

Is Your Software Valueless?

Jon Whittle

Software development ignores human values. As a society, we rely on software systems that neither align with nor respect our core values, such as transparency, gender diversity, social justice, and personal integrity. The past 50 years of software engineering have focused on functionality, cost, safety, availability, and security. But what about broader human values (Figure 1) such as compassion, social responsibility, and justice? The way we design software fundamentally influences society, yet human values—which we would all claim to care about—have been a side concern in software engineering. (See “Where Are the Values in Software?”)

Surely it is high time that we fundamentally reimagine the way we design software. Rather than focusing only on a narrow set of concerns, we should embed all human values into software design. If we don’t, we, as software engineers, will inadvertently create a society that nobody wants.

Admittedly, embedding human values into software is difficult. Even where there is a willingness, and managerial support, to think about values, it proves challenging. Software development defaults back to values that are relatively easy to deal with—accessibility, usability, and availability—for which there are more clearly defined guidelines or tools. Thus, running tools on a graphical user interface that check whether a color scheme is readable by the color-blind population is common but does not help with addressing broader human values. There is a mismatch between what the software development community values—typically automation, productivity, and quality—and broader societal values (Figure 2). There is also often an assumption that the latter naturally leads to the

former, that we are improving people’s lives by automating things using quality software.

Why do values in software matter? The issue of values, and more narrowly ethics, in computing is receiving renewed attention because there are doomsday predictions of discriminatory artificially intelligent systems taking over the world. However, the real problems are much more mundane than are those of sentient machines. The interface for a simple human resources (HR) recruitment system is one example. Most job interviewers are encouraged, if not mandated, to consider periods of time away from work, e.g., parental leave. Yet HR recruitment systems

*IF SUCH A SYSTEM WAS DESIGNED
WITH THE VALUE OF GENDER
EQUALITY IN MIND, THE INTERFACE
WOULD BE DESIGNED VERY
DIFFERENTLY.*

do not prominently display such information; to discover it, interviewers must search through potentially hundreds of curriculum vitae. If such a system was designed with the value of gender equality in mind, the interface would be designed very differently. We have known for decades that design is not values neutral, but software engineers have failed to understand this. We examined the last four years of papers published in the top software engineering conferences and journals; we found that only 16% of papers considered values at all. Of those, a significant majority focused on values of security and privacy.

But does the software industry care about non-financial values? A naive view might argue that it does not, that it is all about the bottom line. However,

