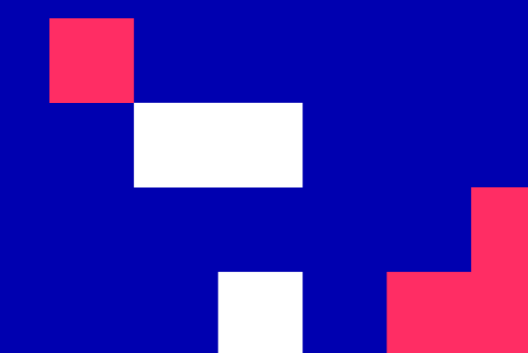


University of Ruse “Angel Kanchev”

MULTIAGENT SYSTEM WITH ARTIFICIAL INTELLIGENCE

assoc. prof. Desislava Atanasova

08,2022

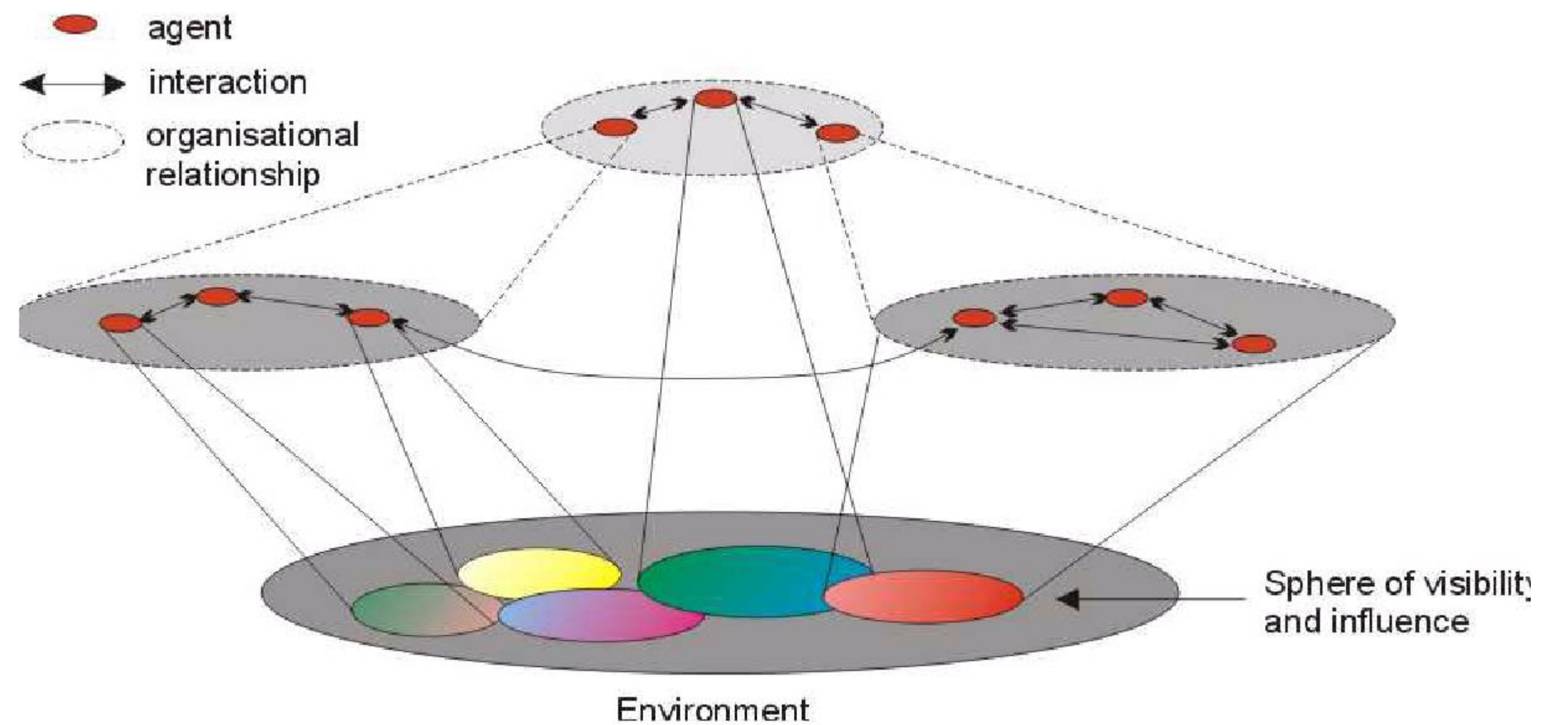


LECTURE 3

Multiagent Systems Interactions

1. Agent Communication
2. Speech Acts
3. KQML and KIF
4. Ontologies

There's no such thing as a single agent system



Jennings, Nicholas R. and Stefan Bussmann. "Agent-based control systems." (2003).

Agent Communication

Agent Communication

Agent Communication Language

FIPA, ACL, KQML, ...

