# Sivakanth Gopi

*Curriculum Vitae*

*Mountain View, CA*
*sigopi@microsoft.com*
*https://gopisivakanth.github.io*

## Interests

I am currently working on quantization of neural networks to reduce inference costs and on improving reasoning abilities of LLMs. Previously at Microsoft, I have worked on designing erasure codes for distributed storage and on differential privacy for generating synthetic data imitating private data and for training deep learning models on private data.

## Work

2023 – **Principal Researcher**, *Algorithms group, Microsoft Research Redmond*

2020 – 2023 **Senior Researcher**, *Algorithms group, Microsoft Research Redmond*

2018 – 2020 **Postdoctoral Researcher**, *Algorithms group, Microsoft Research Redmond*

## Education

2013 – 2018 **PhD in Theoretical Computer Science**, *Princeton University*, Advisor: Prof. Zeev Dvir, PhD Thesis: Locality in Coding Theory, GPA: 3.86/4.0

2009 – 2013 **B.Tech in Computer Science and Engineering with Honors, and Minor in Mathematics**, *Indian Institute of Technology Bombay*, GPA: 9.77/10

## Internships

Fall 2016 **Microsoft Research, Redmond**
*Mentor: Sergey Yekhanin*

Summer 2012 **Microsoft Research, Bangalore**
*Mentors: Prateek Jain, Aditya Nori and Deeparnab Chakrabarty*

Summer 2011 **IST Austria**
*Mentors: Pavol Černý and Thomas Henzinger*

## Theses

2018 **Locality in Coding Theory**, *PhD Thesis*, Princeton University
*Advisor: Zeev Dvir*

2013 **Stability of Linear Threshold Functions**, *Undergraduate Thesis*, IIT Bombay
*Advisors: Prahladh Harsha (TIFR) and Srikanth Srinivasan (IITB)*

## Honors and Awards

- **Best paper award** at Symposium on Theory of Computing (STOC) 2015
- **Gold Medal** (and ranked $9^{th}$) in the **International Physics Olympiad-2009**
- **Institute Silver Medal** given to the most outstanding student of Computer Science department, IIT Bombay
- **Institute Academic Prize** for the year 2010-11 by IIT Bombay
- Ranked $3^{rd}$ in the national entrance test to IITs (IITJEE-2009) taken by around 400,000 students

- **Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship**, a national fellowship for students interested in science by Dept. of Science and Technology, India
- **National Talent Search (NTS) Scholarship** by National Council of Education Research and Training (NCERT), India
- **Aditya Birla Scholarship**, awarded to outstanding engineering undergraduates in India
- **INMO Scholarhip** by National Board for Higher Mathematics (NBHM), India
- **A*STAR India Youth Scholarship** by Agency for Science, Technology and Research (ASTaR) , Government of Singapore

## Service

- Co-organized the *Error Correcting Codes: Theory and Practice* semester program at Simons Institute, Berkeley in Spring 2024.
- Served on PC for ITCS 2024, FSTTCS 2023

## Invited Talks

**DiscQuant: A Quantization Method for Neural Networks Inspired by Discrepancy Theory**
Google Research, Mountain View (Jan 2025)

**Higher Order MDS Codes**
Simons Institute, Berkeley (April 2024)

**Differentially Private Synthetic Data via Foundation Model APIs**
Google Research, NY (June 2023)

**Generic Reed-Solomon codes achieve list-decoding capacity**
Plenary Speaker, ITA 2023, San Diego (Feb 2023)
IISc, Bangalore (Mar 2023)

**Privacy Preserving Machine Learning**
Jovian, Bangalore (Mar 2023)

**Private Convex Optimization via Exponential Mechanism**
Boston Privacy Seminar, co-organized by Harvard, Boston and Northeastern Universities (Mar 2022)
IISc Theory Seminar, Bangalore (Mar 2023)

**CSPs with Global Modular Constraints: Algorithms and Hardness via Polynomial Representations**
CSP Seminar (Jun 2021)

**Fast and Memory Efficient Differentially Private-SGD via JL Projections**
Google Privacy Seminar (May 2021)

**Spanoids - An Abstraction of Spanning Structures, and a Barrier for LCCs**
Highlights of Algorithms (HALG) 2020 (Sep 2020)

