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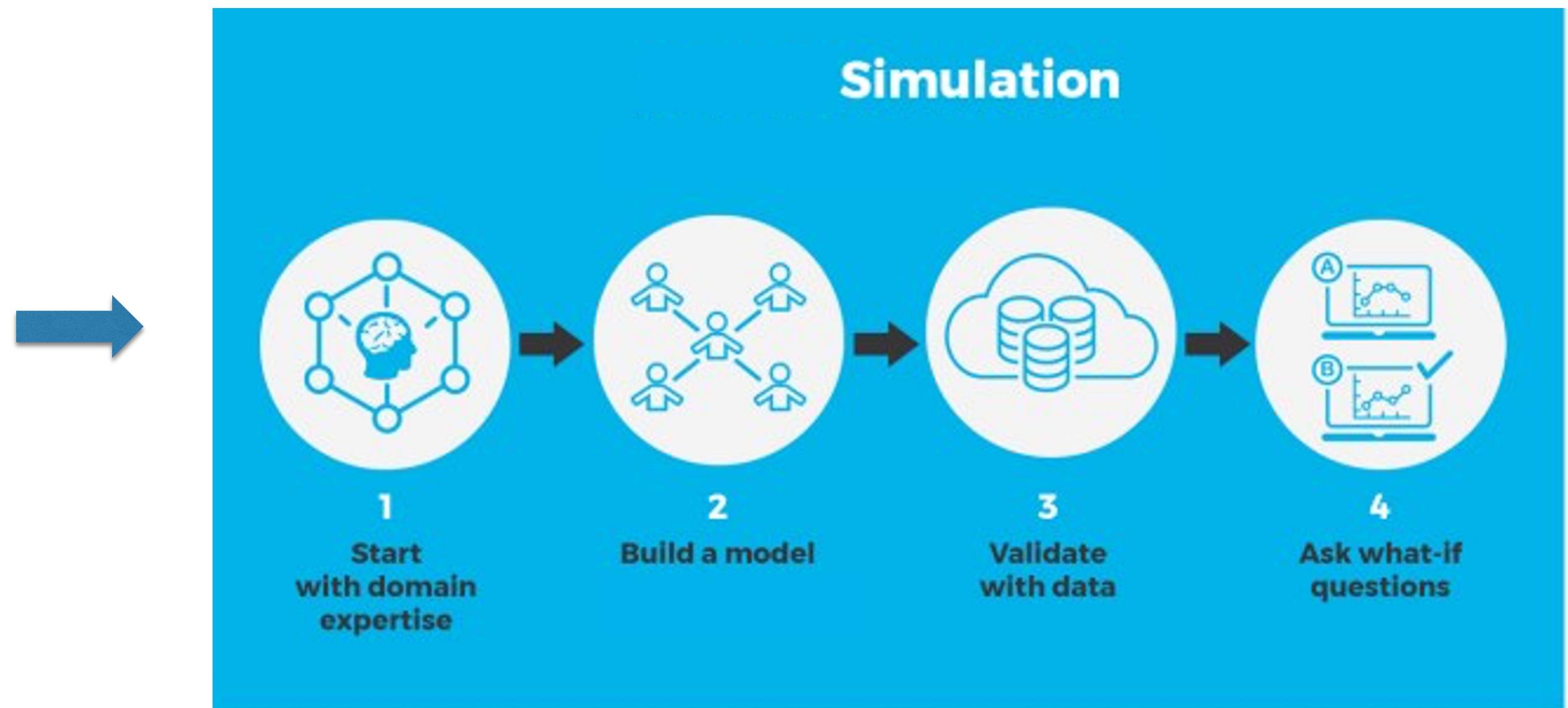
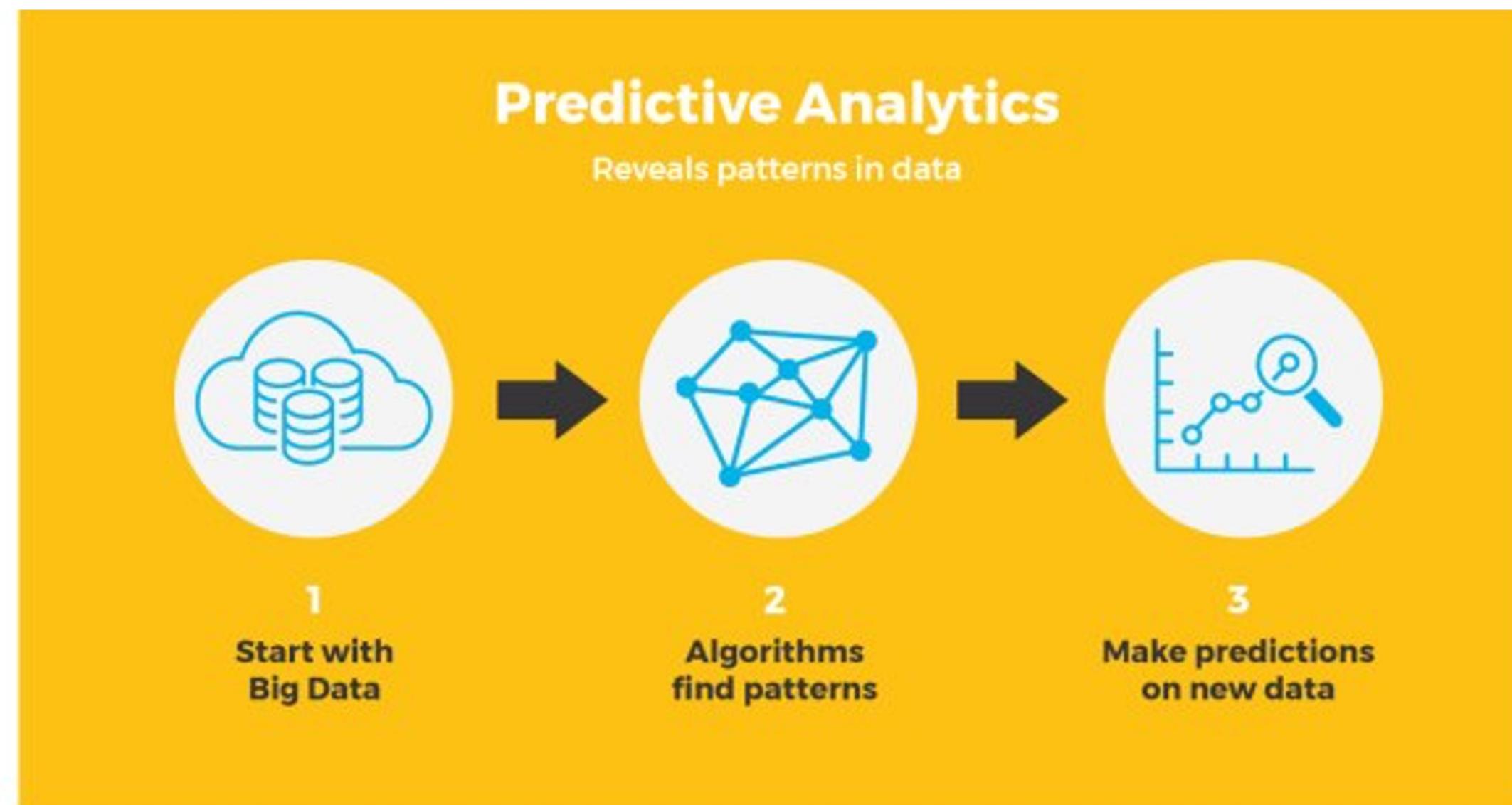
School of Data Analysis and Artificial
Intelligence Department of Computer Science

DATA SCIENCE FOR BUSINESS

Lecture 8. Agent based modeling and simulation

Moscow, June 10th, 2022.

