KAPIL AGRAWAL

kapilagrawal95.github.io | kapila1@uci.edu | Google Scholar

INTERESTS

Interested in designing and building exascale distributed systems with a strong focus on enhancing resilience across all layers of the systems stack.

EDUCATION

University of California, Irvine — Irvine, CA
Ph.D., Computer Science | Advisor: Prof. Sangeetha Abdu Jyothi — *Mar 2023 - Present*
MS, Computer Science | CGPA: 4.00 — *Sept 2021 - Mar 2023*

Delhi Technological University — New Delhi, India
B.Tech (Hons.) in Mathematics and Computing Engineering — *Aug 2013 - Jun 2017*

EXPERIENCE

Microsoft Research — Bengaluru, India
Research Fellow — *Jul 2018 - Jul 2021*

Indian Institute of Technology, Mandi — Himachal Pradesh, India
Research Assistant — *Jun 2017 - Jul 2018*

TECHNICAL SKILLS

Languages: Python, C/C++, GoLang, LaTeX, JavaScript, SQL, Bash, PHP

Frameworks & Services: Kubernetes, Flask, MongoDB, Azure, Jaeger, Redis, Prometheus, Grafana

Toolkits and Packages: Apache HDFS, Apache Spark, Redis, Gurobi, Selenium, NetworkX, D3js, scikit-learn, lifelines

SELECTED PUBLICATIONS

Cooperative Graceful Degradation in Containerized Clouds
Kapil Agrawal, Sangeetha Abdu Jyothi
ASPLOS '25 | *arXiv: 2312.12809* | *Link*

Monitoring Cloud Service Unreachability at Scale
Kapil Agrawal, Viral Mehta, Sundararajan Renganathan, Sreangsu Acharyya, Venkat Padmanabhan, Chakri Kotipalli, Liting Zhao
Proceedings of IEEE INFOCOM 2021

PROJECTS

Storage Systems Resilience — UC Irvine, Google
Advisors: Prof. Sangeetha Abdu Jyothi, Dr. Saurabh Kadekodi (Google) — *June 2024 - Present*

- Large-scale object stores like Google Colossus and Meta Tectonic use redundancy schemes (e.g., 3-way replication, erasure coding) to enhance durability, availability, and performance. However, these schemes are optimized for small-scale failures (1% disk/node failures) and their effectiveness under larger failures (e.g., cooling system failures) remains uncertain.
- Designed and developed a high-fidelity simulator to model metadata replication in large-scale object stores at up to **800 PB** scale (1,000-node cluster). Analyzed file loss rates under various redundancy schemes and realistic failure scenarios, including Top-of-Rack switch failures and correlated node/disk failures.
- Identified that **random replication increases failure susceptibility for larger files**, while **deterministic placement significantly improves durability**. Additionally, 3-way random replication is effective against independent failures but highly vulnerable to correlated failures, which can be mitigated by remote backups beyond failure boundaries.

Automating Resilience Management — UC Irvine
Advisor: Prof. Sangeetha Abdu Jyothi — *Sept 2022 - Nov 2024*

- Proposed a **cooperative graceful degradation** paradigm where applications specify resilience objectives using *criticality tags* (e.g., microservice A is more critical than B) in a **privacy-preserving manner**, enabling collaborative failure mitigation between cloud providers and customers.
- Developed a highly scalable **(100,000-machine) datacenter-scale controller** in Python, integrated with **Kubernetes**, to optimize resilience objectives in multi-tenant settings while balancing cloud provider goals (e.g., fairness, revenue) during failures.
- **Prototyped and open-sourced the controller** on a 25-node Kubernetes testbed running 5 microservice-based applications. Results show that critical services can survive up to 60% cluster failures.[Github]

Multi-Cloud Resilience UC Irvine, IBM

Advisors: Prof. Sangeetha Abdu Jyothi, Dr. Saurabh Jha (IBM) *Apr 2023 - Present*

- Identified and formalized research problems in resilience aspects of multi-cloud architecture that arise as a result when multiple geographically distant clusters coordinate to perform tasks such as horizontal pod autoscalers etc.
- Experimenting with state-of-the-art multi-cloud controllers such as Kubestellar, Open Cluster Management to understand vulnerabilities in their design. Identified one major design bug in Kubestellar repository which was fixed in a later version [Link] .
- Early results show that while most control plane operations such as PodScheduler, ReplicaSetController of Kubernetes do not require strong co-ordination across two clusters running on separate clouds, some controllers such as traffic managements, ResourceQuotas, require strong consistency for correct functioning.

