentation to the Undersecretary for Research and Development, Department of Homeland Security, on Evacuation Planning for Homeland Security, University of Minnesota Science and Technology Day, April 2004.
- Congressional breakfast on GIS for Homeland Security, University Consortium on GIS, February 2004.

- NSA Workshop on Visualization and Mining, University Consortium of GIS, Washington D. C., Novemeber 2003.

- NSF Workshop on Next Generation Geographic Information Systems,, Boston, Novemeber 2003.
- Data Mining and Education Conference, SAS, Las Vegas, October, 2003.
- Workshop on Spatial Data Mining, Army Research Laboratory, Aberdeen, MD, August, 2003.
- Workshop on Data Mining, Army Research Laboratory, Aberdeen, MD, May, 2003.
- AHPCRC/Army Research Lab. PI Workshop on Enabling Technologies, Howard University, May 2003.
- Computer Science Department, University of Illinois, Chicago, March 2003.
- Workshop on Mining Weather Data, Army Research Laboratory, Whitesands, New Mexico, February, 2003.
- NSF workshop on Spatiotemporal Data Models for Biogeophysical Fields, San Diego Supercomputer Center, La Jolla, California, April, 2002.
- NSF Specialist Meeting on Spatial Data Analysis Software Tools, CSISS, Santa Barbara, CA, May 2002.,
- AHPCRC/Army Research Lab. PI Workshop on Enabling Technologies, Minneapolis, MN, summer 2002.
- AHPCRC/Army Research Lab. PI Workshop on Virtual Computing Environments, Florida A&M University, summer 2002.
- Invited plenary talk on spatial data mining, Annual summer assembly of University Consortium on Geographic Information Systems, Buffalo, NY, July 2001.
- University Consortium on GIS Panel on "Critiques of 2010 visions fo GIS Research: A Report from NSF Workshop" May 1999.
- National Science Foundation Workshop on Data Mining in Geographic Information Systems, March 1999.
- National Science Foundation Workshop on Integrating Vector and Rastor Geographic Information Systems, May 1999.
- National Science Foundation Workshop for PIs in Information and Data Management (IDM) Program, March 1999.
- Army Research Lab. PI Workshop, Dec. 2001.
- NASA PI Workshop for Intelligent Data Understanding program, Missoula, Montana, March 2001.
- Army Research Lab. workshop on Virtual Computing Environment, Dec. 2001.
- Army workshop on Scientific Data Mining, July 2000.
- Army workshop on Scientific Data Mining, Fall 1999.
- NASA Workshop for PIs in TerraSIP program, May 1999.
- NASA Workshop for PIs in TerraSIP program, December 1998.
- National Science Foundation Industrial/Academic Workshop on Research Directions in Databases, October 1998.
- Ministry of Science and Technology, Government of India, September 1998.
- Indian Institute of Technology, Delhi (India), September 1998.
- Indian Institute of Technology, Bombay (India), September 1998.
- University of British Columbia, Computer Engineering Dept., January 1998.
- Microsoft Research, Database Group, January 1998.
- Boeing Corporate Research, Database Group, January 1998.
- Ministry of Science and Technology, Government of India, December 1997.
- United Nations Development Program, New Delhi, December 1997.
- Pune University (India), Center for Design of Advanced Computers (CDAC) and Computer Science Dept., December 1997.
- Army Research Laboratory, Workshop on Databases and Object Orientations, July 1997.

- Purdue University, Computer Science Department, November 1997.
- Army Research Laboratory, Digital Battlefield Workshop, July 1997.
- Bell Laboratories, Database Systems Group, March 1997.
- Waterways Experimentation Station, Army Core of Engineers, February 1997.
- Army High Performance Computing Research Center, Support Scientist Workshop ,February 1997.
- Univ. of California, Berkeley, Electrical Eng. and Computer Sc., PATH Project, May 1996.
- CalTrans Center for Interoperability and National Center for Geographic Info. and Analysis (NCGIA, UCSB), March 1996.
- INFORMS Conference on Computer Sc. and Operations Research, Winter 1996.
- ACM Intl. Conf. on Geographic Info. Systems (Panel on Interoperability in GIS), December 1995.
- Environmental Systems Research Institute, Networks Group,($1B software company in GIS, founded by Harvard researchers), Winter 1995.
- Foundation Workshop on Mobile and Wireless Information Systems, October 1994.
- Georgia Institute of Technology, College of Computing, April 1994.
- University of Texas at Austin, Electrical and Computer Engineering Department, February 1994.
- Dartmouth College, School of Engineering, November 1993.
- IBM T. J. Watson Research Center, Database group, May 1993.
- Bell Atlantic, Automatic Records Systems Group, August 1993.
- Bell Laboratories, Advanced Software Group, Spring 1989.
- Bell Core, Multimedia Applications Group and Advanced Software Group, Spring 1989.
- MCC, Artificial Intelligence Group, Spring 1989.
- Andersen Consulting, Center for Strategic Research (Chicago) , Spring 1989.
- Syracuse University, Electrical and Computer Science, Spring 1989.
- George Mason University, Software Engineering group, Spring 1989.
- University of California at Berkeley, Artificial Intelligence Seminar, Spring 1989.

3 RESEARCH GRANTS

3.1 External Grants From Federal/State Agencies & Companies

- Co-P.I., Datanet: Terra Populus: A Global Population Environment Data Network National Science Foundation (NSF), $12 Million (approx.), 5/2011- 5/2016. (w/ S. Ruggles et al).
- Co-P.I., Expedition: Understanding Climate Change: A Data Driven Approach, National Science Foundation (NSF), $10 Million (approx.), 8/15/2010- 8/14/2015. (w/ V. Kumar et al).
- Co-P.I., Discovery of synoptic patterns of climate variability and change using data mining and high performance computing, Civilian Research & Development Foundation 2009 Cooperative Grants Program (CGP 2009): Climate change and energy competition, US Department of State, $94,000, 2010. (with Prof. Gennadiy Averin, Donetsk National Technical University, Donetsk, 83001, Ukraine).
- P.I., Spatial and Spatio-temporal Data Mining for Smarter Planet, IBM. Faculty Award, IBM Global University Relations and Innovation Programs, $20,000 (unrestricted gift), 2009-2010.
- Co-P.I., Indo-US Science & Technology Forum, Workshop on Geospatial information for Developing Countries : Science & Technology (IUSSTF/WS/54-2009), $25,000 (approx), (With Prof. N. L. Sarda, Indian Institute of Technology, Bombay, India).
- P.I., Dynamic Purpose-Aware Graph Models for Composite Networks, $750,000, US Department of Defense (HM1582-08-1-0017), Aug. 14th, 2008 - Aug. 13th, 2013.
- P.I., Spatio-Temporal Pattern Mining for Multi-Jurisdiction Multi-Temporal Activity Datasets, $600,000, US Department of Defense (HM1582-07-1-2035), Aug. 14, 2007 - Dec. 31st, 2012. (w/ L. Khan, U. T. Dallas).
- P.I., IGERT: Non-equilibrium Dynamics Across Space and Time: A Common Approach for Engineers, Earth Scientists and Ecologists, $2,819,194 (approx), National Science Foundation (**NSF**), DGE-0504195, Sept. 2008 - September 2012 (PI-role), Aug. 2005 - September 2012 (w/ C. Paola, M. Hondzo, R. Hozalski, J. Finlay and C. Neuhauser).
- P.I., III-CXT: Spatio-temporal Graph Databases for Transportation Science, $449,993 (approx), National Science Foundation (**NSF**), IIS-0713214, Aug. 2007 - September 2012. (w/ H. Liu)
- P.I., USDOD Army Corps of Engineers (Topographic Engineering Center W9132V-09-C-0009), Cascase Models for Multi-Scale Spatio-temporal Pattern Discovery, $150,000, 02/03/09 - 07/31/12.
- Co-P.I., CRI:IAD Infrastructure for Research in Spatio-Temporal and Context-Aware Systems and Applications, $140,403, National Science Foundation (**NSF**), CNS-0708604, July 2007 - June 2011. (w/ A. Tripathi, M. Mokbel).
- P.I., Spatial Database Research for Mapping and Analysis for Public Safety, $100,000 (unrestricted gift), Ned Levine & Associates, 2006-2009.
- P.I., Modeling and Mining Spatio-temporal Data, USDOD Army Corps of Engineers, $111,000, 03/15/06 - 09/30/08.
- P.I., Army High Performance Computing Research Center (AHPCRC), $5,000,000 (approx.), Army Research Lab. and Network Computing Services, Jan. 2006 - Jan. 2007.
- P.I., Discovering perosnal gazetteers from travel histories (GPS tracks), $40,000 (unrestricted gift), Microsoft Mappoint Research Program, 2005-2006.
- P.I., Spatio-temporal data analysis techniques for behavioural ecology, $576,395, National Science Foundation (**NSF**), September 2004 - August 2007. (w/ J. Srivastava, A. Pusey).
- P.I., Spatio-temporal data mining for sensor networks, $200,000, Oakridge National Laboratory, Department of Energy (DOE), June 2005 - June 2008.
- P.I., High Performance Spatial Data Mining, $100,000, Army Research Lab. (AHPCRC), Jan. 2005 - Jan 2006.
- P.I., Evacuation Planning Software for Twin Cities Metro Area Scenario, $53,011, Minnesota Department of Transportation, February 4th, 2005 to November 30th, 2005.