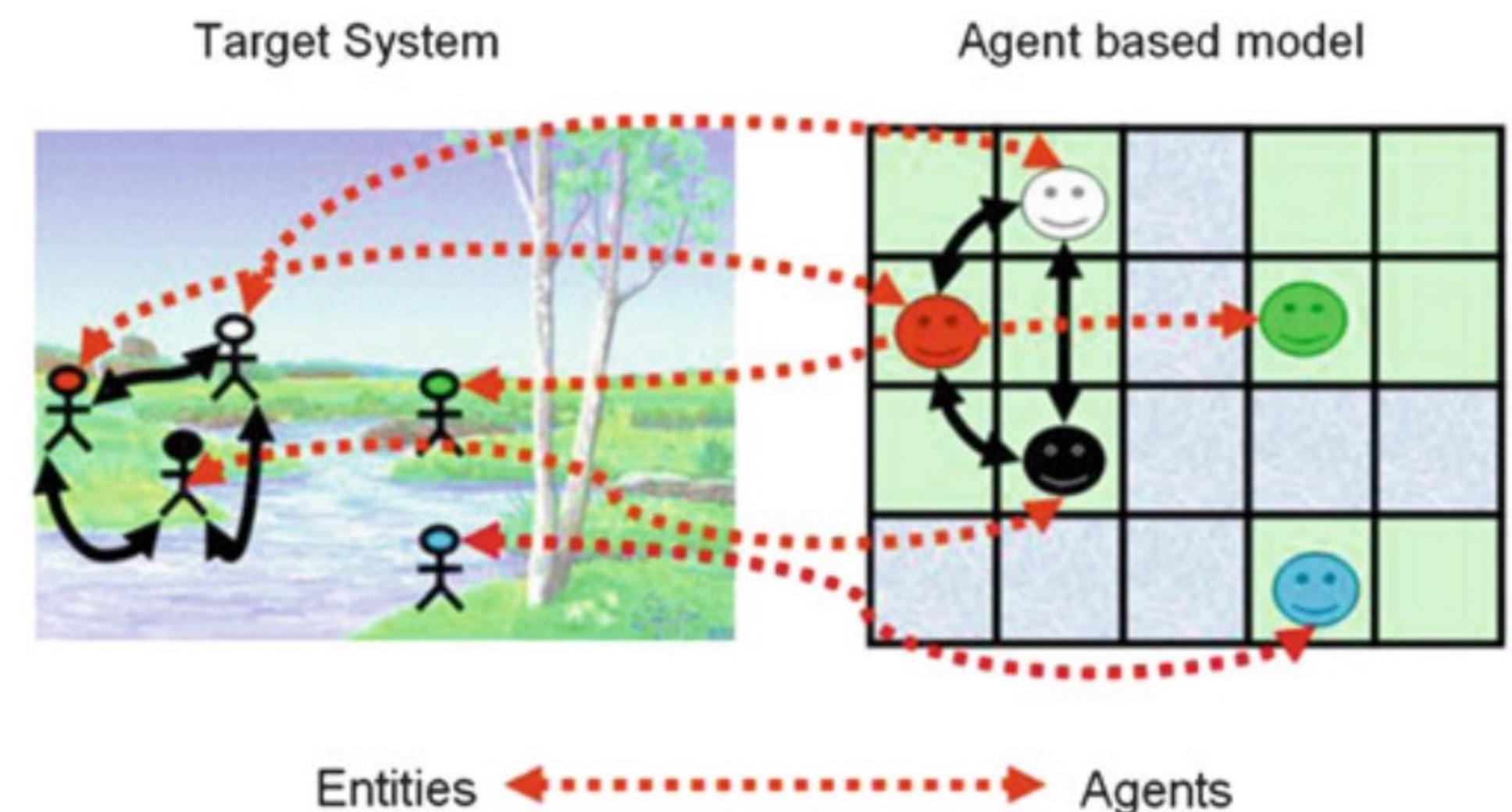
PREDICTIONS VS SIMULATIONS



AGENT BASED MODELING

ABM/ABS

- Agent-based modeling (ABM) is a computational approach to modeling systems comprised of individual, autonomous, interacting entities –agents and simulating their behavior
- An agent is an autonomous discrete entity, individual or object with particular properties, actions, its own goals and behavior.



AGENT BASED MODELING

Marketing



competitor behavior



promotion response



brand loyalty and product switching



consumer behavior

FI & Business process



financial and investment risk analysis and evaluation, providing optimal long-term roadmaps, prioritization, and the development of mitigation strategies



business process optimization and improvement



bottleneck identification and removal



epidemic simulation, evaluating disease spread and mitigation strategies

Transportation



traffic planning, the simulation of changes, additions, or subtractions to a road network



station throughput – testing policies and reducing congestion

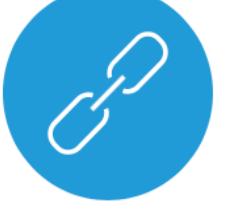


traffic light timing and sequencing to develop system wide optimization



transportation planning and optimization

Operations



supply chain design



warehouse operation setup an



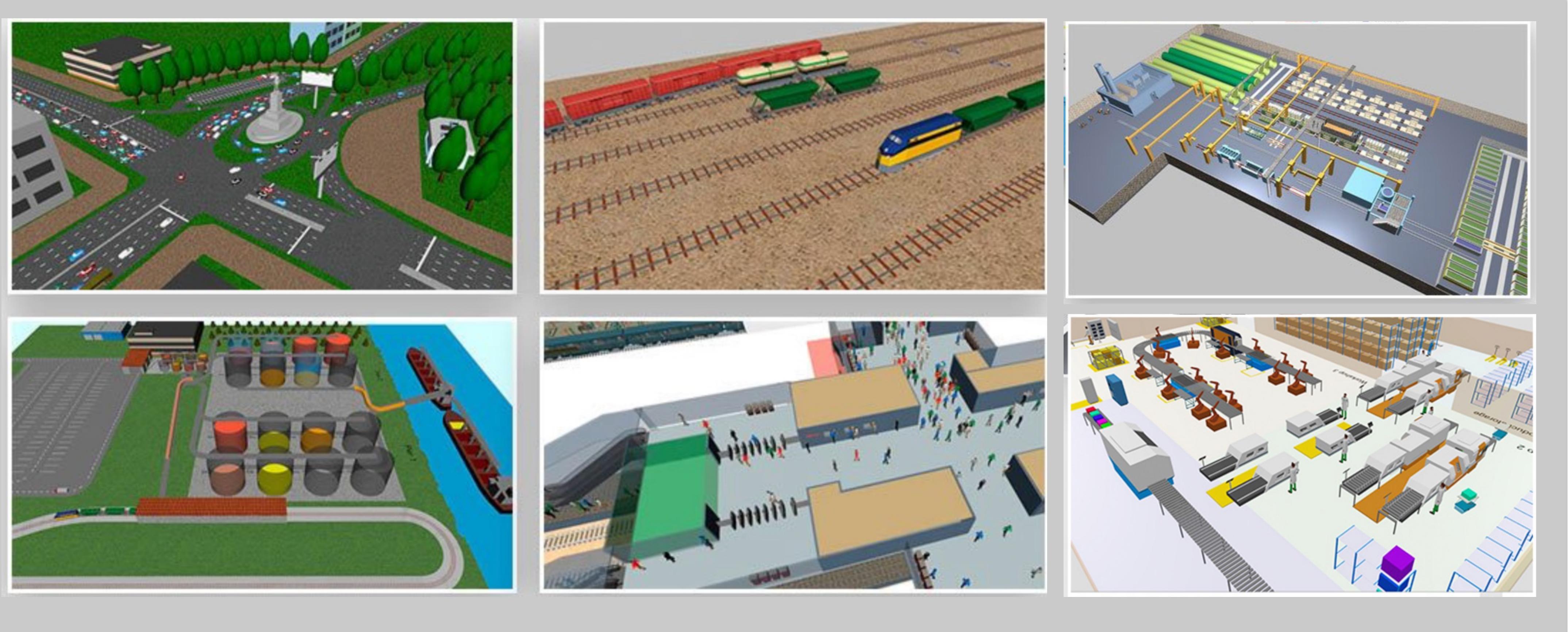
resource allocation: staff and equipment



