

RINA PANIGRAHY

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Home Address:

2521 Royalridge Way
Santa Clara CA 95051
Phone: 4083064607
email:rinapy@gmail.com

Summary

Worked on a variety of applied and theoretical algorithms including nearest neighbor search, locality sensitive hashing, balls and bins processes, cuckoo hashing, learning and prediction (that led to a tool for [stock prediction](#)), algorithms for large graphs such as distance estimation, streaming and sketching algorithms. Many research works have made an impact in industry such as distributed caching for content delivery networks (that led to the founding of **Akamai Technologies**), fast regular expression for worm detection in networks (at Cisco Systems), fast IP lookups using TCAMs, and ad-matching.

Patents/Publications

50+ **patents** issued spanning large number of technologies including networks, power management, hashing and sketching, video indexing, prediction and learning. (list appended)

75+ publications in conference/journals (list appended)

Experience

Google Inc (Nov 2014 - present)

Mountain View, CA

Research Scientist

Worked on algorithms for matching search ads to user queries based on features from the long term query history of the user.

Microsoft Research (Feb 07- Nov 2014)

Mountain View, CA

Principal. Researcher (Mar 2014 – Nov 2014)

Senior Researcher (Mar 2010 – Mar 2017)

Researcher (Feb 07 – Mar 2010)

Member of the Microsoft research lab at Silicon Valley specializing in applied and theoretical algorithms. Worked on problems related to several applications such as web search, load balancing for virtualization, stock prediction, and theoretical problems such as hashing, lower bounds for high dimensional search, learning sparse polynomials and learning using neural networks. Collaborated with several product groups at Microsoft including Bing Search and Ads, MSN, Virtual Machine Management,, SQL Assure, Capital Markets Groups and Xbox. These collaborations resulted in ideas that were implemented in production systems. Product collaborations:

- **Virtual Machine Load Balancing:** Collaborated with the hypervisor VMM team (and the SQL Azure team) on algorithms for multidimensional load-balancing of VMs on physical machines
- **Capital Markets Groups:** Worked with the internal finance team on worst case risk reward analysis for stock investments to produce a technical indicator for algorithmic trading. These algorithms produced better risk/reward ratios such as sharpe and calmar ratios for index funds.
- **Xbox:** Worked on video search and indexing algorithms -- experimented with several methods such as LSH(Locality Sensitive Hashing), LDA(Latent Discriminant Analysis), PCA, K-means and neural networks.
- **Bing Ads:** Worked on measuring and modeling click position bias of search ads for estimating CTR of ads.
- **Bing Social search:** Worked on algorithms for estimating social distance between nodes in a social network in real time for social search on Bing.
- **MSN:** Worked on clustering similar news stories using min-hashing for CDS(content delivery services)

CISCO SYSTEMS (Aug 98 – Mar 2006)

San Jose, CA

Sr Software Engineer

Worked on research/design/implementation of algorithmic solutions for several problems in networking - including - algorithms for regular expression matching and packet parsing at high speeds, algorithmic solutions for longest prefix match at low power using Ternary CAMs, algorithms for high dimensional search for packet classification, algorithms for efficient memory management for tree based longest prefix match, algorithms for

switch scheduling. Filed over 15 patents with USPTO. Also worked on publications in the field of Algorithms and Networking during this period in collaboration with members at Stanford University.

- Worked on invention of a Ternary CAM architecture for IP forwarding at low-power that shows how to perform longest prefix match at a Ternary CAM with a peak power consumption of 2W.
- Worked on scalable algorithms for regular expression matching at high speeds in a load balancing device for URL based load balancing. Invented algorithms to handle a large number of wild-card “.*” characters in regular expressions that normally lead to exponential memory requirements when combined into a single state machine. These algorithms were implemented on the Intel IXP 2800 network processor interacting with Power PC processor with VxWorks.
- Worked on invention of architecture of a parsing chip that performs deep content inspection on packets at a line rate of 10Gbps looking for preconfigured signatures. This chip had a proprietary instruction set that would allow programming it in high-level language using constructs such as if-then -else and loops.
- Designed efficient scalable hashing algorithms to be used in Netflow packet lookups at a rate of 60 million lookups per second while maintaining high memory utilization.
- Worked on design/implementation of Content Processing portions of SSLVPN device using Broadcom 1250 processor.
- Cisco Champion for University research projects with Prof. Mitzenmacher at Harvard University on Hashing for Network search and summarization, and Prof. Nourani at U.T. Dallas on low power network search. The champion plays a central role in funding, approving and working jointly on the progress of the research project.

