



CONTENTS

| | |
|---|---|
| 0: The Art & Science of Building Societies <i>in Silico</i> | 3 |
|---|---|

PART I: LEARNING TO WALK

1: The Foundational Steps of Building an Agent-Based Model

| | |
|--|----|
| Introduction | 19 |
| The Model: Young & Bettinger's Simulation of Dispersal | 20 |
| <i>NetLogo Interface</i> | 23 |
| <i>Setup Procedure</i> | 24 |
| <i>Go Procedure</i> | 28 |
| <i>Introducing the If Statement</i> | 28 |
| Theory of Simulation & Modeling | 32 |
| Modeling a Landscape | 35 |
| Summary | 39 |

2: Trading up to Complex Models of Economic Interaction

| | |
|--|----|
| Introduction | 45 |
| The Model: Simple Roman Trade | 46 |
| Setting up the Trade Model | 49 |
| <i>Manipulating Different Types of Variables</i> | 56 |
| Running the Trade Model | 57 |
| <i>Looping Code Segments</i> | 60 |
| <i>Lists</i> | 61 |
| <i>Plotting Model Data</i> | 64 |
| Debugging | 65 |
| Summary | 70 |

3: Reaping the Rewards: Addressing Archaeological Questions

| | |
|--|----|
| Introduction | 75 |
| The Model: SugarScape & Artificial Anasazi | 76 |

| | |
|--|----|
| First Steps in Subsistence & Model Accounting | 78 |
| <i>A Toy Landscape</i> | 86 |
| Validation: Is my Model "Right"? | 88 |
| Simulating the Creation of an Archaeological Record..... | 90 |
| <i>Dynamic Lists and their Manipulation</i> | 92 |
| Building Artificial Anasazi | 98 |
| Summary | 99 |

PART II: LEARNING TO RUN

4: Mobility Algorithms: How Does Movement Leave Its Mark?

| | |
|---|-----|
| Introduction | 107 |
| Modeling Human Movement..... | 108 |
| An Introduction to Algorithms..... | 110 |
| Pedestrian Movement | 111 |
| <i>Random Walks</i> | 111 |
| <i>Correlated Random Walks</i> | 114 |
| <i>Lévy Flights</i> | 115 |
| <i>Targeted Walk</i> | 116 |
| <i>Weighted Random Walk</i> | 119 |
| <i>Restricted Walks</i> | 121 |
| <i>Remembered Landscapes</i> | 122 |
| <i>Flocking</i> | 127 |
| Group/Household Movement..... | 127 |
| <i>Multilevel Mobility</i> | 130 |
| Population Dispersal | 134 |
| <i>The Basic Model: Fisher-Skellam</i> | 134 |
| <i>Probabilistic Cellular Automata, ABM-style</i> | 135 |
| <i>Leap-Frogging and Despots</i> | 141 |
| Validation | 142 |
| <i>Data Validation</i> | 143 |
| <i>Stylized Facts</i> | 145 |
| <i>Model Selection</i> | 146 |
| Summary | 146 |

5: Exchange Algorithms: How Do People Trade in Goods, Ideas, and Pathogens?

| | |
|--|-----|
| Introduction | 155 |
| Modeling Commercial Exchange | 156 |
| <i>Basic Exchange</i> | 156 |
| <i>Supply & Demand</i> | 159 |
| <i>Price-Setting Mechanisms</i> | 166 |
| Models of Information Transmission | 171 |
| <i>Vertical & Horizontal Transmission</i> | 171 |
| <i>Biased Social Learning</i> | 173 |
| <i>Content Bias</i> | 173 |
| <i>Frequency Bias: Conformist Bias, Anti-Conformist Bias</i> | 176 |
| <i>Payoff or Model-Based Bias</i> | 177 |
| <i>Mutation, Innovation & Error</i> | 178 |
| <i>Cumulative Cultural Evolution</i> | 179 |
| <i>Putting Together a Model of Cultural Transmission</i> | 181 |
| The SIR Family of Models | 183 |
| Ontology Building & Parsimony | 187 |
| Summary | 189 |

6: Subsistence Algorithms: Why Do Some Societies Thrive while Others Fade?

| | |
|---|-----|
| Introduction | 193 |
| Modeling Resource Acquisition | 195 |
| Population Resilience in the Face of Environmental Perturbation . . | 199 |
| Putting Energy to Use: Ways to Increase Resilience | 203 |
| Foraging Models | 208 |
| <i>Patch-Choice Model</i> | 208 |
| <i>Prey-Choice Model</i> | 212 |
| Household-Level Production & Population Dynamics | 214 |
| <i>Population Stability & Growth</i> | 221 |
| <i>Agent Fitness & Evolutionary Dynamics</i> | 223 |
| Tragedy of the Commons | 228 |
| <i>Game Theory</i> | 233 |
| Parameterization, Realism, Abstraction & Heterogeneity | 235 |
| Summary | 237 |

PART III: LEARNING TO FLY

7: Modeling with Spatial Data: Bringing the GIS World to ABM

| | |
|--|-----|
| Introduction | 247 |
| Bringing GIS Data into NetLogo | 249 |
| <i>Raster Data</i> | 250 |
| <i>Importing Patch Landscapes from Raster Data</i> | 252 |
| <i>Importing Places with Vector Data</i> | 254 |
| <i>Perceiving Raster & Vector Data</i> | 257 |
| Agent–Patch Interactions | 260 |
| <i>Agent–Agent & Patch–Patch Interactions</i> | 264 |
| GIS Data Sources & Types | 267 |
| Using Artificial Landscapes to Control Spatial Variables | 269 |
| Profiling your Code | 270 |
| Summary | 277 |

8: Modeling with Relational Data: Relationships and Exchange using Network Science

| | |
|--|-----|
| Introduction | 281 |
| Theories on Exchange | 285 |
| Sahlins's Model of Exchange | 287 |
| Network Models | 290 |
| Code Testing | 302 |
| <i>Visualization</i> | 303 |
| <i>Print Statements & Manual Tests</i> | 303 |
| <i>Extreme Scenario Testing</i> | 305 |
| <i>Assertive Tests</i> | 306 |
| Summary | 308 |

9: Data Analysis: Leveraging Data Science to Explore ABM Results

| | |
|--|-----|
| Introduction | 313 |
| Running Models | 316 |
| <i>What Data to Collect?</i> | 316 |
| <i>How Long Should You Run the Model?</i> | 317 |
| <i>How & When to Export the Data?</i> | 318 |
| Running Experiments with BehaviorSpace | 321 |
| <i>How Many Times Should You Run a Scenario?</i> | 325 |
| <i>Model Calibration & Selection</i> | 325 |

| | |
|---|------------|
| Working with BehaviorSpace Output Data | 326 |
| <i>Microsoft Excel</i> | 327 |
| <i>R & Python</i> | 329 |
| Interpreting ABM Data | 333 |
| <i>Detecting Causality, Sensitivity & Uncertainty</i> | 334 |
| Emergence | 337 |
| How & What to Publish | 338 |
| <i>Publishing Code</i> | 340 |
| Summary | 341 |
| 10: Conclusion | 347 |

APPENDIX & BACK MATTER

Appendix

| | |
|---------------------------------------|------------|
| Glossary | 361 |
| The ABMA Model Zoo | 367 |
| Making Colorblind-Friendly ABMs | 379 |
| Bibliography | 395 |
| Index | 417 |