

**BIOGRAPHICAL SKETCH**

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NAME: Shekhar, Shashi

eRA COMMONS USER NAME (credential, e.g., agency login): SSHEKHAR

POSITION TITLE: McKnight Distinguished University Professor

EDUCATION/TRAINING (*Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.*)

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
Indian Inst. Of Tech., Kanpur, India	B.S.	05/1985	Computer Science
University of California, Berkeley	M.S.	05/1987	Computer Science
University of California, Berkeley	M.S.	12/1989	Business Administration
University of California, Berkeley	Ph.D.	12/1989	Computer Science

**A. Personal Statement**

I have a broad background in Computer Science, with specific training and expertise in Geo-AI, spatial data science, and spatial data mining. A key research focus is on geo-spatial approaches to cancer control including geo-spatial surveillance. We have active collaborations with spatial pathology researchers (e.g., Dr. Arvind Rao, University of Michigan: Radiation Oncology, Computational Medicine and Bioinformatics) to evaluate Geo-AI methods (e.g., spatial colocation, deep neural networks) for separating multiplex immunofluorescence (MxIF) point datasets into disease stages. Furthermore, I am a member of the UMN Masonic Cancer Center (Screening, Prevention, Etiology and Cancer Survivorship research area) and have collaborated with Dr. Shalini Kulasingham on spatial issues in disease transmission dynamics models and with Prof. Logan Spector (Division Director, Epidemiology and Clinical Research) for understanding spatial interactions between childhood cancers and birth defects.

My research group laid the groundwork for the proposed research by developing effective measures and scalable algorithms to mine interesting, novel and non-trivial patterns such as statistically significant clusters, hotspots, colocations, spatial anomalies, etc. The colocation patterns represent subsets of event-types that frequently occur together spatially. For example, lung cancer cases in 1950s often occurred near the ship factories possibly due to asbestos. There is considerable interest in finding colocation between immune and cancer cell-types in multiplex immunofluorescence (MxIF) datas. Here are a few relevant publications:

- Discovering spatial co-location patterns: A summary of results*, Symposium on Spatial and Temporal Databases (selectivity 30%), Springer LNCS: 2121, pp. 236-256. 2001 (w/ Yan Huang).
- Discovering Colocation Patterns from Spatial Data Sets: A General Approach*, IEEE Transactions on Knowledge and Data Engineering, 16(12), pp. 1472-1485, 2004 (with Yan Huang et al.).
- Local Co-location Pattern Detection: A Summary of Results, Proc. 10th Intl. Conf. on Geographic Info. Sc. (GIScience 2018) , Schloss Dagstuhl- Leibniz-Zentrum fuer Informatik, Vol. LIPIcs (Leibniz Intl. Proceedings in Informatics) Vol. 114, 2018, ISBN 978-3-95977-083-5. (w/ Yan Li).
- Significant spatial co-distribution pattern discovery., Computers, Environment and Urban Systems, Elsevier, Vol. 84, 2020. (w/ J. Cai, Y. Xie, M. Deng, X. Tang, and Y. Li).

**B. Positions and Honors****Positions and Employment**

1989-1995      Assistant Professor, University of Minnesota, Minneapolis, MN  
 1995-2000      Associate Professor, University of Minnesota, Minneapolis, MN  
 2001-present    Professor, University of Minnesota, Minneapolis, MN

2005 – 2007	Director, Army High Performance Computing Research Center, University of Minnesota
2005-present	Distinguished McKnight Univ. Professor, University of Minnesota, Minneapolis, MN
2015-present	University Distinguished Teaching Professor, University of Minnesota, Minneapolis, MN

