Karthik C. S.

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Research Interests

I am broadly interested in **Theoretical Computer Science**. In particular, I have spent the last few years proving **Hardness of Approximation** results for problems in **P** and understanding the Hardness of **Geometric** problems, such as **Clustering**, **Steiner Tree**, **Closest Pair**, and **Fixed Point** Computation.

Education

- **Ph.D.** in Computer Science — *September 2014 – June 2019*
  Weizmann Institute of Science, Rehovot, Israel — *Advisor*: Prof. Irit Dinur
  Ph.D. Thesis: New Arenas in Hardness of Approximation
- **M.S.** in Computer Science — *September 2012 – July 2014*
  École Normale Supérieure, Lyon, France — *Advisor*: Prof. Hervé Fournier
  Master Thesis: Lower bounds for Multilinear Branching Programs

Employment

- **Assistant Professor** — *September 2021 – ongoing*
  Rutgers University, New Brunswick, USA
- **Postdoctoral Fellow** — *September 2020 – August 2021*
  Host: Prof. Subhash Khot — **New York University**, New York, USA
- **Postdoctoral Fellow** — *September 2019 – August 2020*
  Host: Prof. Amir Shpilka — **Tel Aviv University**, Tel Aviv, Israel
- **Postdoctoral Fellow** — *July 2019 – September 2019*
  Host: Prof. Irit Dinur — **Weizmann Institute of Science**, Rehovot, Israel

Selected Recent Academic Awards and Honors

- **National Science Foundation** Grant Award ($252,846) — *2024–27*
  Title: DIMACS Special Focus on Fine-Grained Complexity
- **National Science Foundation** Grant Award ($600,000) — *2023–26*
  Title: AF: Small: Hardness of Approximation Meets Parameterized Complexity
- Rutgers Research Council **Individual Fulcrum** Award ($2,000) — *2022-23*
- Rutgers University Libraries **Open and Affordable Textbooks** Award — *Spring 2023*
- **Simons** Foundation **Junior Faculty** Fellow — *2021-24*

Mentoring

Ph.D. Students at Rutgers:

- Surya Teja Gavva — *Graduated March 2023*
  Thesis: Computational Aspects of Some Geometric and Analytic Problems
  Surya joined City University of New York as Lecturer after graduation.

- Adarsh Srinivasan *2022 – ongoing*
- Mursalin Habib *2023 – ongoing*
- Minhao Bai *2021 – ongoing*

Master Students at Rutgers:

- Sharath Punna *Graduated April 2023*
  Thesis: On Clustering Data with Few Clusters **Outstanding Project Award**
  Sharath joined Ansys as R&D Engineer after graduation.

Undergraduate Students at Rutgers: Parth Patel (*Summer 2022*), Kashish Vaibhav (*Summer 2022*), Shakib Rahman (*2022 – 2023*; **Novielli Award**), Keya Patel (*2022 – 2023*), Surya Mantha (*2022 – 2023*), Elijah Rubin (*2022 – 2023*), Enver Aman (*2024*; **Magidson Award**; **Henry Rutgers Scholar Award**).

DIMACS REU Students: Henry Fleischmann (University of Michigan; *Summer 2022*; **Honorable Mention for the CRA** (Computing Research Association) **Outstanding Undergraduate Researcher Award 2023**), Lakshay Patel (University of California Berkeley; *Summer 2022*), Styopa Zharkov (Stanford University; *Summer 2023*; **Honorable Mention for the CRA** (Computing Research Association) **Outstanding Undergraduate Researcher Award 2024**), Ashwin Padaki (Columbia University; *Summer 2023*), Jakub Petr (Charles University; *Summer 2023*), Guillermo Gamboa (Charles University; *Summer 2023, Summer 2024*), Kyrylo Karlov (Charles University; *Summer 2023*), Josef Matějka (Charles University; *Summer 2023*), Patrik Zavoral (Charles University; *Summer 2024*), Todor Antic (Charles University; *Summer 2024*), Jelena Glisic (Charles University; *Summer 2024*).

Professional Service

Program Committee Member: STOC'24, ICDM'24, SODA'24, FSTTCS'23, UAI'23, ICALP'23, WAOA'22, UAI'22 (Recognized as **Top Reviewer**), ITCS'22, UAI'21, IPEC'21.

Workshop Organizer: Dagstuhl Seminar in 2023 titled *Parameterized Approximation: Algorithms and Hardness*, UCSD EnCORE Workshop in 2024 titled *Old Questions and New Directions in Theory of Clustering*, DIMACS Tutorial in 2024 titled *DIMACS Tutorial on Fine-grained Complexity*.

