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Performance Evaluation of Computer Systems and Networks
head[at]cse[dot]iitb[dot]ac[dot]in
+91 22 2576 7731
Head’s office, Kanwal Rekhi Building
Formal methods in Concurrency, Logics and Games, Geometric Complexity Theory
7712
adsul[at]cse[dot]iitb[dot]ac[dot]in
CC317, Computing Complex
Machine learning, Human-AI interaction, Responsible AI
7906
aarpit[at]cse[dot]iitb[dot]ac[dot]in
KR222, Kanwal Rekhi Building
Performance Evaluation of Computer Systems and Networks
7731
varsha[at]cse[dot]iitb[dot]ac[dot]in
KR308, Kanwal Rekhi Building
Functional Programming Applications (Domain Specific Languages), Embedded Systems/ Parallel Programming Languages, Distance Learning
7909
kavi[at]cse[dot]iitb[dot]ac[dot]in
KR316, Kanwal Rekhi Building
Image Analysis, Medical Image Computing, Machine Learning, Computer Vision
7703
suyash[at]cse[dot]iitb[dot]ac[dot]in
KR114, Kanwal Rekhi Building
Adaptive Service Orientation, Managing virtualization and server consolidation in Clouds, Adaptive QoS based routing in DEBN
7865
umesh[at]cse[dot]iitb[dot]ac[dot]in
KR120, Kanwal Rekhi Building
Natural Language Processing, Machine Learning, Machine Translation, Cross
Lingual IR and Web Knowledge Processing
7718
pb[at]cse[dot]iitb[dot]ac[dot]in
CC510, Computing Complex
Discrete and Computational Geometry, Algorithms under Uncertainty, Graph Theory, Algorithmic Robotics.
7715
sujoy[at]cse[dot]iitb[dot]ac[dot]in
CC318, Computing Complex
Hypertext databases, Data mining
7716
soumen[at]cse[dot]iitb[dot]ac[dot]in
KR104, Kanwal Rekhi Building
Formal techniques for analysis, verification, validation of digital systems, Asynchronous timing analysis.
7721
supratik[at]cse[dot]iitb[dot]ac[dot]in
CC314, Computing Complex
Medical Imaging & Health Informatics, Graphics, Computer Vision, Parallel Algorithms, Visualization,
7726
sharat[at]cse[dot]iitb[dot]ac[dot]in
KR102, Kanwal Rekhi Building

Animation, Computer Graphics, Virtual and Augmented Reality, Geometric Computer Vision
7719
paragc[at]cse[dot]iitb[dot]ac[dot]in
KR204, Kanwal Rekhi Building
Architecture and protocol design in wired, wireless and sensor networks,
development of appropriate technology
7976
chebrolu[at]cse[dot]iitb[dot]ac[dot]in
KR302, Kanwal Rekhi Building
Program Derivation, Large Scale Systems, Technology for Social Development
7948
damani[at]cse[dot]iitb[dot]ac[dot]in
KR216, Kanwal Rekhi Building
Machine learning on graphs and sets.
7710
abir[at]cse[dot]iitb[dot]ac[dot]in
KRG12 ,Kanwal Rekhi Building
Algorithms, Theoretical Computer Science
7720
aad[at]cse[dot]iitb[dot]ac[dot]in
CC222, Computing Complex
Network security, privacy, and anonymity
7147
dgosain[at]cse[dot]iitb[dot]ac[dot]in
CC309, Computing Complex
SDN, NFV, Network Architecture, Carrier Ethernet
7911
ashwin[at]cse[dot]iitb[dot]ac[dot]in
KR108, Kanwal Rekhi Building
Formal verification: building model checkers for verification of sequential and concurrent software,Modelling: modelling of biological systems, Constraint solving: constraint logic programming, decision procedures, and automated theorem proving
7724
akg[at]cse[dot]iitb[dot]ac[dot]in
CC320, Computing Complex
Computational Complexity, Derandomization and Pseudorandomness, Polyhedral Combinatorics, Parallel Algorithms
7745
rgurjar[at]cse[dot]iitb[dot]ac[dot]in
CC315, Computing Complex
Object Oriented Systems, Distributed Systems, Software Architectures
7730
rkj[at]cse[dot]iitb[dot]ac[dot]in
KRG10, Kanwal Rekhi Building
Machine learning applied to speech and language
7736
pjyothi[at]cse[dot]iitb[dot]ac[dot]in
CC221, Computing Complex
Reinforcement Learning, Humanoid Robotics & Robot Soccer, Multi-armed Bandits
7704
shivaram[at]cse[dot]iitb[dot]ac[dot]in
CC220, Computing Complex
Cryptography, computational complexity theory, theoretical computer science
7713
ckamath[at]cse[dot]iitb[dot]ac[dot]in

CC305, Computing Complex
Programming Languages, Compilers, Data Flow Analysis.
7717
uday[at]cse[dot]iitb[dot]ac[dot]in
CC306, Computing Complex
Operating systems, Virtualization, Cloud Computing, Computer Networks, Computing systems for developing regions, Technology and development
7910
puru[at]cse[dot]iitb[dot]ac[dot]in
KR304, Kanwal Rekhi Building
Spectral Graph Theory, Planar graph Algorithms, Graph Partitioning, Recovering planted structures in graphs
7722
akash[at]cse[dot]iitb[dot]ac[dot]in
CC219, Computing Complex
Algorithms and Complexity Theory
7732
nutan[at]cse[dot]iitb[dot]ac[dot]in
CC315, Computing Complex
Formal Methods, Analysis of Concurrent programs, logic and games
4777
krishnas[at]cse[dot]iitb[dot]ac[dot]in
CC312, Computing Complex
Game Theory, Computational Mechanism Design,
Computational Social Choice, Artificial Intelligence, Optimization
7755
swaprava[at]cse[dot]iitb[dot]ac[dot]in
CC209, Computing Complex
Computer Architecture for Performance and Security
7740
biswa[at]cse[dot]iitb[dot]ac[dot]in
CC217, Computing Complex
Cryptography, Theoretical Computer Science
7709
mp[at]cse[dot]iitb[dot]ac[dot]in
CC214, Computing Complex
Image Processing, Computer Vision and Signal Processing: Reconstruction, Restoration and Compression of Images and Videos; Compressed Sensing and Matrix Recovery; Probability Density Estimation; Group Testing; Graph Signal Processing.
7981
ajitvr[at]cse[dot]iitb[dot]ac[dot]in
KR118, Kanwal Rekhi Building
Computer networks, Wireless systems, Communication system design for developing regions
7908
br[at]cse[dot]iitb[dot]ac[dot]in
KR306, Kanwal Rekhi Building
Human assisted AI/ML, AI/ML in resource constrained environments, learning with symbolic encoding of domain knowledge in ML and NLP, Data Efficient Machine Learning, Constrained Decoding and Post-editing for Machine translation, OCR and ASR ..
7728
ganesh[at]cse[dot]iitb[dot]ac[dot]in
KR318, Kanwal Rekhi Building
Computer and Network Security (blockchain, intrusion detection, IoT security, DDoS), Internet of Things (IoT), Wireless Networks (cognitive radio, TV white space, LTE, Wi-Fi etc.), Indoor positioning and navigation

7903
vinayr[at]cse[dot]iitb[dot]ac[dot]in
KR206, Kanwal Rekhi Building
Formal methods
7711
akshayss[at]cse[dot]iitb[dot]ac[dot]in
CC507, Computing Complex
Fault and Side-Channel Cryptanalysis, Microarchitectural Attacks, EDA/CAD for Security
7134
sayandeepsaha[at]cse[dot]iitb[dot]ac[dot]in
CC215, Computing Complex
Machine Learning, Databases, Data mining, and Graphical Models as applied to domains like web information extraction, data integration, social networking.
7904
sunita[at]cse[dot]iitb[dot]ac[dot]in
KR220, Kanwal Rekhi Building
Cryptography, Theoretical Computer Science
7138
sruthi[at]cse[dot]iitb[dot]ac[dot]in
CC213, Computing Complex
fairness in databases, computational geometry
7133
surajs[at]cse[dot]iitb[dot]ac[dot]in
CC304, Computing Complex
Automated Reasoning, Logic Programming, Rewrite Systems, Networks, Distributed Systems
7725
siva[at]cse[dot]iitb[dot]ac[dot]in
CC508, Computing Complex
Combinatorial Optimization, Mathematical Programming, Algorithms
7729
sohoni[at]cse[dot]iitb[dot]ac[dot]in
CC311, Computing Complex
Query processing and optimization, Keyword querying on structured and semi-structured data, Testing database applications
7714
sudarsha[at]cse[dot]iitb[dot]ac[dot]in
KR106, Kanwal Rekhi Building
Program analysis, compiler optimizations, parallelization
7739
manas[at]cse[dot]iitb[dot]ac[dot]in
CC308, Computing Complex
Algorithms, Combinatorics, Complexity Theory.
7727
sundar[at]cse[dot]iitb[dot]ac[dot]in
KRG08, Kanwal Rekhi Building
Networking and Systems
7973
mythili[at]cse[dot]iitb[dot]ac[dot]in
KR210, Kanwal Rekhi Building
Cybersecurity, Computer
Architecture, Cyber Physical Cognitive Systems, Formal Verification, Blockchain Technology
9432
viren[at]cse[dot]iitb[dot]ac[dot]in
122-D, EE Main Building
SAT/SMT solvers and their applications in AI, software engineering, security, and mathematics.

Neurosymbolic AI: combinations of logic tools and neural networks. Proof complexity of solvers. Foundations of mathematics..

vganesh[at]cse[dot]iitb[dot]ac[dot]in

Formal Methods for verification of critical systems
7739
gastin[at]cse[dot]iitb[dot]ac[dot]in
CC308, Computing Complex

ngkabra[at]cse[dot]iitb[dot]ac[dot]in

Sequential decision-making, reinforcement learning, control theory, optimisation

harshadk[at]cse[dot]iitb[dot]ac[dot]in
CC207, Computing Complex
Formal Methods for Verification of Machine Learning Systems, Algorithmic Techniques for Constrained Sampling and Counting, Applications of Constrained Counting and Sampling, SAT solvers: Beyond CNF Solvers and Data-Driven Design Paradigm, Interpretable and Explainable Models
-
kuldeepmeel[at]cse[dot]iitb[dot]ac[dot]in

Formal Methods, Dependable Computing, Computational Logic, Cyber-Physical Systems, Computer Security, Design Automation, Programming Systems, Artificial Intelligence, Theory..

sseshia[at]cse[dot]iitb[dot]ac[dot]in

Formal Methods & Software Engineering, Distributed Computing, Network & Information Security & Survivable Systems
7708
rkss[at]cse[dot]iitb[dot]ac[dot]in
CC509, Computing Complex
Logics, Automata, Concurrency, Formal Methods, Embedded Systems and Software Engineering.
7733
pandya58[at]cse[dot]iitb[dot]ac[dot]in
CC216, Computing Complex
Data Base Management Systems, Software Engineering, System Performance Evaluation, Distributed Client Server Information Systems.
7747
dbp[at]cse[dot]iitb[dot]ac[dot]in
KR314, Kanwal Rekhi Building
Parallel algorithms and applications, bioinformatics and systems biology, combinatories scientific computing, applied algorithms
aluru[at]cse[dot]iitb[dot]ac[dot]in
Artificial Intelligence, Parallel Algorithms
sak[at]cse[dot]iitb[dot]ac[dot]in
-
Hardware verification, Neural networks
mrb[at]cse[dot]iitb[dot]ac[dot]in
Optimizing and Parallelizing Compilers, Parallel and Distributed Computing
sb[at]cse[dot]iitb[dot]ac[dot]in
Computational design tools, high-level shape understanding, shape recognition & reconstruction, largescale rendering.
sidch[at]cse[dot]iitb[dot]ac[dot]in

Electrical Power Energy Systems
mudesh[at]cse[dot]iitb[dot]ac[dot]in
Distributed Algorithms, Programming Languages, Operating Systems, Optimizing Compilers
dmd[at]cse[dot]iitb[dot]ac[dot]in
-
magda[at]cse[dot]iitb[dot]ac[dot]in
-
Mobile Computing, Distributed Systems, Educational Software.
sri[at]cse[dot]iitb[dot]ac[dot]in
Machine Learning, Convex Optimization, some applications of machine learning
saketh[at]cse[dot]iitb[dot]ac[dot]in
Deep Learning, Computer Vision and Computer Graphics
ajain[at]cse[dot]iitb[dot]ac[dot]in

sanjayjha[at]cse[dot]iitb[dot]ac[dot]in
Compilers, Data Flow Analysis, Heap Analysis
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-

kelkar[at]cse[dot]iitb[dot]ac[dot]in
Computational Complexity, Algebra and Computation, Error Correcting codes
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Operating Systems, Programming, Data processing
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slm[at]cse[dot]iitb[dot]ac[dot]in
Information Appliances, Electronic Commerce, Java Security, Parallel Computing, Time Series Forecasting
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Algorithms and Complexity
Programming Languages, Compilers
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Machine Intelligence, Pattern Recognition,
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Mobile Computing, IoT, and Wireless Networks
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-
ramar[at]cse[dot]iitb[dot]ac[dot]in
Programming languages, Program analysis and Software engineering
raghavan[at]cse[dot]iitb[dot]ac[dot]in
Real time systems, Databases.
krithi[at]cse[dot]iitb[dot]ac[dot]in

parmesh[at]cse[dot]iitb[dot]ac[dot]in

ramesh[at]cse[dot]iitb[dot]ac[dot]in
Algorithms and Combinatorial Optimization
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prangan[at]cse[dot]iitb[dot]ac[dot]in
-
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VLSI Design, Digital System Design, Advanced Computer Architectures
ssspr[at]cse[dot]iitb[dot]ac[dot]in

hvs[at]cse[dot]iitb[dot]ac[dot]in
Computer networks, Voice routing, QoS in networks, wireless networks, wireless sensor networks, WiMax
sahoo[at]cse[dot]iitb[dot]ac[dot]in
Functional Programming, Compilers, and Programming Languages
as[at]cse[dot]iitb[dot]ac[dot]in
Databases, Information Systems, Software Engineering
nls[at]cse[dot]iitb[dot]ac[dot]in
-
ssriram[at]cse[dot]iitb[dot]ac[dot]in
Formal Methods in Verification and Synthesis, Cyber-Physical Systems,
trivedi[at]cse[dot]iitb[dot]ac[dot]in
Kanwal Rekhi Building,IIT Bombay
Powai, Mumbai - 400076

1.[New]4th and 5th Nov 2024: Emails sent to all applicants regarding: (i) Google form to submit panel preferences, (ii) two briefing sessions on 10th Nov and 14th Nov 2024 respectively, from 5 to 7 pm IST (check your email for the meeting links).
2.RAP/TAP Ph.D. positions have beenannounced.
3.Written tests and interviews for Ph.D. admissions for December 2024 will beconducted IN PERSONon the IITB campus. For theforeign applicants, there will be online tests and interviews.
4.Dates for written tests and interviews for the Ph.D. admissions for December 2024 have been announced.

1.IIT Bombay Deadline: October 25th, 2024(done)
2.Preference form sent to PhD applicants: November 1st, 2024(done)
3.Online interaction sessions between IITB faculty and applicants:November 10th (5pm-7pm IST)and November 14th, 2024 (5pm-7pm IST)
4. Preference form deadline:23:59 IST, November 18th, 2024
5. IN-PERSONtests for PhD applicants at IITB Campus: 9:00 AM to 12 Noon, December 2nd 2024
6. Shortlist for interviews: By evening December 2nd, 2024
7. IN-PERSON interviews at IITB: December 3rd and 4th, 2024

The CSE department at IIT Bombay offers three postgraduate programs:Ph.D.,M.S. by research, andM.Tech. These programmes are designed to prepare you for competitive careers well in tune with these exciting times for the information and communication technology (ICT), information technology (IT), and artificial intelligence (AI) industry in India. In the long run, our contribution to the field of computing will be determined not by the export of low-cost commodity services, but by the quality of intellectual property we produce and own through core technology development. Human intellectual capital is our most valuable asset. If you aspire to distinguish yourself from the mass of "computer professionals" and to play a leading role in transforming the industry through research, advanced development, teaching, or

entrepreneurship, a postgraduate degree in computer science and engineering is essential.
For more information about each program and the differences between the PhD, MS and MTech degrees, please visithere.The IIT Bombay website for admissions ishere.
Please visit the following for details on the admissions process of each program.
Ph.D. admissions
M.S. by research admissions
M.Tech. admissions
The admission to M.Tech. and MS by research is held once per year in May. For Ph.D., there are two cycles of admissions per year, held in May and December.
Please direct all queries related to cutoffs, shortlisting criteria, hostel accommodation, and certificate submissions for admission topgadm@iitb.ac.in.If there is any query specific to CSE interviews/test processes, please contactpgadm@cse.iitb.ac.in.
The entire admissions process isIN-PERSON at IITB, except for foreign applicants.
The numbers of available seats are listed here
Ph.D. TA seats
M.S. by research TA positions
M.Tech. TA positions(will be available only for May 2025)
Ph.D. Project RAP seats(number of available seat = 6)
IIT B.Tech. positions (3 M.S. and 7 M.Tech.)
Armed forces officer positions (2 M.Tech positions)

All applicants, except foreign applicants, meeting the eligibility criteria in their respective categories are called for a test, which is conductedIN-PERSON at IIT Bombay. For Foreign applicants, the tests and interviews will be online (Indian applicants living outside of India are not foreign applicants). Ph.D. and MS by research applicants will appear in a subject test. The applicants for projects for M.S. and non-direct-admissions category M.Tech. applicants will appear for a programming test. Interviews will be conducted for those shortlisted based on test performance. Please make the necessary arrangements to travel to Mumbai and stay here for a few days. A limited amount of accommodation for candidates appearing for the test/interview may be provided -- queries regarding this should be directed to pgadm@iitb.ac.in .
Preference from:Your panel/stream/project preferences will be collected via a Google form which will be sent to the email address given in your application form. We will reach out to you by the given date. This form MUST be filled out by all candidates and submitted by the given deadline. You should receive a confirmation email for the submission of the form.If you do not fill out the form in time, your application will be disqualified.

Day of test:The exam will be held at IIT Bombay. The applicants must be present at the venue of the exam 1 hour before the start of the exam.We will not allow entry after 15 minutes before the exam.

Interviews:The shortlisted students for interviews will be posted here. The interviews will be conducted IN-PERSON at IIT Bombay during the given period. Details of this will be communicated to applicants by the CSE office. The results will be available on the IITB portal on the given date.

The final result will be available as per the admissions calendar of IIT Bombay.

