

Complex Adaptive Systems

Presenter:

Leigh Tesfatsion

Professor of Economics and Mathematics

Department of Economics

Iowa State University

Ames, Iowa 50011-1070

<http://www.econ.iastate.edu/tesfatsi/>

tesfatsi@iastate.edu

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

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- A pencil?
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