Web-based Pervasive Autonomous Systems

Simon Mayer
University of St. Gallen, Switzerland
simon.mayer@unisg.ch

As already in a statement to the 2023 Dagstuhl Seminar on *Agents on the Web*[1], I would like to use this opportunitey to share a particularly stimulating finding that I believe could act as an example and also as a motivator in our attempt to find a common language to identify, discuss, and solve the issues on our path to Internet-scalable communities of autonomous agents and people who work together to seamlessly allocate concerns and reach their objectives. To support more efficient agent-environment interaction, we recently proposed that the environment might contain signification that is *personalized* at run time to each agent (where I am explicitly inclusive of both, human agents and artificial agents) that roams it [10, 5]. This was inspired by affordance theory [3] and computer scientists, philosophers, and psychologists who built on top of it (e.g., [7, 6, 1]), and the basic idea is visible all around us: in (well-designed) signs, furniture, and, famously, door handles [6]. When designed well, signifiers become environmental cues for agents that can be *intuitively and reliably* discovered and interpreted to provide guidance to agents who roam an environment about *what* are the possible behaviors, *whether* they should be actualized by agents, and *how* these behaviors can be performed [10]. However, importantly, while in classical ecology signifiers are assumed to be run-time static and can only be designed a priori and with respect to agent *stereotypes* rather than actual agent features that are measured at run time, we—fascinatingly—may drop these constraints in virtual environments and, more and more, in *physical environments as well*.

For this reason, and driven by advancements from material science to human-computer interaction, I expect that the findings of our combined effort for supporting globally scalable and interoperable autonomous agents that stems from recent Dagstuhl seminars and led to the creation of this Community Group have a high potential to be re-applied to human-computer interaction and, using HCI as a vehicle, to classical ecology. We expect that already in the near future, personalized content will be delivered *to humans* not only through Web browsers and other digital mediation (e.g., mobile apps) but through technologies that mediate individual or group experiences of *physical* reality as well [9]. This delivery may happen through projected or head-worn Mixed Reality, but also through other sensory modalities such as audio [13], haptics [4], or vestibular stimulation [8]; objects in our physical environments with communication and processing abilities [11] might also alter experienced realities directly – e.g., in the context of self-balancing bicycles [12] where it has been shown that users prefer to experience artificially decreased tilting when turning – agent-personalized physics?

Regarding the cognitive dimension, some of these concerns are certainly best left to statistical approaches, in particular if abundant training data is available and can be processed relatively efficiently; others are to be allocated to symbolic systems, not only if more easily accessible explanations of the system's behavior are desired; we should further support neurosymbolic combinations – to this end, I find the current developments in the field of semantic scene understanding (cf. [2]) particularly well-accessible and transferable; and finally, possibly, there will be tasks that humans are well-suited to solve, and that we also enjoy solving. Let us together work on an architecture that will permit the integration of such heterogeneous systems, including means for environments to support autonomous behavior in agent-agent and agent-environment interaction, means to design and govern communities of autonomous entities towards achieving organizational goals, and means to foster the adoption potential of our approaches into more real use cases.

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[1] See https://www.dagstuhl.de/en/seminars/seminar-calendar/seminar-details/23081

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