- co-P.I., Planning for full-scale CLEANER: Options for field facilities and cyberinfrastructure in America's heartland, $69,960, National Science Foundation (**NSF**), August 2004 - July 2006. (w. M. Hondzo et al).
- P.I., Decision Support System for Evacuation Planning, $60,000, Federal Highway Authority (FHWA), August 2004 - November 2005.
- Co-P.I., Complexity of Spatial and Categorical Scale in Land Use Classification, $535,914, National Science Foundation (**NSF**), July 2003 - June 2006. (w/ S. Gopal, Boston U).
- P.I., Evacuation Planning for Homeland Security, $120,000, Army Research Lab. (AHPCRC), Jan. 2004 - Jan 2005.
- P.I., Capacity constrained route planning and Parallelizing Spatial Autoregression, $90,000, Army Research Lab. (AHPCRC), Jan. 2003 - Jan 2004.
- Co-PI, Being There: Mobile Devices for Community and Commerce $120,000, National Science Foundation (**NSF**) EIA-0224392, 2002-2004, with L. Terveen et al. (CISE Research Resource).
- Co-P.I., Discovery of Changes from the Global Carbon Cycle and Climate, **NASA** (Ames Research Center), $525,091.00 , March 2001 - February 2004.
- Co- P.I., Map accuracy assessment for A New Approach to Assessing Road User Charges, $250,000, Department of Transportation from 10 states, April 2001 - June 2003. (w/ M. Donath et al).
- P.I., Research in Virtual Computing Environment, $90,000, Army Research Lab. (AHPCRC), Sept. 2001 - August 2002.
- P.I., Research in Mining Geo-spatial Datasets, $190,000, Army Research Lab. (AHPCRC), Jan. 2000 - Jan. 2001.
- P.I., High Performance Spatial Visualization of Traffic Data, $122,929, USDOT (ITS Inst.), 1/2000 - 2/2001.
- Co-PI, Cluster Computing for Mining Diverse Datasets, $74,000, National Science Foundation (**NSF**), 2000-2001, with G. Karypis et al. (shared equipment grant).
- Co-PI, Research in Networked Information Systems, $97,000, National Science Foundation (**NSF**), Jan. 1999 - Dec. 2001, with A. Tripathi et al. (shared equipment grant).
- Co-PI, Precision Agriculture Center, $3,840,000, U. S. Department of Agriculture, 2000-2003, with R. Pierre et al. (CS share is $50,000)
- Co-PI, A New Approach to Assessing Road User Charges $770,000, U of Minn share is $350,000, Federal Highway Administration and the states of California, Illinois, Indiana, Iowa, Michigan, Minnesota, Nevada, S. Dakota, Texas, and Wisconsin, July 1999 - December 2001, with M. Donath et al. (Our share is about $100,000).
- Co-P.I., Institutionalizing MTPE Data for Land and Environment Management, $1,334,552 National Aeronautics and Space Agency (**NASA**), 9/1997- 8/2001. with T. Burke et al. (Our share is about $100,000).
- P.I., Databases for Spatial Graph Management, $103,647, National Science Foundation (**NSF**), 8/1996-7/99.
- P.I., Research in High Performance Geographic Information Systems, $80,000, Army Research Lab. / AHPCRC, Jan. 1999 - Jan. 2000.
- Co-P.I., Research in Enabling Technologies for High Performance Computing, $248,000, Army Research Lab. / AHPCRC, with Prof. G. Karypis and Prof. V. Kumar, Jan 98 -Jan 99 (Our share was $80,000).
- P.I., Archival of Traffic Data (phase II), $100,000, Federal Highway Authority (FHWA), 1997-98.
- Co-P.I., Enabling Technologies: High Performance Geographic Information Systems, $263,432, Army Research Lab. / AHPCRC, with Prof. V. Kumar, Jan. 97 - Jan. 98 (our share was $80,000).
- P.I., Evaluation of Seven County Twincities Roadmap, $59,591, U.S. Dept. of Transportation, 3/16/96-3/15/97.
- P.I., Archival of Traffic Data From TMC, $100,000, Federal Highway Authority (FHWA), 1995-97.

- P.I., High Performance Geographic Information Systems for DIS, about $90,000, Army Research Lab. / AHPCRC, with Prof. V. Kumar, Jan. 94- Jan. 97 (Our share was $50,000).
- P.I., High Performance Neural Network (Technology Transfer), Army Research Lab. / AHPCRC, with Prof. V. Kumar, 1994 (Our share was about $30,000).
- P.I., Application of GLMX to updating digital roadmaps for the Intellegent Vehicle Highway Systems, $30,000 support for one graduate student for 1 year (Industrial Affiliates Program), with Prof. D. Du, Computing Devices International, 1993-94.
- P.I., Traffic Data Management For Advanced Driver Information Systems, $43,000 from Federal Highway Authority (FHWA), 1993-94.
- P.I., Multimedia Information Presentation in Smart Cars and Highways, $43,000 from Federal Highway Authority (FHWA), 1993-94.
- P.I., Evaluation of Data Management Architecture For Advanced Traveler Information Systems, $20,000 from Federal Highway Authority (FHWA), 1993-94.
- P.I., Trace-driven Driving Simulation, $43,000 from Minnesota Dept. of Transportation, 1992-93.
- P.I., Program Visualization Environment, $6,000 equipment grant from MinnNeXT project, NeXT Corporation, 1991-92.
- P.I., Emulation of an External Laboratory in Driving Simulator, $43,000 from the Center for Transportation Studies, 1991-92.
- P.I., Data Management for Driving Simulation, Collision Detection and Incident Detection, $45,000 from Minnesota Dept. of Transportation, 1991-92.
- Co-P.I., Human Factors in Highway Signage, with P. Hancock, $45,000 from Minnesota Dept. of Transportation, 1991-92 (Our share was about $10,000).
- Co-P.I., An Incidence Detection Expert System, with Y. Stephanades. (The Computer Science share was $10,000.) $45,000 from the Center for Transportation Studies 1990-1991 (Our share was $10,000).
- Co-P.I., Information Presentation in Vehicles, with P. Hancock (The Computer Science share was support for one graduate student, one undergraduate student and $7,667.) $50,000 from the Center for Transportation Studies in 1990-1991.

3.2 Internal Grants

- $2.5 M, U-Spatial (Co-PI with F. Harvey et al.), 2012-2017, Office of Vice President of Research - Infrastructure Investment Initiative (two thirds with one-third from participants).
- $25,000, Minnesota Futures (Phase I: Symposium Grant), Office of Vice President of Research 2008-2009.
- $100,000, McKnight Distinguished University Professorship, 2005-2010.
- P.I., Indoor navigation system for visually impaired, $29,000, Digital Technology Center, July 2005 - June 2006.
- Co-P.I., A digital library to archive research material from Jane Goodall's Gombe chimpanzee project, $27,924, Digital Technology Center, July 2004 - June 2005.
- P.I., Exploring Policy Implications of Traffic Management Center Data, $40,000 from Center for Urban and Regional Affairs, Summer 98 - Summer 1999.
- $10,000, In eight Undergraduate Research Opportunity Program Awards and a CTS Undergraduate Research Assistants Program Award from 1990-present for J. Mitchell, M. Kalantar, A. Fetterer, P. Khandelwal, Hsiang Wu, M. Coyle, B. Amin, and Y. Hooshmand.
- $9000 from the Graduate School in 1992-1993, Geographical Data Management
- $8000 from the Graduate School in 1991-1992, Real Time Search Algorithms.
- $8000 from the Graduate School in 1990-1991, Cooperating Expert Systems.
- Summer Support (1 month) from the Graduate School for 1991, Neural Networks for Generalization.

4 TEACHING ACTIVITIES (2007-2010)

4.1 Material Available via Department

This writeup does not include the information available via the department. These include the following

- **Student Evaluation:** Department has a summary sheet of student evaluations for courses. The median score for question 1 in SRT evaluations were **6 out of 6** for Fall 2008 (Csci 4707), Spring 2009 (Csci 4707), Fall 2009 (Csci 4707), Spring 2010 (Csci 5708, Csci 8715), Fall 2010 (Csci 2010), Spring 2011 (Csci 5708) and Fall 2011 (Csci 8715, Csci 5707).
- **Classroom Innovations:** I regularly attend workshops on techniques to engage students, try ideas and monitor student reaction to those. I have found some of the ideas quite suitable for my courses. These include database/GIS news presentation, active group learning, review quizzes, observational laboratories. The peer evaluation report from Spring 2011 highlights many of these ideas. Thus, this report will not detail those.
- **Peer Evaluation of my teaching:** A peer evaluation was performed in Spring 2011. The letter is available from the Department.
- **Evaluation of Peer Teaching:** I visited the classroom of a peer faculty members and provided a teaching evaluation in Spring 2011. The report is available from the Department.

4.2 Books, Encyclopedias, Survey Papers, Book Chapters, Encyclopedia Articles

- S. Shekhar and H. Xiong (ed.). Encyclopedia of GIS, Spring Verlag, 2008, 1377 pages, isbn 038730858X.

  In the post-Google Earth era, demand of GIS knowledge has increased tremendously. Yet, sources like wikipedia provide scant information on this emerging technology. Thus, we worked with hundreds of GIS researcher to develop an encyclopedia with 230 wikipedia-style articles (with richer illustrations) for general audience.

  We are proud to share that the Encyclopedia has been received well. It was highly recommended by ACM Computing Reviews (Nov., 2008) for Computer Science students (at all levels) and researchers. It was also selected Choice Reviews (July, 2008) to be included in their annual list of most influential technical books to be acquired by for all academic libraries. As a result, it is available in print and electronic form in thousands of college libraries around the world. Google books (books.google.com) also has made a large fraction of article available on the world-wide-web.
- S. Shekhar and R. Vatsavai et al. Trends in Spatial Data Mining, *Data Mining: Next Generation Challenges and Future Directions (Ed. H. Kargupta, J. Han, P. Yu, R. Motwani, V. Kumar)* , Chapman Hall / CRC, Oct. 2008, ISBN: 1420085867, 2nd Edition. National Science Foundation holds periodic workshops on assess trends and directions. Our group is often invited to present its assessment in the sub-area of spatial data mining. We scan many journals and conference proceedings to create an extensive bibliography of papers investigating spatial and spatio-temporal data mining. We summarize the major ideas in a presentation at the workshop and receive comments. This paper summarizes our findings refined by the feedback at the workshop. This paper is becoming a key sources for graduate students and researchers working on spatial data mining all over the world.
- S. Shekhar and J. M. Kang. Spatial Databases, *Encyclopedia of Computer Science and Engineering (Ed. Benjamin Wah)*, John Wiley and Sons Inc, 2009, isbn 978-0471383932. This book chapter is an updated version of our 1999 survey paper in IEEE Transactions on Knowledge and Data Engineering. That survey paper is widely used in graduate courses on spatial databases, geographic information systems. Since then, the field has had significant developments such as spatial data mining, Google Earth, etc. Thus, we dedicated a significant amount of time to update the survey of spatial database research and practice.
- S. Shekhar, J. Kang, and V. Gandhi, Spatial Data Mining (Field Editor: D. Papadias), *Encyclopedia of Database Systems (EICs: T. Ozsu, L. Liu)*, Springer Publishers, 2009, isbn 978-0387355443.

