HICSS Minitrack Session on Self-Organized Criticality

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Complex Systems with characteristics similar to Self-Organized Criticality (SOC) or Highly-Optimized Tolerance (HOT) exhibit failure events of all sizes, typically with a frequency of occurrence described by a heavy-tailed distribution. Some large scale engineered or physical systems, such as the North American electric power grid, have failure statistics consistent with SOC and HOT systems. This suggests that the risks of large-scale failure of these systems should be analyzed using ideas from complex systems. The challenge is to work out which factors in the dyamics, topology and interactions in these systems contribute strongly to the complex behavior and then to construct models capturing these effects so that they can studied with a view to understanding and mitigating catastrophic failures.

We pose some of the interesting issues as questions:

- What are the salient system characteristics causing heavy tailed distributions of failure events? For example, what emphases should be placed on failure modes, engineering optimization, system loading, network topology, nonlinear dynamics, types of interactions between elements, and social and economic forces? What time scales are involved?
- How does engineering of the system in response to societal requirements affect these systems? Is engineering itself part of the dynamics shaping these systems?
- Does the heavy tail distribution represent a system at criticality and is the criticality due to system loading or to system structure?
- How is cascading failure, which often involves rare events and rare interactions, analyzed and prevented in these complex systems?
- Should the models and methods of analysis be dynamical or statistical or both? Is the network topology relevant and do graph theoretic methods apply?
- Are the phenomena common to diverse infrastructures? For example, do similar methods work for power systems and the internet?
- What are the implications for society of the heavy tails and what type of risk analysis and mitigation works for these systems?

We look forward to discussion and interactions at HICSS to address these questions.

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