Reviewer for Conferences: STACS'25, ITCS'25, SOSA'25, SODA'25, FOCS'24, ICALP'24, ITCS'24, SOFSEM'24, SOSA'24, APPROX'23, ESA'23, FOCS'23, ICML'23, STOC'23, SODA'23, ESA'22, ICALP'22, SoCG'22, STOC'22, WALCOM'22, SODA'22, FOCS'21, ESA'21, SPAA'21, CCC'21, ICALP'21, SoCG'21, STOC'21, SODA'21, FOCS'20, ICALP'20, STOC'20, ITCS'20, SODA'20, ISAAC'19, APPROX'19, ESA'19, CCC'19, ICALP'19, STOC'19, FOCS'18, PODC'18, ICALP'18, RANDOM'18, STACS'18, CSR'18, SPAA'17.

Reviewer for Journals: Journal of the ACM, SIAM Journal on Computing, SIAM Journal on Discrete Mathematics, Journal of Computational Complexity, Computer Science Review, Information Processing Letters, IEEE Transactions on Pattern Analysis and Machine Intelligence, Games and Economic Behavior, ACM Journal of Experimental Algorithmics, Algorithmica.

Reviewer for Grant Proposals: French National Research Agency (ANR), Israel Science Foundation (ISF).

(Co-)Organizer of Rutgers/DIMACS theory seminar: 2022 – 24.

Committee Services at Rutgers: Faculty Hiring committee 2024, PhD Admissions committee 2022 – 25, Masters Admissions committee 2025, SAS Honors Program Faculty Mentor 2022 – 24.

Publications

- **Inapproximability of Maximum Diameter Clustering for Few Clusters**
  Joint work with Henry Fleischmann, Kyrylo Karlov, Ashwin Padaki, and Stepan Zharkov.
  In the Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (**SODA**), 2025.
- **Maximum Span Hypothesis: A Weaker Assumption than Gap-ETH for Parameterized Complexity**
  Joint work with Subhash Khot.
  In the Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (**SODA**), 2025.
- **On Equivalence of Parameterized Inapproximability of k-Median, k-Max-Coverage, and 2-CSP**
  Joint work with Euiwoong Lee and Pasin Manurangsi.
  In the Proceedings of the International Symposium on Parameterized and Exact Computation (**IPEC**), 2024.
  Invited to Algorithmica journal Special Issue for IPEC 2024.
- **On connections between k-coloring and Euclidean k-means**
  Joint work with Enver Aman and Sharath Punna.
  In the Proceedings of the European Symposium on Algorithms (**ESA**), 2024.
- **On Inapproximability of Reconfiguration Problems: PSPACE-Hardness and some Tight NP-Hardness Results**
  Joint work with Pasin Manurangsi.
  Manuscript: `https://eccc.weizmann.ac.il/report/2024/007/`
- **Explicit Good Codes Approaching Distance 1 in Ulam Metric**
  Joint work with Elazar Goldenberg and Mursalin Habib.
  In the Proceedings of the International Symposium on Information Theory (**ISIT**), 2024.
- **On Approximability of Steiner Tree in ℓ_p-metrics**
  Joint work with Henry Fleischmann and Surya Teja Gavva.
  In the Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (**SODA**), 2024.
- **Conditional lower bounds for sparse parameterized 2-CSP: A streamlined proof**
  Joint work with Daniel Marx, Marcin Pilipczuk, and Uéverton Souza.
  In the Proceedings of the SIAM Symposium on Simplicity in Algorithms (**SOSA**), 2024.
- **Clustering Categorical Data: Soft Rounding k-modes**
  Joint work with Surya Teja Gavva and Sharath Punna.
  In **Information and Computation**, 296(1): 105–115, 2024.
- **Fairness of Linear Regression in Decision Making**
  Joint work with Vincent Cohen-Addad, Surya Teja Gavva, Claire Mathieu, and Namrata.
  In **International Journal of Data Science and Analytics**, 18(3): 337-347, 2024.
- **On Complexity of 1-Center in Various Metrics**
  Joint work with Amir Abboud, MohammadHossein Bateni, Vincent Cohen-Addad, and Saeed Seddighin.
  In the Proceedings of the International Conference on Approximation Algorithms for Combinatorial Optimization Problems (**APPROX**), 2023.
- **Can You Solve Closest String Faster than Exhaustive Search?**
  Joint work with Amir Abboud, Nick Fischer, Elazar Goldenberg, and Ron Safier.
  In the Proceedings of the European Symposium on Algorithms (**ESA**), 2023.
- **Obtaining Approximately Optimal and Diverse Solutions via Dispersion**
  Joint work with Jie Gao, Mayank Goswami, Meng-Tsung Tsai, Shih-Yu Tsai, and Hao-Tsung

Yang.
In the Proceedings of the Latin American Theoretical Informatics Symposium (**LATIN**), 2022.