- B. George and S. Shekhar, Spatial Network Databases (Field Ed.: R. Guting), *Encyclopedia of Database Systems (EICs: T. Ozsu, L. Liu)*, Springer Publishers, 2009, isbn 978-038 7355443.
- B. George and S. Shekhar, Time Aggregated Graphs (Field Ed.: R. Guting), *Encyclopedia of Database Systems (EICs: T. Ozsu, L. Liu)*, Springer Publishers, 2009, isbn 978-038735 5443.

4.3 Creation of a new undergraduate course

In post Google-Earth era, the demand for geographic information science is increasing dramatically in government, industry and academia. Recently, U.S. Bureau of Labor Statistics listed GIS among top three areas of job-growth [5]. Thus, we have started efforts to create an undergraduate course on computational Geoinformatics. In Fall 2010, I designed and taught such a course (Csci 5980: Computational Geoinformatics). Guest lecturers included Prof. Mokbel, Prof. Terveen, and Prof. Srivastava. I reviewed other GIS courses at the University and elsewhere to shape the content. I spent a significant amount of time designing lectures, projects, home-works, laboratories, and examinations.

Despite being offered the first time, the course attracted about 20 students from computer science, security technologies, geography, epidemiology, etc. All students read a 300-page monograph titled *GIS: A Computing Approach, M. Worboys, CRC Press, 2004* and articles from Encyclopedia of GIS (S. Shekhar and H. Xiong (Ed.), Springer, 2008). They completed four home-works, which included questions on the material from the monograph and hands-on laboratories on Oracle Spatial software. Students read and presented articles from Encyclopedia of GIS. Finally, they worked on individual projects of their choice exploring topics such as from location-determination for web-browsers for banking-fraud detection, study of volunteer motivation in OpenStreetMaps (a high-profile crowd-sourced mapping organization), etc. Results from the latter project were selected for presentation at 2011 Redlands GIS week workshop on VGI and Emergency Management. Another is in process of submission to Intl. Symposium on Spatial and Temporal Databases (2011).

I look forward to next offering of this course towards creating a regular course which may be taught by Prof. Mokbel, Prof. Terveen, myself or other interested faculty members.

4.4 Tutorials in Conferences

- Tutorial on Spatial Data Mining (with V. Bogorny), IEEE International Conference on Data Mining, December 2010.
- Tutorial on Spatial and Spatio-temporal Data Mining (with V. Bogorny), 23rd Brazilian Symposium on Databases, 2008.
- Tutorial on Spatial and Spatio-temporal Data Mining, Annual Retreat of NSF IGERT on Sensor Science, Engineering and Informatics, University of Maine, 2008.
- Tutorial on Spatial Database Management Systems, Annual Meetings of Minnesota LIS/GIS, Fall 2008, Fall 2009.

4.5 Guest Lectures in UMN Courses and Events

- Spring 2012, Guest Speaker on Location Privacy, Department of Homeland Security and University of Minnesota, Cybersecurity Awareness Sessions, April 19, 2012.
- Spring 2011, Exploring Business Plans for Evacuation Planning Software, group Project for five students (T. J. Mattai, Jared Oeth, Andrew Oppeneer, David J Stratioti, Danielle M Gerber), Entrepreneurship Class (MGMT 4080: Applied Technology Entrepreneurship, Instructor: Dr. John Stavig), Gary S. Holmes Center for Enterpreneurship, Carlson School of Business, University of Minnesota.
- Fall 2009, 2010, 2011, Guest lecture on Spatial Data Mining: An Introduction, Masters in Geographic Information Systems Program, Department of Geography, College of Liberal Arts, University of Minnesota.

[5] Mapping Opportunities, Nature, 427, 22nd January 2004

- Fall 2010, Guest lecture on Evacuation Route Planning, GEOG 3521: Digital Planet (Instructor: Prof. Francis Harvey), Department of Geography, College of Liberal Arts, University of Minnesota.
- Summer 2010, 2011 and 2012, Guest lecture on Geographic Information Systems in Homeland Security, MSST 8330: Critical Infrastrcture Protection, Masters of Science in Security Technologies Program, Technological Leadership Institute, College of Science and Engineering, University of Minnesota.

4.6 Interdisciplinary Undergraduate Minor

I was part of the team, which successfully proposed and got approval for a minor in Geographic Information Science for all undergraduates at the University of Minnesota. The team was led was Prof. Steve Manson in the Geography department. I led a successful proposal to the Minnesota Futures initiative from the Office of Vice-President of Research. This grant facilitated a workshop to explore spatio-temporal future for GeoInformatics to bring together almost 50 researchers across 5 colleges and a dozen different departments.

4.7 Interdisciplinary Graduate Training

During 2005-present, I have participated actively in the *NSF/IGERT: Non-Equilibrium Dyamics Across Space and Time: A Common Approach for Engineers, Earth Scientists and Ecologists*. Since 2008, I have shouldered the responsibility of managing the program with 18 graduate students and two dozens faculty members. Highlights include

- **Poster Judge at NSF IGERT PI Workshop (2010, 2011):** I served as a judge for graduate student posters funded under the NSF IGERT program in the area of computational and environmental sciences. A key responsibility was to provide constructive feedback to encourage students to address societally important problems in an objective and transparent way using scientific methods. Each judge was asked to evaluate 11-14 trainee posters, evaluating the trainee's oral presentation for content and delivery, as well as the poster itself. The trainee's poster and the presentation were expected to be geared towards explaining their research to a non-specialist audience. The poster with the highest score in each group was awarded a usd 3,000 travel supplement - there are 10 groups and therefore 10 winners out of hundreds of posters.
- **Guest lectures** on spatial data mining, 2005, 2006, 2007, 2008. The main challenge was to explain computer science ideas to an interdisciplinary audience. Preparation of such a lecture forced me to think about my field from perspective of other disciplines. Since many folks outside perceive computer science to be computer programming, I used following set of analogies to explain the difference: land-surveying instrument and geometry, driving automobiles and Mechanical Engineering, programming vcr/televisions and Electrical Engineering, etc. Students enjoyed a discussion about boundaries of computing in terms of decidable and undecidable problems. The undecidable problems led to a discussion on artificial intelligence (i.e. try to compute as well as a human, e.g. Watson and Deep Blue), social-computational systems (i.e. assist humans instead of full automation) and software engineering (i.e. address specific use-cases, get early user buy-in, testing, etc.). Decidable problems led to computational complexity classes ranging from constant time, logarithmic time, linear time, polynomial time and exponential time. Students also enjoyed tit-bits about President Obama being quizzed at Google about best sorting algorithm as well as a large award associated with open problems such as P = NP ? Finally, I introduced the broad role of Computer Science as new tools and methodologies for all sciences. This included the discussion of computational simulations (e.g. third leg of science) as well as data-intensive fourth paradigms (e.g. data mining, knowledge discovery, visual analytics). Finally, I also mentioned critical computational systems (e.g. financial transaction processing, air-traffic control, process-control, etc.) and the societal vulnerability (e.g. Y2K).
- **Career panels:** Career panels in 2009 and 2010 included a set of speakers from industry and government to help students assess their interest in potential employment avenues.
- **Outreach events:** In 2008, One cohort taught elementary school students about watersheds and careers in science as part of our outreach efforts. It was an invaluable experience. The students were excited to learn about collaboration across scientific disciplines. In 2009, two cohorts built and staffed

a science-themed 'ice shanty' for a local winter festival. We engaged the public in interdisciplinary exploration of the local environment to increase awareness of the complexity and value of MN's lakes. In 2010, cohorts participated in the Twin-cities Regional Science Fair to judge papers from middle- and high-school students. They also presented a poster at a fair for outreach to Twin-cities high school students.

- **Ethics Seminars:** We organized annual ethics seminars. In 2009, the semi Nat included new ways to stimulate discussion to bring the concept of conducting ethical science closer to home. The trainees were asked to anonymously submit scenarios in which they were involved or knew about where professional and scientific ethics came into question. These scenarios were anomalously submitted to a panel of faculty (Sarah Hobbie-Ecology, Evolution and Behavior) and conflict resolution professionals (Josh Casper-Student Conflict Resolution Center) who then expressed their opinions on how each ethical dilemma should have been resolved.
- **Annual Retreat:** At the 2009 annual fall retreat held at Saint Anthony Falls Laboratory, the 2008 cohort (Corey Markfort-Civil Engineering, Ryan Littlewood-Geology, Patrick McNamara-Civil Engineering, Casey Godwin-Ecology, Mike Evans-Computer Science) presented the initial findings of their interdisciplinary research project to IGERT faculty and trainees. The presentation, Probability Based Model of Methane Production in Lakes, was very well received by the audience and the trainees were rewarded with insightful feedback that was interdisciplinary in nature. This exchange of interdisciplinary ideas provided a springboard for the 2008 cohort to move forward with their research.
- Field-trip to Itasca Biological Station, 2009. This included a set of presentations from students and faculty members, experiments to collect water quality data via Hydrolab sensors, use of spatial data mining to analyze the data.

