

# Zooming Multi-Agent Systems



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## Construction of Complex Systems

- Complex systems  $\longleftrightarrow$  biological systems
- ***Hierarchy principle***: a complex system requires **layers** in order to fully understand and reproduce their dynamics and behaviour.
- **Brought to MASs engineering**: agent-oriented processes and methods should support some forms of **MAS layering**

## Layers in AOSE

- Current AOSE methodologies offer very little support for hierarchical (layered) representation of MASs
- Object-Process Methodology (OPM) and its extension OPM/MAS support a form of layering called **zooming**
- Taking inspiration from the zooming principle of OPM, we introduce a simple layering principle in SODA, an AOSE methodology

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## The SODA Methodology

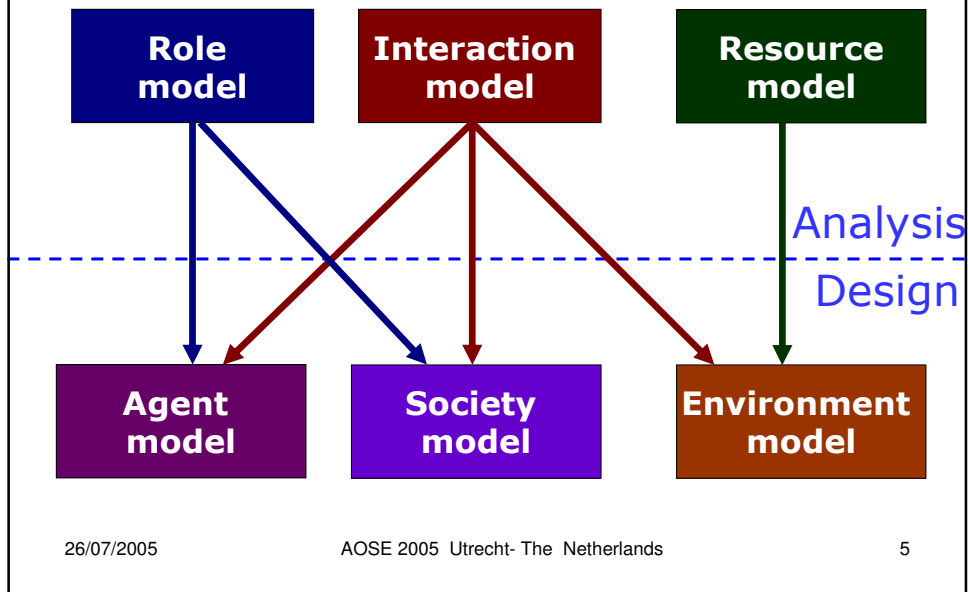
- SODA concentrates on *inter-agent* issues, like the engineering of societies and infrastructure
- The SODA **analysis** phase is based on three models:
  - the *role model*
  - the *resource model*
  - the *interaction model*
- The SODA **design** phase is also based on three models:
  - the *agent model*
  - the *society model*
  - the *environment model*

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# Model Relation



# Analysis

**Role Table**

Role	Task	Interaction Protocols
<i>name</i>	<i>task</i>	<i>list of protocols</i>

**Group Table**

Group	Social Task	Interaction rules
<i>name</i>	<i>task</i>	<i>list of rules</i>

**Resource Table**

Abstract Resource	Service	Policy	Interaction Protocols
<i>name</i>	<i>name</i>	<i>list of permissions</i>	<i>list of protocols</i>

**Interaction Protocols Table**

Interaction Protocol	Information Required	Information provided
<i>name</i>	<i>detail of info</i>	<i>detail of info</i>

**Interaction Rules Table**

Interaction Rule	Description
<i>Name</i>	<i>detail of rule</i>

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# Design

## Agent Table

Agent	Role	Interaction Protocol	Resources	Permissions
<i>name</i>	<i>roles</i>	<i>list of protocols</i>	<i>list of resources</i>	<i>list of permissions</i>

## Society Table

Society	Group	Coordination Media	Resources	Coordination Rule
<i>name</i>	<i>group</i>	<i>medium</i>	<i>resources</i>	<i>list of rules</i>

## Environment Table

Concrete Resource	Abstract Resource	Topological abstraction	Policy	Interaction Protocol
<i>name</i>	<i>name</i>	<i>topology</i>	<i>list of permissions</i>	<i>list of protocols</i>

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# SODA+Zoom

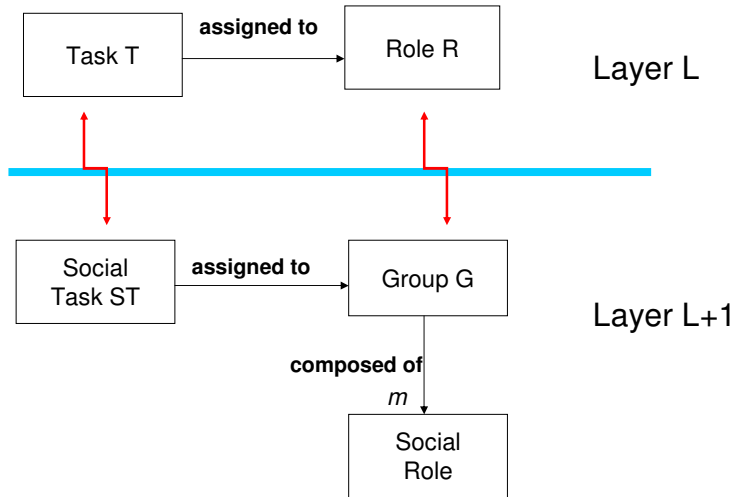
- Goal: scaling with the complexity of task description introducing a simple layering principle into the models of the **analysis** phase (role, resources, interaction models).
- Each layer contains a description of the models at a given abstraction level
- The models of the **design** phase become layered indirectly, since they map the layers described in the analysis phase

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# Zooming Task and Role...

