

# Harish Doraiswamy

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Department of Computer Science and Engineering  
NYU Tandon School of Engineering  
2 Metrotech Center 10<sup>th</sup> Floor  
Brooklyn NY 11201

Email: harishd@nyu.edu  
Tel: +1 646-997-3538  
<http://www.harishd.com>  
Citizen of India

## Research Interests

Scientific visualization, computational topology, urban computing, visual analytics, data management, computer graphics.

## Education

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|-------------|--|
| 2008 - 2013 | Ph.D. (Computer Science and Engineering)<br>Indian Institute of Science, Bangalore<br>Advisor: Dr. Vijay Natarajan   |
| 2006 - 2008 | Master of Engineering (Computer Science and Engineering)<br>Indian Institute of Science, Bangalore<br>Advisor: Prof. Jayant R. Haritsa<br><b>Gold Medalist</b> |
| 2000 - 2004 | Bachelor of Engineering (Computer Science and Engineering)<br>Visveswaraiah Technological University<br>BMS College of Engineering, Bangalore                  |

## Professional Experience

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| Jan. 2016 - present    | Research Scientist, Center for Data Science<br>New York University  |
| Oct. 2012 - present    | Research Assistant Professor, Computer Science and Engineering<br>Tandon School of Engineering, New York University |
| Jan. 2017 - May 2017   | Adjunct Assistant Professor, Center for Data Science<br>New York University   |
| Sept. 2016 - Dec. 2016 | Adjunct Course Advisor, Center for Data Science<br>New York University  |
| 2004 - 2006            | Software Engineer<br>Huawei Technologies India Pvt. Ltd., Bangalore   |

## Recognitions

### Awards

1. *SIGMOD Reproducibility Award* for the paper on Data Polygamy.
2. *Honorable Mention Paper* at the IEEE Intl. Conference on Data Science and Advanced Analytics, 2016.
3. *Microsoft Research India PhD Fellowship* for 2010 (2010–2012).
4. *Infosys PhD Fellowship* for the academic year 2009-2010.
5. *Computer Society of India (Bangalore Chapter) Medal* for the best M.E. student in the Department of Computer Science and Automation by Indian Institute of Science, Bangalore, India.
6. *Best Perspective Seminar award* for presentation at the Perspective seminars (Student's Research Overviews) conducted by the Department of Computer Science and Automation in April, 2009.

## Media Coverage

1. Technology Review - Germany. *Lauschangriff auf Müllwagen*, February 21, 2017.  
<https://www.heise.de/tr/artikel/Lauschangriff-auf-Muellwagen-3606486.html>
2. The New York Times. *Mapping the Shadows of New York City: Every Building, Every Block*, December 21, 2016.  
<https://www.nytimes.com/interactive/2016/12/21/upshot/Mapping-the-Shadows-of-New-York-City.html>
3. The Economist. *Listen to the music of the traffic in the city*, October 22, 2016.  
<http://www.economist.com/news/science-and-technology/21709002-places-people-have-pulses-if-only-you-know-how-measure-them-listen>

## Publications

My research primarily focuses on the visual analysis of large data sets. This requires me to work in the intersection of big data visualization, databases, and data analysis. I thus publish in both, visualization as well as database venues. Most of my research has been published in **Tier I** venues<sup>1</sup> in these domains. These include *ACM Transactions on Graphics (TOG)*, *IEEE Transactions on Visualization and Computer Graphics (TVCG)*, and *Computer Graphics Forum (CGF)* in the visualization domain, and *ACM International Conference on Management of Data (SIGMOD)*, *International Conference on Very Large Databases (VLDB)*, and the *International Conference on Data Engineering (ICDE)* in the database domain.