**CSPs with Global Modular Constraints: Algorithms and Hardness via Polynomial Representations**
Theory seminar, University of Washington (Mar 2019)
CSDM Seminar, Institute for Advanced Study (IAS), Princeton (Mar 2020)

**Gaussian width bounds with applications to arithmetic progressions in random settings**
Combinatorics seminar, Rutgers University (Oct 2018)
Combinatorics seminar, Georgia Tech (Nov 2018)

**Maximally recoverable local reconstruction codes**
Workshop on Coding and Information Theory, CMAS, Harvard University (Apr 2018)

**On the number of rich lines in truly high dimensional sets**
Discrete Math Seminar, Rutgers University (Apr 2015)

**2-Server PIR with sub-polynomial communication**
CSDM Seminar, Institute for Advanced Study (IAS), Princeton (Dec 2015)
Theory Seminar, Rutgers University (Feb 2015)
China Theory Week, Shanghai Jiao Tong University (Aug 2015)
Theory Seminar, CMU (Nov 2015)
Theory Seminar, IISc Bangalore (Dec 2015)
CCC Satellite workshop, Kyoto University (Jun 2016)
DIMACS Workshop on Cryptography and its Interactions, Rutgers University (Jul 2016)
Canadian Discrete and Algorithmic Mathematics Conference (CanaDAM) 2017, Toronto (June 2017)

## Teaching Experience

2019 **Co-instructor, University of Washington**
Modern Coding Theory, cotaught with Prof. Anup Rao

2014 **Graduate Teaching Assistant, Princeton University**
Theory of Computation, Reasoning about Computation

2010 **Undergraduate Teaching Assistant, IIT Bombay**
Linear Algebra, Differential Equations, Modern Physics, Intro to Computer Programming

## Conference Publications

**A Geometric Perspective on the Injective Norm of Sums of Random Tensors**
Afonso Bandeira, Sivakanth Gopi, Haotian Jiang, Kevin Lucca, Thomas Rothvoss.
Symposium of Theory of Computing (STOC) 2025.

**Privacy-preserving in-context learning with differentially private few-shot generation**
Xinyu Tang, Richard Shin, Huseyin Inan, Andre Manoel, Fatemehsadat Mireshghallah, Zinan Lin, Sivakanth Gopi, Janardhan Kulkarni, Robert Sim.
International Conference on Learning Representations (ICLR) 2024.

**Differentially private synthetic data via foundation model apis 2: Text**
Chulin Xie, Zinan Lin, Arturs Backurs, Sivakanth Gopi, Da Yu, Huseyin Inan, Harsha Nori, Haotian Jiang, Huishuai Zhang, Yin Lee, et al.
International Conference on Machine Learning (ICML) 2024.

**Differentially private synthetic data via foundation model apis 1: Images**
Zinan Lin, Sivakanth Gopi, Janardhan Kulkarni, Harsha Nori, Sergey Yekhanin.
International Conference on Learning Representations (ICLR) 2024.

**AG codes achieve list decoding capacity over constant-sized fields**
Joshua Brakensiek, Manik Dhar, Sivakanth Gopi, Zihan Zhang.
Symposium on Theory of Computing (STOC) 2024.

**Generalized GM-MDS: Polynomial Codes are Higher Order MDS**
Joshua Brakensiek, Manik Dhar, Sivakanth Gopi.
Symposium on Theory of Computing (STOC) 2024.

**Training private and efficient language models with synthetic data from LLMs**
Da Yu, Arturs Backurs, Sivakanth Gopi, Huseyin Inan, Janardhan Kulkarni, Zinan Lin, Chulin Xie, Huishuai Zhang, Wanrong Zhang.
Socially Responsible Language Modelling Research 2023.

**Private convex optimization in general norms**
Sivakanth Gopi, Yin Lee, Daogao Liu, Ruoqi Shen, Kevin Tian.
Symposium on Discrete Algorithms (SODA) 2023.

