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Preface

NetLogo is an agent-based programming environment well suited for modeling and inspecting complex systems evolving over time. Since thousands of independent agents and their interactions can be simulated with NetLogo, emerging global patterns arising from the local behavior of these agents can be explored and analyzed.

This book deals with how to use NetLogo in order to design models of complex systems and models of intelligent systems. Specifically, just to mention a few examples, the tackled complex systems in the book are related to cellular automata, fractals, and visualization of graphs, while the addressed intelligent systems have to do with evacuation dynamics, evolutionary computation, and optimization in graphs.

Although version 6.1.0 of NetLogo has been used to design the models contained in this book, it has been written with no specific NetLogo version in mind. In other words, the general aspects of NetLogo are emphasized in the book regardless of the version.

Each of the fifteen chapters of this book includes a number of figures, bibliographic references, and exercises of interest to the reader. The book offers students, practitioners, and researchers a broad coverage of the main aspects of modeling problems with NetLogo in the context of complexity science and artificial intelligence. To that end, NetLogo code is included throughout the book for each presented model and for each addressed problem.

The first part of the book, "Introduction to NetLogo", contains the following chapter:

- **Chapter 1 "NetLogo"** reviews the programming environment and the main NetLogo components: turtles, patches, links, and the observer.

The second part of the book, "Graphs", includes the following chapters:

- **Chapter 2 "Modeling Graphs with NetLogo"** introduces a model for handling graphs that will be used in Chapters 3 to 5.
- **Chapter 3 "Graph Search"** presents a model for optimal path search in graphs. The A* algorithm and Dijkstra's algorithm are studied in detail.
- **Chapter 4 "Graph Coloring"** explains a model that addresses the graph coloring problem, which can be viewed as a constraint satisfaction problem. Greedy algorithms for this problem are analyzed.

- **Chapter 5 "Graph Layout"** deals with a model for graph layout, which can be considered as the problem of visualizing a graph's structure in an aesthetic way. Tutte's method is described in detail.

The third part of the book, "Cellular Automata", consists of the following chapters[1]:

- **Chapter 6 "Modeling Cellular Automata with NetLogo"** reviews cellular automata and outlines their relationship with NetLogo.
- **Chapter 7 "Elementary Cellular Automata"** introduces a model for handling one-dimensional cellular automata. Their four classes of behavior (homogeneous, periodic, chaotic, and complex) are illustrated.
- **Chapter 8 "Two-Dimensional Cellular Automata"** extends the previous chapter to the two-dimensional case. Thus, the game of life and other famous two-dimensional cellular automata are reviewed.
- **Chapter 9 "Applications of Cellular Automata in Physics"** shows several models of physical processes concerning partial differential equations, fluids, Ising spin, sandpile, and diffusion-limited aggregation. Like in the rest of the book, illustrative code and simulations are presented throughout the chapter.
- **Chapter 10 "Applications of Cellular Automata in Excitable Media"** introduces a set of models for excitable media, whose elements iteratively evolve according to a characteristic cycle: From a quiescent state, they become excited and then transit to a refractory state before returning to the initial quiescent state.
- **Chapter 11 "Applications of Cellular Automata in Biology"** presents models for interesting biological processes such as seashell pigmentation patterns, bacterial growth, and predator-prey populations.
- **Chapter 12 "Applications of Cellular Automata in Social Science"** introduces models related to relevant social science processes like Schelling's segregation, evacuation dynamics, game theory, and evolution.

Finally, the fourth part of the book, "Geometry", is formed by the following chapters:

- **Chapter 13 "Fractals"** deals with fractal geometry and reviews both geometric and algebraic fractals. In the case of algebraic fractals (for instance, the Julia sets and the Mandelbrot set), different visualization methods are implemented and illustrated. Interestingly, a new method based on minimum modulus visualization is presented.
- **Chapter 14 "Clustering"** contains a model for DBSCAN clustering, one of the most useful and popular clustering methods.
- **Chapter 15 "Voronoi Diagrams"** includes a model for Voronoi diagrams, a mathematical concept applied in many real-world problems.

[1] The contents of this part are an extension of certain chapters of the book [Galán, 2020].

The author of this book is an associate professor in the Department of Artificial Intelligence at UNED (Spanish Open University). Since the middle 1990s, he has performed teaching and research activities within the field of artificial intelligence, mainly in the areas of Bayesian networks and evolutionary computation.

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Madrid, January 2022