## Refereed Papers

### 2018

1. Shadow Accrual Maps: Efficient Accumulation of City-Scale Shadows over Time  
Fabio Miranda, Harish Doraiswamy, Marcos Lage, Luc Wilson, Mondrian Hsieh, and Cláudio Silva  
*IEEE Transactions on Visualization and Computer Graphics*, 2018, to appear  
**Featured in the New York Times: Mapping the Shadows of New York City: Every Building, Every Block (online, December 21, 2016).**
2. TopoAngler: Interactive Topology-based Extraction of Fishes  
Alexander Bock, Harish Doraiswamy, Adam Summers, and Cláudio Silva  
*IEEE Transactions on Visualization and Computer Graphics (IEEE SciVis '17)*, 24(1), 2017, 812–821

### 2017

1. GPU Rasterization for Real-Time Spatial Aggregation over Arbitrary Polygons  
Eleni Tzirita Zacharitou, Harish Doraiswamy, Anastasia Ailamaki, Claudio Silva, and Juliana Freire  
*Proceedings of the VLDB Endowment (PVLDB)*, 11(3), 2017, 352–365
2. Querying and Exploring Polygamous Relationships in Urban Spatio-Temporal Data Sets  
Yeuk-Yin Chan, Fernando Chirigati, Harish Doraiswamy, Cláudio Silva and Juliana Freire  
*SIGMOD '17: Proc. Intl. Conf. on Management of Data*, 2017, 1643–1646  
**Honorable Mention Demo**
3. Urban Pulse: Capturing the Rhythm of Cities  
Fabio Miranda, Harish Doraiswamy, Marcos Lage, Kai Zhao, Bruno Gonçalves, Luc Wilson, Mondrian Hsieh, and Cláudio T. Silva  
*IEEE Transactions on Visualization and Computer Graphics (IEEE SciVis '16)*, 32(1), 2017, 791–800  
**Featured in the Economist: Listen to the music of the traffic in the city (print and online, October 22, 2016).**  
**Invited to be presented at ACM SIGGRAPH 2017 in a special session on Visualization.**

### 2016

4. Anonymizing NYC Taxi Data: Does It Matter?  
Marie Douriez, Harish Doraiswamy, Cláudio Silva and Juliana Freire  
*DSAA '16: Proc. IEEE Intl. Conf. on Data Science and Advanced Analytics*, 2016, 140–148  
**Honorable Mention Paper**

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<sup>1</sup>Tier I conferences in these domains are very competitive and have high impact. Papers accepted here are fully reviewed and are valued as much as, if not more than leading journals.

5. Data Polygamy: The Many-Many Relationships among Urban Spatio-Temporal Data Sets  
Fernando Chirigati, Harish Doraiswamy, Theodoros Damoulas, and Juliana Freire  
*SIGMOD '16: Proc. Intl. Conf. on Management of Data, 2016, 1011–1025*  
**SIGMOD Most Reproducible Paper Award**
6. Extraction of Robust Voids and Pockets in Proteins  
Raghavendra Sridharamurthy, Talha Bin Masood, Harish Doraiswamy, Siddharth Patel, Raghavan Varadarajan, and Vijay Natarajan  
*Mathematical Methods for Visualization in Medicine and Life Sciences*  
Lars Linsen, Hans-Christian Hege, and Bernd Hamann (Eds.)  
*Springer-Verlag, Mathematics and Visualization Series, 2016, 329–349*  
**Cover Image**
7. A GPU-Based Index to Support Interactive Spatio-Temporal Queries over Historical Data  
Harish Doraiswamy, Huy T. Vo, Cláudio Silva, and Juliana Freire  
*ICDE '16: Proc. Intl. Conf. on Data Engineering, 2016, 1086–1097*