5 GRADUATE STUDENTS, VISITORS, etc.

5.1 Faculty, Postgraduate and Graduate Visitors

1. Prof. Bashkov Evgeniy Aleksandrovich (Vice Rector, R&D) and Prof. Gennadiy Averin (Head, Computer Monitoring Department) from Donetsk National Technical University, Ukraine, visited in January 2011 for two weeks to collaborate on a joint grant on understanding climate change from US Department of State.
2. Prof. Rafal Angryk from Computer Science Faculty, MOntana State University if planning to visit in Fall 2012 to collaborate on a survey of spatio-temporal database literature.
3. Ravdeep Gill from Indian Institute of Technology, Kharagpur, visited in summer 2012 for undergraduate research experience.
4. Ayman Taha, a Ph.D. scholar at Cairo university, Egypt, visited on a fellowship of Egyptian government from Sept., 2011 to May 2011.
5. Abdulvahit Torun from Middle Eastern Technical University (Ankara, Turkey) visited our group from September 14th, 2009 to June 13th, 2010 on a scholarship from TUBITAK (Research Council of Turkey) to collaborate on Spatio-temporal Knowledge Support for Spatial Situation Awareness. He is the Chief of Remote Sensing Branch, General Command of Mapping, Photogrammetry Dept., Ankara, Turkey.
6. Zhanqan Wang, a China Scholarship Council (CSC) scholar, is visiting our group from Fall 2009 to Summer 2010 to collaborate on spatial data mining. He is associate professor of Computer Sc. & Eng. at East China University of Science and Technology, Shanghai, China.
7. Pronab Mohanty, a Humphrey Fellow (U S Dept. of State), is visited our group in Spring 2009 to collaborate on spatial data mining for public safety and security. He is with the Indian Police Service (Banglore, India).
8. Prof. Prabhat Ranjan visted our group for a month in summer 2008 and for a week in summer 2009 to explore collaboration on india center initiative at the University of Minnesota. He heads the Embedded Systems and Sensor Networks research group at the D. Ambani Institute of Information & Communication Technology (intranet.daiict.ac.in), India. His projects include detection of water on the Moon (a part of indian lunar mission, Chandrayaan-2), tracking and preserving wildlife, detection of forest fires, etc.
9. Prof. Sungwon Jung spent a large part of his sabbatical with our group in Fall 2007 and Spring 2008 to collaborate on spatio-temporal databases and query processing. He is with Department of Computer Science, Sogang University, Seoul, Republic of Korea.
10. Prof. Christopher Eick visted our group for a month in two summers (2008, 2006) to explore collaboration on spatial data mining. He is affiliated with the Computer Science faculty at the University of Houston.
11. Dr. (Ms.) Vania Bogorny visited our group during the 2004-5 academic year. She was supported by a government fellowship for the federal government of **Brazil**. She is currently a research fellow (PRODOC/CAPES) at Instituto de Informatica da UFRGS/Brazil.
12. Mete Celik visited our group from Fall 2002 to Summer 2007. He was supported by a NATO fellowship from the governement of **Turkey**. He joined the Computer Eng. faculty at the Erciyes University, Turkey.
13. Dr. Sanjay Chawla worked as a post-doctoral fellow with our group from Fall 1997 to Summer 2000 in the Army High Performance Computing Research Center. He is currently the chair of the Department of Computer Science at the University of Sydney, **Australia**.
14. Prof. B. Y. Hwang visited for his sabbatical year in 1999 from the Department of Computer Science, The Catholic University of Korea, Seoul 121250, **Korea**.
15. Prof. Hemlata Diwakar visited on a **United Nations fellowhip** during Fall 1997 from the Faculty of Computer Science, University of Pune, India.

16. Prof. F. Polat visited on a N.A.T.O. fellowship from Fall 1992 to Spring 1993 from Bilkent University, **Turkey**. He is with the Computer Eng. faculty of the Middle East Technical University (METU), Ankara, Turkey.
17. Prof. I. Singh visited on **a Fullbright fellowhip** during from Fall 1991 to Spring 1992 from the National Inst. of Tech., India.
18. Hosted colloquium and workshop speakers included

    - Prof. Bharat Bhargava (Purdue University)
    - Prof. Mor Namaan (Rutgers University)
    - Prof. Werner Kuhn (Institute of Geoinformatics University of Muenster, Germany)
    - Sumit Sen, Indian Institute of Technology, Bombay, India.
    - Prof. Paul Torrens (Arizona State University)
    - Prof. Michael Goodchild (U. C. Santa Barbara and a NAS member),
    - Prof. May Yuan (Assoc. Dean, U. Oklahoma),
    - Dr. Kentaro Toyama (Microsoft Research),
    - Prof. Michael Worboys (University of Maine, NCGIA),
    - Jack Dangermond (President, ESRI),
    - Prof. Hanan Samet (University of Maryland),
    - Prof. Benjamin Wah (Univ. of Illinois, Urbana-Champaign),
    - Prof. Sham Navathe (Georgia Tech.),
    - Prof. K. Y. Whang (KAIST, Korea), etc.
    - Prof. Bruce Berra (Syracuse U), etc.
    - Prof. Arif Ghafoor (Purdue U), etc.
    - Dr. Eric Hoel (ESRI Geodatabase lead),
    - Dr. Budhendra Bhaduri (OakRidge National Lab., GIS lead),
    - Dr. Tim McGrath (Microsoft Mappoint lead),
    - Dr. Bhavani Thuraisingham (NSF, UT Dallas),
    - Dr. Jim Shine (Topographic Engineering Center, Engineering Research and Development Center, Army Core of Engineers)
    - Dr. Ratko Orlandic (Illinois Inst. of Tech.), etc.

5.2 List of Ph. D. Students (19 graduated, 8 current)

1. Prof. Andrew Yang GRADUATED with a Ph.D. in January 1993. He completed a thesis titled "Spatial Data Management for Motion Processing". He is currently with the Computer Sc. faculty, University of Houston (Clear lake). He was previously with University of Conneticut.
2. Prof. Babak Hamidzadeh GRADUATED with a Ph.D. in July 1993. He is currently with Boeing Research. He was previously an Associate Professor of Computer Engineering at the University of British Columbia. Babak completed a thesis titled "Dynamic Scheduling Of Real Time Tasks: A Graph Theoretic Approach". He was selected to be the *program chair* for the IEEE International Conference on Tools with AI, 2000.
3. Prof. Du-Ren Liu GRADUATED with a Ph.D. in July 1995. He is currently with the faculty of Inst. of Info. Management at National Chiao Tung University in Taiwan. His thesis focused on the design and evaluation of geographic databases to support network computations for transportation networks.
4. Dr. Mark Coyle GRADUATED with a Ph.D. in March 1996. He is currently with Siebel Systems. He was previously with the kernel group at Oracle Corporation and rose to the rank of Vice President. His thesis focused on declustering methods for parallel databases for geographic applications. He is now a Senior Vice President with Appirio, a cloud computing company.
5. Dr. Siva Ravada GRADUATED with a Ph.D. in June 1997. He is a technical lead in the Spatial Data Product Division at Oracle Corporation. His thesis focused on high performance parallel formulation of the range query and spatial join problems in spatial databases. He was selected to be the *program chair* for the ACM International Conference on Geographic Information Systems, 2000.

6. Dr. Ms. Xuan Liu GRADUATED with a Ph.D. in August 2000 and joined IBM T. J. Watson Research Center. Her thesis focused on the modelling and processing of direction predicates for spatial query languages. The pioneering nature of her work was recognized by peer scholars via a best paper award.
7. Prof. C. T. Lu GRADUATED with a Ph.D. in Spring 2002. His thesis focussed on algorithms for spatial data analysis focussing on problems of spatial outlier detection and join index processing. He is a tenured Computer Science faculty member with Virginia Polytechnic University.
8. Prof. Ms. Wei Li Wu GRADUATED with a Ph.D. in Spring 2002. Her thesis focussed on modeling spatial dependence in location prediction problem for geospatial data mining. She is a tenured Computer Science faculty member with the University of Texas at Dallas.
9. Prof. Ms. Huang Yan GRADUATED with a Ph.D. in Spring 2003. Her thesis developed new techniques for mining co-location patterns in spatio temporal datasets. She joined the faculty of Computer Science at University of North Texas.
10. Dr. Pusheng Zhang GRADUATED with a Ph.D. in Summer 2005 and joined Microsoft Mappoint group. His thesis focussed on the problem of efficient indexing methods and query processing strategies for correlation based selection and join over spatial time-series datasets in context of climate modelling applications with Earth Science researchers from NASA. He was awarded a doctoral dissertation fellowship from the University of Minnesota in a university wide competition. He was co-advised by Prof. V. Kumar.
11. Prof. Hui Xiong GRADUATED with a Ph.D. in summer 2005 and joined the faculty of Rutgers University. His thesis explored the problem of identifying correlated item pairs from a large collection of items and transactions. He was co-advised by Prof. V. Kumar. He is now a associate head of the Management Science and Information Systems department at the Rutgers University.
12. Dr. Baris Kazar GRADUATED with a Ph.D. in summer 2005 and joined the Spatial Database group at Oracle corporation. His thesis explores computationally-efficient parameter-estimation methods for the spatial autoregression model. He joined Oracle corporation (Spatial group).
13. Dr. Qing Song Lu GRADUATED with a Ph.D. in Winter 2006 and joined the Microsoft Mappoint group. His thesis developed novel capacity constrained routing algorithms for identifying evacuation routes to minimize evacuation time for homeland security applications. The societal impact of his work was recognized by the CTS partnership award (2006). He joined Microsoft (Virtual Earth group).
14. Dr. Vatsai Ranga Raju GRADUATED with a Ph.D. in Summer 2006. His thesis explored semi-supervised methods for producing land-use classification maps from satellite imagery with very limited ground truth information. He is currently with Oakridge National Laboratory (ORNL) and earlier worked with IBM India.
15. Prof. Ms. Jin Soung Yoo GRADUATED with a Ph.D. in Spring 2007. Her thesis explored spatio-temporal data mining problems. Earlier she explored the nearest neighbor problem in context of open location based services. The pioneering nature of her work was recognized by peer scholars via a best paper award. She joined faculty of Computer Science at Indiana University - Purdue University.
16. Dr. Sangho Kim GRADUATED with a Ph.D. in Spring 2007. His thesis explored large scale flow network algorithms for contra-flow aware evacuation route planning. The societal impact of his work was recognized by the CTS partnership award (2006). He joined the Geo-database group at the Environment Systems Research Institute.
17. Prof. Mete Celik GRADUATED with a Ph.D. in Spring 2008. His thesis investigated scalable methods to quantify and discover the mixed-drove co-occurrence patterns to identify subsets of vehicle-types which often move together given a spatio-temporal datasets describing vehicle trajectories. He also worked closely with Jane Goodall Institute. He joined the Computer Engineering faculty of the Erciyes University, Turkey.
18. Dr. Ms. Betsy George GRADUATED with a Ph.D. in Spring 2008. Her thesis noted that well-known shortest-path algorithms (e.g. A*, Dijktra's) assumed stationary ranking of alternative routes. This assumption is not true due to change in travel time due to rush hours, HOV/Toll lanes, congestions, intersection-control traffic-signals, etc. She proposed new data structures (e.g. time-aggregated graphs) and algorithms to address these challenges. The path-breaking nature of her work was recognized by peer scholars via multiple best paper awards. She joined the Oracle Spatial group in Oracle corporation.

