



LES FACULTÉS
DE L'UNIVERSITÉ
CATHOLIQUE DE LILLE

Theory of systems

AGENT BASED MODELING

Baptiste Mokas

baptiste.mokas@gmail.com

weeki.io/store/????

linktr.ee/baptistemokas

+33 7 69 08 54 19 



OLD VERSION

Fais moi une structure de cours en 4 parties (part 1, 2 ...4) chacune comportant 3 à 4 sous parties (1.1, 1.2, ...), avec un point pour chaque sous-partie, sur la modélisation multi agent. Il faut que tu me fasse une structure qui soit en lien avec les systems complexe mais qui ne couvre pas les systèmes complexes qui seront dans une autres catégorie, un autre cours à part Le cours est en anglais

Part 6: Agent-Based Modeling

6.1 Agent-Based Modeling: Fundamentals

- Basics of Agent-Based Modeling
- Agents, Rules, and Interactions

6.2 Emergent Behavior and Self-Organization

- Emergence in Complex Systems
- Self-Organization and Swarm Intelligence

6.3 Cellular Automata

- Introduction to Cellular Automata
- Game of Life and Rule-Based Systems

6.4 Spatial Models and Pattern Formation

- Spatial Agent-Based Models
- Pattern Formation in Agent-Based Systems

6.5 Applications of Agent-Based Modeling

- Urban Simulation and Transportation Planning
- Epidemiological Modeling with Agents

6.6 Advanced Topics in Agent-Based Modeling

- Hybrid Models and Integration with Other Techniques
- Challenges and Ethical Considerations

KNOWLEDGE TREE

Part 1: Systems Theory Fundamentals

1.1 Introduction to Systems Theory

- What Is Systems Theory?
- Types of Systems (Open, Closed, Complex)
- Systems Thinking

1.2 System Dynamics

- Causal Loop Diagrams
- Stocks and Flows
- Feedback Loops

1.3 Emergence in Systems

- Emergent Properties
- Self-Organization
- Complexity and Chaos

Part 2: Agent-Based Modeling Basics

2.1 Agent-Based Modeling (ABM)

- What Is ABM?
- Agents and Environments
- Agent Interactions

2.2 Modeling Agents and Behaviors

- Defining Agent Characteristics
- Specifying Agent Behaviors
- Agent Decision-Making

2.3 Agent-Based Simulation

- Implementing ABM in Computer Simulations
- Space and Time in ABM
- Validation and Calibration of ABM

Part 3: Mathematical Foundations for Systems Theory

3.1 Linear and Nonlinear Systems

- Linear vs. Nonlinear Systems
- Stability Analysis
- Phase Portraits

3.2 Dynamical Systems

- Differential Equations in Systems Modeling
- Stability and Bifurcations
- Limit Cycles and Chaos

3.3 Network Theory

- Graph Theory in Systems
- Network Topology and Connectivity
- Small-World Networks and Scale-Free Networks

Part 4: Agent-Based Modeling Applications

4.1 Social Sciences Applications

- Agent-Based Models in Sociology
- Economics and ABM
- Social Simulations

4.2 Environmental Modeling

- ABM in Ecology
- Climate Modeling
- Natural Resource Management

4.3 Computational Epidemiology

- Disease Spread Modeling
- Public Health Simulations
- Epidemic Control Strategies

KEYWORDS (NEW)

KEYWORDS

- Linear and Nonlinear Systems
- Stability Analysis
- Phase Portraits
- Dynamical Systems
- Differential Equations in Systems Modeling
- Stability and Bifurcations
- Limit Cycles and Chaos
- Network Theory
- Graph Theory in Systems
- Network Topology and Connectivity
- Small-World Networks
- Scale-Free Networks
- Social Sciences Applications
- Agent-Based Models in Sociology
- Economics and ABM
- Social Simulations
- Environmental Modeling
- ABM in Ecology
- Climate Modeling
- Natural Resource Management
- Computational Epidemiology
- Disease Spread Modeling
- Public Health Simulations
- Epidemic Control Strategies
- Systems Theory
- Open Systems
- Closed Systems
- Complex Systems
- Systems Thinking
- Causal Loop Diagrams
- Stocks and Flows
- Feedback Loops
- Emergent Properties
- Self-Organization
- Complexity
- Chaos
- Agent-Based Modeling (ABM)
- Agents and Environments
- Agent Interactions
- Defining Agent Characteristics
- Specifying Agent Behaviors
- Agent Decision-Making
- Implementing ABM in Computer Simulations
- Space and Time in ABM
- Validation and Calibration of ABM

In the context of the course on Systems Theory and Agent-Based Modeling, one relevant use case is simulating the spread of diseases in a population. This use case touches upon various aspects of the course, including Agent-Based Modeling (ABM), mathematical foundations for systems theory, and its application in computational epidemiology.

Description:

In this use case, we'll create an Agent-Based Model to simulate the spread of a contagious disease within a population. The model will consider individual agents (representing people) who can move, interact with each other, and make decisions regarding their health and contact with others.