Content Language

XML, KIF, WML, HTML

Encoding Schema

Java serialized object, String, Bytecode

Physical Protocols

HTTP, IIOP, TCP/IP, SMTP, Fax, Phone, WAP

Agent
Middleware

Agent Communication

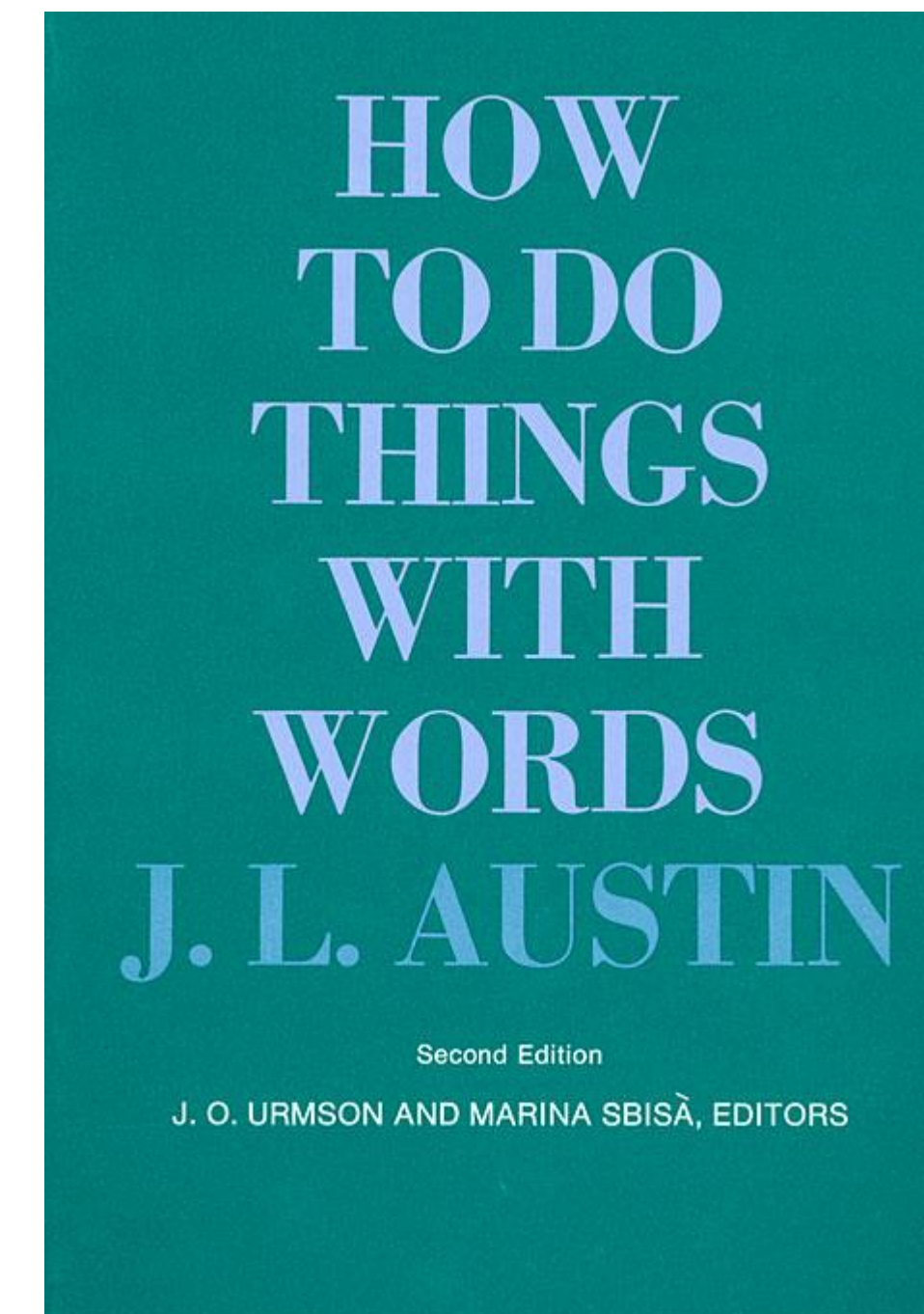
Agent Communication

In order to work together, agents need a means of communication with each other. They could be:

- communication:
 - speech acts; KQML & KIF; FIPA ACL
- ontologies:
 - the role of ontologies in communication
 - aligning ontologies
 - OWL

Agent Communication

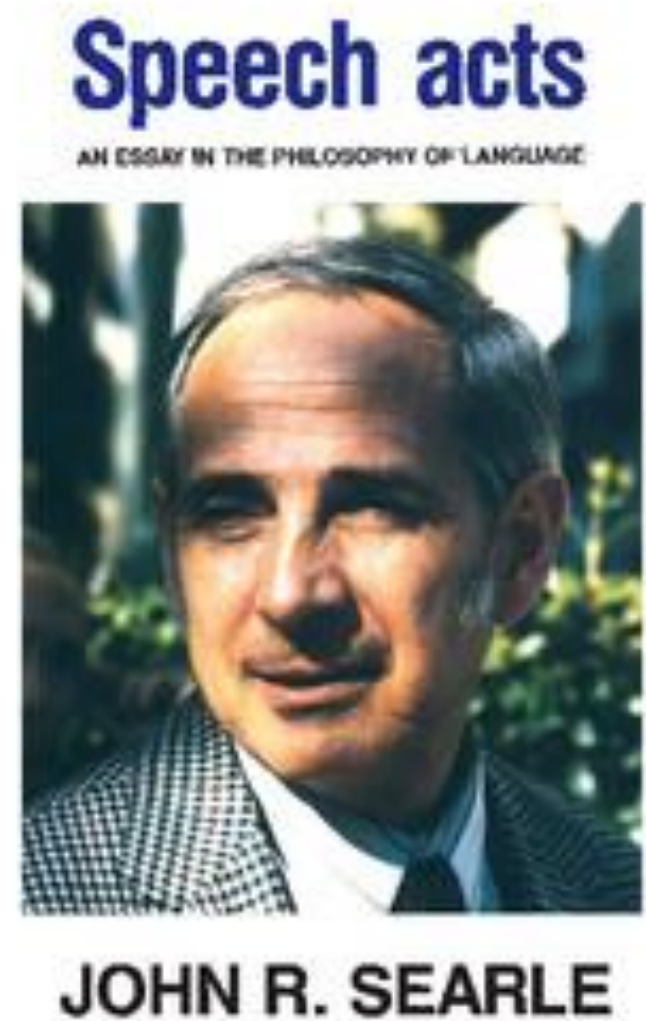
- Austin's 1962 book "How to Do Things with Words" is where speech acts first appeared.
- Speech act theories, or theories of how language is used, are pragmatic theories of language - they make an effort to take into account how language is utilized by individuals on a daily basis to further their objectives and aims
- Speech act theory serves as the foundation for the majority of analyses of communication in (multi-)agent systems...undoubtedly because existing theories on how to model action can be directly related to the "activity" element.
- Austin observed that some statements resemble "physical" gestures.