production planning optimization and scheduling

AGENT BASED MODELING

AnyLogic example in operations



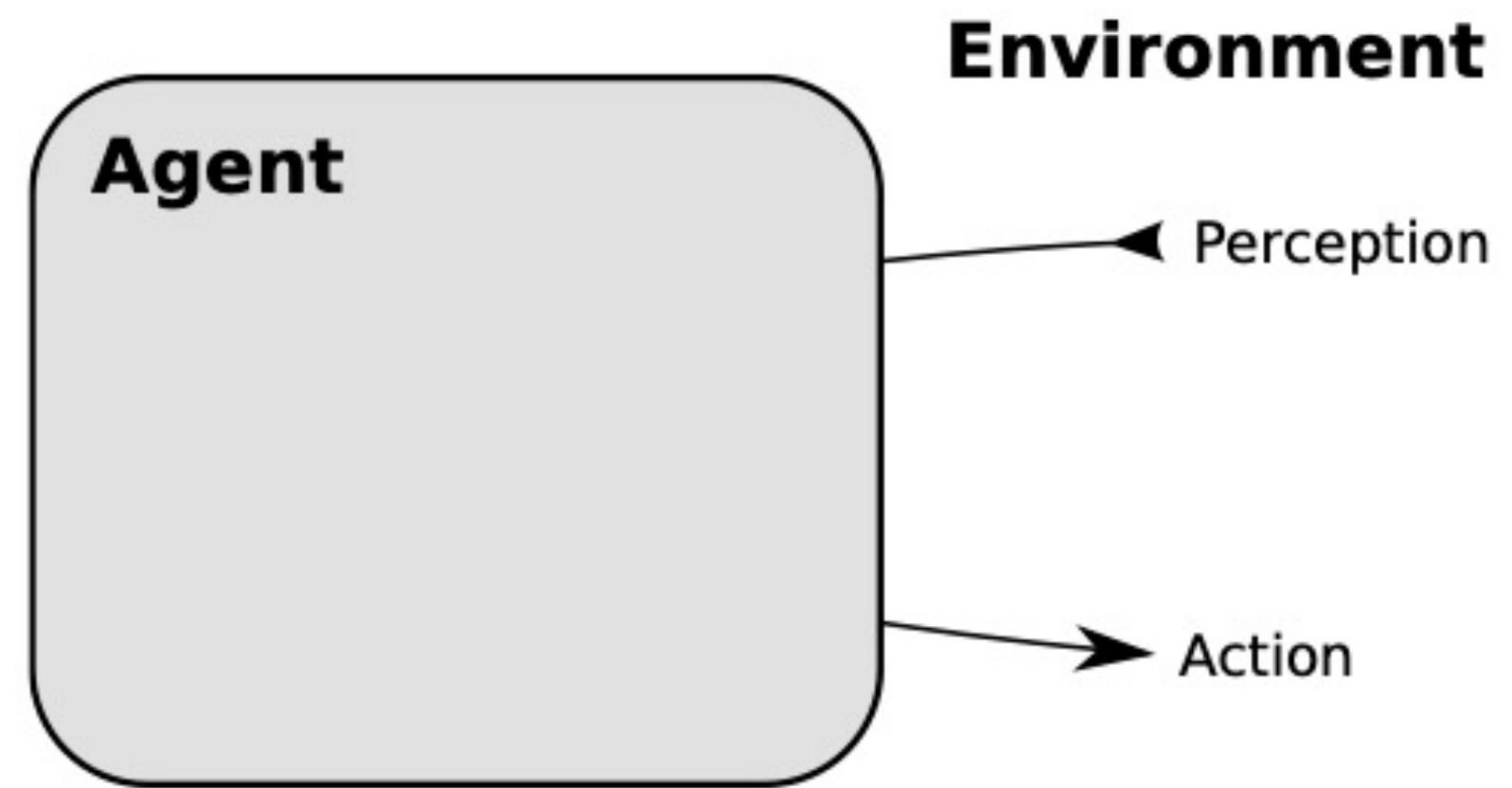


WHY AND WHEN USE AGENT BASED MODELING?

- Real world system becoming very complex and interdependent
- Complex system behavior, but each component follows simple rules
- Decentralized decision making.
- Dynamical very large scale systems
- Need for “what if” scenarios and intuitive simulation and visualization

AGENT BASED SIMULATION

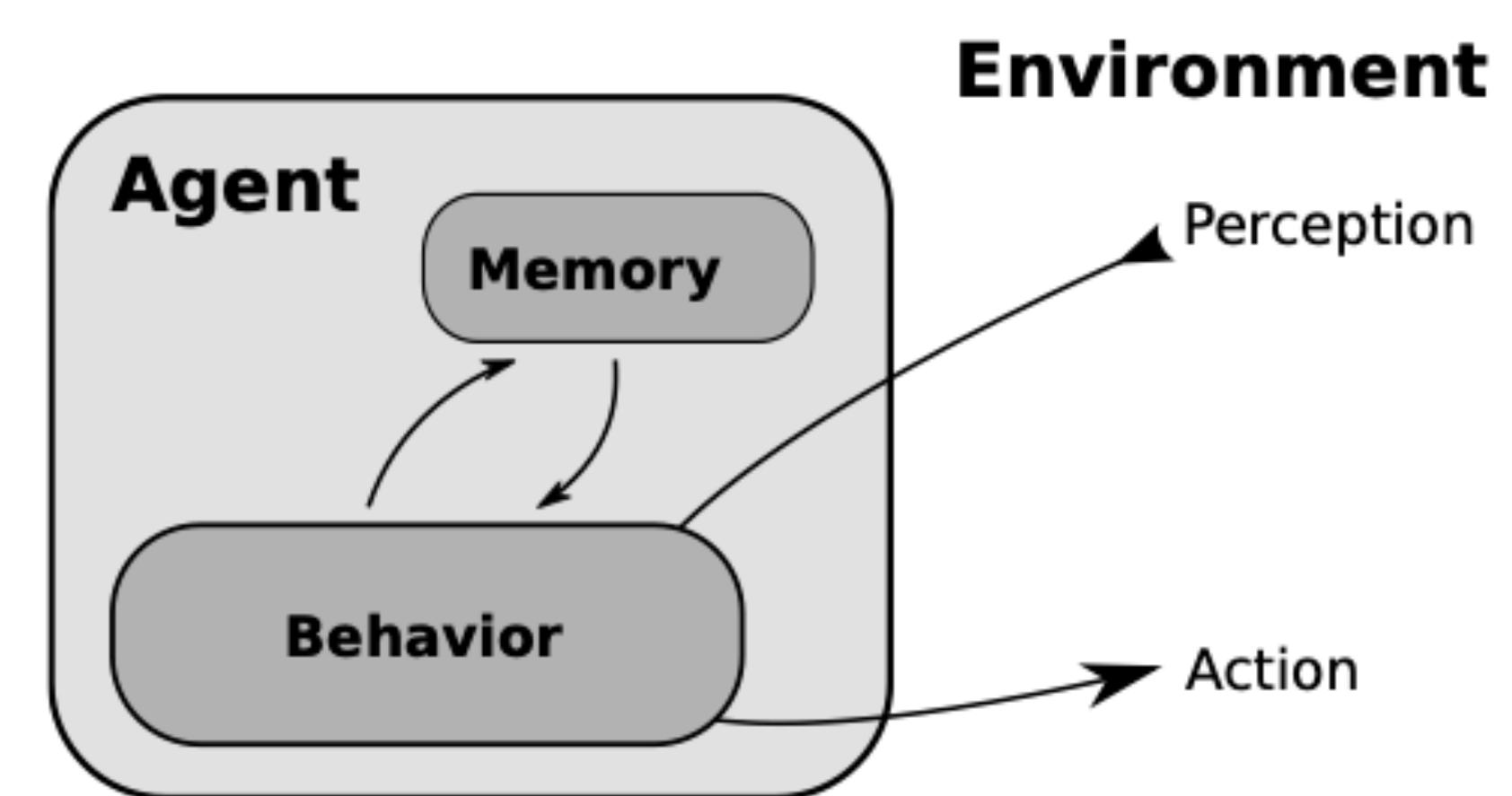
- Defined agents
- Agent relationships/interaction
- Environment



AGENTS

Agents are autonomous decision-making units with diverse characteristics

- A discrete entity with its own goals and behavior
- Autonomous, capable to adapt and modify behavior
- Decisions made independently by each agent
- Agents can be homogeneous or diverse and heterogeneous
- Can have memory and internal models
- Examples: people, robots, organizations, transport





AGENT BASED SIMULATION

- Agent based model consists of a set of user defined agents, a set of agent relationships and environment
- No central controller or authority exists for the system
- Independent move and interaction by any agent, decisions made independently by each agent
- Agents can be homogeneous or diverse and heterogeneous
- Local interaction among agents
- Various topologies connect agents with their neighbors (fee space, grid, network, GIS)
- Optimization can be done for the system globally
- Single clock

SPATIAL MODEL OF SEGREGATION

Tomas Schelling, 1971. 'Dynamic Model of Segregation'



Chicago 2010
census

SPATIAL MODEL OF SEGREGATION

Tomas Schelling, 1971. 'Dynamic Model of Segregation'

- Cities are strongly racially segregated. Are people that racists?
- Global patterns of spatial segregation from homophily at a local level
- Segregated race, ethnicity, native language, income
- Personal preferences lead to collective actions
- Small changes in micro-motives lead to large changes in macro-behavior
- Agent based modeling: agents, rules (dynamics), aggregation