19. Dr. James Kang GRADUATED with a Ph.D. in Summer 2010. His thesis explored spatio-temporal data mining problems, e.g. flow-anomaly detection from sensor data-streams, in context of environmental science application such as water quality monitoring. Earlier he worked on reverse nearest neighbor queries. He joined Innovision research group at the USDOD National Geospatial-Intelligence Agency.
20. Dr. Xiaobin Ma GRADUATED with a Ph.D. in Spring 2012. His thesis explored the problem of Multi-type Nearest Neighbor Queries in context of location based services and mobile commerce. He is with Oracle Corporation. He was previously with Terradata Corporation.
21. Dr. Pradeep Mohan GRADUATED with a Ph.D. in Summer 2012. His thesis spatio-temporal cascade pattern mining and spatial hot-spot analysis in context of mapping and analysis for public safety. He joined SAS Corporation, a leading software company in the area of data mining and statistics.
22. Mr. Michael Robert Evans passed oral preliminary examination in Spring 2009. He joined spatial database research group in Fall 2008 on an NSF IGERT fellowship. He received a doctoral dissertation fellowship for 2012-13. He is exploring computational problems related to eco-routing and spatio-temporal transportation networks.
23. Mr. Xun Zhou passed preliminary examination in Spring 2011. He is exploring computational structure of abrupt change detection, related to a data-driven approach to understanding climate change.
24. Mr. Dev Oliver passed preliminary examination in Spring 2011. He is a graduate of Maclaster College and University of Florida, Gainesville. He is exploring computational problems related to Spatial Data Mining such as street-based summarization of urban activities.
25. Mr. Viswanath Gunturi passed preliminary examination in Spring 2012. He is a graduate of Indian Institute of Technology, Kanpur. He is exploring computational problems related to time-aggregated graphs for modeling spatio-temporal network datasets in transportation and other application domains.
26. Mr. Zhe Jiang joined the spatial database research group in Fall 2010. He is exploring computational problems related to spatial decision tree learning in context of reducing salt and pepper noise in land-cover classification from remotely sensed satellite imagery.
27. Ms. Reem Yousry Ali will join the spatial database research group in Fall 2012. She will explore computational problems related to Spatial Databases and Spatial Data Mining.

5.3 List of M.S. Students (48 graduated, 3 current)

Two students graduated with Plan A option as indicated in bold font.

1. Mr. Wai Yat Wong GRADUATED in Fall 1990 with plan B project option. His project was a controlled study of the generalization ability of neural networks.
2. Mr. Cary Bates GRADUATED in Spring 1992 with plan B project option. His project work focused on the design and evaluation of a garbage collection system for Modula 2. Cary is currently with IBM Rochester, MN.
3. Mr. Meir Shargal GRADUATED in Fall 1992 with plan B project option. His project was titled "Evaluation of Search Algorithms and Clustering Efficiency Measures for Part Machine Clustering". He is currently with IDEAS, Bloomington, MN.
4. Ms. Janelle Kojak GRADUATED in Fall 1992 with plan B project option. Her thesis was titled "Is there transfer of training from virtual reality to the real world?". She is currently with the Electronics and Hardgoods Division of the 3M Corporation, St. Paul, MN.
5. Ms. Hua Ping Li GRADUATED in Summer 1993 with plan B project option. Her project was titled "Supporting Computer Aided Teaching of Access Methods". She is currently with Opin Systems, Bloomington.
6. Ms. Yvonne Zhou GRADUATED in Fall 1993 with an M.S. **(Plan A thesis option)** . She worked on disk allocation methods for parallelizing Grid Files for geographic databases. She is currently with Sybase Inc. in California.
7. Ms. Kathleen Mallery GRADUATED in Spring 1994 with plan B project option. She designed a Group Revenue and Displacement System (GRanD) for Northwest Airlines.

8. Mr. C. F. Lee GRADUATED in Fall 1994 with plan B project option. He designed an integrated database system for the Minnesota Department of Commerce. He is currently with the Dept. of Commerce.
9. Mr. Ashim Kohli GRADUATED in Fall 1994 with plan B project option. He evaluated single pair path computation on road map databases. He is with Oracle Corporation with a rank of Director.
10. Mr. Nitin Jain GRADUATED with a M.S. degree in Summer 1996 with plan B project option. He worked on the design and evaluation of algorithms for spatial join. He is currently with SpanLink Corp. in Minneapolis.
11. Mr. A. A. El Haddi GRADUATED with a M.S. **(Plan A thesis option)** in Summer 1996. He worked on parallelizing spatial databases for managing satellite imagery for ice coverage for the data collection center of the National Weather Service.
12. Mr. Brajesh Goyal GRADUATED with a M.S. degree (plan B) in Summer 1996. He worked on the evaluation of hierarchical formulations of algorithms to compute shortest paths for advanced traveller information systems.
13. Ms. Varsha Kelkar GRADUATED with a M.S. degree (plan B) in summer 1996. She carried out the evaluation of newly emerging extensible relational database technologies for advanced traveller information systems.
14. Mr. Rajat Aggarwal GRADUATED with a M.S. degree (plan B) in Winter 1997. He developed HMETIS, a public domain software incorporating hierarchical algorithms for partitioning hypergraphs.
15. Mr. Ron Grenier GRADUATED with a M.S. degree (plan B) in Spring 1997. He benchmarked the typical network traffic at Medtronics and experimentally compared the performance of computer networks, e.g. 155Mbs ATM and 100 Mbs fast ethernet, for the environment.
16. Mr. Andrew Fetterer GRADUATED with a M. S. degree (plan B) in Summer 1997. He worked on hierarchical algorithms for routing.
17. Ms. Anuradha Thota GRADUATED with a M. S. degree (plan B) in Fall 1997. She worked on storage management for traffic data archival.
18. Mr. Thananjayan GRADUATED with a M. S. degree (plan B) in Winter 1997. He worked on temporal data modeling for storing traffic data.
19. Mr. Seshu Guddanti GRADUATED with a M.S. (plan B) in Fall 1998. He worked on algorithms for data mining for patterns in strings.
20. Mr. Leijun Zheng GRADUATED with a M.S. (plan B) in Spring 2000. He worked on a Java based visualization of path descriptions based on direction predicates.
21. Mr. Chang Qing Zhou GRADUATED with a M.S. (plan B) in Spring 2000. He worked on topological data model based implementations for spatial operators specified in Open Geodata Interchange standard.
22. Mr. Neill Michael GRADUATED with a M.S. (plan B) in Spring 2000. He worked on spatial clustering algorithms for shipping affinities among a set of destinations.
23. Ms. Xinhong Tan GRADUATED with a M.S. (plan B) in Fall 2000. She worked on relational table design for the archival of traffic data collected by the Traffic Management Center at MNDOT.
24. Ms. Namita Sahay GRADUATED with a M.S. (plan B) in Spring 2001. She compared XML parsers (e.g. DOM and SAX) for supporting spatial queries on data encoded in GML, a XML standard for geo-spatial datasets. Her was accepted for publication in ACM Intl. Workshop on GIS, 2001. She is with Medtronics Inc.
25. Ms. Wei Hsin Fu GRADUATED with a M.S. (GIS) in Spring 2001. She developed a benchmark dataset and queries to learn topological data models within the Open Geodata Interchange Standard.
26. Ms. Carie Peterson GRADUATED with a M.S. (plan B) in Fall 2001. She developed a web crawler to extract details of technical publications inspatial database area to analyze statistical trends in popularity of topics over last decade. She is with West Publishing group in Twincities.

27. Ms. Judy Djugash GRADUATED with a M.S. (plan B) in Fall 2001. She developed techniques to customize code-dictionaries for dictionary based compression of vector maps. Her work was accepted for publication in Data Compression Conference 2002.
28. Mr. RuLin (Alen) Liu GRADUATED with a M.S. (plan B) in Spring 2002. He developed a visualization software for identifying pattern in spatio-temporal dataset, e.g. freeway traffic measurement dataset for Twincities highways.
29. Mr. Marcus Gallagher GRADUATED with a M.S. (plan B) in Spring 2002. He developed a model to specify location based security in spatial databases and efficient algorithms to check the spatial security constraints.
30. Mr. Zhihong Yao GRADUATED with a M.S. (plan B) in Spring 2003. He developed a geographic information system to roadmaps and GPS tracks to assess the positional accuracy and map-matching effectiveness of in-vehicle navigation devices. His work was sponsored by the ITS Institute under a project to evaluate technologies for a new approach to road user charges.
31. Mr. Vatsavai Ranga Raju GRADUATED with a M.S. (plan B) in Spring 2003. He developed an online geospatial processing system, namely MapServer, to provide web based access to NASA satellite imagery and derived data (e.g. forest attributes such as NDVI, NPP) about mid-west. This system has hundreds of registered users and dozens of third party application developers. Main results were reported in refereed conferences including ACM Intl. Conf. on GIS and Symposium on Scientific and Statistical Databases.
32. Mr. Nitin Karnani GRADUATED with a M.S. (plan B) in Summer 2003. He developed a digitization assistant to help scan, digitize and interpret paper-based data-sheets for populating spatial database about the Gombe chimpanjee dataset from Jane Goodall Institure for Studies in Primate Behaviour.
33. Ms. Durga Gumaste GRADUATED with a M.S. (plan B) in Summer 2003. She developed a spatial database to facilitate query by example for analyzing the Gombe chimpanjee dataset from Jane Goodall Institure for Studies in Primate Behaviour.
34. Ms. Alina Rimbu GRADUATED with a M.S. (plan B) in Fall 2003. She implemented an extensible map-cube system to visualize aggregation hierarchies on spatio-temporal datasets. Her software was used by Army Research Laboratory.
35. Ms. Lin Peng GRADUATED with a M.S. (plan B) in Spring 2004. She survey SQL standards and SQL implementations across commercial databases for topics in undergraduate courses on databases.
36. Mr. David Swanson Jr GRADUATED with a MS (Software Eng.) in Spring 2004. His capstone project focussed on selection of data modelling tools for health informatics.
37. Mr. Chee Soon Wong GRADUATED with a MS (Software Eng.) in Spring 2004. His capstone project focussed on selection of data modelling tools for health informatics.
38. Ms. Vamshi GRADUATED with a M.S. (plan B) in Fall 2004. She developed an indoor navigation system to assist blind persons in unfamiliar buildings.
39. Ms. Xuejin Ruan GRADUATED with a M.S. (plan B) in Fall 2004. She developed an extended join index to improve the computational performance of common spatio-temporal queries on national historical census datasets at the Minnesota Population Center..
40. Ms. Roshmi Bhoumik GRADUATED with a M.S. (plan B) in Spring 2005. Her M.S. project evaluated indoor location estimation using wireless local area network infra-structure.
41. Ms. Jin Soung Yoo completed a M.S. (plan B) in Fall 2005 and continued work towards a Ph.D. degree. Her M.S. project explored spatial data mining problem of designing faster joinless algorithms for discovering colocation patterns
42. Mr. Xiobin Ma GRADUATED with a M.S. (plan B) in early 2006. He worked on location based services to address the problem of identifying optimal routes to visit spatial instances of a collection of service types. He joined NCR Corporation (Terradata group).
43. Ms. Xiaojia M Li GRADUATED with a M.S. (plan B) in Spring 2006. She worked on data modeling and database design for the Gombe chimpanzee dataset in the Jane Goddall Institute.