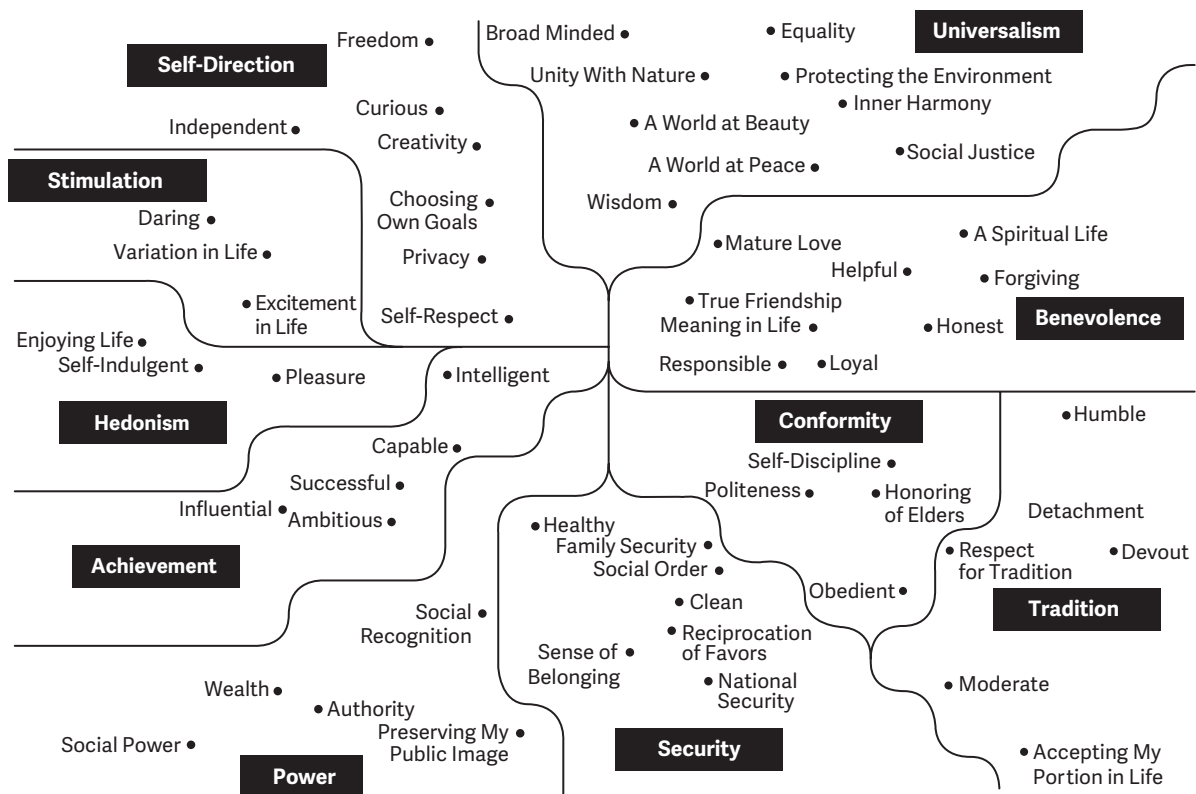


FIGURE 1. A number of theories have attempted to define values, such as the Schwartz Theory of Basic Values.¹ The 10 universal values are boxed and subdivided into finer-grained values. Values closer to each other (as defined by the bullet points) are complementary, and those farther apart are in conflict. Note that values are different from ethics: ethics are culturally agreed-upon moral principles, while values make no moral judgment, so, for example, making money is a perfectly acceptable value. (Adapted from Schwartz⁸.)

companies have at least claimed to care about values for a long time. Ever since Jim Collins' and Jerry Porras' book *Built to Last*,² which found that a key determinant of a company's success is a strong values statement, organizations have put a lot of effort into defining their corporate values. A study by Maitland³ found that 86 of Financial Times Stock Exchange 100 Index companies have public values statements, with values such as corporate integrity, respect, and honesty topping the list. Clearly, companies implement these with various levels of seriousness, but many, if not all, do take them seriously and have managerial mechanisms to create a values culture. However, there is no way to trickle these values down into the software that we build.

At Monash University, Melbourne, Australia, we recently conducted two case studies with software companies to improve our understanding of their

approaches to values. At least for these companies, values are explicitly talked about during software development: this usually takes the form of a values document used hiring decisions, training new staff, performance appraisals, and strategic decision making. Sometimes there are more sophisticated ways to create an open culture, ones in which software developers can talk about and honestly question company values. These include forums for stepping back from day-to-day concerns, having someone designated as a critical friend, clarity in hiring practices, and training programs. However, even in those cases in which values are considered, the approach is limited to creating a values-driven culture as opposed to having it engrained into the act of software development. When companies consider values in developing software, it is during business analysis and requirements engineering only; values are easily forgotten later.

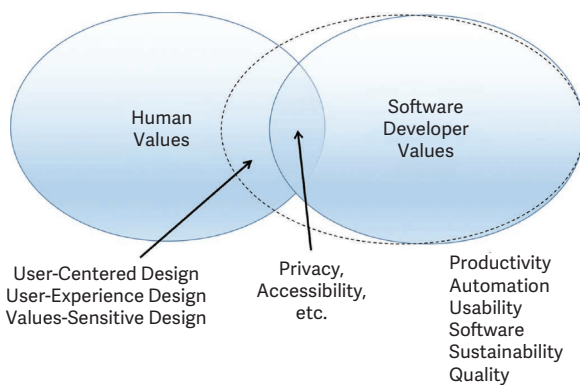


FIGURE 2. A software developer's values versus human values: software engineers value technical concepts such as productivity, automation, usability, and quality, with the assumption that these traits naturally lead to broader human values. This is a naive view, however; human values and software developer values rarely coexist. Methods such as user-centered design, user-experience design, and values-sensitive design⁴ take a broader view, but we are a long way from full alignment between human and developer values.

