Page	Table of Contents			
2	Congress Venues			
3	Social Events			
4-5	Maps: Universitá degli Studi di Milano Meeting Rooms			
6-7	Program at a Glance: Universitá degli Studi di Milano			
8-9	Program at a Glance: NH Collection Milano President			
10	2019 CONGRESS Organizers			
11	CONGRESS Conferences			
12-18	Messages from Organizers			
18	Tutorial 1: IBM Hybrid Cloud for the Enterprise			
19	Tutorial 2: DevOps, Microservices, & Containers - The Perfect Storm			
20	Women in Services Computing			
20	Industry Program			
21	Opening Remarks by Cecilia Metra, 2019 IEEE Computer Society President			
21-22	Keynote 1: Joseph Sifakis			
22	Keynote 2: Kathryn Guarini			
23	Keynote 3: Sumi Helal			
24	Plenary Panel: Blockchain			
24	Plenary Penal: Future of Financial Services			
25	Plenary Panel: AI & Security			
26	Plenary Panel: From EDGE to CLOUD			
26	Plenary Panel: 2020 Tech Predictions			
27-30	Big Data Congress 2019			
31-39	CLOUD 2019			
40-43	EDGE 2019			
44-46	ICCC 2019			
47-50	ICIOT 2019			
51-58	ICWS 2019			
59-63	SCC 2019			
64-66	2019 IEEE SERVICES Symposium on Services Computing: Concise Papers			
67-70	Digital Health as a Service Symposum / Healthcare Services Workshop (DHAASS / DHS)			
71-72	Future of Financial Services Symposium (FFS)			
73	Doctoral Symposium			
74-76	CyberSecurity & Resilience in the Internet of Things Workshop (CSRIoT)			
77-78	Knowledge Graph as a Service Workshop (KGaaS)			
79-80	Network Services Workshop (NET)			
81-82	Serverless Computing / Edge Computing for Autonomous Things Workshops (SWoSC / ECA)			
83-84	Big Data for Public Health Policy Making Workshop (PHP)			

The 2019 SERVICES Congress has sessions and events scheduled in two locations - Universitá degli Studi di Milano and NH Collection Milano President (hotel). The venues are a short walk apart, with the map below showing the route you can walk. Meeting rooms at the Universitá are indicated on the maps on pages 4-5. The meeting rooms at the hotel are easy to find. Both locations will have signs indicating which way to go.

Street addresses: Università main venue: via festa del Perdono, 7 Milano Università – Napoleonica main and parallel rooms: via Sant'Antonio 12, Milano Hotel NH Collection Milano President: Largo Augusto 10, Milano

The Programs at a Glance on pages 6-9 show the schedule for each location. Please refer to the table of contents when seeking a specific program or session, and locate its venue on the Programs at a Glance. If you have questions please visit the registration desk at the Universitá degli Studi di Milano.

University WIFI: SSID: unimi-convegni authentication: WPA2 PSK password: conferences@Unimi1906

Welcome to SERVICES Congress 2019. We hope you enjoy Milan!

MAP: WALKING FROM NH HOTEL TO UNIVERSITA DEGLI STUDI DI MILANO



2019 IEEE SERVICES Congress Social Events

Welcome Reception Tuesday July 9 18:30 - 20:15 Location: Universitá degli Studi di Milano



UNIVERSITÀ DEGLI STUDI DI MILANO The 2019 SERVICES Congress is hosted at the Universitá degli Studi di Milano. Please join us on Tuesday evening for a Welcome Reception at the university. Directions to the reception will be available at the SERVICES registration desk. Universitá degli Studi di Milano is one of the largest universities in Europe, with about 60,000 students, and a permanent teaching and research staff of about 2,000. The University is the only Italian member of the League of European Research Universities (LERU), a group of twenty-

one research-intensive European Universities. It consistently ranks one of the best universities of Italy, both overall and in specific subject areas. One Nobel laureate in physics, Riccardo Giacconi, as well as one Fields medalist, Enrico Bombieri, studied at the University.



2019 SERVICES Congress Banquet Thursday July 11 19:00 - 21:00 Location: Villa Toscanini Via 25 Aprile, 33, 26010 Ripalta Guerina CR, Italy

In the small village of Ripalta Guerina on the banks of the Serio river a few kilometers from Crema, stands Villa Monticelli-Toscanini, an example of minor architecture of the first half of the 700. The villa that for centuries has

been handed down from father to son links its history to the Monticelli family, Crema nobles who used the Ripalta Guerina villa as a summer residence. In 1936 the villa was purchased by the Maestro Arturo Toscanini who chose the quiet town of the Crema countryside as a home to compose some of his works. Here, in fact, the Master gave the final touches to the scores for the inaugural concert of La Scala, rebuilt after the bombings of the Second World War.

Transportation to Villa Toscanini

Please visit the registraiton desk or the mobile app for updates regarding transportation to the Villa!

Buses will transport participants to the Villa starting at 17:00 from the Rogoredo stop on the metro. From the university, take the Yellow Metro line at the Missori stop, take the metro in direction of SAN DONATO and get out at ROGOREDO (7 stops, 10 minutes, see yellow line photo, below). Volunteers at the university and at the Rogoredo stop will be available to help you find your way. The Villa is 40 minute bus ride from the train station.







Program at a Glance Université de gli Stredi di Milene					
ROOM/ TIME	Aula Magna	Sala Crociera Alta di Studi Umanistici 1	Sala Napoleonica Parallel	Alta di Giurisprudenza 2	Sala Napoleonica Main
REGISTRATION: OPEN SUNDAY AT NH COLLECTION, 16:00 - 19:00 OPEN MONDAY - FRIDAY AT Universitá, 8:15 - 17:30, SATURDAY 10:00 - 12:00					
		MONDA	AY JULY 8		
9:15 - 9:45			COFFEE BREA	K	
9:45 - 11:00		BIG DATA 1	ICCC 1	WISC 1	TUTORIAL 1
11:00 - 11:15		v	BREAK		
11:15 - 12:30		BIG DATA 2	ICCC 2	WISC 2	TUTORIAL 1
12:30 - 14:00		v	LUNCH BREAD	K	
14:00 - 15:15		BIG DATA 3	ICCC 3		TUTORIAL 2
15:15 - 15:45			COFFEE BREAT	K	
15:45 - 17:00					TUTORIAL 2
		TUESDA	AY JULY 9		
8:30 - 9:45		BIG DATA 4	ICCC 4	CLOUD 1	CLOUD 2
9:45 - 10:15			COFFEE BREA	K	
10:15 - 11:30	KEYNOTE 1: JOSEPH SIFAKIS (LOCATION: AULA MAGNA)				
11:30 - 11:45			BREAK		
11:45 - 13:00		BIG DATA 5	ICCC 5	CLOUD 3	CLOUD 4
13:00 - 14:00			LUNCH BREAD	K	
14:00 - 15:15		BIG DATA 6	ICIOT 1	CLOUD 5	CLOUD 6
15:15 - 15:45			COFFEE BREA	K	
15:45 - 17:00		PLENAI (LOC	RY PANEL: BLO Ation: Aula M	CKCHAIN 1AGNA)	
17:00 - 17:10	BREAK				
17:10 - 18:25		BIG DATA 7	ICIOT 2	CLOUD 7	CLOUD 8
18:30 - 20:15	IEEE SERVICES CONGRESS WELCOME RECEPTION (LOCATION: UNIVERSITÁ DEGLI STUDI DI MILANO)				
		WEDNESI	DAY JULY 10		
8:30 - 9:45	BIG DATA		EDGE 7	CLOUD 9	CLOUD 10
9:45 - 10:15	COFFEE BREAK				
KEYNOTE 2: KATHRYN GUARIN				GUARINI	
10:15 - 11:30	(LOCATION: AULA MAGNA)				
11:30 - 12:45	PLENARY PANEL: FUTURE OF FINANCIAL SERVICES (LOCATION: AULA MAGNA)				
12:45 - 14:00	LUNCH BREAK				
14:00 - 15:15	FFS SYMP	BIG DATA 9		CLOUD 11	CLOUD 12
15:15 - 15:45			COFFEE BREA	K	
15:45 - 17:30	FFS SYMP DOC SYMP CLOUD 13 CLOUD 14				CLOUD 14
17:30 - 19:00	PHD FORUM - SALA NAPOLEONICA MAIN + PARALLEL				

Program at a Glance Universitá degli Studi di Milano					
ROOM/ TIME	Aula Magna	Sala Crociera Alta di Studi Umanistici 1	Sala Napoleonica Parallel	Sala Crociera Alta Di Giurisprudenza 2	Sala Napoleonica Main
		THURSD	AY JULY 11		
8:30 - 9:45	45 ICIOT 6 CLOUD 15 CLOU				
9:45 - 10:15	COFFEE BREAK				
10:15 - 11:30	PLENARY PANEL: AI & SECURITY (LOCATION: AULA MAGNA)				
11:30 - 11:45	BREAK				
11:45 - 13:00	INDUSTRY ICIOT 7 CLOUD 26 CLC			CLOUD 17	
13:00 - 13:45			LUNCH BREA	K	
13:45 - 14:45		INDUSTRY		CLOUD 27	CLOUD 18
14:45 - 15:00	note: changes		BREAK		
15:00 - 16:00	in red due to transportation strike - please see PLENARY PANEL: FROM EDGE TO CLOUD (LOCATION: AULA MAGNA)				
16:00 - 19:00	mobile app or vis	it MOVING	TO BANQUET	LOCATION	
19:00 - 21:00	the registration	CONGRESS I	BANQUET: VILI	LA TOSCANINI	
	desk for full deta	FRIDA	Y JULY 12		
8:30 - 9:45		CONCISE 3	SWoSC	KGaaS	CLOUD 19
9:45 - 10:15			COFFEE BREA	K	
10:15 - 11:30	KEYNOTE 3: SUMI HELAL (LOCATION: AULA MAGNA)				
11:30 - 11:45			BREAK		
11:45 - 13:00			SWoSC	KGaaS	CLOUD 20
13:00 - 14:00	LUNCH BREAK				
14:00 - 15:15	CONCISE		PHP	ICWS 19	CLOUD 21
15:15 - 15:45	COFFEE BREAK				
15:45 - 17:00	PLENARY PANEL: 2020 TECH PREDICTIONS (LOCATION: AULA MAGNA)				
17:00 - 17:15	BREAK				
17:15 - 18:30			PHP		CLOUD 22
		SATURD	AY JULY 13		
8:30 - 9:45		CONCISE 5	CLOUD 23		ICWS 23
9:45 - 10:15			COFFEE BREA	K	
10:15 - 11:30	DHAASS KEYNOTE: RAMESH JAIN (LOCATION: NH COLLECTION - DURINI/SALA GUASTALLA)				
11:30 - 11:45	BREAK				
11:45 - 13:00			CLOUD 24	KGaaS	ICWS 34
13:00 - 14:00	LUNCH BREAK				
14:00 - 15:15	CLOUD 25				
15:55 - 16:25			BREAK		
16:25 - 17:30	DHAAS PLENARY PANEL: DIGITAL HEALTH AS A SERVICE (LOCATION: NH COLLECTION - DURINI/SALA GUASTALLA)				
17:30 - 18:30	DHAASS TOWN HALL MEETING (LOCATION: NH COLLECTION - DURINI/SALA GUASTALLA)				

Program at a Glance						
	Manfarta/Sala					
TIME	Sforza	Guastalla	Corridoni	Borgogna		
SU	JNDAY JULY 7: REC	GISTRATION OPEN	NAT HOTEL 16:00	- 19:00		
OPEN M	OPEN MONDAY - FRIDAY AT Universitá, 8:15 - 17:30, SATURDAY 10:00 - 12:00					
PLI	PLENARY EVENTS IN BLUE ARE LOCATED AT THE UNIVERSITÁ					
	MONDAY JULY 8					
9:15 - 9:45	COFFEE BREAK					
9:45 - 11:00	EDGE 1 NET 1					
11:00 - 11:15	BREAK					
11:15 - 12:30	EDGE 2 NET 2 CSR 1					
12:30 - 14:00	LUNCH BREAK					
14:00 - 15:15	CSR 2					
15:15 - 15:45		COFFEE	E BREAK			
15:45 - 17:00			CSR 3			
		TUESDAY JULY	<u> </u>			
8:30 - 9:45	EDGE 3	ICWS 1	CSR 4	ICWS 2		
9:45 - 10:15	COFFEE BREAK					
10:15 - 11:30	KEYNOTE 1: JOSEPH SIFAKIS LOCATION: AULA MAGNA (universitá)					
11:30 - 11:45	BREAK					
11:45 - 13:00	:45 - 13:00 EDGE 4 ICWS 3 CSR 5			ICWS 4		
13:00 - 14:00	LUNCH BREAK					
14:00 - 15:15	EDGE 5	ICWS 5		ICWS 6		
15:15 - 15:45	COFFEE BREAK					
15:45 - 17:00	PLENARY PANEL: BLOCKCHAIN LOCATION: AULA MAGNA (universitá)					
17:00 - 17:10 BREAK			EAK			
17:10 - 18:25	EDGE 6		SCC 1	ICWS 7		
18:30 - 20:15	IEEE SERVICES CONGRESS WELCOME RECEPTION LOCATION: (Universitá)					
	V	VEDNESDAY JU	LY 10			
8:30 - 9:45	ICIOT 3	ICWS 8	SCC 2			
9:45 - 10:15	COFFEE BREAK					
10:15 - 11:30		KEYNOTE 2: KAT	HARYN GUARINI	·		
	LOCATION: AULA MAGNA (UNIVERSITÁ)					
11:30 - 12:45	PLENARY PANEL: FUTURE OF FINANCIAL SERVICES					
		LOCATION: AULA N	AGNA (UNIVERSITÁ)			
12:45 - 14:00		LUNCH	BREAK	1		
14:00 - 15:15	ICIOT 4	ICWS 9	SCC 3			
15:15 - 15:45		COFFEE	E BREAK			
15:45 - 17:30	ICIOT 5	ICWS 10	SCC 4	ICWS 11		

Program at a Glance NH Collection Milano President						
ROOM/ TIME	Monforte/Sala Sforza	Durini/Sala Guastalla	Corridoni	Borgogna		
THURSDAY IULY 11						
8:30 - 9:45	CONCISE 1	ICWS 12	SCC 5	ICWS 13		
9:45 - 10:15	COFFEE BREAK					
10:15 - 11:30		PLENARY PANEI Location: Aula N	L: AI & SECURITY MAGNA (universitá)			
11:30 - 11:45	BREAK					
11:45 - 13:00	new time: new time: SCC 6 CONCISE 2 ICWS 15			ICWS 14		
13:00 - 13:45	note: changes	LUNCH	I BREAK			
13:45 - 14:45	in red due to		SCC 7	ICWS 16		
14:45 - 15:00	strike - please see BREAK					
15:00 - 16:00	mobile app or visit the registration	PLENARY PANEL: FRO LOCATION: AULA M	OM EDGE TO CLOUI MAGNA (universitá)	D		
16:00 - 19:00	desk for full details	MOVING TO BAN	QUET LOCATION			
19:00 - 21:00		CONGRESS BANQUE	T: VILLA TOSCANIN	I		
	FRIDAY JULY 12					
8:30 - 9:45	SCC 8	ICWS 17				
9:45 - 10:15	COFFEE BREAK					
10:15 - 11:30	KEYNOTE 3: SUMI HELAL LOCATION: AULA MAGNA (universitá)					
11:30 - 11:45		BRI	EAK			
11:45 - 13:00	SCC 9	ICWS 18				
13:00 - 14:00		LUNCH	I BREAK			
14:00 - 15:15	SCC 10	ICWS 20				
15:15 - 15:45	COFFEE BREAK					
15:45 - 17:00	15:45 - 17:00 PLENARY PANEL: 2020 TECH PREDICTIONS LOCATION: AULA MAGNA (universitá)					
17:00 - 17:15		BRI	EAK			
17:15 - 18:30	ICWS 21	ICWS 22				
		SATURDAY JUL	Y 13			
8:30 - 9:45	SCC 11	DHS				
9:45 - 10:15	COFFEE BREAK					
10:15 - 11:30	DHAASS KEYNOTE: RAMESH JAIN (LOCATION: DURINI/SALA GUASTALLA)					
11:30 - 11:45	1:30 - 11:45 BREAK					
11:45 - 13:00	3:00 SCC 12 DHAASS					
13:00 - 13:45		LUNCH	I BREAK			
13:45 - 15:55	DHAASS					
15:55 - 16:25	- 16:25 BREAK					
16:25 - 17:30	16:25 - 17:30 PLENARY PANEL: DIGITAL HEALTH AS A SERVICE (LOCATION: DURINI/SALA GUASTALLA)					
17:30 - 18:30 DHAASS TOWN HALL MEETIN (LOCATION: DURINI/SALA GUAST)			HALL MEETING I/SALA GUASTALLA)		

2019 IEEE SERVICES Congress Organizing Team

Steering Committee:

Chair: Carl K. Chang, Iowa State University Elisa Bertino, Purdue University Rong N. Chang, IBM Peter Chen, Carnegie Mellon University Ernesto Damiani, Universitá degli Studi di Milano Ian Foster, University of Chicago Dennis Gannon, Indiana University Michael Goul, Arizona State University Frank Leymann, University of Stuttgart Hong Mei, Beijing Institute of Technology Stephen S. Yau, Arizona State University

Honorary General Chair: Stephen S. Yau, Arizona State University General Chair: Peter Chen, Carnegie Mellon University Symposia General Chair: Michael Goul, Arizona State University Program Chair in Chief: Elisa Bertino, Purdue University Vice Program Chair in Chief: Ernesto Damiani, Universitá degli Studi di Milano

Program Operational Committee:

Marco Anisetti, Universitá degli Studi di Milano Nabil El Ioini, Free University of Bolzano Xuanzhe Liu, Peking University Chan Yeob Yeun, Khalifa University of Science & Technology

Symposium on Services Computing Chairs: Yanchun Sun, Peking University; Supratik Mukhopadhyay, Louisiana State University

Panels Committee Chair: Brian Blake, Drexel University

Workshops Committee Chairs: Stephan Reiff-Marganiec, University of Leicester and Shangguang Wang, BUPT

Doctoral Symposium Committee Chairs: Barbara Carminati, University of Insubria; Latifur Khan, University of Texas - Dallas; Yanmei Zhang, Central University of Finance and Economics

Industry Program Committee Chairs: Hemant Jain, The University of Tennessee at Chattanooga; Vito Morreale, Engineering

Tutorial Chair: Carlos Fonseca, IBM

Local Arrangements Chair: Fulvio Frati, Universitá degli Studi di Milano

Finance Chair: Shiyong Lu, Wayne State University

Registration Chairs: Jingwei Yang, California State University, Sacramento; Haiyan Zhao, Peking University

Publication Chairs: Katsunori Oyama, Nihon University; Zhongjie Wang, Harbin Institute of Technology

Publicity Chairs: Paolo Ceravolo, Universitá Degli Studi di Milano; Ali Darvish, Johns Hopkins University; Shuiguang Deng, Zhejiang University

Web Coordinator: Laurel Ming

2019 SERVICES CONGRESS includes the following conferences:

The IEEE International Congress on Big Data (BigData Congress) is the emerging theme-topic conference for quantitative analysis of impact on business insights from Big Data analytics. **2019 General Chairs:** Ernesto Damiani, Universitá degli Studi di Milano (Honorary); Meichun Hsu, Oracle; Laurence Yang, St. Francis Xavier University

2019 Program Chairs: Beth Plale, Indiana University; Sean Wang, Fudan University

The IEEE International Conference on Cloud Computing (CLOUD) is the flagship themetopic conference for modeling, developing, publishing, monitoring, managing, delivering XaaS (everything as a service) in the context of various types of cloud environments.

2019 General Chairs: Geoffrey C. Fox, Indiana University; Frank Leymann, University of Stuttgart **2019 Program Chairs:** Claudio Ardagna, University of Milan; Murat Kantarcioglu, University of Texas at Dallas

The IEEE International Conference on Edge Computing (EDGE) aims to become a premier international forum for researchers and practitioners to exchange the latest technical advances and best practices in edge computing, identify emerging research topics in edge computing, and envision the future of edge computing in terms of the evolution of computing devices and data center clouds. **2019 General Chairs:** John Kubiatowicz, University of California - Berkeley; Nimish Radia, Ericsson **2019 Program Chairs:** James Joshi, University of Pittsburgh; Hong Zhu, Oxford Brookes University

The IEEE International Conference on Cognitive Computing (ICCC) covers all aspects of Sensing Intelligence (SI) as a Service (SIaaS). Cognitive Computing is a sensing-driven-computing (SDC) scheme that explores and integrates intelligence from all types of senses in various scenarios and solution contexts.

2019 General Chairs: Jacky Akoka, CNAM; Rong N. Chang, IBM Research

2019 Program Chairs: Gabriella Pasi, University of Milano-Bicocca; Dinesh Verma, IBM TJ Watson

The IEEE International Congress on Internet of Things (ICIOT) promotes research and application innovations for a new era in which sensors and other types of sensing devices, wired and wireless networks, platforms and tools, processing/visualization/analysis of data, data integration engines, and applications are interconnected to realize the service value of connected things, people, and virtual Internet spaces.

2019 General Chairs: Schahram Dustdar, Vienna University of Technology; Manish Parashar, Rutgers University

2019 Program Chairs: DongSeong Kim, University of Queensland; Surya Nepal, CSIRO

The IEEE International Conference on Web Services (ICWS) has been a prime international forum for both researchers and industry practitioners to exchange the latest fundamental advances in state of the art and practice of Web-based services, identify emerging research topics, and define the future of Web-based services.

2019 General Chairs: Heiko Ludwig, IBM Research; Bhavani Thuraisingham, University of Texas at Dallas

2019 Program Chairs: Elena Ferrari, University of Insubria; Jia Zhang, Carnegie Mellon University

The IEEE International Conference on Services Computing (SCC) is the flagship theme-topic conference for services innovation lifecycle that includes enterprise modeling, business consulting, solution creation, services orchestration, services optimization, services management, services marketing, business process integration and management.

2019 General Chairs: Michael Goul, Arizona State University; Xiaofei Xu, Harbin Institute of Technology

2019 Program Chairs: Luciano Baresi, Politecnico di Milano; Yan Wang, Macquarie University



2019 IEEE World Congress on Services Message from the Steering Committee Chair Carl K. Chang, Iowa State University

The IEEE World Congress on Services has always been a major professional event sponsored by the IEEE Computer Society. Ironically, while some of the key organizers in the past insisted that this is a premier international event, it has never been held outside the US until now. In 2019, we bring this Congress and the affiliated community to Europe for the first time more specifically, to Milan. Our bold move to Europe for the 2019 edition is a convincing success. Our long-range plan is to continue the rotation pattern between the Americas, Europe

and Asia Pacific. As such, on behalf of the Steering Committee, I am pleased to announce that the 2020 IEEE World Congress on Services will be hosted by Peking University in Beijing from July 6-11, 2020. Please mark your calendar accordingly.

In the past year we have been practicing some of the best-in-class practices pursuant to the highest professional standards. We adopted the double-blind review policy and provided an early submission opportunity for those who have papers ready for submission early and are willing to receive early reviews to improve the probability of being accepted in the end. Indeed, under the leadership of Program Chair-in-Chief Elisa Bertino, the program committees of all seven affiliated conferences made concerted decisions in selecting only a small number of the best submissions as full papers to compose a world-class program.