44. Mr. Jeffrey Wolff GRADUATED with a M.S. (plan B) in Summer 2006. He worked on visualization of evacuation routes and schedules. Part of his work was included in a Fox TV news on the evacuation planning project on May 11th, 2006. He joined BAE corporation.
45. Mr. Abhinaya Sinha GRADUATED ith a M.S. (plan B) in Fall 2006. He worked on efficient implementation of spatial database queries for a natural resource software system and mapserver, a public domain software for creating web-sites for distributing geo-spatial information. He joined CNET corporation.
46. Mr. Vijay Gandhi GRADUATED with a M.S. (plan B) in Summer 2007. He worked on computational structure of statistical computations in context of classification of remote sensing imagery using multi-scale models. He joined Oracle corporation.
47. Mr. Chetan Shivarudrappa GRADUATED with a M.S. (plan B) in Fall 2008. His project compared alternative data-structures to support novel routing algorithms for applications where ranking of candidate routes can change over time. He also worked on modularizing CrimeStat, a popular spatial statistical software for mapping and analysis for public safety. He joined amazon.com.
48. Mr. Mark Dietz GRADUATED with a M.S. (plan B) in Fall 2009. His project explored computationally scalable algorithms for fuel-cache site-selection for polar research. His results were accepted for publication in 2009 ACM SIG-Spatial International Workshop on Computational Transportation Science.
49. Mr. KwangSoo Yang joined spatial database group in Summer 2009. He is investigating development of a library for the visualizing spatio-temporal tracks of chimpanzees in the Jane Goodall Institute datasets. He is also working on efficient storage methods for new generation of digital roadmaps showing time-variation of speed over different timepoints in a typical week.
50. Mr. Chintan Patel joined spatial database group in Spring 2009. He is investigating development of a library for the time-aggregated graph data-structure to help researchers using graph representation in exploring temporal questions.
51. Mr. Santosh joined spatial database group in Spring 2009. With Chintan Patel, he is investigating development of a library for the time-aggregated graph data-structure to help researchers using graph representation in exploring temporal questions.

6 SERVICE TO PROFESSION (Journals, Conferences, Award Committees)...

- Member, IEEE Fellows Committee to evaluate Fellow Nominations, IEEE Computer Society, 2012.
- Member, IEEE Technical Achievement Award Committee, IEEE Computer Society, 2010, 2011.
- Member, Steering Committee, NSF Workshop on Computing for Disaster Management, Computing Community Consortium Visioning Workshop Series, April, 2012.
- Program Co-Chair, Bi-annual Intl. Conference on Geographic Information Science, Columbus, OH, September, 2012.
- Guest Co-Editor (with H. Xiong, A. Tuzhilin), Special Issue on Intelligent Mobile Knowledge Discovery and Management Systems, 2012-2013, ACM Transactions on Intelligent Systems and Technology.
- Co-Editor-in-chief, *Geo-Informatica: An Intl. Journal on Advances in Computer Science for Geographic Information Systems*, 2002-present. In 2008, this journal received top-tier rating among 50 GIS journals in a peer-review study [6].
- Series Editor, Springer Briefs: A series of eBooks on Geographic Information Science and Systems, 2010-present.
- General Co-Chair, 12th Bi-annual Intl. Symposium on Spatial and Temporal Databases, Minneapolis, MN , August 24th-26th, 2011. It received a prestigious sponsorhip from the NSF/CRA Computing Community Consortium (CCC) for an inaugural track on challenges and vision papers. CCC is charged with revitalizing the computing community by identifying new directions and research initiatives.
- General-Chair, Intl. Workshop on Computational Transportation Science, (colocated with ACM SIGSpatial Intl. Conf. on GIS), 2009.
- Vice-Chair (Spatial Data Mining), IEEE Intl. Conf. on Data Mining, 2010.
- Vice-Chair (Spatial Data Mining), IEEE Intl. Conf. on Data Mining, 2009.
- Vice-Chair (Spatial Data Mining), SIAM Intl. Conf. on Data Mining, 2009.
- Co-Chair, Workshop on Spatial and Spatio-Temporal Data Mining, IEEE Intl. Conf. on Data Mining, 2007, 2008, 2009, 2010. (http://csdl2.computer.org/comp/proceedings/icdmw/2007/3033/00/3019v.pdf)
- Co-Chair, Indo-US Science & Technology Forum (IUSSTF) Workshop on Geospatial Information for Developing Countries, Indian Institute of Technology, Bombay, India, December 16th-18th, 2009.
- Co-Chair, Panel on GIScience and Computational Transportation Science, Winter Assembly, University Consortium on Geographic Information Science, Washington D.C., February, 2009.
- Co-Chair, Workshop on Exploring Spatio-temporal Future of Geo-Informatics, University of Minnesota, Minneapolis, January, 2009.
- Steering Committee, *ACM Intl. Workshop on Geographic Information Systems,* 2003-present.
- Co-Chair, 2nd Statistical Challenges in E-Commerce Research Symposium, Carlson School of Management, University of Minnesota, May 22-23, 2006 (http://www.misrc.umn.edu/symposia/2006-05-22/).
- Member, Board of Director, University Consortium on Geographic Information Science, 2003-4.
- Editor, *Geo-Informatica: An Intl. Journal on Advances in Computer Science for Geographic Information Systems.*, 2001-2002.
- Associate Editor, *IEEE Transactions on Knowledge and Data Eng.*, 1996-98, and 1998-2000.
- Editor, IEEE-Computer Society Computer Sc. and Eng. Practices Publication Board, 1995-97.
- Editor, Intl. Jr. on Computational Intelligence and Organization, Lawrence Erlbaum and Assoc., Inc., 1996-97.
- *Co-Chair*, Inst. of Math and Its Applications (University of Minnesota) Workshop on Data Models for Multimedia Digital Libraries, January 2001.
- *Co-Chair*, Army Research Laboratory Workshop on Battlefield Visualization, April 2000.

[6] C. Caron et al., GIScience Journals Ranking and Evaluation: An International Delphi Study, Transactions in GIS, 12(3): 293.321, Blackwell Publishing Ltd., 2008.

- *Program Chair*, ACM International Conference on Geographic Information Systems, 1996.
- Steering Committee Member, National Center on Geographic Information and Analysis (NCGIA) Conf. on Navigable Databases, 1996.
- Co-organizer, Mini-track on Neural Networks in Business, Hawaii International Conference on System Sciences, 1996.
- Publicity Vice-Chair, IEEE Intl. Conf. on Tools with AI, 1995.
- Co-Organizer, Workshop on Neural Networks at the Univ. of Minnesota, 1992, 1993.
- Co-Organizer, AAAI Workshop on Integrating Symbolic AI and Neural Networks, 1992.
- Treasurer, IEEE Intl. Conf. on Tools with AI, 1991.
- Served on numerous program committee, including ACM Intl. Conf. on Geographic Info. Systems (1995-present), ACM Symposium on Spatial Databases (1997-present), World wide web and Geographic Info. Systems (2001-3) IEEE International Conference on Data Mining (2003), SIAM International Conference on Data Mining (2000), IEEE International Conference on Data Eng. (2003), IEEE Intl. Conf. on Tools with AI (1991-97), Int'l Conf. on Software Engineering and Knowledge (1990).
- Refereed for numerous journals, including Intl. Jr. on GIS, IEEE Trans. on Knowledge and Data Engineering, IEEE Trans. on Computers, IEEE Trans. on Software Eng., ACM Trans. on Database Systems, VLDB Journal, IEEE Computer, IEEE Expert, Artificial Intelligence Journal, Journal on Parallel and Distributed Computing, Journal on Intelligent Information Systems, Journal of Software Engineering and Knowledge Engineering , Journal of Computer and Software Engineering, Intl. Jr. on Artificial Intelligence Tools, and Information and Software Technology.
- Refereed for numerous conferences, including IEEE Intl. Conf. on Data Engineering, ACM SIGMOD Natl. Conf. on Management of Data, IEEE Tools with AI, AAAI National Conf. on Artificial Intelligence, IEEE Intl. Conf. on Computer and Software Applications (COMPSAC), Intl. Conf. on Parallel Processing (ICPP), and Scalable High Performance Computing Conference.
- Refereed for several textbook publishers including Addison Wesley (*Software Engineering* by Sommerville) McGraw Hill (*Database System Concepts* by Korth and Silberschatz) and Richard D. Irwin Inc. (Software Engineering by Schach).
- Refereed for the following national and international agencies: National Science Foundation, National Aeronautical and Space Agency, Federal Highway Authority, Center for Transportation Studies and Chinese University of Hong Kong.

