Dr. Indrajit Ghosh

Postdoctoral Researcher & Software Engineer

Applied Mathematics • Backend Development • Applied Cryptography • Algorithm Design

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PROFESSIONAL PROFILE

Mathematically rigorous **Postdoctoral Researcher and Software Engineer** with a Ph.D. in Mathematics from the Indian Statistical Institute and extensive expertise in **Python**, **backend development**, **applied cryptography**, and **algorithmic optimization**. Proven track record of designing modular RESTful microservices, implementing zero-knowledge security tools, and solving complex quantitative problems. Experienced in cross-institutional research collaboration, technical instruction, and building production-grade software. Passionate about applying analytical rigor to software engineering, research engineering, and scalable data-driven systems.

TECHNICAL SKILLS

Programming Languages: Python (Advanced), C, C++, SQL (MySQL, SQLite), JavaScript (ES6+), HTML5, CSS3, Bash

Frameworks & Backend: Flask, RESTful API Design, SQLAlchemy ORM, Jinja2, Bootstrap, Microservices Architecture

Software Tools & DevOps: Git, GitHub, Linux/Unix Environments, Shell Scripting, Testing & Debugging, LaTeX

Applied Cryptography: Symmetric Ciphers (AES-CBC, Fernet), PBKDF2/Argon2 Key Derivation, Secure Token Lifecycle, Zero-Knowledge Credential Storage, SHA-256 Checksum Verification

Mathematical Computation: Linear Algebra, Matrix Analysis, Operator Theory, Combinatorial Optimization, Numerical Algorithms, Mathematical Modeling

PROFESSIONAL EXPERIENCE

Institute Postdoctoral Fellow
Mar 2026 – Present

Department of Mathematics, Indian Institute of Technology Kanpur — Kanpur, India

- Conduct advanced mathematical research in Operator Algebras, von Neumann algebras, and quantum symmetries, collaborating with Prof. Keshab Chandra Bakshi.
- Formulate rigorous proofs for structural invariants and combinatorial criteria characterizing operator inclusions in finite and infinite dimensions.
- Serve as Teaching Assistant for undergraduate *Calculus I (MTH111M)*, conducting weekly problem-solving tutorials, designing problem sets, and mentoring students in quantitative problem solving.

Postdoctoral Researcher
Nov 2025 – Feb 2026

Department of Mathematics, Indian Institute of Technology Madras — Chennai, India

- Researched operator-theoretic characterizations of properly infinite von Neumann algebras with Prof. Kunal Krishna Mukherjee.
- Analyzed projection lattices, spatial decompositions, and algebraic homomorphisms, formulating new invariant criteria for operator systems.

Doctoral Researcher & Teaching Fellow
Jul 2019 – Oct 2025

Theoretical Statistics and Mathematics Unit, Indian Statistical Institute (ISI) — Bangalore, India

- Formulated a complete near-semiring algebraic theory and functorial representation for unbounded operators affiliated with von Neumann algebras under Prof. Soumyashant Nayak.
- Published research in *International Mathematics Research Notices (IMRN, Oxford Academic)*, winning the **Subhash Bhatt Award (2026)** from the Indian Mathematical Society.
- Delivered lectures and served as TA for graduate/undergraduate courses including *Optimization*, *Harmonic Analysis*, *Functional Analysis*, *Complex Analysis*, and *Analysis of Several Variables*.

SOFTWARE ENGINEERING PROJECTS

Hermes – Secure Transactional Email API Microservice | *Python, Flask, SQLAlchemy, REST API*
github.com/indrajit912/Hermes

- Architected a standalone RESTful microservice enabling web applications to dispatch transactional emails securely without managing custom SMTP servers.
- Implemented granular API-key authentication, token validation, rate-limiting, and an administrative approval workflow; deployed in live production applications.

VaultSafe – Cryptographic Credential Management CLI | *Python, Cryptography (`hazmat`), PBKDF2, AES*
github.com/indrajit912/VaultSafe

- Engineered an open-source command-line credential manager enforcing zero-knowledge architecture and enterprise-grade symmetric encryption (AES-CBC via Fernet).
- Designed secure key derivation routines (PBKDF2-HMAC-SHA256) with dynamic salt generation, memory protection, and tamper-evident local encrypted JSON storage.