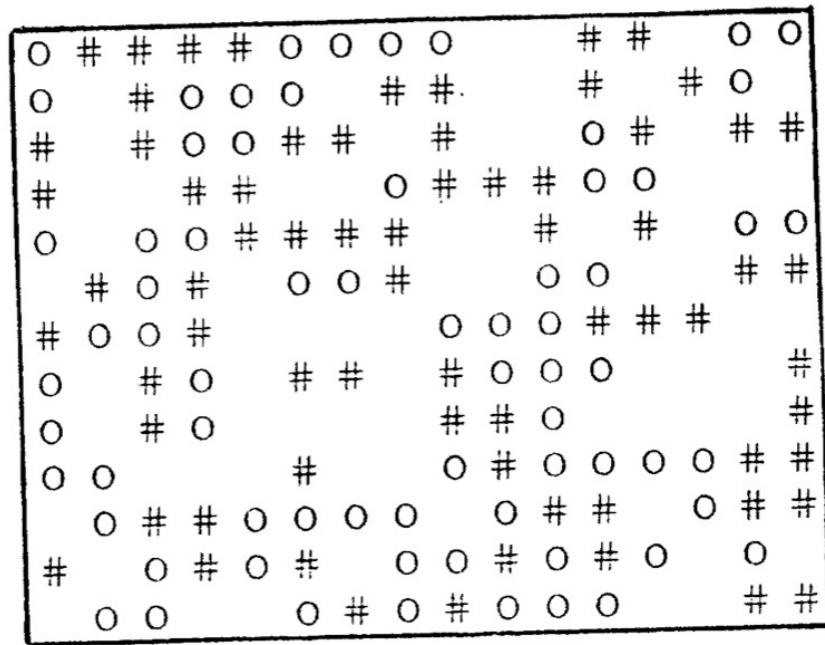


Fig.7

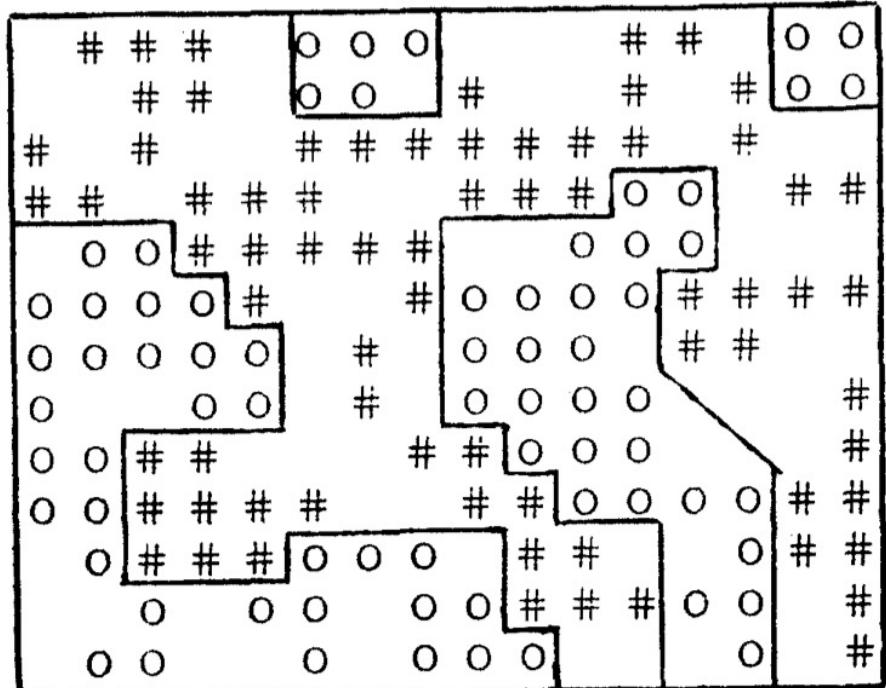


Fig.10

SPATIAL MODEL OF SEGREGATION

Tomas Schelling, 1971. 'Dynamic Model of Segregation'

- Population consists of 2 types of agents
- Agent reside in the cells of the grid (2-dimensional geography of a city), 8 neighbors
- Some cells contain agents, some unpopulated
- Every agent wants to have no more than some fraction (tolerance threshold) of his neighbors "unlike" him (satisfied agent)
- On every round every unsatisfied agent moves to a satisfactory empty cell.
- Continues until everyone is satisfied or can't move