7 SERVICE TO UNIVERSITY OF MINNESOTA

7.1 Service to College, University and State

- Member, Committee to review nomination for McKnight Land-grant Professorships, Office of Vice-President of Research, University of Minnesota, Fall 2011.
- Member, Senate Information Technology Committee, University of Minnesota, 2011-2013. Facilitated review and decisions related to information technology at the office of information technology at the University of Minnesota. Participated in selection of the Chief Information Officer (Fall 2011) including meeting with four candidates.
- Participant, Faculty Recruiting for Electric Power Engineering, Electrical and Computer Engineering, 2011-2012. I met with half a dozen candidates for a tenure-track faculty position in Electrical Power group to provide interdisciplinary collaboration perspective on six candidates. The effort led to a successful hiring in the area.
- Member, Technical Advisory Group (2010-2011), Metropolitan Council - Long-term Forecast for Land-Use and Tranportation Planning: Metropolitan Council is charged by state of Minnesota to prepare models for long-term (20-25 years out) forecasts of land-use and transportation demands to assist policy makers. It will use this model to help develop our long-range population and employment forecasts for metropolitan-area cities. The objective is to adopt a model that allows the Council to forecast the local distribution of regional population and employment for multiple scenarios involving different growth rates, land use policies, and transportation network improvements. Another objective is to develop a forecast model that allows us to better utilize available regional spatial data. The Council plans to develop this forecast model using Cube Land, the commercial version of the MUSSA model (http://www.mussa.cl/E_index.html) developed by Dr. Francisco Martinez at the University of Chile in Santiago. A consultant team will consist of Citilabs (Cube Land' s vendor), Dr. Martinez, and a modeler at his University of Chile modeling laboratory. As part of this project, Council Research has formed a Technical Advisory Group of local subject matter experts representing knowledge areas relevant to land use modeling - such as transportation planning, land use planning, real estate economics and computational spatial analysis. The role of the Technical Advisory Group is to help Council Research review and comment on the results and deliverables of each major project task. I am serving on this technical advisor group to periodically review the project and provide technical advice.
- Faculty Representative, Employee Reward, Recognition and Appreciation Study Committee, Office of the President, University of Minnesota, 2009-2010. Served with representatives of University Senate (Vickie Courtney, Becky Hippert), Office of Human Resources (Stacy Doepner-Hove, Jeff Stafford, Lori Ann Vicich, Deb Kinsley, Mo Perry), University Relation (Ann Freeman, Adam Overland), Facilities Management (Chris Kelleher), University Services (Kathleen Krueger), Recreational Sports (Karen Lovro), and U of M Morris (Sarah Mattson). The charge of the ERRA team was to conduct a study of employee rewards, recognition, and appreciation programs and develop recommendations for such initiatives at the University of Minnesota with the goal of improving employee morale, productivity, and retention. The study was to include a review of existing internal efforts, relevant literature, best practices at other universities as well as corporations, and discussions with employees. Recommendations were to be realistic, taking into account limited resources. The ERRA team was formally charged in January 2010 and it sent a 40-page report with recommendations to the President in summer 2010.
- Chair, All-University Honors Committee, University of Minnesota Senate, 2009-2010. Facilitated review and decisions related to nomination for honorary degrees, distinguished alumni award, honorary naming of buildings, etc. Interfaced with alumni association, university foundation, university senate, and offices of the President and Board of Regents. A key challenge formulation of building naming policy acknowledging the needs of development while protecting university honor.
- Chair, Committee to review President's Award for Outstanding Service nominations, University of Minnesota, 2009-2010. Facilitated review of and decisions for nominations. A key challenge is to develop consensus across three employee groups including faculty, professional/administrative staff and other employees. Assisted the University President in honoring the awardees during award ceremony.

- Senate Honors Committee Representative, Committee to Recommend Naming a Building for a Past President, Office of the Board of Regents, University of Minnesota, 2009-2010.
- Member, Committee to review nominations towards President's Award for Outstanding Service nominations, University Honors and Awards, University of Minnesota, 2008-2009.
- Member, Minnesota Supercomputing Institute Committee to review Database Activities, University of Minnesota, 2009-2010.
- Member, Information Exchange Leadership Committee, Academic Health Center, University of Minnesota, 2010-2011. Attended meetings and teleconference calls to review options (e.g. UofM Masonic Cancer Center Information Exchange, Ohio State Open Metadata Repository, University of Southern Carolina approach, etc.). Provided technical review of the options.
- Faculty Representative, All-University Honors Committee, University of Minnesota Senate, 2007-2009. Participated in review of nomination for honorary degrees, distinguished alumni award, honorary naming of buildings, etc. Specific contributions include revision of honorary degree categories and definitions.
- Member, Geo-spatial Steering Committee, University of Minnesota, 2007-2010. Assisted in creation of GIS undergraduate minor, organizing visit of Jack Dangermond (President and founder, ESRI) to receive a honorary doctorate. Led a successful proposal to Minnesota Futures program (Office of Vice President of Research) and organized a workshop (Jan. 30th-31st, 2009) to bring together the GeoInformatics community across a dozen departments from half a dozen colleges to facilitate. A major goal of the Minnesota Futures initiative is to promote more in-depth work to convert ideas into viable research questions to enable faculty members to respond collaboratively and boldly to emerging opportunities in interdisciplinary research and scholarship.
- Member, Committee exploring India Center, University of Minnesota, 2007-2010. Assisted Vice President McQuaid with strategy formulation towards exploring creation of India Center as requested by Rep. Eric Paulsen and State of Minnesota. Hosted Dr. Mitra, Director of Indo-US Joint Science and Technology Forum (Fall 2008) and Dr. Kentaro Toyama (Microsoft Research). Visited MapForum conference (Feb. 2009) to meet with Secretary of Science & Technology (Government of India), Dr. R Siva Kumar (CEO, National Spatial Data Infrastructure, Govt. of India), Dr. N. L. Sarda (IIT Bombay), to explore possible collaboration opportunities. Also met with Dr. Krishna Kant (NSF, Intel) and Prof. R. Sangal (Director, IIIT-Hyderabad) as well as talked to US leadership of IUSJST to explore opportunities.
- Director, Army High Performance Computing Research Center, Fall 2005-Summer 2007. Defined strategic focus of the center, helped form a new research cluster around network sciences, interfaced with 5 partner universities, and sponsors.
- Member of the Graduate Research Advisory Committee (GRAC), Graduate School, University of Minnesota, Fall 2000 - Spring 2006. Reviewed faculty research proposals to the grant-in-aid program.
- Recruiting Committee, Distinguished ADC Chair, Digital Technology Center, University of Minnesota, 2003-5.
- Program Committee, Carlson School of Business Conference on Electronic Commerce, 2001-2003.
- Faculty organizer, Army Center Summer Institute, 2000.
- Technical contributer, **congressional presentation to members of US House of representatives** by University Consortium on GIS, 1998-99.
- Technical contributer, **congressional presentation to members of US House of representatives** by University Consortium on GIS, 1997-98.
- Member, University Committee on Professional M.S. degree in Geographic Information Systems, 1998-99.
- Member, Institute of Technology Committee on M.S. degree in Computer Engineering, 1997-98.
- Member, Organizing Committee for the University of Minnesota Digital Technology Summit called by President Yudof. Organized the track on Geographic Information Systems with Prof. T. Burk, Fall 1997.

- Member, Institute of Technology Curriculum Committee, 1996-97.
- Member, Institute of Technology Committee on Professional Courses. Assisted Prof. Doug Ernie plan professional courses.
- Member, Institute of Technology Committee on the Bachelor of Information Networking program, 1993.

7.2 Service to Computer Science Department

- Member, Strategic Planning and Recruiting Committee, 2011-2012. This committee reviewed many hundreds of applications for four tenure-track faculty positions to select about a dozen candidate for campus visit and interview. It facilitates the discussion on comparison of candidates towards recommendation for making offers. Besides participating activitely in all activities, I hosted one of the candidates and articulated his case to the committee and faculty. A key success was hiring of four new tenure-track faculty members in Spring 2012.
- Member, Tenured Faculty Evaluation Committee, 2011-2012. This committee reviews tenured faculty members and prepares evaluation reports for discussion at the faculty meeting. It makes recommendations to the department head.
- Member, Open House Planning Committee, 2010-2011. This committee identifies possible topics and speakers for the open house. It also reviews nominations for outstanding alumni award. It makes recommendations to the department head.
- Elected Member, Tenure-track Faculty Evaluation Committee, 2010-2011. Prepared and presented review for a tenure track faculty member to CSE faculty in Spring 2011.
- Member, WPE and Graduate Student Evaluation Committee, 2009-2011. Helped review all graduate students in the department. Served on numerous WPE oral examination committees.
- Member, Committee for DTC Space Reallocation, 2010-2011. Helped resolved potential conflict across CSE faculty members and DTC leadership by identifying space needs, space usage and developing consensus.
- Chair, Awards Committee, 2007-2010. Facilitated preparation of nomination for a variety of faculty award by working closely with nominees, sponsoring faculty members, award committee members, etc. I am proud to see our department received the following awards for the first time in its history: President's award for outstanding service (Prof. Marvin Stein, 2009), and Outstanding International Alumni Award (Dr. Ajay Bhushan Pandey, 2010). We are also proud to share many other successes including McKnight Land-grant Professorships (Volkan Isler, Arindam Banerjee, Tian He, Nick Hopper), McKnight Distinguished University Professorship (Joe Konstan), and Award for Outstanding Contributions to Post-baccalaureate, Graduate, and Professional Education (Joe Konstan).
- Chair, Mentoring Committee for Prof. Mohammed Mokbel, 2007-2010. Organized mentoring committee meeting, advice and feedback on a variety of issues ranging from annual review, summer trip to Microsoft, NSF proposal preparation and revisions in response to reviews, etc. I am proud to see flourishing of Mohammed's career with NSF grants, ACM SIG-Spatial leadership, etc.
- Chair, Strategic Planning Committee, 2004-2005. Facilitated shared goal setting and creation of an environment of mutual trust. Major accomplishments include

  1. Successful formulation of a consensus policy on faculty recruiting to resolve an going rift on this issue.
  2. Analysis of departmental strengths and weaknesses
  3. Identification of strategies to improve national ranking

- Chair, Colloquia, 2002-2005. Supervised nomination, review and selection of speakers for departmental colloquium. Major accomplishments include

  1. Successfully invited following distinguished speakers:

(a) A current and a past presidents of ACM
(b) A current and a past member of the ACM Fellows selection committee
(c) Two members of the CRA board
(d) A NSF program manager
(e) Three NAE memebrs
(f) A member of the NRC CSTB

2. Web-based management of nomination, review and selection of speakers
3. Redesign of the brochure for Cray colloquia
4. Revision of Csci 8970, Graduate course related to Colloquia. Introduced a web-based reporting by students on the main ideas in each lecture. Helped students identify hypothesis, key claims and supporting evidence.

