# **2019 IEEE International Conference on Cloud Engineering** (IC2E 2019)

Prague, Czech Republic 24 – 27 June 2019



**IEEE Catalog Number: CFP1983U-POD ISBN**:

978-1-7281-0219-1

## Copyright © 2019 by the Institute of Electrical and Electronics Engineers, Inc. All Rights Reserved

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.

 IEEE Catalog Number:
 CFP1983U-POD

 ISBN (Print-On-Demand):
 978-1-7281-0219-1

 ISBN (Online):
 978-1-7281-0218-4

#### **Additional Copies of This Publication Are Available From:**

Curran Associates, Inc 57 Morehouse Lane Red Hook, NY 12571 USA Phone: (845) 758-0400

Fax: (845) 758-2633

E-mail: curran@proceedings.com Web: www.proceedings.com



## 2019 IEEE International Conference on Cloud Engineering (IC2E) IC2E 2019

### **Table of Contents**

Message from the General Chairsix
Message from the Program Chair x
Conference Organizationxi
Message from the Workshop Chairxiv
Message from the SQUEET Program Chairsxv
SQUEET Program Committeexvi
Reviewersxvii
Keynotesxix
Tutorialsxxi
Session 1: Application/AI
Query-Driven Descriptive Analytics for IoT and Edge Computing
MESH: A Flexible Distributed Hypergraph Processing System
BARISTA: Efficient and Scalable Serverless Serving System for Deep Learning Prediction Services
Session 2: Cloud Control
Towards Self-Managing Cloud Storage with Reinforcement Learning

Information Models: Creating and Preserving Value in Volatile Cloud Resources
Toward a Workload Allocation Optimizer for Power Saving in Data Centers
Session 3: Invited papers A
Edge-Cloud Orchestration: Strategies for Service Placement and Enactment  Ioan Petri (Cardiff University, UK), Omer Rana (Cardiff University,  UK), Ali Reza Zamani (Rutgers University, USA), and Yacine Rezgui  (Cardiff University, UK)
Edge-Assisted Detection and Summarization of Key Global Events from Distributed Crowd-Sensed Data 7  Abdelrahman Fahim (University of Califronia, Riverside), Ajaya Neupane (University of California, Riverside), Evangelos Papalexakis (University of California, Riverside), Lance Kaplan (Army Research Lab), Srikanth V. Krishnamurthy (University of California, Riverside), and Tarek Abdelzaher (University of Illinois at Urbana Champaign)
Edge Intelligence: The Convergence of Humans, Things, and AI
Session 4: Future of Computing
The Future of Computing is Boring (and that is exciting!)  Aleksander Slominski (IBM T.J Watson Research Center), Vinod Muthusamy (IBM T.J Watson Research Center), and Vatche Isahagian (IBM T.J Watson Research Center)
Host Hypervisor Trace Mining for Virtual Machine Workload Characterization 10  Hani Nemati (Polytechnique Montreal), Seyed Vahid Azhari (Polytechnique Montreal), and Michel R. Dagenais (Polytechnique  Montreal)
ModelOps: Cloud-Based Lifecycle Management for Reliable and Trusted AI
Session 5: Cloud testing
A Study on Container Vulnerability Exploit Detection

ShadeNF: Testing Online Network Functions  Hui Lu (SUNY Binghamton), Abhinav Srivastava (Frame.io), and Yu Sun (SUNY Binghamton)	128
Session 6: Invited papers B	
Importance of Application-Level Resource Management in Multi-Cloud Deployments  Zoran Dimitrijevic (SAP Labs), Cetin Sahin (SAP Labs), Christian  Tinnefeld (SAP Labs), and Jozsef Patvarczki (SAP Labs)	139
Understanding Synchronization Costs for Distributed ML on Transient Cloud Resources  Pradeep Ambati (University of Massachusetts Amherst), David Irwin (University of Massachusetts Amherst), Prashant Shenoy (University of Massachusetts Amherst), Lixin Gao (University of Massachusetts Amherst), Ahmed Ali-Eldin (University of Massachusetts Amherst), and Jeannie Albrecht (Williams College)	145
Addressing the Fragmentation Problem in Distributed and Decentralized Edge Computing: A Vision	156
Session 7: Cloud workload management and scheduling	
ConfAdvisor: A Performance-centric Configuration Tuning Framework for Containers on Kubernetes	168
Maintenance Scheduling for Cloud Infrastructure with Timing Constraints of Live Migration	179
ContainerVisor: Customized Control of Container Resources	190
Session 8: Performance management	
Predicting the End-to-End Tail Latency of Containerized Microservices in the Cloud	200

FECBench: A Holistic Interference-aware Approach for Application Performance Modeling  Yogesh D. Barve (Vanderbilt University, Nashville, TN), Shashank  Shekhar (Siemens Corporate Technology, Princeton, NJ), Ajay Chhokra  (Vanderbilt University, Nashville, TN), Shweta Khare (Vanderbilt  University, Nashville, TN), Anirban Bhattacharjee (Vanderbilt  University, Nashville, TN), Zhuangwei Kang (Vanderbilt University,  Nashville, TN), Hongyang Sun (Vanderbilt University, Nashville, TN),  and Aniruddha Gokhale (Vanderbilt University, Nashville, TN)	211
Analyzing AWS Spot Instance Pricing	222
SQUEET 2019 Workshop	
Detecting IoT Malware by Markov Chain Behavioral Models  Massimo Ficco (University of Campania Luigi Vanvitelli)	229
A secure inter-domain communication for IoT devices  Aniket Anand (Indian Institute of Technology (BHU)), Antonino Galletta (University of Messina), Antonio Celesti (University of Messina), Maria Fazio (University of Messina), and Massimo Villari (University of Messina)	235
Continuous Benchmarking: Using System Benchmarking in Build Pipelines	241
Benchmarking physical and virtual IoT platforms	247
Author Index	253