We initiated several new activities in 2019. Workshops are now independent technical entities to be held in conjunction with the main conferences. We received eight workshop proposals and eventually six will make their first appearance this year. Workshops cover some "vertical" subjects that are not yet adequately covered by the main conferences or are fast emerging new issues and concerns in the field of services. We also started the Congress Symposia structure, under the leadership of Symposia General Chair Michael Goul, to strengthen our offering in a variety of new ways – well beyond paper presentations.

Our long-range planning has now moved into 2021, 2022 and even beyond. We are currently soliciting proposals for future editions, in particular for 2021 and 2022. If your institution is interested in hosting this event, please contact me (chang@iastate.edu), Chair of the Steering Committee (SCC). Note that according to the bylaws passed by the Steering Committee in 2018, each SCC's term is limited to five years. Currently, I am serving my term in the SCC capacity between 2017-2022.

Congress is a large and complex professional event as you can see from the Organizing Committee page on the web. I hereby acknowledge the excellent effort contributed by numerous organizers who are indispensable for composing such a high-impact professional event. In particular, I would like to thank Stephen S. Yau for his outstanding service as the Congress General Chair in 2018. Steve's fine work in 2018 established a solid foundation for the 2019 leadership team to find many great examples, templates and practices to follow. Also, huge thanks are due to Peter Chen, whose leadership and wisdom helped calibrate our directions and improve our coordination from time to time during the past year. Rong N. Chang in his capacity as the chairperson of TCSVC, the 100% sponsoring IEEE unit, has always been there and provided other organizers unwavering support. Now, it is my pleasure and privilege to introduce the members of the Steering Committee of the IEEE World Congress on Services, below, for their strong support to my role as the chair.

Milan has always been one of my most favorite cities because there is so much to explore each time I visit. I encourage you to find time for some fun besides making contributions to the Congress and benefiting from learning and networking. I wish to see you all again in 2020.

2019 IEEE World Congress on Services Steering Committee Members



Elisa Bertino Purdue University



Rong N. Chang IBM



Peter Chen Carnegie Mellon University



Ernesto Damiani Universitá degli Studi di Milano



Ian Foster University of Chicago



Dennis Gannon Indiana University



Michael Goul Arizona State University



Frank Leymann University of Stuttgart



Hong Mei Beijing Institute of Technology



Stephen S. Yau Arizona State University



Message from the CONGRESS General Chair Peter Chen, Carnegie Mellon University

Welcome to the 2019 IEEE World Congress on Services. Many countries in the world are in the process of transition into servicesoriented economies. There are huge demands and needs on developing and applying information technology to improve the quality and productivity of all kinds of services. The SERVICES Congress aims to be the leading platform for presenting the most advanced results in services research and to exchange ideas among thought leaders, researchers, and practitioners.

In this year's Congress, we have seven affiliated conferences focusing on major aspects of services information technologies: big data, internet-of-things, edge computing, cognitive computing, cloud computing, web services, and services computing. We also have more than 10 workshops and symposia to address more specific topics. The congress offers two tutorials, which are oversubscribed. We have also organized a doctoral symposium to provide guidance to the future generation of researchers in services.

The Congress has three outstanding keynote speeches: (1) Autonomous Systems - A Rigorous Architectural Characterization by Joseph Sifakis, a Turing Award winner, (2) Navigating Technology Acceleration: Ensuring Safe Passage to AI-Powered Digital Business by Kathryn Guarini, VP, IBM Industry Research, and (3) Microservice Ecosystem for Digital Health in Integrated Care Settings by Sumi Helal, professor and Chair in Digital Health at Lancaster University, UK. Please don't miss these exciting talks.

There are several plenary panels on hot topics such as blockchain, future financial services, AI & security, from edge to cloud, and 2020 tech perspectives. Several symposia also have invited well-known experts to give invited speeches/papers or participate in panel discussions. Attending those sessions will increase your knowledge significantly.

We have received a lot of help from many talented and dedicated volunteers and professional staff members (particularly, from the IEEE Computer Society). I would like to express my appreciation to Steering Committee Chair Carl Chang and Honorary Congress Chair Steve Yau for their visions and guidance. The excellent Congress technical program was created by Congress Program Chairin-Chief Elisa Bertino and Congress Program Vice Chair-in-Chief Ernesto Damiani, who worked with the program chairs of the 7 affiliated conferences. The exciting program of symposia was created with the endless efforts of Congress Symposia General Chair Michael Goud and 14 general chairs of the affiliated conferences. Furthermore, I would like to thank the Services Computing Technical Committee Chair Rong Chang for his tremendous support of the Congress.

There are about 50 or more volunteers of the Congress. Please visit the Organizing Committee roster to see a list of conference general chairs and program chairs, registration chairs, publicity Chairs, etc. They all have been working very hard. Without them there is no way to organize an international conference of this scale. I appreciate their help very much to make this congress a big success. Milan is a very beautiful city and one of the top fashion capitals of the world. It is also a major financial service center, which matches very well with the focus of our Congress. Hope you will enjoy the Congress and Milan very much.





Message from the Program Chair-in-Chief and the Vice Program Chair-in-Chief Elisa Bertino, Purdue University (Program Chair-in-Chief) Ernesto Damiani, Universitá degli Studi di Milano (Vice Program Chair-in-Chief)

It is our great pleasure to welcome you to the 2019 edition of the IEEE World Congress on Services taking place in the beautiful city of Milan (Italy). This year's edition represents an important milestone as it is the first time that the Congress is held outside the US. Moving the Congress outside the US recognizes the strong research communities around the world that focus on foundations, systems, methodologies, and applications of computing-based services. This is a field that over the years has evolved and expanded to encompass new areas, including edge computing, cognitive systems, IoT, and big data, for which service technologies are critical.

The Congress is organized into seven different conferences, each with its own focus, but that collectively provide a comprehensive view of research advances as well novel applications and industry perspectives.

To further broaden the perspective it offers to participants, the Congress includes several workshops on emerging research topics and symposia. The Congress is thus a key resource for whoever, from academia and industry, is interested in a multi-disciplinary view of the computing-based services field.

In keeping with the highest professional standard, the Congress conferences have all followed a rigorous scientific review process as result of which we have an excellent set of regular research papers. However, the program also includes short research papers reporting promising preliminary research results and work-in-progress papers focusing on research ideas still in the very early stages of exploration. We believe that it is important for the Congress not only to report mature research results but also novel, risky ideas. The program of each conference is complemented by invited papers by world renowned researchers – thus adding their perspectives to the ones given by the authors of the other papers in the program.

Putting together the program of a federation of conferences like the Services Congress may appear a challenging task. We however have been very fortunate to have the collaboration of several colleagues. First, we would like to recognize the program co-chairs of the seven conferences: Beth Plale and Sean Wang (IEEE Big Data Congress), Claudio Ardagna and Murat Kantarcioglu (IEEE Cloud), James Joshi and Hong Zhu (IEEE Edge), Gabriella Pasi and Dinesh Verma and (IEEE ICCC), DongSeong Kim and Surya Nepal (IEEE ICIOT), Elena Ferrari and Jia Zhang (IEEE ICWS), Luciano Baresi and Yang Wang (IEEE SCC). They all worked tirelessly to recruit PC members with strong research tracks, to discuss papers when making the final acceptance decisions, and to organize the conference programs. Several operational activities were undertaken by the program operational committee: Marco Anisetti, Nabil El Ioini, Xuanzhe Liu, and Chan Yeob Yeun. They took care among other matters to check all papers for compliance with the double-blind review policy which has been introduced this year for the first time in the Congress. We are grateful to those young and energetic individuals for always being ready to help with many different organizational tasks. We are particularly grateful to Katsunori Oyama and Zhongjie Wang for their work as publication chairs; they had the important task of coordinating the preparation of the proceedings with the program co-chairs. Last but not least, we would like to thank Carl Chang, chair of the IEEE Services Steering Committee, for his tireless work on so many different tasks, from setting up the Easy Chair installations for all the conferences to establishing the critical deadlines and, most challenging, making sure that everyone would comply with these deadlines. Finally, we would like to thank our colleagues who submitted their best research work to the Congress. It is their work that makes the Congress a strong research forum.

We hope that you will find opportunities to network with other researchers and get interesting and novel directions for your research work. Enjoy the program!!!







Message from the SERVICES Symposium Chairs Michael Goul, Arizona State University (Symposia General Chair) Rong Chang, IBM TJ Watson Research Center -(Symposia General Co-Chair (Congress-wide) Lionel Brunie, Institut National des Sciences Appliquées de Lyon, Département Informatique, Laboratoire LIRIS (Symposia General Co-chair - within conference)

The IEEE World Congress on Services Computing has a long tradition of innovation. This year, under the direction of Peter Chen, 2019 Services Congress General Chair, and Carl Chang, IEEE Services Computing Steering Committee Chair, the 'Symposia' was designed and created in continuation of this tradition. The Symposia program features academic scholars and industry leaders collaborating to deliver state-of-the-art research and development across a broad landscape of topics related to services. There are Congress-wide symposia and within-conference symposia. Congress-wide symposia address grand challenges for the services field, and they advance an in-depth view of our community's longer-term research agenda in services. Within-conference symposia engage researchers in addressing topics relevant to particular conference themes and/or issues relevant to the field(s) of study addressed in that conference.

For 2019, Congress-wide Symposia also include the Symposium on Services Computing (co-chaired by Yanchun Sun, Peking University, Supratik Mukhopadhyay, Louisiana State University) and a Doctoral Symposium (co-chaired by Barbara Carminati, University of Insubria, Latifur Khan,

University of Texas -Dallas and Yanmei Zhang, Central University of Finance and Economics). In addition, two first-of-their-kind Congress-wide symposia were established. One of these addresses Digital Health as a Service (co-chaired by Carl K. Chang, Professor and Director, Smart Home

Laboratory, Iowa State University and Sumi Helal, Professor and Chair in Digital Health, Lancaster University). Another Congress-wide Symposium addresses the Future of Financial Services where there is need for deeper digitization, advancement in data-driven decision intelligence, and research on new enabling business models (chaired by Kumar Bhaskaran, IBM T. J. Watson Research Center). In addition to the general and co-general chairs, other organizing contributors for the 2019 IEEE Services Symposia included Richard Chbeir, Department of Computer Science, University of Pau and Pays de L'Adour, France – Europe Symposia Chair, Yucong Duan, Department of Computer Science, Nihon University, Japan – Asia Symposium Co-Chair, and Maria Krotsiani, University of London, UK – Co-Located Conference Leadership Liaison.

On behalf of the Symposia team, we want to thank all of the Congress-wide Symposia Chairs and Conference General Chairs who participated in designing and developing Symposia. We sincerely appreciate the agility of all of conference leaders as we tested out new approaches and laid new foundations for the future IEEE Services Computing Congress Symposia.





Message from the Workshop Committee Chairs Stephan Reiff-Marganiec, University of Leicester Shangguang Wang, BUPT

On behalf of IEEE BigData/Cloud/Edge/ICCC/ICIOT/ICWS/SCC/ Services 2019 Committees, the IEEE Technical Committee on Services Computing, the IEEE Computer Society and workshops organizers, we would like to extend our welcome to the Workshops Program of IEEE Services 2019! The Services 2019 Workshop Program features a selection of 7 timely workshops that attracted over 140 submissions. All papers were peer-reviewed for novelty, quality, and relevance. Accepted papers are included in the Proceedings of IEEE Services 2019. The program of presentations provides a forum for presenting novel ideas in a less formal and more focused way and a valuable opportunity to explore emerging directions and trends in the area of service computing.

The Workshops program features:

•The 1st IEEE Services Workshop on Healthcare Services: Through information technology and the internet, many new healthcare service models and solutions are emerging across fields. This workshop explores the emerging technologies to facilitate better healthcare services, such as such as cross-border service integration model, crossdomain knowledge graphs, Internet of Things, or blockchains and the impact they are having.

•The 1st IEEE Services Workshop on Network Services: With the development of Software-Defined Anything, software is already penetrating into the Internet and controlling the network. Adoption

of the Service-Oriented Architecture principle in networking has enabled the Network-as-a-Service paradigm that is expected to play a crucial role. The workshop explores developments for emerging network services that can significantly impact performance and behaviours of networks.

• The 1st IEEE Services Workshop on Edge Computing for Autonomous Things: Edge computing extends deployment alternatives for software systems enabling to locate capabilities in the edge of the networks rather than centralize them in the cloud infrastructures. This decentralization of processing and storage operations brings the advantage of reducing communication latency and avoiding unnecessary data flow inefficiencies and inherent cloud risks. This workshop explores ideas and concepts focused on autonomy in things.

• The 1st IEEE Services Workshop on Big Data for Public Health Policy Making: Effective management of health-related problems depends on and requires appropriate public health policies to enable prevention, early diagnosis and early treatment of several diffuse and debilitating conditions. The management of such health problems and their consequences through public

health policies can benefit from the analysis of heterogeneous data (e.g., collected from modern IoT sensors as well as from standard clinical trials) and Big Data Analytic techniques. The workshop presents innovative techniques and solutions for supporting policy makers and clinicians in taking decisions based on evidence and for simulating scenarios aimed at predicting evolutions of health diseases at epidemiological level.

• The 1st IEEE Services Workshop on Cyber Security and Resilience in the Internet of Things: The technological and industrial revolution brought by the Internet of Things (IoT) comes with new forms of threats and attacks that exploit the inherent complexity and heterogeneity of IoT networks. Addressing these is crucial as IoT systems can be quite personal as well as embedded in critical infrastructure. The workshop explores all dimensions that will enable creation of safer IoT systems.

• The 1st IEEE Services Workshop on Knowledge Graph as a Service: Knowledge Graphs are increasingly recognized as an important approach to solving problems related to semantic understanding beyond question and answering systems. Emerging solutions cover Knowledge Graph creation, understanding, searching, reasoning, modification and especially and most recently embedding technologies with Machine Learning. This workshop explores these areas in conjunction with providing service embeddings of Knowledge Graphs.

• The 1st IEEE Services Workshop on Serverless Computing: Serverless Computing has become a hot topic, both in the research community as well as a commercial offering. The workshop includes presentations on computing foundations, platforms and technologies and experience with serverless computing.

We would like to thank all the organizers, program committee members of individual workshops for producing the excellent final workshops program. We also like to thank all authors for their submissions. We hope you enjoy the Workshop program and the conference.



Message from the Technical Committee Chair on Services Computing Rong N. Chang, IBM TJ Watson Research

The IEEE Computer Society (IEEE-CS) Technical Committee on Services Computing (TCSVC), http://tab.computer.org/tcsvc, has endorsed the affiliated technical conferences of IEEE World Congress on Services (SERVICES) since 2004. Over the past 15 years, IEEE-CS has provided 100% financial co-sponsorship for the annual events with the exception

of 2014 to 2017 (during which, IEEE-CS provided 60% financial co-sponsorship). Many innovative growth initiatives have been delivered for the best interests of the worldwide services computing community, a fast-growing R&D community with more than 10,000 active participants. In terms of the total number of IEEE Xplore downloads, IEEE SERVICES was ranked in the top 5% last year. For the past two years, IEEE-CS TCSVC has been working closely with the steering committee of IEEE SERVICES on metamorphosizing the planning and execution of the annual technical conferences affiliated with IEEE SERVICES. Noteworthy changes include establishing IEEE compliant bylaws, institutionalizing a two-year conference planning process, and selecting non-US venues for IEEE SERVICES. The transformation effort has been challenging in terms of the number of unknowns and the various unexpected legal actions we had to take. However, with the help of many committed volunteer leaders, this transformation has been accomplished. Special thanks go to (by family name): Elisa Bertino (Purdue University), Carl K. Chang (Iowa State University), Peter Chen (Carnegie Mellon University), Ernesto Damiani (Khalifa University), Patrick Hung (University of Ontario Institute of Technology), Hausi Muller (2016-2017 IEEE-CS VP of T&C Board), Carmen Saliba (IEEE Manager of Conference & Event Services), Stephen S. Yau (Arizona State University), Xiaofei Xu (Harbin Institute of Technology), and Jia Zhang (Carnegie Mellon University). I would also like to take this opportunity to thank all the members of the IEEE-CS TCSVC committees listed at the end of this message. They are essential to the services provided by IEEE-CS TCSVC. With the aims of promoting women professionals and inspiring young researchers in services computing, IEEE-CS TCSVC established the "Women in Services Computing Award" and the "Rising Star Award" in 2018. Encouraging feedback on those two awards resulted in the creation of two TCSVC committees: "Women in Services Computing (WISC) Committee" and "Young Experts in Services Computing (YESC) Committee." Your active participation in growing these two communities all over the world has been and will be appreciated. One important ongoing initiative of IEEE-CS TCSVC is promoting industry services research as a first-class research area in terms of the global industry transformation needs and the proliferation of crossover industries. Compared with many innovative point technologies that promise revolutionary social impact, much R&D work is needed in services computing to make the innovations safe, trustful, and consumable. 2019 IEEE SERVICES has two signature symposia featuring first-of-its-kind technical leaders in digital health and financial services (FSS). We hope you can join those sessions and contribute to the planning and execution activities related to 2020 IEEE SERVICES. We are fortunate to have this year's annual flagship event be held in the historic and beautiful city of Milan, a culturally rich commercial epicenter full of fascinating tourist sites and adventure. I hope you all enjoy your time here.

Executive Committee of IEEE-CS TCSVC

Chair: Rong N. Chang, IBM Research Executive Vice Chair: Ernesto Damiani, Khalifa University Secretary: Jia Zhang, Carnegie Mellon University Treasurer: Vaijayanthi Desai, IBM GTS Labs Awards Chair: Hemant Jain, University of Tennessee Publicity Chair: Xuanzhe Liu, Peking University Committee Chair of Women in Services Computing (WISC): Yanchun Sun, Peking University Committee Chair of Young Experts in Services Computing (YESC): Shangguang Wang, Beijing University of Posts and Telecommunications (BUPT)

Advisory Committee of IEEE-CS TCSVC

Carl K. Chang, Iowa State University Gopal Pingali, IBM GTS Labs Xiaofei Xu, Harbin Institute of Technology Stephen S. Yau, Arizona State University Membership Committee of IEEE-CS TCSVC Schahram Dustdar, Technical University of Vienna Marcelo Fantinato, University of Sao Paulo Nikolay Kazantsev, National Research University Higher School of Economics Andrzej M. Goscinski, Deakin University Zakaria Maamar, Zayed University Byungchul Tak, Kyungpook National University



Tutorial 1 DevOps, Microservices, & Containers - The Perfect Storm Morning Session, Monday July 8 9:45 - 12:30 Location: Sala Napoleonica Main - Universitá degli Studi di Milano

This tutorial will give attendees first hand experience in building a microservice and deploying it as a container on Kubernetes using DevOps practices and methods. An overview of DevOps culture and microservice architecture will be presented as a backdrop to the hands-on exercise. Attendees will build a simple Python Flask microservice using Test Driven Development techniques and run it locally. Then we will introduce the concepts of Docker and wrap that service in a Docker container and re-run our tests proving that the behavior has not changed. Using Jenkins and minikube, we will set up a CI/CD pipeline and deploy the microservice to a local minikube Kubernetes cluster. Finally we will add persistence to our microservice and deploy a Redis service in our Kubernetes cluster for our microservice to use showing how to use secrets for storing sensitive information like database credentials. The tutorial will switch between lecture and lab several times as new concepts are introduced and then quickly demonstrated and implemented in the hands-on exercise. Attendees will come away with a good understanding of how modern software is delivered using DevOps tools and practices with a programmable containerized infrastructure like Kubernetes.

Background Required

This tutorial is intended for those with little knowledge of DevOps but some software development experience is needed preferably in Python or other high level language. Attendees will need a laptop, preferably Mac, with at least 4GB of memory (8GB recommended) to run Docker and minikube.

Speaker

John J. Rofrano is a Senior Technical Staff Member and DevOps Champion at IBM T.J. Watson Research Center where he leads a variety of research projects exploring the use of AI and Machine Learning for improving Cloud Migration, DevSecOps, and AI-Ops. He also teaches a masters course on DevOps and Agile Methodologies at NYU Courant Institute, and has authored numerous patents, papers, and two books.



Tutorial 2 IBM Hybrid Cloud for the Enterprise Afternoon session, Monday July 8 14:00 - 17:00 Location: Sala Napoleonica Main, Universitá degli Studi di Milano

This tutorial will give attendees experience with using IBM Cloud. It will cover infrastructure components and platform services such as Watson Assistant (Watson Conversation). The tutorial will start with creating a free account that attendees can use to follow along on their laptops. The tutorial will include a solution architecture that can be used to move a business to the IBM Cloud. The solution is based on our experience over the last several years of moving IBM Research to the IBM cloud. It will cover how to deploy infrastructure in the IBM Cloud and how to secure it including the use of virtual private networks and network firewalls. The tutorial will cover how to provision IBM Kubernetes infrastructure and how to best deploy it for an enterprise business. The tutorial will also include a section on the IBM Cloud Private environment and a Watson Studio section where attendees will see how to write a Jupyter notebook to develop and train a deep learning model. It will then show how to deploy the model and use it in a simple language translator Node.js application deployed in a Kubernetes environment.

Background Required

This tutorial is intended for those with little knowledge (but not required) of information technology infrastructure including server hardware, bare metal, virtual machines, and some basic networking concepts. Some experience with Python, Node.js, or JavaScript is preferred but not required.

Speakers

Carlos A. Fonseca, IBM Research Division, Thomas J. Watson Research Center, Yorktown Heights, NY 10598 USA (cafonseca@us.ibm.com)

Carlos Fonseca is an Executive IT Architect, Software Engineer, and a people manager. With over 20 years of software development, and architecture experience, Carlos has provided many contributions to IBM technologies, solutions, and software products. Currently, Carlos manages a high-performance team of software engineers, IT specialist and architects providing innovated Information Technology solutions for IBM. These solutions range from application development, IBM cloud application and infrastructure architecture and design, mobile design and development, wireless technology solutions, emerging client adoption solutions, VPN and secured access solutions. Carlos provides technical leadership in many of the team's contributions including leading several key cloud infrastructure architecture and deployment projects in IBM Research.

Lorraine M. Herger IBM Research Division, Thomas J. Watson Research Center, Yorktown Heights, NY 10598 USA (herger@us.ibm.com)

Ms. Herger is the Director of Research Integrated Solutions and CIO of IBM Research, a worldwide organization with 12 locations; a Master Inventor, with over 50 patents, 25 publications and a Senior Technical Staff Member. Lorraine received the 2017 CIO 100 award for innovative use of technology to drive business for IBM Research by creating a cloud environment where IBM Research can host assets for external partners. Lorraine is the chief technical architect of THINKLab, an innovative environment for immersive experiences and led the team in the design, and installation of each of IBM's 13 THINKLabs. Lorraine and her team currently manage the Cloud for the IBM Research Division.

Mercy Bodarky, Integrated Solutions Team, IBM Research

Mercy Bodarky is a Security focal for the Integrated Solutions Team of IBM Research. In this role, Mercy works across several disciplines including IT Security, Cloud, and Privacy, IT & business operations and collaboration. She manages several global security programs for all services to the division. Mercy is an active member of the IRI, ACM and SWE. She also serves as the webmaster for the SWE, NY City chapter. In her spare time develops outreach projects to educate students of all ages to STEM careers.



Women in Services Computing (WISC) Monday July 8 9:45 - 12:30 Location: Sala Crociera Alta di Giurisprudenza, Universitá degli Studi di Milano

The 3rd IEEE Women in Services Computing (WISC) Workshop will be held on Monday July 8, aiming to provide an international forum for women and those passionate about gender equity in the field of Services Computing to explore the barriers and issues around under representation and models for increasing the pipeline. Specifically, this workshop will expose participants to possibilities and opportunities in Services Computing careers.