- **Almost Polynomial Factor Inapproximability for Parameterized k-Clique**
  Joint work with Subhash Khot.
  In the Proceedings of the Computational Complexity Conference (**CCC**), 2022.
  Invited to Theory of Computing journal Special Issue for CCC 2022.
- **Johnson Coverage Hypothesis: Inapproximability of k-means and k-median in ℓ_p-metrics**
  Joint work with Vincent Cohen-Addad and Euiwoong Lee.
  In the Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (**SODA**), 2022.
- **Applications of Random Algebraic Constructions to Hardness of Approximation**
  Joint work with Boris Bukh and Bhargav Narayanan.
  In the Proceedings of the Symposium on Foundations of Computer Science (**FOCS**), 2021.
  To appear in **Israel Journal of Mathematics**.
- **On Approximability of Clustering Problems Without Candidate Centers**
  Joint work with Vincent Cohen-Addad and Euiwoong Lee.
  In the Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (**SODA**), 2021.
- **Deterministic Replacement Path Covering**
  Joint work with Merav Parter.
  In the Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (**SODA**), 2021.
  To appear in *ACM Transactions on Algorithms* (**TALG**).
- **On Hardness of Approximation of Parameterized Set Cover and Label Cover: Threshold Graphs from Error Correcting Codes**
  Joint work with Inbal Livni Navon.
  In the Proceedings of the SIAM Symposium on Simplicity in Algorithms (**SOSA**), 2021.
- **On Communication Complexity of Fixed Point Computation**
  Joint work with Anat Ganor and Dömötör Pálvölgyi.
  In *ACM Transactions on Economics and Computation* (**TEAC**), 9(4): 25:1–25:27, 2021.
- **On Efficient Low Distortion Ultrametric Embedding**
  Joint work with Vincent Cohen-Addad and Guillaume Lagarde.
  In the Proceedings of the International Conference on Machine Learning (**ICML**), 2020.
- **A Survey on Approximation in Parameterized Complexity: Hardness and Algorithms**
  Joint work with Andreas Emil Feldmann, Euiwoong Lee, and Pasin Manurangsi.
  In **Algorithms**, 13(6), 146, 2020 (*by invitation* to special issue titled 'New Frontiers in Parameterized Complexity and Algorithms').
- **Hardness Amplification of Optimization Problems**
  Joint work with Elazar Goldenberg.
  In the Proceedings of the Innovations in Theoretical Computer Science (**ITCS**), 2020.
- **Inapproximability of Clustering in ℓ_p-metrics**
  Joint work with Vincent Cohen-Addad.
  In the Proceedings of the Symposium on Foundations of Computer Science (**FOCS**), 2019.
- **On Closest Pair in Euclidean Metric: Monochromatic is as Hard as Bichromatic**
  Joint work with Pasin Manurangsi.
  In the Proceedings of the Innovations in Theoretical Computer Science (**ITCS**), 2019.
  In **Combinatorica**, 40(4): 539–573, 2020.
- **Parameterized Intractability of Even Set and Shortest Vector Problem**
  Joint work with Arnab Bhattacharyya, Édouard Bonnet, László Egri, Suprovat Ghoshal,

Bingkai Lin, Pasin Manurangsi, and Dániel Marx.
In *Journal of the ACM* (**JACM**), 68(3): 16:1–16:40, 2021.
An earlier version with Arnab Bhattacharyya, Suprovat Ghoshal, and Pasin Manurangsi, titled *Parameterized Intractability of Even Set and Shortest Vector Problem from Gap-ETH* appeared in Proceedings of International Colloquium on Automata, Languages, and Programming (**ICALP**), 2018.