Tolerance = 4/7

1	2	3
4	X	5
6	7	8

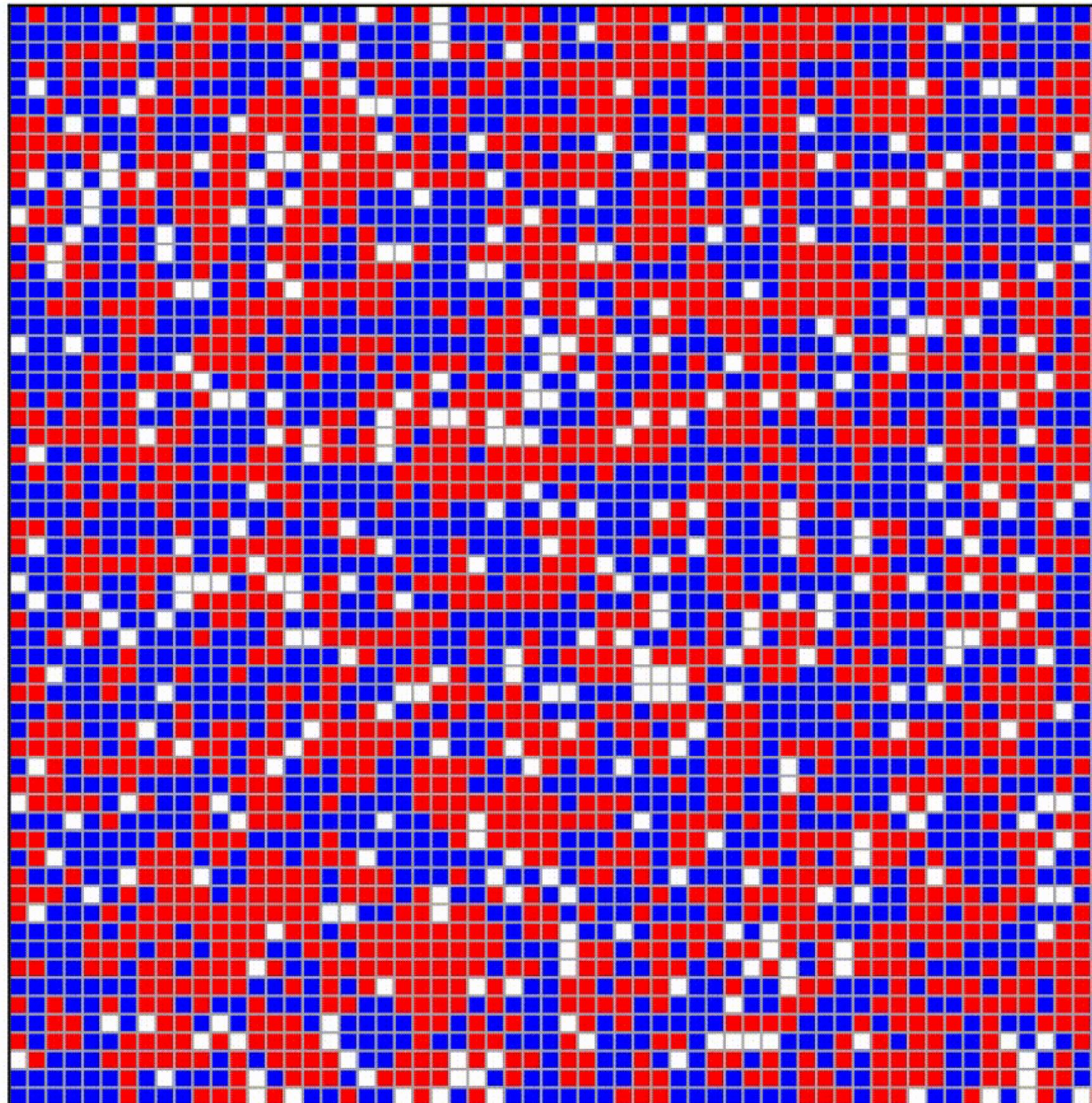
Satisfied agent

1	2	3
4	X	5
6	7	8

Unsatisfied agent

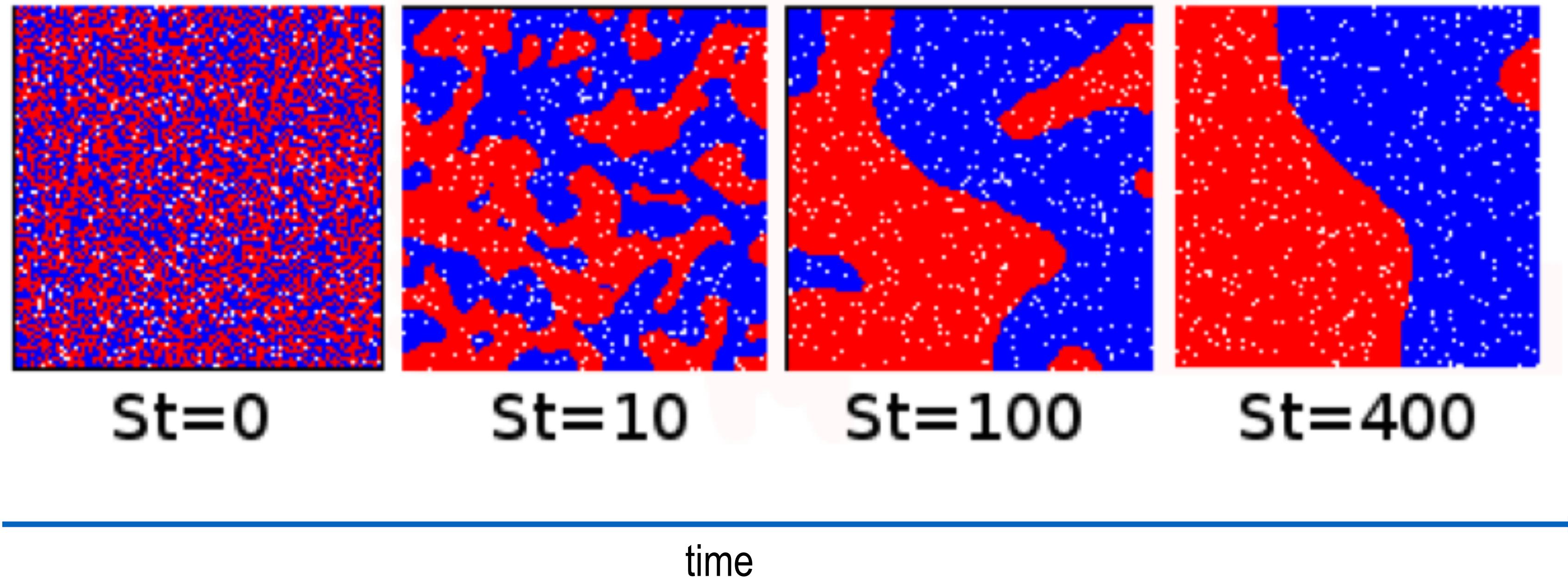
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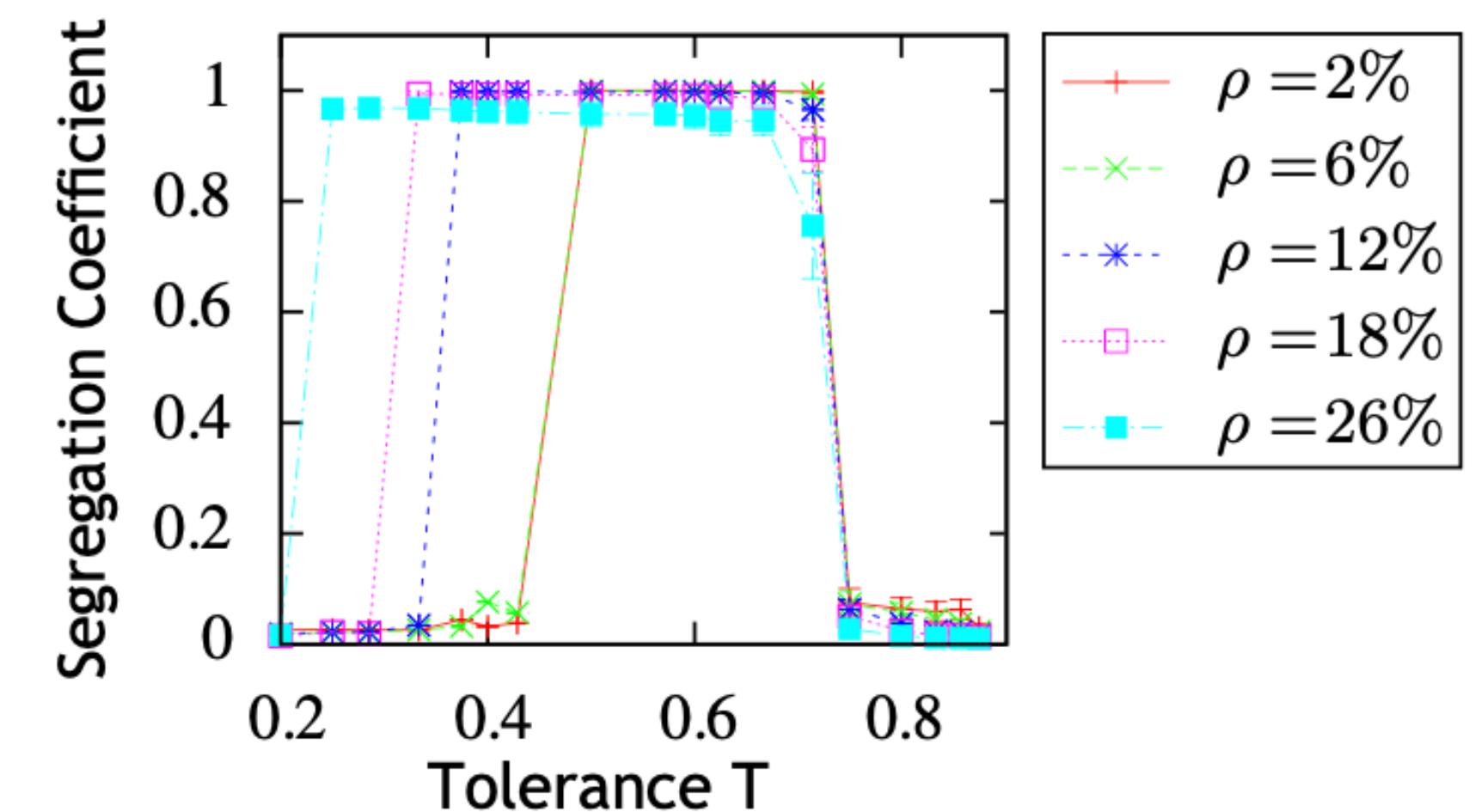
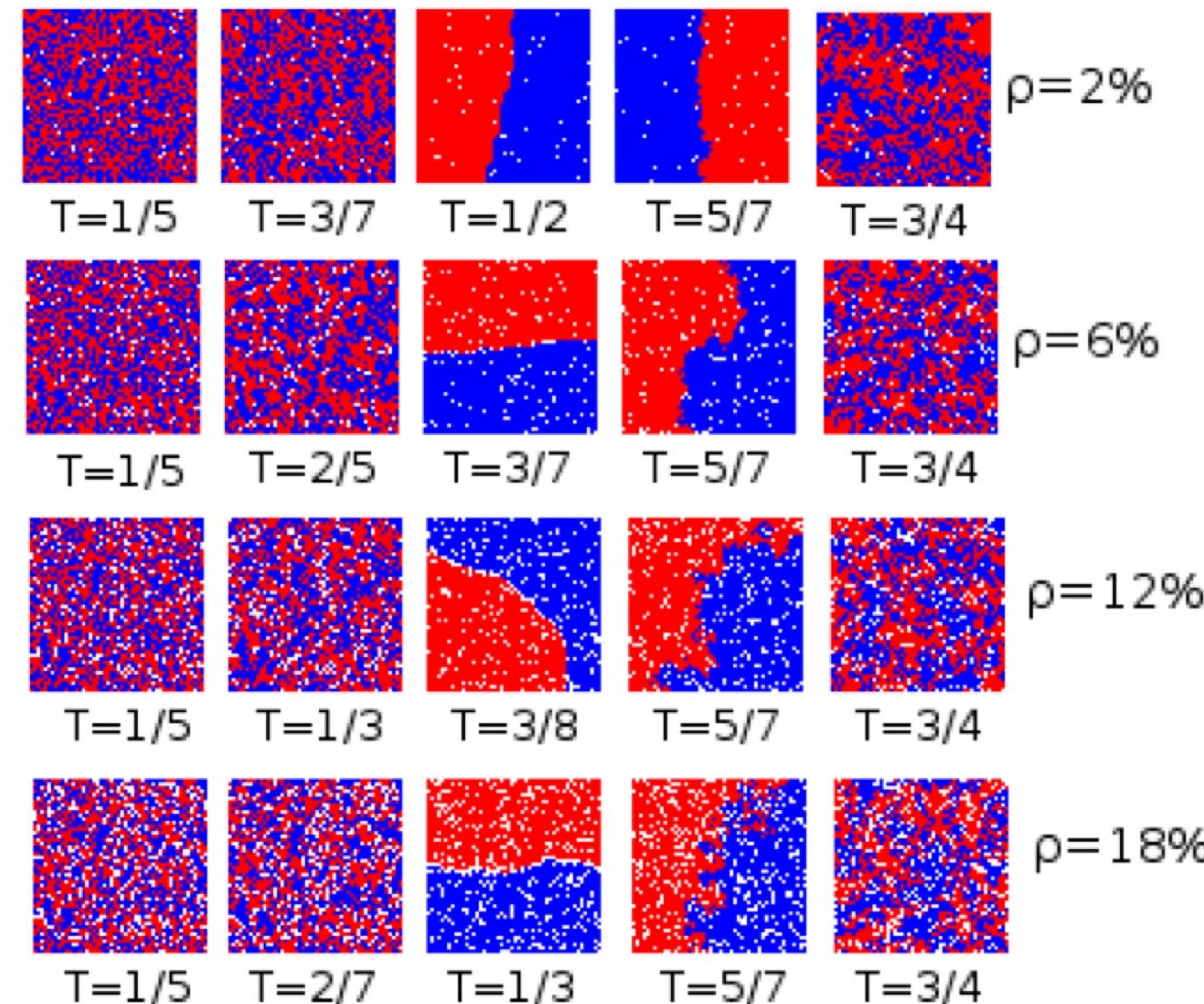


