

Curriculum Vitae

February 25, 2018

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❖ Summary

I am passionate about designing and implementing large-scale distributed systems, and empirically measuring and analyzing their performance.

The overarching goal of my research is to make engineering scalable and efficient distributed applications easier, and the systems I develop are often incarnated as new *middleware*. My research spans middleware, distributed systems, cloud computing, data analytics, programming languages and software engineering

❖ Education

Doctor of Philosophy (PhD) — Computer Science

Thesis Title: **Engineering Efficient Event-based Distributed Systems**
Advisor: Patrick Eugster

June 2005 – June 2012
Purdue University, USA

Master of Science (M.S.) — Computer Science

June 2005 – Dec 2008
Purdue University, USA

Bachelor of Engineering (B.E.), with Honors — Computer Science

Aug 2000 – May 2004
BITS-Pilani, Pilani Campus, India

❖ Awards and Recognitions

- Maurice H. Halstead Memorial Award for outstanding research in Software Engineering, Purdue University, 2011.
- Best (research) paper award at ACM/IFIP/USENIX International Middleware Conference 2010.
- Best (research) paper award at ACM/IFIP/USENIX International Middleware Conference 2013.

❖ Experience

Research Staff Member, Thomas J. Watson Research Center, IBM Research

Feb 2014 – present
Yorktown Heights, NY.

Cognitive Cloud Platform Group, now IBM Research AI. Manager: Dr. Rania Khalaf. March 2016 – present

- (a) Deep Learning as a Service (DLaaS) : Engineering a IBM SoftLayer cloud-based platform for distributed deep learning, supporting open source deep learning frameworks like Caffe and Torch, and coordinating learning through the use of parameter server infrastructures. Developing mechanisms for agile construction of such platforms using technologies like Apache Mesos, Marathon, Kubernetes, ETCD, MongoDB and Docker.
- (b) Scalable dissemination algorithms for deep learning. Exploring alternative communication mechanisms (other than MPI and parameter servers) for deep learning, especially lightweight probabilistic algorithms and gossip-based information dissemination.

Cloud Platform Technologies Group. Manager: Dr. Shu Tao. Feb 2014 – Feb 2016

- (a) Causality Analysis for Elastic Scaling. Designed and implemented static and dynamic program analyses and transformation techniques for inferring causal relationships between components in distributed applications (e.g., through message passing, RPCs, etc.). Demonstrated the use of causality as a fundamental technique for elastic scaling distributed applications, especially datacenter infrastructure applications. April 2014 – Dec 2015

- (b) Accelerating iterative machine learning algorithms implemented in the map-reduce and in-memory big data frameworks (e.g., Apache Spark) with GPGPUs. April 2014 – Dec 2015
- (c) Resource usage prediction and elastic scaling of analytics programs. March 2015 – Dec 2015
- (d) Trustworthy Geographically Fenced Cloud Platforms (TGIF-Cs)
 - i. Integration of scalable hardware-rooted (TPM) host, guest OS and application integrity verification and geographic fencing mechanisms into IaaS cloud platforms (OpenStack). Feb-Dec 2014. Published in Middleware'14.
 - ii. Extension of integrity verification, geo-fencing and controlled decryption to analytics platforms. Jan 2015 – Dec 2015

Postdoctoral Researcher, HP Labs
Intelligent Infrastructure/Systems Lab.

June 2012 – Jan 2014
Palo Alto, CA

- (a) Programming NVRAM-based Datacenters
 - i. Shared persistent regions (SPR) – Novel distributed programming abstractions for data centers that use Non-Volatile Random Access Memory (NVRAM).
 - ii. Designed novel distributed algorithms for scalable, efficient and fault tolerant data storage and access in SPRs, while providing strong ACID guarantees.
- (b) Event Correlation for Intrusion Detection – Worked on the design and implementation of a large-scale rule-based datacenter intrusion detection system where rules and correlation patterns are dynamic, i.e., stateful.
- (c) ElasticRMI

An extension to Java RMI to dynamically increase the number of server objects available to handle remote method calls. Instead of instantiating a single remote object, ElasticRMI creates an object pool and load balances method calls among objects in the pool.

