The 8^{th} International Coding Theory Seminar

A Virtual Conference

Hosted by India

September $26^{th}, 2025$

Contents

About

Organizing committee

China
Xiwang Cao
Lingfei Jin (vice chair)
Hongwei Liu (chair)
Gaojun Luo

India
Manish K Gupta (chair)
Sartaj Ul Hasan
Anuradha Sharma

Japan
(TBA)

Korea
Whan-Hyuk Choi
Boran Kim
Jon-Lark Kim (chair)

Philippines
Rowena Betty
Romar dela Cruz
Lucky Galvez (chair)

Thailand
Arunwan Boripan
Parinyawat Choosuwan
Somphong Jitman (chair)
Ekkasit Sangwisut

Singapore
Han Mao Kiah (chair)
Martianus Frederic Ezerman

International advisors

Nathan Kaplan (USA)

Patrick Sole (France)

Hong-Yeop Song (Korea)

Chaoping Xing (China)

Timetable

All times listed are in Indian Standard Time (GMT+5:30).

Time: September 26th, 2025

Participants Meeting ID: 693 457 4771

Participants Passcode: 8ICTSINDIA

09:15-9:45	**Committee Discussion**	
10:00–10:30	**Inauguration**	
10:30–11:15	**B. Sundar Rajan** IISc Bangalore, India	Function-Correcting Codes with Data Protection
11:15–11:30	**Discussion/Break**	
11:30–12:15	**Lalitha Vadlamani** IIIT Hyderabad, India	Recent Results on Reed-Muller Codes: RPA Decoder Analysis and Service Rate Region
12:15–12:30	**Discussion/Break**	
12:30–13:15	**Shayan Srinivasa Garani** IISc Bangalore, India	Magic State Distillation using Quantum Error Correction
13:15–13:30	**Discussion**	

List of Talks

Talk 1: Function-Correcting Codes with Data Protection

B. Sundar Rajan

Department of Electrical Communication Engineering,
Indian Institute of Science Bangalore
Bangalore, 560012, India
bsrajan@iisc.ac.in

Biography

Prof. B. Sundar Rajan is a Senior Professor in the Department of Electrical Communication Engineering at the Indian Institute of Science (IISc), Bangalore. He received his B.Sc. in Mathematics from Madras University, the B.Tech. in Electronics from the Madras Institute of Technology, and the M.Tech. and Ph.D. in Electrical Engineering from the Indian Institute of Technology, Kanpur. He served as a faculty member at IIT Delhi (1990–1997) before joining IISc in 1998, and was a Distinguished Member of Research Staff at Beceem Communications Pvt. Ltd. (2004–2005). Prof. Rajan is a Fellow of IEEE, a J.C. Bose National Fellow (2016–2020), and a Fellow of all four major Indian science and engineering academies: INSA, INAE, IASc, and NASI, in addition to being a Fellow of IETE, India. He has held prominent editorial positions, including Editor of IEEE Wireless Communications Letters, Associate Editor of IEEE Transactions on Information Theory, and Editor of IEEE Transactions on Wireless Communications. His awards include the IEEE WCNC Best Academic Paper Award (2011), the Khosla National Award (2010) from IIT Roorkee, the Prof. Rustum Choksi Award (2009) from IISc for excellence in research, and the IETE S.V.C. Aiya Award (2004). Prof. Rajan's research focuses on MIMO signal processing and algorithms, space–time coding, coding for multiple-access and relay channels, interference alignment, network coding, index coding, coded caching, and coded computation, with applications to machine learning, D2D, and vehicular communications.

Abstract
Function-correcting codes are designed to provide error protection for the value of a function computed on data. Existing work typically focuses solely on protecting the function value not the underlying data. In this work, we propose a general framework that offers protection for both the data and the function values. Since protecting the data inherently contributes to protecting the function value, we focus on scenarios where the function value requires stronger protection than the data itself. We develop the theory of function-correcting codes under this setting. Furthermore, we present a construction method for such codes and, for certain specific functions, provide explicit constructions using this method. Leveraging the connection between these function-correcting codes and irregular distance codes, we derive bounds on their redundancy. We also explore the class of linear function-correcting codes. Finally, we generalize some existing bounds for error-

correcting codes to function-correcting codes. (Joint work with Charul Rajput, Ragner Freij-Hollanti and Camilla Hollanti).

Bibiography

[1] A. Lenz, R. Bitar, A. Wachter-Zeh, and E. Yaakobi, "Function-correcting codes," *IEEE Transactions on Information Theory*, vol. 69, no. 9, pp. 5604–5618, 2023.

[2] Q. Xia, H. Liu, and B. Chen, "Function-correcting codes for symbol-pair read channels," *IEEE Transactions on Information Theory*, vol. 70, no. 11, pp. 7807–7819, Nov. 2024.

[3] R. Premlal and B. S. Rajan, "On function-correcting codes," *IEEE Transactions on Information Theory*, vol. 71, no. 8, pp. 5884–5897, Aug. 2025.

