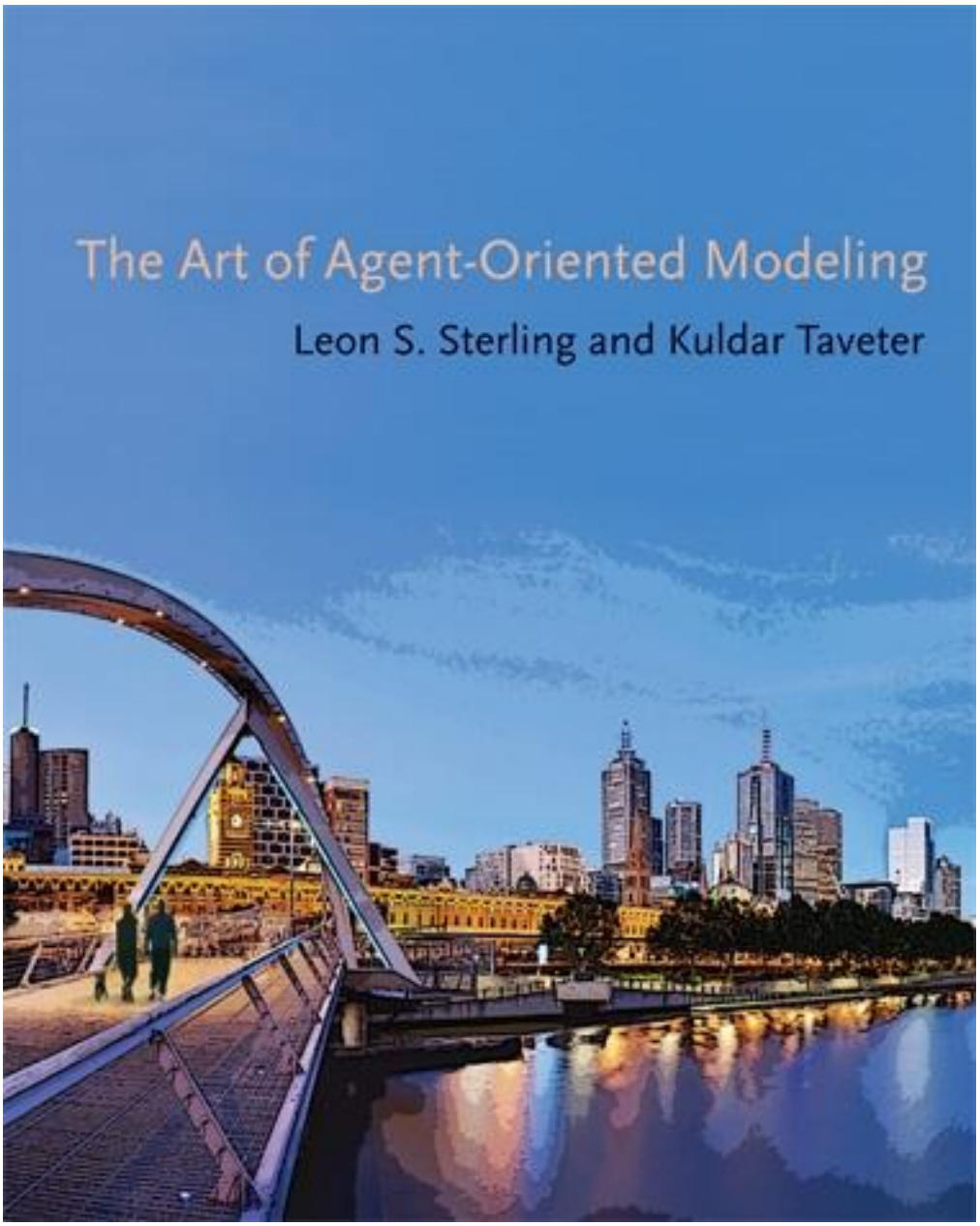
Table 1: A current list of methodologies for engineering MAS

Name	Focus Area
O-MaSE [45]	To allow designers to create customized agent-oriented software development processes. O-MaSE builds off the MaSE methodology.
Prometheus [46]	To support a range of activities from requirements specification through to detailed design agents that are based on goals and plans.
Tropos [47]	To cover the very early phases of requirements analysis, thus allowing for a deeper understanding of the environment where the software must operate, and of the kind of interactions that should occur between software and human agents.
Gaia [48]	To exploit the organizational abstractions such environment, roles, interactions, rules and structures that provide clear guidelines for the analysis and design of complex and open software systems.
PASSI [49]	To design and develop multi-agent societies by integrating design models and concepts from both object-oriented (OO) software engineering and artificial intelligence approaches using the UML notation.
INGENIAS [50], [51]	To combine agent concepts and methods established in MESSAGE/UML [52] in order to define contributions and default activities that help in planning effort required for a given project.

ADELFE [53]	To the design of multi-agent systems that are complex, open, and not well-specified, i.e., adaptive and self-organise systems.
ROADMAP [54]	To extend Gaia methodology [48] by providing support for modelling complex open systems through requirement gathering, a formal model for the environment and knowledge, a role hierarchy, explicit modelling of social aspects between agents, and modelling of dynamic changes.
RAP/AOR [55]	To employ a certain form of agent-based discrete event simulation for achieving more agility in the development process through the support of a foundational ontology.



