

Computational Mechanics: Natural Computation and Self-organization

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Abstract. The tutorial explores how nature's structure reflects how nature computes. It reviews intrinsic unpredictability (deterministic chaos) and the emergence of structure (self-organization) in natural complex systems. Using statistical mechanics, information theory, and computation theory, it develops a systematic framework for analyzing processes in terms of their causal architecture. This is determined by answering three questions: (i) How much historical information does a process store? (ii) In what architecture is that information stored? And (iii) how is the stored information used to produce future behavior? The answers to these questions tell one how a system intrinsically computes.

Readings. For the tutorial, see the articles, going from less to more technical (that is, the recommended reading order):

1. *Is Anything Ever New? Considering Emergence*
<http://cse.ucdavis.edu/~cmg/compmech/pubs/EverNewTitlePage.htm>
2. *Regularities Unseen, Randomness Observed: Levels of Entropy Convergence*
<http://cse.ucdavis.edu/~cmg/compmech/pubs/ruro.htm>
3. *The Calculi of Emergence: Computation, Dynamics, and Induction*
<http://cse.ucdavis.edu/~cmg/compmech/pubs/CalcEmergTitlePage.htm>
4. *Computational Mechanics: Pattern and Prediction, Structure and Simplicity*
<http://cse.ucdavis.edu/~cmg/compmech/pubs/cmpps.htm>
5. *The Organization of Intrinsic Computation: Complexity-Entropy Diagrams and the Diversity of Natural Information Processing*
<http://cse.ucdavis.edu/~cmg/compmech/pubs/oic.htm>
6. *Structure or Noise?*
<http://cse.ucdavis.edu/~cmg/compmech/pubs/son.htm>