[4] G. Ge, Z. Xu, X. Zhang, and Y. Zhang, "Optimal redundancy of function-correcting codes," *arXiv preprint* arXiv:2502.16983, 2025.

[5] A. Singh, A. K. Singh, and E. Yaakobi, "Function-correcting codes for b-symbol read channels," *arXiv preprint* arXiv:2503.12894, 2025.

[6] C. Rajput, B. S. Rajan, R. Freij-Hollanti, and C. Hollanti, "Function-correcting codes for locally bounded functions," *arXiv preprint* arXiv:2504.07804, 2025.

[7] G. K. Verma, A. Singh, and A. K. Singh, "Function-correcting b-symbol codes for locally (λ, ρ, b)-functions," *arXiv preprint* arXiv:2505.09473, 2025.

[8] H. Ly and E. Soljanin, "On the redundancy of function-correcting codes over finite fields," *arXiv preprint* arXiv:2504.14410, 2025.

Talk 2: Recent Results on Reed-Muller Codes: RPA Decoder Analysis and Service Rate Region

Lalitha Vadlamani

Signal Processing and Communications Research Center,
International Institute of Information Technology, Hyderabad
Hyderabad, 500032, India
lalitha.v@iiit.ac.in

Biography

Lalitha Vadlamani received her B.E. degree in Electronics and Communication Engineering from the Osmania University, Hyderabad, in 2003 and her M.E.and Ph.D. degrees from the Indian Institute of Science (IISc), Bangalore,in 2005 and 2015 respectively. From May 2015, she has been at IIIT Hyderabad, where she is affiliated to Signal Processing and Communications Research Center and she is currently an Associate Professor. Her research interests include coding for distributed storage and computing, quantum error correcting codes, index coding, polar codes and Reed-Muller codes. She is a recipient of Prof. I.S.N. Murthy medal from IISc, 2005 and the TCS Research Scholarship for the year 2011. She was a visiting Scientist at the Simons Institute of the Theory of Computing, Berkeley and also a visiting professor at the Indian Institute of Science, Bangalore, in 2024. She is currently serving as the Newsletter Editor of the IEEE Information Theory Society.

Abstract

In this talk, we will present two recent results in the area of Reed-Muller codes.
In the first result, we consider the Recursive Projection-Aggregation (RPA) decoder, of Ye and Abbe (2020), for Reed-Muller (RM) codes. Our main contribution is an explicit upper bound on the probability of incorrect decoding, using the RPA decoder, over a binary symmetric channel (BSC). Importantly, we focus on the events where a single iteration of the RPA decoder, in each recursive call, is sufficient for convergence. Key components of our analysis are explicit estimates of the probability of incorrect decoding of first-order RM codes using a maximum likelihood (ML) decoder, and estimates of the error probabilities during the aggregation phase of the RPA decoder. Our results allow us to show that for RM codes with block length 2^m, the RPA decoder can achieve vanishing error probabilities, in the large block length limit, for RM orders that grow roughly logarithmically in m. This is joint work with V. Arvind Rameshwar.
In the second result, we study the Service Rate Region of Reed–Muller codes in the context of distributed storage systems. The service rate region is a convex polytope comprising all achievable data access request rates under a given coding scheme. It represents a critical metric for evaluating system efficiency and scalability. Using the geometric properties of Reed–Muller codes, we characterize recovery sets for data objects, including their existence, uniqueness, and enumeration. This analysis reveals a connection between recovery sets and minimum weight codewords in the dual Reed–Muller code, providing a framework for identifying those recovery sets. Leveraging these results, we derive explicit and tight bounds on the maximal achievable demand for individual data objects, thereby defining the maximal simplex within the service rate region and the smallest simplex containing it. These two provide a tight approximation of the service rate region of Reed–Muller codes. This is joint work with Hoang Ly and Emina Soljanin.

Bibliography

[1] D.E. Muller, “Application of Boolean algebra to switching circuit design and to error detection,” *Transactions of the IRE Professional Group on Electronic Computers*, vol. EC-3, no. 3, pp. 6—12, 1954. DOI: 10.1109/IREPGELC.1954.6499441

[2] I.S. Reed, “A class of multiple-error-correcting codes and the decoding scheme,” *Transactions of the IRE Professional Group on Information Theory*, vol. 4, no. 4, pp. 38-–49, 1954. DOI: 10.1109/TIT.1954.1057465

[3] E. Abbe, O. Sberlo, A. Shpilka, and M. Ye, “Reed-Muller Codes”, *Foundations and Trends in Communications and Information Theory*, vol. 20, nos. 1–2, pp. 1–156, 2023. DOI: 10.1561/0100000123

[4] M. Ye, Min, and E. Abbe, “Recursive projection-aggregation decoding of Reed-Muller codes,” *IEEE Transactions on Information Theory*, vol. 66, no. 8, pp. 4948-4965, August 2020.