Agent Communication

Speech Acts

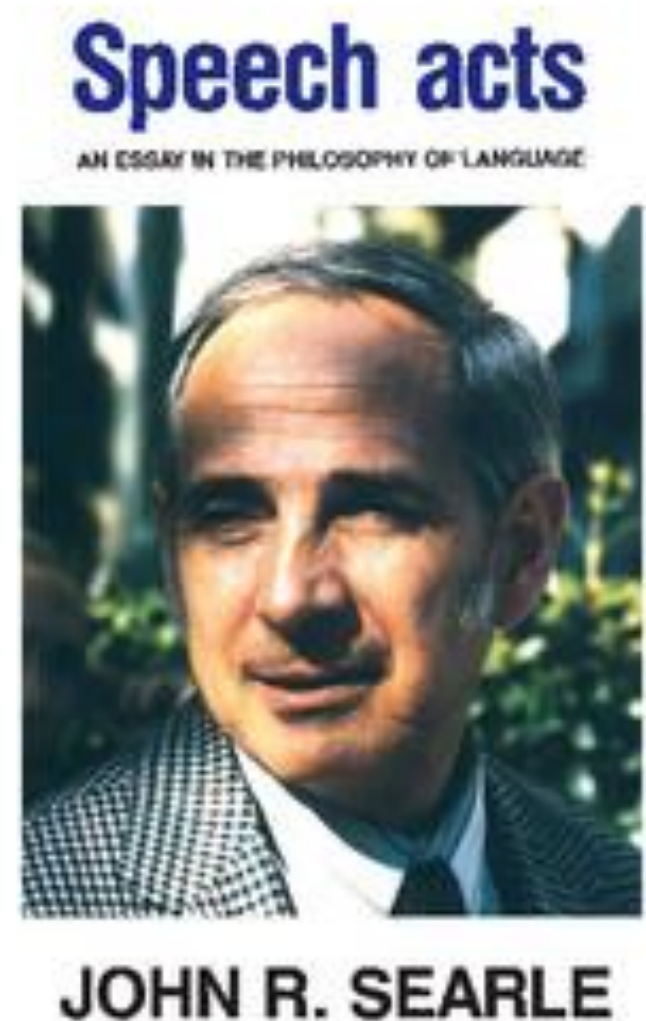
- John R. Searle noted the following in his first published in 1969 book *Speech Acts: An Essay in the Philosophy of Language*:
 - *representatives*:
 - such as informing, e.g., 'It is raining'
 - *directives*:
 - attempts to get the hearer to do something e.g., 'please make the tea'
 - *commissives*:
 - which commit the speaker to doing something, e.g., 'I promise to...'