**Generic Reed-Solomon codes achieve list-decoding capacity**
Joshua Brakensiek, Sivakanth Gopi, Visu Makam.
Symposium on Theory of Computing (STOC) 2023.

**Algorithmic aspects of the log-Laplace transform and a non-Euclidean proximal sampler**
Sivakanth Gopi, Yin Lee, Daogao Liu, Ruoqi Shen, Kevin Tian.
Conference on Learning Theory (COLT) 2023.

**A construction of Maximally Recoverable LRCs for small number of local groups**
Manik Dhar, Sivakanth Gopi.
IEEE International Symposium on Information Theory (ISIT) 2023.

**Private convex optimization via exponential mechanism**
Sivakanth Gopi, Yin Lee, Daogao Liu.
Conference on Learning Theory (COLT) 2022.

**Differentially private fine-tuning of language models**
Da Yu, Saurabh Naik, Arturs Backurs, Sivakanth Gopi, Huseyin Inan, Gautam Kamath, Janardhan (Jana) Kulkarni, Yin Tat Lee, Andre Manoel, Lukas Wutschitz, Sergey Yekhanin and Huishuai Zhang.
International Conference on Learning Representations (ICLR) 2022.

**Trellis BMA: coded trace reconstruction on IDS channels for DNA storage**
Sundara Rajan Srinivasavaradhan, Sivakanth Gopi, Henry Pfister and Sergey Yekhanin.
International Symposium on Information Theory (ISIT) 2021.

**Numerical Composition of Differential Privacy**
Sivakanth Gopi, Yin Tat Lee and Lukas Wutschitz.
Neural Information Processing Systems (NeurIPS 2021.

**Differentially private n-gram extraction**
Kunho Kim, Sivakanth Gopi, Janardhan Kulkarni and Sergey Yekhanin.
Neural Information Processing Systems (NeurIPS) 2021.

**Fast and Memory Efficient Differentially Private-SGD via JL Projections**
Zhiqi Bu, Sivakanth Gopi, Janardhan Kulkarni, Yin Tat Lee, Judy Hanwen Shen and Uthaipon Tantipongpipat.
Neural Information Processing Systems (NeurIPS) 2021.

**Locally Private Hypothesis Selection**
Sivakanth Gopi, Gautam Kamath, Janardhan Kulkarni, Aleksandar Nikolov, Zhiwei Steven Wu and Huanyu Zhang.
Conference on Learning Theory (COLT), 2020.

**Differentially Private Set Union**
Sivakanth Gopi, Pankaj Gulhane, Janardhan Kulkarni, Judy Hanwen Shen, Milad Shokouhi and Sergey Yekhanin.
International Conference on Machine Learning (ICML) 2020.
Theory and Practice of Differential Privacy (TPDP) 2020 (Contributed Talk) .

**CSPs with Global Modular Constraints: Algorithms and Hardness via Polynomial Representations**
Joshua Brakensiek, Sivakanth Gopi and Venkatesan Guruswami.
ACM Symposium on Theory of Computing (STOC) 2019.

**Spanoids - an abstraction of spanning structures, and a barrier for LCCs**
Zeev Dvir, Sivakanth Gopi, Yuzhou Gu and Avi Wigderson.
Innovations in Theoretical Computer Science (ITCS) 2019.

**On Maximally Recoverable Local Reconstruction Codes**
Sivakanth Gopi, Venkat Guruswami and Sergey Yekhanin.
Symposium on Discrete Algorithms (SODA) 2019.

**Lower bounds for 2-query LCCs over large alphabet**
Arnab Bhattacharyya, Sivakanth Gopi and Avishay Tal.
RANDOM 2017.

**Outlaw distributions and locally decodable codes**
Jop Briët, Zeev Dvir and Sivakanth Gopi.
Innovations in Theoretical Computer Science (ITCS) 2017.

**Locally testable and Locally correctable Codes Approaching the Gilbert-Varshamov Bound**
Sivakanth Gopi, Swastik Kopparty, Rafael Oliveira, Noga Ron-Zewi and Shubhangi Saraf.
Symposium on Discrete Algorithms (SODA) 2017.

