CITS7211 Modelling Complex Systems

Lecture 4: Cellular Automata II

Overview

This lecture continues to explore cellular (and molecular) automata and their applications to modelling complex systems. We discuss practical considerations of implementing cellular automata, the process for converting rules and observations into a cellular automaton model, the limitations of cellular automata, and methodologies for validating cellular automata. We will conclude with an open discussion about the steps to build a cellular automaton.

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Topics:

1. (From Lecture 3) Review of cellular automata, and generalizations to interacting automata:
    a. Neighbourhoods: 1 dimensional, n dimensional, Von Neumann, Moore, Margolus alternations, triangles, hexagons, Vonori Diagrams.
    b. Boundary conditions: wrapped topology (periodic), fixed, adiabetic, reflective.
    c. Extensions: Probabilistic rule sets, molecular automata (turtles), network automata.
2. Classic Examples:
    a. Conway's Game of Life: self-replication, Turing completeness, and simple organisms, oscillators, gliders, spaceships, guns.
    b. Wolfram numbers: absolute simplification, and categorization.
    c. Properties: totalistic functions, (fixed/periodic) equilibria, chaotic behaviour, persistant complex behaviour (emergent behaviour).
3. The cellular automaton process. Defining cell properties, update functions, selecting boundary conditions.
4. Validating cellular automata. Defining aggregate qualities, comparing to theoretical models, identifying emergent behaviour.
5. Discussion: A cellular automata for a grass fire.

Reading:

1. Bastien Chopard and Michel Droz. Celllular Automata Modeling of Physical Systems, Chapters 1 and 2.
2. CSSE library: There are a selection of honours theses on modelling complex systems. Some names that come to mind are Lightfoot and Gout (2002), and Fermanis (2005).
3. Nino Boccara, *Modeling Complex Systems,* Springer 2004, Sections 6.1 - 6.3

Tim French, 2009.