Tolerance $T = \frac{1}{2}$, vacancy = 5%

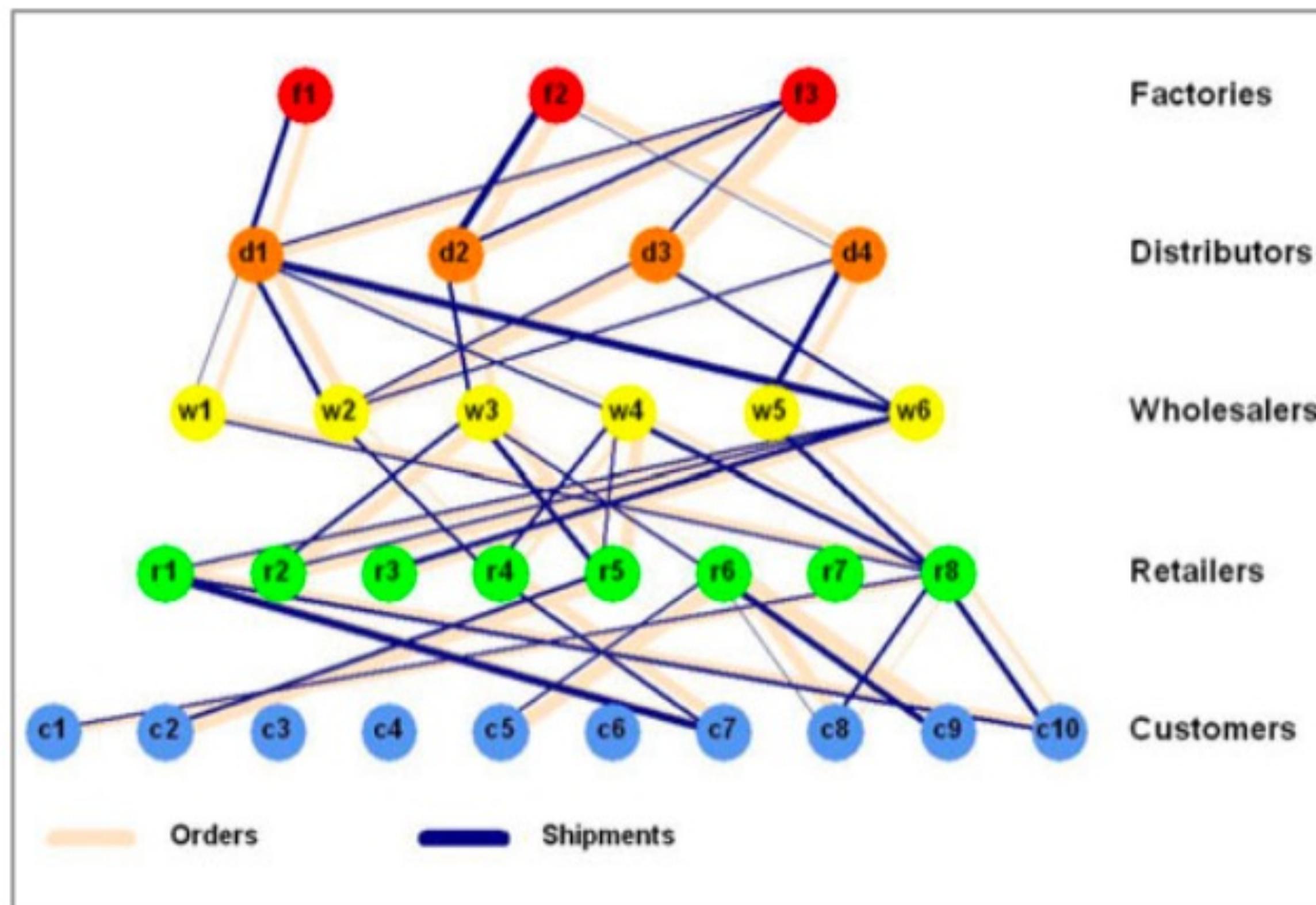
SPATIAL MODEL OF SEGREGATION

Tomas Schelling, 1971. 'Dynamic Model of Segregation'