Vista Research (Nov 05 – Sep 06)

Palo Alto, CA

Member of a ‘Society of Industry Leaders’ to provide consulting advice on technology and market trends in network device search engines.

ORACLE CORPORATION (June 97 – Aug 99)

Redwood Shores, CA

Staff Consultant at Oracle Consulting Services. Worked on integrating heterogeneous applications for customers. Involved working on a Messaging middleware system to transport database objects across applications.

MICROSOFT (Summer Intern 96)

Redmond, WA

Implemented Http and Ftp API's to be used by a Web browser on a P.D.A. These API's supported caching and multithreaded access.

Stanford University (Summer 06)

Palo Alto, CA

Course instructor for Introduction to Algorithms. Responsibilities include preparing and delivering course lectures and working with TA on homework and exam preparation and administration. Also served as a teaching assistant for this class in Autumn 06.

Education

STANFORD UNIVERSITY (Sep 2004-Dec 2006)

Palo Alto, CA

Ph.D. in computer science, Dec 2006. Advisor: Rajeve Motwani.

Thesis on hashing and sketching for space efficient search in high dimensional spaces with applications such as web document similarity search and image search.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY (Aug 1995-1997)

Cambridge, MA

M.S. in Computer Science, June 1997. **GPA 5.0/5.0.**

Masters Thesis: "Relieving Hot Spots on the World Wide Web". Involved design and implementation of replication and caching techniques for managing load on Web sites with excessive demand. This work was used in the founding of **Akamai Technologies**

INDIAN INSTITUTE OF TECHNOLOGY (June 1991-1995)

Bombay, India

B.Tech. degree in Computer Science, June, 1995. Bachelor Thesis: "Online Algorithms for competitive Paged Caching". **GPA 9.9/10.0. (3rd rank in the Institute)**

Awards and Honors

Best paper award in PODS 2008.

Best student paper award in SODA 2005.

Received the Gold Star Award at Microsoft Research for technology transfer and product impact 2010

Masters Thesis work at MIT was used at the founding technology at Akamai Technologies.

Won a **Gold Medal** at the 31st **International Mathematics Olympiad**, 1990, Beijing, China among 308 participants from 53 countries. Also won a **Silver Medal** at the 32nd International Mathematics Olympiad, 1991, Sigtuna, Sweden.

Won Gold Medal at the National Standard Examination in Physics for the years 1990 and 1991.

Top rank at the **All India Entrance Examination** for admission to IIT among **80,000** candidates nationwide, 1990.

Won the National Talent Search Scholarship. Only 700 students all over India are offered the scholarship

Won the Essar Scholarship 1991. Only ten students all over India are offered this scholarship based on academic achievements, original thinking and drive for success.

Program Committees

PC member at KDD 14, WWW 14, ICWSM 14, STOC 2013, WSDM 2013, STOC 2012, KDD 2012, SODA 2012, ESA 2012, WWW 2012, KDD 2011, WWW 2011, SODA 2010, ICDM 2010, ALENEX09, WWW09.

Served as an **NSF Panelist (Algorithms)** in 2011 and 2015.

Invited Talks

Invited talks at ICAA 2014, Data Streams Workshop (Dortmund) 2013, TIFR (Mumbai) 2012, Synergies in Lower bounds (Aarhus) 2011, Data Streams (Kharagpur) 2011, Engineering Cool Talk (Microsoft) 2011, Georgia Tech Algorithms Seminar 2009, Nerd Lunch (Cisco Systems).

Students Advised (as summer interns)

- Alex Andoni from MIT, now faculty member at Columbia University,
- Krsztoff Onak from MIT, now at IBM T.J. Watson
- Nikhil Srivastava from Yale, now faculty member at U.C.Berkeley,
- Atish Das Sarma from Georgia Tech,
- Ding Yuan from UIUC, now at UToronto,
- Preyas Popat from UIUC, now at Google,
- Mikhail Kapralov from Stanford, soon to be at EPFL
- Behnam Neyshabur from TTI Chicago.
- Majid Janzamin from UC Irvine.

