PARCo: a Knowledge-Based Agent for Context-Sensitive Reasoning and Decision-Making Regarding Privacy

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Keywords: privacy, intelligent agent, ontology, argumentation, Internet of Things

Substantial technological developments are pushing digital devices into virtually all spheres of humans' lives. While these devices exploit users' generated data to offer a number of valuable services, the exchange of such information has increasingly raised concerns regarding users' privacy. In particular, privacy concerns are likely to arise due to massive and uncontrolled data exchange among interconnected devices in the scope of the Internet of Things (IoT).

Traditional legal approaches, which to date are still used to settle privacy disputes, such as the US Constitution and the GDPR, have obtained particularly little success with respect to dynamic scenarios like Online Social Networks and the IoT. These environments share the common characteristic of allowing privacy violations to occur implicitly. With respect to implicit privacy violations however, studies show that the dichotomy distinguishing between private and not private information, mainly used by legal approaches, provides no satisfactory tool to prevent violations.

Alternatively, Contextual Integrity has been advanced as another account to privacy [3]. This definition focuses on the appropriateness of information exchange with respect to contextual norms. In other words, privacy is maintained when information exchange respects the appropriateness and distribution norms related to a certain context. Such concept has inspired a number of scholars to provide privacy-preserving approaches in the environment of OSNs and the IoT. These approaches share the common intuition of the need of a context concept to be used towards achieving appropriate information exchange. Nevertheless, to date, there is no established privacy preserving approach applicable to Online Social Networks nor for the Internet of Things environments. In particular, due to its scale and heterogeneity, the IoT environment in particular, has been addressed by a limited number of efficient methods.

The literature suggests that available approaches would benefit from a definition of contexts which can capture contexts' relations, allowing contexts' inference from fragmentary information. Furthermore, these approaches should display decision-making capabilities in partially observable and incomplete information environments.

We therefore envision an Internet of Things environment, in which participating entities are represented by agents. That is the case, because as pointed out by the literature, it is unfeasible that humans would be able to cope with the overwhelming number of surrounding connected devices. Instead, agents provide a convenient support for autonomous reasoning and decision-making.

To tackle appropriate information exchange with respect to context, we propose PARCo, a knowledge-based agent which reasons on its internal context representation implemented by way of an OWL ontology, and subsequently uses argumentation to take an information sharing decision in the IoT environment. Specifically, the main contributions of our work lie in: i. exploiting OWL expressivity for representing contexts and by means of a reasoner, infer new knowledge; ii. using a knowledge-based agent which manipulates such a domain knowledge in a convenient way, in this case by assigning degrees of belief, and using it in the ASPIC argumentation engine in order to reach a share decision.

For instance, consider a smart work environment having a surveillance system which which runs an instance of our agent PARCo. Consider that such agent can exchange information with other surrounding agents, for example, those of employees. In a scenario in which one employee, Bob, would like to access video information concerning another employee, Alice, thanks to our approach, the surveillance system would be able to reason on available information coming from available agents, and decide whether to share the video by taking into consideration Alice's context [2]. By using its internal representation of contexts, specified in terms of an ontology of concepts, PARCo is able to infer Alice's active contexts. Consequently, PARCo will use argumentation to reach the a final share decision, based on the arguments built for each active context [1].

The decisions taken by PARCo were finally evaluated within a selection of IoT scenarios and compared to a previous approach. Within each scenario the human intuition based decision was assessed by means of personal interviews and further used as a benchmark for comparison. PARCo has showed improvements in the decisions taken with respect to previous approaches within the selected IoT scenarios.

We have concluded that by exploiting an ontology of concepts for knowledge inference, and by manipulating the inferred information, PARCo achieved better information sharing decisions according to human intuition, with respect to a previous approach.

References

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