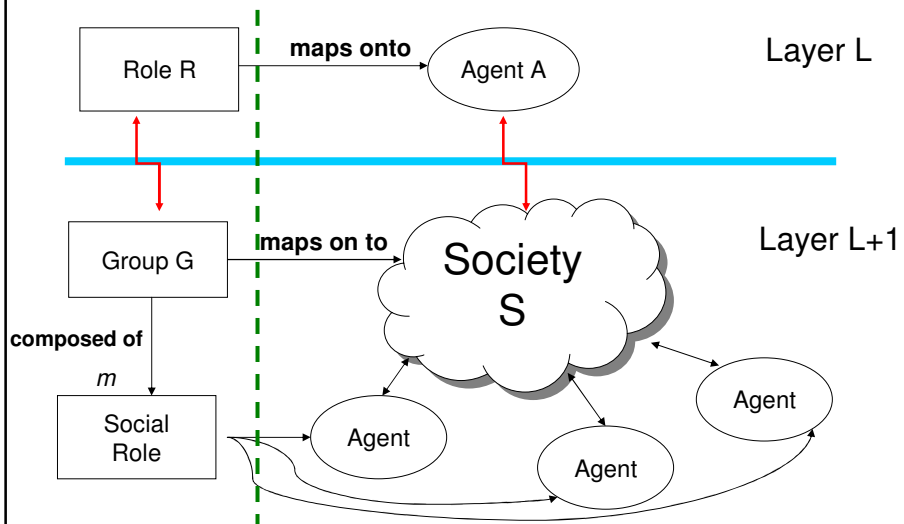


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# ...Zooming Role and Agent



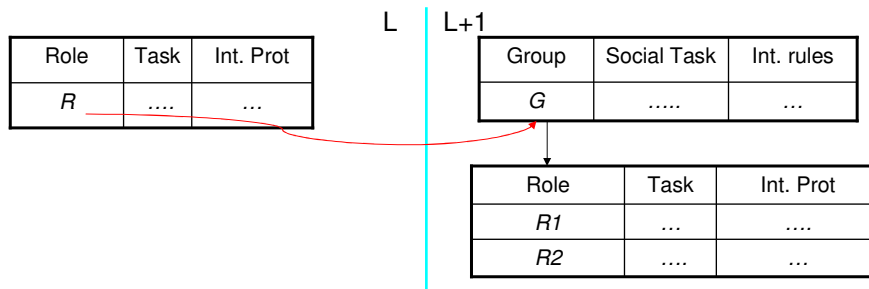
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# Tabular Description

- An entry in a Role Table at layer L can be exploded into a entry of Group Table at layer L+1, plus all the information concerning the new group
- Analogously for Agent Table and Society Table



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# Zooming Table

- For each pair of adjacent layers there is a Zooming Table
- The *Zooming table* tracks the relation between Layer L and Layer L+1

Name of abstraction at layer L	Name of abstraction at layer L+1
<i>Role name</i>	<i>Group name</i>
<i>Agent Name</i>	<i>Society name</i>

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# Consistency Rule

- Zooming rule  $\implies$  Consistency rule
- Let us focus on the Interaction Protocols for role **R**

Interaction Protocol	Information Required	Information provided
<i>name 1</i>	} <b>IN(R)</b>	} <b>OUT(R)</b>
<i>name 2</i>		

- If **R** is the role at layer L zoomed as group **G** at layer L+1, then
  - The information required from **R**, **IN(R)**, **must** be a subset of union of all the sets of information required by social roles of **G**
  - The information provided by **R**, **OUT(R)**, **must** be a subset of union of all the sets of information provided by social roles of **G**

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# Conclusions

- Zooming as a fundamental principle for engineering (analysis and design) MASs
  - layering
- SODA+Zoom
  - extension of an AOSE methodology to support zooming
- Zooming as a link between individual and social aspects
  - e.g., from individual roles to groups

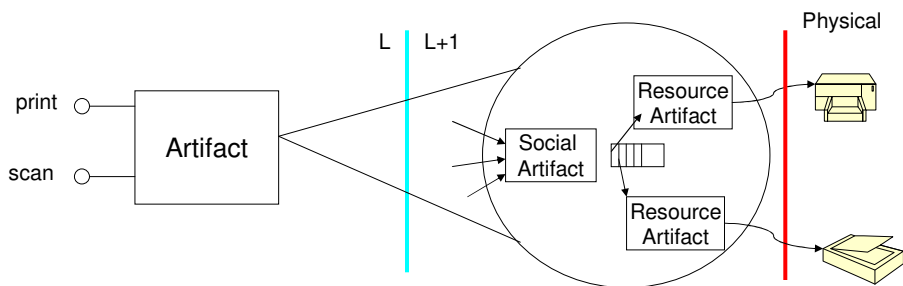
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# Ongoing Work: A Roadmap to Artifacts

- Meta-model:
  - Agents + Artifacts
  - Agents speak to agents and
  - Agents use Artifacts
- Example: Zooming Artifacts



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## Future Work

- Understanding the implications of zooming in terms of the fundamental agent-oriented abstractions.
- Developing suitable design tools for modelling systems with SODA+Zoom
- Forthcoming in SODA+zoom :
  - a *topological model*
  - an *organisational model*

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