Students who join our Ph.D. program are eligible forgrantsfrom the following list:
1) Ajay Vashee Grant
2) Nilesh Vashee Grant

Students will be selected for these grants based on various criteria assessed during the selection process, such as performance in the written test and interview. Each grant carries a total cash prize ofRs. 1,80,000, which shall be awarded subject to the student meeting specified academic criteria in the first two semesters.
Students who join our M.S. by Research program are eligible forgrantsfrom the following list.
1) Ajay Vashee Grant

2) Nilesh Vashee Grant
3) Thomas Dooie Class of 1974 Grant
4) Dr. George B. Fernandes Grant
5) Dr. Winifred A. Fernandes Grant (forwomencandidates)
Students will be selected for these grants based on various criteria assessed during the selection process, such as performance in the written test and interview. Each grant carries a total cash prize of Rs. 1,00,000, which shall be awarded subject to the student meeting specified academic criteria in the first two semesters.

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Powai, Mumbai - 400076

Ordered List:

1. Ph.D. admissions
2. M.S. by research admissions
3. M.Tech. admissions

Ordered List:

1. Ph.D. TA seats
2. M.S. by research TA positions
3. M.Tech. TA positions(will be available only for May 2025)
4. Ph.D. Project RAP seats(number of available seat = 6)
5. IIT B.Tech. positions (3 M.S. and 7 M.Tech.)
6. Armed forces officer positions (2 M.Tech positions)

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IIT Bombay is located at Powai, which is a suburb in the north-eastern part of Mumbai. Mumbai is a long narrow island, thrusting southwards into the Arabian Sea. It can be broadly divided into four zones. South Bombay (Colaba, Chhatrapati Shivaji Terminus (CST), Fort, Chruchgate, Nariman Point), Central Bombay (Dadar, Bombay Central, Worli), the Western Suburbs (Bandra, Juhu, Andheri, Borivali), and the Eastern Suburbs (Kurla, Chembur, Ghatkopar, Mulund, Kanjur Marg, Vikhroli). There is also Navi Mumbai (Vashi, Turbhe) across the Thane Creek on the mainland.
Public Transport.Mumbai has one of the most efficient and reliable public transport networks. One can travel by autorickshaws or taxis to reach IITB from the nearest stations (autorickshaws, however, do not go further south than Sion and Bandra). For longer distance, you can use either the BEST bus network or the Mumbai Local train system.
Suburban Railway Transport.Those coming by Central Railway Suburban train will have to get down at Kanjur Marg, Vikhroli or Ghatkopar which are the nearest stations from IITB. If you are coming by the Western Railway Suburban train you will have to get down at Andheri, Bandra, Goregaon or Malad. We give below the road network to reach IITB along with the approximate bus, autorickshaws and taxi fares.
Stations for Through Trains Coming to Mumbai.There is a terminus at Kurla where some Central as well as Western Railway trains terminate. There is no convenient bus route from Kurla terminus to IITB. An autorickshaw is the best option. However, it would be more economical to take a suburban train from Kurla to Kanjur Marg and then take an auto from Kanjur Marg to IITB Campus.
Central Railway: Chhatrapati Shivaji Terminus (CST), Dadar, Kurla, Thane.
Western Railway: Mumbai Central, Dadar, Bandra, Andheri, Borivali.
Air Ports.International flights land at Terminal 2, Chatrapati Shivaji International Airport, which is about 10 kms from IIT Bombay. The Domestic Airport is at Terminal1A and Terminal1B (Santa Cruz), which is

about 15 kms. Call taxis, pre-paid taxis and autorickshaws are available at the airports.
TheIITB Campus Map(including a mobile app) helps you navigate through the IIT Bombay Campus. It is specially designed for first time visitors and new entrants, to find their way around IITB with ease.
Computer Science and Engineering (CSE) buildings (numbered 12 and 13) are in block B4 on the map.

Kanwal Rekhi Building,IIT Bombay
Powai, Mumbai - 400076

Table:

Kanwal Rekhi Building,Department of Computer Science and Engineering,Indian Institute of Technology (IIT) Bombay,Powai, Mumbai 400 076. Phone no. : +91-22-2576 7901/02

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Computer Networks, Operating Systems, Computer Architecture, Compilers and Programming Languages, Database Systems, Distributed Systems, Network and Information Security, Embedded Systems, Wireless Networks and Sensors, Software Engineering, System Dynamics, Technology for Social Development
Algorithms and Complexity Theory, Cryptography, Combinatorics, Graph Theory, Geometry, Formal Methods and Verification, Logic and Automata Theory
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Powai, Mumbai - 400076

Table:

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Powai, Mumbai - 400076

Ordered List:

1. Fast Static and Dynamic Approximation Algorithms for Geometric Optimization Problems: Piercing, Independent Set, Vertex Cover, and Matching
2. Spanners in Planar Domains via Steiner Spanners and non-Steiner Tree Covers

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The CSE department offers B.Tech., B.Tech. Dual-Degree, M.Tech., M.S., M.Tech. Dual-Degree and Ph.D. programmes in computer science and engineering. M.Tech., M.S. and Ph.D. are post-graduate programmes, B.Tech. is the undergraduate programme, while the B.Tech. Dual-Degree is a programme in which you come in at the undergraduate level, stay for five years, and are awarded both a B.Tech. and an M.Tech degree at the end. Details regarding all these programmes can be found here. In addition to the above, some department-specific information is given below. Please follow the appropriate links to find what you need.

The B.Tech. programme at the Department of CSE, IIT Bombay, follows a flexible curriculum that covers the theoretical underpinnings of computer science as well as a range of essential topics in computer systems.

The M.Tech. programme is a post-graduate programme combines academic coursework with a substantial research component. It offers flexibility for academic and research-oriented students.

M.S. by Research in CSE is a new programme (introduced in 2020) designed for students who wish to explore a career in R&D. It can serve as a first step towards a Ph.D. or a high-end R&D-oriented career in industry.

The Ph.D. programme is a post-graduate programme primarily focussed on original research that can lead to potential publications in premier conferences or top journals.

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3.Written tests and interviews for Ph.D. admissions for December 2024 will beconducted IN PERSONon the IITB campus. For theforeign applicants, there will be online tests and interviews.
4.Dates for written tests and interviews for the Ph.D. admissions for December 2024 have been announced.
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Table:

Course Codesort Course Namesort Instructorsort
CS 101 Computer Programming and Utilization Prof. Manoj Prabhakaran
CS 105 Discrete Structures Prof. Akshay S.
CS 213 Data Structures and Algorithms Prof. Ashutosh Gupta
CS 215 Data Analysis and Interpretation Prof. Sunita Sarawagi
CS 218 M Design and Analysis of Algorithms Prof. Ajit Diwan
CS 228 Logic For CS Prof. Krishna S.
CS 230 Digital Logic Design and Computer Architecture Prof. Bhaskaran Raman/ Prof. Sayandeep Saha
CS 231 Digital Logic and Computer Architecture Lab Prof. Bhaskaran Raman/ Prof. Sayandeep Saha
CS 293 Data Structures Lab Prof. Ashutosh Gupta
CS 317 M Database and Information Systems Prof. Suraj Shetiya
CS 339 Abstractions and Paradigms for Programming Prof. Manas Thakur
CS 347 M Operating Systems Prof. Mythili Vutukuru
CS 348 Computer Networks Prof. Vinay Ribeiro
CS 355 Programming Paradigms Laboratory Prof. Manas Thakur
CS 378 Computer Networks Lab Prof. Vinay Ribeiro
CS 405 Game Theory and Algorithmic Mechanism Design Prof. Swaprava Nath
CS 409 M Introduction to Cryptography Prof. Sruthi Sekar
CS 419 M Introduction to Machine Learning Prof. Abir De
CS 6001 Game Theory and Algorithmic Mechanism Design Prof. Swaprava Nath
CS 6003 Web security Prof. Kameswari Chebrolu
CS 601 Algorithms and Complexity Prof. Akash Kumar
CS 602 Applied Algorithms Prof. Sujoy Bhore
CS 618 Program Analysis Prof. Uday Khedkar
CS 626 Speech, Natural Language Processing and the Web Prof. Pushpak Bhattacharyya
CS 631 Implementation Techniques for Relational Database Systems Prof. Sudarshan S.
CS 635 Indexing, retrieval and learning for text and graphs Prof. Soumen Chakrabarti
CS 663 Fundamentals of Digital Image Processing Prof. Ajit Rajwade
CS 683 Advanced Computer Architecture Prof. Biswabandan Panda
CS 699 Software Lab. Prof. Om Damani
CS 725 Foundations of machine learning Prof. Preethi Jyothi
CS 744 Design and Engineering of Computing Systems Prof. Purushottam Kulkarni
CS 760 Topics in Computational Complexity Prof. Rohit Gurjar
CS 771 Foundations of verification and automated reasoning Prof. Paritosh Pandya
CS 781 Formal Methods in Machine Learning Prof. Supratik Chakraborty

CS 782 Algebra and Computation Prof. Milind Sohoni
CS 783 Theoretical Foundations of Cryptography Prof. Chethan Kamath
CS 787 Language Engineering for Complex Programs: A C++ Perspective Prof. Rushikesh K Joshi
CS 788 Algebraic Automata Theory Prof. Bharat Adsul

Table:

Course Codesort Course Namesort Instructorsort
CS 101 Computer Programming and Utilization Prof. Preethi Jyothi
CS 108 Software Systems Lab Prof. Kameswari Chebrolu
CS 207 M Discrete Structures Prof. Bharat Adsul
CS 213 M Data Structures and Algorithms Prof. Milind Sohoni
CS 217 Artificial Intelligence and Machine Learning Prof. Pushpak Bhattacharyya
CS 218 Design and Analysis of Algorithms Prof. Rohit Gurjar
CS 219 Operating Systems Prof. Mythili Vutukuru
CS 224 M Computer Networks Prof. Varsha Apte
CS 228 M Logic For CS Prof. Supratik Chakraborty
CS 236 Operating Systems Lab Prof. Mythili Vutukuru
CS 240 Artificial Intelligence and Machine Learning (Lab) Prof. Pushpak Bhattacharyya
CS 302 Implementation of Programming Languages Prof. Uday Khedker
CS 310 M Automata Theory Prof. G Sivakumar
CS 316 Implementation of Programming Languages Lab Prof. Uday Khedker
CS 317 Database and Information Systems Prof. S Sudarshan/ Prof. Suraj Shetiya
CS 349 Database and Information Systems + Lab (along with Sudarshan) Prof. Suraj Shetiya/ Prof. S Sudarshan
CS 387 Database and Information Systems Lab Prof. S Sudarshan
CS 433 Automated reasoning Prof. Ashutosh Gupta
CS 6002 Selected Areas of Mechanism Design Prof. Swaprava Nath
CS 603 Geometric Algorithms Prof. Sujoy Bhore
CS 614 Advanced Compilers Prof. Manas Thakur
CS 621 Artificial Intelligence Prof. G Sivakumar
CS 648 Selected Topics in Network Algorithms Prof. Ashwin Gumaste
CS 726 Advanced machine learning Prof. Sunita Sarawagi
CS 728 Organization of Web information Prof. Soumen Chakrabarti
CS 736 Medical Image Computing Prof. Suyash P. Awate
CS 738 Concepts, Algorithms and Tools for Model-Checking Prof. Paritosh Pandya
CS 747 Foundations of Intelligent and Learning Agents Prof. Shivaram Kalyanakrishnan
CS 752 System Dynamics: Modeling & Simulation for Development Prof. Om Damani
CS 754 Advanced Image Processing Prof. Ajit Rajwade
CS 755 Competitive programming Prof. Ajit Diwan
CS 765 Introduction of Blockchains, Cryptocurrencies, and Smart Contracts Prof. Vinay Ribeiro
CS 766 Analysis of Concurrent Programs Prof. S Krishna
CS 768 Learning with Graphs Prof. Abir De
CS 769 Optimization in Machine Learning Prof. Ganesh Ramakrishnan
CS 770 Process Engineering Prof. Rushikesh K. Joshi
CS 772 Deep Learning for Natural Language Processing Prof. Pushpak Bhattacharyya
CS 773 Computer Architecture for Performance and Security Prof. Biswabandan Panda
CS 774 Spectral Graph Theory Prof. Akash Kumar
CS 784 Image Synthesis Prof. Parag Chaudhuri
CS 899 Communication Skills Prof. Bhaskaran Raman
CS--- Generative AI and LLM design for Network Configuration Prof. Ashwin Gumaste
CS---- Quantitative verification Prof. Akshay S

Table:

Course Codesort Course Namesort Instructorsort

Table:

Course Codesort Course Namesort
CS 101 Computer Programming and Utilization
CS 101 MSc Computer Programming and Utilization (M.Sc students)
CS 103 Computing and Science
CS 104 Software Systems Lab
CS 105 Discrete Structures
CS 108 Software Systems Lab
CS 152 Abstractions and Paradigms for Programming
CS 154 Programming Paradigms Laboratory
CS 202 Programming
CS 203 Discrete Structures
CS 204 Switching Theory and Logic Design
CS 205 Programming
CS 206 Formal Methods in CS
CS 207 Discrete Structures
CS 207 M Discrete Structures
CS 208 Automata Theory and Logic
CS 210 Logic Design
CS 211 Software Lab two
CS 212 Electronics Design I
CS 213 Data Structures and Algorithms

Table:

Course No of NUS Courses at IITB
CS2012 CS317
CS2102 CS387
CS2106 CS347
CS2016 CS377
CS3243 CS344+CS386 (new No.CS337+CS335)
CS4215 CS302+CS316+CS306
CS3241 CS475
CS3245 CS635
EE4212 CS763
CS2100 CS226+CS254
CS3230 CS218
CS2105 CS224+CS252
CS2106 CS347+CS333
CS3244 CS725
MA3252 CS435+CS750
CS3234+CS4269+CS5469 CS228
CS6216 CS726
CS3233 CS755

CS2103 CS682
CS3211 CS751
CS5331+CS5321 CS416
CS5260 CS772
CP3106 CS485
CS2100 CS305
EE4704 & EE3206 CS663
EC4204 CS224
EE2026 CS226
CS4222 CS743
CS4248 CS772

Table:

Course No of DTU Courses at IITB
2223 CS684
2561 CS475
2505 CS736
01227 CS408
02256 CS433
2450 CS725

Table:

Course No of SFU Courses at IITB
CMPT379 CS302
CMPT310 CS344
CMPT361 CS675
CMPT404 CS724
CMPT431 CS451
CMPT454 CS632
CMPT471 CS348
CMPT740 CS631
CMPT310 + CMPT726 CS337 + CS335
CMPT295 CS305
CMPT300 CS347 + CS333
CMPT404 CS406
ENSC254 CS305+CS341
ENSC474 CS663
CMPT354 CS317
CMPT361 CS675+CS475
MATH308 CS435
MATH445 CS408

Table:

Course No of KAIST Courses at IITB
CS211 CS226 & CS254
CS341 CS224 & CS252

CS402 CS228
CS500 CS218
EE303 CS226+CS254
CS300 CS218
CS380 CS675
CS576 CS763
EE523 CS709

Table:

Course No of CUHK	Courses at IITB
CS3201	CS224 & CS252
CS4335	CS218

Table:

Course No of NTU	Courses at IITB
Cz3005	CS344
CE4024	CS416(m)
Cz1006	CS305+CS341
Cz2005	CS347+CS333
MH4302	CS310
Cz2003	CS475
EE4476	CS663 (Subject to passing CS736)
Cz3005	CS335+CS337 (Subject to passing CS726)
EE2008	CS213

Table:

Course No of Geneva	Courses at IITB
S403011 CR	CS419M

Table:

Course No of Aalto	Courses at IITB
CS-C3140	CS347
CS-C3140	CS333
MS-A0402	CS207M
CS-E4580	CS751
CS-E4565	CS604
CS-C2160	CS310M

Table:

Course No of EPFL	Courses at IITB
CS450	CS218M
CS341	CS475
CS439	CS769
CS206	CS751
CS442	CS763
CS322	CS317
CS420	CS614
CS440	CS775

Table:

Course No of KAIST	Courses at IITB
CS211	CS226+CS254
CS341	CS224+CS252
CS402	CS228
CS500	CS218
EE303	CS226+CS254
CS300	CS218
CS380	CS675
CS576	CS763
EE523	CS709

Table:

Course No of KTH	Courses at IITB
DT2119	CS753
DH2320	CS475
ID2203	CS451

Table:

Course No of ETH	Courses at IITB
227-0558-00L	CS451
263-4400-00L	CS602
252-0579-00L	CS763
263-5352-00L	CS713

Table:

Course No of Houston	Courses at IITB
COSC3380	CS317
COSC4393	CS663

Table:

Course No of KUL Courses at IITB
B-KUL_H09J2A CS663
B-KUL_H02A6A CS753

Table:

Course No of Politecnico Di Milano Courses at IITB
088949 CS683

Table:

Course No of INSA Lyon Courses at IITB
IF-3-GL CS682

Table:

Course No of CTU Courses at IITB
BEZM321BEA CS406
BE4B36FUP CS613
NIE-VCC CS695

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Leading computer science department in India
Our faculty has been honoured with awards such as thePadma Shri, ACM and IEEE Fellowship, Shanti Swarup Bhatnagar award, Infosys Prize, and many other prestigious fellowships.
It routinely attracts50 of the top 75 ranks in JEE to its B.Tech. programand applicants withGATE scores greater than 850 to its M.Tech. program.
Every year, we produceover 100 research publications in top-tier conferences and journals(as ranked by CORE). Publications from CSE@IITB have amassedmore than 37500 citationsin the period 2014-2019.
The department has astar-studded alumni body,consisting of leading researchers around the world, entrepreneurs, experts, successful engineers and impactful policy makers.
Our faculty has attractedsponsored research projects(by the Government and the private sector)worth Rs. 50 crores.

The first computing activity in IIT Bombay started with the arrival of theMinsk IIcomputer in 1967, which had 2nd generation discrete transistor based circuitry, paper tape input-output, and off-line printers.Prof. J.R. Isaacspearheaded the initial efforts in setting up the Computer Center assisted by five faculty members.
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The center was initially allocated space in the same premises as that of the Department of Mathematics. Immediately thereafter, the Centre started offering elective courses in Computers as a part of the UG and PG programmes in Electrical Engineering. In 1973 the center started offering academic programmes in the form of an inter-disciplinary M.Tech. programme and a DIIT (Post Graduate Diploma of IIT) in Computer Science.
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In 1974, EC-1030, a Soviet-made computer with 3rd generation LSI circuitry (equivalent to IBM 360) was acquired. The same year two more faculty members joined the centre. During the period 1975 to 1980, the center undertook several indigenous efforts to enhance both the software and hardware resources of this machine. The center supported the entire computing needs of the academic community of IIT Bombay. By 1977 the number of faculty members rose to 11.
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The CC building at IIT Bombay was built in 2014.

