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 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   **Madison**
M.S/Ph.D., CGPA: 3.75/4.00   *2015–Present*
Advisors: Aditya Akella and Loris D'Antoni

Indian Institute of Technology, Bombay   **Bombay**
BTech. Computer Science and Engineering, CGPA: 8.94/10.00   *2011–2015*

Publications

○ **Scalable Synthesis of Hierarchical Distributed Router Configurations**
Kausik Subramanian, Loris D'Antoni and Aditya Akella
Manuscript

○ **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, Paris, France, 2017, (23% acceptance rate)

Research Projects

○ **Genesis: Switch Table Synthesis for Multi-tenant Networks**

Developed Genesis, a network management system with support for end-to-end policies like reachability, middlebox traversals, isolation, traffic engineering and network resource management. Genesis synthesizes switch forwarding tables using fast off-the-shelf SMT and MaxSMT solvers, thus offering generality and extensibility. To speed up synthesis, Genesis incorporates domain-specific search strategies which leverage the structure of datacenter topologies and policy interactions. Genesis supports network repair which minimizes the overhead of rule updates in the event of network failures, and synthesis of policy-compliant resilient data-planes by transforming input policies with isolation policies, which can be used to synthesize edge-disjoint paths between endpoints.

○ **Scalable Synthesis of Hierarchical Distributed Router Configurations**

While Software-defined Networking (SDN) provides centralized custom routing functionality in networks to realize policies, many networks still deploy traditional control planes running distributed routing protocols like OSPF and BGP because these protocols are scalable and robust to failures. However, realization of policies by distributed control plane configurations is manual and error-prone. We show that synthesizing hierarchical policy-compliant control planes is a challenging problem and propose a two-phase architecture to automatically generate policy-compliant control planes. The first phase uses Genesis to synthesize policy-compliant paths and the second phase Zeppelin uses constraint solving and Monte Carlo search to synthesize a control plane that satisfies the policies pertaining to the control plane and that produces the paths synthesized in the first phase.

Other Projects

○ **Predictive Queue Management in SDNs:** *Advanced Networks Course Project @ UW-Madison*

We provide latency guarantees to latency-sensitive flows in a software-defined datacenter setting by building predictive models of switch queue buildups using OpenFlow's support for querying switches for flow statistics to predict flow characteristics. With a predictive model in place, we develop a greedy earliest-deadline-first scheduling algorithm for finding new paths for flows to prevent queue buildups affecting mice flows.

○ **POXVine: Multi-Tenant Virtual Network Emulator:** *BTech. Thesis Project @ IIT Bombay*
Advisors: Prof. Purushottam Kulkarni and Prof. Umesh Bellur

Designed and built a multi-tenant virtual network emulation application POXVine using the POX controller which controls a network emulated over Mininet. POXVine emulates multiple virtual networks over an emulated physical network in Mininet. The virtual-to-physical mapping tries to minimize the number of physical switches which contain rules to the virtual topology. The POX controller adds routing rules such that the virtual network abstraction is preserved, on the physical topology, packets traverse the virtual network entities in the order of the virtual network topology.
Github repository: https://github.com/sskausik08/poxvine

○ **Hadoop Optimizations:** *Internship @ Samsung Software R&D Center, South Korea*
Advisors: Dr. Jeongshik In and Dr. 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: (1) Replicator: Independent module to find frequently accessed files in a cluster and increase its replication factor. (2) Disk Access Optimization: Analysed the bottleneck in read operations at a datanode and implemented a memory-buffered read to reduce disk seeks. Achieved a 6 percent improvement for a single datanode benchmark. (3) Balanced Block Placement Policy: Modified Hadoop's default block placement policy to create a balanced cluster by accounting memory usage of nodes and racks while choosing a node to place a replica. (4) Block-level Caching and Pre-fetching: Extended HDFS's file-level caching mechanism to a finer block-level caching and performed pre-fetching of blocks in a read operation. Achieved 6% improvement in a 4-node cluster.

Talks and Posters

○ Genesis: Synthesizing Forwarding Tables in Multi-tenant Networks
Talk at POPL'17, Paris, France
○ Synthesizing Data and Control Planes for Multi-tenant Networks
Poster at Google Networking Research Summit 2017

Academic Honors

○ Awarded the UW-Madison CS Summer Research Assistantship, 2016 (awarded to 6 people).
○ Awarded Grant to attend POPL and PLMW 2017, held in Paris, France.
○ Awarded Student Travel Grant to SIGCOMM'16, held in Florianopolis, Brazil.
○ Secured All India Rank 87 in IIT-JEE 2011 out of 485,000 students.
○ Secured All India Rank 3 in 10th 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, Z3, Gurobi, LATEX
○ Familiar with Android, C++, Java, Hadoop, POX

Courses

○ Networks: Advanced Networking

- Programming Languages: Program Verification and Synthesis, Theory of Programming Languages, Advanced Compilation
- Pedagogy: Teaching in the College Classroom
- Miscellaneous: Topics in Databases, Advanced Algorithms, Computational Complexity Theory

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

References

- Available on request