SARTHAK CHAKRABORTY

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RESEARCH INTERESTS

My broad research interests lies in the area of applying machine learning advances for efficient system design. More specifically, I am interested in building autonomous and reliable distributed systems optimized under dynamic workload changes that can heal itself during degradations. Apart from this, I also have experience with data-driven systems and federated learning.

EDUCATION

- **Dual Degree (B. Tech + M. Tech) in Computer Science and Engineering** July 2016 - April 2021
  Indian Institute of Technology Kharagpur, India
  Cumulative GPA: 9.74/10.00 (Class Rank 2)

PUBLICATIONS AND PREPRINTS

[1] *Sarthak Chakraborty*, Shaddy Garg, Shiv Kumar Saini, Shubham Agarwal, Ayush Chauhan. **CausIL: Causal Graph for Instance Level Microservice Data.** Under Review at *The Web Conference 2023*. [Preprint]

[2] Azam Ikram, *Sarthak Chakraborty*, Subrata Mitra, Shiv Kumar Saini, Saurabh Bagchi, Murat Kocaoglu. **Root Cause Analysis of Failures in Microservices through Causal Discovery.** In *Advances in Neural Information Processing Systems* (NeurIPS '22), 2022. [LINK] (Accpt. Rate: 25.6%)

[3] *Sarthak Chakraborty*, Sandip Chakraborty. **Proof of Federated Training: Accountable Cross-Network Model Training and Inference.** In *2022 IEEE International Conference on Blockchain and Cryptocurrency* (ICBC '22), pp. 1-9, 2022. [LINK] (Accpt. Rate: 18.6%)

[4] Lovish Chopra*, *Sarthak Chakraborty**, Abhijit Mondal, and Sandip Chakraborty. **PARIMA: Viewport Adaptive 360-degree Video Streaming.** In *Proceedings of the Web Conference 2021* (WWW '21), pages 2379–-2391, 2021. [LINK] (Accpt. Rate: 20.6%)

PATENTS

[1] Sunav Choudhary, Atanu R. Sinha, *Sarthak Chakraborty*, Sai Shashank Kalakonda, Liza Dahiya, Purnima Grover, Kartavya Jain. **LiveStreaming AI: Merchandisable Moment Identification and Offer Generation.** [Under filing process]

[2] *Sarthak Chakraborty*, Sunav Choudhary, Atanu R. Sinha, Sapthotharan Nair, Manoj Ghuhan 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)

WORK EXPERIENCE

- **Research Associate - Adobe Inc. (BigData Intelligence Lab)** Jul 2021 - ongoing
  Group: Data-driven Systems, Insights and Experience *Bangalore, India*
  - Worked on a variety of topics including analyzing system data to provide reliability for cloud-based systems, edge aware user profile compression, GNN training under resource constraints and budget-constrained media spend strategy
  - Submitted papers, filed patents and developed research technologies that were successfully integrated into products
  - Participated and selected as a speaker in a global internal technical conference at Adobe Tech Summit 2022

- **Research Intern - Adobe Inc. (BigData Intelligence Lab)** Apr 2020 - Jul 2020
  Topic: Architecting Large-Scale Asynchronous Federated Learning *Sunav Choudhary, Manoj Ghuhan*
  - 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

- **MITACS Globalink Research Intern - University of Waterloo** May 2019 - Aug 2019
  Topic: Advanced Optimization Methods for Machine Learning | *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

- Performed several diagnostics and validated our method against benchmark algorithms for tensor completion like conventional ALS, SGD, CCD++ and RRALS algorithms

- **Undergraduate Research Intern - IIT Kharagpur(Funded by Shell India Pvt. Ltd.)** May 2018 - Oct 2018
  Topic: Predictive Maintenance of Sensors | *Github Link* *Dr. Swanand Khare*
  - Designed an algorithm to model sensor data and generated threshold conditions to detect anomaly
  - Modelled data under GMM distribution and estimated its parameters by a randomized version of EM algorithm

SELECTED PROJECTS

- **Runtime Prediction for Spark Jobs in Multi-Tenant System** Feb 2022 - ongoing
  Adobe Research (Integrated into product)
  - Designed a pipeline to predict latencies of spark jobs and thus the health of the system using only their workload descriptions (without any configuration details of the clusters running them) in a multi-tenant streaming system
  - Engineered features to capture system state and used random forest based model to forecast latency and detect anomalies
  - Worked with the engineering team to successfully transfer the model to a production system at Adobe

- **Outage Prediction in Production System using Alerts** Feb 2022 - ongoing
  Adobe Research (Integrated into product)
  - Monitored alerts fired from a microservice-based system and performed domain-specific feature engineering
  - Designed and implemented an outage prediction model and leveraged Shapley value based explainability model to localize the alerts responsible for generating outage predictions
  - Implemented the inference and training pipeline and successfully incorporated the model into the engineering stack