- Member, Computing Committee, 2002-2003.
- Chair, Computing Committee, 2001-2002. Key achievement include a complete redesign of the departmental web-site (www.cs.umn.edu) content.
- Member, Graduate Committee for Computer Science, 2001-2002.
- Member, Graduate Committee for Computer Engineering, 2001-2002.
- Member, post-tenure evaluation committee, 2000-2001.
- Member, Graduate committee, 2000-2001.
- Member, Curriculum committee, 2000-2001.
- Member, recruiting committee for a joint faculty position with Department of Psychology, 2000-2001.
- Member, External Affairs Committee, 1999-2000.
- Coordinator, Written Preliminary Examinations (software systems area), 1998 - 2000. Key achievements included
  - Developing a consensus strategy for revision of the WPE syllabus in face of the semester conversion.
  - Consolidation of WPE examination schedule from five evening sessions over a week to two Friday afternoon sessions.
  - Successful negotiation to move compilers to Computer Engineering
  - Smooth coordination of a large group of faculty members working on examination preparations and grading.
- Chair, Curriculum Committee, 1998-2000. Key accomplishments include
  - Developing a consensus strategy for moving our first course (CSci 1902) from C++ to Java to modernize our curriculum.
  - Guiding the development of writing intensive courses
  - Developing detailed week by week syllabi for required undergraduate courses to reduce variation across offerings.
  - Starting discussion of comprehensive curriculum revision towards goals of ACM/IEEE-CS Curriculum 2001.
- Director, Undergraduate Studies (DUGS), 1995-1997. Key accomplishments include
  - Started the COOP program for Computer Science and recruited over two dozen companies and students to participate in it.
  - Started a highly visible WWW-page competition to increase the visibility of the committee among undergraduates, faculty and staff.

– Created an undergraduate colloquium to allow technical interaction between undergraduates and industries.
– Streamlined the operation of undergraduate committee by instituting clear division of responsibilities.
– Substantially improved the relationship of Computer Science department with colleges (IT and CLA) as acknowledged by the head of the department.

8 SOFTWARE DEVELOPED

8.1 UMN MapServer: Software to Publish Geo-spatial Data on Internet

Our group (e.g. R. R. Vatsavai, A. Sinha) played a key role in development of many components and design decisions related to computational scalability of MapServer. MapServer is an open source development environment for building spatially-enabled internet applications. It can run as a CGI program or via MapScript which supports several programming languages (using SWIG). Since mid-1990s, it is used by thousands of web-sites to distributed geo-spatial data on Internet.

MapServer was originally developed at the University of Minnesota under leadership of Prof. Tom Burk with support from NASA, which needed a way to make its satellite imagery available to the public. Recently, Autodesk, the MapServer Technical Steering Committee Members, the University of Minnesota, and DM Solutions Group announced the creation of the MapServer Foundation. More details are available from its wikipedia entry (http://en.wikipedia.org/wiki/MapServer) and homepage (http://mapserver.org/).

8.2 CrimeStat : Crime Analysis Software

CrimeStat is a spatial statistical software to identify spatial patterns in crime reports. The software and manual are distributed for free by the U.S. Department of Justice under the program on Mapping and Analysis for Public Safety within the National Institute of Justice (NIJ). This software is used by hundred of police departments around the country.

CrimeStat performs spatial analysis on objects located in a GIS. The objects can be points (e.g., events, locations), zones (e.g., blocks, traffic analysis zones, cities) or lines (e.g., street segments). The program can analyze the distribution of the objects, identify hot spots, indicate spatial autocorrelation, monitor the interaction of events in space and time, and model travel behavior. There is a regression module for non-linear spatial modeling. Some of its tools are specific to crime analysis. Others can by applied in many fields. There are 55 statistical routines in the software. More details are available from its wikipedia entry (http://en.wikipedia.org/wiki/CrimeStat) as well as software distribution web-site (http://www.icpsr.umich.edu/CrimeStat/).

Our group helped Dr. Ned Levine and Ron Wilson in modernizing the software (release 3.2 in 2009 and 3.3 in 2010) towards scaling it up to large datasets and re-architecting it into components. We talked to a number of users to understand the requirements before re-engineering the software. Our group helped develop documentation on the application programming interfaces for the components. It also developed drivers to test the components. We also conducted a alpha-testing and beta-testing of new releases with a large number of users. Our group was honored in the bi-annual USDOJ/NIJ Crime Mapping conference for these contributions. Scalability results were also accepted for publication in the ACM SIG-Spatial International Conference on GIS (2008).

8.3 Evacuation Route Planning Software

My research group developed a web-based software system to help transportation professionals and first responders to develop *evacuation route* for many scenarios as mandated by the Department of Homeland Security. It was used by Emergency Management professionals to prepare evacuation plan for Twin-cities metropolitan area. It is receiving wide publicity in local media including newspaper (March 8th, 2006 Pioneer Press) and TV (FoxTV news, summer 2006). It was also highlighted by the University of Minnesota Vice President of Research in the 2007 annual report (Research magazine) as well as University of Minnesota foundation magazine.

The software uses databases to get transportation network (e.g. road maps), census (e.g. night time population) maps and employment statistics by location. The software tool has a web-based interface to display a map showing evacuation routes (and schedules) to minimize evacuation time after taking critical evacuation parameters including the geographic location and size of evacuation area, destinations, time of evacuation (e.g. day or night) to estimate population, transportation modes (e.g. driving vs. pedestrian). These options help first responders to compare possible alternatives of scenarios and evaluate their impacts. For example, they compared the overall efficiency of evacuation scenarios around the Mall of America when the affected people move out either with vehicles or by walking.

The software system was built on a Web server with mapping technology, thereby, reducing the cost of installation and maintenance and increasing the accessibility and availability. The graphic user interface of the software was improved after feedback given at two major evacuation workshops and a number of user meetings. At the second workshop, we installed a small booth for potential users to play the software. The testing and calibrating tasks were carried out using the five predefined evacuation scenarios. The resulting routes from this software were delivered to the parent project, Metro Evacuation Planning. The software and users manual were finalized in 2005 based on suggestions received from workshop participants including Mn/DOT, State and Local Emergency Management and Public Safety Officials, Transit Providers, and private sector personnel.

Computer Science Contributions: Mass evacuations are among the most difficult challenges faced by transportation professionals, but planning for a complete evacuation of a specific city is particularly difficult because such evacuations are only rarely necessary. As a result, developing evacuation plans has been carried out largely on the basis of engineering judgment and educated guesses about how to best make use of the road system.

Previously, computational techniques for solving evacuation problems often relied on the mathematical programming (MP) approach, which is widely used in optimization problems involving flow within transportation networks. Mathematical programming techniques are proven to produce optimal solutions to network flow problems and are known to work well for computing evacuation plans for smaller networks such as a single building. However, the high computational cost associated with current MP methods makes it difficult to scale MP methods up to problems involving extensive urban transportation networks with large numbers of evacuees.

Our research team focused its efforts on developing a novel and more practical form of heuristic algorithm for evacuation planning one that would take into account the capacity constraints built into transportation networks but also determine a good solution to any large-scale evacuation problem in much less time than a mathematical programming approach would require. After development of two preliminary algorithms, this effort culminated in the Capacity Constrained Route Planner (CCRP) algorithm. Experiments with synthetic and real evacuation datasets showed that CCRP took significantly less computational time and resources to identify evacuation routes. In addition, the evacuation routes produced by CCRP were comparable to those produced by mathematical programming techniques in terms of total evacuation time.

This is a significant scientific breakthrough in terms of the design of the evacuation planning algorithm, which is not only novel but also improved. It is also significant from a transportation perspective, since the reduced computational cost of CCRP helps emergency planners at two different stages. During planning and preparedness, emergency planners can evaluate many more scenarios using CCRP given specific computational resources relative to mathematical programming techniques. During operation, they have the option of revising evacuation routes using CCRP in response to major events (e.g. bridge failure in New Orleans) which were not anticipated during planning and preparedness.

Accrued, quantifiable benefits: In 2005, the software implementing the novel CCRP evacuation

planning algorithm was used to identify evacuation routes for five selected scenarios in the Twin-Cities for the Metro Evacuation Traffic Management Plan, which is now serving as the baseline for the entire mass evacuation plan that the US Department of Homeland Security is requiring every state to submit by March 2006. Discussions are underway with Metro Emergency Management Officials regarding the adoption and use of these tools in their emergency management plans as well.

The CCRP algorithm aims at identifying the most efficient routes among all possible route combinations. Thus, it can identify some critical routes which might be missing in the handcrafted plans typically used by local and state governments. One example is the comparative results of the University of Minnesota scenario. Even though the handcrafted version made by a select group of emergency planners covered several major routes including those to I-94 or I-35, our system was able to find additional routes to reduce evacuation time by using routes through Riverside Avenue or another way to I35 through Como Avenue. In an earlier evaluation, the CCRP algorithm identified ways to reduce evacuation time for the Montecillo Nuclear Power Plan evacuation zone by identifying potential congestion near the destination and adding additional routes to relieve it.

Recognitions: The Center for Transportation Studies (CTS) honored this work via the **2006 Research Partnership Award**, which recognizes research projects within the CTS program that have **resulted in significant impacts on transportation**, and rewards teams of individuals who have drawn on the strengths of their diverse partnerships to achieve those results. This work was invited for presentation in multiple public forums including the Intelligent Transportation Systems forum (March 8th, 2006), and the Annual CTS Conference (May, 2006). University of Minnesota venture center is evaluating this software towards potential commercialization.

9 PUBLICATIONS

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