**Competitive analysis of the top-K ranking problem**
Xi Chen, Sivakanth Gopi, Jieming Mao and Jon Schneider.
Symposium on Discrete Algorithms (SODA) 2017.

**Lower bounds for affine invariant LCCs and LTCs**
Arnab Bhattacharya and Sivakanth Gopi.
Conference on Computational Complexity (CCC) 2016.

**On the number of rich lines in truly high dimensional sets**
Zeev Dvir and Sivakanth Gopi.
International Symposium on Computational Geometry (SoCG) 2015.

**2-Server PIR with sub-polynomial communication**
Zeev Dvir and Sivakanth Gopi.
ACM Symposium on Theory of Computing (STOC) 2015.
Co-winner of best paper award

**One-bit compressed sensing: Provable support and vector recovery**
Sivakanth Gopi, Praneeth Netrapalli, Prateek Jain and Aditya V. Nori.
International Conference on Machine Learning (ICML) 2013.

**Synthesis from incompatible specifications**
Pavol Cerný, Sivakanth Gopi, Thomas A. Henzinger, Arjun Radhakrishna and Nishant Totla.
International Conference on Embedded Software (EMSOFT) 2012.

## Preprints and Manuscripts

**On the Emergence of Thinking in LLMs I: Searching for the Right Intuition**
Guanghao Ye, Khiem Pham, Xinzhi Zhang, Sivakanth Gopi, Baolin Peng, Beibin Li, Janardhan Kulkarni, Huseyin Inan.

**DiscQuant: A Quantization Method for Neural Networks Inspired by Discrepancy Theory**
Jerry Chee, Arturs Backurs, Rainie Heck, Li Zhang, Janardhan Kulkarni, Thomas Rothvoss, Sivakanth Gopi.

**Rigidity matroids and linear algebraic matroids with applications to matrix completion and tensor codes**
Joshua Brakensiek, Manik Dhar, Jiyang Gao, Sivakanth Gopi, Matt Larson.

**Phi-2: The surprising power of small language models**
Mojan Javaheripi, Sébastien Bubeck, Marah Abdin, Jyoti Aneja, Sebastien Bubeck, Caio Mendes, Weizhu Chen, Allie Del, Ronen Eldan, Sivakanth Gopi, et al.

**Textbooks are all you need**
Suriya Gunasekar, Yi Zhang, Jyoti Aneja, Caio Mendes, Allie Del, Sivakanth Gopi, Mojan Javaheripi, Piero Kauffmann, Gustavo Rosa, Olli Saarikivi, et al.

**Ranking with Multiple Objectives**
Nikhil Devanur and Sivakanth Gopi.

## Journal Publications

**Selective pre-training for private fine-tuning.**
Da Yu, Sivakanth Gopi, Janardhan Kulkarni, Zinan Lin, Saurabh Naik, Tomasz Religa, Jian Yin, Huishuai Zhang.
Transactions on Machine Learning Research (TMLR), 2024.

**Improved field size bounds for higher order MDS codes.**
Joshua Brakensiek, Manik Dhar, Sivakanth Gopi.
IEEE Transactions on Information Theory, 2024.

**Generic Reed–Solomon Codes Achieve List-Decoding Capacity.**
Joshua Brakensiek, Sivakanth Gopi, Visu Makam.
Invited article in SIAM Journal on Computing. https://doi.org/10.1137/23M1598064.
Preliminary version appeared in STOC 2023.

**Differentially Private Fine-Tuning of Language Models.**
Yu, Da, Saurabh Naik, Arturs Backurs, Sivakanth Gopi, Huseyin A. Inan, Gautam Kamath, Janardhan Kulkarni, Yin Tat Lee, Andre Manoel, Lukas Wutschitz, Sergey Yekhanin, and Huishuai Zhang.
Journal of Privacy and Confidentiality 14 (2). https://doi.org/10.29012/jpc.880.
Preliminary version appeared in ICLR 2022.

**Private Convex Optimization via Exponential Mechanism.**
Gopi, Sivakanth, Yin Tat Lee, and Daogao Liu.
Journal of Privacy and Confidentiality 14 (1). https://doi.org/10.29012/jpc.869.
Preliminary version appeared in COLT 2022.