Implemented on Apache Mesos, and dynamically instantiates additional server objects in the pool on new Mesos slices.

Research and Teaching Assistant, Purdue University
Department of Computer Science

June 2005 – Dec 2011
West Lafayette, IN, USA

- (a) Served as a graduate assistant in Purdue University while pursuing my PhD.
- (b) Teaching Assistant : Fall 2007, Spring 2009, Spring 2011, Fall 2011 (Four semesters)
- (c) Research Assistant : All the rest of the time, except during internships to Prof. Patrick Eugster and Prof. Aditya Mathur. Ten semesters and four summers.

Research Intern, Thomas J. Watson Research Center, IBM Research
Cloud Management Group

May 2011 – Dec 2011
Hawthorne, NY, USA.

- (a) Analyzed the similarity between virtual machine (VM) images in a production data center using black-box similarity detection techniques like fixed size chunking and Rabin fingerprinting.
- (b) Designed and implement a content-aware hypervisor level cache for VM images to improve the runtime performance of VM instances in clouds that stream VM images on demand to the hypervisor.

Software Engineering Intern, Amazon.com Inc., Amazon Web Services (AWS)
Amazon Simple Workflow Service (SWF)

May 2010 – Sep 2010
Seattle, WA, USA

- (a) Worked on the *horizontal scalability* of the AWS Simple Workflow (SWF) web service that uses event-based messaging to orchestrate distributed computations in the AWS ecosystem.
- (b) Implemented a scalable, persistent (3 way replication of events for fault tolerance), topic-based event matcher using distributed hash tables.
- (c) Proposed novel load balancing techniques using redundant consistent hashing.

Software Engineering Intern, Microsoft Inc.

May 2007 – Aug 2007

Static Driver Verifier (SDV) Team

Redmond, WA, USA

- (a) Extended Static Driver Verifier (SDV) to check Interrupt Request Level (IRQL) properties of Windows Kernel Mode Driver Framework (KMDF) drivers.
- (b) Compared the fault-detection effectiveness of SDV vs. Prefast (with annotations) for checking IRQL properties of KMDF drivers.

Software Engineer, Alcatel-Lucent Inc.

Aug 2004 – May 2005

Optical Network Management (ONM) Team

Bangalore, India

- (a) Developed software modules for the remote management of backbone SONET/SDH optical networks. Users of the software included T-Mobile Germany and service providers in Australia and Saudi Arabia.

Research Intern, INRIA Sophia-Antipolis

Jan 2004 – May 2004

Project MIMOSA (MIgration and MObility : Semantics and Applications)

Marseille, France

- (a) Worked on Formal Verification of Cryptographic protocols towards my Bachelor's thesis
- (b) Proved that the verification of cryptographic protocols is decidable in the absence of name generation, even in the presence of an unbounded number of interacting processes.
- (c) Developed a symbolic reduction technique for the efficient formal verification of cryptographic protocols.

❖ Journal Publications**IBM Deep Learning Service**

Sep 2017

J7

Bishwaranjan Bhattacharjee, Scott Boag, Chandani Doshi, Parijat Dube, Ben Herta, Vatche Ishakian, K. R. Jayaram, Rania Khalaf, Avesh Krishna, Y. B. Li, Vinod Muthusamy, Ruchir Puri, Yufei Ren, Florian Rosenberg, Seetharami R. Seelam, Yi Wang, J. M. Zhang, L. Zhang
In IBM Journal of Research and Development

Software Architectures for Self-protection in IaaS Clouds

Feb 2017

J6

K. R. Jayaram, Aleksandar Milenkoski and Samuel Kounev
Self-Aware Computer Systems (Peer Reviewed Book Chapter)

Benchmarking Intrusion Detection Systems with Adaptive Provisioning of Virtualized Resources

Feb 2017

J5

Aleksandar Milenkoski, K. R. Jayaram and Samuel Kounev
Self-Aware Computer Systems (Peer Reviewed Book Chapter)

Subscription Normalization for Effective Content-based Messaging.

