

CITS7211 Modelling Complex Systems

Lecture 1: Introduction

Overview

In this lecture we begin by motivating the need to model complex systems and set the scope of what we will study in this unit. We introduce the basic concept of a system and identify some factors that make them complex. We give a brief overview of the types of models that may be used to describe a system. We give a general discussion of the steps used in the modelling process. Finally we give a brief demonstration of NetLogo 4.0.4, an agent-modelling environment.

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Topics:

1. Systems theory – what makes a system, what makes a system complex?
2. Characteristics of complex systems: interaction, interdependence, concurrency and emergence.
3. What is a model? How does it differ from simulation? Why do we want a model?
4. Agent-based vs Mean-field (Aggregate) models.
5. Dimensional Analysis: simplification, and ruling out nonsensical models.
6. Examples:
 - a. Population growth / predator-prey models.
 - b. Simple pendulums and other oscillators
 - c. Insect colonies
7. Applications and reasons to model complex systems.
8. A modelling methodology: Observation, hypothesis, formulation, application verification.
9. Principals: Occam's Razor, subsystem decomposition, abstraction, boundary cases.
10. Netlogo 4.0.4 demonstration. NetLogo is a self contained programming language and environment that allows you to rapidly implement agent-based models. It is available from <http://ccl.northwestern.edu/netlogo/> and is installed under Linux in the computer labs. Type netlogo.sh in the terminal to load.

Reading:

1. John D. Sterman, 1994, *Learning in and about complex systems* in System Dynamics Review, Vol 10, Num 2-3 pp. 291-330
2. NetLogo 4.0.4 User Manual Tutorials 1, 2 and 3 (pages 29-70). The user manual is available under the help menu of NetLogo.

Tim French, 2008.