## 2015

8. Topology-based Catalogue Exploration Framework for Identifying View-Enhanced Tower Designs  
Harish Doraiswamy, Nivan Ferreira, Marcos Lage, Huy T. Vo, Luc Wilson, Heidi Werner, Muchan Park, and Cláudio T. Silva  
*ACM Transactions on Graphics (SIGGRAPH Asia '15), 34(6), 2015, 230:1–230:13*
9. Urbane: A 3D Framework to Support Data Driven Decision Making in Urban Development  
Nivan Ferreira, Marcos Lage, Harish Doraiswamy, Huy T. Vo, Luc Wilson, Heidi Werner, Muchan Park, and Cláudio Silva  
*VAST '15: Proc. IEEE Conf. on Visual Analytics Science and Technology, 2015, 97–104*
10. Using Maximum Topology Matching to Explore Differences in Species Distribution Models  
Jorge Poco, Harish Doraiswamy, Marian Talbert, Jeffrey Morisette, and Cláudio Silva  
*SciVis '15: Proc. IEEE Scientific Visualization Conf., 2015, 9–16*
11. Exploring Traffic Dynamics in Urban Environments Using Vector-Valued Functions  
Jorge Poco, Harish Doraiswamy, Huy. T. Vo, Joao L. D. Comba, Juliana Freire, and Cláudio Silva  
*Computer Graphics Forum (EuroVis '15), 34(3), 2015, 161–170*

## 2014

12. Riding from Urban Data to Insight Using New York City Taxis  
Juliana Freire, Cláudio Silva, Huy Vo, Harish Doraiswamy, Nivan Ferreira, and Jorge Poco  
*IEEE Data Engineering Bulletin, 37(4), 2014, 43–55*
13. Using Physically Based Rendering to Benchmark Structured Light Scanners  
Esdras Medeiros, Harish Doraiswamy, Matthew Berger, and Cláudio Silva  
*Computer Graphics Forum (Pacific Graphics '14), 33(7), 2014, 71–80*
14. Using Topological Analysis to Support Event-Guided Exploration in Urban Data  
Harish Doraiswamy, Nivan Ferreira, Theodoros Damoulas, Juliana Freire, and Cláudio Silva  
*IEEE Transactions on Visualization and Computer Graphics (IEEE SciVis '14), 20(12), 2014, 2634–2643*
15. Genotet: An Interactive Web-based Visual Exploration Framework to Support Validation of Gene Regulatory Networks  
Bowen Yu, Harish Doraiswamy, Xi Chen, Emily Miraldi, Mario Luis Arrieta-Ortiz, Christoph Hafemeister, Aviv Madar, Richard Bonneau, and Cláudio Silva  
*IEEE Transactions on Visualization and Computer Graphics (IEEE VAST '14), 20(12), 2014, 1903–1912*

## 2013

16. An Exploration Framework to Identify and Track Movement of Cloud Systems  
Harish Doraiswamy, Vijay Natarajan, and Ravi S. Nanjundiah  
*IEEE Transactions on Visualization and Computer Graphics (IEEE SciVis '13), 19 (12), 2013, 2896–2905*

17. Topological Saliency  
Harish Doraiswamy, Nithin Shivashankar, Vijay Natarajan, and Yusu Wang  
*Computers & Graphics*, 37 (7), 2013, 787–799
18. Computing Reeb Graphs as a Union of Contour Trees  
Harish Doraiswamy and Vijay Natarajan  
*IEEE Transactions on Visualization and Computer Graphics*, 19(2), 2013, 249–262
19. Extraction of Robust Voids and Pockets in Proteins  
Raghavendra Sridharamurthy, Harish Doraiswamy, Siddharth Patel, Raghavan Varadarajan, and Vijay Natarajan  
*EuroVis '13: Proc. Eurographics Conf. Visualization (short paper)*, 2013, 67–71

## 2012

20. Output-Sensitive Construction of Reeb Graphs  
Harish Doraiswamy and Vijay Natarajan  
*IEEE Transactions on Visualization and Computer Graphics*, 18(1), 2012, 146–159
21. A Hybrid Parallel Algorithm for Computing and Tracking Level Set Topology  
Senthilnathan Maadasamy, Harish Doraiswamy and Vijay Natarajan  
*HiPC '12: Proc. Intl. Conf. on High Performance Computing*, 2012, 12.1–12.10