Welcome

Yanchun Sun, Chair, IEEE TCSVC-WISC

Presentation

IEEE TCSVC Women in Services Computing Award

Keynote

Elena Ferrari, University of Insubria

Invited Presentations

Elisa Bertino, Purdue University Barbara Carminati, University of Insubria Bhavani Thuraisingham, University of Texas at Dallas Jia Zhang, Carnegie Mellon University

Short Presentations

(5 minutes) by attendees

Discussions Growing the Community of Women in Services Computing



Industry Program

Thursday July 11 11:45 - 13:00, 13:45 - 14:45 Location: Sala Crociera Alta di Studi Umanistici (1) Universitá degli Studi di Milano

The objectives of the Industry program at the 2019 SERVICES Congress is to serve as a bridge between academia and industry. Industry experience and application needs can help to ground academic research in reality. Distinguished participants are invited by Industry program chairs to present some of the research problems industry are focusing on. They also challenge academic researchers on some of the most daunting tasks they are facing in real-life situations and seek at-scale solutions. This may develop into collaborative research opportunities. The sessions are highly interactive and very well attended.

Join us in engaging with researchers and research managers from companies like SAP, Zucchetti, IBM, FIAT, TIM, Engineering and other companies make exciting presentations and participate in the discussion. Full details are available on the Congress website!



Congress Opening Remarks - Tuesday July 9 Cecilia Metra, 2019 IEEE Computer Society President 10:15 - Tuesday July 9 Location: Aula Magna, Universitá degli Studi di Milano

Cecilia Metra is the President 2019 of the IEEE Computer Society. She is a full professor and the Deputy-President of the Engineering School at the University of Bologna, Italy, where she has worked since 1991, and from which she received a PhD in electronic engineering and computer science. In 2002, she was visiting faculty consultant for Intel Corporation.

She was a member of the IEEE Computer Society Board of Governors (2013-2017), the Vice President of Member and Geographic Activities 2017, and the Vice-President for Technical and Conference Activities 2014.

She is Editor in Chief of the IEEE Transactions on Emerging Topics in Computing (2018, 2020) and she was Editor in Chief of Computing Now (2013-2016) and Associate Editor in Chief of IEEE Transactions on Computers (2007-2012). She is on the IEEE The Institute Advisory Board as well as on editorial boards of several journals, including IEEE Transactions on Computers, IEEE Design&Test, and the Journal of Electronic Testing.

She contributed to numerous IEEE international conferences, symposia, workshops as general/program chair/co-chair (14 times), vice-general/program chair/co-chair (6 times), topic/track chair (34 times), and technical program committee member (90+ times). She has published extensively on design for test and reliability of integrated circuits and systems. Her research has received public and private funding (from companies such as Intel Corporation, STMicroelectronics, etc.) at national and international levels.

She is an IEEE Fellow, IEEE Computer Society Golden Core Member, and a member of the IEEE Honor Society IEEE-HKN. She has received two Meritorious Service Awards and five Certificates of Appreciation from the IEEE Computer Society.



Congress Keynote - Tuesday July 9 10:15 - 11:30 - Keynote Address Location: Aula Magna, Universitá degli Studi di Milano Joseph Sifakis, Emeritus Senior CNRS Researcher at Verimag Recipient of the 2007 Turing Award

Autonomous Systems - A Rigorous Architectural Characterization

Abstract: The concept of autonomy is key to the IoT vision promising increasing integration of smart services and systems minimizing human intervention. This vision challenges our capability to build complex open trustworthy autonomous

systems. We lack a rigorous common semantic framework for autonomous systems. There is currently a lot of confusion regarding the main characteristics of autonomous systems. In the literature, we find a profusion of poorly understood "self"-prefixed terms related to autonomy such as Self-healing, Selfoptimization, Self-protection, Self-awareness, Self-organization etc. It is remarkable that the debate about autonomous vehicles focuses almost exclusively on AI and learning techniques while it ignores many other equally important autonomous system design issues.

Autonomous systems involve agents and objects coordinated in some common environment so that their collective behavior meets a set of global goals. We propose a general computational model combining a system architecture model and an agent model. The architecture model allows expression of dynamic reconfigurable multi-mode coordination between components. The agent model consists of five interacting modules implementing each one a characteristic feature: perception, reflection, goal management, planning and self-adaptation. It determines a concept of autonomic complexity accounting for the specific difficulty to build autonomous systems.

We emphasize that the main characteristic of autonomous systems is their ability to handle knowledge and adaptively respond to environment changes. A main conclusion is that autonomy should be associated with functionality and not with specific techniques. We conclude that autonomy is a kind of broad intelligence. Building trustworthy and optimal autonomous systems goes far beyond the AI challenge.

Bio: Joseph Sifakis is Emeritus Senior CNRS Researcher at Verimag. His current research interests cover fundamental and applied aspects of system design. The main focus of his work is on the formalization of system design as a process leading from given requirements to trustworthy, optimized and correct-by-construction implementations.

Joseph Sifakis has been a full professor at Ecole Polytechnique Fédérale de Lausanne (EPFL) for the period 2011-2016. He is the founder of the Verimag laboratory in Grenoble, which he directed for 13 years. In 2007, he received the Turing Award for his contribution to the theory and application of model checking, the most widely used system verification technique today.

Joseph Sifakis is a member of the French Academy of Sciences, a member of the French National Academy of Engineering, a member of Academia Europea, a member of the American Academy of Arts and Sciences, and a member of the National Academy of Engineering. He is a Grand Officer of the French National Order of Merit, a Commander of the French Legion of Honor. He has received the Leonardo da Vinci Medal in 2012.



Congress Keynote - Wednesday July 10 10:15 - 11:30 - Keynote Address Location: Aula Magna, Universitá degli Studi di Milano Kathryn Guarini, Vice President, IBM Industry Research

Navigating Technology Acceleration: Ensuring Safe Passage to AI-Powered Digital Business

Abstract: Technology advancements are accelerating, creating new opportunities for industry transformation and business growth. Artificial intelligence (AI) and blockchain have emerged as key disruptors. This talk will describe the rapid

progress of these advanced technologies, highlight the unique requirements for enterprise deployment, and showcase compelling use cases across different industries.

Bio: Kathryn Guarini is Vice President, IBM Industry Research, where she leads IBM's global research programs focused on applying advanced technologies to solve the hardest problems across different industries. Her team focuses particularly on artificial intelligence (AI), blockchain, and internet of things (IoT) solutions in industries including Healthcare and Life Sciences, Financial Services, and Industrials.

Prior Kathryn was Vice President of IBM Research Strategy, where she drove technology strategy for the global research community at IBM. Her focus included forward-looking technology vision as well as cross-research strategic initiatives, including IBM's Global Technology Outlook. Previously, Kathryn was IBM Vice President, Offering Management for z Systems and LinuxONE, where she drove mainframe platform growth focus areas including Cloud, Analytics, Mobile, Security, Linux, and Industry Solutions. In 2015 her team launched LinuxONE, a trusted, efficient, and powerful platform for enterprise-grade Linux.

Kathryn has held various technical, management, and executive positions in research, development, and business. She has led large global teams to deliver complex solutions that meet the ever-changing needs of IT customers. From requirements gathering through innovative design implementation to customer support, Kathryn has played important product development leadership roles including enterprise microprocessor design and systems technology development. She is also experienced in technical strategy and leadership development.

Kathryn's innovative technical research in semiconductor device integration and nanotechnology has been recognized with various industry awards. She holds more than 63 U.S. patents and she is a prolific writer with over 60 technical publications. Kathryn received a Ph.D. from Stanford University and a B.S. degree from Yale University, both in applied physics. Kathryn is active in mentoring, inspiring, and recruiting scientists and engineers of all ages, especially women.



Congress Keynote - Friday July 12 10:15 - 11:30 - Keynote Address Location: Aula Magna, Universitá degli Studi di Milano Sumi Helal, Professor and Chair in Digital Health Lancaster University

Microservice Ecosystem for Digital Health in Integrated Care Settings

Abstract: Digital Health promises measurable improvements in the quality of personalized care, positive changes in health outcomes, and efficiency gains in

the care delivery system. This is especially the case in integrated care settings such as integrated health and social services, integrated primary and specialist care, integrated physical and mental health, and integrated service care with self-care. Microservices promise to enable additional powerful integrations notably integrating human health expertise with machine health expertise (leveraging IoT and AI), and integrating professional health services with crowdsourced community-delivered services (unleashing the "Uber of digital health"). In this talk, I will present a microservices architecture for digital health in the domain of active and healthy aging and chronic disease management. I will particularly demonstrate how microservices can integrate Health IoT devices into clinical care pathways. I will then show how microservices may empower communities economically and promote a shift of outcome-based efficient delivery of care through a new operational and financial model giving rise to a new and "healthy" digital health economy. I will conclude by analyzing some of the key challenges that need to be addressed before the full potential of this new ecosystem can be realized.

Bio: Sumi Helal, PhD, is professor and Chair in Digital Health at Lancaster University, UK, where he leads interdisciplinary research initiatives in digital health in both the School of Computing and Communications (Faculty of Science and Technology) and the Division of Health Research (Faculty of Health and Medicine). As Director of Lancaster University's Center on Digital Health and Quality of Life Technologies, he leads several active projects on Connected Health Cities, Healthy New Towns design and implementation, suicide prevention using cybernetics and analytics, Airport Accessibility for the hearing impaired, and intelligent primary care GP-Patient interactions. He is a board member and lead of the digital health infrastructure and strategies in the Fylde Whyndyke Garden Village - one of ten NHS England Healthy New Towns development project (a 1400-unit, green grass development which provides for a unique opportunity to embed health elements, by design, in public areas, neighborhoods, and the town community hub (school, wellness center and health care facility), to promote health and wellbeing, active and healthy living and ageing, prevent illnesses and improve people's quality of life.

Before joining Lancaster, Sumi was a Computer & Information Science and Engineering Professor at the University of Florida, USA, and Director of its Mobile and Pervasive Computing Laboratory. He co-founded and directed the Gator Tech Smart House, a real-world deployment project that aimed at identifying key barriers and opportunities to make the Smart Home concept a common place (creating the "Smart Home in a Box" concept). His active areas of research focus on architectural and programmability aspects of the Internet of Things, and on pervasive/ubiquitous systems and their human-centric applications with special focus on smart spaces, proactive health/wellness, patient empowerment and e-coaching, and assistive technology in support of personal health, aging, disabilities, and independence. Professor Helal served as the Editor-in-Chief of IEEE Computer (2015-2018), the Computer Society's flagship and premier publication. He currently serves as member of the Board of Governors of the IEEE Computer Society, and Chair of its Magazine Operational Committee. Professor Helal is a Boilermaker (Ph.D., Purdue University, class of 1991) and a Fellow of the IEEE.



Panel Chair: Stephen S. Yau, Arizona State University Paneilsts: Peter P. Chen, Carnegie Mellon University Andreas Kind, Siemens Zheng Yan, Xidian University

Panel Description: Blockchain has been shown to be quite useful in providing important services for various business and IT applications, such as bitcoin, smart contracts, and protection of privacy and security of critical data. However, there are still major challenges which need to be addressed in order to make the applications of blockchain practical and extendable to other application domains. In this panel, challenges, such as large overhead, incorporation and enforcement of trust accuracy and security in business and scientific applications will be discussed. Each panelist will give an opening presentation of his/her point of view, and the discussion will be open to the floor.



Panel Chair: Kumar Bhaskaran, IBM Research Panelists: Natalie Gil, MIT Rong N. Chang, IBM Research Rong (Emily) Liu, Stevens Institute of Technology Ricardo Collado Soto, Stevens Institute of Technology Michael Goul, Arizona State University Jorge Sanz, IBM Research; Luxembourg Institute of Science & Technology Christophe Spoerry, Entrepreneur in residence, AREA42

Panel Description: The financial services (FSS) industry (including banking, insurance and financial markets) is facing mounting pressure to reduce costs, improve customer experience, compete with emerging players and comply with new regulations. At the same time, the industry is seeking and investing in innovations with the potential to transform financial services using technologies like artificial intelligence (AI), blockchain, quantum computing, Internet-of-Things (IoT), cybersecurity, and cloud. These advances are surfacing new capabilities in risk modeling, fraud detection, regulatory compliance, distributed and decentralized trust models, digital customer journeys and data privacy. Financial institutions will be required to embrace these advanced technologies now in order to set a viable course for future growth. This panel will focus on exchange of minds with several academia and industry FSS experts to better understand existing challenges in the industry and potential R&D advances that can bring transformative changes to the financial industry in coming years.



Plenary Panel: AI & Security Thursday July 11 10:15 - 11:30 Location: Aula Magna, Universitá degli Studi di Milano

Panel Chair: Bhavani Thuraisingham, Univeristy of Texas at Dallas Panelists: Elisa Bertino, Purdue University Hiroki Takakura, National Institute of Informatics Ernesto Damiani, Universitá degli Studi di Milano Murat Kantarcioglu, University of Texas at Dallas

Panel Description: Artificial Intelligence (AI) emerged as a field of study in Computer Science in the late 1950s. Researchers were interested in designing and developing systems that could behave like humans. This interest resulted in substantial developments in areas such as expert systems, machine learning, planning systems, reasoning systems and robotics. However, it is only recently that these AI systems are being used in practical applications in various fields such as medicine, finance, marketing, defense, and manufacturing. The main reason behind the success of these AI systems is due to the developments in data science and high-performance computing. For example, it is now possible collect, store, manipulate, analyze and retain massive amounts of data and therefore the AI systems are now able to learn patterns from this data and make useful predictions.

While AI has been evolving as a field during the past sixty years, the developments in computing systems and data management systems have resulted in serious security and privacy considerations. Various regulations are being proposed to handle big data so that the privacy of the individuals is not violated. For example, even if personally identifiable information is removed from the data, when data is combined with other data, an individual can be identified. Furthermore, the computing systems are being attacked by malware resulting in disastrous consequences. In order words, as progress is being made with technology, the security of these technologies is in serious question due to the malicious attacks.

Over the decade. AI and Security are being integrated. For example, machine learning techniques are being applied to solve security problems such as malware analysis, intrusion detection and insider threat detection. However, there is also a major concern that the machine learning techniques themselves could be attacked. Therefore, the machine leading techniques are being adapted to handle adversarial attacks. This area is known as adversarial machine learning. Furthermore, while collecting massive amounts of data causes security and privacy concerns, big data analytics applications in cyber security is exploding. For example, an organization can outsource activities such as identity management, intrusion detection and malware analysis to the cloud.

While AI techniques are being applied to solve cyber security problems, the AI systems have to be protected. For example, how can the machine learning systems be protected from the attacks? What are the threats to the planning systems? How can expert system carry out their functions in the midst of malware attacks? What are the appropriate access control models for AI systems? How can we develop appropriate security policies for AI systems? These are questions that researchers are beginning to provide answers to.

To assess the developments on the integration of AI and Security over the past decade and to determine future directions, the panel will focus on two major questions: (i) how can the developments in AI techniques be used to solve security problems and (ii) how can we ensure that the AI systems are secure and adapt to adversarial attacks? The panel will first provide an an overview of the security and privacy considerations for AI sytems. Second, it will describe the application of AI including machine learning for cyber security applications such as insider threat detection. Third, it will discuss the trends in areas such as adversarial machine learning that take into consideration the attacker's behavior in developing machine learning techniques. Fourth, it will discuss some emerging trends in carrying out trustworthy AI so that the AI techniques can be secured against malicious attacks. Fifth, it will focus on the privacy threats due to the collection of massive amounts of data and potential solutions. Finally, it will discuss the integration of services computing including cloud-based services for AI and Security.



Panel Chairs: Nimish Radia, Ericsson Geoffrey Charles Fox, Indiana University Panelists: Fatemeh Jalali, IBM Research Judy Qiu, Indiana University Umakishore Ramachandran, Georgia Tech Azimeh Sefidcon, Ericsson Massimo Villari, University of Messina

Panel Description: Edge computing is gaining momentum as part of the new distributed computing/ systems paradigm to address the challenges and opportunities in areas such as IoT, 5G and AI/ML. The hype is reaching its crescendo with many major industry players announcing their EDGE strategies/ offerings/products, the launch of Linux Foundation Edge initiative and excitements in academia. At the same time, the CLOUD continues to serve as a focal point for much existing and planned network functionality moving forward. This panel of industry and academic leaders will discuss the opportunities and challenges at the intersection of EDGE and CLOUD systems, including:

- What are the research and industrialization problems to be solved?
- What do you view as the most important issue that need to be solved (such as programming, security, privacy, durability, or trust) in the EDGE/CLOUD environment?
- What are some key use-cases from industry and academic perspectives?



Panel Chair: Dejan Milojicic, Hewlett Packard Labs Panelists: Cecilia Metra, IEEE Computer Society 2019 President Zoran Dimitrijevic, Altiscale Robert Saracco, University of Trento Sumi Helal, Lancaster University Mark Sherman, CERT

Panel Description: IEEE Computer Society technology experts provide annual predictions for the future of tech, presenting what they believe will be the most widely adopted technology trends for the following year. We also describe additional promising technologies that have not yet reached broad adoption and will be revisited next year, as well as technologies that have outpaced many others, and have reached adoption. This panel will provide a sneak peek of the next year's predictions.



Laurence T. Yang St. Francis Xavier University General Chair



Meichun Hsu Oracle General Chair



Beth Plale Indiana University Program Chair



X. Sean Wang Fudan University Program Chair

8th IEEE International Congress on Big Data (BigData Congress 2019) Message from the Chairs

Welcome to the 8th IEEE International Congress on Big Data (BigData Congress 2019), held in Milan, Italy, between July 8th and 13th of 2019.

The IEEE BigData Congress is now recognized as a mainstream event covering the many dimensions of Big Data research, including Models and Algorithms, Data Systems Engineering, Big Data Management, Security and Privacy, Service Performance, Optimization and Visualization, and Case Studies and Experiences.

This year, the conference used two-stage submission model, with an early submission stage and a regular submission stage. The papers submitted in the early stage were reviewed and the authors had the chance of revising the paper and resubmit at the regular submission stage. A few papers were accepted at the early submission stage without revision, but most papers were encouraged to resubmit at the regular submission time. This year's conference also accepted work-in-progress (WiP) paper submissions.

The conference was made possible by the contributions from the research community. The conference received a total of 57 submissions spanning over the early and regular submission stages, and 5 WiP papers. Following a rigorous single-blind peer-review process, each submission was reviewed by at least three experts in the relevant areas for each paper, on the basis of their significance, novelty, technical quality, presentation, and practical impact. After an intense post-review discussion by the program committee, the conference accepted 13 papers as regular-length papers (i.e., acceptance rate was 22.8% for regular-length papers). The conference also accepted 8 papers as short-length papers, and 1 paper among the submitted WiP papers. In addition to these submitted contributions, the conference invited 5 papers to be included in the program as invited papers.

The 2018 IEEE BigData Congress was also made possible by the efforts of the many who volunteered their time and energy for the success of the conference. We would like to thank the excellent work of the program committee members for their great efforts in reading, reviewing, discussing, and finally selecting the papers. Our appreciation extends to all the external reviewers for assisting the program committee.

We would also like to thank the generous guidance and support of Carl K. Chang (Service Congress Steering Committee Chair), Peter Chen (Services Congress General Chair), Elisa Bertino and Ernesto Damiani (Service Congress Program Chair in Chief and Vice Chair in Chief, resp.), as well as Katsunori Oyama (Services Congress Publication Chair) and many others in the Service Congress and BigData Congress 2019 organization.

We wish you all a productive and enjoyable conference in Milan and hope you find the program a valuable source of information on Big Data research.

IEEE Big Data Congress 2019 Technical Program

Note: (REG)=Regular paper (INV)=Invited paper (SHT)=Short paper (WIP)=Work-in-Progress

Monday July 8

9:45 - 11:00 **Session 1: Security and Privacy** Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(INV) Context-Aware Enforcement of Privacy Policies in Edge Computing Clemens Lachner, Thomas Rausch and Schahram Dustdar

(INV) Big Data and Analytics in the Age of the GDPR Piero Bonatti and Sabrina Kirrane

(REG) Mining Semantic Information in Rumor Detection via a Deep Visual Perception Based **Recurrent Neural Networks** Feng Xing and Caili Guo

11:15 - 12:30 Session 2: Resource Management Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(INV) Efficient Re-computation of Big Data Analytics Processes in the Presence of Changes: Computational Framework, Reference Architecture, and Applications Paolo Missier and Jacek Cała

(REG) LPOD: A Local Path Based Optimized Scheduling Algorithm for Deadline-Constrained Big Data Workflows in the Cloud Changxin Bai, Shiyong Lu, Ishtiaq Ahmed and Dunren Che

(REG) Dynamic Resource Shaping for Compute Clusters Francesco Pace, Dimitrios Milios, Damiano Carra and Pietro Michiardi

14:00 - 15:15 Session 3: Applications Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(INV) Big Data Analytics and Predictive Modeling Approaches for the Energy Sector Roberto Corizzo, Michelangelo Ceci and Donato Malerba

(REG) Neural Network Based Transaction Classification System for Chinese Transaction Behavior Analysis Jianyang Yu, Yuanyuan Qiao, Nanfei Shu, Kewu Sun, Shenshen Zhou and Jie Yang

(SHT) CarPredictor: Forecasting the Number of Free Floating Car Sharing Vehicles Within **Restricted Urban Areas**

Luca Cagliero, Silvia Chiusano, Elena Daraio and Paolo Garza

Tuesday July 9

8:30 – 9:45 Session 4: Platform 1 Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(REG) Distributed, Numerically Stable Distance and Covariance Computation with MPI for Extremely Large Datasets Daniel Peralta and Yvan Saeys

(REG) HyperSpark: A Data-Intensive Programming Environment for Parallel Metaheuristics Damian Andrew Tamburri, Michele Ciavotta, Srdjan Krstic and Willem-Jan van den Heuvel

(SHT) BiDaML: A Suite of Visual Languages for Supporting End-user Data Analytics Hourieh Khalajzadeh, Mohamed Abdelrazek, John Grundy, John Hosking and Qiang He

11:45 - 13:00

Session 5: Analysis Methods 1 Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(REG) A Service Clustering Method based on Wisdom of Crowds Hui Gao, Karolina K. Dluzniak, Hong Xia, Jie Wei, Yanping Chen, Wei Xing and Xin Wang

(SHT) Big Data Integration of Heterogeneous Data Sources: the ANONYMOUS Case Study Francesco Guerra, Matteo Paganelli, Paolo Sottovia and Maurizio Vincini

14:00 – 15:15 Session 6: Recommendation Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(INV) dpSmart: A Flexible Group based Recommendation Framework for Digital Repository Systems

Boyuan Guan, Liting Hu, Pinchao Liu, Hailu Xu, Jennifer Fu and Qingyang Wang

(REG) Sequences of Recommendations for Dynamic Groups: What is the Role of Context? Sara Migliorini, Elisa Quintarelli, Damiano Carra and Alberto Belussi

(WIP) An Approach to Cross-lingual Sentiment Lexicon Construction Chia-Hsuan Chang, Ming-Lun Wu and San-Yih Hwang

17:10 – 18:25 Session 7: Prediction Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(REG) Mobility Prediction with Missing Locations based on Modified Markov Model for Wireless Users

Junyao Guo, Lu Liu, Sihai Zhang and Jinkang Zhu

(SHT) PREMISES, A Scalable Data-driven Service to Predict Alarms in Slowly-degrading Multicycle Industrial Processes

Stefano Proto, Francesco Ventura, Daniele Apiletti, Tania Cerquitelli, Elena Baralis, Alberto Macii and Enrico Macii

(SHT) A New Unsupervised Predictive-model Self-assessment Approach that SCALEs Francesco Ventura, Stefano Proto, Daniele Apiletti, Tania Cerquitelli, Simone Panicucci, Elena Baralis, Alberto Macii and Enrico Macii

Wednesday July 10

8:30 – 9:45 Session 8: Platform 2 Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(REG) DLBench: An Experimental Evaluation of Deep Learning Frameworks Sherif Sakr

(REG) Scalable Block Reporting for HopsFS Mahmoud Ismail, August Bonds, Salman Niazi, Jim Dowling and Seif Haridi

(SHT) AIOps for a Cloud Object Storage Service Anna Levin, Shelly Garion, Hillel Kolodner, Dean Lorenz, Katherine Barabash, Michael Kugler and Niall McShane

14:00 – 15:15 Session 9: Analysis Methods 2 Location: Sala Crociera Alta di Studi Umanistici (1), Universitá degli Studi di Milano

(REG) Cluster-Based Join for Geographically Distributed Big RDF Data Fan Yang, Adina Crainiceanu, Zhiyuan Chen and Don Needham

(SHT) Reducing Feature Embedding Data for Discovering Relations in Big Text Data Haojie Huang and Raymond Wong



Geoffrey Fox Indiana University General Chair



Frank Leymann University of Stuttgart General Chair



Claudio Ardagna University of Milan Program Chair



Murat Kantarcioglu University of Texas at Dallas Program Chair

2019 IEEE International Conference on Cloud Computing (CLOUD 2019) Message from the Chairs

Welcome to the 2019 IEEE International Conference on Cloud Computing (CLOUD 2019)!

