

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 <http://www.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 which 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

Which (if any) of the following systems would you classify as a **complex adaptive system**?

- A pencil?
- A thermostat?
- The Colorado River?
- A labor market (i.e., a job market)?