## 2007 – 2009

22. Efficient Algorithms for Computing Reeb Graphs  
Harish Doraiswamy and Vijay Natarajan  
*Computational Geometry: Theory and Applications*, 42, 2009, 606–616
23. Identifying Robust Plans through Plan Diagram Reduction  
Harish D., Pooja N. Darera, Jayant R. Haritsa  
*Proceedings of the VLDB Endowment (VLDB '08)*, 1(1), 2008, 1124–1140
24. Efficiently Approximating Query Optimizer Plan Diagrams  
Atreyee Dey, Sourjya Bhaumik, Harish D., Jayant R. Haritsa  
*Proceedings of the VLDB Endowment (VLDB '08)*, 1(2), 2008, 1325–1336
25. Efficient Output-Sensitive Construction of Reeb Graphs  
Harish Doraiswamy and Vijay Natarajan  
*ISAAC '08: Proc. Intl. Symp. Algorithms and Computation*, 2008, 557–568
26. On the Production of Anorexic Plan Diagrams  
Harish D., Pooja N. Darera, Jayant R. Haritsa  
*VLDB '07: Proc. of 33rd Intl. Conf. on Very Large Data Bases*, 2007, 1081–1092

## Refereed Posters and Videos

1. Computing Reeb Graphs as a Union of Contour Trees  
Harish Doraiswamy and Vijay Natarajan  
*Poster at IEEE Visualization*, 2011
2. Constructing Reeb Graphs using Cylinder Maps  
Harish Doraiswamy, Aneesh Sood, and Vijay Natarajan  
*ACM Symposium on Computational Geometry, Video / Multimedia track*, 2010

## Theses

1. Reeb Graphs: Computation, Visualization and Applications  
Harish D.  
*Ph.D. Thesis*, Indian Institute of Science (Bangalore), June 2012

2. SIGHT and SEER: Efficient Production and Reduction of Query Optimizer Plan Diagrams  
Harish D.  
*M.E. Thesis, Indian Institute of Science (Bangalore), July 2008*

### Technical Reports

1. Extraction of Robust Voids and Pockets in Proteins  
Raghavendra Sridharamurthy, Harish Doraiswamy, Siddharth Patel, Raghavan Varadarajan, and Vijay Natarajan  
*IISc-CSA-TR-2013-3, CSA, Indian Institute of Science*
2. Efficient Generation of Approximate Plan Diagrams  
Atreyee Dey, Sourjya Bhaumik, Harish D., Jayant R. Haritsa  
*TR-2008-01, DSL/SERC, Indian Institute of Science*
3. Robust Plans through Plan Diagram Reduction  
Harish D., Pooja N. Darera, Jayant R. Haritsa  
*TR-2007-02, DSL/SERC, Indian Institute of Science*
4. Reduction of Query Optimizer Plan Diagrams  
Harish D., Pooja N. Darera, Jayant R. Haritsa  
*TR-2007-01, DSL/SERC, Indian Institute of Science*