**Constraint Satisfaction Problems with Global Modular Constraints: Algorithms and Hardness via Polynomial Representations.**
Joshua Brakensiek, Sivakanth Gopi, and Venkatesan Guruswami.
SIAM Journal on Computing 51, no. 3 (2022): 577-626.
Preliminary version appeared in STOC 2019.

**Improved maximally recoverable LRCs using skew polynomials.**
Sivakanth Gopi, Venkatesan Guruswami.
IEEE Transactions on Information Theory, 2022.

**Lower bounds for maximally recoverable tensor codes and higher order MDS codes.**
Joshua Brakensiek, Sivakanth Gopi, Visu Makam.
IEEE Transactions on Information Theory, 2022.

**Numerical Composition of Differential Privacy.**

Gopi, Sivakanth, Yin Tat Lee, and Lukas Wutschitz. 2024.
Journal of Privacy and Confidentiality 14 (1). https://doi.org/10.29012/jpc.870.
Preliminary version appeared in NeurIPS 2021.

**Differentially Private Set Union**

Sivakanth Gopi, Pankaj Gulhane, Janardhan Kulkarni, Judy Hanwen Shen, Milad Shokouhi and Sergey Yekhanin.
Journal of Privacy and Confidentiality, 11(3). doi: 10.29012/jpc.780.
Preliminary version appeared in ICML 2020.

**Maximally Recoverable LRCs: A field size lower bound and constructions for few heavy parities**

Sivakanth Gopi, Venkatesan Guruswami and Sergey Yekhanin.
IEEE Transactions on Information Theory, 2020. DOI: 10.1109/TIT.2020.2990981.
Preliminary version appeared in SODA 2019.

**Spanoids - an abstraction of spanning structures, and a barrier for LCCs**

Zeev Dvir, Sivakanth Gopi, Yuzhou Gu and Avi Wigderson.
SIAM Journal on Computing, 49(3), 465–496, 2020. DOI: 10.1137/19M124647X.
Preliminary version appeared in ITCS 2019.

**Outlaw Distributions and Locally Decodable Codes**

Jop Briët, Zeev Dvir and Sivakanth Gopi.
Theory of Computing, Volume 15(12), pp. 1-24, 2019. DOI: 10.4086/toc.2019.v015a012.
Preliminary version appeared in ITCS 2017.

**Gaussian width bounds with applications to arithmetic progressions in random settings**

Jop Briët and Sivakanth Gopi.
International Mathematics Research Notices (IMRN), 2018, rny238. DOI: 10.1093/imrn/rny238.

**Locally testable and Locally correctable Codes Approaching the Gilbert-Varshamov Bound**

Sivakanth Gopi, Swastik Kopparty, Rafael Oliveira, Noga Ron-Zewi and Shubhangi Saraf.
IEEE Transactions on Information Theory, Volume 64 Issue 8, Aug 2018, Pages: 5813 - 5831.
DOI: 10.1109/TIT.2018.2809788.
Preliminary version appeared in SODA 2017.

**Optimal Instance Adaptive Algorithm for the Top-K Ranking Problem**

Xi Chen, Sivakanth Gopi, Jieming Mao and Jon Schneider.
IEEE Transactions on Information Theory, Volume 64 Issue 9, Sep 2018, Pages: 6139 - 6160.
DOI: 10.1109/TIT.2018.2851986.
Preliminary version appeared in SODA 2017.

**2-Server PIR with sub-polynomial communication**

Zeev Dvir and Sivakanth Gopi.
Invited article in Journal of the ACM (JACM), Volume 63 Issue 4, Nov 2016, Article 39.
DOI: 10.1145/2968443.
Preliminary version appeared in STOC 2015.

**Lower Bounds for Constant Query Affine-Invariant LCCs and LTCs**

Arnab Bhattacharyya and Sivakanth Gopi.
ACM Transactions on Computing Theory (TOCT), Volume 9 Issue 2, May 2017, Article 7.
DOI: 10.1145/3016802.
Preliminary version appeared in CCC 2016.