Therefore, the current state, at least for software companies that appreciate values, is a reliance on organizational culture. However, there is very little, if anything, to support technical work. This is not all bad news, however. Many existing software development approaches can be adapted easily to work with values. Therefore, while a revolution in the mind-set of developers is necessary, more of an evolution could suffice from a process point of view. For example, agile development methods lend themselves naturally to thinking about values. In their current form, values will not immediately receive attention, but through a designated values guardian in a Scrum team, user stories could easily become values stories, and measurement approximations, such as T-shirt sizing, would be useful for dealing with the inherent complexity of a nuanced concept such as values. Furthermore, we would go a long way by introducing well-established participatory design techniques into user-experience and user-centered design approaches. Participatory design methods are good at ensuring that end-user values are taken into account but have suffered from a lack of clarity and a refusal to simplify.⁵

More generally, there could be values versions of successful tricks that the software industry has

WHERE ARE THE VALUES IN SOFTWARE?

Value is an overloaded term. Values-based methods are well known in human-computer interaction (HCI) and information systems^{4,9,10} but are nonexistent in software engineering. HCI and information systems do not deal with the business of actually building software, so although they could apply in the early stage of software engineering, they offer little guidance as to how to handle values in the more technical stages of development. The word *value* is often referred to in agile methods, but then the focus is only on business value. Similarly, Boehm's value-based software engineering¹¹ deals almost entirely with economic value. Some emerging works in software engineering take a more human-values approach, such as GenderMag¹² for discovering gender bias in software, but this is still very early.

used. Imagine a values manifesto with the beauty and simplicity of the agile manifesto, making it clear to developers that values are important. Or there could be a values maturity model that helps organizations to self-assess their values culture, such as level 0, ad-hoc consideration of values; level 1, a clear, published corporate values statement but no real way to implement it; level 2, some processes to deal with values; level 3, proactive and structured ways to ensure that values are considered at all stages of the software lifecycle; and level 4, software tools to support values. You get the idea. Requirements engineering methods could be applied easily to refine what values mean. After all, one of the biggest challenges in instilling values in software is that values are, by definition, vague concepts. However, specifying values in concrete terms, in the context of an actual project, plays to the strengths of requirements engineering methods. Also, well-accepted technical methods could be adapted to look at software development through a values lens: take A/B testing, for example,

which could be used to test out how different software versions impact values.

It is time that the software industry takes human values seriously, but not just for the greater social good. Violations of human values can have serious negative financial consequences for the economy. In a sample of Internet security breaches, Cavusoglu⁶ found an average market-capitalization loss of US\$1.65 billion for the companies affected. In the Volkswagen (VW) emissions scandal,⁷ software designers deliberately contradicted the company's corporate value of responsible thinking, a decision that led to the resignation of the chief executive officer, a 30% drop in VW's stock price, and a 25% drop in sales within one year. Therefore, value violations are big business. Software researchers and practitioners must respond by doing what they do best: creating methods for handling such problems before a catastrophe hits. 🌍

ACKNOWLEDGMENTS

The ideas in this article benefited from discussions with Waqar Hussain and Davoud Mougouei.


