SELF-AWARE AND SELF-EXPRESSIVE SYSTEMS

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Systems that gather unpredictable input data while responding and self-adapting in uncertain environments are transforming our relationship with and use of computers. This issue of Computer explores a variety of approaches and applications for such systems.

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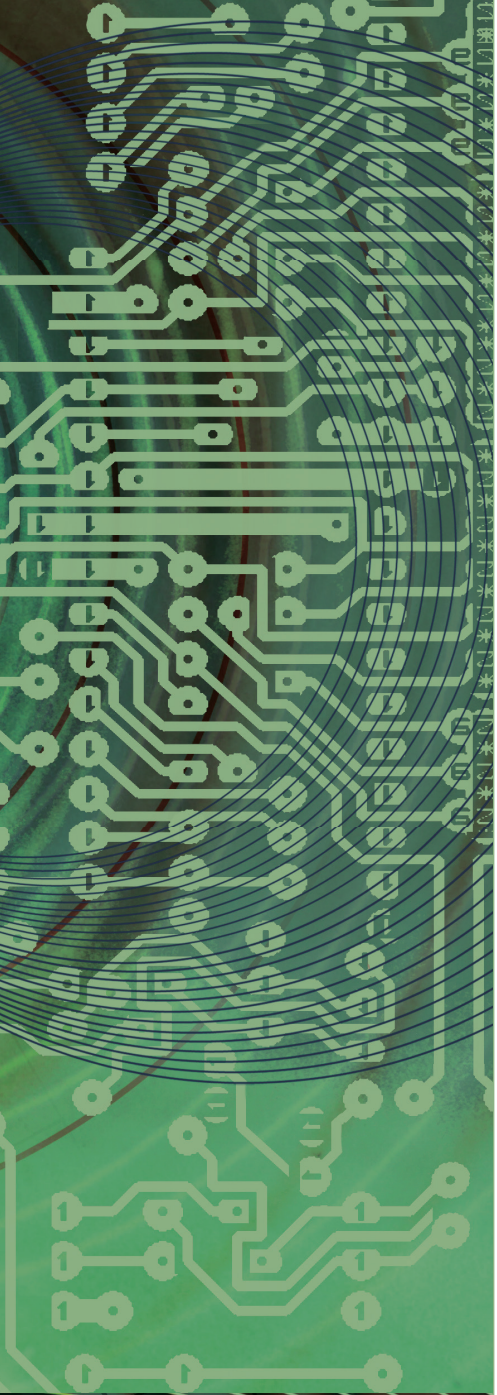

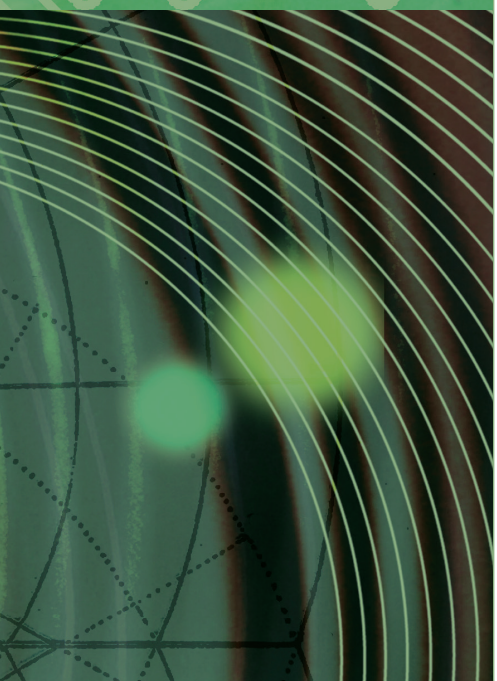

Self-aware and self-expressive computing describes an emerging paradigm for systems and applications that proactively gather information; maintain knowledge about their own internal states and environments; and then use this knowledge to reason about behaviors, revise self-imposed goals, and self-adapt. This approach fosters an aptitude for advanced intelligent decision making in dynamic and uncertain environments, which can in turn support effective, autonomous, and self-adaptive system behaviors.