Slotify – Automated Hostel Resource Scheduling System | *Python, Flask, SQLAlchemy, Bootstrap, SQLite*
github.com/indrajit912/Slotify

- Developed a full-stack scheduling application for hostel laundry facilities to resolve physical booking collisions and eliminate scheduling conflicts.
- Implemented role-based access control (RBAC), conflict-free timeslot reservation algorithms, and real-time visual schedule monitoring.

MindCanvas – End-to-End Encrypted Knowledge Management Platform | *Python, Flask, Cryptography, MathJax*
github.com/indrajit912/MindCanvas

- Built a secure personal journaling and research documentation web app featuring client/server encryption, taxonomy tagging, and fast full-text querying.
- Integrated dynamic MathJax rendering for real-time mathematical expression evaluation and LaTeX formula visualization.

EDUCATION

Doctor of Philosophy (Ph.D.) in Mathematics — **Jul 2019 – Oct 2025 (Awarded Feb 2026)**
Theoretical Statistics and Mathematics Unit, Indian Statistical Institute (ISI) — Bangalore, India

- **Thesis:** *On Algebraic Aspects and Functoriality of the Set of Unbounded Operators Affiliated with a von Neumann Algebra*
- **Advisor:** Prof. Soumyashant Nayak

Master of Science (M.Sc.) in Pure Mathematics — **2016 – 2018**
Department of Pure Mathematics, University of Calcutta — Kolkata, India

Bachelor of Science (B.Sc. Hons.) in Mathematics — **2013 – 2016**
Barasat Government College, West Bengal State University — Barasat, India

- First Class Honours in Mathematics

HONORS, AWARDS & FELLOWSHIPS

- **Subhash Bhatt Award (2026)**, *Indian Mathematical Society (IMS)* – Awarded for best research paper in *IMRN (2024)*.
- **NBHM Ph.D. Research Fellowship (2019)**, *National Board for Higher Mathematics*, Dept. of Atomic Energy, Govt. of India.
- **CSIR-UGC NET Junior Research Fellowship (JRF)** in Mathematical Sciences (Dec 2018), *CSIR*, Govt. of India.
- **Graduate Aptitude Test in Engineering (GATE)** in Mathematics (2019), *Govt. of India*.
- **Junior Research Fellowship Offers (2019):** Accepted offer at ISI Bangalore; also selected at IIT Madras and IISER Bhopal.

SELECTED PUBLICATIONS & PREPRINTS

- **I. Ghosh** and S. Nayak (2024). *Algebraic aspects and functoriality of the set of affiliated operators*. **International Mathematics Research Notices (IMRN)**, Oxford University Press, Vol. 2024, Issue 21, pp. 13525–13562. [DOI:10.1093/imrn/rnae203] | [arXiv:2311.16170] | *Recipient of the Subhash Bhatt Award (2026)*
- **I. Ghosh** and S. Kumar (2026). *Distances Between von Neumann Subalgebras: Spin Models, Commuting Squares, and Free Group Factors*. arXiv preprint (33 pages). [arXiv:2609.34856]
- **I. Ghosh** and S. Kumar (2026). *Kadison–Kastler Distance and Interior Angle for Masas: Connections with Entropy and Probabilistic Index*. arXiv preprint (28 pages). [arXiv:2609.38206]
- K. C. Bakshi and **I. Ghosh** (2026). *Regularity for Subfactors*. arXiv preprint (18 pages). [arXiv:2609.10118]
- **I. Ghosh** and S. Kumar (2026). *A Complete Characterization of Cartan Inclusions of Finite Dimensional C^*-algebras*. arXiv preprint (16 pages). [arXiv:2608.11711]
- K. C. Bakshi, **I. Ghosh**, and S. Kumar (2026). *A Complete Characterization of Regular Inclusions of Finite Dimensional C^*-algebras*. arXiv preprint (21 pages). [arXiv:2608.04572]

Complete list of publications, preprints, and citation metrics available on arXiv Profile and Google Scholar.