- **Root Cause Analysis via Intervention Modeling of Faults** Nov 2021 - Sep 2022
  Adobe Research | Paper Link
  - Designed an algorithm to detect root causes of faults in a microservice-based system by modeling faults as interventions
  - Designed a hierarchical and localized causal discovery algorithm to model metrics of various microservices using non-faulty observational data and faulty interventional data, thus identifying the intervention target and hence the root cause
  - Significantly reduced computation time against popular baselines and evaluated against real-world production data

- **Edge Aware User Profile Compression** Aug 2021 - Jan 2022
  Adobe Research | US Patent Filed
  - Designed a concise user profile embedding using the behavioral attributes of the user to serve multiple downstream tasks
  - Involved techniques of sequence modelling and multi-task learning to generate the representations that aimed to bring user profile from the hub (cloud) to the edge servers
  - Representations were faithful to the storage constraints of the edge server, with various evaluations performed around compression and updatability of the embeddings

- **Cross-Chain Training of Learning Models via Blockchain Interoperability** Aug 2020 - Apr 2021
  Advisor: Dr. Sandip Chakraborty | *Github Link* | Paper Link *Master's Thesis Project*
  - 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

- **Distributed Collaborative Editor** Jan 2021 - Apr 2021
  Supervisor: Dr. Aurobinda Gupta | *Github Link* *Term Project - Distributed Systems*
  - Designed a distributed system to allow multiple users to collaboratively edit a single document at once
  - Used Operational Transformation concept to maintain consistency in the documents at the server side and the client side
  - Implemented distributed system concepts like passive replication scheme, crash detection and recovery handling in case of faults. The system used a master-worker architecture of servers

- **PARIMA: Viewport Adaptive 360-degree Video Streaming** Jul 2019 - May 2020
  Advisor: Dr. Sandip Chakraborty | *Github Link* | Paper Link *Bachelor's Thesis Project*
  - Designed an online viewport-adaptive video streaming algorithm along with a client-server streaming platform
  - Developed 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 to maximize the Quality of Experience
- Used HEVC video encoding, GPAC for segmenting video chunks and 'MP4Client' for client streaming of video

- **Scalable Method for Representing Large Scale Graphs** Aug 2019 - Jan 2020
  Dr. Sourangshu Bhattacharya | Github Link *Term Project - Scalable Data Mining*
  - Developed a hierarchical community-detection based algorithm for network embedding of large scale graphs
  - Constructed hierarchy tree using Louvain community detection algorithm and studied the community structure of the graph to establish relevant inter-community links at each hierarchy level
  - Generated embedding using Node2vec/Deepwalk at each hierarchy level and combined the individual node embeddings to get the network embedding

TEACHING AND SERVICES

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

MISCELLANEOUS PROJECTS

- Designed an image and content based search engine to query similar images from news article given a keyword and an image. It filters relevant documents using the keyword and then runs KNN over R-Tree to retrieve images similar to the query image
- Implemented max and min heap using a Loadable Kernel Module by maintaining concurrency control so that multiple processes can access it and have individual heap structures.
- Implemented Multimodal Emotion Classifier for conversations in MELD datasets. Used visual, textual, and acoustic as individual modes and trained a trimodal classifier to combine the activations from these modes
- MRP: Implemented a reliable message-oriented communication protocol over an unreliable User Datagram protocol
- Developed APIs of memory-resident file systems for linked-list based FAT and indexed based inode implementations
- TinyC: Implemented a compiler for a subset of C functionalities to translate the C code to x86 Assembly Language
- KGP-RISC: Designed a 32-bit single cycle CPU(RISC based architecture) in Verilog VHDL and tested it on FPGA

SKILLS

- **Languages** Python, C, C++, Java, SQL, Golang, Verilog, MIPS, Scala
- **Packages and Frameworks** scikit-learn, PyTorch, Keras, TensorFlow, DGL, Tensorflow-Federated, Git, Hyperledger Fabric, MongoDB, Docker, Kafka, Spark

HONOURS AND AWARDS

- Graduated with a Department Rank and an Institute Rank of 2 among all the Dual degree students 2020
- Selected as a Mitacs Globalink Research Intern at the University of Waterloo, Canada 2019
- 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

- **Core Courses:** Algorithms, Discrete Structures, Formal Language and Automata Theory, Compilers, Computer Organization and Architecture, Operating Systems, Computer Networks, Database Management Systems, High Performance Computer Architecture, Machine Learning, Artificial Intelligence, Scalable Data Mining, Reinforcement Learning, Deep Learning, Advances in Operating Systems Design, Advanced Database Systems, Distributed Systems
- **Other Courses:** Probability and Statistics, Linear Algebra, Regression and Time Series Models, Operations Research

EXTRA-CURRICULAR

- Presented my work on Federated Learning at the global internal technical summit at Adobe, Adobe Tech Summit 2022
- Successfully completed the three-day long summer school on AI organized by Google Research India 2020
- Had been a member of Team AUV, IIT Kharagpur and worked on design changes to bring stability in the existing model of underwater vehicle, Kraken 3.0 2017-2018