Kausik Subramanian

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My research interests lie in the application of formal reasoning and programming languages techniques for verification and synthesis of networks. In recent times, networks have become increasingly complex and difficult to reason about and manage. My vision envisages developing techniques for verifiying and correctly programming networks based on intent, where operators should specify what the network should do, instead of how these intents are met.

Education

- **University of Wisconsin-Madison**
  M.S Computer Science, CGPA: 3.868/4.00 — *Fall 2015–Fall 2017*
  PhD Computer Science, Advisors: Aditya Akella and Loris D'Antoni — *Fall 2017–Present*

- **Indian Institute of Technology, Bombay**
  BTech. Computer Science and Engineering — Fall 2011-Spring 2015
  Advisors: Purushottam Kulkarni and Umesh Bellur

Publications

- **Genesis: Synthesizing Forwarding Tables in Multi-tenant Networks**
  Kausik Subramanian, Loris D'Antoni, and Aditya Akella
  44th ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages (POPL), Paris, France, 2017, (23% acceptance rate)
  - A general and extensible approach to synthesize policy-compliant SDN forwarding tables for multi-tenant cloud settings using SMT solvers. Can support complex policies like reachability, waypoint traversal, path isolation and traffic engineering

- **Synthesis of Fault-Tolerant Distributed Router Configurations**
  Kausik Subramanian, Loris D'Antoni, and Aditya Akella
  Proceedings of the ACM on Measurement and Analysis of Computing Systems - SIGMETRICS, Irvine, California, USA, 2018
  - A two phase synthesis algorithm for generating policy-compliant OSPF and BGP configurations which comply with high-level policies, even under failures. First, we use Genesis to synthesize a policy-compliant data plane, and then Zeppelin uses ILP solvers to generate OSPF and BGP configurations which converge to the policy-compliant data plane.

- **Detecting Network Load Violations for Distributed Control Planes**
  Kausik Subramanian, Anubhavnidhi Abhashkumar, Loris D'Antoni, Aditya Akella and Yibo Zhu
  Under submission
  - By using an abstract representation of the control plane (ARC), we formulate a multi-node Mixed-Integer Linear Program which can be used to verify across machines if network links are overloaded (utilization exceeds capacity) under different failure scenarios. QARC models different routing protocols like OSPF and BGP and distributed load balancing strategies like ECMP/WCMP.

- **D2R: Dataplane-Only Policy-Compliant Routing Under Failures**
  Kausik Subramanian, Anubhavnidhi Abhashkumar, Loris D'Antoni, and Aditya Akella

Under submission

- We design a network architecture where routing (computing active network paths) is done completely in the data plane using programmable P4 switches. Packets carry failure information and each switch can perform graph traversal algorithms completely in the data planes at near line rates, and thus, avoiding losses incurred due to slow control planes.

Experience

- **Facebook Menlo Park, USA** *Summer 2019*
  Software Engineering Intern, Network Routing Mentors: Mahesh Maddikayala
  - Worked on OpenR (https://github.com/facebook/openr), Facebook's internal routing platform. I implemented the Netlink protocol for OpenR (∼3k LoC) to interface with the Linux kernel to program routes and listen to link/address/route events for protocol convergence.
- **Microsoft Research, Cambridge, UK** *Summer 2018*
  Research Intern, Network Verification Mentors: Andrey Rybalchenko and Nuno Lopes
  - Worked on developing a framework to for global MPLS tunnel path allocation for Microsoft's Wide Area Network. Using the framework, we analyse current production network allocation with the optimal allocation to make recommendations for improvements and future planning of the WAN.
- **Barefoot Networks, Santa Clara** *Summer 2017*
  Research Intern, Advanced Applications Mentors: JK Lee, Robert Soule and Changhoon Kim
  - Implemented various static analysis techniques for optimizing P4 programs in the Barefoot Tofino backend compiler pertaining to table dependencies and metadata usage based on P4 developers' programming styles. Made several bug fixes to the open-source P4 compiler (https://github.com/p4lang/p4c).
- **Samsung Electronics, Suwon, South Korea** *Summer 2014*
  Research Intern, Software R&D Center Mentors: Jeongshik In and Jaehoon Ko
  - Proposed four Optimizations for Hadoop's Distributed File System. Analysed and modified the source code of HDFS to find the performance bottlenecks and add features to block placement and replication policy modules.
- **Fraunhofer ITWM, Kaiserslautern, Germany** *Summer 2013*
  Research Intern Mentor: Mirko Rahn
  - Implemented the Chord distributed hash table protocol using Fraunhofer's communication middleware GPI, which provides synchronous and asynchronous communication methods

Talks and Posters

- Zeppelin: Synthesis of Fault-Tolerant Distributed Router Configurations
  Talk at SIGMETRICS'18, Irvine, California, USA
- Genesis: Synthesizing Forwarding Tables in Multi-tenant Networks
  Talk at POPL'17, Paris, France
  Talk at VMWare Research Group, August 2017
- Synthesizing Data and Control Planes for Multi-tenant Networks
  Poster at Google Networking Research Summit 2017
  Poster at NSF workshop on Programmable Networks, NYU, 2018

Academic Honors

- Awarded the UW-Madison CS Summer Research Assistantship, 2016 (awarded to 6 people).
- Awarded Student Grants to attend SIGCOMM 2016, POPL 2017 and SIGMETRICS 2018.
- Secured All India Rank 87 in IIT-JEE 2011 out of 485,000 students.
- Secured All India Rank 3 in 10^{th} CBSE Board Examination, 2009. Was invited by the PM's Office to

witness the Republic Day Parade from the Prime Minister Box in New Delhi in 2010

Technical and Personal skills

- Proficient in Python, C++, Java, Z3, Gurobi, LaTeX, P4
- Familiar with Android, Hadoop, POX

Courses

- *Networks/Systems*: Advanced Networking, Big Data Systems
- *Programming Languages*: Program Verification and Synthesis, Theory of Programming Languages, Advanced Compilation
- *Pedagogy*: Teaching in the College Classroom, Effective Teaching in Internationally Diverse College Classroom
- *Miscellaneous*: Topics in Databases, Advanced Algorithms, Computational Complexity Theory, Management and Marketing, and Accounting and Finance for non-Business majors

Positions of Responsibility

- Mentor, Institute Student Mentorship Programme 2014-15
  Mentoring a group of 12 freshmen and easing their transition to the academic and social aspects of institute life. Also serving as a Department Academic Mentor to 12 sophomores, guiding them about CS academic aspects.
- Internship Coordinator, Placement Cell 2013-14
  Involved in the communication and scheduling of various companies as well as universities and assisting them in the process of recruiting of students for internships. Awarded Certificate of Appreciation by Dean, Academic Affairs for exemplary work during the tenure.

Teaching

- Teaching Assistant, Computer Networks (CS640)
  University of Wisconsin-Madison Fall 2015
  Prof. Paul Barford
- Teaching Assistant, Compilers Lab (CS306)
  Indian Institute of Technology, Bombay Spring 2015
  Prof. Amitabha Sanyal