

# SARTHAK CHAKRABORTY

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## RESEARCH INTERESTS

My research interests lie in developing efficient designs and protocols for enhancing the performance of cloud systems which encompasses various aspects including reliability, correctness and optimizations. My research experiences include cloud system reliability, ML for system reliability, systems for ML, data-driven systems and federated learning.

## EDUCATION

- **PhD in Computer Science** August 2023 - Ongoing  
*University of Illinois Urbana-Champaign*  
Advisor: Dr. Indranil Gupta  
Funded by *Illinois Distinguished Fellowship*
- **Dual Degree (B. Tech + M. Tech) in Computer Science and Engineering** July 2016 - April 2021  
*Indian Institute of Technology (IIT) Kharagpur, India*  
Cumulative GPA: 9.74/10.00  
Institute Rank: 2 | Department Rank: 2

## PUBLICATIONS

- [1] (NSDI '24) Shubham Agarwal, Subrata Mitra, **Sarthak Chakraborty**, Srikrishna Karanam, Koyel Mukherjee, Shiv Saini. **Approximate Caching for Efficiently Serving Diffusion Models**. In *21st USENIX Symposium on Networked Systems Design and Implementation*, 2024. [\[LINK\]](#) (Acpt. Rate: 18.6%)
- [2] (ASE '23) **Sarthak Chakraborty**, Shubham Agarwal, Shaddy Garg, Abhimanyu Sethia, Udit Narayan Pandey, Videh Aggarwal, Shiv Saini. **ESRO: Experience Assisted Service Reliability against Outages**. In *The 38th IEEE/ACM International Conference on Automated Software Engineering*, 2023. [\[LINK\]](#) (Acpt. Rate: 21.3%)
- [3] (ESEC/FSE '23) Shubham Agarwal, **Sarthak Chakraborty**, Shaddy Garg, Sumit Bisht, Chahat Jain, Ashritha Gonnuguntla, Shiv Saini. **Outage-Watch: Early Prediction of Outages using Extreme Event Regularizer**. In *The 31st ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering*, pp. 682-694, 2023. [\[LINK\]](#) (Acpt. Rate: 25.6%)
- [4] (WWW '23) **Sarthak Chakraborty**, Shaddy Garg, Shubham Agarwal, Ayush Chauhan, Shiv Saini. **CausIL: Causal Graph for Instance Level Microservice Data**. In *Proceedings of The Web Conference 2023*, pp. 2905-2915, 2023. [\[LINK\]](#) (Acpt. Rate: 19.2%)
- [5] (NeurIPS '22) Azam Ikram, **Sarthak Chakraborty**, Subrata Mitra, Shiv Saini, Saurabh Bagchi, Murat Kocaoglu. **Root Cause Analysis of Failures in Microservices through Causal Discovery**. *Advances in Neural Information Processing Systems 35*, pp. 31158-31170, 2022. [\[LINK\]](#) (Acpt. Rate: 25.6%)
- [6] (ICBC '22) **Sarthak Chakraborty**, Sandip Chakraborty. **Proof of Federated Training: Accountable Cross-Network Model Training and Inference**. In *2022 IEEE International Conference on Blockchain and Cryptocurrency*, pp. 1-9, 2022. [\[LINK\]](#) (Acpt. Rate: 18.6%)
- [7] (WWW '21) Lovish Chopra\*, **Sarthak Chakraborty\***, Abhijit Mondal, and Sandip Chakraborty. **PARIMA: Viewport Adaptive 360-degree Video Streaming**. In *Proceedings of The Web Conference 2021*, pp. 2379-2391, 2021. [\[LINK\]](#) (Acpt. Rate: 20.6%)

## INDUSTRIAL RESEARCH

- **Research Associate 2 - Adobe Inc. (BigData Intelligence Lab)** Jul 2021 - Aug 2023  
*Group: Systems and Insights Group* *Bangalore, India*
  - \* Published 5 papers, filed 2 patents and successfully integrated research technologies into 2 products within 2 years
  - \* Mentored 10 undergraduate interns and 1 PhD intern during summer internships at Adobe over a span of 2 years
  - \* Selected as a speaker to present at Adobe Tech Summit 2022, a company-wide global internal technical conference
  - \* **ML for System Reliability**
    - **Runtime Prediction of Incoming Jobs in Multi-Tenant System (Integrated into Product)**: Designed a pipeline that engineers features based on system state and predicts the latency of incoming Spark jobs with a MAPE value of  $\sim 0.4$ . The pipeline is used by the internal developers to decide if preventive measures are necessary

