

Complex Adaptive Systems

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Researchers often refer to the following as *“Complex Adaptive Systems”*

- ▣ Immune systems;
- ▣ Multi-cellular organisms;
- ▣ Insect colonies;
- ▣ Ecologies;
- ▣ Decentralized market economies;
- ▣ Robot “herds” (groups of robots interacting with each other in an environment).

But what does this really mean?

Rough Definition of a Complex System

- **Reference:** Sunny Auyang, “Synthetic Analysis of Complex Systems,” available at “ACE Intro Materials” site at:
<https://www2.econ.iastate.edu/tesfatsi/aintro.htm>
- ▣ A *system* is any entity to be described.
- ▣ A *complex system* is a system that:
 - is composed of interacting units (components, primitive elements, constituents,...), and
 - exhibits *emergent* properties, i.e., properties arising from the interactions of the units that are not properties of the individual units themselves.

Definition of a Complex System... Continued

- Which (if any) of the following systems would you classify as a *complex system*?
 - ▣ A pencil?
 - ▣ A thermostat?
 - ▣ The Colorado River?
 - ▣ A labor market (i.e., a job market)?

What about a *Complex Adaptive System*?

A range of possible definitions:

A *complex adaptive system (CAS)* is a complex system that contains at least some units that are...

DEF 1: reactive, i.e., they have an internal structure that reacts systematically to different environmental conditions.

DEF 2: goal-directed, i.e., they are reactive, and at least some of their reactions are directed towards achievement of goals.

DEF 3: planners, i.e., they are goal-directed and they attempt to exert some degree of control over their environment to facilitate achievement of these goals.

Definition of CAS ... Continued

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