REFERENCES

1. S. Schwartz, "Basic human values: Theory, measurement, and applications," *Revue Francaise de Sociologie*, vol. 47, no. 4, pp. 929–985, 2006.
2. J. Collins and J. Porras, *Built to Last: Successful Habits of Visionary Companies*. New York: HarperBusiness, 1997.
3. S. Walker, "The values most valued by UK plc," Maitland. Accessed on: Feb. 20, 2019. [Online]. Available: <http://www.maitland.co.uk/wp-content/uploads/2015/10/20151001-Maitland-Values-Report.pdf>
4. B. Friedman, D. Hendry, and A. Borning, "A survey of value sensitive design methods," in *Foundations and Trends in Human Computer Interaction*. Boston: Now Publishers, 2017.
5. J. Whittle, "How much participation is enough? A comparison of six participatory design projects in terms of outcomes," in *Proc. Participatory Design Conf.*, 2014, pp. 121–130.
6. H. Cavusoglu, B. Mishra, and S. Raghunathan, "The effect of Internet security breach announcements on market value: Capital market reactions for breached firms and Internet security developers," *Int. J. Electron. Commerce*, vol. 9, no. 1, pp. 70–104, 2004.
7. B. Georgievski and A. Alqudah, "The effect of the Volkswagen scandal: A comparative case study," *Res. J. Finance Accounting*, vol. 7, no. 2, pp. 54–57, 2016.
8. S. Schwartz, "I've built a good mousetrap and people come to use it," *Psychologist*, vol. 31, pp. 56–59, June 2018.
9. C. Knobel and G. Bowker, "Values in design," *Commun. ACM*, vol. 54, no. 7, pp. 26–28, 2011.
10. G. Cockton, "Value-centred HCI," in *Proc. NordCHI*, 2004, pp. 149–160.
11. S. Biffl, A. Aurum, B. Boehm, H. Erdogmus, and P. Grunbacher, *Value-Based Software Engineering*. New York: Springer, 2006.
12. M. Burnett et al., "GenderMag: A method for evaluating software's gender inclusiveness," *Interacting Computers*, vol. 28, no. 6, pp. 760–787, 2016.




JON WHITTLE is the dean of the faculty of information technology at Monash University. Contact him at Jon.Whittle@monash.edu.

stay on the **Cutting Edge** of Artificial Intelligence



IEEE Intelligent Systems provides peer-reviewed, cutting-edge articles on the theory and applications of systems that perceive, reason, learn, and act intelligently.

The #1 AI Magazine
www.computer.org/intelligent



Shaping Our Common Digital Future

Susanne Boll, *University of Oldenburg*

The global spread of a vicious disease in our interconnected world is threatening the health and livelihoods of millions of people. Beyond the immediate effects of the disease on individuals, families, and communities, we can anticipate the long-term impact on whole societies and economies. Our lives are changing not only because of the coronavirus pandemic, but also because of climate change and environmental damage. These are the defining crises of our time, and they are shining a harsh spotlight on the intractable socioeconomic inequalities long plaguing the world's people. We cannot meet these challenges only on a local or national scale. Global crises require a global response.

MULTIMEDIA IN TIMES OF THE PANDEMIC

We have only begun to understand the importance of multimedia communication in the face of a pandemic. Electronic products and services, especially interactive ones, that combine text, sound, video, etc., quickly proved essential socially and economically when global quarantine became necessary. Previous multimedia research and existing tools have contributed a "safety net" of sorts to allow continuation of at least some education, business, and government communication.

Research in multimedia over the past decades has contributed to understanding, interpreting, transporting, delivering, and interactively presenting multimedia experiences across many domains. Software and tools

rooted in this field support multimedia networking and streaming, interactive video conferencing, and communication and interaction on social media. Now, physical events and meetings, including those of global leaders, have by necessity become virtual. Multimedia research has thus become mainstream and usable for everyone. Confined by stay-at-home orders, we have found tools to connect, to keep in touch, to work and learn. Even when this disease is brought under control, however, our daily lives will never be what they were. Furthermore, the crisis has starkly exposed long-troubling, deep social and economic inequalities. Consequently, the questions now are how will this pandemic transform our future work life and educational systems, and how can we use this transformation to level the playing field, to address inequalities wasting so much human potential around the world?

Multimedia technologies are already building blocks for many application domains much needed in these days: Health care, education, additive manufacturing, logistics, crisis management, and many more. So, we could sit back and be satisfied—or we could understand our field from a philanthropic angle and help shape our common digital future, positively and inclusively.

MULTIMEDIA FOR OUR COMMON DIGITAL FUTURE

The challenges of the day have been well framed by the United Nations, when in 2015 they decided on a 2030 Agenda for Sustainable Development. This agenda "is a plan of action for people, planet and prosperity" and forms "universal goals and targets which involve the entire world, developed and developing countries alike."¹ The agenda addresses

Digital Object Identifier 10.1109/MMUL.2020.3017875

Date of current version 28 August 2020.

17 sustainability goals and describes actionable objectives, from ending poverty to ensuring access to clean water and clean energy, to education and decent work for all. In meeting these Sustainable Development Goals (SDGs), digitization will play an important, even transformative, role.

