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Complexity and Cyclic Instability in Ambient Intelligence

(Abstract)

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Abstract

Ambient Intelligence (AmI) can be seen as a complex rule-based multi-agent system, where the user can customize a number of services, either manually or automatically. As a consequence, and due to there being multiple and sometimes interacting rules programmed, Ambient Intelligence has been found to suffer from cyclic instability, i.e. periodic oscillations of the devices (turning *on* and *off*).

As, from complex systems theory, it has been shown it is impossible to determine when a set of such rules and initial conditions will lead the system into this behaviour, we have developed a theoretical framework called Interaction Networks (IN) that capture the rule dependencies in the form of a directed graph. Additionally, we have developed a mechanism, *Instability Prevention System (INPRES)* to prevent this phenomenon. INPRES finds cycles in the IN associated and locks a device member of each cycle. As a tool to visualise the pervasive space, we have developed a graphical *Multidimensional Model (MDM)* to visualize the *device-state-time* pervasive space. The MDM has been found to be an important tool to analyze the dynamic of the environment.

In this work we introduce the concept of density of cycles . This parameter enables us to characterize, in a practical way, the usability of a given system. In particular, we have found that a system with a density (for the case of an even number of agents) is guaranteed to have coupled cycles. Furthermore we have shown that low density is an important requirement for the usability of an ambient intelligence system.

In addition, we discuss future improvements to INPRES based on the analysis of the weak and strong coupling of the rules. Finally, we offer some examples using computing simulations of systems with different parameters which demonstrate the effectiveness of our methods.