A self-aware and self-expressive system acquires knowledge about its internal states, history, social or physical environment, goals, and even its own way of representing or reasoning about these things. Self-expression describes self-adaptive behavior that is based on the knowledge acquired through system self-awareness. A self-expressive system can adapt to its users, and thus limits the need for users to adapt to fixed system behaviors.

Self-awareness is not a new term in computing, and its meaning has well-established roots in the fields of psychology and cognitive science. However, a precise definition and interpretation of self-awareness in computer science and engineering is lacking. What it is, what it should be, and how it could help in computing system design engenders much debate. Peter R. Lewis and his colleagues surveyed the concept's various definitions and applications vis-à-vis computer science to achieve a better understanding, which has proved useful as this area continues to expand.[1] With this expansion comes the increasingly potent technological and social impacts of systems becoming ever more "aware" of their environment—as well as the people in it.[2] From service provisioning to the cloud to principled architectural design of software systems with a variety of self-adaptive capabilities, areas in which self-awareness has been useful in computer science, its applications, and systems will have an increasing impact on the human world.[3,4]

This special issue focuses on the latest methodologies and solutions within self-aware and self-expressive computing systems. Articles on this topic have been scattered among different journals and conferences. By bringing together the latest research results, this issue provides a common platform to foster discussion, identify challenges, promote future collaborations, and highlight broader perspectives in self-aware and self-expressive computing.

IN THIS ISSUE

The four feature articles in this issue examine and apply self-awareness and self-expression within widely differing application domains. However, they all share a focus on heterogeneous and distributed computing, and incorporate a range of concepts from high-performance datacenters to applications using smart remote sensors.

Camera networks are now ubiquitous, with applications in fields ranging from security to environmental monitoring. Smart cameras perform onboard image analysis, adapt their algorithms in response to changes in their environments, and collaborate with other cameras to effectively analyze objects' dynamic behavior in partly unknown environments. In "Self-Aware and Self-Expressive Camera Networks," Bernhard Rinner, Lukas Esterle, Jennifer Simonjan, Georg Nebehay, Roman Pflugfelder, Gustavo Fernández Domínguez, and Peter R. Lewis demonstrate how concepts of self-awareness and self-expression can be adopted for autonomous monitoring of the camera network's state and progress as well as adapting system behavior in response to changing conditions.

Distributed systems consisting of multiple autonomous nodes that

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communicate through a network are in widespread use. In "Toward Collective Self-Awareness and Self-Expression in Distributed Systems," Michele Amoretti and Stefano Cagnoni outline how simultaneously applying hierarchy and recursion is a suitable approach for enabling self-awareness and self-expression in distributed systems. Their article describes how this strategy could improve efficiency and scalability in distributed systems.

Fog computing takes place in distributed nodes—such as within smart sensors—typically on the edge of the network and not in datacenters as with cloud computing. In "The Benefits of Self-Awareness and Attention in Fog and Mist Computing," Jürgo S. Preden, Kalle Tammemäe, Axel Jantsch, Mairo Leier, Andri Riid, and Emine Calis use experimental results from a health-monitoring scenario to provide an overview of how self-awareness enables efficient fog computing through a continuous interpretation of the datastream collected from the environment in the context of the sensors' goals and objectives. This represents an interesting cyber-physical systems application of self-awareness.

Resource management and scheduling in high-performance datacenters are challenging but increasingly important due to the expansion of the digital economy and cloud computing. In "Self-Expressive Management of Business-Critical Workloads in Virtualized Datacenters," Vincent van Beek, Jesse Donkervliet, Tim Hegeman, Stefan Hugtenburg, and Alexandru Iosup propose an architecture with self-aware and self-expressive features to address this challenge. Using real-world workloads, the authors use an experiment to demonstrate the approach's superior performance.

With applications in many different domains, exploring self-aware and self-expressive computing systems should yield more efficient and intelligent systems. We hope this special issue inspires further research and exploration of these concepts, as they have the potential to improve future human–machine interactions.

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