Sep 2014

J4

K. R. Jayaram, Weihang Wang and Patrick Eugster
In IEEE Transactions on Parallel and Distributed Systems (TPDS).

Decentralized Fault Tolerant Event Correlation

July 2014

J3

Aaron Wilkin, Patrick Eugster and K. R. Jayaram
ACM Transactions on Internet Technology (TOIT) - Special Issue on Event Recognition

Parametric Content-based Publish/Subscribe.

May 2013

J2

K. R. Jayaram, Patrick Eugster and Chamikara Jayalath
ACM Transactions on Computer Systems (TOCS)

Abstracting Contexts in Event-based Software.

2012

J1

Adrian Holzer, Lukasz Ziarek, K. R. Jayaram and Patrick Eugster
Transactions on Aspect Oriented Software Development (TAOSD).

❖ Conference Publications

- General Chair and Co-Editor** Dec 2017
- C20 K. R. Jayaram, Anshul Gandhi, Bettina Kemme and Peter Pietzuch
Proceedings of the 18th ACM/IFIP/USENIX International Middleware Conference (MIDDLEWARE)
- Scalable, Efficient Anonymization with INCOGNITO – Framework and Algorithm** June 2017
- C19 Antorweep Chakravorty, Chunming Rong, K. R. Jayaram and Shu Tao
IEEE International Congress on Big Data
- Agile Composition of Compliant Data Analytics Platforms** Mar 2017
- C18 Michael Le, K. R. Jayaram, Yaron Weinsberg, Daniel J. Dean and Shu Tao
IEEE International Conference on Cloud Engineering (IC2E)
- Exploiting Causality to Engineer Elastic Distributed Software** Oct 2016
- C17 Aleksandar Milenkoski, K. R. Jayaram, Nuno Antunes, Marco Vieira and Samuel Kounev
IEEE International Symposium on Software Reliability Engineering (ISSRE)
- Exploiting Causality to Engineer Elastic Distributed Software** June 2016
- C16 K. R. Jayaram
36th International Conference on Distributed Computing Systems (ICDCS)
- Towards Explicitly Elastic Programming Frameworks** May 2015
- C15 K. R. Jayaram
37th International Conference on Software Engineering (ICSE)
- Trustworthy Geographically Fenced Hybrid Clouds** Dec 2014
- C14 K. R. Jayaram, David Safford, Upendra Sharma, Vijay Naik, Dimitrios Pendarakis and Shu Tao.
ACM/IFIP/USENIX 15th International Middleware Conference (MIDDLEWARE)
- Fast, Expressive Top-k Matching** Dec 2014
- C13 William Culhane, K. R. Jayaram and Patrick Eugster.
ACM/IFIP/USENIX 15th International Middleware Conference (MIDDLEWARE)
- Elastic Remote Methods** Dec 2013
- C12 K. R. Jayaram
ACM/IFIP/USENIX 14th International Middleware Conference (MIDDLEWARE)
- Views and Transactional Storage for Large Graphs.** Dec 2013
- C11 Michael Mihn-Jong Lee, Indrajit Roy, Alvin AuYoung, Vanish Talwar, K. R. Jayaram and Yuanyuan Zhou.
ACM/IFIP/USENIX 14th International Middleware Conference (MIDDLEWARE)
Best Paper Award
- Brief Announcement : Weighted Partial Message Matching for Implicit Multicast Systems** Oct 2012
- C10 William Culhane, K. R. Jayaram and Patrick Eugster
26th International Symposium on Distributed Computing (DISC)
- An Empirical Analysis of Similarity in Virtual Machine Images** Dec 2011
- C9 K. R. Jayaram, Chunyi Peng, Zhe Zhang, Minkyong Kim, Han Chen and Hui Lei
In ACM/IFIP/USENIX 12th International Middleware Conference (Industry Track)
- FAIDECs: Fair Decentralized Event Correlation** Dec 2011
- C8 Gregory Aaron Wilkin, K. R. Jayaram, Patrick Eugster and Ankur Khetrpal
In ACM/IFIP/USENIX 12th International Middleware Conference (MIDDLEWARE)
- Program Analysis for Event-based Distributed Systems** July 2011
- C7 K. R. Jayaram and Patrick Eugster
5th ACM International Conference on Distributed Event-based Systems (DEBS)
- Split and Subsume: Subscription Normalization for Effective Content-based Messaging** June 2011
- C6 K. R. Jayaram and Patrick Eugster
31st IEEE International Conference on Distributed Computing Systems (ICDCS)