Final equilibrium configuration

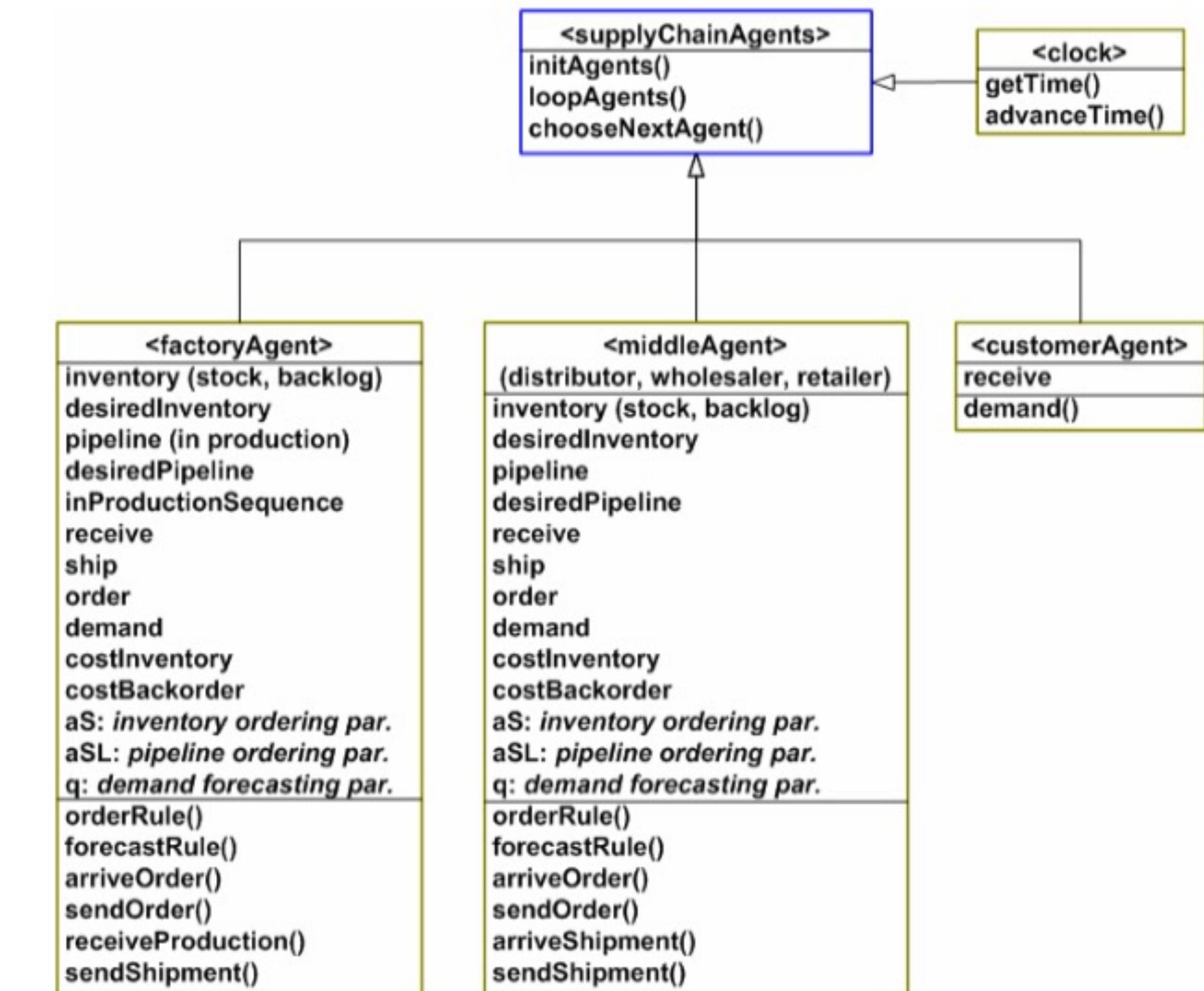
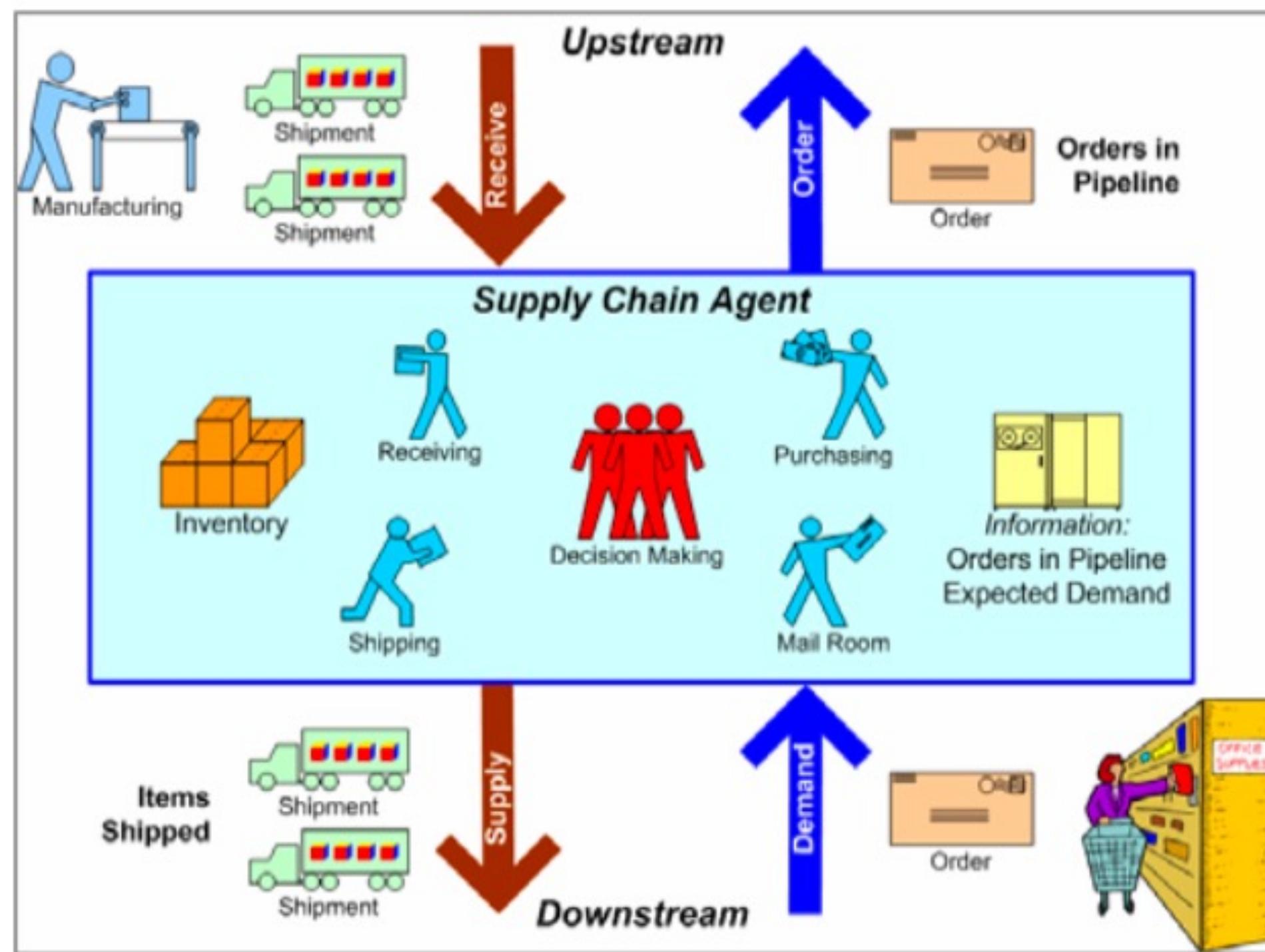


SUPPLY CHAIN MODELING



1. A customer places an order with the retailer.
2. The retailer fills the order from its respective inventory
3. The retailer orders/receives a shipment from the upstream wholesaler in response to previous orders, explicit inventory or pipeline goals.
4. Each wholesaler receives a shipment from the upstream distributor, forecasts future demand by the downstream retailer, and places an order with the distributor.
5. The factory decides on how much to put into new production based on demand

