

## **A Positive Theory of Emergence for Multi-Agent Systems**

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Certain usages of the term 'emergence' in the multi-agent systems (MAS) and complex adaptive systems (CAS) literatures are formalized. In particular, descriptions of the behavior of such systems are often given at multiple levels: at the level of the individual agents in the system (micro-level) as well as at some higher level involving many system components (macro-level). Emergent properties are ones that obtain at one level while being absent at the other. A formal way to relate multi-level descriptions of a phenomenon is given by the theory of model aggregation. The concept of an emergent property of a system falls out naturally from considerations of model aggregation, and is distinguished from simple resultant properties. Two distinct types of emergent properties are identified. Examples of emergent properties in social systems are given. In particular, it is argued that certain social structures (e.g., social norms, markets, firms, institutions) are best understood as emergent.