Key Components:

Agents: Each agent represents an individual in the population. Agents have attributes such as age, health status, and infection status.

Agent Interactions: Agents can interact with each other, potentially leading to the transmission of the disease. These interactions can occur within a certain radius of each agent.

Agent Decision-Making: Agents make decisions based on their health status and the risk of infection. For example, a healthy agent may decide to maintain social distance or wear a mask in crowded places.

Emergent Properties: The spread of the disease within the population will exhibit emergent properties, such as the overall infection rate and patterns of disease transmission.

Dynamical Systems: Differential equations and mathematical modeling will be used to describe the dynamics of disease transmission, including the infection rate, recovery rate, and the impact of interventions.

Validation and Calibration: The model will be validated and calibrated using real-world data to ensure that it accurately represents the dynamics of the specific disease being simulated.

Here is a simplified example of Python code for an Agent-Based Model to simulate disease spread:

```
1 import random
2
3 # Define agent attributes
4 class Agent:
5     def __init__(self, health_status):
6         self.health_status = health_status
7         self.infected = False
8
9     def interact(self, other_agent):
10        # Define rules for agent interactions and disease transmission
11        if self.infected and not other_agent.infected:
12            if random.random() < transmission_probability:
13                other_agent.infected = True
14
15 # Create a population of agents
16 population = [Agent("healthy") for _ in range(population_size)]
17 patient_zero = random.choice(population)
18 patient_zero.infected = True
19
20 # Simulate agent interactions and disease spread over time
21 for day in range(simulation_duration):
22     for agent in population:
23         if agent.infected:
24             # Define agent's actions when infected
25             # For example, they may interact with nearby agents
26             nearby_agents = [other_agent for other_agent in population if distance(agent, other_agent) < interaction_radius]
27             for other_agent in nearby_agents:
28                 agent.interact(other_agent)
29
30 # Analyze and visualize the results
31 # Calculate infection rates, plot graphs, etc.
```

This use case demonstrates how Systems Theory and Agent-Based Modeling can be applied to simulate and analyze the spread of diseases, helping researchers and policymakers understand and develop strategies for disease control and prevention.

- Bertalanffy, L. von. (1968). General System theory: Foundations, Development, Applications. George Braziller Inc.
- Meadows, D. H. (2008). Thinking in Systems: A Primer. Chelsea Green Publishing.
- Senge, P. M. (1990). The Fifth Discipline: The Art and Practice of the Learning Organization. Doubleday.
- Gilbert, N., & Troitzsch, K. (2005). Simulation for the Social Scientist. Open University Press.
- Macal, C. M., & North, M. J. (2010). Tutorial on agent-based modelling and simulation. Journal of Simulation, 4(3), 151-162.
- Railsback, S. F., & Grimm, V. (2019). Agent-Based and Individual-Based Modeling: A Practical Introduction. Princeton University Press.
- Strogatz, S. (2014). Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. CRC Press.
- Khalil, H. K. (2002). Nonlinear Systems. Prentice Hall.
- Newman, M. E. J. (2018). Networks. Oxford University Press.
- Epstein, J. M. (2006). Generative Social Science: Studies in Agent-Based Computational Modeling. Princeton University Press.
- Bonabeau, E. (2002). Agent-based modeling: Methods and techniques for simulating human systems. Proceedings of the National Academy of Sciences, 99(Supplement 3), 7280-7287.
- Keeling, M. J., & Rohani, P. (2011). Modeling Infectious Diseases in Humans and Animals. Princeton University Press.
- Barabási, A. L. (2016). Network Science. Cambridge University Press.
- Holland, J. H. (1995). Hidden Order: How Adaptation Builds Complexity. Helix Books.
- Mitchell, M. (2009). Complexity: A Guided Tour. Oxford University Press.
- Page, S. E. (2018). The Model Thinker: What You Need to Know to Make Data Work for You. Basic Books.
- Wolfram, S. (2002). A New Kind of Science. Wolfram Media.
- Casti, J. L. (1997). Would-Be Worlds: How Simulation Is Changing the Frontiers of Science. John Wiley & Sons.
- Tesfatsion, L., & Judd, K. L. (Eds.). (2006). Handbook of Computational Economics: Agent-Based Computational Economics, Vol. 2. Elsevier.
- Batty, M. (2005). Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals. MIT Press.