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M.S by Research in CSE ,designed for students who wish to explore a career in R&D, and can serve as a first step either towards a Ph.D. or towards a high-end R&D oriented career in industry.
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Kanwal Rekhi Building,IIT Bombay
Powai, Mumbai - 400076

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The Department of CSE (IITB) invites applications for faculty positions at all levels and in all areas in Computer Science and Engineering. Applications for sabbatical/short-term visits are also welcome. Applicants must have a Ph.D. in Computer Science or related areas and should show evidence of exceptional research potential.
The Indian Institute of Technology Bombay (IITB) is well-known as one of India’s premier engineering institutes, and has produced highly successful researchers and entrepreneurs. We take pride in our active and vibrant academic research environment. The Department of CSE (IITB) has not only the largest set of CSE faculty (see faculty list here), but also among the best research minds in almost every area of Computer Science. We provide a nurturing, friendly, and flexible environment for faculty to develop their academic research careers. Last but not the least, the quality of living on the picturesque IIT Bombay campus is very high.
The CSE department and the institute, offer an environment conducive to research, e.g.
In addition to this, it is possible to raise grant money for research through various government and industry sources.
IIT Bombay has very strong graduate programmes.
Faculty enjoy several personal benefits, for example
Benefits are subject to availability and other conditions. The above reflects typical benefits enjoyed by most faculty members. However, all final decisions are made by the corresponding authorities.
Living on the IIT Bombay campus offers an absolutely unbeatable combination of opportunities - that of living in a city that is the financial, business, and entertainment hub of India, while still enjoying the peace and quiet of a lush green campus nestled between a lake and rolling hills. The campus has all amenities needed for a high quality of living - green, tree-filled and pollution-free surroundings, children’s park, swimming pool and various sports facilities: tennis, badminton, squash, volley-ball, basket-ball, hockey, cricket, football, etc. There is an on-campus creche (day-care centre), and two schools.

The campus is vibrant with student-led cultural activities throughout the year. Faculty gets free, premium seating at professional performances during the main cultural festival (Mood Indigo), as well as at the enthralling Performance Arts Functions (student performances). There are additional cultural events (music, dance, theater, movies) throughout the year in the various campus auditoriums.The campus community is a warm, friendly community of IIT Bombay faculty, staff and students that comes together for events such as Holi and Diwali. The CSE department itself has informal get-togethers, such as faculty picnics and dinners, and faculty-student cricket matches.
Just outside IIT Bombay lies the vibrant neighborhood of Powai and Hiranandani, an entertainment hub with international restaurant chains and enticing shopping destinations. Moreover, the campus is conveniently located a mere 45-minute train ride away from captivating downtown areas, perfect for day trips. For the adventurous, trekking in the nearby Sahyadris is a beloved weekend pastime for both

Mumbai residents and IITB students and faculty, creating numerous opportunities for shared experiences.In addition to exploring Mumbai, if you have family across India, you’ll find no better-connected city than Mumbai, ensuring easy access to your loved ones. And for those with international aspirations, the city serves as a gateway to the world, with major international airlines operating daily flights to and from Mumbai, offering seamless global connectivity.
Please submit the following material on the appropriate portal as directed onthis link:
The application is processed in the following steps:
Candidates from under-represented categories including SC/ST, OBC-NC, EWS, PWD as well as women candidates are encouraged to apply.
People with extensive and impactful industrial experience are invited to apply for Professor of Practice (PoP) positions. More information about the eligibility criteria and job description for these positions are included inthis document. The application process is similar to that described earlier in this document.
Institute Post-doctoral (post-doc) fellowships are available in the CSE Department as well as various other academic Departments, Centres, Schools and Inter-disciplinary programs. There is no last date for the applications. The Search Committees meet regularly to consider the applications and arrange for invited seminars and/or interviews as the need arises. Please write to the head of the department with your CV, and information on any faculty members you propose to work with.
The evaluation parameters are as follows:
In addition to this take note of the following:
Kanwal Rekhi Building,IIT Bombay
Powai, Mumbai - 400076

Table:

Experience Fellowship Amount
Fresh PhD with no post-PhD experience Rs. 65,000/- p.m.
PhD + 1 year of post-PhD experience Rs. 68,000/-p.m
PhD + 2 years of post-PhD experience Rs. 71,000/-p.m.
Non-lapsable contingency grant Rs. 15,000/year

Ordered List:

1. Government agencies invite proposals all year round, and are generally keen to grant funding in various thrust areas.
2. Mumbai(Bombay) is home to big corporate houses in the information technology space (e.g., Tata) which continue to fund large projects at IIT Bombay.
3. Several Bangalore and Pune based technology companies fund exciting research projects at IIT Bombay (seeFunded Projects). IIT Bombay’s most significant advantage in this respect is, again, it’s location - Mumbai is very well-connected to Bangalore and Pune.

Ordered List:

1. Apart from the M.Tech. and Ph.D. program that routinely attract top students across the country, we also have a new M.S. by Research program with an emphasis on research over coursework.
2. The M.S. program has a lot more flexibility in its program structure. The maximum duration of the M.S. program is 3 years, but students who have done exceptionally well can graduate as early as 1.5 years!
3. All graduate students admitted through the main selection program are guaranteed teaching assistantships for the entire duration of their programmes including summers (i.e., two years for M.Tech., M.S, and five years for Ph.D. students).
4. Apart from the regular stipends, we also offer many attractive fellowships to M.S. and Ph.D. students both at admission-time and after enrolling in the program.

5. Graduate students are offered excellent resources, with state-of-the-art lab facilities and work places for each student.

Ordered List:

1. A beautiful residential campus, with top-notch sporting facilities.
2. On-campus housing and free high-speed LAN connection at home.
3. There are two schools within campus, Kendriya Vidyalaya (Central School) as well as the Campus School, to which faculty can admit their children. There are also several other good quality schools in the vicinity of the campus.
4. On-campus free or subsidized medical care for faculty and their dependents.
5. Consulting: Faculty are allowed to earn additional personal income by offering their expert services to industry clients. IIT Bombay’sIRCC(Industrial Research and Consultancy Centre) facilitates this activity.

Ordered List:

1. Curriculum Vitae
2. Statement of Research
3. Statement of Teaching
4. Copies of 3 papers that you consider your best
5. Names and contact information including official website and e-mail addresses of 3 or more referees
6. Any other information required as directed on the portal

Ordered List:

1. Application:Candidate sends full application, and department receives reference letters from referees
2. Departmental interview:Candidate visits the department for 2 days for a research talk and one-to-one meetings and interaction with departmental faculty
3. Institute selection committee:This is the interview by the official selection committee which is scheduled once the department recommends the candidate; while in most cases the departmental recommendation is taken, the committee is not bound by the same.

Ordered List:

1. The candidate should have at least 2 publications in top-tier good conferences or journals coming out of the work done for Ph.D.
2. Continued good performance in research post-PhD (for those who are not fresh out of PhD). This may be relaxed for candidates who have worked in non-research jobs.
3. The work of the candidate, as exhibited in the 2 to 3 papers submitted by the candidate as a part of the application, should be adjudged to be of high quality by the departmental committee.
4. The candidate should have at least two letters of recommendation from people conversant with the research area of the candidate.

Ordered List:

1. Candidates can join once they have submitted their PhD thesis. Having defended the PhD thesis is not a requirement. However, the PostDoc offer will be conditional on the successful defense in some time limit.
2. It is expected that candidates should be recent graduates within a couple of years of finishing the PhD, although exceptions are possible. In particular for women who have taken a break to have kids, and wish to get back into research.
3. A candidate doing a postdoc at IIT Bombay cannot be considered for faculty positions at IITB immediately.
4. A faculty member of the department should be willing to act as guide/mentor.
5. Apply Here:(seehttps://www.iitb.ac.in/en/careers/institute-post-doctoral-fellows-recruitment).

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If you are interested in undergraduate courses, the resources available below will help you understand what it takes to get into IIT Bombay. The section below describes the program structure of IIT Bombay, the admissions procedures, the fees, special financial assistance information, and student facilities like counselling and mentorship.
Available Programmes
Joint Entrance Examination (JEE) & Procedures
Admission Day
Fee Schedules & Financial Assistance / Scholarship Information
Student Counselling Programme
Student Mentorship Programme
Kanwal Rekhi Building,IIT Bombay
Powai, Mumbai - 400076

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A derandomization approach in quantum information processing with applications in benchmarking a quantum gate and finding channels with superadditive classical capacity; and a One-shot cost region for Multiple Access Channel Simulation
In this talk, we will first see a derandomization technique in quantum computation and information processing. Quantum logic gates (and hence circuits) are generally unitary operators and in order to prove existential results via a probabilistic method one needs to sample these unitary operators randomly. The distribution of a unitary operator chosen uniformly at random from the unitary group is described via the Haar measure and we call these as Haar random unitaries. It is proven that the sampling and implementation of Haar random unitaries are exponentially hard. Hence, we consider one finite (pseudorandom) ensemble of unitaries which mimics Haar random unitaries approximately, upto first [image: t]-moments (over a polynomial in entries of the unitary). This pseudorandom ensemble of unitaries is called an approximate unitary [image: t] design. Brandao et al. (2012) and Sen (2019) have shown that approximate unitary [image: t]-designs can be constructed efficiently if the value of the parameter [image: t=O(poly (\log n))]. We first describe a known method of Low et al. (2009) of using these designs analogous to [image: t]-wise independent random variables and find large deviation bounds for polynomials in entries of such unitaries. This leads to replacing Haar random unitaries via designs and we shall refer to this process as derandomization.

We then come to the first task of constructing efficient algorithms for benchmarking a quantum logic gate using these designs. Our algorithms use less random bits and do a tighter error analysis than the state of art. This is one of the fundamental steps in experimentally implementing a quantum computer (given the reliability of the building blocks for quantum gates).

We then consider the problem of finding quantum channels that have single letter characterization of the classical capacity also called the Holevo capacity. Holevo capacity is the maximum rate at which classical information can be transmitted over a quantum channel. This is the first generalization of classical information theory in a quantum setting.
Hastings(2008) in a major breakthrough, proved for the first time that there exists quantum channels exhibiting superadditive Holevo capacity, which was conjectured otherwise (Holevo, 2000) and in fact the conjecture was shown to be true for a wide variety of channels. This superadditivity of Holevo capacity implies that the quantum channels may not always have a single letter capacity formula, making it extremely difficult to compute and construct "optimal" error correction codes. Hastings used channels that are represented by choosing Haar random unitaries ([image: U_{n \times n}]). Constructing these

channels (even approximately) requires exponentially many qubits ([image: n^2 \log n], [image: n=2^{ \char"0023   qubits}]). Hence, the hunt for efficient channels having superadditive Holevo capacity has been a long-standing open problem. We take a step in this direction by aiming to derandomize Hastings counter example. In particular, we consider channels sampled uniformly from approximate unitary [image: n^{2/3}]-designs and show that these channels have superadditive Holevo capacity with exponentially high probability. Although the value of the design parameter [image: t] in our counterexample (for additivity of Holevo capacity) is [image: n^{2/3}], we still save a lot in terms of random bits ([image: O(n^{2/3} \log n]) for implementation leading to a partial derandomization. We use tools from geometric functional analysis to do a novel stratified analysis of the unit [image: n]-sphere ([image: \mathcal{S}^n]) and prove a measure concentration theorem for the random subspaces coming from [image: \mathcal{S}^n]. This leads to proving a discretized version of the so-called Dvoretzky's theorem (not to be discussed in the talk). An advantage of our main result is that it can be directly used to unify the previous analysis on this problem.

We will finally discuss the problem of *universally* simulating a classical Multiple Access Channel in the one-shot setting with independent inputs and infinite shared randomness. We show that we have an almost tight one-shot universal rate region for MAC, which we prove is tight asymptotically. The achievability is based on an elegant rejection sampling technique and converse is shown using a novel information-spectrum inspired technique. One-shot rate region is characterized in terms of the smoothed max-mutual information.

Dr. Aditya did his Master's and Ph.D. from STCS, TIFR, Mumbai in Quantum Information Theory on derandomizing Haar random unitaries via approximate unitary-designs to search for computationally efficient protocols. This involved, derandomizing the seminal result of Hastings that there exists quantum channels with superadditive classical capacity, prove a measure concentration for the decoupling theorem and construct efficient benchmarking protocols for a quantum logic gate.

After PhD, He was a Specially Appointed Assistant Prof. in Nagoya University, Japan continuing research in quantum information (Shannon) theory and resource theory. At present He is a postdoc in the Institute of Quantum Information, Department of Physics at RWTH Aachen University. His research interests are in classical and quantum information theory, quantum computing and applied probability.

Rapid LLM Deployments: with Great Power Comes Great Responsibility

With the ubiquitous use-cases of modern LLMs, the deployment scale of these models is unforeseen. This has led to a large-scale datacenter expansion with GPUs, currently running into an energy wall worldwide. This talk will focus on the properties of generative LLMs that can be used to make the deployment of these models more power-efficient. The talk will also introduce POLCA, Splitwise, and DynamoLLM: three techniques to reduce the power consumption for the LLM serving.

Esha Choukse is a Principal Researcher at Microsoft in the Azure Research – Systems group. Her current research focus is on efficient AI in the cloud, spanning the layers of AI platforms, hardware, and datacenter design and provisioning. In the past, Esha has also worked on sustainability, memory systems, and compression. Esha has a PhD from University of Texas at Austin and has published several papers at ISCA, ASPLOS, MICRO, HPCA, SC, and NSDI.

Here is a link to her profile: https://www.microsoft.com/en-us/research/people/eschouks/.

Generalization of a Lemma of Polischuk & Spielman and Low Degree Test in the High Error Regime

A celebrated lemma of Polischuk and Spielman that is crucial for many PCP constructions states that the following:

If A(x,y,z) is a polynomial of the form A_0(x,y) + z A_1(x,y), and suppose we are told that A_1(alpha, y) divides A_0(alpha, y) for many alphas, and A_1(x, beta) divides A_0(x, beta) for many betas. Then, A_1(x,y) divides A_0(x,y) as bivariate polynomials. In other words, A(x,y,z) has a factor of the form (z - Q(x,y)).

A natural question is whether a higher degree generalization of this holds, where the z-degree in A is more than one. We show that a suitable generalization of the above hypothesis does indeed yield a generalization. We then use this generalization to analyse the line-point low degree test in the high error regime. In the lectures, we will discuss a proof of the original lemma of Polischuk-Spielman, its aforementioned generalization and the application to the line point low degree test.

The discussion will mostly be self contained and should be accessible to a general theory audience.

Please note that the second part of the talk will be held at 15:00 hrs. on the same day and at same venue.
1. Prof. Mrinal Kumar is a faculty member at TIFR Mumbai. Earlier, he was a faculty here at IIT Bombay. His research interests lie in Computational Complexity, Algebraic Complexity, Algebra & Computation and Error Correcting Codes.

2. Prof. Ramprasad Saptharishi is a faculty member at TIFR Mumbai. His research interests lie in Pseudorandomness and derandomization Algebraic circuit complexity and broadly in anything with an algebraic flavour.
Fairness and Incentives in Federated Learning via Social Choice
Federated learning provides an effective paradigm to jointly optimize a model benefited from rich distributed data while protecting data privacy. Nonetheless, the heterogeneous nature of distributed data makes it challenging to define and ensure fairness among local agents, and create incentive issues. For instance, it is intuitively "unfair" for agents with data of high quality to sacrifice their performance due to other agents with low quality data. Furthermore, on the one hand agents benefit from the global model trained on shared data, while on the other hand by participating in federated learning, they may also incur costs (related to privacy and communication) due to data sharing.

In this talk I will attempt to take social choice theoretic and game theoretic perspective to address these fairness and incentive issues. In this process I will show how FL and SCT can inform each other, leading to newer insights and avenues.

Based on joint work with (in alphabetical order) Bhaskar Ray Chaudhary, Mingtong Kang, Bo Li, Linyi Li, Aniket Murhekar, Ariel Procaccia, and Zhuowen Yuan.
Bio: Ruta Mehta is an Associate Professor of Computer Science at the University of Illinois at Urbana-Champaign. Prior to joining UIUC, she was a postdoctoral fellow at Simons Institute, UC Berkeley, and at College of Computing, Georgia Tech. She did her Ph.D. from the Indian Institute of Technology Bombay, India. Her research interests lie in theoretical computer science and its interface with economics, games theory, fair division, and learning. For her research, she has received the NSF CAREER Award, the Simons-Berkeley Research Fellowship, and the Best Postdoctoral Award (given by CoC@GT). Her Ph.D. thesis won the ACM India Doctoral Dissertation Award and the IIT-Bombay Excellence in Ph.D. Thesis Award.
Outlier Robust Multivariate Polynomial Regression
We study the problem of robust multivariate polynomial regression: let $p : \reals^n \to \reals$ be an unknown n-variate polynomial of degree at most d in each variable. We are given as input a set of random samples $(\mathbf{x}_i, y_i) \in [-1,1]^n \times \reals$ that are noisy versions of $(\mathbf{x}_i, p(\mathbf{x}_i))$. More precisely, each $\mathbf{x}_i$ is sampled independently from some distribution χ on $[1,1]^n$, and for each i independently, y_i is arbitrary (i.e., an outlier) with probability at most $\rho < 1/2$, and otherwise satisfies $|y_i - p(\mathbf{x}_i)| \leq \sigma$. The goal is to output a polynomial $\hat{p}$, of degree at most d in each variable, within an ℓ_∞-distance of at most $O(\sigma)$ from p.

Kane, Karmalkar, and Price [FOCS'17] solved this problem for $n=1$. We generalize their results to the n-variate setting, showing an algorithm that achieves a sample complexity of $O_n(d^n \log d)$, where the hidden constant depends on n, if χ is the n-dimensional Chebyshev distribution. The sample complexity is $O_n(d^{2n} \log d)$, if the samples are drawn from the uniform distribution instead. The approximation error is guaranteed to be at most $O(\sigma)$, and the run-time depends on $\log(1/\sigma)$. In the setting where each $\mathbf{x}_i$ and y_i are known up to N bits of precision, the run-time's dependence on N is linear. We also show that our sample complexities are optimal in terms of d^n. Furthermore, we show that it is possible to have the run-time be independent of $1/\sigma$, at the cost ofa higher sample complexity.