Recently, the German Advisory Council on Global Change published their Flagship report, “Towards Our Common Digital Future.”² This excellent, comprehensive report describes the enormous potential digitization holds for our common digital future: “Digital change is epochal and opens the door to a new era of human development.” The report frames digitization as an opportunity to shape the digital societies of the future and lays out how to shape the “Great Transformation” to address sustainability goals. The advisory council not only sees digital technologies as important for this transformation but also emphasizes the necessity to link digitization and sustainability.

Technology and science will play an important role in this common digital future, and so can the field of multimedia. However, technological advances alone are not necessarily a sure-fire success. We witnessed several examples in the last decade showing that the narrative of an always positive use of digitization cannot be told anymore—digital technologies can be used not only for the good of humans but also to their detriment. It is on us to actively shape this change for the better, for all of us.

MULTIMEDIA—WHERE TO GO?

Multimedia can be a rich source for addressing many global challenges. Here, we focus on the potential of multimedia to advance progress toward selected SDGs.

The Sustainable Development Goal 3: *Good Health and Well-being* focuses on the severe inequalities worldwide that leave much of the world's population struggling just to survive, much less experience good health and a sense of well-being. It is time to mount a concerted global effort to alleviate this condition. Multimedia can be instrumental to implementing global solutions. Multimedia researchers have already contributed to significant advances in personal health, from multimedia signals to a new generation of future personal digital health technology.³ Multimedia can act as an accelerator for understanding

personal health and supporting the individual in gaining and maintaining good health.⁴ Current developments have only begun to unfold the potential to better understand, diagnose and predict courses of disease, and to contribute dramatically to universal health solutions.

The Sustainable Development Goal 4: *Quality Education* aims to ensure inclusive and equitable, quality education and to promote lifelong learning opportunities for all. While the field of multimedia has been working for some time on interactive digital education and social media for learning,⁵ the pandemic has given digital education a boost. It revealed the gap between digital technologies and digital education. The challenge is to integrate these new technologies into our learning contexts and curricula and use them to provide high quality education to *everyone*.

The Sustainable Development Goal 8: *Decent work and economic growth* aims to promote inclusive and sustainable economic growth, full and productive employment, and decent work for all. Digitization, along with multimedia and interactive technologies, will be the driving force of the workplace of the future. Widespread transformation of the workplace will require that people accept and want to use digital technologies.⁶ Participatory design work can result in new technologies conducive to learning, to inclusion, and to access for the transformed job market of the future.

The Sustainable Development Goal 10: *Reduced Inequalities* aims at reducing inequality within and among countries. In our field, social media usage and social media coverage are studied to understand political information and disinformation on social media and how news is perceived on social media around the globe.⁷

For example, existing work has investigated the role of social media in political engagement and the technologies in play dispensing political information and mediating political engagement. We must develop technologies that allow people to “freely express themselves, access trustworthy information, engage in meaningful deliberation, and organize themselves without fear of being commoditized, manipulated, monitored, or harassed by authorities.”⁸

Currently these SDGs are mapped to national research agendas. In Germany, for example, you will

now find different SDG objectives to be addressed in different calls for grant proposals.

We need to discuss and identify how the field of multimedia can contribute to a positive digital future for all of us. What does this mean for researchers and practitioners in higher education institutions, research institutes, and companies, and what can be our personal contribution to society to shape a digital future for the betterment of all? 🌐