Since its inception, CLOUD has rapidly grown to become a top-ranked international forum for researchers and practitioners in the area of cloud computing. CLOUD brings together a diverse community to share ideas, present research results, and discuss experiences in building some of the world's most challenging cloud system and applications.

CLOUD 2019 is the 11th IEEE International Conference on Cloud Computing to be held since 2009. As the most prestigious academic conference in the field of Cloud Computing, the CLOUD conferences have proven to be an important venue for enabling research and collaboration, and we expect that CLOUD 2019 will continue this trend.

Cloud Computing has become an elastic pay-as-you-go service creation, delivery, consumption, and management platform in Services Computing. The technical foundations of Cloud Computing include service-oriented architectures, virtualization of hardware and software, process and workflow optimization, data management and storage, and usage-based accounting and billing. The goal of Cloud Computing is to cost-effectively manage the lifecycle of quality-assured services and to share resources among service consumers, partners, and vendors in the cloud value chain. The resource sharing at various levels results in different cloud offerings, such as infrastructure clouds (e.g. hardware, IT infrastructure management), software clouds (e.g. software as a service focusing on middleware as a service, or traditional CRM as a service), application clouds (e.g. business process as a service).

This year's conference attracted 139 submissions from 31 countries from 5 different continents. Each paper was reviewed by at least 3 program committee members. After initial review and follow-up discussions, the program committee selected 29 articles to appear as full papers (resulting in an acceptance rate of 20.8%) for presentation in the research track. Also another 29 articles have been selected as short papers. In addition, we had an exciting "work in progress" track that consisted of recent works related to many emerging cloud computing research challenges. These accepted papers covered a variety of topics including cloud resource management, monitoring, data management in the cloud, deep learning framework leveraging cloud architectures, and data security. In addition to these papers, the conference program included three exciting invited research papers and a symposium of seven additional research papers.

The organization of a conference like CLOUD requires the collaboration of many individuals. First of all, we would like to thank the authors for submitting their work to the reviewers for their efforts in reviewing the papers, engaging in active online discussion during the tough selection process and providing valuable feedback to authors. Meanwhile, we want to thank the Service Congress Steering Committee led by Carl K. Chang, and Service Congress General Chair Peter Chen, and the Service Congress Organizing Committee for their help in putting together such an exciting program. Also, we would like to thank Elisa

Bertino for answering our many questions during the entire process. Finally, we thank all of you who have come to the conference. We hope you find the meeting both stimulating and enjoyable, and that you will also be able to take time to appreciate the beautiful city of Milan!

IEEE International Conference on Cloud Computing 2019 Technical Program

Note: (REG)=Regular paper (ICI)=CLOUD Symposium invited paper (INV)=Invited paper (SHT)=Short paper (WIP)=Work-in-Progress

Tuesday July 9

8:30 - 9:45

Session 1: Cloud Modeling and Provisioning Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Nabil El Ioini, Free University of Bozen, Italy

(SHT) Cloud Readiness Planning Tool (CRPT): An AI-based Framework to Automate Migration Planning Chen Lin, Hongtan Sun, Maja Vukovic, Jinho Hwang and John Rofrano

(SHT) A Deadline-Constrained Preemptive Scheduler Using Queuing Systems for Multi-tenancy Clouds Jia Ru, Yun Yang, John Grundy, Jacky Keung and Li Hao

(SHT) Cloud VM Provisioning using Analytical Performance Models Yasir Shoaib and Olivia Das

8:30 - 9:45

Session 2: Privacy and Data Protection

Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Claudio A. Ardagna, Universitá degli Studi di Milano

(REG) Privacy-preserving Smart Surveillance using Local Color Correction and Optimized ElGamal Cryptosystem Over Cloud Amitesh Singh Rajput and Balasubramanian Raman

(SHT) Data Protection as a Service in the Multi-cloud Environment Maurizio Colombo, Rasool Asal, Quang Hieu Hieu, Ali Sajiad, Fadi Ali El-Moussa and Theo Dimitrakos

(SHT) Children Privacy Identification System in LINE Chatbot for Smart Toys Pei-Chun Lin, Benjamin Yankson, Zhihui Lu, and Patrick C. K. Hung

11:45 - 13:00

Session 3: Cloud Performance and Optimization Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Roberto Di Pietro, Hamad Bin Khalifa University

(REG) Traffic-aware and Reliability-guaranteed Virtual Machine Placement Optimization in Cloud Datacenters Xuan Liu, Bo Cheng, Yi Yue, Meng Wang, Biyi Li and Jun-Liang Chen

(REG) Machine Learning for Performance Prediction of Spark Cloud Applications Alexandre Maros, Fabricio Murai, Ana Paula Couto da Silva, Jussara M. Almeida, Marco Lattuada, Eugenio Gianniti, Marjan Hosseini and Danilo Ardagna (REG) SafeDB: Spark Acceleration on FPGA Clouds with Enclaved Data Processing and Bitstream Protection

Han-Yee Kim, Lei Xu, Rohyoung Myung, Boeui Hong, Heonchang Yu, Weidong Shi and Taeweon Suh

11:45 - 13:00

Session 4: Cloud Management

Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Ying-Feng Hsu, Osaka University

(REG) Failure-Aware Application Placement Modeling and Optimization in High Turnover DevOps Environment Tonghoon Suk, Jinho Hwang, Muhammed Bulut and Zemei Zeng

Tonghoon Suk, Jinho Hwang, Muhammed Bulut and Zemei Zeng

(REG) An Approach to Cloud Execution Failure Diagnosis Based on Exception Logs in OpenStack Yue Yuan, Wenchang Shi, Bin Liang and Bo Qin

(SHT) Using Structural Similarity to Predict Future Workload Behavior in the Cloud Frederick Nwanganga and Nitesh V. Chawla

14:00 - 15:15

Session 5: Cloud Performance and Optimization Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Claudio Ardagna, Politecnico di Milano

(INV) Online VM Consolidation in Cloud Environments Deafallah Alsadie, Zahir Tari and Eidah Alzahrani

(INV) SLA Aware and Deadline Constrained Profit Optimization for Cloud Resource Management in Big Data Analytics-as-a-Service Platforms Yali Zhao, Rodrigo N. Calheiros, Athanasios Vasilakos, James Bailey and Richard O. Sinnott

(INV) A Framework for Monitoring Microservice-oriented Cloud Applications in Heterogeneous Virtualization Environment Ayman Noor, Devki Nandan Jha, Karan Mitray, Prem Prakash Jayaramanz, Arthur Souzax, Rajiv Ranjan and Schahram Dustdar

14:00 – 15:15 Session 6: Cloud Security Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Giovanni Livraga, Universitá degli Studi di Milano

(REG) DMFD: Non-Intrusive Dependency Inference and Flow Ratio Model for Performance Anomaly Detection in Multi-tier Cloud Applications Senbo Fu, Hyong Kim and Rui Prior

(SHT) Toward an Online Network Intrusion Detection System Based on Ensemble Learning Ying-Feng Hsu, Zhenyu He, Yuya Tarutani and Morito Matsuoka

(REG) Anomaly Detection from System Tracing Data using Multimodal Deep Learning Sasho Nedelkoski, Jorge Cardoso and Odej Kao

17:10 – 18:25 Session 7: Cloud Performance Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Paolo Ceravolo, Universitá degli Studi di Milano

(WIP) Improving Big Data Application Performance in Edge-cloud Systems David Haja, Balazs Vass and Laszlo Toka

(WIP) Real-time Workload Allocation Optimizer for Computing Systems by using Deep Learning Hayato Kuwahara, Ying-Feng Hsu, Kazuhiro Matsuda and Morito Matsuoka

(WIP) A Function Clustering Algorithm for Resource Utilization in Service Function Chaining Hidehiro Kanemitsu, Kenji Kanai, Jiro Katto and Hidenori Nakazato

(WIP) Dynamic Virtual Machine Placement Considering CPU and Memory Resource Requirements Abdelkhalik Mosa and Rizos Sakellariou

17:10 - 18:25

Session 8: CLOUD Symposium - Mainly Cloud Futures Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Geoffrey Fox, Indiana University

(ICI) Big Data Benchmarks of High-Performance Storage Systems on Commercial Bare Metal Clouds Hyungro Lee and Geoffrey Fox

Panel Discussion: Cloud Futures Moderator: Geoffrey Fox Participants: Madhusudhan Govindaraju, Kate Keahey, Tevfik Kosar, Haiying Shen

Wednesday July 10

8:30 – 9:45 Session 9: Cost Effective Cloud Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Paolo Ceravolo, Universitá degli Studi di Milano

(REG) Spock: Exploiting Serverless Functions for SLO and Cost aware Resource Procurement in Public Cloud Jashwant Raj Gunasekaran, Prashanth Thinakaran, Mahmut Kandemir, Bhuvan Urgaonkar, George Kesidis and Chitaranjan Das

(SHT) Cost-efficient Stream Processing on the Cloud Tri Truong, Aaron Harwood, Richard O. Sinnott and Shiping Chen

(SHT) Utility-based Strategy for Balanced Cost and Availability at the Cloud Spot Market Gustavo Portella, Eduardo Nakano, Genaina Rodrigues and Alba Cristina Melo

8:30 - 9:45

Session 10: Spatial Cloud Applications Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: R. Balasubramanian, Indian Institute of Technology Roorkee

(SHT) Robust Management of Trans-cloud Applications Antonio Brogi, Jose Carrasco, Francisco Durán, Ernesto Pimentel and Jacopo Soldani (SHT) STRETCH : Autoscalable In-Memory Distributed Storage for Large-scale Geospatial Analytics Bibek Shrestha, Saptashwa Mitra and Sangmi Pallickara

(SHT) A Transactional Framework for Broadening Access to Geo-Diversification Jared Polonitza, David Chiu and Bin Ren

14:00 – 15:15 Session 11: Cloud Verification

Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Jacopo Soldani, Universitá di Pisa

(REG) Cognitive Compliance: Analyze, Monitor and Enforce Compliance in the Cloud Constantin Adam, Muhammed Fatih Bulut, Milton Hernandez and Maja Vukovic

(REG) Testing for Bugs of Cloud-Based Applications Resulting from Spot Instance Revocations Abdullah Alourani, Ajay D. Kshemkalyani and Mark Grechanik

(SHT) Finding Risk Patterns in Cloud System Models Florian Kunz and Zoltan Mann

14:00 – 15:15 Session 12: Cloud Performance Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Zahir Tari, RMIT University

(REG) Data Reduction, Compression, and Recovery for Online Performance Monitoring Salvador Decelles, Matthew Stamm and Nagarajan Kandasamy

(REG) DAGBENCH: A Performance Evaluation Framework for DAG Distributed Ledgers Zhongli Dong, Emma Zheng, Young Choon Lee and Albert Zomaya

(REG) Towards Latency Sensitive Cloud Native Applications: A Performance Study on AWS István Pelle, János Czentye, János Dóka and Balázs Sonkoly

15:45 - 17:30

Session 13: Cloud Management

Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Valerio Bellandi, Universita degli Studi di Milano

(REG) Adaptive Partition Migration for Irregular Graph Algorithms on Elastic Resources Ravikant Dindokar and Yogesh Simmhan

(SHT) Towards the Modelling of Hybrid Cloud Applications Kyriakos Kritikos, Pawel Skrzypek, Oliviu Matei and Alexandru Moga

(SHT) An Adaptive Approach for Dealing with Flow Disruption in Virtualized Water-Cooled Data Centers Udaya Puvvadi, Anuroop Desu, Tyler Stachecki, Kanad Ghose and Bahgat Sammakia

15:45 – 17:30 Session 14: Cloud Applications Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Gopi Ganapathy, Bharathidasan University (REG) DiCeS: Detecting Communities in Network Streams Over the Cloud Panagiotis Liakos, Katia Papakonstantinopoulou, Alexandros Ntoulas and Alex Delis

(REG) Non-Intrusive Cloud Application Transaction Pattern Discovery Shay Horovitz, Yair Arian, Maxim Vaisbrot and Noam Peretz

(REG) Empowering Owners with Control in Digital Data Markets Sabrina De Capitani di Vimercati, Sara Foresti, Giovanni Livraga and Pierangela Samarati

Thursday July 11

8:30 - 9:45

Session 15: Cloud Management

Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Marco Anisetti, Universita degli Studi di Milano

(REG) Horizontal and Vertical Scaling of Container-based Applications using Reinforcement Learning Fabiana Rossi, Matteo Nardelli and Valeria Cardellini

(SHT) Power and Time aware VM Migration for Multi-tier Applications over Geo-distributed Clouds Sourav Kanti Addya, Anurag Satpathy, Bishakh Chandra Ghosh, Sandip Chakraborty and Soumya K. Ghosh

(SHT) Multi-Objective Resource Mapping and Allocation for Volunteer Cloud Computing Tessema Mengistu, Dunren Che and Shiyong Lu

8:30 – 9:45 Session 16: Cloud Efficiency Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Raja Chiky, ISEP

(REG) QuADD: QUantifying Accelerator Disaggregated Datacenter Efficiency Anubhav Guleria, Lakshmi J and Chakri Padala

(REG) Bolt: Towards a Scalable Docker Registry Michael Littley, Ali Anwar, Hannan Fayyaz, Zeshan Fayyaz, Vasily Tarasov, Lukas Rupprecht, Dimitrios Skourtis, Mohamed Mohamed, Heiko Ludwig, Yue Cheng and Ali R. Butt

(SHT) z-READ: Towards Efficient and TransparentZero-copy Read Jiwoong Park, Cheolgi Min, Heonyoung Yeom and Yongseok Son

11:45 – 13:00 Session 26: CLOUD Symposium - Cloud and Edge Systems Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Geoffrey C. Fox, Indiana University

(ICI) Anomaly Detection over Streaming Data: Indy500 Case Study Chathura Widanage, Jiayu Li, Sahil Tyagi, Ravi Teja, Bo Peng, Supun Kamburugamuve, Jon Koskey, Dan Baum, Dayle Smith and Judy Qiu

(ICI) Elevating the Edge to be a Peer of the Cloud Umakishore Ramachandran, Harshit Gupta, Adam Hall, Enrique Saurez Apuy and Zhuangdi Xu
(ICI) Cross-layer Optimization of Big Data Transfer Throughput and Energy Consumption Luigi Di Tacchio, Zulkar Nine, Tevfik Kosar, Fatih Bulut and Jinho Hwang

11:45 - 13:00

Session 17: Cloud Services Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Nabil El Ioini, Free University of Bozen

(REG) TrIMS: Transparent and Isolated Model Sharing for Low Latency Deep Learning Inference in Function as a Service Environments Abdul Dakkak, Cheng Li, Simon Garcia de Gonzalo, Jinjun Xiong and Wen-Mei Hwu

(REG) Industrial-scale Stateless Network Functions Mark Szalay, Mate Nagy, Daniel Gehberger, Zoltan Kiss, Peter Matray, Felician Nemeth, Gergely Pongracz, Gabor Retvari and Laszlo Toka

(SHT) Karamel: A System for Timely Provisioning Large-Scale Software Across IaaS Clouds Kamal Hakimzadeh and Jim Dowling

13:45 - 14:45

Session 27: CLOUD 2019 Symposium - Cloud Systems Location: Sala Crociera alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Geoffrey C. Fox, Indiana University

(ICI) Exploring Potential for Non-Disruptive Vertical Auto Scaling and Resource Estimation in Kubernetes Gourav Rattihalli, Madhusudhan Govindaraju, Hui Lu and Devesh Tiwari

(ICI) Managing Allocatable ResourcesKate Keahey, Pierre Riteau, Jason Anderson and Zhuo Zhen(ICI) An Economic Analysis of Cloud Computing Service Using Reclaimed ResourcesChenbo Zhu, Haiying Shen and Jie Xu

13:45 - 14:45

Session 18: Cloud XaaS Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Kyriakos Kritikos, FORTH

(REG) Cuckoo: A Mechanism for Exploiting Ephemeral and Heterogeneous Cloud Resources Jean-Emile Dartois, Heverson B Ribeiro, Jalil Boukhobza and Olivier Barais

(SHT) Seneca: Fast and Low Cost Hyperparameter Search for Machine Learning Models Michael Zhang, Chandra Krintz, Markus Mock and Rich Wolski

(SHT) Workload Characterization for a Non-Hyperscale Public Cloud Platform Loïc Perennou, Mar Callau-Zori, Sylvain Lefebvre and Raja Chiky

Friday July 12

8:30 – 9:45 Session 19: Cloud Modeling Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Wolf Zimmermann, Martin Luther University Halle-Wittenberg (REG) On-premises Serverless Computing for Event-Driven Data Processing Applications Alfonso Pérez, Sebastián Risco, Diana María Naranjo, Miguel Caballer and Germán Moltó

(REG) Model-Driven Orchestration for Cloud Resources Hayet Brabra, Achraf Mtibaa, Walid Gaaloul, Boualem Benatallah and Faiez Gargouri

(SHT) CadaML: A Modeling Language for Multi-Tenant Cloud Application Data Architectures Assylbek Jumagaliyev and Yehia Elkhatib

11:45 - 13:00

Session 20: Cloud Algorithms

Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Panagiotis Liakos, University of Athens

(REG) A Framework for Collaborative Learning in Secure High-Dimensional Space Mohsen Imani, Yeseong Kim, Sadegh Riazi, John Messerly, Patrick Liu, Farinaz Koushanfar and Tajana Rosing

(SHT) Time-Sensitive Provisioning of Bare Metal Compute as a Cloud Service Sreekrishnan Venkateswaran and Santonu Sarkar

(SHT) Novel Genetic Algorithm with Dual Chromosome Representation for Resource Allocation in Container-based Clouds Boxiong Tan, Hui Ma and Yi Mei

14:00 - 15:15

Session 21: Cloud Applications Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Marcus Mock, University of Applied Sciences Landshut

(REG) Distributing an SQL Query over a Cluster of Containers David Holland and Weining Zhang

(SHT) uSendfile: A User-space Sendfile Verb based on RDMA and Flash Hongzhang Yang, Yahui Yang, Yaofeng Tu and Ping Wang

(SHT) In Method We Trust: Towards an Open Method Kit for Characterizing Spot Cloud Service Pricing Zheng Li, Xuefei Li and Bing Li

17:15 - 18:30

Session 22: Cloud Infrastructure Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Valerio Bellandi, Universita degli Studi di Milano

(WIP) Evaluation of NUMA-Aware Scheduling in Warehouse-Scale Clusters Richard Wu, Xiao Zhang, Xiangling Kong, Yangyi Chen, Robert Hagmann and Rohit Jnagal

(WIP) Scalable Pathogen Pipeline Platform (SP3) Fan Yang-Turner, Denis Volk, Philip Fowler, Jeremy Swann, Matthew Bull, Sarah Hoosdally, Thomas Connor, Tim Peto, and Derrick Crook

(WIP) Towards Approximating Expected Job Completion Time in Dynamic Vehicular Clouds Aida Ghazizadeh, Puya Ghazizadeh, Ravi Mukkamala and Stephan Olariu

(WIP) Blockchain-based e-Vote-as-a-Service Paolo Ceravolo, Emanuele Bellini and Ernesto Damiani

Saturday July 13

8:30 - 9:45

Session 23: Cloud Algorithms Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Zheng Li, University of Conceptión

(WIP) Privacy-preserving Association Rule Mining Algorithm for Encrypted Data in Cloud Computing Hyeongjin Kim, Jaehwan Shin, Youngho Song and Jaewoo Chang

(WIP) Virtual Machine Pre-provisioning for Computation Offloading Service in Edge Cloud Jungwoong Sung, Seungjae Han and Jinwoo Kim

(WIP) Fast and Lightweight Execution Time Predictions for Spark Applications Yasaman Amannejad, Sarah Shah, Diwakar Krishnamurthy and Mea Wang

(WIP) A Highly Efficient Data Locality Aware Task Scheduler for Cloud-based Systems Jia Ru, Yun Yang, John Grundy, Jacky Keung and Li Hao

11:45 - 13:00

Session 24: Serverless Functions and SDN Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Murat Kantarcioglu, University of Texas at Dallas

(WIP) Exploiting Serverless Runtimes for Large-Scale Optimization Arda Aytekin and Mikael Johansson

(WIP) FunctionBench : A Suite of Workloads for Serverless Cloud Function Service Jeongchul Kim and Kyungyong Lee

(WIP) FAVE: Bandwidth-aware Failover in Virtualized SDN for Clouds Heesang Jin, Gyeongsik Yang, Bong-Yeol Yu and Chuck Yoo

(WIP) GlobalFlow: A Cross-Region Orchestration Service for Serverless Computing Services Ge Zheng and Yang Peng

14:00 - 15:15

Session 25: Cloud Infrastructure & Containers Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: David Holland, University of Texas at San Antonio; San Antonio College

(WIP) Analysis and Evaluation of Kubernetes based NFV management and orchestration Maciej Gaweł and Krzysztof Zielinski

(WIP) Towards Scalable k-out-of-n Models for Assessing the Availability of Large-scale Functionas-a-Service Systems with Bayesian Networks Otto Bibartiu, Frank Dürr, Kurt Rothermel, Beate Ottenwälder and Andreas Grau

(WIP) Slimmer: Weight Loss Secrets for Docker Registries Nannan Zhao, Ali Anwar, Vasily Tarasov, Lukas Rupprecht, Dimitrios Skourtis, Amit S Warke, Mohamed Mohamed, and Ali R. Butt

(WIP) Efficient Deep Learning Hyperparameter Tuning using Cloud Infrastructure Mercy Prasanna Ranjit, Gopinath Ganapathy, Kalaivani Sridhar and Vikram Arumugham



John Kubiatowicz University of California Berkeley General Chair



Nimish Radia Ericsson General Chair



James Joshi University of Pittsburgh Program Chair



Hong Zhu Oxford Brookes University Program Chair

3rd IEEE International Conference on Edge Computing (EDGE 2019) Message from the Chairs

Welcome to IEEE EDGE 2019! IEEE EDGE 2019 is the 3nd edition of the IEEE topranked international forum for researchers and practitioners in the relatively new but very active area of Edge Computing and Fog Computing. It brings together a diverse community to share ideas, present experimental results, and discuss experiences in building some of the world's most challenging systems. It is an integral part of the IEEE 2018 Congress of Services.

