

Information theory for complex systems

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Classical information theory is a concept that was designed explicitly for Markovian or ergodic systems or processes.

We present recent ideas of how information theory can be modified and extended such that it becomes a suitable theoretical framework for describing statistical complex systems. We argue that many complex systems are intrinsically non-Markovian or non-ergodic, which by definition, excludes the use of classic information theory. We will show that there exist ways to generalise the information theoretic concept in a mathematically concise and consistent way. We demonstrate the practical use of this in the classification of complex systems. We will learn that the concept of entropy can be generalised and that entropy becomes a much richer concept than in classical information theory, statistical mechanics, or from inference methods involving entropy functionals. We finally explore several practical applications of the new framework in the context of path-dependent systems.