- **Towards a General Direct Product Testing Theorem**
  Joint work with Elazar Goldenberg.
  In the Proceedings of the IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (**FSTTCS**), 2018.
  In *ACM Transactions on Computation Theory* (**TOCT**), 12(1): 7:1–7:18, 2020.
- **On the Parameterized Complexity of Approximating Dominating Set**
  Joint work with Bundit Laekhanukit and Pasin Manurangsi.
  In the Proceedings of the Symposium on Theory of Computing (**STOC**), 2018.
  In *Journal of the ACM* (**JACM**), 66(5): 33:1–33:38, 2019.
  Invited to SIAM Journal on Computing Special Issue for STOC 2018 (*regretfully declined*).
  Invited to Highlights of Algorithms (**HALG**) 2019.
- **On The Complexity of Closest Pair via Polar-Pair of Point-Sets**
  Joint work with Roee David and Bundit Laekhanukit.
  In the Proceedings of the Symposium on Computational Geometry (**SoCG**), 2018.
  In *SIAM Journal on Discrete Mathematics* (**SIDMA**), 33(1): 509–527, 2019.
- **Communication Complexity of Correlated Equilibrium with Small Support**
  Joint work with Anat Ganor.
  In the Proceedings of the International Conference on Approximation Algorithms for Combinatorial Optimization Problems (**APPROX**), 2018.
- **Ham Sandwich is Equivalent to Borsuk-Ulam**
  Joint work with Arpan Saha.
  In the Proceedings of the Symposium on Computational Geometry (**SoCG**), 2017.
- **An Efficient Representation for Filtrations of Simplicial Complexes**
  Joint work with Jean-Daniel Boissonnat.
  In the Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (**SODA**), 2017.
  In *ACM Transactions on Algorithms* (**TALG**), 14(4): 44:1–44:21, 2018.
- **Did the Train Reach its Destination: The Complexity of Finding a Witness**
  In *Information Processing Letters* (**IPL**), 121(5): 17–21, 2017.
- **On the Sensitivity Conjecture for Disjunctive Normal Forms**
  Joint work with Sébastien Tavenas.
  In the Proceedings of the IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (**FSTTCS**), 2016.
- **Building Efficient and Compact Data Structures for Simplicial Complexes**
  Joint work with Jean-Daniel Boissonnat and Sébastien Tavenas.
  In the Proceedings of the Symposium on Computational Geometry (**SoCG**), 2015.
  In **Algorithmica**, 79(2): 530–567, 2017.

Selected Invited Talks

- **Hardness of Approximation of Diameter Clustering**
  Queens College CUNY Computer Science Colloquium October 2023
  Bangalore Theory Seminar November 2023

- **Hardness of Approximating Steiner Tree in ℓ_p-metrics**
  Bangalore Theory Seminar January 2023
  NYU Theory Seminar March 2023
  Weizmann Institute of Science May 2023
- **Hardness of Approximation for Metric Clustering**
  STOC workshop: The Recent Past and Near Future of Clustering (virtual talk) June 2021
  Recent Trends in Algorithms, India (virtual talk) March 2022
  Indian Institute of Technology Bombay Theory Seminar, India August 2023
- **Recent Hardness of Approximation results in Parameterized Complexity**
  Workshop at Hausdorff Center for Mathematics (virtual talk) December 2021
- **Reversing Color Coding**
  University of Michigan and Purdue University Joint Theory Seminar (virtual talk) September 2021
  Rutgers University Theory Seminar (virtual talk) September 2021
  Cornell University Theory Seminar (virtual talk) September 2021
- **Fairness in Decision Making: Is Linear Regression Fair?**
  New York University Scholar Speaker Series (virtual talk) November 2020
- **Towards a Unified Framework for Hardness of Approximation in P**
  TAU Theory Fest, Tel Aviv January 2020
  Frontiers of Parameterized Complexity (virtual talk) August 2020
  Parameterized Complexity Workshop (virtual talk) December 2020
  Combinatorics Seminar, Tel Aviv University (virtual talk) March 2021
- **Ultrametrics meet Fine-Grained Complexity**
  Weizmann Institute of Science (virtual talk) July 2020
  Yahoo Research Seminar (virtual talk) January 2021
- **Clustering: How hard is it to classify data?**
  Google, Mountain View November 2019
  Columbia University November 2019
  Weizmann Institute of Science December 2019
  Hebrew University of Jerusalem December 2019
- **Inapproximability of Clustering in ℓ_p-metrics**
  Fine-Grained Approximation Algorithms & Complexity Workshop, Bertinoro May 2019
  Shanghai University of Finance & Economics June 2019
  Tel Aviv University June 2019
  Microsoft Research India August 2019
  Indian Institute of Science August 2019
  Eötvös Loránd University, Budapest September 2019
- **New Arenas in Hardness Amplification**
  Ben-Gurion University March 2019
  Hebrew University of Jerusalem April 2019
  Sorbonne University April 2019
- **On Complexity of Closest Pair Problem**
  Indian Institute of Science August 2018
  FILOFOCS Workshop, Institut Henri Poincaré, Paris October 2018
  Tel Aviv University October 2018
  Technion – Israel Institute of Technology January 2019
  Hebrew University of Jerusalem April 2019
  National Institute of Science Education and Research, Bhubaneswar August 2019

- **A Framework for Parameterized Hardness of Approximation**
  Hebrew University of Jerusalem January 2018
  Tel Aviv University March 2018
  Stanford University July 2018
  Simons Institute for Theory of Computing, Berkeley August 2018
- **An Efficient Representation for Filtrations of Simplicial Complexes**
  Topology for Data Analysis Winter School, INRIA Sophia Antipolis January 2017
- **Building Efficient and Compact Data Structures for Simplicial Complexes**
  Ben-Gurion University December 2015
- **In and Around the Sensitivity Conjecture**
  Microsoft Research, India September 2015