Edge 2019 received a total of 30 submissions, including 27 submissions of regular papers, 3 work-in-progress papers. Each paper was reviewed by at least 3 PC members followed by online discussions. The final decisions were made by the PC chairs according to the review results. As the result, 6 papers were accepted as regular papers with a highly competitive acceptance rate of 22.2%. The overall quality of submissions was very high and many difficult decisions had to be made to ensure our aim of selecting highest quality submissions. As always, several strong papers could not be accepted as regular papers, thus we accepted 7 papers as short papers, and recommended 7 to the work-in-progress track. We also invited some world-renowned researchers in the subject area to submit invited papers to report their current work and their visions on future development. We are honored by Prof. Mahadev Satyanarayanan of Carnegie Mellon University, Prof. Jiannong Cao of The Hong Kong Polytechnic University, and Prof. Roberto Di Pietro of Hamad Bin Khalifa University, who accepted our invitations and each submitted a high quality research paper co-authored with their research team. As a community we can be proud of the work composing the technical program of the conference. It consists of 7 sessions on various aspects of edge computing.

We would like to thank the PC members and additional reviewers for their dedicated service that they provided for the community to ensure that the large number of submissions received the consideration and attention they deserve. As conference chairs and program committee chairs we especially appreciate the detailed and very thorough yet timely completion of reviews and the input into the final selection phases.

We sincerely appreciate the work and effort of the authors for preparing their submissions for review, considering and addressing the reviewers' comments before submitting the camera-ready versions of their accepted papers, and attending the conference to present and discuss their work. We also want to thank the IEEE 2019 Congress of Services Organizing Committee, especially Congress General Chair Peter Chen, Congress Steering Committee Chair Carl Chang, and Congress Program Chair-In-Chief Elisa Bertino for their help in putting together such an exciting program. Finally, we thank all of you who have come to the conference and hope that you find the conference both stimulating and enjoyable!

IEEE International Conference on Edge Computing 2019 Technical Program

Note: (REG)=Regular paper (INV)=Invited paper (SHT)=Short paper (WIP)=Work-in-Progress

Monday July 8

9:45 – 11:00 Session 1: AI and Machine Learning in Edge Computing Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Jian Yang, Macquarie University

(REG) Efficient Deep Neural Networks for Edge Computing Mohammed Alnemari and Nader Bagherzadeh

(SHT) Multilayer Active Learning for Efficient Learning and Resource Usage in Distributed IoT Architectures Sasho Nedelkoski, Lauritz Thamsen, Ilya Verbitskiy and Odej Kao

(SHT) Meet Genetic Algorithms in Monte Carlo: Optimised Placement of Multi-Service Applications in the Fog Antonio Brogi, Stefano Forti, Carlos Guerrero and Isaac Lera

11:15 – 12:30 Session 2: Work in Progress Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Donggang Cao, Peking University

(WIP) Edge-based and Privacy-preserving Multi-modal Monitoring of Student Engagement in Online Learning Environments Davy Preuveneers and Wouter Joosen

(WIP Enabling Multi-source Coded Downloads Patrik János Braun, Derya Malak, Muriel Médard and Péter Ekler

(WIP) Pushing Participatory Sensing Further to the Edge Zheng Song, Junjie Cheng, Abhishek Chauhan and Eli Tilevich

(WIP) Architectural Issues for Self-adaptive Service Migration Management in Mobile Edge Computing Scenarios Vincenzo Grassi and Vittoria De Nitto Personè

(WIP) Remote Debugging for Containerized Applications in Edge Computing Environments Muhammet Oguz Ozcan, Fatih Odaci and Ismail Ari

Tuesday July 9

8:30 – 9:45 Session 3: Edge-enabled Applications Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Rajiv Ranjan, Newcastle University

(INV) The Seminal Role of Edge-Native Applications Mahadev Satyanarayanan, Guenter Klas, Marco Silva, Simone Mangiante

(REG) Liv(e)-ing on the Edge: User-Uploaded Live Streams Driven by "First-Mile" Edge Decisions Jiasi Chen, Bharath Balasubramanian and Zhe Huang

(SHT) An Integrated IoT enabled On-demand Grocery Shopping and Delivery Cloud System using MTComm at the Edge S M Nahian Al Sunny, Xiaoqing Liu and Md Rakib Shahriar

11:45 – 13:00 Session 4: Resource Allocation in Edge Computing Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Shuiguang Deng, Zhejiang University

(INV) QoS Guaranteed Resource Allocation for Live VM Migration in Edge Clouds Lei Yang, Doudou Yang, Jiannong Cao, Yuvraj Sahni, Xiaohua Xu

(REG) A Programming Model for Reliable and Efficient Edge-Based Execution Under Resource Variability Zheng Song and Eli Tilevich

(SHT) Decentralized Resource Auctioning for Latency-Sensitive Edge Computing Cosmin Avasalcai, Christos Tsigkanos and Schahram Dustdar

14:00 – 15:15 Session 5: Edge Clouds Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Frank Liu, University of Arkansas

(REG) DEFT: Dynamic Edge Fabric Environment (Seamless and automatic switching among resources at the edge of IoT network and cloud) Fatemeh Jalali, Timothy Lynar, Olivia J. Smith, Ramachandra Rao Kolluri, Claire V. Hardgrove, Nick Waywood and Frank Suits

(REG) Towards Analyzing the Performance of Hybrid Edge-Cloud Processing Dumitrel Loghin, Lavanya Ramapantulu and Yong Meng Teo

(SHT) Mandrake: Implementing Durability for Edge Clouds Kyle Carson, John Thomason, Markus Mock, Rich Wolski and Chandra Krintz

17:10 – 18:25 Session 6: From Edge to Fog and Cloud Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Rajiv Ranjan, Newcastle University

(SHT) SMURF: Efficient and Scalable Metadata Access for Distributed Applications from Edge to the Cloud Bing Zhang and Tevfik Kosar

(WIP) Multi Authority Access Control in a Cloud EHR System with MA-ABE Sharad Dixit, Karuna Joshi and Seung Geol Choi

(WIP) Cloud-Assisted Model Predictive Control Per Skarin, Karl-Erik Årzen, Maria Kihl and Johan Eker

(WIP) Enhancing Context-Awareness in Autonomous Fog Nodes for IoT Systems Basil Nikolopoulos, Maria Voreakou, Mara Nikolaidou and Dimosthenis Anagnostopoulos

Wednesday July 10

8:30 – 9:45 Session 7: Security and Privacy Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: I-Ling Yen, University of Texas at Dallas

(INV) Edge Computing Perspectives: Architectures, Technologies, and Open Security Issues Maurantonio Caprolu, Roberto Di Pietro, Flavio Lombardi, and Simone Raponi

(REG) Reducing Temporal Interference in Private Clouds through Real-Time Containers Tommaso Cucinotta, Luca Abeni, Mauro Marinoni, Alessio Balsini and Carlo Vitucci

(SHT) NetFPGA-based Firewall Solution for 5G Multi-Tenant Architectures Ruben Ricart-Sanchez, Pedro Malagon, Jose M. Alcaraz-Calero and Qi Wang



Jacky Akoka CNAM General Chair



Rong N. Chang IBM Research General Chair



Gabriella Pasi University of Milano-Bicocca Program Chair



Dinesh Verma IBM Research Program Chair

2019 IEEE International Conference on Cognitive Computing (ICCC 2019) Message from the Chairs

We would like to welcome you to the fourth IEEE International Conference on Cognitive Computing (IEEE ICCC 2019). Cognitive Computing is the field exploring technologies to build real-world systems and services that can continuously improve on their own without human intervention. Cognitive Systems can be built using AI and Machine Learning methods, as well as by exploring traditional means to create self-improving systems.

In this year's conference, we have received many different types of papers dealing with many aspects of cognitive computing. An important aspect of any cognitive system is its ability to secure itself against external threats. A set of papers dealing with security of systems, and how that can be improved using cognitive computing forms the first session of the conference for this year. The papers in this session explore intrusion detection, protection against malware, and detecting unwanted devices in a network.

The next session explores solutions that are built using cognitive computing techniques, including emotion prediction, sentiment analysis, efficient activations for machine learning and better ways to remember passwords. These provide components that can be used to build cognitive computing solutions.

The short paper session covers some cognitive computing systems that are being built currently, which include approaches for machine learning model management, identification of important features in learning, brain computer interfaces and automatic understanding of taxonomy in a domain.

A special feature of cognitive computing is that it spans work in traditional computer science with that in the social sciences. Research that falls in this area can be called cognitive humanities. This year, we have a special session on cognitive humanities that covers topics of social connection recommendation, understanding peer pressure, and identifying characters in fictional narrative.

Fundamental advances in understanding cognitive computing are covered in the cognitive science session, which explores visual representation of abstract concepts, learning without forgetting and enhancements to random graph embeddings.

Taken together, these five sessions in cognitive computing cover exciting new topics that should be interesting to both the theoretician as well as the practical system builder. We look forward to seeing you in the sessions and having interactive discussions on the new advances in the field.

We would like to take this opportunity to thank all the authors who submitted quality papers to the Conference, as well as the program committee members

and external reviewers for their hard work. They have made it possible for us to put together a highquality program for IEEE ICCC 2019. Special thanks go to Peter Chen, general chair of IEEE SERVICES 2019, and Carl K. Chang, steering committee chair of IEEE SERVICES, for their leadership and proactive pivotal contributions to the Conference.

IEEE International Conference on Cognitive Computing 2019 Technical Program

Note: (REG)=Regular paper (INV)=Invited paper (SHT)=Short paper (WIP)=Work-in-Progress

Monday July 8

9:45 – 11:00 Session 1: Cognitive Security Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Kaushik Roy, Purdue University

(REG) An AI enabled system for Distributed System Characterization Seraphin Calo, Dinesh Verma, Maroun Touma, Franck Le, Douglas Freimuth and Erich Nahum

(REG) Identifying and Clustering Users for Unsupervised Intrusion Detection in Corporate Audit Sessions Mathieu Garchery and Michael Granitzer

11:15 – 12:30 Session 2: Cognitive Solutions Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Linsong Chu, IBM

(REG) Difficulties and Improvements to Graph-based Lexical Sentiment Analysis using LISA Mireille Fares, Angela Moufarrej, Eliane Jreij, Joe Tekli and Willam Grosky

(REG) Fusing Acoustic and Electroencephalographic Modalities for User-Independent Emotion Prediction Stavros Ntalampiras, Federico Avanzini and Luca Andrea Ludovico

(REG) Using EEG to Predict and Analyze Password Memorability Ruba Alomari, Miguel Vargas Martin, Shane MacDonald and Christopher Bellman

(INV) Scaling Deep Spiking Neural Networks with Binary Stochastic Activations Kaushik Roy, Deboleena Roy and Indranil Chakraborty

14:00 – 15:15 Session 3: Short Paper Session Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Dinesh Verma, IBM TJ Watson

(SHT) IoT Data Management System for Rapid Development of Machine Learning Models Keith Grueneberg, Bongun Ko, David Wood, Xiping Wang, Dean Steuer and Yeonsup Lim

(WIP) Feature Importance Identification through Bottleneck Reconstruction Linsong Chu, Ramya Raghavendra, Mudhakar Srivatsa, Alun Preece and Daniel Harborne

(WIP) Towards Classifying Motor Imagery Using a Consumer-Grade Brain-Computer Interface Ganyu Wang, Miguel Martin, Patrick Hung and Shane MacDonald

Tuesday July 9

8:30 – 9:45 Session 4: Cognitive Science Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Gabriella Pasi, University of Milano-Bicocca

(REG) The Visual Representation of Abstract Verbs: Merging Verb Classification With Iconicity in Sign Language Simone Scicluna and Carlo Strapparava

(REG) Investigating Extensions to Random Walk Based Graph Embedding Jörg Schlötterer, Martin Wehking, Fatemeh Salehi Rizi and Michael Granitzer

(REG) Criteria for Learning without Forgetting in Artificial Neural Networks Rupesh Karn, Prabhakar Kudva and Ibrahim Elfadel

Bargaining Compatible Explanations Ernesto Damiani, Bruno Apolloni, Aamna Al Shehhi

11:45 – 13:00 Session 5: Cognitive Humanities Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Dinesh Verma, IBM TJ Watson

(REG) An Opinion Diversity Enhanced Social Connection Recommendation Re-ranking Method based on Opinion Distance in Cyber Argumentation with Social Networking Joseph Sirrianni, Md Mahfuzer Rahman, Xiaoqing Frank Liu and Douglas Adams

(REG) The Impact of Peer Pressure: Extending Axelrod's Model on Cultural Polarization Rhodri Morris, Liam Turner, Cheryl Giammanco and Roger Whitaker

(REG) Tackling the Challenge of Computational Identification of Characters in Fictional Narratives Cristina Barros, Marta Vicente and Elena Lloret

(REG) Securing Malware Cognitive Systems against Adversarial Attacks Yuede Ji, Benjamin Bowman and H. Howie Huang

(WIP) Extraction of Taxonomic Relation of Complex Terms by Recurrent Neural Network Atsushi Oba and Incheon Paik



Schahram Dustdar TU Wien General Chair



Manish Parashar Rutgers University General Chair



Surya Nepal CSIRO's Data61 Program Chair



Dong Seong Kim University of Queensland Program Chair

2019 IEEE International Congress on Internet of Things (ICIOT 2019) Message from the Chairs

Welcome to the 2019 IEEE International Congress on Internet of Things (ICIOT 2019)!

Internet of Things (IoT) is one of core networking paradigms and is now moving into a new era which is termed as Internet of Things Services. In this era, sensors and other types of sensing devices, wired and wireless networks, platforms and tools, data processing/visualization/analysis and integration engines, and other components of traditional IoT are interconnected through innovative services to realize the value of connected things, people, and virtual Internet spaces. The way of building new IoT applications is changing. We indeed need creative thinking, long-term visions, and innovative methodologies to respond to such a change. The 3rd IEEE International Congress on Internet of Things (ICIOT 2019) is organized to continue promote research and application innovations around the world. The IEEE ICIOT 2019 invited original papers addressing all aspects of IoT systems and services for these systems including IoT architectures, IoT based various solutions, security and privacy issues for IoT and so on.

We received research papers in three tracks this year: 1) early paper submissions track, 2) normal paper submissions track and 3) work-in-progress (WIP) track. In the early paper submissions track, we selected 4 papers out of 8 valid submissions. In the normal paper submissions track, we accepted a total of 14 full papers and 3 short papers out of 33 submitted papers. In both early and normal paper submissions tracks, each paper was rigorously reviewed at least 3 reviewers. In the WIP track, we accepted 3 papers out of 9 submitted papers. In addition to the above accepted papers, we have 3 invited papers as follows:

• Eunil Seo, Hyoungshick Kim and Tai-Myoung Chung. Profiling-based classification algorithms for security applications in Internet of Things.

• Christian Rondanini, Barbara Carminati and Elena Ferrari. Confidential Discovery of IoT devices through Blockchain.

• Anas Dawod Alrefaee, Dimitrios Georgakopoulos, Prem Prakash Jayaraman and Ampalavanapillai Nirmalathas. Advancements Towards a Universal IoT Device Discovery and Integration.

We are so grateful to all the members of the program committee and external reviewers for their hard work for quality reviews. We would like to express our gratitude to all the authors who submitted their papers.

IEEE International Conference on Internet of Things 2019 Technical Program

Note: (REG)=Regular paper (INV)=Invited paper (SHT)=Short paper (WIP)=Work-in-Progress

Tuesday July 9

14:00 – 15:15 Session 1: Discovery Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Mara Nikolaidou, Harokopio University of Athens

(INV) Confidential Discovery of IoT devices through Blockchain Christian Rondanini, Barbara Carminati and Elena Ferrari

(REG) Automated Detection of Rule Conflicts for Enterprise IoT Mari Abe, Gaku Yamamoto, Sanehiro Furuichi and Kazuhito Akiyama

(REG) How to Discover IoT Devices When Network Traffic is Encrypted Ray Valdez, Hani Jamjoom and Dimitrios Pendarakis

17:10 – 18:25 Session 2: Networking Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Mohan Baruwal Chhetri, Swinburne University of Technology

(REG) LoRa Network Planning: Gateway Placement and Device Configuration Behnam Ousat and Majid Ghaderi

(REG) A Blockchain-Based Architecture for Traffic Signal Control Systems Wanxin Li, Mark Nejad, and Rui Zhang

(REG) Control as a Service Architecture to Support Cloud-based and Event-driven Control Application Development Minhu Lyu, Frederique Biennier and Parisa Ghodous

(WIP) CoAP Accelerator in Programmable Logic for Processor-Constrained Devices Lucas Brasilino and Martin Swany

Wednesday July 10

8:30 – 9:45 Session 3: Architecture Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Pavan Murali, IBM TJ Watson Research Center

(REG) Advances in Deployment and Orchestration Approaches for IoT - A Systematic Review Phu H. Nguyen, Nicolas Ferry, Gencer Erdogan, Hui Song, Stéphane Lavirotte, Jean-Yves Tigli and Arnor Solberg

(REG) A Strategic Game for Task Offloading among Capacitated UAV-mounted Cloudlets Weibin Ma, Xuanzhang Liu and Lena Mashayekhy

(SHT) An Extensible Approach for Integrating Health and Activity Wearables in Mobile IoT Apps Ilse Bohé, Michiel Willocx and Vincent Naessens (WIP) ActSen – AI-enabled Real-time IoT-based Ergonomic Risk Assessment System Jia Xin Low, Yongmei Wei, Joshua Chow and Iskandar F. B. Ali

(WIP) Designing the GDPR Compliant Consent Procedure for Personal Information Collection in the Iot Environment Goo Yeon Lee, Kyung Jin Cha and Hwa Jong Kim

14:00 – 15:15 Session 4: Security & Safety Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Dimitrios Georgakopolus, Swinburne University of Technology

(REG) Detection of Anomalous Behavior in Wireless Devices Using Changepoint Analysis Ricardo Manzano, Abdurhman Albasir, Kshirasagar Naik, Jim Kozlowski and Nishith Goel

(REG) Authorization Transparency for Accountable Access to IoT services Luca Ferretti, Francesco Longo, Michele Colajanni, Giovanni Merlino and Nachiket Tapas

(REG) A Model-Based Approach for the Design of Cyber-Physical Human Systems Emphasizing Human Concerns Christos Kotronis, Ioannis Routis, Anargyros Tsadimas, Mara Nikolaidou and Dimosthenis Anagnostopoulos

15:45 – 17:30 Session 5: Applications Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Mari Abe, Tokyo Software & Systems Development Laboratory (TSDL), IBM

(REG) Forecasting Building Energy Consumption with Deep Learning: A Sequence to Sequence Approach Ljubisa Sehovac, Cornelius Nesen and Katarina Grolinger

(REG) Improving the Accuracy of Outdoor Temperature Prediction by IoT Devices Nevena Golubovic, Rich Wolski, Chandra Krintz and Markus Mock

(REG) A Prediction-Optimization Framework for Site-wide Process Optimization Pavankumar Murali, Dharmashankar Subramanian, Nianjun Zhou, Claire Ma, Jayant Kalagnanam, Giovane Cesar Da Silva and Raju Pavuluri

(SHT) Automating Energy Demand Modeling and Forecasting Using Smart Meter Data Poojitha Amin, Ludmila Cherkasova, Rob Aitken and Vikas Kache

Thursday July 11

8:30 – 9:45 Session 6: Algorithms Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Katarina Grolinger, Western Universtiy

(INV) Profiling-based Classification Algorithms for Security Applications in Internet of Things Eunil Seo, Hyoungshick Kim and Tai-Myoung Chung

(INV) Advancements Towards a Universal IoT Device Discovery and Integration Anas Dawod Alrefaee, Dimitrios Georgakopoulos, Prem Prakash Jayaraman and Ampalavanapillai Nirmalathas (REG) A Credible and Lightweight Multidimensional Trust Evaluation Mechanism for Serviceoriented IoT Edge Computing Environment Zhipeng Gao, Wensi Zhao, Chenxi Xia, Kaile Xiao, Zijia Mo, Qian Wang and Yang Yang

11:45 – 13:00 Session 7: Privacy & Security Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Shuo Wang, Monash University

(REG) Adapting Users' Privacy Preferences in Smart Environments Md. Zulfikar Alom, Barbara Carminati and Elena Ferrari

(REG) Privacy and Security in Internet-Connected Cameras Junia Valente, Keerthi Koneru and Alvaro Cardenas

(REG) How Secure is Your IoT Network? Joshua Payne, Karan Budhraja and Ashish Kundu

(SHT) On the Bulk Ingestion of IoT Devices from Heterogeneous IoT Brokers Elefelious Getachew Belay, Sara Bonfitto, Fatima Hachem, Stefano Valtolina and Marco Mesiti



Heiko Ludwig IBM Research General Chair



Bhavani Thuraisingham University of Texas at Dallas General Chair



Elena Ferrari University of Insubria Program Chair



Jia Zhang Carnegie Mellon University Program Chair

2019 IEEE International Conference on Web Services (ICWS 2019) Message from the Chairs

Welcome to the 2019 IEEE International Conference on Web Services (ICWS 2019) and welcome to Milan! IEEE ICWS 2019 is the 26th conference of the top ranked international forum for researchers and practitioners in the area of Web Services. IEEE ICWS brings together a diverse community to share ideas, present exciting new research and experimental results, and discuss experiences in building some of the world's most challenging systems for a very rapidly changing technology. The breadth of the field is reflected in the variety of topics covered by submitted papers, including Web services discovery and composition, Web services specifications and enhancements, Web Services QoS, Web Services security, privacy and trust, Web services–based applications and solutions, and all aspects of Service-Oriented Architecture (SOA) infrastructure and middleware.

The call for papers attracted about 178 submissions from a variety of countries around the world. Each paper has been reviewed by at least three reviewers who are experts in the field. Extensive online discussions took place to make the final selection for the conference. The program committee finally accepted 32 regular papers, leading to a highly competitive acceptance rate of around 18%. In addition, 40 papers were accepted as short papers and 10 as work-in-progress papers. We would like to thank the program committee for the amazing service that they provided to the community. We also appreciate the work and effort by the authors in preparing their submissions for review, considering and addressing the reviewers' comments before submitting the camera-ready copies of their accepted papers, and attending the conference to present and discuss their work.

We also want to thank every member of the IEEE ICWS 2019 Organizing Committee for their help and support in putting together such an exciting program. In particular, special thanks go to Peter Chen, General Chair of the 2019 IEEE Services Congress, Stephen S. Yau, Honorary General Chair of the 2019 IEEE Services Congress, Elisa Bertino, Services Congress Program Chair in Chief, Ernesto Damiani, Services Congress Vice Program Chair in Chief, and Carl K. Chang, Steering Committee Chair of the Congress, for their visions and guidance. Finally, we thank everyone attending ICWS 2019.

We hope that you will find this program interesting and thought-provoking and that the conference will provide you with a valuable opportunity to share ideas with other researchers and practitioners from institutions and organization around the world.