### Other Experience and Professional Memberships

2016-2022	Member, Board of Directors, Computing Research Association (CRA).
2017 – 2018	President, University Consortium for Geographic Information Science (UCGIS)
2016 - present	Member, Masonic Cancer Center, University of Minnesota.
2016	Presented a talk in the Conference on Geospatial Approaches to Cancer Control and Population Sciences, September 12-14, NIH National Cancer Institute, Bethesda, MD, 2016.
2016-2019	Chair, Board of Directors, Symp. on Spatial and Temporal Databases (SSTD) Endowment.
2015-2016	Member, National Academies Committees on “From Maps to Models: Augmenting Nation’s Geospatial-Intelligence Capabilities”
2013	Distinguished Colloquium on “From GPS and Virtual Earth to Spatial Computing 2020”, Division of Cancer Control and Population Sciences, NIH National Cancer Institute, Dec. 12th, 2013.
2012-2013	Invited speaker in three NIH-AAG workshops on Geospatial Frontiers in Health and Social Environment: Towards a Unified Vision, National Inst. of Health & Am. Asso. of Geographers.
2012-2015	Member, CRA Computing Community Consortium Council.
2012-2013	Member, National Academies Committee on Geo-targeted Alerts and Warning,
2011-2012	Member, National Academies’ Committee on Future Workforce for Geospatial Intelligence.
2004-2005	Member, National Academies) Committee to review basic and applied research at the USDOD National Geo-spatial Intelligence Agency (NGA).
2003-2009	Member, Mapping Sciences Committee, National Academy of Sciences.

### Honors

2015	Education Award, University Consortium on Geographic Information Science
2015	Post-baccalaureate, Graduate and Professional Teaching Award, University of Minnesota
2011	Elected a Fellow of the Institute on Environment, University of Minnesota
2006	Elected an AAAS Fellow for distinguished research, service and teaching contributions to the advancement of science in the fields of spatial databases, spatial data mining and GIS.
2006	Awarded the IEEE Computer Society Technical Achievement Award for distinguished contributions to research, teaching and service in spatial databases.
2005	McKnight Distinguished University Professorship, University of Minnesota
2003	Elected an IEEE Fellow for contributions to spatial database storage methods, data mining, and geographic information systems.

### C. Contributions to Science

- Cluster Analysis:** Our group has experience in cluster analysis, particularly hotspots that are geographic areas with unusually large number of events. Further, the group has extended SaTScan style statistically significant circular hotspots to statistically significant linear, ring shaped and elliptical hotspots. For example, we have conducted case study on a New York Bronx Legionnaires’ diseases outbreak dataset, and found ring-shaped hotspots to be effective in identifying the most relevant water tank (Reference a. below).

  - A Unified Framework for Robust and Efficient Hotspot Detection in Smart Cities, Transactions on Data Science (Special Issue on Urban Computing and Smart Cities), ACM, Vol. 1, No. 3, September 2020, Special Issue on Smart Cities. (w/ Yiqun Xie).*
  - Significant DBSCAN towards Statistically Robust Clustering, Inter- national Symposium on Spatial and Temporal Databases (SSTD’19), , Aug. 2019, Best Paper Award. (w/ Yiqun Xie).*
  - Towards Spatial Variability Aware Deep Neural Net- works (SVANN): A Summary of Results, 1st SIGKDD Workshop on Deep Learning for Spatiotemporal Data, Applications, and Systems (DeepSpatial2020), ACM, August 2020, Best Paper Award. (w/ Jayant Gupta, and Yiqun Xie).*
  - Significant Linear Hotspot Discovery, IEEE Transactions on Big Data, 3(2), pp.140-153, 2017 (w/ Xun Tang, Emre Eftelioglu, Dev Oliver).*
- Spatial Data Mining:** Beyond hotspot and colocation, my research has also explored other spatial pattern families in the broad area of spatial data mining, which is concerned with detection of useful, interesting,

and non-trivial patterns from geospatial data. Examples include spatial outlier detection and spatial decision tree learning.

- a. *Transdisciplinary Foundations of Geospatial Data Science*, *ISPRS International Journal of Geo-Information*, 6(12), 2017. doi:10.3390/ijgi6120395. (with Yiqun Xie, Emre Eftelioglu, Reem Ali, Xun Tang, Yan Li, and Ruhi Doshi).
- b. *Spatiotemporal Data Mining: A Computational Perspective*, Special Issue on Advances in Spatio-Temporal Data Analysis and Mining, *ISPRS International Journal of Geo-Information*, MDPI, 4(4), 2306-2338, 2015. (w/ Zhe Jiang, Reem Y. Ali, Emre Eftelioglu, Xun Tang, Venkata M. V. Gunturi, and Xun Zhou)
- c. *Focal-test-based spatial decision tree learning*, *IEEE Transactions on Knowledge and Data Engineering*, 27(6), pp.1547-1559, 2015 (w/ Zhe Jiang, Xun Zhou, Joseph Knight, and Jennifer Corcoran.).
- d. *Identifying patterns in spatial information: A survey of methods*, *Wiley Interdisciplinary Review: Data Mining and Knowledge Discovery* 1(3), 2011. (w/ Michael R. Evans, James M. Kang, Pradeep Mohan).

