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Coupling Analysis and Instability Prevention in Multi-Agent Systems

Abstract

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Ambient Intelligence (AmI) has been found to suffer from cyclic instability that manifests itself in the form of periodic oscillation of device states, such as lights flickering in smart homes. This behaviour emerges from interaction between rule based devices.

Complex systems theory has shown that it is not possible, in general, to predict whether a set of rules and initial conditions will lead a system into periodic behaviour. As a consequence, we have developed a strategy called *Instability Prevention Systems* (INPRES) to prevent this unwanted behaviour and a framework called *Interaction Networks* (IN) that captures the rule dependencies using graph theory. INPRES uses IN theory to analyse the rules and dependencies, identifying potential causes of instability and inoculating the network against instability by selectively locking network nodes in a way that seeks to preserve environment functionality..

The INPRES strategy has been proven effective for preventing this oscillatory behaviour; however, it has the inherent disadvantage of preventing information spreading across the system due to locking nodes. Thus, locking needs to be applied in a selective way. Towards this end we have found that the analysis of the local rules of the systems can provide additional information, that can improve the performance of INPRES: that is, it is possible to lock fewer agents therebye reducing the extent of the disabling effects of the locking.

In this paper we show how this can be achieved by presenting the concept of weak and strong coupling of oscillatory subsystems and showing how this can be used as part of the IN methodology to produce a more effective locking arrangement. Additionally, some examples of this refinement using computing simulations are given.

Finally, we discuss the potential for applying this work applications ranging from pervasive computing to political and financial systems.