The Web Engineering 3

Introduction to Semantic Web

Lecture 5
Semantic Web Technologies and Layered Approach (Cont.)

Presented by
Prof. Khaled Wassif

Course Topics

➢ Introduction to the semantic web.

➢ Semantic web technologies and layered approach.

➢ Structured web documents in XML.

➢ Describing web resources in basic elements of Resource Description Framework (RDF).

➢ Web Ontology Language: OWL.
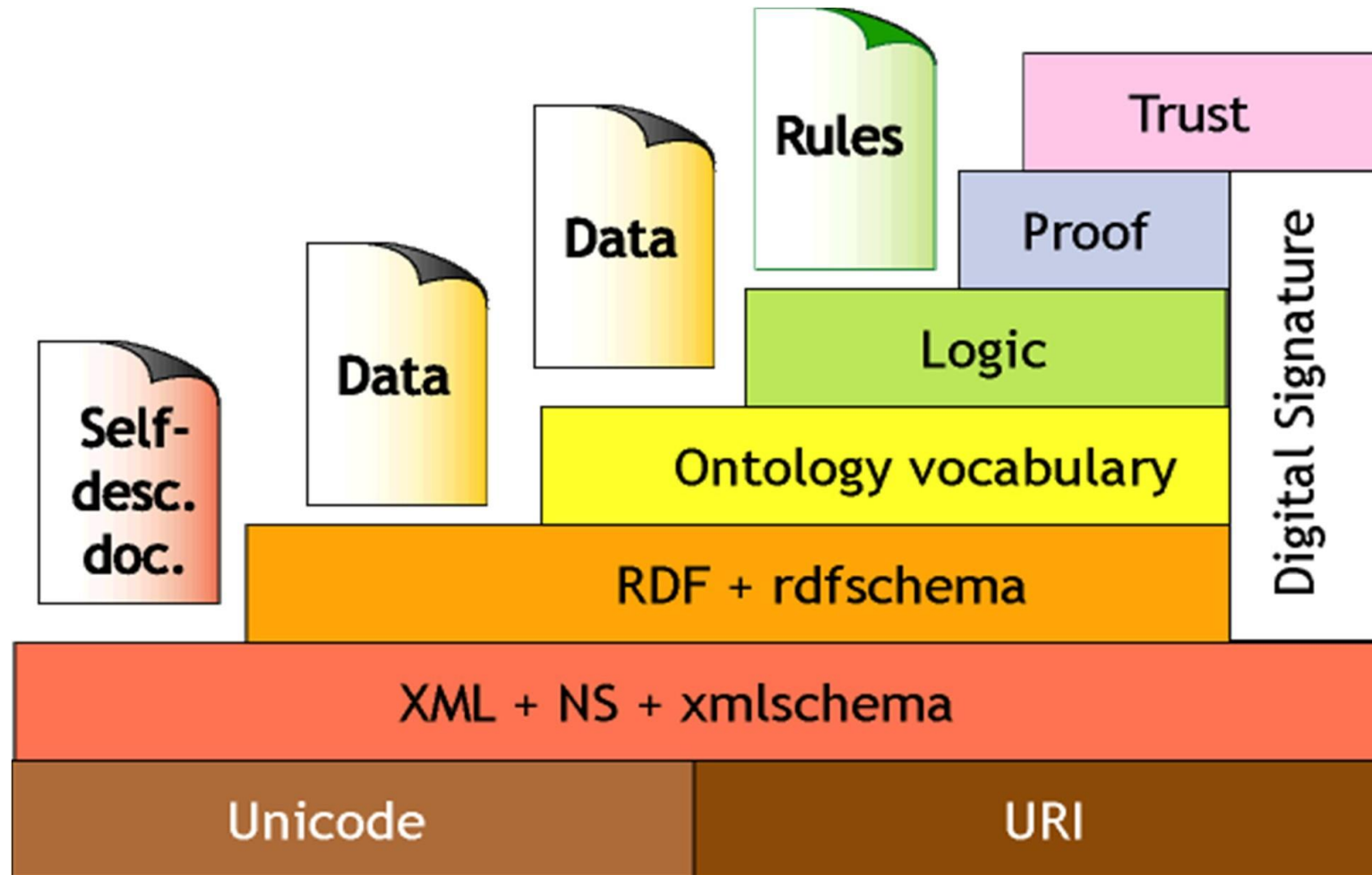
➢ Ontologies Applications.

Course References

1. Grigoris Antoniou, Paul Groth, Frank van Harmelen, Rinke Hoekstra, "A Semantic Web Primer", 2012.

2. John Domingue, Dieter Fensel, James A. Hendler, "Introduction to the Semantic Web Technologies", 2011.

Lecture 4 Outlines

➢ Current Web Technologies and their Problems.

➢ What is the solution?

➢ Design Principles of the Semantic Web.

➢ Semantic Web Technologies.

- Semantic Web Structure and layers.
- Ontologies.
  - Ontologies definition.
  - Components of Ontologies.
  - Ontologies Languages.
    - ✓ RDF Schema.
   - ✓ OWL .

➢ Semantic Web Agents.

4

The Semantic Web Structure

➢ The development of the Semantic Web proceeds in steps.

➢ Each step building a layer on top of another.

4. Logical Layer

1) Called logical and interface layer.

2) Performs a generalization of the categories of relationships described in the previous layer (ontology layer).