This is a joint work with Arnab Bhattacharyya, Mathews Boban, Venkatesan Guruswami, and Esty Kelman, and appeared at ESA'24.

Vipul is a final year PhD student at Dept of CS, School of Computing, National University of Singapore, advised by Prof Arnab Bhattacharyya. His research interests lie in Complexity Theory, Combinatorics, Information Theory, and Theoretical CS, in general. His current work is focused in Property Testing, and Theoretical Machine Learning.

Low Degree Testing over the Reals

We study the problem of testing whether a function $f: \reals^n \to \reals$ is a polynomial of degree at most d in the distribution-free testing model. Here, the distance between functions is measured with respect to an unknown distribution D over $\reals^n$ from which we can draw samples. In contrast to previous work, we do not assume that D has finite support.

We design a tester that given query access to f, and sample access to D, makes $\poly(d/\eps)$ many queries to f, accepts with probability 1 if f is a polynomial of degree d, and rejects with probability at least $2/3$ if every degree-d polynomial P disagrees with f on a set of mass at least $\eps$ with respect to D.

Our result also holds under mild assumptions when we receive only a polynomial number of bits of precision for each query to f, or when f can only be queried on rational points representable using a logarithmic number of bits. Along the way, we prove a new stability theorem for multivariate polynomials that may be of independent interest.

This is a joint work with Arnab Bhattacharyya, Esty Kelman, Noah Fleming, and Yuichi Yoshida, and appeared in SODA'23.

Vipul is a final year PhD student at Dept of CS, School of Computing, National University of Singapore, advised by Prof Arnab Bhattacharyya. His research interests lie in Complexity Theory, Combinatorics, Information Theory, and Theoretical CS, in general. His current work is focused in Property Testing, and Theoretical Machine Learning.

Auction-Based Scheduling

Sequential decision-making tasks often require satisfaction of multiple, partially contradictory objectives. Existing approaches are monolithic, where a single policy fulfills all objectives. I will present auction-based scheduling, a new modular framework for multi-objective sequential decision-making. In this framework, each objective is fulfilled using a separate and independent policy. The policies are then composed through a novel run-time composition mechanism, where at each step, they need to bid from pre-allocated budgets for the privilege of choosing the next action. The bidding encourages the policies to adjust their bids according to their urgencies to act, and whoever bids the highest gets scheduled first. We study the following decentralized synthesis problem: How to compute bidding-equipped policies whose composition will simultaneously fulfill all objectives? I will present solutions of the decentralized synthesis problem for path planning on finite graphs with two temporal objectives.

Kaushik Mallik is a postdoctoral researcher at the Institute of Science and Technology Austria (ISTA). His research interests are broadly in formal verification and synthesis of reactive software systems. He received the 2023 ETAPS Doctoral Dissertation Award, nominations for best paper awards in HSCC, TACAS, and CONCUR, and a number of merit-based fellowships during his bachelor's and master's studies. He holds B. Tech (2012) in Electrical Engineering from Meghnad Saha Institute of Technology (Kolkata), M. Tech (2015) in System and Control from IIT Roorkee, and PhD (2022) in Computer Science from Max-Planck Institute for Software Systems (Germany).

Certified Policy Verification and Synthesis for MDPs under Distributional Properties

Markov Decision Processes (MDPs) are a classical model for decision making in the presence of uncertainty. Often they are viewed as state transformers with planning objectives defined with respect to paths over MDP states. An increasingly popular alternative is to view them as distribution transformers, giving rise to a sequence of probability distributions over MDP states. For instance, reachability and safety properties in modelling robot swarms or chemical reaction networks are naturally defined in terms of probability distributions over states. Verifying such distributional properties is known to be hard and often beyond the reach of classical state-based verification techniques. In this talk, we will consider the problems of certified policy (i.e. controller) verification and synthesis in MDPs under distributional properties. We will present a method that, along with a policy, synthesises a (checkable) certificate ensuring that the MDP indeed satisfies the property. The method is applicable to distributional reachability, safety and reach-avoidance specifications. The method is based on the notion of distributional certificates and provides a fully automated procedures for (1) synthesising a certificate for a given policy, and (2) synthesising a policy together with the certificate, both providing formal guarantees on certificate correctness.

Djordje Zikelic is an assistant professor at the School of Computing and Information Systems, Singapore Management University. Prior to joining SMU, he obtained his PhD in computer science at the Institute of Science and Technology Austria (ISTA) and bachelor's and master's degrees in mathematics at the University of Cambridge. His research focuses on formal verification and synthesis of software and AI systems and lies at the interplay of formal methods, trustworthy AI and programming languages research. His work is regularly published at premier venues in formal methods, programming languages, AI and ML, including CAV, FM, PLDI, POPL, OOPSLA, AAAI, NeurIPS and IJCAI. For his PhD work, he received the Outstanding PhD Thesis award and the Outstanding Scientific Achievement award at ISTA.

EdgeRIC: Empowering AI-based Real Time Intelligent Control, Optimization and Security in NextG Networks

In the rapidly evolving landscape of robotics, AR/VR/XR, automotive perception, and machine learning applications, traditional approaches to network optimization focused solely on QoS optimization cannot deliver diverse application requirements. Furthermore, optimizing QoE is crucial to delivering an enhanced user experience. Such requirements are often impossible to consider during standardization and are incredibly challenging to optimize.

In this talk, I will first present the limitations of existing RAN intelligent controllers (RICs) in adapting to highly mobile wireless channels, which restricts their ability to meet the on-demand needs of applications. I will next introduce EdgeRIC—a real-time RAN intelligent controller that leverages the power of AI, specifically Reinforcement Learning, to elevate the performance of ORAN (Open RAN) stacks and address the diverse requirements of various applications in real-time. Decoupled from the RAN stack, EdgeRIC functions as an intelligent controller that employs AI-powered optimization techniques to provide control decisions to the RAN across multiple layers. Next, to train these AI models, we have developed a digital twin that ensures the spatial and temporal consistency of the wireless channel. Our deployment showcases the integration of EdgeRIC with an open-source ORAN stack, highlighting the remarkable over-the-air performance improvements achieved. With an application-aware intelligent scheduling policy, we present compelling results demonstrating a substantial 90% reduction in video streaming stalls. In addition to this, we would present MIMO apps that secure connectivity and cancel unwanted interference in challenging urban environments. Finally, I briefly cover several activities in my group -- from sensing to communication.

Dinesh Bharadia has been an associate professor in the ECE department at the University of California San Diego since July 2022, where he directs the WCSNG group. He received early promotion to a tenured professorship and held Assistant Professorship for four brief years from 2018 – 2022. He received his Ph.D. from Stanford University in 2016 and was a Postdoctoral Associate at MIT. Specifically, he built a prototype of a radio that invalidated a long held assumption in wireless that radios cannot transmit and receive simultaneously on the same frequency, which inspired research on this topic from different communities (communication theory to RFIC). From 2013 to 2015, he worked to commercialize his research on full-duplex radios, building a product that underwent successful field trials at Tier 1 network providers worldwide like Deutsche Telekom and SK Telecom. He serves as a technical advisor for multiple startups. Dinesh was named to Forbes 30 under 30 for the science category worldwide list in recognition of his work. Dinesh was named a Marconi Young Scholar for outstanding wireless research and was awarded the Michael Dukakis Leadership Award. MIT Technology Review also named him among the top 35 Innovators under 35 worldwide in 2016.

At UC San Diego, his group WCSNG designs and prototypes systems for Wireless Communication, Computing, Sensing, Networking, and sensor design with applications to privacy, security, robotics, health, and everyday life. Much of the group's research has inspired new research areas for border communities: communication theory, circuits, RFIC, and robotics. Much of his research has been translated into startups and commercial products (Haila, Kumu Networks, Totemic Labs).

Polynomial Time Algorithms for Integer Programming and Unbounded Subset Sum in the Total Regime
The Unbounded Subset Sum (USS) problem is an NP-hard computational problem where the goal is to decide whether there is a positive integer combination of numbers a1,...,an that is equal to b. The problem can be solved in pseudopolynomial time, while there are specialized cases, such as when b exceeds the Frobenius number of a1,...,an, for which a solution is guaranteed to exist.

In this talk, I will consider the search version of this problem, where the goal is to find the solution. explores the concept of totality in USS. The challenge in this setting is to actually find a solution, even though we know its existence is guaranteed. We focus on the instances of USS where solutions are guaranteed for large b. I will show that if b is slightly larger than the Frobenius number, then a solution can be found in polynomial time.

We then show how our results extend to Integer Programming with Equalities (ILPE), highlighting conditions under which ILPE becomes total. We investigate the diagonal Frobenius number, which is the appropriate generalization of the Frobenius number to this context. In this setting, we give a polynomial-time algorithm to find a solution of ILPE. The bound obtained from our algorithmic procedure for finding a solution almost matches the recent existential bound of Bach, Eisenbrand, Rothvoss, and Weismantel (2024).

This talk is based on joint work with Antoine Joux, Miklos Santha, and Karol Wegrzycki.
Divesh Aggarwal is an Associate Professor in the Department of Computer Science and a Principal Investigator at the Centre for Quantum Technologies at the National University of Singapore. He earned his PhD from ETH Zurich, where he focused on the theoretical foundations of cryptography. His research spans lattice-based cryptography, pseudorandomness, computational complexity, and coding theory. He has made significant contributions to the field, including developing some of the fastest known algorithms for lattice problems and advancing the understanding of their computational hardness. His work also includes pioneering constructions in non-malleable codes and extractors, which play a crucial role in modern cryptographic protocols. In recognition of his innovative research, he was awarded the NRF Investigatorship in 2024, a prestigious honor granted to leading scientists in Singapore to support high-impact, risk-taking research.
On the composition question for randomized query complexity.
A query algorithm (also known as a decision tree) that computes a Boolean function f on n variables, queries various bits of an input to f,possibly in an adaptive fashion and using randomness. It eventually produces a bit as an output, which is supposed to equal the value of f on that input with high probability. The complexity measure of such an algorithm is the number of queries that it makes in the worst case. This talk considers the query complexity of a class of Boolean function called ’composed functions’. Composition of two Boolean functions f and g is, informally speaking, the Boolean function (say h) obtained by successive applications of g and f. The composition question, instantiated for query complexity, asks whether there exists a query algorithm that computes h that is significantly more efficient than what the definition of h suggests: first compute g and then compute f. The question has been the centre of a lot of research, and stands open to this day. In this work we present some results in relation to this question. The
talk is based on a work that was accepted to STACS 2024.
Swagato is an Assistant Professor at IIT Kharagpur. His research interests lie in Computational Complexity and in Analysis of Boolean Functions. He did his PhD at TIFR and his thesis won ACM India Doctoral Dissertation Award in 2018.
Secure Multiparty Computation and its Application to Graph Analysis
The growing volumes of data being collected and its analysis to provide better services are creating worries about digital privacy. To address privacy concerns and give practical solutions, the literature has relied on secure multiparty computation (MPC) techniques. MPC enables a set of distrusting parties to carry out a joint computation on their inputs while ensuring that parties only learn the output and nothing beyond. MPC finds use in various domains such as healthcare, finance, and even the social sectors, facilitating privacy-preserving applications including but not limited to machine learning, fraud detection, recommendation systems, etc. In this talk, we will focus on the use-case of performing privacy-preserving computations on graph structured data.

In general, privacy-preserving graph analysis allows performing computations on graphs that store sensitive information, while ensuring all the information about the topology of the graph as well as data associated with the nodes and edges remains hidden. The current work addresses this problem by designing a highly scalable framework, Graphiti, that allows securely realising any graph algorithm. Graphiti relies on the technique of secure multiparty computation (MPC) to design a generic framework that improves over the state-of-the-art framework of GraphSC by Araki et al. (CCS'21). The key technical contribution is that Graphiti has round complexity independent of the graph size, which in turn allows attaining the desired scalability. The performance of Graphiti is also benchmarked to showcase its practicality.

This is a joint work with Varsha Bhat Kukkala, Arpita Patra and Bhavish Raj Gopal, and has been accepted to ACM CCS 2024.

Nishat Koti obtained her PhD from Indian Institute of Science, Bangalore, where she was working with Prof. Arpita Patra. She then undertook a post-doctoral research position at TU Darmstadt, Germany. Prior to this, she obtained her M.Tech and B.Tech degrees in Computer Science and Engineering from National Institute of Technology, Goa. Nishat's research interests lie in the area of secure multiparty computation (MPC), where she has worked on designing MPC protocols for privacy-conscious applications such as allegation escrow system, machine learning, fraud detection, and dark pools, to name few.

Presburger Arithmetic : Quantifier Elimination and Some Applications

In this talk, we revisit the fundamental problem of quantifier elimination in Existential Presburger Arithmetic. As one of the main highlights, we challenge the long-standing claim that eliminating a block of existentially quantified variables necessarily requires doubly exponential time. Our recent work refutes this by introducing a novel procedure which accomplishes quantifier elimination in singly exponential time. The core of our approach is a small model property for parametric integer programming, which extends the seminal results of von zur Gathen and Sieveking on small integer points within convex polytopes. Additionally, if time permits, I will discuss a compelling application of Presburger Arithmetic in proving a dichotomy related to the reachability problem for counter machines with infrequent reversals. By analyzing the growth of small solutions for iterations of Presburger-definable constraints, we show that any counter machine falls into one of two categories: (i) the number of reversals is uniformly bounded by a constant across all runs, or (ii) the number of reversals grows at least logarithmically with the length of the run. Moreover, reachability is undecidable for counter machines where the number of reversals grows logarithmically. This result indicates that, vis-à-vis counter machines, classical reversal bounding encompasses all the decidable cases within the broader framework of infrequent reversals.

Khushraj Madnani is a postdoctoral researcher at the Max-Planck Institute for Software Systems in Kaiserslautern, Germany, associated with the Rigorous Software Engineering group and the Models of Computation group. His research interests is broadly within the domain of formal verification of infinite-state systems, focusing primarily on (1) automata and logics for timed systems, (2) formal logics and models of computation, and (3) network controlled cyber physical systems. Khushraj completed his Master's and Ph.D. in Computer Science and Engineering at the Indian Institute of Technology (IIT) Bombay, Mumbai, India, under the guidance of Prof. S. Krishna and Prof. Paritosh K. Pandya where he defended his thesis titled "On Decidable Extensions of Metric Temporal Logic". Before joining the Max-Planck Institute, Khushraj was a postdoctoral researcher at the Delft Center for Systems and Control (DCSC) within the Faculty of Mechanical Engineering at Delft University of Technology, The Netherlands. He also served as a visiting postdoctoral fellow at the Tata Institute of Fundamental Research (TIFR) in Mumbai, India.

Computer Vision: From Research to Production for Online Shopping

Computer Vision is the cornerstone of perceiving, generating, and editing visual data like images, videos, and 3D models. While vision comes easy to us humans, it's deceptively hard for machines. In this talk, Shubham will present his PhD research on 3D Computer Vision and the work he's been doing in industry - to make such 3D and 2D research production-ready for enterprise.

The first half of the talk will introduce the audience to 3D Computer Vision -- the inverse problem of inferring 3D structure from 2D images, often in an under-constrained setting. Shubham will present how it has progressed over the last few years, including his PhD work on 3D reconstructing humans, animals, birds, and everyday objects from images and videos, especially in the absence of large amounts of GT supervision.

The second half of the talk will discuss the challenges involved in taking computer vision research (both 3D and 2D) to production. Shubham will do so using examples of problems they're solving at his startup, Avataar, where they're reimagining how to visualize products for online shopping.
Shubham Goel is a Research Scientist at Avataar working on Computer Vision. He did his B.Tech. in Computer Science from IIT Bombay in 2018 and then graduated from UC Berkeley with a PhD in 3D Computer Vision. Simultaneously, he spent a year at Facebook AI Research as a Visiting Researcher. During his PhD, he has worked on building models and systems that can infer 3D structure from 2D images and videos of birds, animals, objects, and humans, and has published his work in top-tier vision conferences. Now at Avataar, he continues to work on challenging computer vision problems — pushing its limits to production quality enterprise scale to change how we visualize products when shopping online.
Bridging the Theory and Practice of Cryptography
In the current internet landscape, cryptography plays a central role in securing communication. We rely on mathematical proofs to ensure security of the cryptographic systems that are deployed in practice. However, in many cases, due to issues like efficiency constraints, there is a gap between what these deployments need and what we can prove. In this talk, I will describe how my research identifies these gaps and makes progress towards bridging these gaps using new theoretical insights and techniques from different areas of computer science like complexity theory, algorithms, combinatorics, information theory, etc. More concretely, my work contributes towards bridging these gaps in three different ways. First, I provide exact security analyses of cryptographic systems that have been deployed at scale that did not have such analyses before. With the exact analyses available, practitioners can set parameters of the cryptographic system in a way that maximizes efficiency without sacrificing security. Secondly, I construct new cryptographic schemes that are better than existing schemes in terms of efficiency. This work helps make purely theoretical cryptographic notions practical. Finally, my work incorporates newer perspectives into the framework of security proofs that captures a more complete picture of the real world. This is in contrast to prior work where only certain adversarial resources were taken into account. A more complete picture of adversarial resources often helps in setting parameters in a way that increases efficiency of cryptographic systems.
Ashrujit Ghoshal is a postdoctoral fellow at Carnegie Mellon University. He received his PhD from the University of Washington in 2023. His research focuses on bridging the gap between the theory and practice of cryptography by developing new theory that characterizes security and efficiency of cryptographic systems as precisely as possible. In particular his work has provided exact security analyses for cryptography that is widely used in practice e.g., standard hash functions like SHA-2 and SHA-3, TLS, etc. His work has also made progress towards making theoretical cryptographic functionalities like private information retrieval more practical by giving new concretely efficient constructions.These works have led to several papers at the two main cryptography conferences- CRYPTO and EUROCRYPT.
3D Avatars: Towards Playing the Imitation Game in Virtual Reality
Faithful reconstruction of humans as virtual 3D avatars that can be animated and rendered photorealistically is a frontier challenge in computer graphics and 3D vision research. As algorithms mature, they are poised to revolutionize telepresence, mixed reality, and human-computer interaction. In this talk, I will first introduce the key tasks involved in modeling the geometry and appearance of human avatars. In the second half, I will discuss our latest works on animating these 3D avatars using generative models, based on multi-modal controls such as text, speech, and lighting.
Rishabh Dabral is a Research Group Leader at the Max Planck Institute for Informatics (MPII), where he heads the 3D Visual Intelligence group. He received his PhD from IIT Bombay in 2022 and conducted postdoctoral research at MPII with Prof. Christian Theobalt. His research focuses on perception and synthesis of the 3D world through visual cues. He is particularly interested in synthesizing 3D human motion, geometry, and appearance for interactive systems.
A new information complexity measure for Streaming algorithms
In this talk, we will introduce a new notion of information complexity for one-pass and multi-pass streaming problems, and use it to prove memory lower bounds for the coin problem. In the coin problem,

one sees a stream of i.i.d. uniform bits and one would like to compute the majority (or sum) with constant advantage. We show that any constant pass algorithm must use Ω(log) bits of memory. This information complexity notion is also useful to prove tight space complexity for the needle problem, which in turn implies tight bounds for the problem of approximating higher frequency moments in a data stream.