SUPPLY CHAIN MODELING



Satisfied
agent

MODELING CONSUMER BEHAVIOR FOR B2C E-COMM

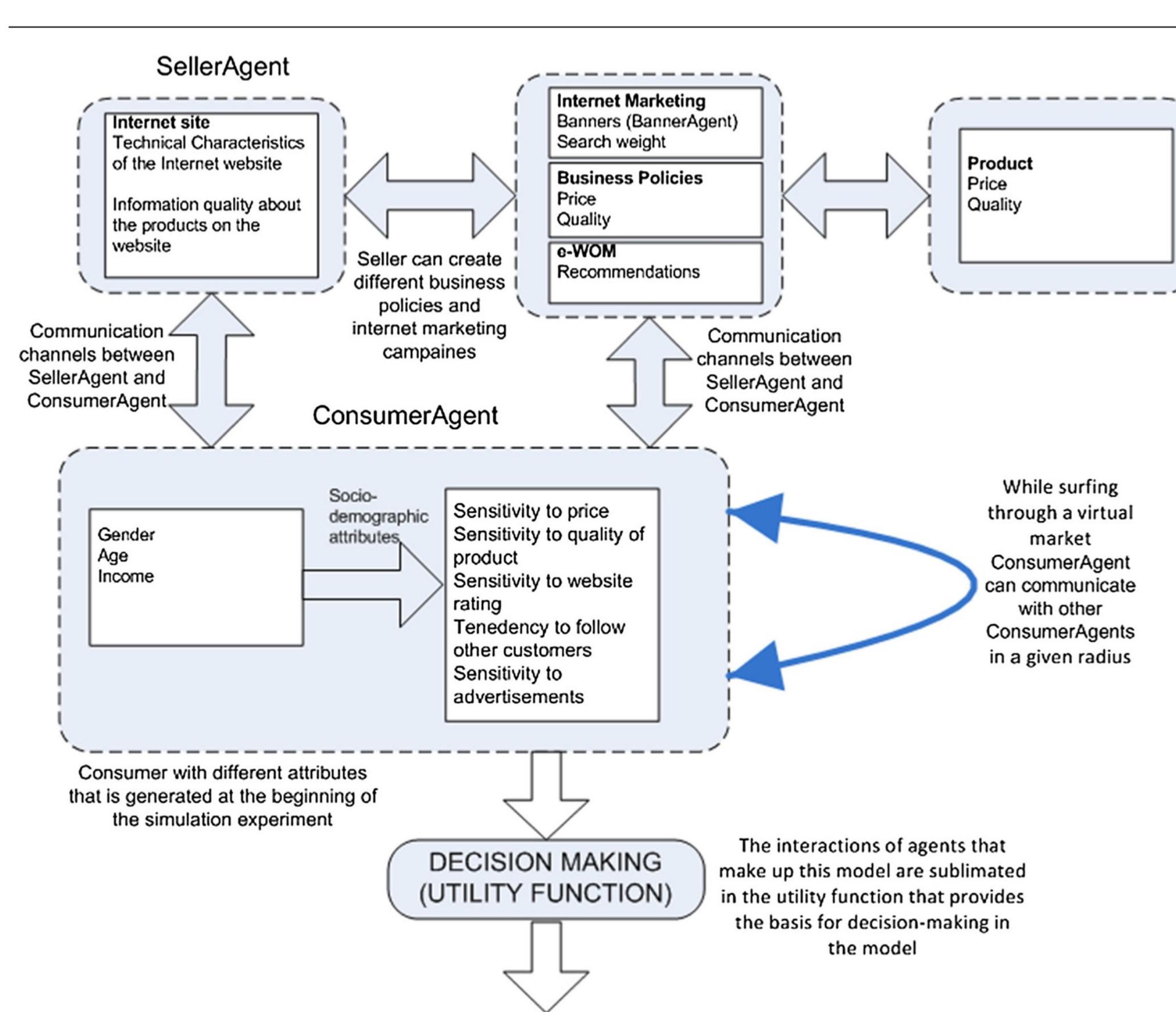
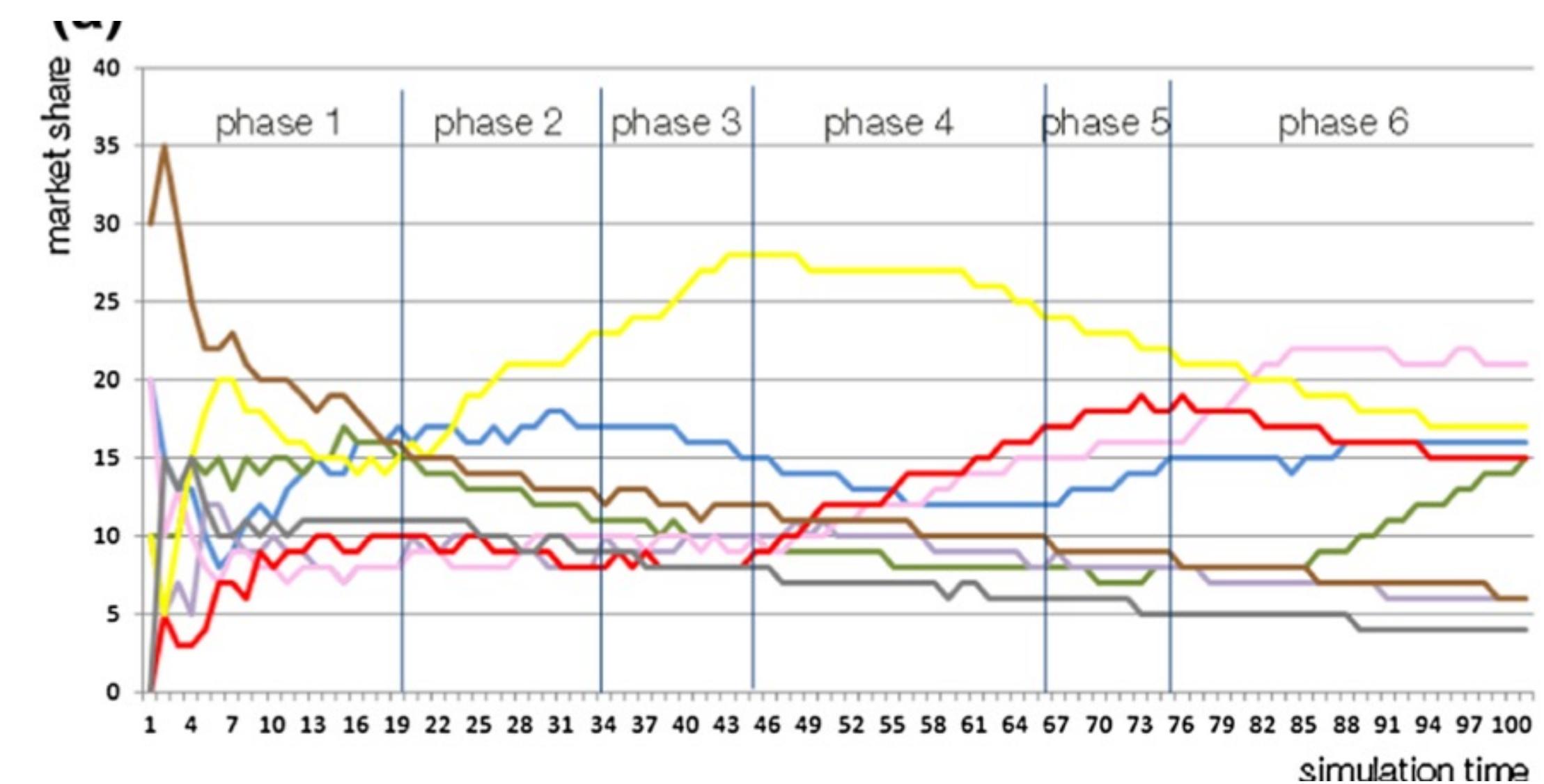


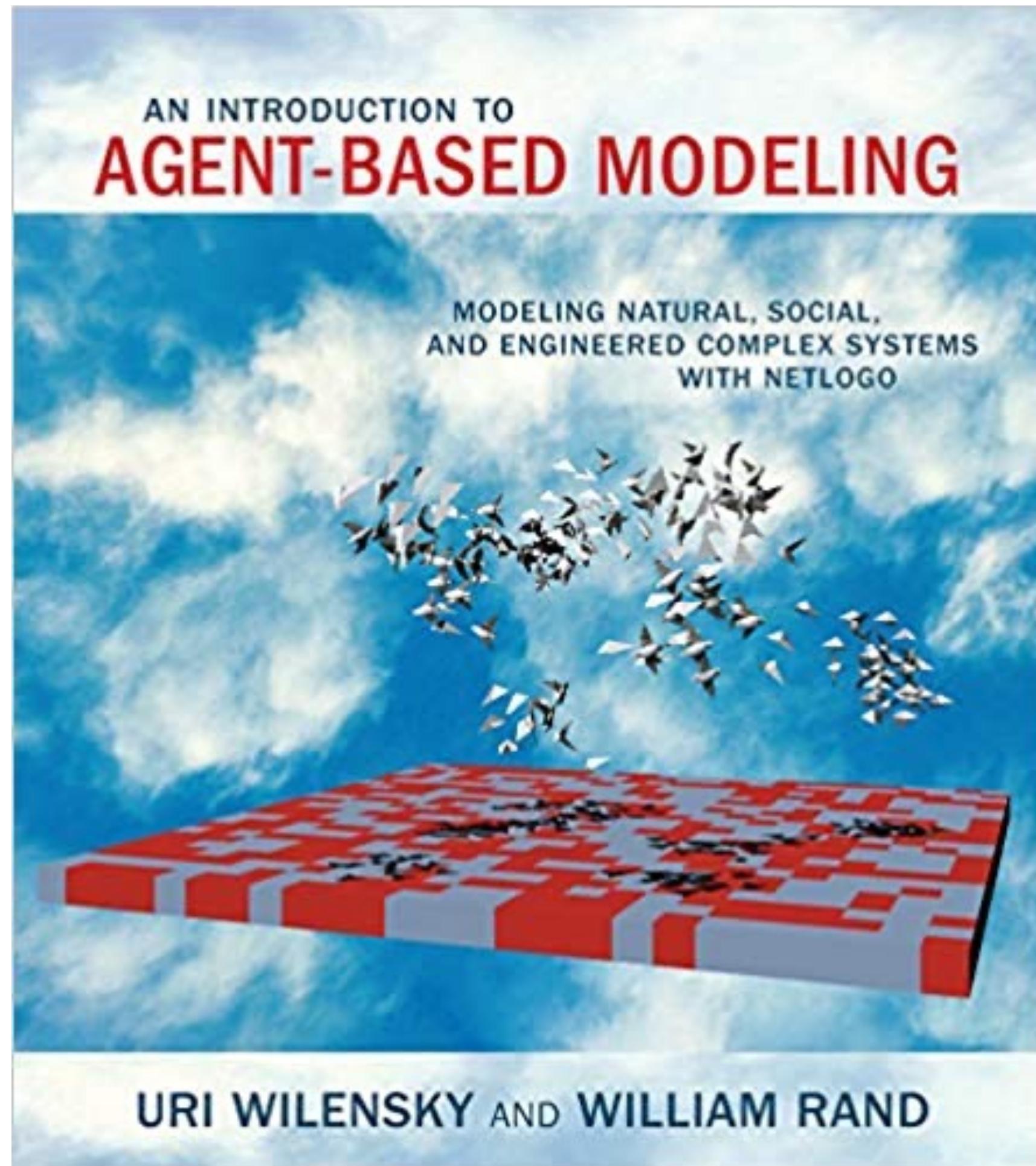
Table 3 SellerAgents input parameters

Type of SellerAgent	Price	BannerAdvertising	Search weight	Visibility	Product information	Design and technical characteristics	Website trust
Blue	100		5		10	10	10
Green	100			5	10	10	10
Turquoise	100	10			10	10	10
Pink	100		5		10	10	10
Red	95				10	10	10
Yellow	100	15			12	12	12
Brown	100			7	10	10	10
Grey	100	20	5		10	10	10





BOOK





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