### Software Systems

1. *Raster Join*. Fast spatial aggregation queries using GPUs. <https://github.com/ViDA-NYU/raster-join>
2. *Urban Pulse*. Analyze and compare cities using urban data. <https://github.com/ViDA-NYU/urban-pulse>
3. *TopoAngler*. Interactive tool to extract fishes from CT scans. <https://github.com/ViDA-NYU/Segmentangling>
4. *The Data Polygamy framework*. Scalable topology-based framework that automatically identifies relationships across large collections of spatio-temporal data sets. <https://github.com/ViDA-NYU/data-polygamy>.
5. *MongoDB with STIG*. GPU-based spatio-temporal index (STIG) integrated into MongoDB. This index provides sub-second response times to queries over large spatio-temporal data sets and is orders of magnitude faster than commercial and open-source databases. <https://github.com/harishd10/mongodb>.
6. *The Urbane Framework*. An interactive visual analytics framework that enables the querying and visualization of large urban 2D and 3D data sets.
7. *The Urbane Software Suite*. A collection of software tools for architects built on top of the Urbane framework. Used by architects at Kohn Pedersen Fox Associates PC (KPF), New York City.
8. *Genotet*. An interactive web-based visual exploration framework to support validation of gene regulatory networks. <https://github.com/ViDA-NYU/genotet>
9. *Cloud Exploration Framework*. A visual exploration framework to track and query cloud systems. <https://github.com/harishd10/cloud-track>
10. *Recon*. A fast algorithm that computes the Reeb graph of a scalar function defined on a simplicial mesh. This is the fastest known algorithm for computing Reeb graphs. <https://github.com/harishd10/recon>
11. *RobustCavities*. Web-portal for RobustCavities, a software which computes cavities in proteins robustly taking into account uncertainties in the atomic radii. <http://vgl.serc.iisc.ernet.in/robustCavities/>
12. *libRG*. A library to compute Reeb graph of a scalar function defined on a simplicial mesh, available at <http://vgl.serc.iisc.ernet.in/software/software.php?pid=001>

## Talks / Seminars

### Keynote Presentations and Invited Talks

1. *The Shape of Urban Data: What does it tell about a City?* Peruvian Symposium on Computer Graphics and Imaging (SCGI 2017), Arequipa, Peru, November 2017.
2. *Urban Pulse: Capturing the Rhythm of Cities*, IEEE TVCG Special Session on Advances in Data Visualization at SIGGRAPH 2017, Los Angeles, USA, August 2017.
3. *The Shape of Urban Data: What does it tell about a City?*, **Keynote** at the 2<sup>nd</sup> International Workshop on Smart Cities and Urban Analytics (UrbanGIS), October 2016.
4. *Data Polygamy: The Many-Many Relationships among Urban Spatio-Temporal Datasets*, AWS re:Invent 2016, November 2016.
5. *Data Polygamy: The Many-Many Relationships among Urban Spatio-Temporal Data Sets*, Dept. of Computer Science and Automation, Indian Institute of Science, Bangalore, India, September 2016.
6. *Riding from Urban Data to Insight Using New York City Taxis*, Dept. of Computer Science and Automation, Indian Institute of Science, Bangalore, India, August 2015.
7. *Identifying and Exploring Traffic Patterns using the NYC Taxi Data*, Workshop on Big Data for Social Policy, Fields Institute, Toronto, CA, April 2015.
8. *Topology of Level Sets: Representation, Computation and Applications*, Dept. of Mathematics, Universidade Federal do Ceará, Fortaleza, Brazil, February 2014.
9. *Reeb Graph: Computation, Visualization and Applications*, Dept. of Computer Science, University of California, Irvine, USA, November 2011.

### Conference Presentations

10. *Urban Pulse: Capturing the Rhythm of Cities*, Talk at IEEE SciVis, Baltimore, USA, October 2016.
11. *Anonymizing NYC Taxi Data: Does It Matter?*, Talk at IEEE DSAA, Montreal, Canada, October 2016.
12. *A GPU-Based Index to Support Interactive Spatio-Temporal Queries over Historical Data*, Talk at ICDE, Helsinki, Finland, May 2016.
13. *Topology-based Catalogue Exploration Framework for Identifying View-Enhanced Tower Designs*, Talk at SIGGRAPH ASIA, Kobe, Japan, November 2015.
14. *Exploring Traffic Dynamics in Urban Environments Using Vector-Valued Functions*, Talk at EuroVis, Cagliari, Italy, May 2015.
15. *Using Topological Analysis to Support Event-Guided Exploration in Urban Data*, Talk at IEEE SciVis, Paris, France, November 2014.
16. *An Exploration Framework to Identify and Track Movement of Cloud Systems*, Talk at IEEE SciVis, Atlanta, USA, October 2013.
17. *Computing Reeb Graphs as a Union of Contour Trees*, Talk at IEEE SciVis, Seattle, USA, October 2012.
18. *Efficient output-sensitive construction of Reeb graphs*, Talk at the Intl. Symp. Algorithms and Computation, Gold Coast, Australia, December 2008.