[5] E. Abbe, A. Shpilka, and M. Ye, “Reed–Muller codes: Theory and algorithms,” *IEEE Transactions on Information Theory*, vol. 67, no. 6, pp. 3251-3277, June 2020.

[6] V. Arvind Rameshwar, and V. Lalitha, “An Analysis of RPA Decoding of Reed-Muller Codes Over the BSC,” *arXiv preprint arXiv:2412.08129*, 2024.

[7] M. Aktaş, G. Joshi, S. Kadhe, F. Kazemi, and E. Soljanin, “Service rate region: A new aspect of coded distributed system design,” *IEEE Transactions on Information Theory*, vol. 67, no. 12, pp. 7940-7963, December 2021.

[8] H. Ly, E. Soljanin, and V. Lalitha, “On the Service Rate Region of Reed-Muller Codes,” *arXiv preprint arXiv:2501.13105*, 2025.

Talk 3: Magic State Distillation using Quantum Error Correction

Shayan Srinivasa Garani

Dept. of Electronics Syst. Eng.,
Division of EECS
Indian Institute of Science
Bengaluru, 560012, India
Web: https://pnsil.dese.iisc.ac.in
shayangs@iisc.ac.in

Biography
Shayan Srinivasa Garani is a Full Professor at the Indian Institute of Science within the Div. of Electrical, Electronics and Computer Sciences. He received his Ph.D. in Electrical and Computer Engineering from Georgia Institute of Technology, Atlanta, M.S. in Electrical and Computer Engineering from the University of Florida, Gainesville, and B.E. in Electronics and Communication Engineering from Mysore University. Prior to joining IISc in 2012, he was leading various in-house research and development activities, managing and directing research and external university research programs within Western Digital, related to read channels engineering for hard disk drives and solid state devices. His research interests include broad areas of channels engineering for physical data storage, quantum information processing, neural networks theory and applications, and music signal processing. Outside academics, he is a performing Carnatic classical vocalist.

Abstract
Magic-state distillation is a protocol to purify noisy quantum states using quantum stabilizer codes, useful for realizing non-Clifford gates. In this talk, I will explain the theory behind magic state distillation and describe how the noise threshold scales as a function of the underlying quantum stabilizer code parameters. Quantum error correcting codes (QECCs) for distilling qubit and qutrit Hadamard states with *near-optimal* thresholds over the depolarizing channel will be described. Towards the end, I will motivate the ideas behind entanglement-assisted fault-tolerant computation and how these results are useful for quantum information processing. This is based on the joint work with my Ph.D. student Abhi Kumar Sharma.

Bibliography

[1] S. Bravyi and A. Kitaev. Universal quantum computation with ideal Clifford gates and noisy ancillas *Phys. Rev. A.*, Feb. 2005.

[2] S. Prakash. Magic state distillation with the ternary Golay code *Proc. R. Soc. A*, Sep. 2020.

[3] A. K. Sharma and S. S. Garani. Near-threshold qudit stabilizer codes with efficient encoding circuits for magic state distillation *Phys. Rev. A.*, May. 2024. Errata published in Oct. 2024.

[4] A. K. Sharma and S. S. Garani. Entanglement-assisted fault-tolerant encoding and decoding for qudit stabilizer codes. *Phys. Rev. A.*, Dec. 2024.

Code of Conduct for ICTS 2025

A code of conduct for a virtual conference ICTS 2025 has been established as guidelines for behaviour and interactions among attendees, speakers, and organizers.

1. **Respect:** Treat all participants with respect and consideration, valuing a diversity of views and opinions.

2. **Inclusivity:** Create an inclusive environment where everyone feels welcome, regardless of race, ethnicity, gender, sexual orientation, disability, age, religion, or other factors.

3. **Harassment-Free Zone:** Harassment and discriminatory behaviour will not be tolerated. This includes but is not limited to: offensive verbal comments related to race, gender, sexual orientation, disability, or religion; deliberate intimidation, stalking, following, or harassing photography or recording; sustained disruption of talks or other events; inappropriate physical contact; and unwelcome sexual attention.

4. **Professionalism:** Maintain professionalism in all interactions. Do not engage in disruptive behaviour that interferes with the conference proceedings.

5. **Privacy:** Respect the privacy of others. Do not share personal information about attendees without their consent.

6. **Appropriate Content:** Refrain from using language or sharing content that is offensive, abusive, or inappropriate for a professional setting.

7. **Intellectual Property:** Respect intellectual property rights. Do not share copyrighted material without permission.

8. **Reporting:** If you experience or witness any violations of the code of conduct, report it to the conference organizers immediately. They will investigate and take appropriate action.

9. **Q&A:** If you have any question for the speaker, please type it in chat window. We can take up those questions with the speaker if time permits. Please type questions for the speaker only in the chat window.

10. **Consequences:** Violation of the code of conduct may result in expulsion from the conference, and further action may be taken as necessary.c

11. **Acknowledgment:** By participating in the conference, you acknowledge that you have read and agreed to abide by this code of conduct.