IEEE International Conference on Web Services 2019 Technical Program

Note: (REG)=Regular paper (INV)=Invited paper (SHT)=Short paper (WIP)=Work-in-Progress

Tuesday July 9

8:30 - 9:45 Session 1: Privacy Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Elena Ferrari, University of Insubria

(REG) P-STM: Privacy-protected Social Tie Mining of Individual Trajectories Shuo Wang, Surya Nepal, Richard Sinnott and Carsten Rudolph

(REG) Privacy-Preserving Architecture for Cloud-IoT Platforms Maribel Fernandez, Jenjira Jaimunk and Bhavani Thuraisingham

8:30 – 9:45 Session 2: Blockchain Location: Borgogna, NH Collection President Session Chair: Phu Hong Nguyen, SINTEF

(INV) Federated AI for the Enterprise: A Web Services based Implementation Dinesh Verma, Graham White and Geeth de Mel

(SHT) Composing Drone-as-a-Services (DaaS) for Delivery Babar Shahzaad, Athman Bouguettaya, Sajib Mistry and Azadeh Ghari Neiat

(REG) A Semantic Approach for Automating Knowledge in Policies of Cyber Insurance Services Ketki Joshi, Karuna Joshi and Sudip Mittal

11:45 – 13:00 Session 3: IoT Services Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Chouki Tibermacine, LIRMM, CNRS, Montpellier University

(REG) Effect-driven Dynamic Selection of Physical Media for Visual IoT Services using Reinforcement Learning Kyeongdeok Baek and In-Young Ko

(SHT) IoT Service Composition for Concurrent Timed Applications Mengyu Sun, Zhangbing Zhou, Wenbo Zhang and Patrick C. K. Hung

(SHT) Service Specification and Discovery in IoT Networks Hessam Moeini, I-Ling Yen and Farokh Bastani

11:45 – 13:00 Session 4: Microservices Location: Borgogna, NH Collection Milano President Session Chair: In-Young Ko, Korea Advanced Institute of Science & Technology

(REG) MS-Rank: Multi-Metric and Self-Adaptive Root Cause Diagnosis for Microservice Applications Meng Ma, Weilan Lin, Disheng Pan and Ping Wang (REG) Microscaler: Automatic Scaling for Microservices with an Online Learning Approach Guangba Yu, Pengfei Chen and Zibin Zheng

(REG) Reg: An Ultra-lightweight Container that Maximizes Memory Sharing and Minimizes the Runtime Environment Wei Wang, Liqing Zhang, Dong Guo, Shaoling Wu, Haibo Cui, and Fenglin Bi

14:00 - 15:15

Session 5: Edge Computing

Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Pethuru Raj, Reliance Jio Infocomm. Ltd. (RJIL)

(REG) Service Capacity Enhanced Task Offloading and Resource Allocation in Multi-Server Edge Computing Environment Wei Du, Tao Lei, Qiang He, Wei Liu, Qiwang Lei, Hailiang Zhao and Wei Wang

(REG) Mobility-aware and Migration-enabled Online Edge User Allocation in Mobile Edge Computing Qinglan Peng, Yunni Xia, Zeng Feng, Jia Lee, Chunrong Wu, Xin Luo, Wanbo Zheng, Hui Liu, Yidian Qin, Peng Chen

(REG) Data Caching Optimization in the Edge Computing Environment Ying Liu, Qiang He, Dequan Zheng, Mingwei Zhang and Bin Zhang

14:00 – 15:15 Session 6: Service Composition Location: Borgogna, NH Collection Milano President Session Chair: Massimo Mecella, Sapienza Università di Roma

(REG) Availability-aware Service Chain Composition and Mapping in NFV-enabled Networks Meng Wang, Bo Cheng, Shuai Zhao, Wendi Feng, and Junliang Chen

(SHT) Pre-joined Semantic Indexing Graph for QoS-aware Service Composition Jing Li, Guodong Fan, Ming Zhu and Yuhong Yan

(SHT) Identifying and Estimating Technical Debt for Service Composition in SaaS Cloud Satish Kumar, Rami Bahsoon, Tao Chen and Rajkumar Buyya

17:10 – 18:25 Session 7: Recommender Systems Location: Borgogna, NH Collection Milano President Session Chair: Jia Zhang, Carnegie Mellon University

(REG) Diversified Quality Centric Service Recommendation Yiwen Zhang, Lei Wu, Qiang He, Feifei Chen, Shuiguang Deng and Yun Yang

(SHT) Deep Attentive Factorization Machine for App Recommendation Service Chenkai Guo, Yifan Xu, Xiaolei Hou, Naipeng Dong, Jing Xu, and Quanai Ye

(REG) SocialST: Social Liveness and Trust Enhancement Based Social Recommendation Ran Li, Hong Lin, Yilong Shi and Hongxia Wang

Wednesday July 10

8:30 - 9:45 Session 8: Resource Allocation & Discovery Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Hui Ma, Victoria University Wellington

(REG) Automatic K-Resources Discovery for Hybrid Web Connected Environments Lara Kallab, Richard Chbeir and Michael Mrissa

(SHT) Multiple Energy Harvesting Devices Enabled Joint Computation Offloading and Dynamic Resource Allocation for Mobile-Edge Computing Systems Wei Du, Qiwang Lei, Qiang He, Wei Liu, Feifei Chen, Lei Pan, Tao Lei and Hailiang Zhao

14:00 - 15:15 **Session 9: Social Services** Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Shijun Liu, Shangdong University

(SHT) A Community-based Collaborative Filtering Method for Social Recommender Systems Bin Liang, Bo Xu, Xiaowei Wu, Dong Wu, Deqing Yang, Yanghua Xiao and Wei Wang

(INV) Towards a Service-Oriented Architecture for Pre-processing Crowd-Sourced Sentiment from Twitter

M. Brian Blake, Julian Jarrett and Kimberly Hemming-Jarrett

15:45-17:30 Session 10: Reputation & Trust Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Bhavani Thuraisingham, University of Texas at Dallas

(REG) Adaptive Trust: Usage-Based Trust in Crowdsourced IoT Services Mohammed Bahutair, Athman Bouguettaya and Azadeh Gharineiat

(REG) Reputation Evaluation with Malicious Feedback Prevention Using a HITS-Based Model Okba Tibermacine, Chouki Tibermacine and Mohamed Lamine Kerdoudi

(SHT) Machine Learning-Driven Trust for MEC-based IoT Services Prabath Abeysekara, Hai Dong and Kai Qin

15:45 - 17:30 Session 11: Mobile Service Computing Location: Borgogna, NH Collection Milano President Session Chair: Heiko Ludwig, IBM Research

(REG) A Mobility-Aware Cross-edge Computation Offloading Framework for Partitionable Applications Hailiang Zhao, Shuiguang Deng, Chen Zhang, Wei Du, Qiang He, Jianwei Yin

(REG) Mobility-Aware Service Selection in Mobile Edge Computing Systems Hongyue Wu, Shuiguang Deng, Wei Li, Jianwei Yin, Xiaohong Li, Zhiyong Feng, and Albert Zomaya

(SHT) A Multi-Objective Crowdsourcing Method for Mobile Video Streaming Xiaolong Xu, Shucun Fu, Lianyong Qi, Xuyun Zhang, and Wanchun Dou

Thursday July 11

8:30 - 9:45

Session 12: Service Applications Beyond the Web Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Sandeep Kumar, Indian Institute of Technology Roorkee

(SHT) Block Chain-Based Data Audit and Access Control Mechanism in Service Collaboration Chao Wang, Shizhan Chen, Zhiyong Feng, Yanan Jiang and Xiao Xue

(SHT) A Full-Spectrum Blockchain-as-a-Service for Business Collaboration Yaoliang Chen, Jingxiao Gu, Shi Chen, Sheng Huang and Xiaoyang Wang

(SHT) Services as Enterprise Smart Contracts in the Digital Factory Ada Bagozi, Devis Bianchini, Valeria De Antonellis, Massimiliano Garda and Michele Melchiori

8:30 – 9:45 Session 13: Service Composition & Planning Location: Borgogna, NH Collection Milano President Session Chair: Ya Bin Dang, IBM Research China

(INV) A Conceptual Architecture and Model for Smart Manufacturing Relying on Service-based Digital Twins Tiziana Catarci, Donatella Firmani, Francesco Leotta, Federica Mandreoli, Massimo Mecella and Francesco Sapio

(SHT) Crossover Service Fusion Approach Based on Microservice Architecture Siying Guo, Chao Xu, Shizhan Chen, Xiao Xue, Zhiyong Feng and Shiping Chen

(SHT) Bandwidth Planning of Web Services in Changing Contexts Based on Network Simulation Jianpeng Hu, Linpeng Huang, Ying Fan, Lanxuan Tong, and Wenqiang Hu

11:45 – 13:00 Session 14: Service Selection Location: Borgogna, NH Collection Milano President Session Chair: Devis Bianchini, University of Brescia

(REG) Relationship Network Augmented Web Services Clustering Yingcheng Cao, Jianxun Liu, Min Shi, Buqing Cao, Xiangping Zhang, and Yan Wang

(SHT) FASS: A Fairness-Aware Approach for Concurrent Service Selection with Constraints Songyuan Li, Jiwei Huang, Bo Cheng, Lizhen Cui and Yuliang Shi

(SHT) Clustering Based Approach for Web Service Selection using Skyline Computations Sandeep Kumar and Lalit Purohit

11:45 - 13:00 (schedule change due to transportation strike) Session 15: Service Recommendation & Prediction Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Yanping Chen, Xi'an University of Posts & Telecommunication

(REG) Generative Adversarial Network Based Service Recommendation in Heterogeneous Information Networks Fenfang Xie, Shenghui Li, Liang Chen, Yangjun Xu and Zibin Zheng

(REG) Recommending Packages of Multi-criteria Items to Groups Edgar Ceh-Varela and Huiping Cao (REG) CSSAP: Software Aging Prediction for Cloud Services Based on ARIMA-LSTM Hybrid Model Jing Liu, Xue-Yong Tan and Yan Wang

13:45 - 14:45

Session 16: Cloud Location: Borgogna, NH Collection Milano President Session Chair: Eli Tilevich, Virginia Tech

(SHT) DCStore: A Deduplication-Based Cloud-of-Clouds Storage Service Bo An, Yan Li, Junming Ma, Gang Huang, Xiangqun Chen and Donggang Cao

(REG) An Online Algorithm for Selling Your Reserved IaaS Instances in Amazon EC2 Marketplace Shengsong Yang, Li Pan and Shijun Liu

(REG) Long-term IaaS Provider Selection using Short-term Trial Experience Sheik Mohammad Mostakim Fattah, Athman Bouguettaya and Sajib Mistry

Friday July 12

8:30 – 9:45 Session 17: Location-based and Mobile Services Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Chenkai Guo, Nankai University

(REG) Deep Representation Learning of Activity Trajectory Similarity Computation Yifan Zhang, An Liu, Guanfeng Liu, Zhixu Li and Qing Li

(REG) Edge-Based Shortest Path Caching for Location-Based Services Detian Zhang, An Liu, Gaoming Jin and Qing Li

(REG) A First Look at Instant Service Consumption with Quick Apps on Mobile Devices Yi Liu, Enze Xu, Yun Ma and Xuanzhe Liu

11:45 – 13:00 Session 18: Data-driven Services Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Incheon Paik, University of Aizu

(REG) ElfStore: A Resilient Data Storage Service for Federated Edge and Fog Resources Sumit Monga, Sheshadri Ramachandra and Yogesh Simmhan

(REG) A Data-driven Service Creation Approach for Effectively Capturing Events from Multiple Sensor Streams Zhongmei Zhang, Jian Yu, Xiaohong Li, Chen Liu , Yanbo Han, and Yunan Ma

(SHT) Data-intensive Application Deployment at Edge: A Deep Reinforcement Learning Approach Yishan Chen, Hailiang Zhao, Qiang He, Shuiguang Deng, Ying Li, and Honghao Gao

14:00 – 15:15 Session 19: Service Monitoring & Management Location: Sala Crociera Alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Shuiguang Deng, Zhejiang University

(REG) Outcome-Oriented Predictive Process Monitoring with Attention-based Bidirectional LSTM Neural Networks Jiaojiao Wang, Dongjin Yu, Chengfei Liu and Xiaoxiao Sun (SHT) Selecting Publishing Points for the Optimal Sharing of Predictive Monitoring Information of a Service Process Jian Cao, Xiaofu Huang, Yi Wei and Qing Qi

(REG) AIMS: A Predictive Web API Invocation Behavior Monitoring System Lanxuan Tong, Jian Cao, Qing Qi, and Shiyou Qian

14:00 – 15:15 Session 20: Business Process Management Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Jing Li, Shandong University

(SHT) A Novel Part of Speech Tagging Framework for NLP based Business Process Management Xue Han, Yabin Dang, Lijun Mei, Yanfei Wang, Shaochun Li and Xin Zhou

(SHT) Filtering out Noise Logs for Process Modelling Based on Event Dependency Xiaoxiao Sun, Wenjie Hou, Dongjin Yu, Jiaojiao Wang and Jianliang Pan

(SHT) On-the-fly Collaboration for Legacy Business Process Systems in An Open Service Environment Lin Ye, Biqi Zhu, Chenglong Hu, Hong-Linh Truong and Liang Zhang

17:15 – 18:30 Session 21: Web Services Application Location: Montforte/Sala Sforza, NH Collection Milano President Session Chair: Hongyue Wu, Tianjin University

(SHT) Deep Multimodal Learning: An Effective Method for Video Classification Tianqi Zhao

(SHT) Promoting Higher Revenues for Both Crowdsourcer and Crowds in Crowdsourcing via Contest

Song Xu, Lei Liu, Lizhen Cui, Qingzhong Li and Zhongmin Yan

(SHT) KS-Diff: A Key Structure based Difference Detection Method for Process Models Jiaxing Wang, Jianchao Lu, Bin Cao, Jing Fan and Dapeng Tan

17:15 – 18:30 Session 22: Provenance, Security & Reliability Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Hong Zhu, Oxford Brookes University

(SHT) Value Attribution Through Provenance Tracking in Blockchain Networks Shreya Chakraborty, Praveen Jayachandran and Balaji Vishwanathan

(REG) On Computing Throttling Rate Limits in Web APIs through Statistical Inference Donatella Firmani, Francesco Leotta and Massimo Mecella

(REG) Equivalence-Enhanced Microservice Workflow Orchestration to Efficiently Increase Reliability Zheng Song and Eli Tilevich

Saturday July 13

8:30 - 9:45

Session 23 (WIP Session 1): Deep Learning in Services Computing Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Shi Bing, Wuhan University of Technology

(WIP) DeepWSC: A Novel Framework with Deep Neural Network for Web Service Clustering Guobing Zou, Zhen Qin, Qiang He, Pengwei Wang, Bofeng Zhang and Yanglan Gan

(WIP) Adaptable Deep Learning Generation by Automatic Service Composition Incheon Paik and Ryo Ataka

(WIP) Deep Learning for Web Services Classification Yilong Yang, Wei Ke, Weiru Wang and Yongxin Zhao

11:45 - 13:00

Session 24 (WIP Session 2): Service Management Location: Sala Napoleonica Main, Universitá degli Studi di Milano Session Chair: Dongjin Yu, Hangzhou Dianzi University

(WIP) Checking Temporal Service Level Agreements for Web Service Compositions with Temporal Parameters Marco Franceschetti and Johann Eder

(WIP) Customizing Multi-Tenant SaaS by Microservices: A Reference Architecture Hui Song, Phu H. Nguyen, Franck Chauvel, Jens Glattetre and Thomas Schjerpen

(WIP) GTAA: A Geo-Aware Task Allocation Approach in Cloud Workflow Meng Niu, Bo Cheng and Junliang Chen

(WIP) VCA-Optimizer: SOA-based Customizable Virtual Cluster Allocation in the Cloud Datacenter Xuan Liu, Bo Cheng and Jun-Liang Chen



Michael Goul Arizona State University General Chair



Xiaofei Xu Harbin Institute of Technology General Chair



Yan Wan Macquarie University Program Chair



Luciano Baresi Politecnico of Milan Program Chair

2019 IEEE International Conference on Services Computing (SCC 2019) Message from the Chairs

Welcome to the 2019 IEEE International Conference on Services Computing (IEEE SCC 2019). SCC 2019 is co-located with other six conferences/congresses under the umbrella of the 2019 IEEE World Congress (IEEE SERVICES 2019), held on July 8-13, 2019 in Milan, Italy. The six conferences/congresses include 2019 IEEE International Congress on Big Data (BIGDATA CONGRESS 2019), 2019 IEEE International on Cloud Computing (IEEE CLOUD 2019), 2019 IEEE International Conference on Edge Computing (IEEE EDGE 2019), 2019 IEEE International Conference on Cognitive Computing (IEEE ICCC 2019), 2019 IEEE International Conference on Internet of Things (IEEE ICIOT 2019), and 2019 IEEE International Conference on Web Services (IEEE ICWS 2019).

Services account for a major part of today's IT industry. Companies increasingly like to focus on their core expertise area and use IT services to address all their peripheral needs. Services Computing is a new science which aims to study and better understand the foundations of this highly popular industry. It covers the science and technology of leveraging computing and information technology to model, create, operate, and manage business services. Like its predecessors, IEEE SCC 2019 aims to bridge the gap between business services and information technology by driving research in technologies such as serviceoriented architecture (SOA), business process integration and management, service engineering, cloud computing, and Web 2.o. It covers the whole lifecycle of innovative research and enabling technologies, which includes enterprise modelling, business consulting, solution creation, services delivery, services orchestration, services optimization, services management, services marketing, services delivery and cloud computing, service-oriented architecture (SOA), business process integration and management, and web services technologies and standards.

The IEEE SCC 2019 Program Committee consists of 90 experts from 17 countries. This year we have received a total of 114 submissions. Each submission was reviewed by at least three program committee members. After a rigorous double-blind review process, we accepted 16 full papers and 14 short papers in the Research Track, and 4 papers in the Work-in-Progress Track.

We would like to give our special thanks to all members in the program committee and many volunteers, for conducting a rigorous reviewing process with a tight schedule. We also would like to take this opportunity to express our deep appreciation to SERVICES CONGRESS Honorary General Chair Prof. Stephen Yau, SERVICES CONGRESS General Chair Prof. Peter Chen, SERVICES CONGRESS Program Chair in Chief Prof. Elisa Bertino, SERVICES CONGRESS Vice Program Chair in Chief Prof. Ernesto Damiani, and Steering Committee Chair Prof. Carl Chang for their guidance and assistance. All of the leadership and help they provided has been critical to the successful organisation of this important conference for the services computing community.

Last but not least, we thank all of you for participating in IEEE SCC 2019, and hope that you will enjoy the technical presentations and discussions.

IEEE International Conference on Services Computing 2019 Technical Program

Note: (REG)=Regular paper (INV)=Invited paper (SHT)=Short paper (WIP)=Work-in-Progress

Tuesday July 9

17:10 – 18:25 Session 1: Service Recommendation I Location: Corridoni, NH Collection Milano President Session Chair: Yan Wang, Macquarie University

(REG) Regularizing Matrix Factorization with Implicit User Preference Embeddings for Web API Recommendation Kenneth Fletcher

(SHT) Helpfulness-aware Matrix Factorization for Cross-Category Service Recommendations Bowen Zhou, Raymond Wong, Victor Chu, Tengyue Li, Simon Fong and Chi-Hung Chi

(SHT) Recommending Energy-Efficient Data Mining Services with Data as Contextual Factors Zainab Al-Zanbouri and Chen Ding

Wednesday July 10

8:30 – 9:45 Session 2: Fog Computing Location: Corridoni, NH Collection Milano President Session Chair: Luciano Baresi, Politecnico di Milano

(REG) Service Placement in Fog Computing Using Constraint Programming Farah Ait Salaht, Frederic Desprez, Adrien Lèbre, Charles Prud'Homme and Mohamed Abderrahim

(REG) Fog Function: Serverless Fog Computing for Data Intensive IoT Services Bin Cheng, Jonathan Fuerst, Gurkan Solmaz and Takuya Sanada

14:00 – 15:15 Session 3: IoT Systems & Stream Processing Location: Corridoni, NH Collection Milano President Session Chair: Akhilesh Bajaj, University of Tulsa

(INV) Engineering Resilient Collaborative Edge-enabled IoT Roberto Casadei, Mirko Viroli, Christos Tsigkanos and Schahram Dustdar

(SHT) Trustworty IoT: An Evidence Collection Approach based on Smart Contracts Claudio Ardagna, Rasool Asal, Ernesto Damiani, Nabil El Ioini and Claus Pahl

(SHT) Increased Fault-Tolerance and Real-time Performance Resiliency for Stream Processing Workloads through Redundancy Geoffrey Phi Tran, John Paul Walters and Stephen Crago

15:45 – 17:30 Session 4: Containers & Edge Computing Location: Corridoni, NH Collection Milano President Session Chair: Giovanni Quattrocchi, Politecnico di Milano

(REG) Your Containers should be WYSIWYG Mathieu Bacou, Alain Tchana and Daniel Hagimont (REG) A Container Scheduling Strategy Based on Machine Learning in Microservice Architecture Jingze Lv, Mingchang Wei and Yang Yu

(INV) Context-aware Multi-QoS Prediction for Services in Mobile Edge Computing Zhizhong Liu, Quan Z. Sheng, Wei Emma Zhang, Dianhui Chu and Xiaofei Xu

Thursday July 11

8:30 – 9:45 Session 5: Security & Privacy Location: Corridoni, NH Collection Milano President Session Chair: Michael Goul, Arizona State University

(REG) F-LaaS: A Control-Flow-Attack Immune License-as-a-Service Model Sandeep Kumar, Diksha Moolchandani, Takatsugu Ono and Smruti Sarangi

(REG) FlashGhost: Data Sanitization with Privacy Protection Based on Frequent Colliding Hash Table Yan Zhu, Shuai Yang and William Cheng-Chung Chu

(INV) Helping Users Managing Context-based Privacy Preferences Md. Zulfikar Alom, Barbara Carminati and Elena Ferrari

11:45 – 13:00 Session 6: Service & Data Management Location: Corridoni, NH Collection Milano President Session Chair: Supratik Mkhopadhyay, Louisiana State University

(REG) FM4SN: A Feature-Oriented Approach to Tenant-Driven Customization of Multi-Tenant Service Networks Indika Kumara, Jun Han, Willem-Jan van den Heuvel, Alan Colman and Damian Tamburri

(SHT) An Online Personalized Reputation Estimation Model for Service-oriented Systems Jianlong Xu, Xin Du, Weihong Cai, Changsheng Zhu and Yindong Chen

(SHT) Set-Covering Theory-based Data Placement Cost Optimization for Online Social Networks Xia Ji, Ruiyue Zhu and Xuejun Li

13:45 - 14:45

Session 7: Service Composition & Pipelines Location: Corridoni, NH Collection Milano President Session Chair: Massimo Mecella, Sapienza University of Rome

(REG) NLSC: Unrestricted Natural Language-based Service Composition through Sentence Embeddings Oscar L Romero, Ankit Dangi and Sushma Akoju

Oscar J. Romero, Ankit Dangi and Sushma Akoju

(SHT) Enhancing Monitoring Queries Invoking Composition of Services Malik Khalfallah and Parisa Ghodous

(SHT) On the Design and Architecture of Deployment Pipelines in Cloud and Service Based Computing -- A Model-Based Qualitative Study Uwe Zdun, Evangelos Ntentos, Konstantinos Plakidas, Amine El Malki, Daniel Schall and Fei Li

Friday July 12

8:30 – 9:45 Session 8: Cloud Services Location: Montforte/Sala Sforza, NH Collection Milano President Session Chair: Zhi Jin, Peking University

(REG) A Genetic-based Approach to Location-aware Cloud Service Brokering in Multi-cloud Environment Tao Shi, Hui Ma and Gang Chen

(REG) A Transactional Approach for Reliable Elastic Cloud Resources Farah Bellaaj Elloumi, Hayet Brabra, Mohamed Sellami, Walid Gaaloul and Sami Bhiri

