Generalizing Entropy and Information Concepts

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Abstract: Although the concept of entropy has its origins in the physics of heat engines, it was relatively quickly generalized to physical chemistry by way of gases, and then to chemical interactions, and to organic chemistry. By further extension it is at home in biochemistry and the chemistry of macromolecules. This last case allows the integration of chemical entropy with information concepts (Holzmüller 1984), and the ideas can be extended to the analysis of chemical machines without doing any violence to the concept of entropy's origins (Schneider 2005). Extensions to domains that are less clearly connected to physics are more controversial, though Prigogine has applied the ideas to traffic flow and the growth of cities, to name but two high level applications. I conjecture that the concept of entropy can be generalized to any system in which there is an objective (but possibly relative) distinction between macrostates and microstates, in which the microstates are random relative to the macrostates. In particular, some information systems have this property, especially in biology. I give the required definitions to rationalize my conjecture. Several interesting results concerning dynamical systems follow from the conjecture, illustrating that thermodynamics is a special case of a more general dynamical theory. Infodynamics, or the dynamics of form (*morphodynamics*), is a non-thermodynamic interpretation that deals substance in its guise as form (*substantial forms*) rather than energy. This dynamical approach to information requires regarding information as embodied but independent of interpretation. It therefore requires both a restriction and a generalization of standard abstract approaches to information (Shannon, Kolmogorov, Ingarden et al). The unifying principle behind these generalizations is the concept of *work*. If this concept is neglected, the common foundations cannot be properly motivated or even seen.

Holzmüller, W. (1984) *Information in Biological Systems: the Role of Macromolecules.* Cambridge: Cambridge University Press.
Schneider, Tom (2005) *Molecular Information Theory and the Theory of Molecular Machines*
(web site: http://www.lecb.ncifcrf.gov/~toms/)