Joint works with Mark Braverman, Qian Li, Shuo Wang, David P. Woodruff and Jiapeng Zhang.
Sumegha Garg is an Assistant Professor in the CS Department at Rutgers University. Before, she was a postdoctoral fellow at Stanford CS, and Rabin postdoctoral fellow in Harvard's Theory of Computation group. She completed her PhD in Computer Science at Princeton University, advised by Mark Braverman. She received her bachelor's degree in CSE from IIT, Delhi. She uses her background in computational complexity theory to answer questions in applied areas such as learning and data streaming. In particular, she is interested in memory lower bounds and theory of fair predictions.
Covering a graph with dense subgraphs: theory and some practice
We look at a problem of decomposing a graph into several disjoint subgraphs with strict guarantees of internal density. This relates to the rich community structure observed in real-world networks, particularly social networks. We present a spectral condition for the existence of a decomposition of a graph into such pieces and present algorithms to recover such dense subgraphs efficiently. The results require a structural assumption on the graph that relates to triadic closure/transitivity commonly observed in such networks; it is a distribution-free statement. Moreover, we present a new, stronger metric for assessing the 'goodness' of communities and show that this presents several advantages over traditional notions of density; our decomposition outputs subgraphs that satisfy this notion.
Sabyasachi Basu is a PhD student at UC Santa Cruz currently advised by Prof C. Seshadhri. He is interested in algorithms for graph mining and community detection. Earlier, he did his Bachelors at IISc.
DQBF Solving and Certification via Property-Directed Reachability Analysis
Recently a refined complexity analysis of the satisfiability of Dependency Quantified Boolean Formula (DQBF) was established. In particular, it is shown that the satisfiability of 3-DQBF (i.e., DQBF with 3 existential variables) is NEXP-complete and it becomes PSPACE-complete for 2-DQBF. While all state of the art DQBF solvers focus on general DQBF, it is natural to ask if there is an efficient approach for solving 2-DQBF -- similar to how modern SAT solvers differentiate between 2-SAT and 3-SAT instances. In this work, we show how to exploit modern Property Directed Reachbility (PDR) solvers to solve 2-DQBF instances. We present a novel linear time reduction from 2-DQBF instances to PDR instances and show how to convert the inductive invariant certificates provided by PDR solvers to the Skolem-function certificates for 2 DQBF instances. The experimental results show that the approach is indeed more efficient than other state-of-the-art DQBF solvers, at least in solving 2-DQBF instances.
Jie-Hong R. Jiang received the B.S. and M.S. degrees in Electronics Engineering from National Chiao Tung University, Hsinchu, Taiwan, in 1996 and 1998, respectively. In 2004, he received the Ph.D. degree in Electrical Engineering and Computer Sciences from the University of California, Berkeley. He joined National Taiwan University in 2005, and is currently a Professor in the Department of Electrical Engineering and the Graduate Institute of Electronics Engineering at National Taiwan University. His research interests include foundations of system construction, system analysis and verification, hardware synthesis and optimization, computation with quantum physics, and analysis of biological systems.
Counterexample-Guided DQBF Solving
In a Dependency Quantified Boolean Formula (DQBF), each existentially quantified variable is annotated with a dependency set consisting of universally quantified variables. A model of a DQBF consists of functions that correctly assign values to the existentially quantified variables based on the values of the universally quantified variables they depend on. Determining whether a DQBF has a model is NEXP complete, and DQBFs can naturally express a range of synthesis problems. This talk presents an algorithm for finding a model of a DQBF that iteratively refines a candidate model based on counterexamples. It covers techniques that are crucial to make this approach work well in practice, such as identifying unique Skolem functions by propositional definition extraction, and finding local repairs of invalid functions.
Friedrich Slivovsky is a lecturer in computer science at the University of Liverpool. He holds a PhD from TU Wien (Vienna), where he also completed a postdoctoral fellowship. His research focuses on propositional satisfiability (SAT) and its generalizations, such as quantified Boolean formulas (QBF).
Does In-Context-Learning Offer the Best Tradeoff in Accuracy, Robustness, and Efficiency for Model

Adaptation?
Adapting a model trained on vast amounts of data to new tasks with limited labeled data has long been a challenging problem, and over the years, a diverse range of techniques have been explored. Effective model adaptation requires achieving high accuracy through task-specific specialization without forgetting previous learnings, robustly handling the high variance from limited task-relevant supervision, and doing so efficiently with minimal compute and memory overheads. Recently, large language models (LLMs) have demonstrated remarkable ease of adaptation to new tasks with just a few examples provided in context, without any explicit training for such a capability. Puzzled by this apparent success, many researchers have sought to explain why in-context learning (ICL) works, but we still have only an incomplete understanding.. In this talk, we examine this emerging phenomenon and assess its potential to meet our longstanding model adaptation goals in terms of accuracy, robustness, and efficiency.

Advances and Challenges in Fair Division: Quantiles, Subsidies, and Randomization
The question of how to fairly divide a collection of indivisible items amongst a set of agents has remained of central importance to humanity since antiquity. In this fundamental problem, the agents have varied preferences, and an allocator seeks to find a single allocation such that every agent perceives its bundle as fair. This problem arises in various applications, ranging from classical examples like the division of inherited estates and international borders to modern applications such as assigning seats in college courses and allocating computational resources fairly.

Recent decades have witnessed significant progress, transforming this problem into a fascinating mathematical landscape with surprising results and intriguing new challenges. The broad goal of the community is to devise definitions of fairness that mirror our intuitive understanding of what it means to be fair, and then study questions such as: does a fair allocation always exist?; can one be (efficiently) computed?; what are the precise limits to the degree of fairness one can guarantee? Fair division is emerging as a major research area, with an increasing number of publications at Theory and AI conferences each year. In this talk, I will focus on selected recent papers of mine, highlighting three techniques (Quantiles, Subsidies, and Randomization) we use to extend the study of fair allocations to general valuation classes and resolve some conjectures and open problems. This talk will also provide an overview of my research trajectory and plans for future work.
Vishnu V. Narayan is a postdoctoral fellow hosted by Michal Feldman at Tel Aviv University. His main research focus is on the fair division of indivisible items. He is also broadly interested in the many intersections of combinatorics, algorithms, and game theory. He has a best paper award from SAGT 2019 and a Highlights Session selection at EC 2024. Earlier, he completed his Ph.D. in Computer Science at McGill University under the supervision of Adrian Vetta, and his M.Math. in Combinatorics and Optimization at the University of Waterloo with Joseph Cheriyan.
Testbeds for Evaluating Cybersecurity Systems
Cybersecurity is a multifaceted phenomenon, encompassing technological, societal and organizational vulnerabilities and practices that can lead to data leakage and loss, including hardware and software malfunction. Over the last two decades, my group has deployed and operated cybersecurity testbeds to addresses unique problems in cybersecurity through experimentation with novel hardware, tools, and datasets. This talk will discuss several research projects that leverage testbed technologies for experiment-based cybersecurity research.
Dr. Alefiya Hussain is the Deputy Director of USC Center for Research in Space Technology (USC CREST), supervising computer scientist and research team leader at the USC Information Sciences Institute. She has more than two decades of experience in system development, experimentation, and data sharing platforms for networking and cybersecurity. She has led cross disciplinary teams, to model and analyze complex interconnected techno-economic-social cyber physical systems, developed robust measurements and metrics for ML-based network optimizations, and codified methodology for large and complex experimentation. She has led and participated in several large cybersecurity data collection efforts, led tutorials, and workshops to share best practices.
What are we engineering? Does an engineering mindset help us solve real problems?
In this talk, I provide a brief overview of my published research and ongoing projects in software engineering, focusing on sustainable and user-centric design of socio technical systems. I raise several questions to challenge the conventional discussions in software engineering. Finally, I discuss how

universities of applied sciences and arts function in Switzerland and describe my job profile as a research associate.

I am currently serving as a research associate at FHNW (University of Applied Sciences and Arts, Northwestern Switzerland) within the Institute for Interactive Technologies. I earned my Ph.D. from the University of Bern, specifically from the Software Composition Group under the guidance of Prof. Oscar Nierstrasz. My work primarily focuses on requirements engineering, with a keen interest in engaging various stakeholders in the software development process by providing them with a minimal number of tools complemented by the appropriate interfaces.

NLP for Nyay: Towards Machines that Organize and Understand Indian Legal Texts

Given the huge pendency of cases, Indian legal system is struggling to cope up. This talk is about a relatively new and exciting area of applying NLP technologies to streamline the Indian legal system. I will follow a grounds-up approach. I will begin the talk by exploring some fundamental questions about why do we need to develop specialized techniques and models for legal texts. I will discuss what makes legal texts different and consequently what makes it more challenging to process. This will be followed by an overview of different tasks and applications in the legal NLP domain. In later half of the talk I am going to describe some of the recent techniques and models developed by our research group. Towards the end of the talk I will outline future directions and ideas and how the NLP community could contribute towards legal text processing.

Ashutosh Modi is Assistant Professor at Computer Science and Engineering (CSE)department,IIT Kanpur (Indian Institute of Technology Kanpur).He researches in areas of/Natural Language Processing (NLP)/,/Machine Learning (ML)/, and/Artificial Intelligence (AI)/. Previously, he worked at Disney Research (DR) , (erstwhile) Pittsburgh, Los Angeles and Zurich. He got his Ph.D. at Saarland University , Germany under the supervision of Prof. Dr. Manfred PinkalandDr. Ivan Titov.

Packing Squares into a Disk with Optimal Worst-Case Density

We provide a tight result for a fundamental problem arising from packing squares into a circular container: The critical density of packing squares into a disk is $\delta = 8/5\pi \approx 0.509$. This implies that any set of (not necessarily equal) squares of total area $A \leq 8/5$ can always be packed into a disk with radius 1; in contrast, for any $\varepsilon > 0$ there are sets of squares of total area $8/5 + \varepsilon$ that cannot be packed, even if squares may be rotated. This settles the last (and arguably, most elusive) case of packing circular or square objects into a circular or square container: The critical densities for squares in a square (1/2), circles in a square ($\pi/(3+2\sqrt{2}) \approx 0.539$) and circles in a circle (1/2) have already been established, making use of recursive subdivisions of a square container into pieces bounded by straight lines, or the ability to use recursive arguments based on similarity of objects and container; neither of these approaches can be applied when packing squares into a circular container. Our proof uses a careful manual analysis, complemented by a computer-assisted part that is based on interval arithmetic. Beyond the basic mathematical importance, our result is also useful as a black box lemma for the analysis of recursive packing algorithms. At the same time, our approach showcases the power of a general framework for computer-assisted proofs, based on interval arithmetic.

Vijaykrishna completed his B.Tech. in Computer Science and Engineering at IIT Bombay. He has an interest in theoretical computer science. In the past, he has worked on algorithmic questions arising under different settings such as geometry, communication- efficient vector averaging and discrepancy theory. He is currently on a leave of absence from the CS PhD programme at Stanford University.

Modeling Dynamic (De)Allocations of Local Memory for Translation Validation

End-to-End Translation Validation is the problem of verifying the executable code generated by a compiler against the corresponding input source code for a single compilation. This becomes particularly hard in the presence of dynamically-allocated local memory where addresses of local memory may be observed by the program. In the context of validating the translation of a C procedure to executable code, a validator needs to tackle constant-length local arrays, address-taken local variables, address-taken formal parameters, variable-length local arrays, procedure-call arguments (including variadic arguments), and the alloca() operator. We provide an execution model, a definition of refinement, and an algorithm to soundly convert a refinement check into first-order logic queries that an off-the-shelf SMT solver can handle efficiently. In our experiments, we perform blackbox translation validation of C procedures (with up to 100+ SLOC), involving these local memory allocation constructs, against their corresponding assembly implementations (with up to 200+ instructions) generated by an optimizing compiler with complex loop and vectorizing transformations.

This talk is based on a paper published at OOPSLA 2024. Before diving into its details, I will first motivate the need for automatic translation validation to solve the problem of ever- increasing compiler complexity.
Sorav Bansal is a Microsoft Chair Professor at the CS department at IIT Delhi, and works in the areas that combine compiler design, formal verification, and AI algorithms. He is also involved in a startup that aims to commercialize the end-to-end translation validator developed as a part of the research done in his group at IIT Delhi. Sorav obtained his B.Tech. from IIT Delhi, and Ph.D. from Stanford University.
POWER OF PRETRAINING
The power of pretraining, in the context of machine learning and artificial intelligence, refers to the practice of training a neural network on a large dataset before fine-tuning it for a specific task. Pretraining is a critical component of transfer learning, which has become a powerful technique in various AI applications, including natural language processing, computer vision, and speech recognition. It's important to note that while pretraining is a powerful technique, it's not a one-size-fits-all solution. The choice of pretraining architecture, dataset, and fine-tuning strategy depends on the specific task and domain. This talk will highlight some of our work where we have tackled several problems related to pretraining. I will talk about domain specific pretraining in several NLP domains, then extend the pretraining concept to non-language strings like Gene sequence and the challenge thereof. Finally I will talk about pretraining techniques used for graphs with a special focus on crystal induced networks.
Dr. Niloy Ganguly is a Professor in the Dept. of Computer Science and Engineering at IIT Kharagpur and a Fellow of Indian Academy of Engineering. He was a Visiting Professor in Leibnitz University of Hannover for two years for the period 2021 - 2022. He has also spent 2 years as a Research Scientist in Technical University, Dresden, before joining IIT Kharagpur in 2005, and has risen to the rank of Professor in 2014. He has done his Btech from IIT Kharagpur and his Phd from IIEST, Shibpur. His research interests lie primarily in Social Computing, Machine Learning, Natural Language Processing and Network Science. He has published in 80 journals and 200 conferences, several of which are in reputed international venues such as NeurIPS, KDD, ICDM, IJCAI, WWW, CSCW, ACL, EMNLP, NAACL, CHI, ICWSM, INFOCOM, Physical Reviews, IEEE and ACM Transaction etc. He has served in the organizing committee of COMSNETS, NetSciCom, JCDL, WWW, DEBS and CODS. Prof Ganguly's work has been recognized through awards by NSF, Cisco, NetApp, Samsung, and Yahoo!, among others. He has received prestigious research grants and projects, notably from Data Transparency Lab, IMPRINT, ITRA, Intel, HPE, Adobe, Microsoft Research, Accenture, BEL, and TCS. He has guided 20 Ph.D. and 9 M.S. students during this tenure. He is the founding member of the Complex Networks Research Group (CNeRG), comprising faculty members, research scholars, and other students affiliated to the department. The group is a success story in itself, with several long-standing impactful collaborations, and presence in reputed venues across domains such as Social Computing, Machine Learning and Deep Learning, Natural Language Processing, Network Science, Networked Systems, etc.
How digital transformation enables internationalization and European university alliances
Using examples from our European university alliance EDUC (European Digital UniverCity), I will give some insights how digital transformation promotes the integration of the European university landscape and its collaborations with our research partners abroad. I will also report on how the current political crises worldwide affect our campus life and how university management can deal with these challenges.
Oliver Günther, currently serving as the President of the University of Potsdam since 2012, has a rich academic and professional background. Prior to his presidency, he held the position of Professor of Information Systems at Humboldt-Universität zu Berlin for nearly two decades, during which he also served as Dean of the School of Business and Economics. His research spans diverse areas including enterprise information systems, IT strategy, security, digital asset management, and collaborative software. He has authored numerous publications and spearheaded significant research projects funded by prestigious institutions. Günther's expertise extends beyond academia; he has advised government agencies and technology companies, holding notable roles such as Chairman of the Board of Poptel AG and Chief Technology Officer of Teamtoolz, Inc. He has also contributed to the advancement of informatics as the former President of the German Informatics Society. Günther's academic journey began with accolades in mathematics during his high school years, culminating in a Diploma in Industrial Engineering from the University of Karlsruhe, followed by M.S. and Ph.D. degrees in Computer Science from the University of California at Berkeley. His professional journey includes stints at various esteemed institutions and organizations, showcasing his commitment to both academia and industry

A Learner-verifier Framework for Certifying Neural Controllers in Stochastic Systems

Learning-based methods such as reinforcement learning are receiving increasing attention for solving challenging control tasks. However, the lack of safety assurances about learned controllers poses a significant barrier to their practical deployment. In this talk, we will present a framework for learning and/or formally verifying neural controllers. The framework is applicable to stochastic dynamical systems, thus also taking into account environment uncertainty. Given a property and a probability bound, the framework jointly learns and formally verifies a controller together with a formal certificate of the property being satisfied with at least the specified probability, both parametrized as neural networks. Certificates are martingale-like objects that can be effectively used to formally reason about stochastic systems in a fully automated fashion. We will show how the framework can be applied to solve reachability, safety, reach-avoidance and stability tasks, as well as a compositional framework allowing us to reason about a more expressive logic of probabilistic properties.

Djordje Zikelic is an assistant professor of computer science at the School of Computing and Information Systems, Singapore Management University. Prior to joining SMU, he obtained his PhD in computer science at the Institute of Science and Technology Austria (ISTA) and bachelor’s and master’s degrees in mathematics at the University of Cambridge. His research focuses on formal verification and synthesis of software and intelligent systems and lies at the interplay of formal methods, trustworthy AI and programming languages research. He received the 2023 Outstanding Scientific Achievement award at ISTA for his work on developing a framework for learning and verifying neural controllers in stochastic dynamical systems.

Towards Exponentially Cheaper AI

The recent advancements in the capabilities of AI models have been extraordinary. However, training and deploying these models is prohibitively costly. The primary reason for increasing costs is the exponential increase in model sizes, which requires commensurate computing and memory resources. The high resource usage is the root of many problems: (1) Training these AI models is possible for only a few large corporations -- the majority of the AI community cannot participate and benefit from the growth opportunities it offers. (2) Training these models is financially draining and leaves an enormous carbon footprint. (3) Even the developed models cannot be deployed on devices we interact with the most, such as phones, etc. How do we make AI more resource-efficient? The existing research in efficiency can only provide a constant factor improvement in performance. Thus, to combat the exponential demand for resources, we need to rethink the efficiency of AI more fundamentally. In this talk, I will discuss a new approach to making ML models efficient, drawing inspiration from probabilistic algorithms. Focusing on reducing the model's memory, I will discuss how we developed a probabilistic parameter memory that provides better memory-quality tradeoff and exponentially reduced the size of the Deep Learning Recommendation Model (DLRM) from 100GB to 10MB without losing quality, improving throughput by a factor of 3x and decreasing training and inference costs by orders of magnitude. I will briefly talk about my current efforts in solving memory challenges in LLM deployment towards the end.