- C5 **Putting Events in Context: Aspects for Event-based Distributed Programming** Mar 2011
Adrian Holzer, Lukasz Ziarek, K. R. Jayaram and Patrick Eugster
10th International Conference on Aspect Oriented Software Development (AOSD)
- C4 **Parametric Subscriptions for Content-based Publish/Subscribe Networks** Dec 2010
K. R. Jayaram, Chamikara Jayalath and Patrick Eugster
ACM/IFIP/USENIX 11th International Middleware Conference (MIDDLEWARE)
Best Paper Award
- C3 **Scalable Efficient Composite Event Detection** June 2010
K. R. Jayaram and Patrick Eugster
12th International Conference on Coordination Models and Languages (COORDINATION)
- C2 **EventJava: An Extension of Java for Event Correlation** July 2009
Patrick Eugster and K. R. Jayaram
23rd European Conference on Object Oriented Programming (ECOOP)
- C1 **Lazy Argument Passing in Java RMI** Sep 2008
Christopher Line, K. R. Jayaram and Patrick Eugster
ACM International Conference on Principles and Practice of Programming In Java (PPPJ)

❖ Workshop Publications

- W3 **Context Oriented Programming with EventJava** July 2009
K. R. Jayaram and Patrick Eugster
Intenational workshop on Context-oriented Programming (COP)
- W2 **On the Adequacy of Statecharts as a Source of Tests for Cryptographic Protocols** July 2008
K. R. Jayaram and Aditya Mathur
International Workshop on Security in Software Engineering (IWSSE), co-located with COMPSAC
- W1 **Identifying and testing for insecure paths in cryptographic protocol implementations** Sep 2006
K. R. Jayaram
IEEE Computer Software and Applications Conference (COMPSAC)

❖ Journal and Conference Reviewing/Co-chairing

- *Conference Co-chair*: 18th ACM/IFIP/USENIX International Middleware Conference (MIDDLEWARE 2017)
- *Program Committee Co-chair*: 16th ACM/IFIP/USENIX International Middleware Conference (MIDDLEWARE 2015).
- Industry Track
- *Research Posters Committee Co-chair*: ACM International Conference on Systems, Programming, Languages and Applications: Software for Humanity (SPLASH), 2014.
- *Research Posters Committee Co-chair*: ACM International Conference on Systems, Programming, Languages and Applications: Software for Humanity (SPLASH), 2013.
- *Program Committee Member*: ACM/IFIP/USENIX International Middleware Conference (MIDDLEWARE) 2018
- *Program Committee Member*: ACM International Conference on Distributed Event-Based Systems (DEBS) 2017
- *Program Committee Member*: ACM International Conference on Distributed Event-Based Systems (DEBS) 2017 Industry Track
- *Program Committee Member*: IFIP International Conference on Distributed Applications and Interoperable Services (DAIS) 2017
- *Program Committee Member*: ACM International Conference on Distributed Event-Based Systems (DEBS) 2016
- *Program Committee Member*: IFIP International Conference on Distributed Applications and Interoperable Services (DAIS) 2016
- *Program Committee Member*: IEEE International Conference on Cloud Engineering (IC2E) 2016
- *Program Committee Member*: IEEE International Conference on Distributed Computing Systems (ICDCS) 2016

