Complex Dynamical Systems

A Series of Ten Lectures to the Ross Institute, 2011-2012

by

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Lectures 1-5

1. Nov 2, Intro: Epiphany, What, Why, How

2. Nov 9, Grs. K, 1: Dynamical Systems

3. Nov 16, Grs 2, 3, 4: Complex Dyn Sys

4. Nov 21, Grs 5, 6, 7, 8: NetLogo Models

5. Dec 7, Grs 9, 10, 11: NetLogo Models

Lec. 1: Introduction

- A. My epiphany of the miracle year, 1972.
- B. WHAT: Systems thinking, General systems theory, cybernetics, system dynamics, and complex dynamical systems (CDS).
- C. WHY: The Spiral and World Cultural History as systems, systems thinking to understand the future.
- D. HOW: Foregrounding the systems of each grade with NetLogo (needs participation).

Lec. 2: Dynamical Sys.

- A. Stairway 2 Chaos
- B. Attractors, Basins, and Separatrices
- C. Schemes and Bifurcations
- D. Animated Examples

Lec. 3: Complex DS

- Grade K: Logistic, Period doubling bifurcation
- Grade 1: Van der Pol, Hopf bifurcation
- Grade 2: Daisyworld (CDS)
- Grade 3: Wolves and sheep
- Grade 4: Rabbits, grass, and weeds

Lec. 4: Middle School

- Grade 5: Riverine Civilizations, 3500-1450 BCE
  Ecosystem, Markets, Warfare

- Grade 6: Cultural Transformation, 1450-350 BCE
  Trade of ideas, paper, plunder

- Grade 7: Religions, Empires, 350 BCE -800 CE
  Silk Road, Lingua Franca, Currency

- Grade 8: Medieval Climax, 800-1453 CE
  Judeo-Christian-Islamic transmissions, Mecca

Fibers/Themes

- Threads (eg, systems thread) consist of fibers or themes (eg, ecosystem, trade route)

- Lower school exemplary systems (daisyworld, wolves-sheep, rabbits-grass-weeds) are all in the ecosystem theme

- Middle school exemplary systems will be in the trade route theme

Lec. 5: High School

- Grade 9: Modernism, World Economy, 1453-1688
  Circulatory system, Solar system

- Grade 10: Revolution, Individual, 1688-1851
  Statistics, Food riots, Malthus, Irish famine,
  Catastrophe, Tragedy of the Commons

- Grade 11: Global economics, Visionary revolt
  1851-1948, Class warfare, Arms races

- Grade 12: The Present, 1948-2000
  Planetary dynamics, chaos, catastrophes

Lectures 6-10

6. Jan 25, NetLogo Patches

7. Feb 1, NetLogo Turtles

8. Feb 8, NetLogo Links

9. Feb 15, NetLogo Extensions

X. Mar 28, NetLogo CDS Models

Lec. 6: Patches

- A. Complex Systems
- B. Computer Graphic Revolution.
- C. NetLogo Programming: Patch Patterns.

A. Complex Systems

A Recent Definition

FROM

Complex Systems: A Survey

M. E. J. Newman

Am. J. Phys. 79, 800-810 (2011)

A complex system is a system composed of many interacting parts, often called agents, which displays collective behavior that does not follow trivially from the behaviors of the individual parts.

B. Computer Graphic Revolution

An Animated Histomap (NetLogo Model)

The Whirlwind computer at MIT (circa 1951). In this photo, Stephen Dodd, Jay Forrester, Robert Everett, and Ramona Ferenz (seated at the CRT display) convene at the Whirlwind I test control in the Barta Building at MIT.

Source: Mitre

C. NetLogo Programming

Patch Patterns

Homework

- Create your own patch pattern in LetLogo.
- Catch up HW #4.

End of Lecture
Six of Ten