REFERENCES

1. United Nations. Transforming Our World. The 2030 Agenda for Sustainable Development, 2015. [Online]. Available: <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>
2. German Advisory Council on Global Change. Flagship Report: Towards Our Common Digital Future. 2019. [Online]. Available: https://www.wbgu.de/fileadmin/user_upload/wbgu/publikationen/hauptgutachten/hg2019/pdf/wbgu_hg2019_en.pdf
3. P. Cesar, V. Singh, R. Jain, N. Sebe, and N. Oliver, "New signals in multimedia systems and applications," *IEEE MultiMedia*, vol. 25, no. 1, pp. 12–13, Jan.–Mar. 2018.
4. S. Boll, J. Meyer and N. E. O'Connor, "Health media: From multimedia signals to personal health insights," *IEEE MultiMedia*, vol. 25, no. 1, pp. 51–60, Jan.–Mar. 2018.
5. Q. Li, R. W. H. Lau, E. Popescu, Y. Rao, H. Leung, and X. Zhu, "Social media for ubiquitous learning and adaptive tutoring [guest editors' introduction]," *IEEE MultiMedia*, vol. 23, no. 1, pp. 18–24, Jan.–Mar. 2016.
6. O. Bode, S. Boll, S. Falk, M. Koch, S. Riedel, and V. Wulf, "Arbeitswelten der Zukunft gestalten! (Shaping the working worlds of the future!)," *i-com*, vol. 17, no. 3, pp. 265–266, 2018.
7. A. El Ali, T. C. Stratmann, S. Park, J. Schöning, W. Heuten, and S. C. J. Boll, "Measuring, understanding, and classifying news media sympathy on twitter after crisis events," in *Proc. CHI Conf. Human Factors Comput. Syst. Assoc. Comput. Machinery*, New York, NY, USA, 2018, Paper 556.
8. D. Gayo-Avello, "Social media, democracy, and democratization," *IEEE MultiMedia*, vol. 22, no. 2, pp. 10–16, Apr.–Jun. 2015.

ADVANCE YOUR TECH CAREER

EARN A **100% ONLINE** MASTER'S OR GRADUATE CERTIFICATE

RANKED #4 NATIONWIDE

100% ONLINE CLASSES

FLEXIBLE SCHEDULING

12 AREAS OF SPECIALIZATION

- ANALYTICS & BUSINESS INTELLIGENCE
- BIG DATA
- BUSINESS INFORMATION SYSTEMS
- CYBERSECURITY
- CYBERSECURITY MANAGEMENT
- CYBERSECURITY POLICY
- DECISION SUPPORT SYSTEMS
- HEALTH INFORMATION TECHNOLOGY
- INNOVATION IN AI/ML
- NETWORKING
- SOFTWARE DEVELOPMENT
- SOFTWARE ENGINEERING

10 GRADUATE CERTIFICATES

NO GMAT/GRE REQUIRED

LEARN MORE AT **VTMIT.VT.EDU**



MASTER OF
INFORMATION TECHNOLOGY
VIRGINIA TECH.



Conference Calendar

IEEE Computer Society conferences are valuable forums for learning on broad and dynamically shifting topics from within the computing profession. With over 200 conferences featuring leading experts and thought leaders, we have an event that is right for you. Questions? Contact conferences@computer.org.

FEBRUARY

27 February

- CGO (IEEE/ACM Int'l Symposium on Code Generation and Optimization), virtual
- HPCA (IEEE Int'l Symposium on High-Performance Computer Architecture), virtual

MARCH

9 March

- SANER (IEEE Int'l Conf. on Software Analysis, Evolution and Reengineering), virtual

22 March

- ICSA (IEEE Int'l Conf. on Software Architecture), Stuttgart, Germany
- MIPR (IEEE Int'l Conf. on Multimedia Information Processing and Retrieval), Tokyo, Japan
- PerCom (IEEE Int'l Conf. on Pervasive Computing and Communications), Kassel, Germany

27 March

- IEEE VR (IEEE Conf. on Virtual Reality and 3D User Interfaces), Lisbon, Portugal

28 March

- ISPASS (IEEE Int'l Symposium on Performance Analysis of Systems and Software), Stony Brook, USA

APRIL

12 April

- ICST (IEEE Conf. on Software Testing, Verification and Validation), virtual

14 April

- COOL Chips (IEEE Symposium on Low-Power and High-Speed Chips and Systems), Tokyo, Japan

19 April

- ICDE (IEEE Int'l Conf. on Data Engineering), Chania, Greece

21 April

- SELSE (IEEE Workshop on Silicon Errors in Logic - System Effects), Los Angeles, USA

25 April

- VTS (IEEE VLSI Test Symposium), San Diego, USA

28 April

- MetroCAD (Int'l Conf. on Connected and Autonomous Driving), Detroit, USA

MAY

10 May

- CCGrid (IEEE/ACM Int'l Symposium on Cluster, Cloud and Internet Computing), Melbourne, Australia
- ICFEC (IEEE Int'l Conf. on Fog and Edge Computing), Melbourne, Australia