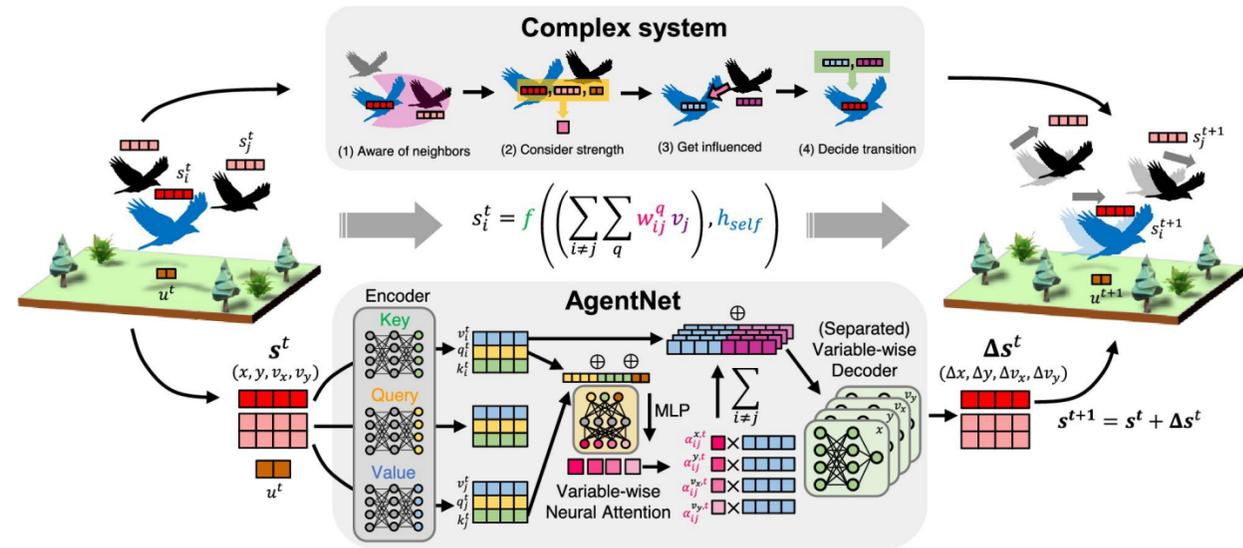
Step into a world where the intricate interplay of systems, agents, and mathematical foundations forms the bedrock of understanding complex phenomena. Our course, "Systems Theory and Agent-Based Modeling," offers you a captivating intellectual journey, where you'll explore the fascinating realm of systems theory and agent-based modeling. Imagine embarking on this quest for knowledge, where the very fabric of the world's complexities is unraveled through systems thinking, dynamic modeling, mathematical foundations, and practical applications.

To truly appreciate the significance of this course, we must acknowledge the influential minds and groundbreaking works that have paved the way for systems theory and agent-based modeling. Think of luminaries like Ludwig von Bertalanffy, whose pioneering ideas in systems theory laid the groundwork for understanding the interactions within complex systems. Reflect on the contributions of John Holland, the father of genetic algorithms, and his pioneering work in agent-based modeling. Their insights and innovations have forever changed the way we perceive and model complex systems.

The reach of "Systems Theory and Agent-Based Modeling" extends across diverse domains. Mathematicians, scientists, engineers, and social scientists all find value in this course. Systems analysts use these principles to model dynamic systems in engineering and economics. Environmental scientists employ agent-based modeling to simulate ecological systems and climate dynamics. Epidemiologists harness the power of agent-based modeling to predict disease spread and devise effective control strategies. Whether you're an aspiring modeler, a researcher, or a professional seeking a deeper understanding of complex systems, this course offers invaluable insights.

Understanding systems theory and agent-based modeling isn't just about acquiring knowledge; it's about gaining the ability to decode and model complex phenomena that shape our world. In an era where interdisciplinary collaboration is paramount, this course equips you with the tools to analyze and simulate dynamic systems, understand emergent behavior, and make informed decisions in various fields. Moreover, it opens doors to innovative research, where you can contribute to solving real-world challenges through dynamic modeling and simulation.

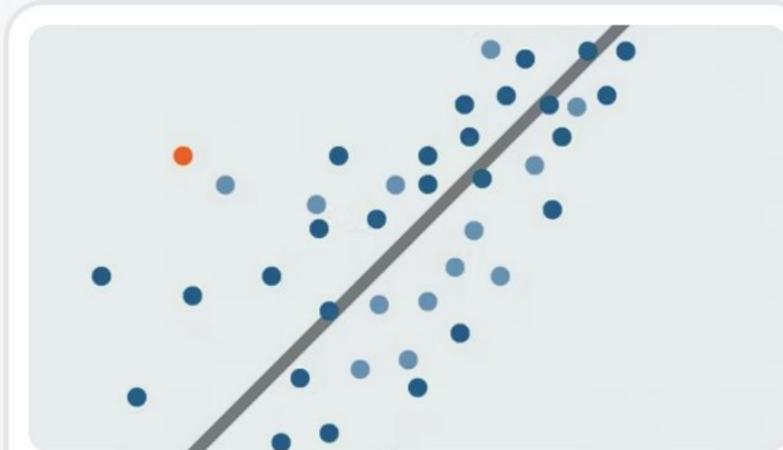
DESIGN DE LA CARD



Author: Baptiste Mokas, Weeki

Course Name: Simple Linear Regression

#SystemsThinking
#AgentBasedModeling
#ComplexSystems



Duke University

Linear Regression and Modeling

Compétences que vous acquerez: Probability & Statistics, Regression, Business Analysis, Data Analysis, General Statistics, Statistical Analysis,...

★ 4.8 (1.7k avis)

Débutant · Course · 1 à 4 semaines