Taveter, Kuldar, and LEON STERLING. The Art of Agent-Oriented Modelling. MIT Press, 2009.

Table 3: Viewpoint framework adopted from [55]

Viewpoint models	Viewpoint aspect		
Abstraction layer	Interaction	Knowledge	Behaviour
Conceptual domain modelling			
Platform independent design modelling			
Platform specific design models			

Table 1: MESSAGE methodology mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	Structural relationships model, acquaintance relationships model, Interaction view		Goal view, delegation structure
PIM	Agent diagram view, Interaction protocol diagram, Organisation based architecture	Class diagram	Task workflow models, agent goal decomposition
PSM			

Table 2: Prometheus methodology mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	Analysis Overview Diagram, System Roles Diagram		Goal Overview Diagram, Functionalities, Scenarios
PIM	Agent Acquaintance Diagram, Interaction Diagrams, Interaction Protocol Diagrams, System Overview Diagram	Data coupling Diagram	Agent Descriptors
PSM	Event Descriptors	Data Descriptors	Agent Overview Diagrams, Process specifications, Capability Overview Diagrams

Table 3: Tropos methodology mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	Actor Diagram	Actor diagram	Goal Diagrams
PIM			Refined Goal Diagrams
PSM	Agent Interaction Diagrams	UML Class Diagrams	Capability Diagrams, Plan Diagrams

Table 4: MaSE methodology mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	Sequence Diagrams		Goal Hierarchy, Use Cases, Role Model
PIM	Conversation Diagrams		Concurrent Tasks, Agent class Diagrams
PSM			Agent Architecture Diagrams, Deployment Diagrams

Table 5: Gaia methodology mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	Interaction Model		Role model
PIM	Acquaintance model	Sevices model	Agent model
PSM			

Table 6: ROADMAP methodology mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	Interaction model, Protocol model	Environment model	Role Model, Use Case Model
PIM	Acquaintance model	Knowledge model, Service model	Agent Model
PSM			

Table 7: RAP/AOR methodology mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	AOR Agent Diagrams, UML Use Case Diagrams, AOR Interaction Frame Diagrams, AOR Interaction Sequence Diagrams	AOR Agent Diagrams	AOR Interaction Pattern Diagram, Goal-Based Use Case models, AOR Activity Diagrams
PIM	UML Use Case Diagrams, UML Frame Diagrams, User Interface Design Models, Security Models, UML Class Diagrams, UML Interaction Diagrams	AOR Agent Diagrams	AOR Reaction Pattern Diagrams, AOR Internal Activity Diagrams, UML State Machine Diagrams

PSM	UML Deployment Diagrams	UML Class Diagram	UML Class Diagrams

Table 8: AOM for STS mapped to viewpoint framework

	Interaction	Knowledge	Behaviour
CIM	Role models, organisation models	Domain models	Goal models, motivational scenarios
PIM	Agent models, acquaintance models, interaction sequence diagrams, interaction protocol diagrams, interaction frame diagrams	Knowledge models	Scenarios, behaviour models
PSM	Agent interface, interaction specifications	Data models, service models	Agent behaviour specifications

	CIM			PIM			PSM			Sum
	I	K	B	I	K	B	I	K	B	
AOM for STS	2	1	2	5	1	3	2	2	1	19
Gaia	1	0	1	1	1	1	0	0	0	5
MESSAGE	3	0	2	3	1	2	0	0	0	11
O-MaSE	1	0	3	1	0	2	0	0	2	9
Prometheus	2	0	3	4	1	1	1	1	3	16
Tropos	1	1	1	0	0	1	1	1	2	8

Table 4: A list of case studies that apply AOM [18] in STS

Author(s)	Focus Area
Miller, Tim, et al.	The use of goal modelling in the case study of emergency systems to address emotional needs of users that increases technology adoption and usage [65].
Shvartsman, Inna, et al.	Modelling of conflict resolution that has an impact on winning "hearts and minds" of the occupied territory's population [66].
Narendra, Nanjangud C., et al.	Modelling of Sound Conflict Management for Virtual-Enterprise Collaboration in the case study from automobile production [67]
Cheah, WaiShiang, et al.	Modelling of factors that influence the sustainability of e-commerce for the rural community [68].
Du, Hongying, et al.	Modelling of societal healthcare information system for simulation purposes [69].
Zupancic, Eva, et al.	Modelling of trust management sub-system for socio-technical system [70]
Norta, Alex, et al.	Modelling of large socio-technical service-ecosystem for the provision of emergence healthcare services [10]
Pedell, Sonja, et al.	Modelling of domestic scenario that encourages engagement between grandparents and grandchildren separated by distance [71].

Some main features of AOM4STS Tool

1. Online Diagramming Software
2. Graphical User Interface
3. Propagation
4. Consistency checking
5. Error prevention and correction
6. Transformation of AOM to CPN Tools
7. Saving and Loading