15 May

- BigDataSecurity (IEEE Int'l Conf. on Big Data Security on Cloud), New York, USA

17 May

- IPDPS (IEEE Int'l Parallel and Distributed Processing Symposium), Portland, Oregon, USA

18 May

- RTAS (IEEE Real-Time and Embedded Technology and Applications Symposium), Nashville, USA

22 May

- ISCA (ACM/IEEE Int'l Symposium on Computer Architecture), Valencia, Spain

23 May

- ICCP (IEEE Int'l Conf. on Computational Photography), Haifa, Israel
- ICSE (IEEE/ACM Int'l Conf. on Software Engineering), Madrid, Spain
- SP (IEEE Symposium on Security and Privacy), San Francisco, USA

25 May

- ISMVL (IEEE Int'l Symposium on Multiple-Valued Logic), Nur-Sultan, Kazakhstan

JUNE

1 June

- ISORC (IEEE Int'l Symposium



on Real-Time Distributed Computing), Daegu, South Korea

7 June

- BCD (IEEE/ACIS Int'l Conf. on Big Data, Cloud Computing, and Data Science Eng.), Macao
- CBMS (IEEE Int'l Symposium on Computer-Based Medical Systems), Aveiro, Portugal
- WoWMoM (IEEE Int'l Symposium on a World of Wireless, Mobile and Multimedia Networks), Pisa, Italy

14 June

- ARITH (IEEE Int'l Symposium on Computer Arithmetic), virtual

20 June

- SERA (IEEE/ACIS Int'l Conf. on Software Engineering Research, Management and Applications), Kanazawa, Japan

21 June

- CSF (IEEE Computer Security Foundations Symposium), Dubrovnik, Croatia
- DSN (IEEE/IFIP Int'l Conf. on Dependable Systems and Networks), Taipei, Taiwan

26 June

- CSCloud (IEEE Int'l Conf. on Cyber Security and Cloud Computing), Washington, DC, USA

JULY

5 July

- ICME (IEEE Int'l Conf. on

Multimedia and Expo), Shenzhen, China

- SERVICES (IEEE World Congress on Services), Chicago, USA

7 July

- ICDCS (IEEE Int'l Conf. on Distributed Computing Systems), Washington, DC, USA
- SNPD (IEEE/ACIS Int'l Conf. on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing), Taichung, Taiwan

12 July

- COMPSAC (IEEE Computers, Software, and Applications Conf.), Madrid, Spain

27 July

- SMC-IT (IEEE Int'l Conf. on Space Mission Challenges for Information Technology), virtual

AUGUST

23 August

- SCC (IEEE Space Computing Conf.), virtual

SEPTEMBER

7 September

- CLUSTER (IEEE Int'l Conf. on Cluster Computing), Portland, Oregon, USA

20 September

- eScience (IEEE Int'l Conf. on eScience), Innsbruck, Austria

OCTOBER

13 October

- FIE (IEEE Frontiers in Education

Conf.), Lincoln, Nebraska, USA

- ICIS Fall (IEEE/ACIS Int'l Fall Conf. on Computer and Information Science), Xi'an, China

29 October

- IPCCC (Int'l Performance Computing and Communications Conf.), Austin, USA

NOVEMBER

15 November

- ASE (IEEE/ACM Int'l Conf. on Automated Software Engineering), Melbourne, Australia

DECEMBER

20 December

- MCSoc (IEEE Int'l Symposium on Embedded Multicore/Many-Core Systems-on-Chip), Singapore

Learn more
about IEEE
Computer
Society
conferences

computer.org/conferences



Get Published in the *IEEE Open Journal of the Computer Society*

Submit a paper today to the premier open access journal in computing and information technology.

Your research will benefit from the IEEE marketing launch and 5 million unique monthly users of the IEEE *Xplore*® Digital Library. Plus, this journal is fully open and compliant with funder mandates, including Plan S.

Submit your paper today!

Visit www.computer.org/oj to learn more.