(SHT) Towards a Democratic Federation for Infrastructure Service Provisioning Bishakh Chandra Ghosh, Sourav Kanti Addya, Anurag Satpathy, Soumya K. Ghosh and Sandip Chakraborty

11:45 – 13:00 Session 9: Processes & Workflows Location: Montforte/Sala Sforza, NH Collection Milano President Session Chair: Flavio De Paoli, Universitá Milano Bicocca

(REG) Overlapping Analytic Stages in Online Process Mining Gabriel Marques Tavares, Paolo Ceravolo, Victor Guilherme Turrisi da Costa, Ernesto Damiani and Sylvio Barbon Junior

(REG) Novel Discovery Mechanism for Crossing-Workflow Fragments Leveraging Activity Relevance Jinfeng Wen and Zhangbing Zhou

(SHT) Leveraging Shallow Machine Learning to Predict Business Process Behavior Annalisa Appice, Nicola Di Mauro and Donato Malerba

14:00 – 15:15 Session 10: Service Recommendation II Location: Montforte/Sala Sforza, NH Collection Milano President Session Chair: Claudio Ardagna, Universitá degli Studi di Milano

(REG) Service Recommendation based on Attentional Factorization Machine Yingcheng Cao, Jianxun Liu, Min Shi, Buqing Cao, Ting Chen and Yiping Wen

(SHT) A POI-Sensitive Knowledge Graph based Service Recommendation Method Hu Sihang, Tu Zhiying, Wang Zhongjie and Xu Xiaofei

(REG) QF-RNN: QI-Matrix Factorization Based RNN for Time-Aware Service Recommendation Xing Wu, Yushun Fan, Jia Zhang, Haozhe Lin and Junqi Zhang

Saturday July 13

8:30 – 9:45 Session 11: Resource Management Location: Montforte/Sala Sforza, NH Collection Milano President Session Chair: Kenneth Fletcher, University of Massachusetts Boston

(SHT) Towards Risk-Aware Cost-Optimal Resource Allocation for Cloud Applications Mohan Baruwal Chhetri, Abdur Rahim Mohammad Forkan, Bao Vo, Surya Nepal and Ryszard Kowalczyk (SHT) Dynamic Data Routing Decisions for Compliant Data Handling in Service- and Cloud-Based Architectures: A Performance Analysis Amirali Amiri, Christoph Krieger, Uwe Zdun and Frank Leymann

(REG) Enhancing Availability of Traffic-aware Virtual Cluster Allocation in Cloud Datacenters Xuan Liu, Bo Cheng, Jun-Liang Chen, Yi Yue, Meng Wang, and Biyi Li

11:45 – 13:00 Session 12: Work in Progress Location: Montforte/Sala Sforza, NH Collection Milano President Session Chair: Luciano Baresi, Politecnico di Milano

(WIP) Situation-Aware Access Control in Federated Data-as-a-Service for Maritime Search And Rescue Samson Oni, Zhiyuan Chen, Adina Crainiceanu, Karuna Joshi and Don Needham

(WIP) Facilitating the Support of Cloud-Based Service Marketplaces Jacqueline Büttner, Marc Hesenius and Volker Gruhn

(WIP) Ephemeral Data Handling in Microservices Saverio Giallorenzo, Fabrizio Montesi, Larisa Safina and Stefano Pio Zingaro

(WIP) Winnability Prediction for IT Services Bids Pei Guo, Aly Megahed, Shubhi Asthana and Paul Messinger



Yanchun Sun Peking University Co-Chair



Supratik Mukhopadhyay Louisiana State University Co-Chair

2019 SERVICES Symposium on Service Computing (CONCISE) Message from the Chairs

Welcome to the 2019 IEEE SERVICES Symposium on Service Computing! Services Computing has become a hot research topic and attracted more and more attention in recent years. The 2019 IEEE SERVICES Symposium on Service Computing covers all aspects of services computing and applications, current or emerging. It covers various systems and networking research pertaining to cloud, edge and Internet-of-Things (IoT), as well as technologies for intelligent computing, learning, big data, and blockchain applications, while addressing critical requirements such as high performance, security, privacy, dependability, trustworthiness, re-usability, interoperability, and cost-effectiveness. The 2019 IEEE SERVICES Symposium on Service Computing is organized to continue to promote research and application innovations on service computing around the world.

We received 41 research papers from concise paper track this year. Each paper was reviewed by at least 3 program committee members. After initial review and follow-up discussions, the program committee accepted 23 papers for presentation in the symposium.

We are grateful to all the members of the program committee and external reviewers for their hard work for quality reviews. We would like to express our gratitude to all the authors who submitted their papers. Meanwhile, we want to thank the Service Congress Steering Committee led by Carl K. Chang, and Service Congress General Chair Peter Chen, and the Service Congress Organizing Committee for their help in putting together such an exciting program.

2019 IEEE SERVICES Symposium on Services Computing Concise Papers

Thursday July 11

8:30 - 9:45 Session 1 Location: Monforte/Sala Sforza, NH Collection Milano President Session Chair: Zhiying Tu, Harbin Institute of Technology

e-SBOT: A Soft Service Robot for User-Centric Smart Service Delivery Xiaofei Xu, Zhongjie Wang, Zhiying Tu, Dianhui Chu and Yunming Ye

Policy-based De-identification Test Framework Armin Gerl and Stefan Becher

A Question-Driven Source Code Recommendation Service Based on Stack Overflow Hang Yin, Zhiyu Sun, Yanchun Sun and Wenpin Jiao

An Automatic Semantic Code Repair Service Based on Deep Learning for Programs with Single Error Zhiyu Sun, Chao Xin and Yanchun Sun

A Systematic Cloud Workload Clustering Technique in Large Scale Data Centres Salam Isamaeel and Ali Miri

11:45 - 13:00 (schedule change due to transportation strike) Session 2 Location: Monforte/Sala Sforza, NH Collection Milano President

Session Chair: Bradley D. Taylor, The Catholic University of America

Measurement and Observation of Cross-Provider Cross-Region Latency for Cloud-based IoT Systems

Thy Vu, Chayanne Jaye Mediran and Yang Peng

ERAMIS: A Reference Architecture-based Methodology for IoT Systems Paul Kearney and Rasool Asal

A Multigraph for RESTful Services Discovery in IoT Ecosystem Ivan Madjarov and Fatma Slaimi

Landcover Based 3-Dimensional Inverse Distance Weighting for Visualization of Radiation Dose Ryo Kikawa, Katsunori Oyama and Hua Ming

A Reinforcement Learning Approach to Web API Recommendation for Mashup Development Richard Anarfi and Kenneth Fletcher

Friday July 12

8:30 – 9:45 Session 3 Location: Sala Crociera Alta di Umanistici (1), Universitá degli Studi di Milano Session Chair: Hui Ma, Victoria University of Wellington

A User Profile based Pension Service Recommendation Algorithm Chunshan Li, Chu Dianhui, Xiaofei Xu and Yunfei Bu

Output and Input Data Perturbations for Differentially Private Databases Fatema Rashid and Ali Miri

A Smart and Safe Construction Application Design for Fog Computing Petar Kochovski, Marko Bajec, Rizos Sakellariou and Vlado Stankovski

Towards a Methodology for Evaluating Big Data Platforms Evangelia Kavakli, Rizos Sakellariou and Vlado Stankovski

RESTfulness of APIs in the Wild Irina Astrova, Arne Koschel, Maximilian Blankschyn, Kevin Schulze, Dominik Schöner and Igor Astrov

14:00 – 15:15 Session 4 Location: Sala Crociera Alta di Umanistici (1), Universitá degli Studi di Milano Session Chair: Sandeep Kumar, Indian Institute of Technology Roorkee

Where Are We Looking? Understanding Android Static Analysis Techniques Suzanna Schmeelk

Analyzing Effect of Ensemble Models on Multi-Layer Perceptron Network for Software Effort Estimation Suyash Shukla and Sandeep Kumar Query Data Inconsistency for Business Processes Yongping Tang and Jian Yang

Dynamic Service Composition Orchestrated by Cognitive Agents in Mobile & Pervasive Computing Oscar Javier Romero López

Saturday July 13

8:30 – 9:45 Session 5 Location: Sala Crociera Alta di Umanistici (1), Universitá degli Studi di Milano Session Chair: Supratik Mukhopadhyay, Louisiana State University

Dyn-YCSB: Benchmarking Adaptive Frameworks Subhajit Sidhanta, Supratik Mukhopadhyay and Wojciech Golab

Towards Specification of a Software Architecture for Cross-Sectoral Big Data Applications Ioannis Arapakis, Yolanda Becerra, Omer Boehm, George Bravos, Vassilis Chatzigiannakis, Cesare Cugnasco, Giorgos Demetriou, Iliada Eleftheriou, Julien Etienne Mascolo, Lidija Fodor, Sotiris Ioannidis, Dusan Jakovetic, Leonidas Kallipolitis, Evangelia Kavakli, Despina Kopanaki, Nicolas Kourtellis, Mario Maawad Marcos, Ramon Martin de Pozuelo, Nemanja Milosevic, Giuditta Morandi, Enric Pages Montanera, Gerald Ristow, Rizos Sakellariou, Raul Sirvent, Srdjan Skrbic, Ilias Spais, Giorgos Vasiliadis and Michael Vinov

Delivering Data Mining Services in Cloud Computing Manuel Parra-Royon and José M. Benítez

Evaluation of Big Data Governance - Combining a Multi-Criteria Approach and Systems Theory Jacky Akoka and Isabelle Comyn-Wattiau



Sumi Helal Lancaster University Co-Chair



Carl K. Chang Iowa State University Co-Chair

IEEE World Congress on SERVICES 1st IEEE Digital Health as a Service Symposium (DHAASS) Message from the Chairs

Digital health entails the use of ICT technology for radical improvements in the pathways of disease treatment, etiology (discovery), learning health sciences, diagnosis, monitoring and managing long-term conditions (LTC), and care delivery including emergency care and timely interventions. But digital health does promise a little more. It promises to help individuals and populations maintain a healthy lifestyle promoting and ensuring active and healthy living and aging. Digital health ICT technology is broad and spans Internet-of-Things covering many personal health devices (Health IoT), mobile apps (Mobile Health), human-computer interactions (HCI), biomedical engineering and electronics (e.g., new sensors involving interdisciplinary research in physics and chemistry), new materials and sensors (e.g., nanowire materials, and epidermal electronics for sensing or drug delivery), virtual reality, machine learning, blockchain, brain computer interfaces, and much more.

One of the most anticipated transformations promised by digital health is overhauling the traditional care delivery model by: (a) supporting preventive health and promoting active and healthy living and aging through life-long lifestyle guidance and modulation; (b) increasing the care delivery system scalability and sustainability (for instance, technology will augment and supplement the inadequate healthcare work force); (c) significantly improving

the quality of delivery by utilizing real-time health and behavior data enabling a continuum-of-care and just-in-time interventions – a care model of superior quality when compared to the current point-of-care system; (d) reducing unit and total cost of care saving governments, employers, insurance companies, and individuals billions annually; and (e) ultimately, improving health outcomes and people's quality of life. Medically, the impact of digital health will go further by enabling an order of magnitude cheaper, and an order of magnitude faster evidence-based clinical research. Such powerful capabilities will help speed up technology-based transformations of the world's health care systems regardless of geography or the overarching payer and financial models.

Digital Health as a Service: Looking at health and integrated care through a services' spectacles reveals significant opportunities for engaging digital health to affect an ecosystem shift in which a new health economy is unleashed by engaging multiple and new roles including communities in their own integrated healthcare services delivery. Broadly speaking, healthcare related services discovery, services composition, and services provisioning will need to be based on cutting-edge computer technologies and digital media/data so that quality factors including timing, granularity, scale, cost-effectiveness and precision are integral parts of the value chain in such an ecosystem. Digital Health services can include, among many other innovative methods, preventive and predictive capabilities of machine learning based data analytics, actionable recommendations based on in-situ monitoring and assessment of an individual's real-time performance and mental conditions, trade-off analysis between cloud-based versus edge-based sensory data streaming and data analytics. Developing effective techniques for maintaining security and privacy pertaining to malicious manipulation of end-users data to distort ML algorithm performance, and hijacking of biomedical/wearable devices by hackers are examples of most critical, emerging challenges to our collective wisdom.

Metaphorically, service and microservice models have the potential to introduce the "Uber" of integrated healthcare in which micro-tasks, that are part of the integrated healthcare delivery, and that may not require medical or specialized expertise, can be crowd-sourced to trusted capable roles and trained members of the community. Transporting patients, administering and transporting a urine samples, and numerous activities of daily living needed by patients, people with special needs, and the elderly population are examples of the scope of such micro-tasks.

But Digital Health as a Service (DHAAS) is not a one-way street. It is a bi-directional concept covering both care provision by the provider and care giver, as well as care demand by the end service user or their

families. For instance, on the demand side, a patient may request an appointment service, or a remote doc service for more urgent matters. An elderly patient may request home help in one of the activities of daily living. On the provision side, a nurse may request a "check on Mr. Johnson" service; or request an "urgent urine sample from Mr. Johnson".

Given the importance of Digital Health and the promise and opportunities that the service model can bring to its implementation, we are pleased to launch the first IEEE DHAASS Symposium. The symposium aims to bring together leading researchers and community leaders in the area of digital health to share their research and visions of the future of health. Equally importantly, the invited speakers are selected bearing in mind their track record and potential for being agents of change who will help define digital health globally as a new and emerging discipline. A special, townhall session is planned to discuss a number of digital health initiatives with active participation by leaders and members from the IEEE Computer Society (ad hoc committee on digital health), the Information Processing Society of Japan, the China Computer Federation, among other collaborators and stakeholders.

Besides the main invited lectures track, the symposium includes two short workshops (the Big Data for Public Health Policy Workshop on July 12, and the Workshop on Digital Health on July 13), a Keynote by Professor Ramesh Jain, Professor and Director of the Institute for Future Health, University of California, Irvine, a concluding panel, in addition to a townhall planning meeting.

The DHAASS Symposium was not possible to put together without the great help of an international Inaugural Advisory Committee (IAC), which we recognize below.

Zhiyong Feng, School of Computer Software, Tianjin University, China Tien Hsu, College of Health Sciences and Technology, National Central University, Taiwan Jianying Hu, Center for Computational Health, IBM Research, USA Ramesh Jain, Institute for Future Health, University of California, Irvine, USA Christopher Nugent, Smart Environments Research Group, Ulster University, UK Pattanasak Mongkolwat, Faculty of ICT, Madihol University, Thailand

We hope that you find the symposium to be informative and exciting and look forward to learning from you through your active participation. Finally, we look forward to welcome you in person in Milan!



Zhiyong Feng Tianjin University Chair



Patric C.K. Hung University of Ontario Chair

ist IEEE Services Workshop on Healthcare Services/ Digital Health (DHS 2019) Message from the Workshop Chairs

Aging across the globe is impacting the demand for healthcare facilities and services. However, there are many problems in the existing healthcare service industry, such as lack or regulation and standardization, low service levels, poor service quality, and other issues. In response to problems, the convergence of healthcare services and many other areas such as insurance, payment options, education, entertainment, and information services have attracted the attention of domain experts and companies. Many hospitals and institutions share data that can be used to explore the hidden demands of people; many companies are seeking to satisfy user needs regarding healthcare services. The convergence of healthcare and services can improve the standardization and quality of both. At the same time, the variety, convergence, and complexity of the healthcare service ecosystem calls for the adoption of new technologies and solutions.

Through information technology and the internet, many new healthcare service models and solutions are emerging across fields. Healthcare service provisions are being further facilitated by the upgrading of technologies, such as the crossborder service integration model, the lower cost cloud platform, cross-domain knowledge graph, increasingly pervasive Internet of Things, block-chain for



privacy, and so on. Directions for areas include, but are not limited to: Healthcare Service Ecosystem; Healthcare Service Innovation Model; Crossover Service in Healthcare Industry; Healthcare Service Value Chain; Healthcare Service Credit Evaluation; Healthcare Service Quality Assurance; Transboundary Healthcare Service Matching and Discovery; Healthcare Service Integration Model and Framework; Healthcare Service Data Fusion; Healthcare Data Analysis Model; Integration Verification of Healthcare Service; Intelligent Interactive Environment; Healthcare Service in IoT

Walid Gaaloul Institut Mines Telecom & Paris Saclay University Chair

IEEE World Congress on SERVICES 1st IEEE Digital Health as a Service Symposium 2019 Technical Program

Saturday July 13

8:30 – 9:45 DHS Workshop: Healthcare Services/Digital Health Crossover Healthcare Service Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Xiao Xue, University of TianJin at TianJin

A Scenario-based Requirement Model for Crossover Healthcare Service Meng Xi, Ying Li, Yongna Wei, Naibo Wang, Yuyu Yini, Zhiling Luo, Shuiguang Deng, Jianwei Yin

Design and Implementation of Credit Evaluation System for Health Aged Service Chao Li, Yiqin Zhao, Sen Li, Penghao Wang, Ziping Zhao

10:15 – 11:30 DHAASS Symposium Location: Durini/Sala Guastalla, NH Collection Milano President

Symposium Opening Carl K. Chang, Iowa State University and Sumi Helal, Lancaster University

Keynote: Opportunities Created by Digitalization of Life and Health Ramesh Jain, University of California-Irvine

11:45 – 13:00 DHAASS Symposium Location: Durini/Sala Guastalla, NH Collection Milano President

Artificial Intelligence in Home Care Settings in South Karelia Social and Healthcare District in Finland Pentti Itkonen, South Karelia Social and Healthcare District, Finland

Digital Health Challenges in the Silver Era Loranzo Chiari, Bologna University

A Holistic View of a Patient Medical Record Pat Mongkowlwat, Mahidol University

13:00 - Lunch Break (boxed lunches will be provided)

13:45 - 15:55 DHAASS Symposium Location: Durini/Sala Guastalla, NH Collection Milano President

Application of Deep Learning to Screening Test of Dementia Kaoru Sakatani, University of Tokyo

From Connected Health to Smart Healthcare: A Path to Equitable Care Deliver Lin-Qun Xu, China Mobile

Integration Platform of Health Services in Aging Society Zhiyong Feng, Tianjin University

Resilient Mechanisms for Reliable Digital Health Services Hiroki Takakura

16:25 - 17:30 DHAAS Plenary Panel Transforming Health and Social Care using Digital Health: Challenges and How to Overcome Them Location: Durini/Sala Guastalla, NH Collection Milano President

Chair: Sumi Helal, Lancaster University Panelists: Ramesh Jain, University of California-Irvine Pentti Itkonen, South Karelia Social and Healthcare District Hiroshi Takakura, National Institute of Informatics Pat Mongkowlwat, Mahidol University Daqing Zhang, TELECOM SudPairs Lorenzo Chiara, Bologna University

17:30 - 18:30 DHAASS Townhall Meeting Location: Durini/Sala Guastalla, NH Collection Milano President



Kumar Bhaskaran IBM TJ Watson Research Center Chair

2019 Future of Financial Services Symposia Message from the Chair

The IEEE World Congress on Services, a major professional event sponsored by the IEEE Computer Society, has for the very first time this year introduced the Future of Financial Services Symposium. This signature symposium will be all day on July 10th and we have an exciting agenda that will be high impact and professional. Following the plenary keynote the morning of July 10th we will have a plenary panel of industry and academic experts discussing business and technology trends and drivers shaping the finance industry. The IEEE World Congress on Services is being held this year for the first time outside the US in Europe. In keeping with the spirit of this World Congress the afternoon keynote will focus on FinTech in Europe and highlight key R&D projects underway in the EU. This will be followed by a technical session that will outline the major innovations and challenges in the industry and look at emerging financial

ecosystems as well as how service compouting can play a major role in a regulated industry such as Finance. The symposium will conclude with a PhD Forum and by passing the baton to the 2020 IEEE World Congress on Services symposium organizers; hosted by Peking University in Beijing from July 6-11, 2020. Please mark your calendar accordingly.

The financial services industry (banking, insurance and financial markets) faces mounting pressure to reduce costs, improve customer experience, compete with emerging players and comply with new regulations. At the same time, the industry is seeking and investing in innovations with the potential to transform financial services using technologies like artificial intelligence (AI), blockchain, quantum computing, Internet-of-Things (IoT), cybersecurity, and cloud. These advances are surfacing new capabilities in risk modeling, fraud detection, regulatory compliance, distributed and decentralized trust models, digital customer journeys and data privacy. Financial institutions will be required to embrace these advanced technologies now in order to set a viable course for future growth.

The primary objective of this symposium is to bring academia and industry domain experts together to define the innovation opportunities in the industry inspired by data-driven and socio-technical topics that are essential to successfully lead the digital future of financial services. This symposium will focus on exchange of minds to better understand existing challenges in the industry and potential R&D advances that can bring transformative changes to the financial industry in coming years. The symposium will address four research themes that is driving the digital disruption and shaping the future of financial services: 1) Decentralization as a new model of trust, 2) AI and the interconnectedness of everything, 3) Secure and trusted cloud services, and 4) Applications of quantum computing in finance.

The global economy is underpinned by financial services and every human life is practically touched by it. The transdormation of this industry and its digital future for the benefit of all will require the expertise of the world's largest technical professional organization such as the IEEE. We encourage everyone attending the World Congress to find time to participate in this important first signature symposium on the Future of Financial Services and benefit from learning and networking and help us fashion an impactful R&D agenda.

IEEE SERVICES - Future of Financial Services Symposia 2019 Technical Program

Wednesday July 10

14:00 – 15:15 Session 1 Location: Aula Magna, Universitá degli Studi di Milano

Keynote: FinTech: European Union Perspective Mirjana Pejic' Bach, Zagreb University

15:45 - 17:30 Session 2 Location: Aula Magna, Universitá degli Studi di Milano

Services Computing and RegTech Michael Goul

Financial Services Industry Challenges and Opportunity Kumar Bhaskaran, Rong N. Chang, Jorge Sanz, Prasenjit Dey

A Marketplace Approach to Trade Risk Data Christophe Spoerry

Quantum Computing in Finance Ricardo Collado Soto

17:30 - 19:00 PhD Forum Location: Sala Napoleonica (Parallel & Main), Universitá degli Studi di Milano


Barbara Carminati University of Insubria Chair



Latifur Khan University of Texas at Dallas Chair



Yanmei Zhang Central University of Finance and Economics Chair

2019 Doctoral Symposium Message from the Symposium Chairs

Welcome to the Doctoral Symposium of the IEEE World Congress on Services (IEEE SERVICES 2019) at beautiful city Milan, Italy. This is the first PhD symposium in IEEE World Congress on Services marking a historic event.

We received a healthy number of submissions from PhD students from all over the world such as Italy, China, United States of America, and India. After review and discussion phases, the PC chairs accepted 9 submissions. Two papers were accepted as long presentations and the rest are accepted as short presentations. In addition, one paper will be presented as a poster. These accepted manuscripts cover a diversified topics such as but not limited to service computing, big data and analytics.

We would like to thank Professor Peter Chan, Professor Carl Chang, and Professor Ernesto Damiani for their leadership to make the PhD symposium successful.

The best presenter will receive \$100 cash prize. We would like to thank IBM for monetary cash prize.