4. **Spatial Computing:** Beyond spatial data mining, my work has also explored spatial databases and routing algorithms.

- a. *Spatial Computing*, The MIT Press Essential Knowledge series, 2020. (w/ Pamela Vold).
- b. *Encyclopedia of GIS*, 2<sup>nd</sup> Ed. Springer, 2017, (w/ Hui Xiong, Xun Zhou).
- c. *Spatial Computing*, *Communications of the ACM* (Association for Computing Machinery), cover article, 59(1), Jan. 2016 (w/ Steven K. Feiner, Walid G. Aref).
- d. *Spatial Databases: A Tour*, Prentice Hall, 2003 (w/ S. Chawla).

#### **Complete List of Published Work in My Bibliography:**

<https://www-users.cs.umn.edu/~shekhar/bio/2021/full.pdf>

#### **D. Additional Information: Research Support and/or Scholastic Performance**

##### **Ongoing Research Support**

NSF CISE/IIS/III (2040459)

09/2020 – 08/2020

*EAGER: Spatiotemporal Big Data Analysis to Understand COVID-19 Effects.* The goal of this project is to study emerging spatial big datasets (e.g., aggregated privacy-protected mobile device data) to understand the impact of pandemic and interventions on mobility.

Role: Principal Investigator

USDOD-NGA (HM0476-20-1-0009)

06/2020 – 06/2022

*Identifying Aberration Patterns in Multi-Attribute Trajectory Data with Gaps.* This project explores novel physics-guided gap-aware Geo-AI anomaly detection in emerging ship trajectory big data.

Role: Principal Investigator

USDOE EERE via Volvo (CX-020456)

01/2020 – 12/2022

*Improving the Freight Productivity of a Heavy-Duty, Battery Electric Truck:* The goal is to exploit vehicle big data (e.g., onboard diagnostic) to extend the range of electric trucks by recommending energy efficient routes.

Role: Co-Principal Investigator

NSF CISE/IIS/III (1901099)

08/2019 – 08/2023

*Spatio-temporal Informatics for Transportation Science:* This project explore novel spatio-temporal informatics methods (e.g., regional colocation mining) to improve emissions and energy use models leveraging the vehicle big data such as onboard diagnostics.

Role: Principal Investigator

NSF OCI (1916518)

06/2019 – 05/2023

*Midwest Big Data Hub: Building Communities to Harness the Data Revolution:* The goal is to build and grow multi-sector community to accelerate adoption of big data.

Role: Co-Principal Investigator

NIH CTSA (UL1 TR002494, KL2 TR002492, TL1 TR002493)

03/2018 – 02/2023

Clinical and Translational Science Award (CTSA), National Center for Advancing Translational Sciences, (P.I.: B. Blazar): My role is to provide input on spatial and spatio-temporal data science and Geo-AI challenges.

Role: Senior Personnel

NSF Computer and Network Systems (1737633)

09/2017 – 09/2021

*Connecting the Smart-City Paradigm with a Sustainable Urban Infrastructure Systems Framework to Advance Equity in Communities*: This project will investigate a smart urban infrastructure systems framework for advancing access and wellbeing in cities. With transformative new infrastructures (e.g., smart electricity grid, urban farms) on the horizon, this research will provide new perspectives on how the future spatial deployment of these new infrastructures in cities will shape wellbeing, health, and the environmental sustainability of outcomes in the different areas of cities.

Role: Principal Investigator

USDA Current Research Information System (2017-51181-27222)

09/2017 – 08/2022

*Increasing low-input turfgrass adoption through breeding, innovation, and public education*: The long-term goal of this project is to increase the use of well-adapted fine fescue cultivars in sustainable landscapes by the provision of new tools for consumers to use when making grass seed purchasing decisions, new turfgrass seed cultivars with improved low-input adaptation, new knowledge about the stress tolerance of fine fescues, new tools for public and private plant breeders to use when selecting fine fescues.

Role: Co-Principal Investigator.

### **Completed Research Support**

<http://www.cs.umn.edu/~shekhar/bio/2016/fullreport.pdf>