Aditya is a 5th-year PhD student at Rice University, where his research focuses on evaluating the tradeoffs between resources (such as memory, compute, and energy) and utility (including model quality metrics) in AI systems. His goal is to reduce resource usage while identifying representations and schemes that offer improved resource-utility tradeoffs. He employs probabilistic algorithms and data structures to address scalability challenges in AI. Aditya's work has been recognized at MLSys 22 with an outstanding paper award, and he received the Rice Future Faculty Fellowship in 2024. Additionally, he co-organized the Research on Algorithms & Data Structures (ROADS) to Mega-AI Models Workshop at MLSys 2023. Prior to his doctoral studies, Aditya spent five years as a Quantitative Analyst at Tower Research Capital after completing his undergraduate degree at IIT Kanpur.

Runtime vs. extracted proof size: an exponential gap for CDCL on QBFs

Conflict-driven clause learning (CDCL) is the dominating algorithmic paradigm for SAT solving and hugely successful in practice. In its lifted version QCDCL, it is one of the main approaches for solving quantified Boolean formulas (QBF). In both SAT and QBF, proofs can be efficiently extracted from runs of (Q)CDCL solvers. While for CDCL, it is known that the proof size in the underlying proof system propositional resolution matches the CDCL runtime up to a polynomial factor, we show that in QBF there is an exponential gap between QCDCL runtime and the size of the extracted proofs in QBF resolution systems. We demonstrate that this is not just a gap between QCDCL runtime and the size of any QBF resolution proof, but even the extracted proofs are exponentially smaller for some instances. Hence searching for a

small proof via QCDCL (even with non-deterministic decision policies) will provably incur an exponential overhead for some instances. (Joint work with Olaf Beyersdorff and Benjamin Boehm. Appeared at AAAI 2024.)
Prof. Meena Mahajan is an currently Professor at The Institute of Mathematical Sciences, Chennai. She obtained her BTech degree in Computer Science & Engg from IIT Bombay in 1986 & MTech by Research degree in Computer Science & Engg from IIT Bombay in 1988 and PhD from IIT Madras in 1993. Her research interests lie in Complexity Theory: algebraic complexity, counting classes, proof complexity, circuits, communication & Combinatorial and Discrete Algorithms. She is a fellow of the Indian Academy of Sciences , recipient of the J. C. Bose Fellowship, and has been profiled in Her Story: IIT Bombay Gen Zero Women , and Vigyan Vidushi - 75 Women Trailblazers of Science , a resource book published by DST Vigyan Prasar in 2023, comprising biographies of 75 Indian women scientists. More details about her are available at https://www.imsc.res.in/meena_mahajan.
Approximate Nearest Neighbor Search algorithms for web-scale search and recommendation
Web-scale search and recommendation scenarios increasingly use Approximate Nearest Neighbor Search (ANNS) algorithms to index and retrieve objects based on the similarity of their learnt representations in a geometric space. Since these scenarios often span billions or trillions of objects, efficient and scalable ANNS algorithms are critical to making these systems practical.

In this talk we discuss some recent empirical progress on this problem. Specifically, we present DiskANN, an ANNS algorithm that can index a billion points and serve queries at latencies of few milliseconds on a single commodity machine. This represents an order of magnitude more points indexed per machine than previous work. We will also discuss some fundamental open problems in this space in the latter half of the talk.

Based on joint works with Harsha Simhadri, Sujas J Subramanya, Aditi Singh, Rohan Kadekodi, Devvrit, Shikhar Jaiswal, Magdalen Dobson, Siddharth Gollapudi, Neel Karia, Varun Sivashankar, and Varun Suriyanarayana.
Ravishankar is a principal researcher at Microsoft Research India. He completed his PhD at Carnegie Mellon University in 2012. From 2012-2014, He was a Simons Postdoctoral Fellow at the CS Department in Princeton University. Long, long ago, also He was an undergrad at IIT Madras.
Using hardness-randomness connections in algebraic complexity
Finding explicit polynomials that require circuits of super-polynomial size is a major open question in algebraic complexity. Over the years, this question has seen significant progress in various structured settings, but this has not translated into lower bounds for circuits, where the state-of-the-art remains to be Omega(n log n). This has led to some works (e.g. Forbes, Shpilka and Volk (2018)) that investigate whether algebraic circuit lower bounds admit a "barrier" similar to the boolean setting.

The closely related question of blackbox identity testing, asks for a deterministic query algorithm that determines if the circuit being queried computes the "unsatisfiable" zero polynomial. Here again, the state-of-the-art for circuits remains to be a trivial, exponential-time algorithm.

In this talk, we will first see how the above two questions are connected. I will then describe two of my works that utilize these connections to throw some light on the questions themselves. The first work reveals a "threshold behaviour" of identity testing, while the other provides insights into the "barrier question".
Anamay Tengse completed his MTech from IIT Bombay, and later obtained a PhD from Tata Institute of Fundamental Research in Mumbai. Subsequently, he was at the University of Haifa, and Reichman University as a postdoctoral researcher. His research interests are in theoretical CS, primarily in complexity theory. In addition to algebraic complexity, he is also interested in studying the complexity of communication protocols.
Algebraic combinatorial optimization on the degree of determinants of noncommutative symbolic matrices
We address the computation of the degrees of minors of a noncommutative symbolic matrix of form $A[c] := \sum_{k=1}^m A_k t^{c_k} x_k$, where A_k are matrices over a field, x_i are noncommutative variables, c_k are integer weights, and t is a commuting variable specifying the degree. This problem extends noncommutative Edmonds' problem (Ivanyos et al. 2017), and can formulate various combinatorial

optimization problems. Extending the study by Hirai 2018, and Hirai, Ikeda 2022, we provide novel duality theorems and polyhedral characterization for the maximum degrees of minors of A[c], and develop a strongly polynomial-time algorithm for computing them. This algorithm is viewed as a unified algebraization of the classical Hungarian method for bipartite matching and the weight-splitting algorithm for linear matroid intersection.
Taihei Oki (pronounced as “tie-hey ohki”) is a project research associate at The University of Tokyo. He researches discrete and algebraic mathematical objects, mainly from the viewpoint of algorithms. He is also interested in their applications to scientific computing.
Efficient and elastic Large Models
Generative LLMs are transforming multiple industries and have proven to be robust for multitude of use cases across industries and settings. One of the key impediments to their widespread deployment is the cost of serving and it's deployability across multiple devices/settings. In this talk, we will discuss the key challenges in improving efficiency of LLM serving. We will then give an overview of multiple techniques to address the problem that we are developing at Google Research India. In particular, we will discuss matformers -- a technique to train one model but read-off 100s of smaller models -- along with techniques to speed up decoding in LLMs.
Prateek Jain is a research scientist at Google Research India where he leads the Machine Learning and Optimization team. He obtained his doctorate from UT Austin and BTech from IIT-Kanpur. He has conducted foundational research in the areas of large-scale and non-convex optimization, and resource-constrained ML. Prateek regularly serves on the senior PC of top ML conferences and is on the editorial board of top ML journals including JMLR, SIMODS. He has also won multiple best paper awards including the 2020 Best Paper by IEEE Signal Processing Society. Prateek also received the Young Alumnus Award from IIT Kanpur in 2021 and the ACM India Early Career Researcher Award in 2022.
Lower Bounds for some Algebraic Models of Computation
Algebraic circuits and formulas are two of the most natural models for computing polynomials, and proving super-polynomial lower bounds against these models are central questions in the field of complexity theory. A long line of works culminating in the recent breakthrough work of Limaye, Srinivasan and Tavenas proved the first super-polynomial lower bound against constant depth algebraic circuits and formulas. However, proving lower bounds in the general case continues to remain widely open. Another important model for computing polynomials is that of algebraic branching programs, whose power lies in between that of circuits and formulas.

In this talk we will discuss the current state-of-the art for lower bounds against these models of computation in the general as well as some structured settings. I will then describe two of my recent works, one with Hrubes (CCC 2023) and another with Kush, Saraf and Shpilka (under submission), in greater detail; and conclude with some future directions that I am excited about.
Dr. Prerona Chatterjee is an Azrieli International Postdoctoral Fellow at Tel Aviv University, where she is advised by Amir Shpilka. Prior to this, she was a postdoctoral fellow at the Czech Academy of Sciences in Prague, where she was advised by Pavel Hrubes. Prerona completed her MSc and PhD in Computer Science from TIFR Mumbai, during which she received a Google PhD Fellowship for Algorithms and Theory; and was also selected to give a talk at the TCS Women Spotlight Event as part of STOC 2021. She additionally has an MSc in Mathematics and Computing from IIT Guwahati, for which she received the Institute Silver Medal. Prerona is also deeply passionate about outreach, especially in attracting more women towards exact sciences, and has been part of various such initiatives and activities.
"Designing fast Oracles to answer metric spaces queries"
Metric spaces provide an abstract framework for representing data from diverse applications. With vast amount of data being collected (big data), optimising the speed and efficiency of systems that utilize metric spaces is an important area. This talk delves into the design of fast distance Oracles which provide an "approximate" distance value between any two objects.

In this talk, we will look at the different existing techniques designed to answer these queries. We will also discuss some of the recent advancements in the field. Some of the interesting open problems in the field will also be discussed.
Suraj is a Assistant Professor in the CSE department of IIT Bombay. He completed his PhD under the guidance of Dr. Gautam Das from UTA in 2023. His research interest lies in the area of Data

Management and Fairness. In addition, he is interested in algorithmic and conceptual problems in computational geometry, graph algorithms, and metric space, with the goal to design efficient algorithms.

TAU Performance System and the Extreme-Scale Scientific Software Stack

The talk will introduce the TAU Performance System [http://tau.uoregon.edu], a versatile profiling and tracing toolkit for the performance evaluation of applications written in Python, C++, C, Fortran, and Java. It supports GPU runtimes from Intel, AMD, and NVIDIA and requires no modification to the source code, build system, and application binaries. TAU is one of the main tools in the E4S collection.

The U.S. Department of Energy has developed the Extreme-scale Scientific Software Stack (E4S) [https://e4s.io], a curated Spack [https://spack.io] based software ecosystem that enables the efficient execution of over 100 HPC and AI/ML applications on diverse platforms that include GPUs from NVIDIA, Intel, and AMD. E4S provides both source builds through the Spack platform and a set of containers that feature a broad collection of HPC software packages. E4S includes HPC tools including numerical solvers such as PETSc, Trilinos, Sundials, and performance evaluation tools such as TAU, HPCToolkit, and PAPI, and visualization tools such as VisIt and ParaView, and I/O tools such as HDF5, parallel netCDF, and ADIOS2, and applications such as Quantum Espresso, LAMMPS, and OpenFOAM. E4S includes AI/ML tools such as TensorFlow, PyTorch, JAX, LBANN, Scikit-Learn, Pandas, and Keras and other Python tools such as matplotlib, numpy and SciPy that may be launched using integrated Jupyter notebooks. Hands-on sessions will feature interfaces to these tools as well as developing a custom chatbot using Generative AI tools using OpenAI's Python interface. E4S supports laptops, desktops, department clusters, to the world's largest supercomputers and commercial cloud platforms such as AWS, Oracle Cloud Infrastructure, Google Cloud, and Microsoft Azure.

TAU and E4S can boost developer productivity by providing insights in the inner workings of the applications and creating an extensible platform for developing and deploying the next generation of High Performance Computing and AI/ML applications.

The talk will describe the community engagements and interactions that led to the many artifacts produced by E4S and how to collaborate with the team and contribute to E4S.

Sameer Shende serves as a Research Professor and the Director of the Performance Research Laboratory at the University of Oregon and the President and Director of ParaTools, Inc. (USA) and ParaTools, SAS (France). He serves as the lead developer of the Extreme-scale Scientific Software Stack (E4S), TAU Performance System, Program Database Toolkit (PDT), and HPC Linux. His research interests include scientific software stacks, performance instrumentation, compiler optimizations, measurement, and analysis tools for HPC. He received his B.Tech. in Electrical Engineering from IIT Bombay in 1991, and his M.S. and Ph.D. in Computer and Information Science from the University of Oregon in 1996 and 2001, respectively.

Distribution Testing in the Small Sample Regime

Understanding unknown probability distributions with limited samples is a fundamental challenge in statistics and data analysis, with far-reaching applications spanning diverse scientific domains. Traditional methods for distribution testing often rely on having large amounts of samples, which may not always be available, leading to a gap in our ability to analyze distributions efficiently. This has prompted a shift towards new algorithmic approaches that work well with fewer samples. These approaches explore alternative sampling models, offering stronger access to the distributions.

The talk will focus on these developments, particularly on recent progress in achieving optimal bounds for equivalence testing—determining if two unknown distributions are identical or distinct—when the algorithm is granted conditional sampling access. Additionally, I will explore the significant role that distribution testing plays in other fields such as Approximate Model Counting.

Gunjan Kumar completed his B.Tech in Computer Science and Engineering at the Indian Institute of Technology, Guwahati, and earned his Ph.D. from the Tata Institute of Fundamental Research, Mumbai. He is presently a postdoctoral researcher at the National University of Singapore. His research is primarily in the fields of Algorithms and Complexity, with a special emphasis on approximation and sublinear algorithms. Of late, his focus has expanded to include statistical estimation problems, particularly on challenges associated with small sample regimes.

Algorithmic Decision-Making in the Presence of Biased Data
Algorithms for optimization problems such as selection, ranking, and classification typically assume that the inputs are what they are promised to be. However, in several real world applications of these problems, the input may contain systematic biases along socially salient attributes associated with inputs such as race, gender, or political opinion. Such biases can not only lead the outputs of the current algorithms to output sub-optimal solutions with respect to true inputs but may also adversely affect opportunities for individuals in disadvantaged socially salient groups. This talk will consider the question of using optimization to solve the aforementioned problems in the presence of biased inputs. It will start with models of biases in inputs and discuss alternate ways to design algorithms for the underlying problem that can mitigate the effects of biases by taking into account knowledge about biases. This talk is based on several joint works with several co-authors.
Nisheeth Vishnoi is the A. Bartlett Giamatti Professor of Computer Science and a co- founder of the Computation and Society Initiative at Yale University. He is a co-PI of an NSF-funded AI Institute: The Institute for Learning-enabled Optimization at Scale. His research spans various areas of Theoretical Computer Science, Optimization, and Artificial Intelligence. Specific current research topics include Responsible AI, foundations of AI, and data reduction methods. He is also interested in understanding nature and society from a computational viewpoint.

Professor Vishnoi was the recipient of the Best Paper Award at IEEE Symposium on Foundations of Computer Science in 2005, the IBM Research Pat Goldberg Memorial Award in 2006, the Indian National Science Academy Young Scientist Award in 2011, the IIT Bombay Young Alumni Achievers Award in 2016, and the Best Paper award at ACM Conference on Fairness, Accountability, and Transparency in 2019. He was named an ACM Fellow in 2019. His most recent book Algorithms for Convex Optimization was published by Cambridge University Press.
Towards Robust and Reliable Machine Learning: Adversaries and Fundamental Limits
While ML-based AI systems are increasingly deployed in safety-critical settings, they continue to remain unreliable under adverse conditions that violate underlying statistical assumptions. In my work, I aim to (i) understand the conditions under which a lack of reliability can occur and (ii) reason rigorously about the limits of robustness, during both training and test phases.

In the first part of the talk, I demonstrate the existence of strong but stealthy training-time attacks on federated learning, a recent paradigm in distributed learning. I show how a small number of compromised agents can modify model parameters via optimized updates to ensure desired data is misclassified by the global model, while bypassing custom detection methods. Experimentally, this model poisoning attack leads to a lack of reliable prediction on standard datasets.

Test-time attacks via adversarial examples, i.e. imperceptible perturbations to test inputs, have sparked an attack-defense arms race. In the second part of the talk, I step away from this arms race to provide model-agnostic fundamental limits on the loss under adversarial input perturbations. The robust loss is shown to be lower bounded by the optimal transport cost between class-wise distributions using an appropriate adversarial point-wise cost, the latter of which can be efficiently computed via a linear program for empirical distributions of interest.

To conclude, I will discuss my ongoing efforts and future vision towards building continuously reliable and accessible ML systems by accounting for novel attack vectors and new ML paradigms such as generative AI, as well as developing algorithmic tools to improve performance in data-scarce regimes.
Arjun Bhagoji is a Research Scientist in the Department of Computer Science at the University of Chicago. He obtained his Ph.D. in Electrical and Computer Engineering from Princeton University, where he was advised by Prateek Mittal. Before that, he received his Dual Degree (B.Tech+M.Tech) in Electrical Engineering at IIT Madras, where he was advised by Andrew Thangaraj and Pradeep Sarvepalli. Arjun's research has been recognized with a Spotlight at the NeurIPS 2023 conference, the Siemens FutureMakers Fellowship in Machine Learning (2018-2019) and the 2018 SEAS Award for Excellence at Princeton University. He was a 2021 UChicago Rising Star in Data Science, a finalist for the 2020 Bede Liu Best Dissertation Award in Princeton's ECE Department and a finalist for the 2017 Bell Labs Prize.
New Lower Bounds for Symmetric Torus Polynomials

Torus polynomials were introduced by Bhrushundi, Hosseini, Lovett, and Rao at ITCS'19 as an algebraic tool to address a longstanding conjecture by Barrington from '89. The conjecture states that the majority function cannot be computed by constant-depth polynomial-size Boolean circuits with AND and MODm gates, where a MODm gate outputs 1 if the sum of its inputs is divisible by m. A polynomial is called a torus polynomial "close" to a Boolean function if its _fractional_ part closely approximates half the value of the function across all Boolean inputs.

To establish the usefulness of torus polynomials, Bhrushundi et al. proved that there is a _low_ degree torus polynomial "close" to any Boolean function computed by the circuits described above. They conjectured that the same does not hold for the majority function, providing evidence by showing that _symmetric_ torus polynomials- polynomials invariant under variable permutations--must have _high_ degree when approximating the majority function.

