2018 Outlook: The Emerging Web and Information Sciences

Sumi Helal, Lancaster University

Welcome to Computer’s annual Outlook issue, which as usual provides a glimpse into the emerging and developing topics of computing technologies. However, before I introduce this issue’s articles, I would like to first provide a quick overview of some editorial board updates.

Editorial Board Updates
After several years of volunteer service, several editorial board members are stepping down. This includes Charles (Chuck) Severance, editor of the Computing Conversations column (2013–2017); Brian David Johnson, editor of the Science Fiction Prototyping column (2014–2016), and The Future Today column (in 2017); Antti Oulasvirta, editor of the Indistinguishable from Magic column (2015–2017); San Murugesan, editor of the Cloud Cover column (2013–2017); Charlene (“Chuck”) Walrad, editor of the Standards column (2014–2017); Rolf Oppliger, Security and Privacy area editor (2011–2017); and Renee Bryce, Software area editor (2012–2017). Our sincere thanks and gratitude go to Chuck S., Brian, Antti, San, Chuck W., Rolf, and Renee for their great service and dedication to Computer. We wish them all the best.
Don Wright, president of the IEEE Standards Association, is joining us as Chuck Walrad’s successor to edit the important Standards column. We welcome Don to the editorial board.

Zeljko Obrenovic, principal consultant and head of software measurement at the Netherlands-based Software Improvements Group, will join Computer as its Web editor. Zeljko already contributed to Computer’s website by developing an easily searchable index for Computer’s front covers, articles, and authors. We welcome Zeljko and look forward to working with him on bolstering Computer’s website.

**NEW COLUMNS AND DEPARTMENTS**

Computer will feature two new columns starting 2018. The Policy Corner will be a bimonthly column edited by Mina J. Hanna, a senior applications consultant at Synopsys, who also serves as chair of IEEE-USA’s Artificial Intelligence Policy committee, and vice chair of its R&D Policy committee. This new column will present summaries of important and timely technology policies relevant to Computer readers. It will bring increased awareness as to how such policies are shaped in different parts of the world and how researchers and scientists may influence or engage in policy matters.

Cyber-Physical Systems is another bimonthly column edited by Dimitrios Serpanos, professor at the University of Patras. The column will cover safety-critical aspects of cyber-physical systems applied to the automotive and aerospace industries, medical devices and systems, energy systems, and smart manufacturing.

Computer will also feature a new comic strip department titled Computing through Time, with original cartoons by Ergun Akleman, professor of visualization (and adjunct Computer Science professor) at Texas A&M University. The comic strip will be co-located with the 50 & 25 Years Ago department edited by Erich Neuhold.

We welcome Mina, Dimitrios, and Ergun to Computer’s editorial board.

**The Outlook**

This year we can see into the future of information, its perceived value, influence, and how it can be construed, interpreted, and trusted in presence of all kinds of noise. From cyberattacks to fake news, and from online rumors and data breeches to viral social media misrepresentations, our ability to access information and blast it en masse to thousands of our closest friends all over the world is incredibly powerful—a power that is clearly exploitable and uncontrollable.

The first two articles look carefully at information through the lenses of two emerging sciences: Web science and information science. In the first article, readers get a glimpse at the influence of social media–generated information as compared to alternative information sourcing, and in the second, we come to know of an emerging and fascinating new science of information that extends Claude E. Shannon’s and Alan Turing’s information theory and concept of computation, respectively, to allow us to formulate and solve more complex problems surrounding information in a multitude of application domains.

In the third article, we revisit shared memory architectures with an interesting and powerful approach that gives us a model that is much easier to use and program (while still hiding the details of its implementation) through a novel software-defined server architecture. The fourth article observes the evolution of operating systems (OSs) into a ubiquitous spectrum of specific systems for the Web, the cloud, the smart home, the smart car, among others. Here again software-defined concepts are exploited and a framework is proposed for reforming and designing OSs into “software-defined everything,” allowing the same general principles of abstractions and resource management to prevail but in a much more flexible form—all while being targeted to the specific OS being sought. I will now introduce each article in a little more detail.

In “From Brexit to Trump: The Role of Social Media in Democracy,” Wendy Hall, Ramine Tinati, and Will Jennings examine critical utilization of information—its influence and perceived value—in the context of political campaigns. The article uses datasets from Twitter to analyze the role of social media in both the UK’s referendum on leaving the European Union, commonly referred to as Brexit, and the campaigns of the 2016 US presidential election. The article attempts to understand how and why information that flows through social media channels was ultimately a better predictor of election results as compared to information obtained reliably through traditional polling and mainstream media analyses guided by expert political scientists. Although the authors admit their work is not conclusive at this time—given limitations of the obtained Twitter datasets and how they were sampled—the article illuminates important areas for future work. A firmer understanding of how the “pipes and conduits” through which information flows actually affect the net value of the received information and a careful analysis of how we perceive or are influenced by what information reaches us is
increasingly critical as such platforms are now widely adopted for all kinds of campaigns.

In “Frontiers of Science of Information: Shannon Meets Turing,” Wojciech Szpankowski and Ananth Grama give us the blueprint for an emerging new “science of information.” In contrast to Shannon’s information theory focusing on the limits of signal processing sampling and communication, the science of information extends the scope of analysis from communication-only, to processing, inference, aggregation, and, in general, to domain-specific semantics and analyses. Structure, space, time, and semantics are new elements of information that will allow this science to generate formulas and theories around more complex problems surrounding information. As a simple example, partial information that arrives on time might be of greater value than delayed complete information; or maybe not? Delay, or the time aspect, was not part of the original information theory. This generalization will also allow us to exploit structures embedded in the information of some domains such as alignment in genomic sequences, which could yield powerful information-based analysis. At the heart of this new scientific approach are the powerful mathematics of so-called observer functions; these extract and represent the relative, distinguishable, and learnable information from a dataset. The article demonstrates the value of this new science to other scientific areas and problem domains, including data science, information security, and privacy.

In “Toward Ubiquitous Operating Systems: A Software-Defined Perspective,” Hong Mei and Yao Guo also resort to software-defined concepts to reason about the multiple evolutionary paths OSs have recently taken. From data-center OSs, to the various “things” comprising the Internet of Things, the article presents an Internetware-based architecture of OSs in which key resources and their managers are mapped to cloud resources, and in which OS system calls are mapped to Internetware APIs. The architecture utilizes the concept of Application Frameworks, similar to the one introduced by the Android OS, which allows the architecture to specialize to a particular type using the appropriate framework and its services and runtime libraries. The article briefly describes three software-defined OS prototypes developed by the authors’ group to demonstrate their framework.

I hope you find this year’s Outlook issue enjoyable, and I look forward to receiving your suggestions and comments regarding any improvements or changes you would like to see in Computer.