- *Program Committee Member.* IEEE International Workshop on Big Data and Cloud Performance (DCPerf) 2016
- *Program Committee Member.* IEEE International Conference on Distributed Computing Systems (ICDCS) 2015
- *Program Committee Member.* IEEE International Conference on Autonomic Computing (ICAC) 2015
- *Program Committee Member.* Workshop on Reactive and Event-based Languages and Systems (REBLS) 2015
- *Program Committee Member.* IFIP International Conference on Distributed Applications and Interoperable Services (DAIS) 2015
- *Program Committee Member.* ACM/IFIP/USENIX International Middleware Conference (MIDDLEWARE) 2014
- *Program Committee Member.* IEEE International Conference on Cloud Engineering (IC2E) 2014
- *Program Committee Member.* IFIP International Conference on Distributed Applications and Interoperable Services (DAIS) 2014
- *Program Committee Member.* IEEE International Conference on Distributed Computing Systems (ICDCS) 2013
- *Journal Reviewer.* IEEE Transactions on Mobile Computing, 2014-2015
- *Journal Reviewer.* Elsevier Journal of Software: Practice and Experience, 2014-2015
- *Journal Reviewer.* IEEE Transactions on Software Engineering, 2015
- *Journal Reviewer.* ACM Transactions on Internet Technology, 2013

❖ Teaching Experience

Graduate Teaching Assistant, Purdue University, West Lafayette, USA

1. CS 505 Distributed Systems (graduate), Jan 2009 - May 2009, Jan 2011 - May 2011.
 - Assisted Prof. Patrick Eugster (2009) and Prof. Ananth Grama (2011)
 - Designed and evaluated programming assignments and lab sessions
 - Assisted in preparing and grading midterms and final exams.
2. CS 390DS Distributed Systems (undergraduate), August 2011 - Dec 2011.
 - Assisted Prof. Patrick Eugster.
 - Designed and evaluated programming assignments and lab sessions
 - Assisted in preparing and grading midterms and final exams.
3. CS 422 Computer Networks (undergraduate) Jan 2009 - May 2009.
 - Assisted Prof. Gustavo Rodriguez Rivera.
 - Designed and evaluated programming assignments and lab sessions
 - Assisted in preparing and grading midterms and final exams.
4. CS 307 Software Engineering (undergraduate), August 2007 - Dec 2007.
 - Assisted Prof. Patrick Eugster.
 - Course involved a live project for Hewlett-Packard (HP)
 - Supervised four student teams through all phases of the project (requirements engineering, design, implementation and testing) resulting in four high quality prototypes to HP.
5. CS 456 Programming Languages (undergraduate). Jan 2007 – May 2007.
 - Assisted Prof. Patrick Eugster.
 - Assisted in preparing and teaching compiler design exercises for domain specific languages using Polyglot.

Undergraduate Teaching Assistant, Birla Institute of Technology and Science (BITS), Pilani, India

1. TA C252 Computer Programming II. Jan 2003 - May 2003.
 - Second course in computer programming taken by all undergraduate students of BITS.
 - Advanced concepts in C and introduction to data structures
 - I designed and conducted programming lab sessions

2. CS 363 Data Structures and Algorithms. Jan 2003 - May 2003.
 - Undergraduate algorithms course taken by computer science majors.
 - I designed and graded programming assignments.
3. TA C162 Computer Programming I, August 2002 - December 2002.
 - First course in computer programming (C) taken by all undergraduate students of BITS.
 - I designed and conducted programming lab sessions.

❖ Coursework

Graduate: Distributed Programming, Software Reliability, Software Engineering, Advanced Topics in Distributed Systems, Information Security, Model-based Software Testing, Algorithm Analysis and Design, Programming Languages, Computer Networks, Operating Systems

Under-graduate: Software Engineering, Data Structures and Algorithms, Operating Systems, Data Communications and Networks, Digital Design, Computer Architecture, Compilers, Database Systems, Discrete Mathematics, Fuzzy Logic