References

- Piotr Indyk, Professor, MIT Computer Science and Artificial Intelligence Lab, Room G642 32 Vassar Street Cambridge, Massachusetts 02139, Phone (617) 452-3402, email: indyk@theory.lcs.mit.edu
- Moses Charikar, Professor, Gates Computer Science Bldg. Room 462 353 Serra Mall, Stanford University, Stanford, CA 94305, Phone: 650 725 4404, email: mooses@cs.stanford.edu
- Ashish Goel, Professor, Management Science and Engineering, 475 via Ortega, Huang Engineering Center room 359, Stanford CA 94305-4026. Phone 650 814 1478, email: ashishg@stanford.edu
- George Varghese, Principal Researcher, Microsoft Research 1288 Pear Avenue Mountain View, CA 94043, 858-335-6996, varghese@microsoft.com
- Ravi Kumar, Research Scientist, Google Mountain View, CA 94043, 408-718-1108, ravi.k53@gmail.com

Publications

Available online at <http://theory.stanford.edu/~rinap>

- Rina Panigrahy, Preyas Papat, [Fractal Structures in Adversarial Prediction](#), in ITCS 2015
- Alexandr Andoni, Rina Panigrahy, Gregory Valiant, and Li Zhang, [Learning Polynomials with Neural Networks](#) in ICML, 2014
- Alexandr Andoni, Rina Panigrahy, Gregory Valiant, and Li Zhang, [Learning sparse polynomials](#), in *SODA*, ACM, 2014
- Abhimanyu Das, Sreenivas Gollapudi, Rina Panigrahy, and Mahyar Salek, [Debiasing Social Wisdom](#), ACM International Conference on Knowledge Discovery and Data Mining, August 2013
- Rina Panigrahy, Marc Najork, and Yinglian Xie, [How User Behavior is Related to Social Affinity](#), in *5th ACM International Conference on Web Search and Data Mining (WSDM)*, ACM, February 2012
- Anish Das Sarma, Sreenivas Gollapudi, Rina Panigrahy, and Li Zhang, [Understanding cyclic trends in social choices](#), in *Proc. ACM Conf on Web Search and Data Mining*, ACM, February 2012
- Michael Kapralov and Rina Panigrahy, [Prediction strategies without loss](#), Neural Information Processing Systems Foundation, 2012
- Michael Kapralov and Rina Panigrahy, [Spectral sparsification via random spanners](#), Innovations in Theoretical Computer Science, 2012
- Ding Yuan, Yinglian Xie, Rina Panigrahy, Junfeng Yang, Chad Verbowski, and Arunvijay Kumar, [Context-based Online Configuration-Error Detection](#), in *The 2011 USENIX Annual Technical Conference*, USENIX, June 2011
- Rina Panigrahy, Kunal Talwar, Lincoln Uyeda, and Udi Wieder, [Heuristics for Vector Bin Packing](#), 2011
- Sangmin Lee, Rina Panigrahy, Vijayan Prabhakaran, Venugopalan Ramasubramanian, Kunal Talwar, Lincoln Uyeda, and Udi Wieder, [Validating Heuristics for Virtual Machines Consolidation](#), no. MSR-TR-2011-9, January 2011
- Rina Panigrahy, Kunal Talwar, and Udi Wieder, [Lower Bounds on Near Neighbor Search via Metric Expansion](#), in *FOCS*, IEEE Computer Society, October 2010
- Gagan Aggarwal, Tomás Feder, Krishnam Kenthapadi, Samir Khuller, Rina Panigrahy, Dilys Thomas, and An Zhu, [Achieving anonymity via clustering](#), in *ACM Transactions on Algorithms (TALG)*, vol. 6, no. 3, pp. 49:1–49:19, ACM, July 2010
- Atish Das Sarma, Sreenivas Gollapudi, Marc Najork, and Rina Panigrahy, [A Sketch-Based Distance Oracle for Web-Scale Graphs](#), in *3rd ACM International Conference on Web Search and Data Mining (WSDM)*, Association for Computing Machinery, Inc., February 2010
- Anish Das Sarma, Atish Das Sarma, Sreenivas Gollapudi, and Rina Panigrahy, [Ranking Mechanisms for Twitter-Like Forums](#), in *Proc. of Third ACM International Conference on Web Search and Data Mining (WSDM)*, Association for Computing Machinery, Inc., 2010
- Atish Das Sarma, Sreenivas Gollapudi, and Rina Panigrahy, [Sparse Cut Projections in Graph Streams](#), in *17th Annual European Symposium on Algorithms (ESA)*, European Association for Theoretical Computer Science, September 2009