Agent Communication

Speech Acts

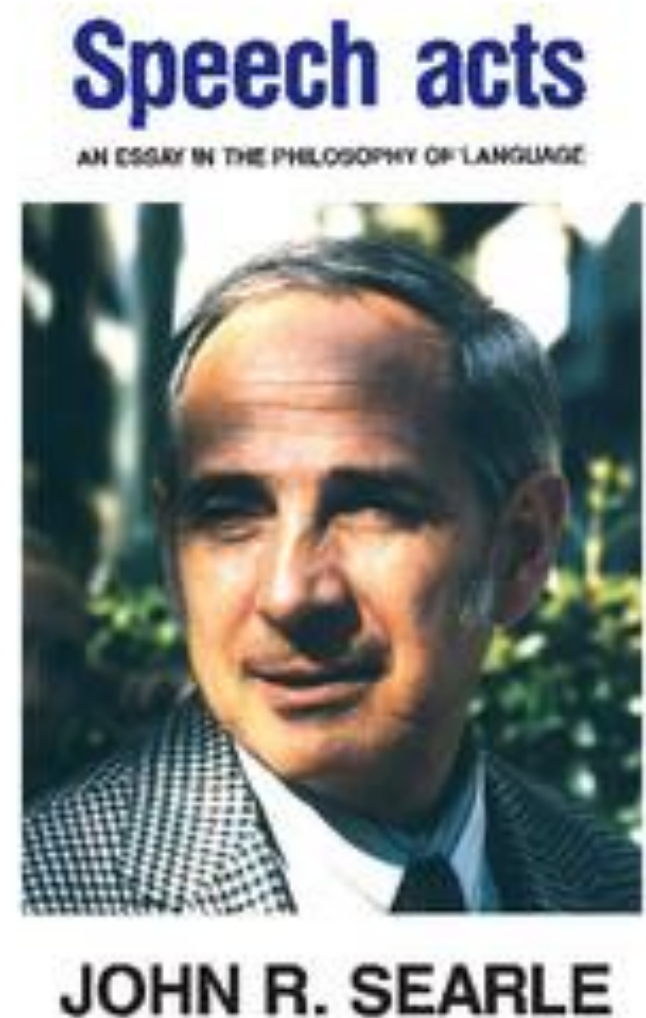
- John R. Searle noted the following in his first published in 1969 book *Speech Acts: An Essay in the Philosophy of Language*:
 - *expressives*:
 - whereby a speaker expresses a mental state, e.g., 'thank you!'
 - *declarations*:
 - such as declaring war or naming.



Agent Communication

Speech Acts

- There is some disagreement over the appropriateness of this (or any!) categorization of speech activities.
- Generally speaking, a speech act can be divided into two parts:
 - *a performative verb:*
 - e.g., request, inform, ask, ...
 - *propositional content.*
 - e.g. “the door is closed”, “the box is delivered”...



Agent Communication

Speech Acts

- How is the semantics of speech acts defined?
- When is it appropriate to indicate that someone has made a request or informed you?
- Similar to STRIPS planner, Cohen and Perrault (1979) developed the semantics of speech acts using the precondition-delete-add list formalism of planning research.
- Remember that a speaker cannot, in most cases, compel a listener to adopt a particular mental state.

Agent Communication

KQML and KIF

- Agent communication languages (ACLs) - standard message exchange format
- Knowledge Query and Manipulation Language (KQML), well known ACL, developed by the DARPA-funded Knowledge Sharing Effort (KSE).
- It consists of two parts:
 - the message itself: the Knowledge Query and Manipulation Language (KQML);
 - the body of the message: the Knowledge interchange format (KIF)



Agent Communication

KQML and KIF

- KQML is an ‘outer’ language, that defines various acceptable ‘communicative verbs’, or performatives.
- Example performatives:
 - ask-if (‘is it true that. . . ’)
 - perform (‘please perform the following action. . . ’)
 - tell (‘it is true that. . . ’)
 - reply (‘the answer is . . . ’)
- KIF is a language for expressing message content, or domain knowledge.
 - It can be used to writing down ontologies.
 - KIF is based on first-order logic.

Agent Communication

Ontologies

- Ontologies are designed for a variety of purposes, including knowledge representation, exchange, management, modeling, engineering, and education.
- The Air Force Institute of Technology has been studying the Multiagent Systems Engineering (MaSE) methodology recently. The goal of research is to create a reliable approach for creating multiagent systems. Multiagent system development is broken down into three steps by MaSE: analysis, design, and implementation. As seen in the graphic, MaSE originally had four steps in the design phase and three steps in the analysis phase.