Doctoral Symposium 2019 Technical Program Wednesday July 10 15:45 - 17:30

Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Xiao Xue

Long Presentations

Self-management of Containers Deployment in Decentralized Environments Fabiana Rossi

Data Distribution and Exploitation in a Global Microservice Artefact Observatory

Panagiotis Gkikopoulos

Short Presentations

A Dynamic Scheduling Framework for Multi-Tenancy Clouds Jia Ru

A Semantics-enabled Approach for Data Lake Exploration Services Massimiliano Garda

Service Function Chain Composition and Mapping in NFV-enabled Networks Meng Wang, Bo Cheng and Jun-Liang Chen

MLModelScope: Evaluate and Introspect Cognitive Pipelines Cheng Li, Abdul Dakkak, Jinjun Xiong and Wen-Mei Hwu

Applicability of Neural Network based Models for Software Effort Estimation Suyash Shukla and Sandeep Kumar

Improving the Attribute-based Active Learning by Clustering the New Items Junxin Zhou and Raja Chiky

IDEAaS: Interactive Data Exploration As-a Service Ada Bagozi

A Data Logistics System for Internet of Things Syed Juned Ali, Radha Krishna Pisipati and Kamal Karlapalem



Emanuele Bellini Khalifa University Chair



Stavros Shiaeles University of Plymouth Chair



Nicholas Kolokotronis University of Peloponnese Chair

1st IEEE Services Workshop on Cyber Security and Resilience in the Internet of Things (CSRIoT 2019) Message from the Workshop Chairs

It is our great honor and pleasure to welcome you to the 1st IEEE Services Workshop on Cyber Security and Resilience in the Internet of Things (CSRIoT), hosted in Milan, Italy, from the 8th to 13th of July 2019. The aim of the CSRIoT workshop is to establish an international forum for engineers and scientists to present their ideas and advancements in the fields of Cyber Security and Resilience.

The explosive development of the concept of Internet of Things (IoT) is accompanied by an unprecedented revolution in the physical and cyber world. Smart, always-connected IoT devices provide real-time contextual information with low overhead to optimize processes and improve how companies and individuals interact, work, and live. An increased number of businesses, homes and public areas are now starting to explore IoT applications and services. The number of the interconnected IoT devices in use worldwide now exceeds 8 billion, a number that is expected to grow to 22 billion by 2024. To address the comprehensive nature and emerging challenges of Cyber Security and Resilience in IoT, the CSRIoT workshop discusses approaches, tools, solutions, and advancements in this area. Its goal is to focus on both the theoretical and practical aspects of the security, privacy, trust and resilience of the IoT networks (wide-area and short-range IoT), including applications, services, and novel ways to deal with their vulnerabilities and mitigate sophisticated cyber-attacks in a number of sectors (e.g. information and communication technologies, critical infrastructures, transportation systems, healthcare, energy, etc.).

We are delighted to announced that we received many high-quality submissions that underwent a rigorous peer review process on the basis of their significance, novelty, technical quality, and practical impact. Eventually, 16 high-quality research papers have been selected and will be presented in CSRIoT with topics focusing on data collection and processing from the dark web to efficiently implement countermeasures, the emergence of Blockchain in collecting and retaining forensic evidence along with managing trustworthy IoT deployment in a secure by design fashion, new methods to analyze and understand attack

propagation dynamics, sustain adaptive behavior and exhibit resilience on attacks, as well as and novel attack mitigation strategies using machine learning techniques.

There is always a great team behind a successful event. We would like to take this chance to thank the entire organizing committee of the IEEE Services conference for their endless effort and support in order to make this workshop a success. Of course, we want to express our sincere gratitude to all the authors, participants, PC members, and many others who greatly contributed to this workshop in many different ways. We sincerely hope you will find the 2019 CSRIoT workshop quite informative and interesting for you research and professional activities.

IEEE SERVICES Workshop on Cyber Security & Resilience in the Internet of Things (CSRIoT 2019) 2019 Technical Program

Monday July 8

11:15 – 12:30 Session 1 Location: Corrodoni, NH Collection Milano President Session Chair: Stavros Shiaeles, University of Peloponnese

A Crawler Architecture for Harvesting the Clear, Social, and Dark Web for IoT-related Cyber-threat Intelligence Paris Koloveas, Thanasis Chantzios, Christos Tryfonopoulos and Spiros Skiadopoulos

Investigating Attack Propagation in a SoS via a Service Decomposition Elena Lisova, Jamal El Hachem and Aida Causevic

14:00 – 15:15 Session 2 Location: Corrodoni, NH Collection Milano President Session Chair: Stavros Shiaeles, University of Peloponnese

On Blockchain Architectures for Trust-based Collaborative Intrusion Detection Nicholas Kolokotronis, Sotirios Brotsis, Georgios Germanos, Costas Vassilakis and Stavros Shiaeles

A Watermark Inspection Game for IoT settings Gabriele Gianini, Corrado Mio, Leopold Ghemmogne Fossi and Elod Egyed-Zsigmond

A Forensics-by-design Management Framework for Medical Devices based on Blockchai Vangelis Malamas, Thomas Dasaklis, Panayiotis Kotzanikolaou, Mike Burmester and Sokratis Katsikas

15:45 - 17:00 Session 3 Location: Corrodoni, NH Collection Milano President Session Chair: Stavros Shiaeles, University of Peloponnese

Attacking IEC-60870-5-104 SCADA Systems Panagiotis Radoglou Grammatikis, Panagiotis Sarigiannidis, Ioannis Giannoulakis, Emmanouil Kafetzakis and Emmanouil Panaousis

MQTTSA: A Tool for Automatically Assisting the Secure Deployments of MQTT Brokers Paolo Prem, Andrea Palmieri, Silvio Ranise, Umberto Morelli and Tahir Ahmad

Impact of Misbehaving Devices in Mobile Crowd Sourcing Systems Menatalla Abououf, Shakti Singh, Rabeb Mizouni and Hadi Otrok

Tuesday July 9

8:30 – 9:45 Session 4 Location: Corrodoni, NH Collection Milano President Session Chair: Emanuele Bellini, Khalifa University

DDoS Attack Mitigation through Root-DNS Server: A Case Study Betty Saridou, Stavros Shiaeles and Basil Papadopoulos

Data Verification and Privacy in IoT Architecture Richard Lomotey

Cyber Resilience in IoT Network: Methodology and Example of Assessment through Epidemic Spreading Approach Emanuele Bellini, Franco Bagnoli, Igor Linkov and Alexander A. Ganin

11:45 – 13:00 Session 5 Location: Corrodoni, NH Collection Milano President Session Chair: Emanuele Bellini, Khalifa University

IoT Vulnerability Data Crawling and Analysis Stavros Shiaeles, Nicholas Kolokotronis and Emanuele Bellini

New Two-Level µTESLA Protocol for IoT Environment Alia Al Dhaheri, Ernesto Damiani and Chan Yeob Yeun

Deep Learning Based Approach for Classifying Power Signals and Detecting Anomalous Behavior of Wireless Devices Abdurhman Albasir, Ricardo Alejandro Manzano and K Naik

An Initial Investigation on Sliding Windows for Anomaly-Based Intrusion Detection Tommaso Zoppi, Andrea Ceccarelli and Andrea Bondavalli

Blockchain Security by Design Framework for Trust and Adoption in IoT Environment Gohar Sargsyan, Nicolas Castellon, Peter Cozijnsen and Raymond Binnendijk



Yucong Duan Hainan University Chair



Katsunori Oyama Nihon University Chair

1st IEEE Services Workshop on Knowledge Graph as a Service (KGaaS 2019)Message from the Workshop Chairs

Everything as a Service (EaaS or XaaS) has followed the development of Software-Defined Everything as stakeholders determine the ultimate culmination of human production of both tangible and intangible services. However, in the light of the overall trend of AI driven conversion from traditional services to intelligent services, prevailing challenges arise for both conceptual foundations and technical preparation, especially involving semantic understanding and utilizations.

As Knowledge Graphs are increasingly recognized as an important approach to solving problems related to semantic understanding beyond question and answering systems, various solutions focusing on Knowledge Graphs have been proposed. These cover Knowledge Graph creation, understanding, searching, reasoning, modification and especially and most recently embedding technologies with Machine Learning. A foreseeable AI landscape with explainable and interactive human interactions is becoming feasible based on Knowledge Graphs. The boundaries of the capability of Knowledge Graph usages are constantly expanding, but there are also open questions as to what issues can be solved by Knowledge Graphs alone. Hierarchical architectures which project Data, Information, Knowledge and Wisdom (DIKW) seem to be well paired with the organizing capability of Knowledge Graph technologies in

terms of the 5W (What, Where, When, How and Why). Although not yet formally settled as a uniform concept itself, Knowledge Graphs have been actually or implicitly functioning as Data Graph, Information Graph, Knowledge Graph and Wisdom Graph according to the DIKW hierarchy. Recently we have also seen the emergence of various applications and models of Knowledge Graph as a Service (KGaaS) as a gradual acceleration towards an era of strong AI in contrast to the currently prevailing weak AI.

This workshop aims to bring together scientists, researchers, and industrial engineers to discuss and exchange experimental and theoretical results, novel designs, work-in-progress and case studies on theories, design mechanisms and extensions on Knowledge Graph as a Service. We received 9 submissions among which 7 papers are accepted for oral presentations at the workshop. The accepted papers cover the emergent topics in the area of KGaaS, including models and frameworks of Knowledge Graph, application of ontology, learning process, service recommendation and customer analysis.

We believe that this workshop will bring the key technologies to the art of service computing by discussion among the researchers and practitioners from various fields, not only service computing. We are looking forward to your participation in a successful, engaging and rewarding event.

IEEE SERVICES Workshop on Knowledge Graph as a Service 2019 Technical Program

Friday July 12

8:30 - 9:45 Session 1: Knowledge Graph Models Location: Sala Crociera Alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Kenneth K. Fletcher, University of Massachusetts, Boston

Keynote: Scalable Graph Learning for Finance Toyotaro Suzumaura, IBM TJ Watson Research

Knowledge Graph Provision for Heterogeneous Service Network Lei Yu and Yucong Duan

Mapping ERD to Knowledge Graph Abdelrahman Elfaki, Amer Aljaedi and Yucong Duan

11:45 - 13:00

Session 2: Knowledge Graph in Service Computing Location: Sala Crociera Alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Amer Aljaedi, University of Tabuk

A Knowledge Graph based Framework for Web API Recommendation Benjamin Kwapong and Kenneth Fletcher

Service Recommendation Based on User Dynamic Preference Extraction and Prediction Yanmei Zhang, Ya Qian and Mengjiao Gan

Knowledge-as-a-service: A Community Knowledge Base for Research Infrastructures in Environmental and Earth Sciences Zhiming Zhao

Saturday July 13

11:45 – 13:00 Session 3: Application of Knowledge Graph Location: Sala Crociera Alta di Giurisprudenza (2), Universitá degli Studi di Milano Session Chair: Zhiming Zhao, University of Amsterdam

Dimensional Situation Analytics: An Introduction and Its Application Prospects Hua Ming and Katsunori Oyama

Visualization System for Analyzing Customer Comments in Marketing Research Support System Keita Arai, Yoshitaka Sakurai, Eriko Sakurai, Setsuo Tsuruta and Rainer Knauf

Learning Process Models in IoT Edge Long Cheng, Cong Liu, Qingzhi Liu, Yucong Duan and John Murphy



Shangguang Wang Bijing University of Posts & Telecommunications Chair



Nawaf I. Almoosa Khalifa University Chair



Qiang Duan Pennsylvania State University Chair



Alex X. Liu Michigan State University Chair

1st IEEE Services Workshop on Network Services (NET 2019)Message from the Workshop Chairs

With rapid developments in the technologies of networking and service computing, these two fields are merging together to form a converged networking-computing ecosystem for supporting a wide spectrum of services and applications. Networking has become an indispensable component of the infrastructure for service computing, for example data centers for cloud computing and in-network servers for edge/fog computing. Recent progress in the software-defined anything mechanism allows software to penetrate the Internet to not only control network operations but also define network architecture and service model. Application layer software now can interact with the underlying network infrastructure in a more flexible manner thus is able to customize network services for meeting application requirements and utilize network information for optimizing application performance. In parallel, key technologies for service computing - virtualization and serviceoriented abstraction – have been widely adopted as key attributes in the next generation network architecture, which lead to the latest progress in networking technologies such as Network Function Virtualization (NFV), Software-Defined Networking (SDN), Network-as-a-Service, and Network Slicing. The merging network services are usually composition of multiple service components, APIs, or network functions, based on new mechanisms such as service mesh, internet of services, and service function chaining, running on the network layer and/ or application layer.

Therefore, network service becomes a key element of service computing and the convergence of networking and computing service provisioning brings in new challenges and thus research opportunities in this exciting field. Some interesting and important research topics include but not limited to service function chaining, converged network-compute service orchestration, network slice-as-a-service, internet of services, network security, network services in edge computing, network services in IoT/IoV, network services in 5G networks, SDN for network services, NFV for network services, network service modeling and performance evaluation, etc.

This workshop aims to provide a forum for researchers and practitioners to present their latest progress in network service-related work and discuss the status and developing directions of this area. We received 14 submissions among which 6 papers are accepted for oral presentations at the workshop. The accepted papers cover some important subjects in network services, including cloud-fog architecture upon network infrastructure, integration of service function chaining and SDN, network service security, security for SDN, and evaluation of network services.

We hope that this workshop will reflect the state of the art of network servicerelated research, facilitate discussions and collaboration among researchers and practitioners in this area, and arouse the research community's interest in this exciting interdisciplinary research field. We believe that cross-fertilization between networking and service computing will enable some innovative research progress that my greatly enhance the future information infrastructure and improve network/cloud service provisioning.

IEEE SERVICES Workshop on Network Services 2019 Technical Program

Monday July 8

9:45 - 11:00

Session 1: Network Service Architecture & Platform Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Shangguang Wang, Beijing University of Posts & Telecommunications

Network Cloudficiation Enabling Network—Cloud/Fog Service Unification: State of the Art and Challenges Qiang Duan and Shangguang Wang

Integrating Service Function Chain Management into Software Defined Network Controller Lakshmi B S and J. Lakshmi

Space-based Cloud-fog Computing Architecture and its Applications Suzhi Cao, Yi Zhao, Junyong Wei, Shuling Yang, Hao Han, Xue Sun, Lei Yan

Space-based Computing Platform Based on SoC FPGA Shuling Yang, Suzhui Cao, Junyong Wei, Yi Zhao, Hao Han, Lei Yan

11:15 - 12:30

Session 2: Network Service Security & Evaluation Location: Durini/Sala Guastalla, NH Collection Milano President Session Chair: Qiang Duan, Pennsylvania State University

Investigation of Moving Target Defense Technique to Prevent Poisoning Attacks in SDN Saumil Macwan and Chung-Horng Lung

DDoS Attacks Detection and Mitigation in SDN using Machine-Learning Obaid Rahman, Mohammad Ali Gauhar Quraishi, and Chung-Horng Lung

More General Evaluation of a Client-Centered Counseling Agent Tsubasa Horii, Yoshitaka Sakurai, Eriko Sakurai, Setsuo Tsuruta, Rainer Knauf, Ernesto Damiani, and Andrea Kutics



Fanjing Meng IBM Research Chair



Donggang Cao Peking University Chair

1st IEEE Workshop on Serverless Computing Frameworks and Services(SWoSC 2019)Message from the Workshop Chairs

Serverless Computing, as an emerging cloud application computing paradigm, has become a hot topic and attracted more and more attentions in recent years. Meanwhile, many commercial Serverless Computing platforms including Amazon Lambda, Google Cloud Functions, Microsoft Azure Functions, IBM Cloud Functions are available for developers to build their Serverless Computing application. The 1st IEEE SERVICES Workshop on Serverless Computing (SWoSC) aims to provide a forum for researchers and practitioners to exchange innovative ideas, latest research results, practical experiences and lessons learned, and future directions. We welcome you wholeheartedly to the SWoSC in Milan, Italy and thank you very much for making this workshop a success by presenting your cutting-edge research and participating in constructive discussions. We are grateful to the 10 program committee members and many external reviewers for their high quality constructive and critical reviews. They have reviewed and discussed the submissions carefully, critically, and constructively. This conference received 4 papers. After a rigorous review process and internal discussion, we have accepted 2 workshop papers. We are pleased to have a number of distinguished, high-profile researchers as keynote speakers at IEEE SERVICES Congress 2019. We strongly believe that attendees will fully engage with and enjoy this thought-provoking workshop program. Our ultimate objective is not only to give you the opportunity to share ideas with

other researchers and practitioners around the globe but also to foster new research and innovations in Serverless Computing. We hope that all of you enjoy both the conference activities including keynotes, workshop, and paper presentations, as well as your stay in Milan, Italy. We look forward to meeting you in Milan, Italy for a great networking and productive discussions.



Stephan Reiff-Marganiec University of Leicester Chair



Bruno Tardiole Kuehne Federal University of Itajuba Chair

1st IEEE Services Workshop on Edge Computing for Autonomous Things (ECAT 2019)Message from the Workshop Chairs

Welcome to the 1st IEEE Workshop on Edge Computing for Autonomous Things (ECAT 2019). It is exciting to bring together this research community around the active field of edge computing with special focus in applications for objects, devices or things. The key motivation of the workshop comes from the idea of taking advantage of on-device resources to be able to tackle current challenges on service-based systems such as low latency, high accuracy and real-time processing, among others. The relevance of the workshop is evident as these challenges are experienced in several use cases ranging from autonomous cars to industrial automation and smart health domains.

Despite recent controversy about current validity of Moore's law in regards evolution of hardware platforms, available platforms for the, so called, smart things are powerful enough to host services that exploit local resources addressing ad hoc processes or general decision-making routines. Current efforts in developing communication infrastructure for the future networks beyond 5G, require equivalent progress in the exploitation of the end-points, i.e., the devices or things that are the closest to where the data is generated and where actions in the physical environment must be taken.

In this workshop, we will discuss issues and challenges identified when using edge resources to address key system functions in contrast to have them



Marco Perez Hernandez University of Cambridge Chair

deployed in remote, resourceful infrastructures. From this perspective, the resource constraints are key drivers for development of services, techniques and algorithms being used for data processing, service lifecycle management and decision making, among others. Through the presentation of accepted papers and open discussions we will try to understand and identify what are the key challenges for engineering systems leveraging in the power of edge resources. We hope to identify not only issues but also opportunities that will lead to further progress and bring even more attention to an area critical for the success of multiple applied fields.

This year we have one interesting use case about how constrained platforms can be used to perform encryption processes. These processes are processor-intensive and represent a good example of the kind of challenges that service-systems are facing nowadays.

Multiple relevant questions emerge when functionality is carried out on the edge. Which requirements give an idea that edge-computing techniques should be used for development of a service-based system? What are the criteria to keep data processing on-device as opposed to move it to the cloud? What characteristics the data and processing methods should exhibit for choosing a design based on edge processing? What advantages are expected from running processor-intensive computations on-device?

These are only some of the issues and questions we would like to consider during the workshop. We encourage you to participate actively and contribute from your own experience to identify the promising research directions and clear the way towards future developments in the area.

IEEE SERVICES Workshop on Serverless Computing (SWoSC) 2019 Technical Program

Friday July 12

8:30 – 9:45 Session 1: Serverless Computing Workshop Opening Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Donggang Cao, Peking University

Welcome from the Chairs Donggang Cao

Invited Talk: The Future of Services Computing: Cognitive, Hybrid, Automated, Serverless, Open Gopal Pingali, Vice President of the IBM Global Technology Services Labs, IBM Distinguished Engineer

11:45 – 13:00 Session 2: Serverless Computing Framework & Services Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair: Donggan Cao, Peking University

Simulation-as-a-Service with Serverless Computing Kyriakos Kritikos, Pawel Skrzypek

An Evaluation of Open Source Serverless Computing Frameworks Support at the Edge Andrei Palade, Aqeel Kazmi, Siobhan Clarke

(ECA Workshop paper) Data Encryption and Fragmentation in Autonomous Vehicles using Raspberry Pi 3 Sahand Murad, Stavros Shiaeles, Asiya Khan and Giovanni Masala



Marco Anisetti Universita degli Studi di Milano Chair



George Spanoudakis City University of London Chair

1st IEEE Services Workshop on Big Data for Public Health Policy Making (PHP 2019)Message from the Workshop Chairs

The effective management of health-related problems depends on and requires appropriate public health policies. Public health policies can have a significant effect on the prevention and early diagnosis and treatment of medical conditions and the effective provision of health care services. The management of health problems and their consequences through public health policies can benefit from the analysis of large sets of heterogeneous data, collected from medical devices, IoT sensors and standard clinical trials, enabling the investigation of specific health problems, comorbidities between them, relations to contextual factors, patterns of emergence and evolution etc. The collection, management and analysis of such data can benefit significantly from the use of novel Big Data Analytic techniques. enable the

The 1st IEEE SERVICES Workshop on Big Data for public health policy focuses on all the theoretical and practical aspects concerning the adoption of Big Data Analytics in the context of evidence-based public health policy making. These include innovative techniques and solutions for (i) establishing, enacting, monitoring and revising health policies, and (ii) simulating policy scenarios to establish their effect on public health. The workshop was also aimed at investigating security and privacy concerns related to the analysis of health data and the possible impact that security and privacy measures may produce

on the achievable quality of analyses and the effectiveness of health policies.

The workshop attracted submissions from researchers of different disciplines, including policy makers, clinicians, and data scientists. The work covered topics related to big data acquisition and management architectures and tools for electronic health records and public health policy making; analysis of social media data for public health policy making; data driven decision models for specific medical conditions and emergency health services; heterogeneous human activity data harmonization and merging to enable health related analytics.

We would like to thank all authors who submitted their work to the workshop and the program committee members who have helped us review the submissions and make decisions in a timely manner. The quality of submissions was high and the selection of the papers to be presented at the workshop was difficult. This process has resulted in a high-quality final program, which will certainly spark interesting discussions during the workshop.

Finally, we would like to thank all of you who have come to the workshop, hoping that you find it both stimulating and enjoyable.

IEEE SERVICES Workshop on Big Data for Public Health Policy 2019 Technical Program

Friday July 12

14:00 – 15:15 Session 1: Policy Making & Decision Support Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair:

Decision Support for EMS Policy Making Using Data Analytics and Real-Time Alerts Melanie Reuter-Oppermann, Dave Richards

Evidence Based Public Health Policy Making: Tool Support Ioannis Basdekis, Konstantin Pozdniakov, Marios Prasinos, Konstantina Koloutsou

The Need of Social Campaigning in Public Health Policy Decision Making Panagiotis Katrakazas, Ourania Manta, Dimitris Koutsouris, Nikos Dimakopoulos, Giorgos Giotis, Efstratios Tzoannos

17:15 - 18:30

Session 2: Big Data for Health-related Applications Location: Sala Napoleonica Parallel, Universitá degli Studi di Milano Session Chair:

A Big Data Architecture for the Extraction and Analysis of EHR Data Stefano Silvestri, Angelo Esposito, Francesco Gargiulo, Mario Sicuranza, Mario Ciampi, Giuseppe De Pietro

Risk of Pneumonia and Associated Outcomes in Intensive Care Unit: An Integrated Approach of Visual and Cluster Analysis Giuliana Favara, Paolo Riela, Andrea Maugeri, Martina Barchitta, Giovanni Gallo, Antonella Agodi

On the Homogenization of Heterogeneous Inertial-based Databases for Human Activity Recognition Anna Ferrari, Daniela Micucci, Marco Mobilio, Paolo Napoletano

Innovations and Convergence in Mobile Medical Applications and Cloud-Based Hospital Information Systems for the Real-Time Monitoring of Patients and Early Warning of Diseases Mustafa Asim Kazancigil

Improving Hearing Healthcare with Big Data Analytics of Real-time Hearing Aid Data Jeppe Christensen, Niels H Pontoppidan, Marco Anisetti, Marco Cremonini and Valerio Bellandi