In this talk, we present two results concerning symmetric torus polynomials. First, we establish an error-degree tradeoff for symmetric torus polynomials approximating the majority function, reaffirming Bhrushundi et al.'s findings. Second, we extend the same lower bound to the AND function, proving that symmetric torus polynomials lack the power of their asymmetric counterparts. Our approach simplifies the task of proving polynomial non-existence by framing it as an existence question, leveraging techniques from linear programming. Furthermore, it paves the way for deeper analysis that may lead to stronger results or the resolution of the original conjecture.

This work is in collaboration with Sundar Vishwanathan at CSE IITB.
Vaibhav Krishan is pursuing PhD in CSE at IITB under the mentorship of Sundar Vishwanathan and Nutan Limaye. He holds a B.Tech. in CSE from IITB.
Towards Adaptive Intelligence
Intelligent systems powered by machine learning are ubiquitous today. However, their current rigid design fails and requires dedicated efforts to cater to ever-changing data, use cases, and deployment settings. In this talk, I will present my work towards enabling adaptive machine learning solutions for flexible and seamless deployment across widely changing scenarios through the lens of web search. First, I present Matryoshka embeddings for adaptive data representations that can power web-scale adaptive retrieval. Next, I extend these principles to the neural networks, crafting MatFormer models that adapt their computational footprint based on input and device with minimal overhead during deployment. Further, to address the inherent rigidity in the design of web search systems, I will dive into differentiable search solutions, fundamentally rethinking how large-scale AI pipelines harness data for continuous improvement. Finally, I conclude with future works directed towards adaptive contextual and continual intelligence across disciplines.
Aditya Kusupati is a final year PhD student at the University of Washington advised by Ali Farhadi and Sham Kakade. He is also a Student Researcher at Google Research in the Perception team. His research focuses on designing fundamental Machine Learning algorithms with strong empirical performance & real-world deployability geared towards enabling efficient, elastic, and contextual intelligence. Some of his algorithms are deployed at Google, OpenAI, Pinterest, and Microsoft serving over a billion users daily, and his work has been awarded a Google Research grant. He also has won several awards including a Best Paper award at the NeurIPS ENLSP workshop and a Best Paper Runner-up award at BuildSys. Previously, he was a Research Fellow at Microsoft Research and completed his undergraduate degree from IIT Bombay.
Towards Exponentially Cheap AI
The recent advancements in the capabilities of AI models have been extraordinary. However, training and deploying these models is prohibitively costly. The primary reason for increasing costs is the exponential increase in model sizes, which requires commensurate computing and memory resources. The high resource usage is the root of many problems: (1) Training these AI models is possible for only a few large corporations -- the majority of the AI community cannot participate and benefit from the growth opportunities it offers. (2) Training these models is financially draining and leaves an enormous carbon footprint. (3) Even the developed models cannot be deployed on devices we interact with the most, such as phones, etc. How do we make AI more resource-efficient? The existing research in efficiency can only provide a constant factor improvement in performance. Thus, to combat the exponential demand for

resources, we need to rethink the efficiency of AI more fundamentally. In this talk, I will discuss a new approach to making ML models efficient, drawing inspiration from probabilistic methods. Focusing on reducing the model's memory, I will discuss how we developed probabilistic method of using memory that provides better memory-quality tradeoff and exponentially reduced the size of the Deep Learning Recommendation Model (DLRM) from 100GB to 10MB.
Aditya Desai is currently a Ph.D. student at Rice University and Holding a BTech from IIT Kanpur (2013), Aditya has professional experience at Tower Research Capital LLC from 2013 to 2018. His research interests encompass probabilistic methods for affordable and sustainable deep learning, as well as large-scale and resource-constrained machine learning. Aditya published research in renowned venues such as NeurIPS, ICML, ICLR, MLSys, and SIGMOD. Notably, He received recognition for an outstanding paper at MLSYS 2022.
Advancing the frontiers in Propositional Proof Complexity
Proof theory is a foundational field of modern mathematics, dealing with study of the structure of mathematical proofs. It has a rich history starting with Aristotle's intuitive notions of a rigorous proof, Euclid's semi-formal system of logic underlying geometry, Frege's notions of a formal system of logic with a complete set of inference rules, Hilbert's attempted program to formalize the whole of mathematics, Gödel's incompleteness results that put an end to this program, and finally Turing's seminal paper building on Gödel's work defining a formal notion of a computer and laying the foundations of most of theoretical computer science as we know it today.

In modern computer science, we are interested in computational aspects of these classical notions. Proof complexity is an area that studies lengths of proofs in formal systems of logic. In this talk, we will go over state of the art lower bounds on proofs in well studied systems of propositional logic proved over the past few decades. We will then touch upon our recent work that proves new connections between known proof systems, and new boundary-pushing lower bounds building on recent developments. We will conclude with some of the most interesting open problems in this area.
Sasank Mouli completed his doctoral studies in Electrical Engineering at UC San Diego under the guidance of Russell Impagliazzo. He completed his undergraduate studies in Electrical Engineering at Indian Institute of Technology, Kanpur. He is currently an assistant professor at Mahindra University, Hyderabad.
Coordinated Motion Planning: Reconfiguring a Swarm of Robots
How do we coordinate the motion of many robots, vehicles, aircraft, or people? If each mobile agent has a destination in mind, how can it find an efficient route that avoids collisions with other agents as they simultaneously move to their destinations? These basic questions arise in many application domains, such as ground swarm robotics, aerial swarm robotics, air traffic control, warehouse management, and vehicular traffic networks. They also have a long tradition in Computational Geometry, reaching back at least until the seminal work of Schwartz and Sharir fro the early 1980s.

In this talk, we will discuss a number of different algorithmic results. Starting with a labeled set of robots on a grid, we consider the total time for letting each agent reach its destination. We show that we can always achieve constant stretch, i.e., compute a well- choreographed set of trajectories in which the total time until completion is within a multiplicative constant of the largest initial distance. For settings in which the swarm needs to stay connected at all time, we will discuss two additional sets of results, based on different approaches. We also sketch some results for reconfiguring a swarm when agents do not have individual control, but have to follow uniform global forces.
Sándor Fekete holds the chair for Algorithmics in the Department of Computer Science at the Braunschweig University of Technology in Germany. From 2011-2019 he was also director of the interdisciplinary Research Center for Informatics, Information Technologies and Digitalization (TUBS.digital). Having received his Ph.D. in mathematics from the University of Waterloo in Canada, he has held positions at the University of Cologne, SUNY Stony Brook and TU Berlin. His research interests range all the way from theoretical foundations of algorithms and optimization (with a focuson geometric and distributed methods) to applications areas such as practical computer science, electrical engineering, economics, biology, physics, and climate change, leading to close to 400 entries in DBLP with over 300 different coauthors.
Exploring Algebraic Methods: Applications and Key Challenges in Polynomials.

Polynomials are widely used throughout computer science, ranging from heavily applied algorithms in signal processing to purely theoretical endeavors in complexity theory. So, what makes polynomials so applicable across domains? And what are the fundamental problems linked with polynomials? In this talk, we will address these questions.

For this, the talk will focus on the following two very different problems, striking a balance between purely structural questions about polynomials and applications in other domains.

Decomposing Low-Rank Tensors: Tensor decomposition is a basic computational primitive underlying many algorithms for various data analysis tasks. Due to known NP hardness results, most known algorithms for this task are either average-case or heuristic. We will present a *worst-case* algorithm for decomposing low-rank tensors. This algorithm is grounded in the intriguing connection between tensor decomposition and the learning of special depth-3 arithmetic circuits.

Factoring Sparse Polynomials: Shifting towards more structural inquiries: Are factors of sparse polynomials themselves sparse? In other words, can multiplying polynomials lead to massive cancellation? To establish bounds, we will employ tools from convex geometry, including the theory of Newton polytopes and an approximate version of Carathéodory's Theorem.

We will conclude by giving a bird's-eye view of some of the exciting research directions and questions pertaining to this theme.

I am a Mathematics Prestigious Postdoctoral Fellow at the University of Waterloo. I earned my Ph.D. at Rutgers under the guidance of Shubhangi Saraf, and my undergraduate studies were completed at IIT Kanpur. My research interests revolve around the theoretical aspects of computer science, with a keen focus on Computational Complexity, Pseudorandomness, Computational Algebra or anything with an Algebraic or Number Theoretic flavor. Beyond academia, I enjoy long-distance running and was once deeply involved in dramatics.

What's Wrong with Large Language Models and What We Should Be Building Instead

Large Language Models provide a pre-trained foundation for training many interesting AI systems. However, they have many shortcomings. They are expensive to train and to update, their non-linguistic knowledge is poor, they make false and self-contradictory statements, and these statements can be socially and ethically inappropriate. This talk will review these shortcomings and current efforts to address them within the existing LLM framework. It will then argue for a different, more modular architecture that decomposes the functions of existing LLMs and adds several additional components. We believe this alternative can address all of the shortcomings of LLMs.

Dr. Dietterich (AB Oberlin College 1977; MS University of Illinois 1979; PhD Stanford University 1984) is Distinguished Professor Emeritus in the School of Electrical Engineering and Computer Science at Oregon State University. Dietterich is one of the pioneers of the field of Machine Learning and has authored more than 200 refereed publications and two books. His current research topics include robust artificial intelligence, robust human-AI systems, and applications in sustainability.

Anomaly Detection for OOD and Novel Category Detection

Every deployed learning system should be accompanied by a competence model that can detect when new queries fall outside its region of competence. This presentation will discuss the application of anomaly detection to provide a competence model for object classification in deep learning. We consider two threats to competence: queries that are out-of-distribution and queries that correspond to novel classes. The talk will review the four main strategies for anomaly detection and then survey some of the many recently-published methods for anomaly detection in deep learning. The central challenge is to learn a representation that assigns distinct representations to the anomalies. The talk will conclude with a discussion of how to set the anomaly detection threshold to achieve a desired missed-alarm rate without relying on labeled anomaly data.

Dr. Dietterich (AB Oberlin College 1977; MS University of Illinois 1979; PhD Stanford University 1984) is Distinguished Professor Emeritus in the School of Electrical Engineering and Computer Science at Oregon State University. Dietterich is one of the pioneers of the field of Machine Learning and has authored more than 200 refereed publications and two books. His current research topics include robust artificial intelligence, robust human-AI systems, and applications in sustainability.

Scalable Rowhammer Protection at Ultra- Low Cost
The Rowhammer bug pervades modern memory, where frequent activations to a DRAM row induce bit flips in nearby rows. Solutions that work for the current Rowhammer threshold of row activations impose drastic overheads at lower thresholds that are likely in the future. Many more rows reach such ultra-low thresholds, requiring impractical dedicated resources for row-tracking and rendering secure mitigative actions resilient to complex attacks prohibitively expensive. As we develop solutions for future systems, currently deployed systems remain exposed due to vulnerable hardware, and software- based protection, like isolating untrusting domains in memory, suffers from excessive runtime overheads, making them infeasible.

I have been examining the efficacy of Rowhammer protection. In this talk, I will present our recent works that provide near-ideal Rowhammer tracking with virtually no dedicated resources (HPCA-2024), enable secure mitigations at ultra-low thresholds by minimizing episodes of rows that reach the threshold (ASPLOS-2024), and rethink the memory allocation to isolate software-defined domains of any size at low cost without hardware changes. I will conclude by giving an overview of Rowhammer-centric developments in DDR5 and highlighting key research problems.
Anish Saxena is a third-year PhD student at the Georgia Institute of Technology, advised by Prof. Moinuddin Qureshi. He is interested in hardware security, datacenter memory systems, and efficient generative AI. His recent works include practical and secure defenses against the severe Rowhammer security threat and bandwidth-centric server designs based on the emerging CXL memory interconnect. Anish is currently exploring system-level optimizations to improve Large Language Model training and serving. His varied interests stem from examining impactful problems in research labs at Intel, Nvidia, Micron, and AMD as part of internships. Anish is an Aditya Birla Group Scholar and received his B.Tech. from IIT Kanpur.
Demystifying LEO satellite broadband
Upstart space companies are building massive constellations of low-flying satellites to provide Internet service. These developments comprise “one giant leap” in Internet infrastructure, promising global coverage and lower latency. However, fully exploiting the potential of such satellite constellations requires tackling their inherent challenges: thousands of low-Earth orbit (LEO) satellites travel at high velocities relative to each other, and to terrestrial ground stations. The resulting highly dynamic connectivity is at odds with the Internet’s design, which assumes a largely static core infrastructure. Virtually every aspect of Internet design — physical interconnection, routing, congestion control, and application behavior — will need substantial rethinking to integrate this new building block.

In this talk, I will first explain what the LEO broadband hype is about and what are the new performance opportunities and challenges. I will then deep-dive into the LEO dynamics and how we need to carefully rethink many of the terrestrial networking aspects in the context of these 'new space' networks. I will explain my past work on LEO topology design and packet-level simulations. I will also discuss some ongoing work on LEO broadband in our lab and beyond.
Debopam joined Microsoft Research India as a Senior Researcher after receiving his PhD in computer networks from ETH Zurich in 2021. His research focuses on “new space” satellite networks, low latency terrestrial networks, and Internet architecture. Debopam earned his masters degree from KTH Royal Institute of Technology. He earned his bachelors degree in computer science from Jadavpur University. For further details, please refer to his Web page: https://bdebopam.github.io
Emotion and Explainable AI driven technologies and application to learning, health and wellbeing.
This presentation will cover the case for applying Emotion AI driven technologies with students with Intellectual Disabilities and Autism, where schools are receiving more diverse students in their classrooms requiring diverse teaching. Approaches that address the real issue of teachers not having enough capacity to attend to each child’s individual learning needs, or to support their best behavioural outcomes in class are called for, to ensure that all students are supported to develop their full academic and social potential. Recent research at NTU in using Emotion AI driven technologies within immersive environments as an exposure therapy whereby students are encouraged to control their own gradual exposure to virtual threat will also be covered. Recognising that contemporary screening tools to measure cognitive decline in neurotypical populations are often not suitable for those with Intellectual Disabilities, the next project reviewed in this talk proposes the development of a virtual triangle completion task to assess spatial

navigation involving path integration without visual cues as an alternative, more ecologically valid computer-based test. This platform will use both task related errors and an analysis of electroencephalogram time series data (from the retrosplenial cortex) in the development of a generalised model that could be used to indicate early cognitive decline in populations that are genetically predisposed to experience Alzheimer’s disease at a relatively early life stage. A central theme running throughout these research studies is approaches to using eXplainable AI (XAI) and the final project reviewed is the use of XAI to identify patients at greatest risk of lung cancer - one of the most common cancers and often diagnosed at a late stage. An individual-level explanation of feature importance is crucial in mission-critical applications such as healthcare to better understand personal health and lifestyle factors in the early prediction of diseases that may lead to terminal illness.
David is Chair of the International Conference on Disability, Virtual Reality and Associated Technology. He is both a Principal and Co-Investigator on a range of European and UKRI projects investigating the role of multimodal affect recognition to promote engagement in learning and positive mental wellbeing for students with Intellectual Disabilities and Autism; and in the use of XAI to identify patients at greatest risk of a range of cancers using electronic health records. He is Associate Editor for Frontiers: Virtual Reality in Medicine (https://www.frontiersin.org/journals/virtual- reality/sections/virtual-reality-in-medicine).
Walker-Breaker hamiltonicity game on Random board
In this talk, I will introduce myself and provide an overview of my research thus far.

I will follow this up with a discussion on one of my works, with my colleagues Dennis Clemens and Yannick Mogge, on the Walker-Breaker game.

The Maker-Breaker connectivity game and Hamilton cycle game belong to the best studied games in positional games theory, including results on biased games, games on random graphs and fast winning strategies. Recently, the Connector-Breaker game variant, in which Connector has to claim edges such that her graph stays connected throughout the game, as well as the Walker-Breaker game variant, in which Walker has to claim her edges according to a walk, have received growing attention. For instance, London and Pluhár studied the threshold bias for the Connector-Breaker connectivity game on a complete graph and showed that there is a big difference between the cases when the Maker’s bias equals 1 or 2. Moreover, a recent result of Clemens, Mogge, and Kirsch shows that the threshold probability p for the (2 : 2) Connector-Breaker connectivity game on a random graph G ~ G(n,p) is of order n ^{-2/3 + o(1)}. We extend this result further to Walker-Breaker games and prove that this probability is also enough for Walker to create a Hamilton cycle.
Hello, my name is Pranshu Gupta and I am currently a PostDoc at the Faculty of Computer Science and Mathematics at the University of Passau. Last year, I was awarded my PhD by the Hamburg University of Technology. My advisor for my doctoral research was Prof. Taraz. During my time there, I have had the pleasure of collaborating with many bright minds. I enjoy being in the midst of a lively conversation and learn and contribute along the way.
Towards Machine Understanding of Dynamic and Interactive Human Scenes
Everyday human activities are highly dynamic and interactive. Machines that can understand and act in dynamic human environments could revolutionize our lives but remain elusive. In this talk, I will discuss my group's work on taking a step towards more capable machines by building 3D computer vision and machine learning methods for understanding dynamic human environments. I will first introduce DiVA-360, a real- world 360° dynamic visual dataset of table-scale scenes designed to accelerate progress in dynamic scene understanding. I will then discuss the techniques we are building to capture, analyze, and generate dynamic human hand skills. Our goal is to build representations and methods to holistically understand dynamic and interactive human scenes.
Srinath Sridhar (https://srinathsridhar.com) is an assistant professor of computer science at Brown University. He received his PhD at the Max Planck Institute for Informatics and was subsequently a postdoctoral researcher at Stanford. His research interests are in 3D computer vision and machine learning. Specifically, his group (https://ivl.cs.brown.edu) focuses on visual understanding of 3D human physical interactions with applications ranging from robotics to mixed reality. He is a recipient of the NSF CAREER award, a Google Research Scholar award, and his work received the Eurographics Best Paper Honorable Mention. He spends part of his time as a visiting academic at Amazon Robotics and has previously spent time at Microsoft Research Redmond and Honda Research Institute.

The transformation of regular expressions into finite automata: old and new results
Not many results in Computer Science are recognised to be as basic and fundamental as Kleene Theorem. It states the equality of two sets of objects that we call now languages. A slight change of focus on this result shows how it is essentially the combination of two families of algorithms: algorithms that transform a finite automaton into a regular expression on one hand and algorithms that build a finite automaton from a regular expression on the other.

In this talk, I shall consider the algorithms of the latter family, a much laboured subject of both theoretical and practical interests. I shall present three different constructions, classically attributed to Thompson, Glushkov, and Brzozowski-Antimirov respectively, and their relationships.