### Research Funding

1. *DARPA*. Streamlining Model Design, Comparison and Curation.  
PI: Juliana Freire; Co-PIs: Enrico Bertini, Kyunghyun Cho, **Harish Doraiswamy**, and Cláudio T. Silva.  
US\$ 3.8 million. March 2017.

## Teaching and Mentoring

### Courses

- *Topics in Data Science: Topological Data Analysis and Graph Signal Processing* (DS-GA 3001) (with Luis Gustavo Nonato), NYU CDS, Spring 2017.

### Invited Lectures

- *Spatio-Temporal Query Processing*, Big Data (DS-GA 1004), NYU CDS, Spring 2015, 2016.

### Mentoring

- *Fabio Miranda*, Ph.D. student, 2015 – present.
- *Fernando Chirigati*, Ph.D. student, 2014 – present.
- *Eleni Tzirita Zacharatou*, Summer Intern, 2016.
- *Nivan Ferreira*, Ph.D. student, 2013 – 2015.
- *Jorge Poco*, Ph.D. student, 2013 – 2015.
- *Marie Douriez*, Summer Intern, 2015.
- *Yunzhe Jia*, Master's thesis, Spring 2015.

### Teaching Assistant

- *Computer Graphics* (E0 271), Dept. of CSA, IISc., August 2010.
- *Computer Graphics* (E0 271), Dept. of CSA, IISc., August 2009.
- *Database Management Systems* (E0 261), Dept. of CSA, IISc., August 2007.

## Professional Service

### Organizing committee

- International Workshop on Smart Cities and Urban Analytics (UrbanGIS), Redondo Beach, USA, November 2017.
- International Workshop on Smart Cities and Urban Analytics (UrbanGIS), San Francisco, USA, October 2016.

### Program committee member

- IEEE SciVis (part of IEEE VIS), Berlin, Germany, October 2018.
- Workshop on Visual Analytics, Information Visualization and Scientific Visualization (WVIS), Rio de Janeiro, Brazil, October 2017.
- Intl. Conf. on Very Large Data Bases (VLDB), Rio De Janeiro, Brazil, August 2018.
- Intl. Conf. on Management of Data (SIGMOD), Chicago, USA, May 2017.
- Workshop on Human-In-the-Loop Data Analytics (HILDA), Chicago, USA, May 2017.
- Intl. Conf. on Data Engineering (ICDE) - Industrial Track, San Diego, USA, April 2017.
- Indian Conf. on Computer Vision, Graphics and Image Processing (ICVGIP), Guwahati, India, December 2016.
- EuroVis 2016 (short papers), Groningen, the Netherlands, June 2016.
- EuroVis 2015 (short papers), Cagliari, Italy, June 2015.
- AAAI workshop on 'AI for Cities', Austin, USA, January 2015.
- Indian Conf. on Computer Vision, Graphics and Image Processing (ICVGIP), Bangalore, India, December 2014.
- SIBGRAPI Conf. on Graphics, Patterns and Images (SIBGRAPI), Rio De Janeiro, Brazil, August 2014.

**Conference reviewer**

- IEEE VIS (accepted papers published in *IEEE TVCG*)
- EuroVis: EG/VGTC Conference on Visualization (accepted papers published in *CGF*)
- IEEE Pacific Visualization Symposium

**Journal reviewer**

- IEEE Transactions on Visualization and Computer Graphics (TVCG)
- Computers & Graphics
- Computer Graphics Forum (CGF)
- IEEE Transactions on Knowledge and Data Engineering (TKDE)
- IEEE Transactions on Big Data (TBD)