Monitoring Last-Mile Network Unreachability for Office365 Microsoft

Advisors: Dr. Venkat Padmanabhan & Dr. Sreangsu Acharyya *Jul 2019 - Mar 2020*

- Carried out a Microsoft-scale study of first-party services and observed that users' requests were often not directed to the nearest service point causing a bump in latency consequently prompting interest to actuate the first planet-scale measurement platform, Odin, for Microsoft's 2 billion+ users.
- Built a lightweight highly scalable **ML-based time-series detection tool**, NetDetector implemented in Python, that monitors availability across 110+ countries atop Odin, a client-side javascript agent, that probes Outlook by mimicking users. **NetDetector reduced customer complaints from over 100+ complaints per month to zero in 3 months after deployment**.
- Developed a **boolean satisfiability based drill-down mechanism** that performed on-demand distributed search over the vast space of possible reasons to explain the root cause of failures as a one-click auto-debug feature for on-call engineers thereby reducing the time from **2+ hours down to less than a minute**.

Data-driven Networking for Exchange Datacenters Microsoft

Advisors: Dr. Venkat Padmanabhan & Dr. Sreangsu Acharyya *Jan 2020 - Jan 2021*

- Co-led a Microsoft-scale study to understand which workloads consume the most network bandwidth and found that **Migration** client contributes the most with 40%, of which Mailbox Migration alone contributes 70%.
- Streamlined SQL pipelines to generate daily reports on Microsoft's cold storage, CosmosDB, Microsoft's data lakehouse, that processed billions of mailboxes to study access patterns on mailboxes. Used smoothing techniques such as sliding window, moving average.
- Modeled access patterns of individual workloads as a function of the age of emails by applying the Kaplan-Meier filter implemented using python's lifelines package on a representative mailbox population and found three buggy clients that brought about bulk accesses burdening the Office Exchange Store.

SSD Cache Modelling for Outlook Mail Microsoft

Advisors: Dr. Venkat Padmanabhan & Dr. Sreangsu Acharyya *Jan 2020 - Jul 2021*

- Partnered with Exchange Store Team to model access patterns to devise a new cache eviction policy. Developed an open gym on SQL and python to test several caching policies and analyze performance overheads.
- Launched a monitoring tool to track access patterns of 50+ workloads by building an efficient pipeline that implemented downstream survival analysis tasks on access pattern logs for more than **300K mailboxes in minutes every day**.
- Pioneered a testbed that replays accesses on mailboxes to compare cache eviction policies. Engineered a data-driven mechanism to auto-tune the time parameter in TTL-based cache eviction policy that **outperformed LRU's 60% cache hit rate with an improved cache hit rate of 95%**.

Focused Extraction from Structured Data Microsoft

Advisor: Dr. Arun Iyer *Jul 2018 - Dec 2018*

- Designed a highly accurate ML-based feature for Outlook that extracts information from organized content such as order summaries, flight itineraries, etc. This feature allowed Outlook to extract information on unseen templates which was previously not possible.
- Curated a large data repository with >10000 labeled examples as a testbed to examine ML models on information retrieval tasks such as email summarization, and autofill feature in Excel with Microsoft-wide adoption.
- Devised a technique that leverages visual cues in the structured text to form segmentation trees to generate embeddings for entire text blocks. Assembled a semi-supervised Conditional Random Field (CRF) based classifier using sklearn-crfsuite which improved the overall precision of the two-staged ML model from 90% to 99% with <100 data points.