- **Root Cause and Remediation Consolidation System** [\[Paper Link\]](#): Constructed a knowledge graph utilizing both structured alerts data and unstructured incident reports data, enabling the consolidation of potential root causes and remediation strategies for a series of triggered alerts. The knowledge graph was employed to predict possible root causes in real-time, resulting in an improvement of  $\sim 27\%$  over prior methods
- **Designing Instance-aware Causal Graph from Telemetry Data** [\[Paper Link\]](#): Formulated an algorithm that builds the causal structure among performance metrics at the instance level in a microservice-based cloud system, integrating domain knowledge derived from system architecture. This resulted in a 25% enhancement in the accuracy of graph estimation
- \* **Cloud System Reliability**
  - **Outage Prediction in Production System (Integrated into Product)** [\[Paper Link\]](#): Implemented the inference and training pipeline of an outage forecasting model by inventing a novel distribution learning approach, exhibiting AUC of 0.8. To implement the pipeline into product, we leveraged Shapley value based explainability system to localize faulty system alerts.
  - **Root Cause Analysis via Intervention Modeling of Faults** [\[Paper Link\]](#): Developed a hierarchical and localized causal discovery algorithm to model microservice metrics and detect the root causes of faults. Significantly reduced computation time against popular baselines and evaluated against real-world production data
- \* **System Optimizations for ML**
  - **Approximate Caching to Efficiently Serve Diffusion Models** [\[Paper Link\]](#): Built an end-to-end diffusion model serving system and innovated a novel caching technique to reduce the cost and latency of text-to-image generation by intelligently reusing intermediate states. We are able to achieve 21% GPU savings and 19.8% reduction in latency without compromising the accuracy of generation
- **Research Intern - Adobe Inc. (BigData Intelligence Lab)** Apr 2020 - Jul 2020  
*Topic: Architecting Large-Scale Asynchronous Federated Learning* *Bangalore, India*
  - \* Designed a scalable and flexible framework for federated learning to support synchronous and asynchronous model training, with on-device learning on heterogeneous target devices such as android mobiles, web browsers, and desktops
  - \* Devised an algorithmic strategy to effectively aggregate stale gradients and deployed the framework on over 100 clients to perform image classification and boundary prediction task with real world production models
  - \* Supported on-device federated learning on heterogeneous target devices including android mobiles (tflite), web browsers (tfjs), IoT (Raspberry Pie) and desktop
  - \* Among one of the 6 interns in a pool of 64 interns to receive a pre-placement offer for full-time role in the research team

## ACADEMIC RESEARCH

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- **Optimizing and Automating Cloud Application Deployment Process** Aug 2023 - Ongoing  
*University of Illinois Urbana-Champaign* *Dr. Indranil Gupta*
    - \* Currently working on a project that aims at automating the deployment phase of microservice applications given the application configuration, expected load and SLO on cloud platforms through Kubernetes
    - \* Exploring the use of rich cloud observability data to make informed decisions during cloud deployment phase
    - \* Studying various Kubernetes configurations that are tuned during manual deployment process and exploring ways to intelligently automate them
  - **Cross-Chain Training of Learning Models via Blockchain Interoperability** Aug 2020 - Apr 2021  
*Master's Thesis Project | IIT Kharagpur | [Paper Link](#)* *Dr. Sandip Chakraborty*
    - \* Developed an end-to-end system to train a common machine learning model in a cross-silo setting over multiple smart contract enabled federated networks via the concept of blockchain interoperability
    - \* Incorporated permissioned blockchain networks to store auditable model states learned by the federated system
    - \* Constructed a relay-based cross-chain transfer mechanism to transfer the model state from one network to the other via HTTP channel. Signatures ensured that the data transferred was verifiable and authentic
  - **PARIMA: Viewport Adaptive 360-degree Video Streaming** Jul 2019 - May 2020  
*Bachelor's Thesis Project | IIT Kharagpur | [Paper Link](#)* *Dr. Sandip Chakraborty*
    - \* Designed an online viewport-adaptive video streaming algorithm along with a client-server streaming platform
    - \* Implemented a novel PARIMA algorithm: an augmented Passive-Aggressive(PA) model and time series(ARIMA) model for viewport detection using video content as well as personalized head movement tracking.
    - \* Employed a pyramidal adaptive bitrate allocation scheme and improved the Quality of Experience by  $\sim 30\%$
    - \* Used HEVC video encoding, GPAC for segmenting video chunks and 'MP4Client' for client streaming of video

