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Stigmergy as a Universal Coordination Mechanism II: Varieties and evolution

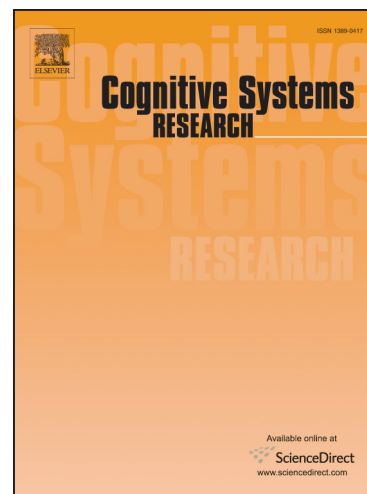
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**Stigmergy as a Universal Coordination Mechanism II: varieties and evolution**

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**Abstract:** The concept of stigmergy, a mechanism for the coordination of actions via the trace they leave in a medium, can explain self-organizing activities in a broad range of domains, including social insects, collaborative websites, and human institutions. The present paper attempts to bring some order to these diverse applications by classifying varieties of stigmergy according to general aspects: the number of agents involved, the relative persistence or transience of the trace, the use of sematectonic or marker-based traces, and the quantitative or qualitative characteristics of traces. The resulting cases are essentially continuous, as more complex cases can be understood as having evolved out of simpler ones. One application is cognition, which can be viewed as an interiorization of the individual stigmergy that helps an agent to perform a complex project by registering the state of the work in the trace, thus providing an external memory. Another application is the evolution of cooperation, in which agents learn to profit from the synergy produced by the spontaneous stigmergic coordination between their initially independent actions, thus bypassing the problem of “free riders” that exploit the cooperators’ efforts.

*Keywords:* stigmergy, coordination, sematectonic, cognition, extended mind, evolution of cooperation, free riders

**Introduction**

In a preceding paper (Heylighen, 2015), stigmergy was defined as a mechanism for the coordination of actions, in which the trace left by an action on some medium stimulates the performance of a subsequent action. This generic definition is applicable to a very broad variety of cases, including the pheromone traces used by ants to find food, the self-

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