We shall then see how the extension of Kleene Theorem beyond languages: to subsets of arbitrary monoids first and second to subsets with multiplicity, leads to a modification of the construction for the first one and to a radical transformation of the proof for the third.

All recent results were obtained in joint works with Sylvain Lombardy.
Jacques Sakarovitch is an Emeritus Reasearcher at CNRS and Emeritus Professor at Telecom Paris.

For 50 years now, his area of research is theoretical computer science and more precisely automata theory, under its many various aspects, from pushdown automata and context-free languages to functions realized by finite automata, from combinatorics of words and combinatorial theory of groups and semigroups to non standard numeration systems. He has published at Cambridge University Press a monograph 'Elements of Automata Theory' on the subject.

He has been the director of the federation of the Computer Science laboratories of Paris 6 and Paris 7 universities, as well as the coordinator of a European Project gathering teams from seventeen universities, in the 90's. From 2013 to 2018, he was the Chair of the Technical Committee on Foundations of Computer Science of the International Federation of Information Processing (IFIP). He is currently a vice-president of IFIP.
On the security of the NIST lightweight Standard Ascon
Ascon is a family of authenticated encryption with associated data and hashing algorithms that has been selected as the NIST standard for lightweight applications. Having won this competition, and once NIST publishes the final Ascon standard, it will be deployed in millions of lightweight devices and network protocols. Therefore, a continuous understanding of the security of Ascon is crucial from both academic and industrial perspective. In this talk, first I will present several cryptanalytic results on Ascon: (1) best-known distinguishers and key recovery attacks [1, 2]; (2) new bounds on the differential and linear properties [3]. Then, I will briefly discuss the design of Gaston — a new cryptographic permutation with better security properties than Ascon. Finally, I will discuss some future research directions.
Raghvendra Rohit is a lead cryptographer at the Cryptography Research Center of the Technology Innovation Institute, Abu Dhabi. At TII, he works on research and development projects related to the UAE's sovereign cryptographic library.

Raghvendra holds a PhD degree in electrical and computer engineering with a specialization in symmetric-key cryptography from the University of Waterloo, Canada. Prior to that, he completed his bachelors and master's in mathematical sciences from the Indian Institute of Science Education and Research, Kolkata.

His current research spans several aspects of theoretical and practical cryptography such as symmetric-key cryptanalysis, design of cryptographic primitives, secure and efficient implementations in hardware and software, and side-channel analysis.
Scalable Program Analysis via Parameterization
Many classical tasks in compiler optimization, program analysis and formal verification are formalized in terms of graph problems, usually over the control-flow or call graphs of programs. Examples include data-flow analyses (such as null-pointer and reaching definitions), register allocation, and the entire framework of algebraic program analysis (APA). The resulting graph problems often end up being

NP-hard. Even when a PTIME solution exists, it is not usually linear-time and fails to scale up to handle modern software systems with hundreds of millions of lines of code. As it turns out, control-flow and call graphs of programs are often sparse and exhibit certain desirable structures, such as tree-likeness, which can be exploited to obtain much faster algorithms for these classical tasks. In this talk, we formalize the sparsity of graphs arising in programs in terms of treewidth, pathwidth and treedepth and present new bounds and algorithms that scale lightweight formal methods to billions of lines of code.
Amir Goharshady is an Assistant Professor of Computer Science and Mathematics at the Hong Kong University of Science and Technology (HKUST). Amir's research is focused on formal and mathematical aspects of computer science. His specific emphases are: (i) scalable parameterized algorithms for program analysis on systems with tens of millions of lines of code, (ii) algebro-geometric and martingale-based methods in formal program verification, and (iii) theoretical foundations of blockchains. His research has been supported by generous grants and fellowships from the Hong Kong Research Grants Council, Kaisa, IBM, Facebook, the Austrian Academy of Sciences, and the Royal Commission for the Exhibition of 1851, and won the Iranian Presidential Medal of Research (Khwarizmi Award) and two IEEE Computer Society Larson Best Paper Awards. He is also an AUA fellow visiting Dept of CSE at IIT Bombay.
Algebro-Geometric Algorithms for Template-Based Program Synthesis
Abstract:This talk will begin with a brief introduction to the central theme of my doctoral research: the exploration of Algebro-Geometric Algorithms across various domains of Natural Sciences and Computer Science. I will then provide a quick overview and motivation for Algebraic Geometry, introducing basic notations, important classical theorems, and the difficulties of solving polynomial equations. Following this, I will lay the groundwork and preliminary concepts, leading to a detailed discussion on the problem of Program Synthesis, specifically focusing on the synthesis of polynomial programs. The final part of my talk will showcase the pivotal classical theorems from Real Algebraic Geometry that have been key in developing our sound, semi-complete, and efficient synthesis algorithm. The talk's content is structured to be self-contained, with all the necessary definitions and theorems included to facilitate understanding of the algorithm.

This talk is based on our joint work, available at https://dl.acm.org/doi/abs/10.1145/3586052 which appeared in OOPSLA 2023, where it received the ACM SIGPLAN Distinguished Paper award.
Dr. Harshit J. Motwani completed his undergraduate studies in Mathematics and Computing at IIT Kharagpur, graduating in the class of 2020. Subsequently, he pursued a PhD in Applied Algebraic Geometry at Ghent University's Department of Mathematics in Belgium. His doctoral thesis focused on the development of algebro-geometric algorithms to address challenges in Computer Science, Quantum Physics, and Statistics. Having completed his PhD in 2023, he began his Postdoctoral position working under Prof. Amir Goharshady at the Department of Computer Science and Engineering, HKUST, in Hong Kong. His current research involves applying his expertise in algebraic geometry to Formal Verification and Automated Theorem Proving. Additionally, he is delving into the realm of Parameterized Algorithms and actively engaged in devising efficient parameterized algorithms for applications in Computational Chemistry and Quantum Physics.
Parallel Repetition of k-Player Projection Games
In a k-player game, k>=2, a verifier sends k questions according to a fixed distribution to k provers. The provers, without communicating with each other, respond with their answers. The verifier then decides, based on the question-tuple and the received answer tuple, whether to accept or reject. The value of the game is the maximum, over the provers' strategies, the accepting probability of the verifier.

In a n-fold parallel repetition of the game, the verifier samples n independent question tuples and sends the respective questions to the provers. The provers again respond with answers to every question they receive. The verifier accepts if all the n question-tuples and answer-tuples are accepted by the verifier in a single round game.

Certainly, if the value of a game is 1, then the value of the n-fold parallel repetition of the game is also 1. One important question is: How does the value of the n-fold parallel repetition of a game decay, if the value of the game is <1 to begin with?

While we know the answer to this question for 2-player games, the situation in the k player games is far from being resolved. In this talk, I will discuss k-player projection games, which is a generalization of 2-player projection games. We show that if the value of a k player projection game is <1, then the n-fold parallel repetition of the game has value at most exp(-\Omega(n)).

Based on a joint work with Mark Braverman, Subhash Khot, Yang P. Liu, and Dor Minzer.
Amey Bhangale is an Assistant Professor in the Computer Science Department at the University of California, Riverside. Upon completing his undergraduate degree at VJTI, Mumbai, he proceeded to pursue his Ph.D. at Rutgers University under the guidance of Swastik Kopparty. Before joining UC Riverside, he spent two years in Israel where he was a postdoctoral fellow at the Weizmann Institute of Science, hosted by Irit Dinur. He is interested in approximation algorithms, hardness of approximation and the analysis of
Boolean functions.
Directions in databases and AI
In this talk, Amit will discuss the past, present, and future of managing data at scale and building intelligent systems and services at the confluence of data and AI. We will discuss the evolution and future direction of systems, data and AI at Google.
Amit Ganesh is the Vice President of Engineering for Databases at Google. He is responsible for Managed Database services, and Migration and Duet AI in Google Cloud. Amit's focus is on building the industry's most innovative data management platform to help customers develop and run their database, analytics and AI powered applications.

Amit has over two decades of experience building industry-leading products for the enterprise. Prior to joining Google, Amit was an SVP at Oracle where he was responsible for cloud services in manageability, analytics and cybersecurity. Earlier, Amit led engineering for the Oracle Database and is a co-creator of Exadata and Real Application Clusters.

He holds a Masters in Computer Science from Stanford University and a B.Tech. in Computer Science & Engineering from IIT Mumbai
Robustness in Sequential Learning: Demystifying Heavy Tails
Numerous real-world machine learning applications involve making decisions sequentially through dynamic interactions with the environment. Tech giants like Google and Meta use sequential learning algorithms to generate billions in revenue. However, their adoption in safety-critical domains like healthcare, defence, and autonomous vehicles is low due to a limited understanding of their behaviour in diverse practical environments.

In this talk, we will look at designing robust algorithms safe for real-world applications. For concreteness, we will consider the classical regret minimization problem in the multi armed bandit (MAB) setting with minimal assumptions about the arm distributions. We will discuss an optimal algorithm for this problem and the ideas involved in its design and analysis. I will also briefly present an overview of my other works in this space and conclude with future research directions I am excited about.
Shubhada Agrawal is a Herbert A. Johnson Postdoctoral Fellow in ISyE at Georgia Tech. She completed her PhD in Computer and Systems Science from TIFR, Mumbai, and her undergraduate degree in Mathematics and Computing from IIT Delhi. She has extensively explored various problems within the multi-armed bandit framework. Lately, she has been working towards enriching the theoretical foundations of reinforcement learning algorithms. She received the Google PhD Fellowship in Machine Learning (2021) and the Sarojini Damodaran Foundation Fellowship (2022). She has been recognised as a Rising Star at the TCS-for-all Workshop, STOC (2023), and a US Junior Oberwolfach Fellow (2024).
Specification-guided Reinforcement Learning
Reinforcement learning (RL) aims to learn optimal policies for accomplishing tasks in unknown environments, and has been recently successful in applications in robotics and games. Traditionally, the task is encoded in the form of a local state-based reward function which becomes cumbersome for long-horizon goals. An appealing alternative is to use high-level logical specifications, opening the direction of RL from logical specifications. In this talk, I will review both theoretical results and practical tools in this emerging area.

Rajeev Alur is Zisman Family Professor of Computer and Information Science and the Founding Director of ASSET (Center for AI-Enabled Systems: Safe Explainable, and Trustworthy) at University of Pennsylvania. He obtained his bachelor's degree from IIT Kanpur in 1987 and PhD from Stanford University in 1991. He is a Fellow of the AAAS, ACM, and IEEE, a Sloan Faculty Fellow, and a Simons Investigator, and his awards include the inaugural CAV (Computer-Aided Verification) award, the inaugural Alonzo Church award, and IIT Kanpur Distinguished Alumnus Award.

Fast Numerical Multivariate Multipoint Evaluation

Multipoint evaluation is the computational task of evaluating a polynomial given as a list of coefficients at a given set of evaluation inputs. A straightforward algorithm for this problem is to just iteratively evaluate the polynomial at each of the inputs. The question of obtaining faster-than-naive (and ideally, close to linear time) algorithms for this problem is a natural and basic question in computational algebra.

The classical FFT algorithm gives such an algorithm for the special case of univariate polynomials and a well-structured set of evaluation points (say roots of unity). Only as recently as last year, was the multivariate version of this problem for all sets of evaluation points resolved for finite fields due to the works of Bhargava, Ghosh, Guo, Kumar & Umans.

The case of infinite fields (eg, reals, rationals) is complicated due to subtleties arising from the bit-complexity of the output compelling one to work with either an approximate version of the problem or an exact version where the algorithm is allowed to run in time nearly-linear in the output size. Only as recently as 2021, was the univariate version of this problem over infinite fields resolved by Moroz.

In this talk, we will show how to extend these results to obtain similar nearly-linear time results for the multivariate version of the problem over infinite fields such as rationals, reals both in the approximate and exact setting.

[Joint work with Sumanta Ghosh, Simao Herdade, Mrinal Kumar and Ramprasad Saptharishi]

Prahladh Harsha is a Professor at the School of Technology and Computer Science at the Tata Institute of Fundamental Research (TIFR), Mumbai, India. He obtained his BTech degree in Computer Science and Engineering from IIT Madras in 1998 and his PhD in Computer Science from the Massachusetts Institute of Technology (MIT) in 2004. He has worked at Microsoft Research, TTI Chicago and has been at TIFR since 2010.

Prahladh's research interests are in the area of theoretical computer science, with special emphasis on computational complexity theory and algebraic coding theory. He is best known for his work in the area of probabilistically checkable proofs. Prahladh Harsha is a winner of the NASI Young Scientist Award for Mathematics and the Swarnajayanti Fellowship (Govt. of India).

Prof. Harsha has served on the editorial boards of SIAM Journal on Computing and Algorithmica. He is currently the Editor-in-Chief of the ACM Transactions on Computation Theory.

List Decoding of Tanner and Expander Amplified Codes from Distance Certificates

In the theory of error-correcting codes, list decoding is a relaxation of unique decoding useful for tolerating higher levels of noise. Design of list decoding algorithms for algebraic codes, such as Reed-Solomon, has found numerous applications in error correction, as well as in complexity theory and pseudorandomnness. However, we know of very few techniques for list decoding algorithms when the code may not have such algebraic structure, such as Tanner codes which are defined using sparse expander graphs.

In this talk, I will describe how continuous relaxations based on the Sum-of-Squares hierarchy can be used to design the first list decoding algorithm for Tanner codes of Sipser-Spielman [IEEE Trans. Inf. Theory 1996]. The techniques include a novel proof of the Johnson bound for arbitrary codes, distance proofs for pseudocodewords, and correlation rounding for convex hierarchies. I will also discuss extensions to a distance amplification scheme of Alon-Edmonds-Luby [FOCS 1995].

Based on joint work with Fernando Granha Jeronimo and Madhur Tulsiani.

Shashank Srivastava is a final year PhD student at the Toyota Technological Institute at Chicago, where he is advised by Madhur Tulsiani. His research interests include coding theory, pseudorandomness and constraint satisfaction problems. Earlier, he received a B.Tech. in Computer Science and Engineering from IIT Kharagpur, where he received an award for best project work among graduating students.

Algorithmic list decoding Boot Camp - 2

In this talk we will see basics of coding theory. The talk will assume minimal background. This is intended as a bootcamp series which will cover all the prerequisites one needs for the seminar which is planned on Wednesday.

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Towards Evolving Operating Systems

In this talk, I will present our ongoing effort to dynamically specialize the OS kernel based on the application requirements. In the first part of the talk, I will propose a new synchronization paradigm, contextual concurrency control (C3), that enables applications to tune concurrency control in the kernel. C3 allows developers to change the behavior and parameters of kernel locks, switch between different lock implementations, and dynamically profile one or multiple locks for a specific scenario of interest. This approach opens up a plethora of opportunities to fine-tune concurrency control mechanisms on the fly.

In the later part, I will present a new approach to designing a storage stack that allows file system developers to design userspace file systems without compromising file system security guarantees while at the same time ensuring direct access to non-volatile memory (NVM) hardware. I will present a new file system architecture called Trio that decouples file system design, access control, and metadata integrity enforcement. The key insight is that other state (i.e., auxiliary state) in a file system can be regenerated from its “ground truth” state (i.e, core state). This approach can pave the way for providing a clean structure to design file systems.

Sanidhya Kashyap is a systems researcher and an Assistant Professor at the School of Computer and Communication Sciences at EPFL. His research focuses on designing robust and scalable systems software, such as operating systems, file systems, and system security. He has published in top-tier systems conferences (SOSP, OSDI, ASPLOS, ATC, and EuroSys) and security conferences (CCS, IEEE S\&P, and USENIX Security). He is the recipient of the VMware Early Career Faculty Award. He received his Ph.D. degree from Georgia Tech in 2020.

Algorithmic list decoding Boot Camp - 1

In this talk we will see basics of coding theory. The talk will assume minimal background. This is intended as a bootcamp series which will cover all the prerequisites one needs for the seminar which is planned on Wednesday.

Shashank Srivastava is a final year PhD student at the Toyota Technological Institute at Chicago, where he is advised by Madhur Tulsiani. His research interests include coding theory, pseudorandomness and constraint satisfaction problems. Earlier, he received a B.Tech. in Computer Science and Engineering from IIT Kharagpur, where he received an award for best project work among graduating students.

On various notions of negative dependence

"Negative dependence" captures the intuitive notion of random variables being negatively correlated and comes in various forms, from the relatively-weak "cylinder negative correlation" (even which suffices to get Chernoff-style large-deviation bounds) all the way to the much-stronger "Strongly Rayleigh" distributions. I will survey some aspects of this vast area.

Aravind Srinivasan is a Distinguished University Professor and Professor of Computer Science at the University of Maryland, College Park. His interests include algorithms, probabilistic methods, data science, network science, and machine learning: theory, and applications in areas including health, E-commerce, cloud computing, Internet advertising, and fairness.

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RISC 2025
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Our faculty have made high-quality instructional material on various topics widely available. Please visit the individual faculty pages and contact the faculty members if you would like to make use of such material in your courses. Our faculty members also give invited talks, participate in instructional workshops, and offer online courses viaedXandNPTEL, and organize short-term courses via IIT Bombay'sContinuing Education Programme. We have also been involved with an initiative totrain thousands of teachersto enhance the teaching skills of faculty in core engineering and science subjects across the country. Oure-Yantrainitiative is focused on spreading education in embedded systems and robotics, by setting up robotics labs at colleges around the country, organizing competitions and summer interships for undergraduate students, etc.
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Standing in the way of raising the IITB CSE department from arguably the best department in the country to one that is highly ranked globally, are several resource constraints. We seek your support in raising resources to meet several immediate and longer-term goals:

Below is a partial list of many things you can contribute towards. You can associate the name of an individual or organization with your contribution. Apart from chairs, awards, fellowships you can institute and research centres you may support, the naming rights to the various labs and even the new building that houses much of the department are up for grabs.

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Dr. Lalitesh Katragadda is a pioneer in crowdsourcing and platforms for the underserved. He developed Google Map Maker, which tripled the world's digital maps, covering 4 billion people in 187 countries. Lalitesh co-founded Google's first international engineering center and retired as Google’s Head of India Products, where he invented and led initiatives including crowdsourced YouTube subtitles, crowdsourced translation corpus, Indic handwriting, and Google Transliteration. He is now focused on India’s nation-building efforts through his roles as founder of Indihood, Swaja Labs, and co-founder of Avanti Finance.

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Dispatch (legwork), Classroom opening/closing/setup, logistic support for meetings/events
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ashokbn[at]cse[dot]iitb[dot]ac[dot]in
Dispatch (Table work and leg work), Logistics arrangement for meetings/events, Room booking for meetings
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Assitance to Systems Team, Member of AV team

4705
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