## • Advanced Optimization Methods for Machine Learning

May 2019 - Aug 2019

MITACS Globalink Research Intern | University of Waterloo | [Github Link](#)

Dr. Hans de Sterck

- Designed a randomized ALS algorithm targeted for CP Decomposition and Completion of Sparse Tensors
- Computed leverage scores for the rows of factor matrices to sample non-zero data points using weighted reservoir sampling
- Measured improvement of 25% in RMSE with 30% sampling rate against benchmark algorithms for tensor completion like conventional ALS, SGD, CCD++ and RRALS algorithms

## PATENTS

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- [1] Shubham Agarwal, Subrata Mitra, *Sarthak Chakraborty*, Srikrishna Karanam, Koyel Mukherjee, Shiv Kumar Saini. **Intelligent Use of Caching and Retrieval of Intermediate Noise for Resource Efficient Diffusion Models**. [Approved for Filing]
- [2] Sunav Choudhary, Atanu R. Sinha, *Sarthak Chakraborty*, Sai Shashank Kalakonda, Liza Dahiya, Purnima Grover, Kartavya Jain. **LiveStreaming AI: Merchandisable Moment Identification and Offer Generation**. [Filed] (US Patent App. 18/176,114)
- [3] *Sarthak Chakraborty*, Sunav Choudhary, Atanu R. Sinha, Sapthotharan Nair, Manoj Ghuman A, Yuvraj Gagneja, Atharva Anand Joshi, Atharv Tyagi, Shivi Gupta. **Generating Concise and Common User Representations for Edge Systems from Event Sequence Data stored on Hub Systems**. [Filed] (US Patent App. 17/849,320)

## TEACHING AND SERVICES

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- **Undergraduate Teaching Assistant:** *Database Management Systems (CS43002)*, *Theory of Computation (CS41001)*
- **Reviewer:** ATC 2023, IEEE TCSVT 2023, EuroSys 2023, IEEE TSNM 2022, SRDS 2022, DSN 2022

## TERM PROJECTS

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- Designed an externally synchronous replicated file system that performs faster than the traditional synchronous file system by implementing fast and slow path for multiple system calls.
- [\[Link\]](#) Developed a reduced version of Hadoop for running Map-Reduce tasks from scratch by implementing a distributed logging service, failure detection, distributed file system and an SQL wrapper parser.
- [\[Link\]](#) Developed a Distributed Collaboration System where multiple users can collaborate on a single document at once that maintained consistency along with a passive replication scheme. It used a master-worker architecture of servers.
- [\[Link\]](#) Developed a search engine to retrieve similar images to a given query keyword and image from news articles. It filters relevant documents using the keyword and then runs KNN over R-Tree to retrieve images similar to the query image
- [\[Link\]](#) Designed an in-memory disk emulator with 4kB block size and built an ext2 like simple file system on top of the disk
- [\[Link\]](#) MRP: Implemented a reliable message-oriented communication protocol over an unreliable User Datagram protocol
- [\[Link\]](#) TinyC: Implemented a compiler for a subset of C functionalities to translate the C code to x86 Assembly Language
- [\[Link\]](#) KGP-RISC: Designed a 32-bit single cycle CPU(RISC based architecture) in Verilog VHDL and tested it on FPGA

## SKILLS

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|----------------------------------|--|
| • <b>Languages</b>               | Python, C, C++, Java, SQL, Golang, Verilog, MIPS   |
| • <b>Packages and Frameworks</b> | Kubernetes, Docker, Kafka, MongoDB, scikit-learn, PyTorch, Keras, TensorFlow, DGL, Tensorflow-Federated, Git, Hyperledger Fabric |

## HONOURS AND AWARDS

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| • Recipient of ACM SIGSOFT CAPS Student Travel Grant to attend ESEC/FSE 2023                                    | 2023      |
| • Recipient of the Illinois Distinguished Fellowship for academic achievements among incoming graduate students | 2023      |
| • Recipient of the Goralal Syngal Memorial Scholarship awarded by the Institute for academic excellence         | 2020, '19 |
| • Received the prestigious MITACS Globalink Research Fellowship for a research internship in Canada             | 2019      |

## RELEVANT COURSES

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- **Graduate Courses:** Distributed Systems, Cloud Storage Systems

- **Undergraduate Courses:** Operating Systems, Advances in Operating Systems Design, Database Systems, Advanced Database Systems, Distributed Systems, Computer Networks, High Performance Computer Architecture, Compilers, Scalable Data Mining, Machine Learning, Algorithms, Probability and Statistics, Operations Research