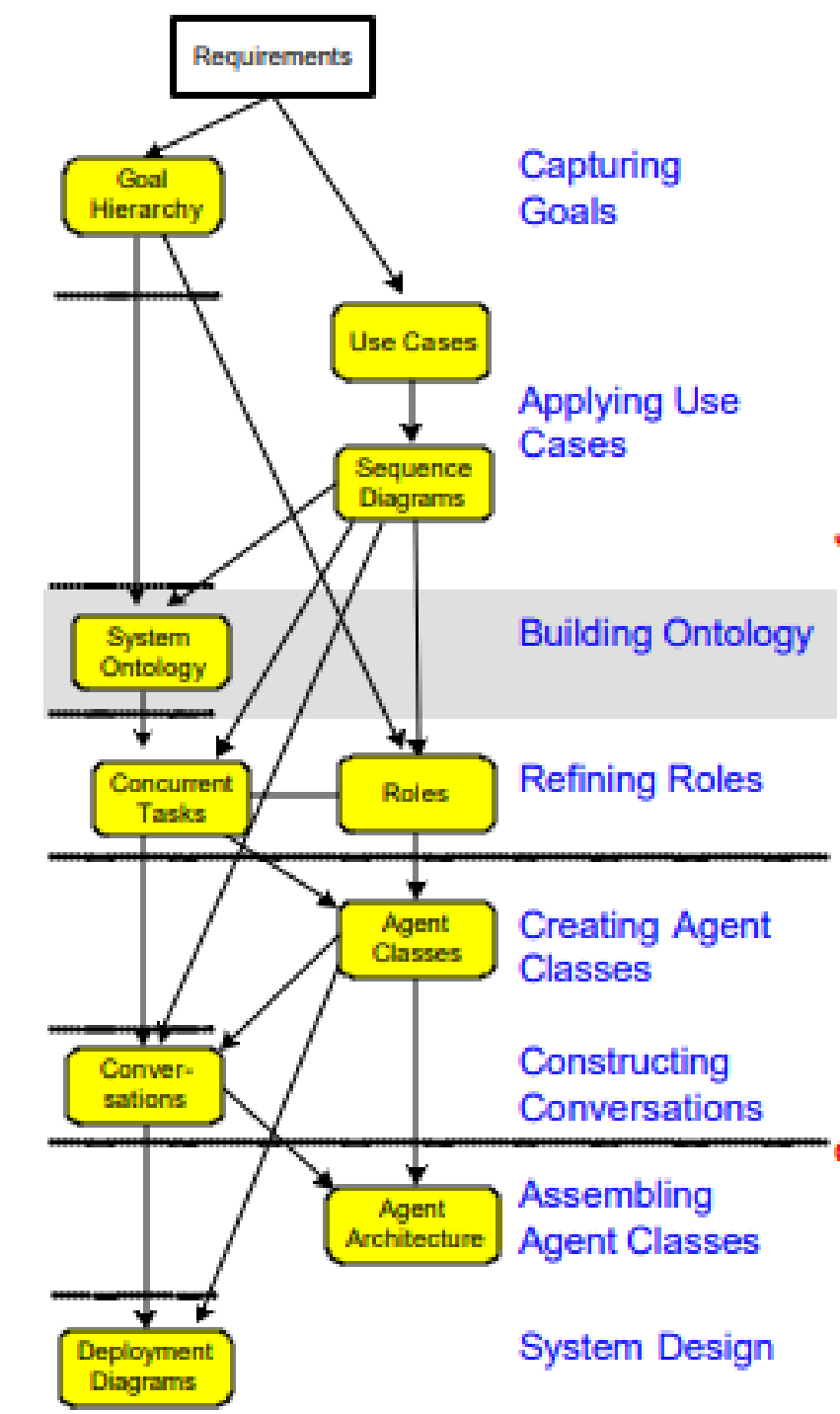


Fig. 1. Extended MaSE Phases, Steps and Models

Agent Communication

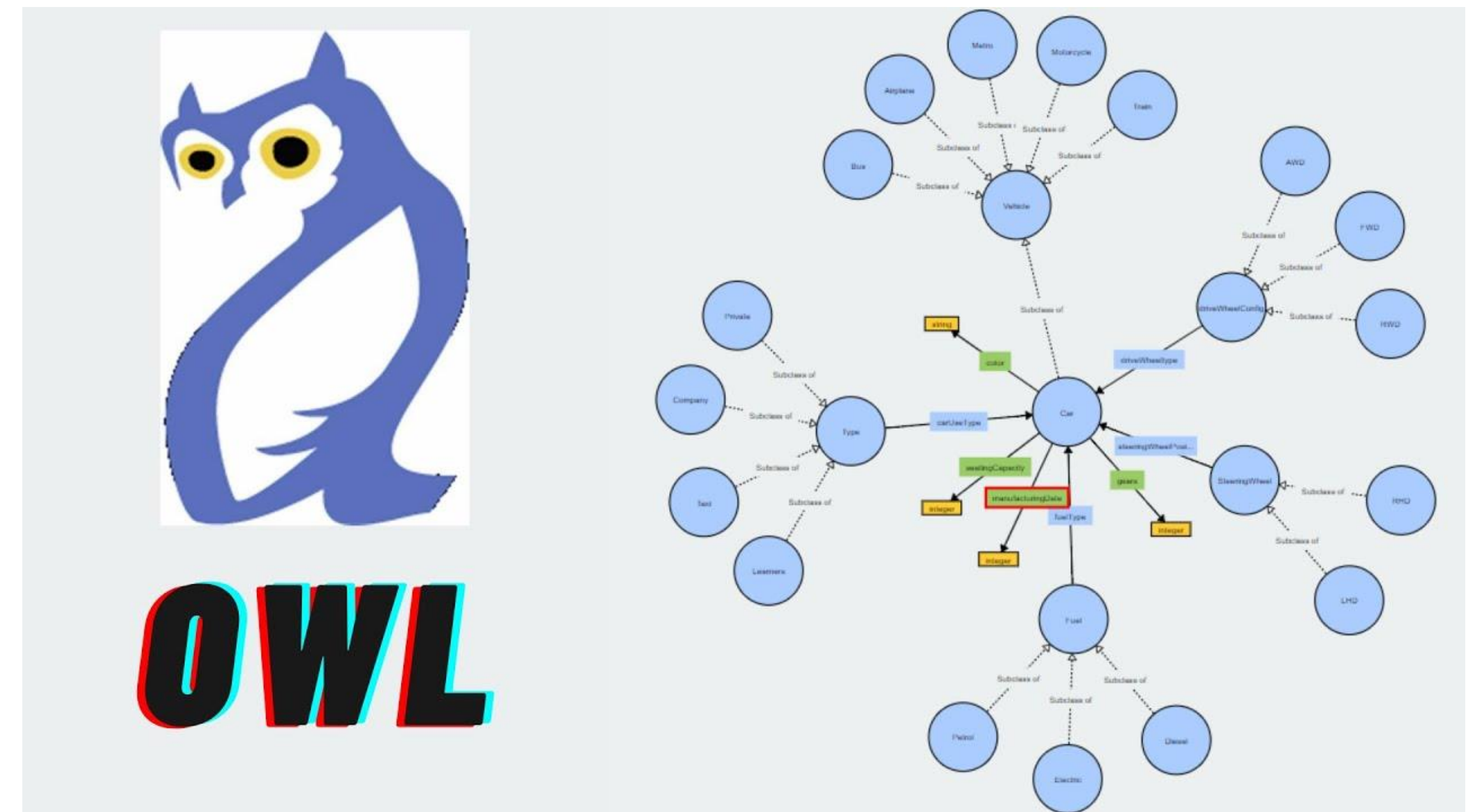
Ontologies

- Ontologies generally come in varying levels of granularity.
 - Application ontology
 - Domain ontology
 - Upper ontology
- An ontology is less reusable the more specialized it is.
- Application and domain ontologies will typically overlap
 - Illustrated by the challenges of facilitating interoperability between similar ontologies.
 - Different knowledge systems can be integrated to form merged knowledge bases
- But in many instances, understanding is all that is required.!

Agent Communication

Ontologies

- Given that various designers have varied contexts and requirements, modeling ontologies is a challenge.
- OWL - Web Ontology Language
- OWL is a language built on the semantic web and computational logic that is intended to represent complicated knowledge about objects and their relationships. Additionally, it offers thorough, reliable, and significant differences between classes, properties, and connections.



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