- Andrew McGregor Krzysztof Onak and Rina Panigrahy, [The Oil Searching Problem](#), in *ESA*, Springer Verlag, July 2009
- Marc Najork, Sreenivas Gollapudi, and Rina Panigrahy, [Less is More: Sampling the Neighborhood Graph Makes SALSA Better and Faster](#), in *2nd ACM International Conference on Web Search and Data Mining (WSDM)*, Association for Computing Machinery, Inc., February 2009
- Eric Lehman and Rina Panigrahy, [3.5-Way Cuckoo Hashing for the Price of 2-and-a-Bit](#), in *ESA*, Springer Verlag, 2009
- Rina Panigrahy, Kunal Talwar, and Udi Wieder, [A Geometric Approach to Lower Bounds for Approximate Near-Neighbor Search and Partial Match](#), in *FOCS '08: Proceedings of the 49th annual IEEE Symposium on Foundations of Computer Science*, IEEE, October 2008
- Yinglian Xie, Fang Yu, Kannan Achan, Rina Panigrahy, Geoff Hulten, and Ivan Osipkov, [Spamming Botnet: Signatures and Characteristics](#), in *ACM SIGCOMM 2008, Seattle, WA*, August 2008
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- Rina Panigrahy, [An Improved Algorithm Finding Nearest Neighbor Using Kd-trees](#), in *Latin American Symposium on Theoretical Informatics (LATIN)*, Springer, Búzios, Brazil, April 2008
- Thomas Holenstein, Michael Mitzenmacher, Rina Panigrahy, and Udi Wieder, [Trace reconstruction with constant deletion probability and related results](#), in *ACM-SIAM Symposium on Discrete Algorithms (SODA)*, San Francisco, CA, January 2008
- Sreenivas Gollapudi, Marc Najork, and Rina Panigrahy, [Using Bloom Filters to Speed Up HITS-like Ranking Algorithms](#), in *5th Workshop on Algorithms and Models for the Web Graph (WAW)*, Springer-Verlag, December 2007
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- Rina Panigrahy and Ravi Kumar, [On Finding Frequent Elements in a Data Stream](#), in *Workshop on Randomization and Computation (RANDOM)*, Princeton University, NJ, August 2007
- Rajeev Motwani, Rina Panigrahy, and Ying Xu 0002, [Estimating Sum by Weighted Sampling](#), in *International Colloquium on Automata, Languages and Programming, (ICALP)*, Wroclaw, Poland, July 2007
- Rina Panigrahy, ["Hashing Searching Sketching"](#), in *Ph.D. Thesis, Stanford University.*, 2007
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- Sreenivas Gollapudi and Rina Panigrahy, [A dictionary for approximate string search and longest prefix search](#), in *Proceedings of the 2006 ACM CIKM International Conference on Information and Knowledge Management*, Association for Computational Linguistics, November 2006
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- "Estimating Corpus Size via Queries" with A. Broder, M. Fontoura, V. Josifovski, R. Kumar and R. Motwani. CIKM 2006
- ["Lower bounds on Locality Sensitive Hashing". SOCG 2006.](#)
- ["Near-Perfect Fractional Matching via Balls-and-Bins" with Rajeev Motwani and Ying Xu. RANDOM 2006.](#)
- ["Entropy based Nearest Neighbor Search in High Dimensions". SODA 2006.](#)
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- "Web Caching With Request Reordering" with T. Feder, R. Motwani, and A. Zhu. Proceedings of the Thirteenth Annual ACM-SIAM Symposium on Discrete Algorithms, 2002.
- "Sorting and Searching using Ternary CAMs" with Samar Sharma. Hot Interconnects 2002.
- "Reducing TCAM Power Consumption and Increasing Throughput" with Samar Sharma. Hot Interconnects 2002
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Patents

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- Abhijit Patra, Rina Panigrahy, Samar Sharma: Techniques for efficient memory management for longest prefix match problems. Cisco Technology April 2004: US 06725326 (26 worldwide citation)
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