

THE PROPERTIES OF COMPLEX SYSTEMS

① UNIVERSALITY

The underlying properties and behaviors of all complex systems are essentially the same, that is, they are universal. Therefore, they can be studied in principle without delving into the particular details of each system. The resulting analyses, however, can be applied to the understanding of any complex system. These universal properties are:

- ☞ **Power-Law Distributions:** *small events are common or frequent; large events are rare and infrequent. Distributions plot as a straight line on log-log graph paper. All events have the same cause, regardless of size.*
- ☞ **1/f noise:** *where the strength or power of a signal is inversely proportional to its frequency*
- ☞ **Avalanche Behavior:** *Chain reactions of events in a domino effect.*
- ☞ **Fractal Properties:**

② SELF-EVOLVE TO THE CRITICAL STATE THROUGH A LONG EVOLUTIONARY PROCESS

Without help from an outside agent, complex systems absorb and store energy up to a critical state where avalanches of chain reaction events spontaneously occur.

- ☞ **Autocatalytic Networks of Stuart Kaufman**
- ☞ **Self Evolved Criticality of Per Bak**

③ ARE FAR FROM EQUILIBRIUM; THEY ARE OUT OF BALANCE

- ☞ *They have evolved to the critical state where small changes can produce unexpected outcomes. That is, they possess sensitive dependence.*

④ PRODUCE CATASTROPHES FOR NO REASON WHATSOEVER

Although catastrophes can have a triggering mechanism, it is quite possible within the dynamics of a complex system for catastrophes to occur for no reason whatsoever, except the natural perturbations within the system. We must accept catastrophes as inevitable in biology, history, and economics.