    ❑ There are six main types of relationships between classes: inheritance, realization / implementation, composition, aggregation, association, and dependency.
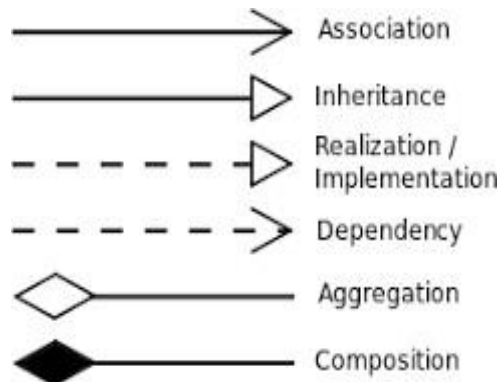
4. Logical Layer

3) Logic layer: is the controlling layer that studies the principles of semantic reasoning (final decision about data linking)

Semantic reasoning:

✓ is the ability of a system to infer new **facts** from existing data based on inference from **ontologies**.

✓ In simple terms, the logic layer uses ontologies to add new information to the existing dataset, adding context, knowledge, and valuable insights.

4. Logical Layer

4) Automated reasons can be concluded from the given knowledge in the ontology layer.

5) Formal languages for expressing knowledge

6) Well-understood the formal and standard semantics

7) The rules are written in a restricted language to maintain complex computability properties.

An Inference Example

prof(X) $\rightarrow$ faculty(X)

faculty(X) $\rightarrow$ staff(X)

prof(Noor)

We can obtain the following **conclusions**:

faculty(Noor)

staff(Noor)

prof(X) $\rightarrow$ staff(X)

Logic versus Ontologies

➢ The previous example involves knowledge typically found in ontologies.

  – Logic can be used to uncover and formalize ontological knowledge that is implicitly given in the ontology layer.

  – It can also help uncover unexpected relationships and inconsistencies.

➢ Logic is more general than ontologies.

  – It can also be used by intelligent agents for making decisions and selecting courses of action

The Semantic Web Structure

➢ The development of the Semantic Web proceeds in steps.

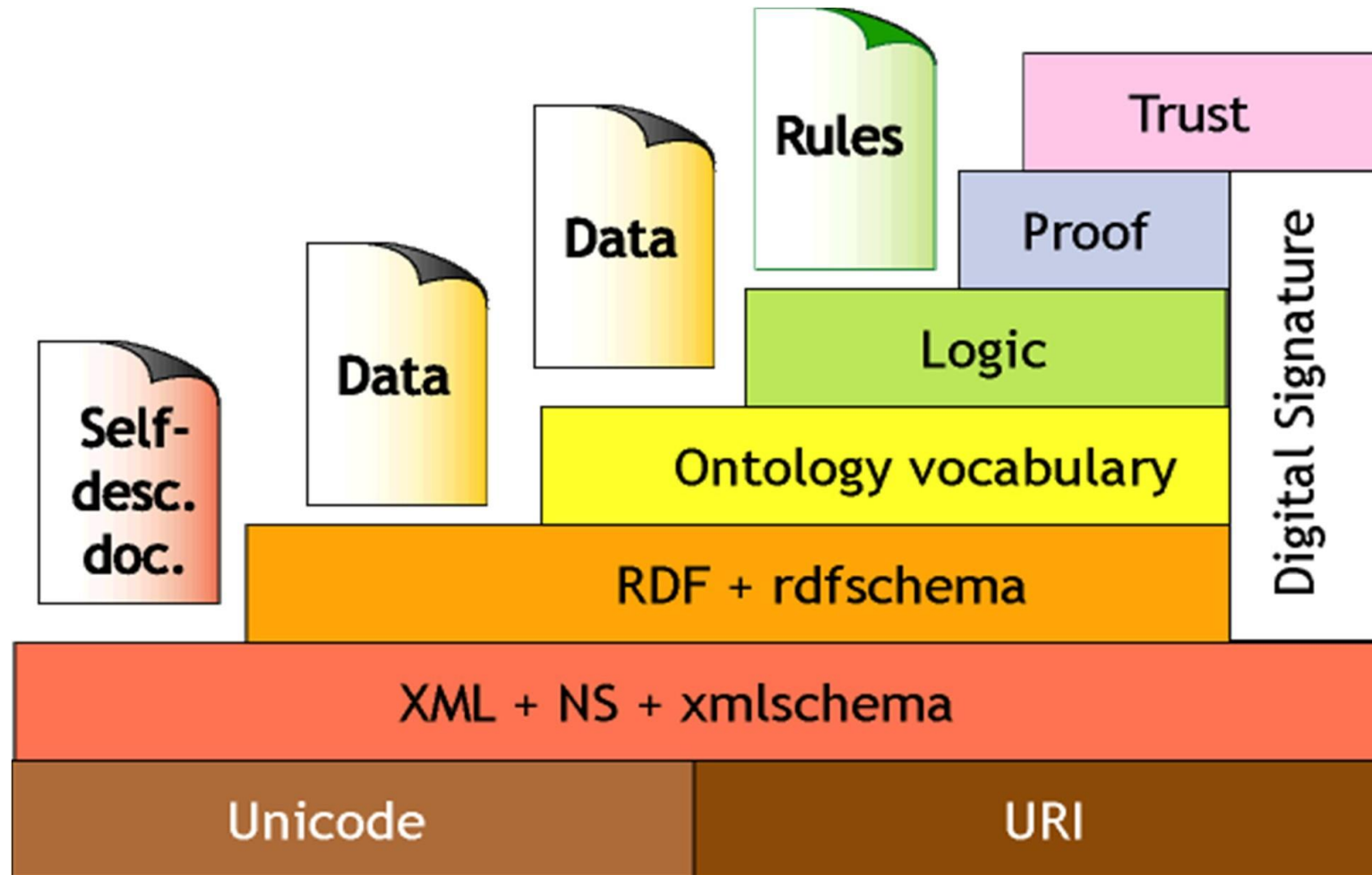➢ Each step building a layer on top of another.
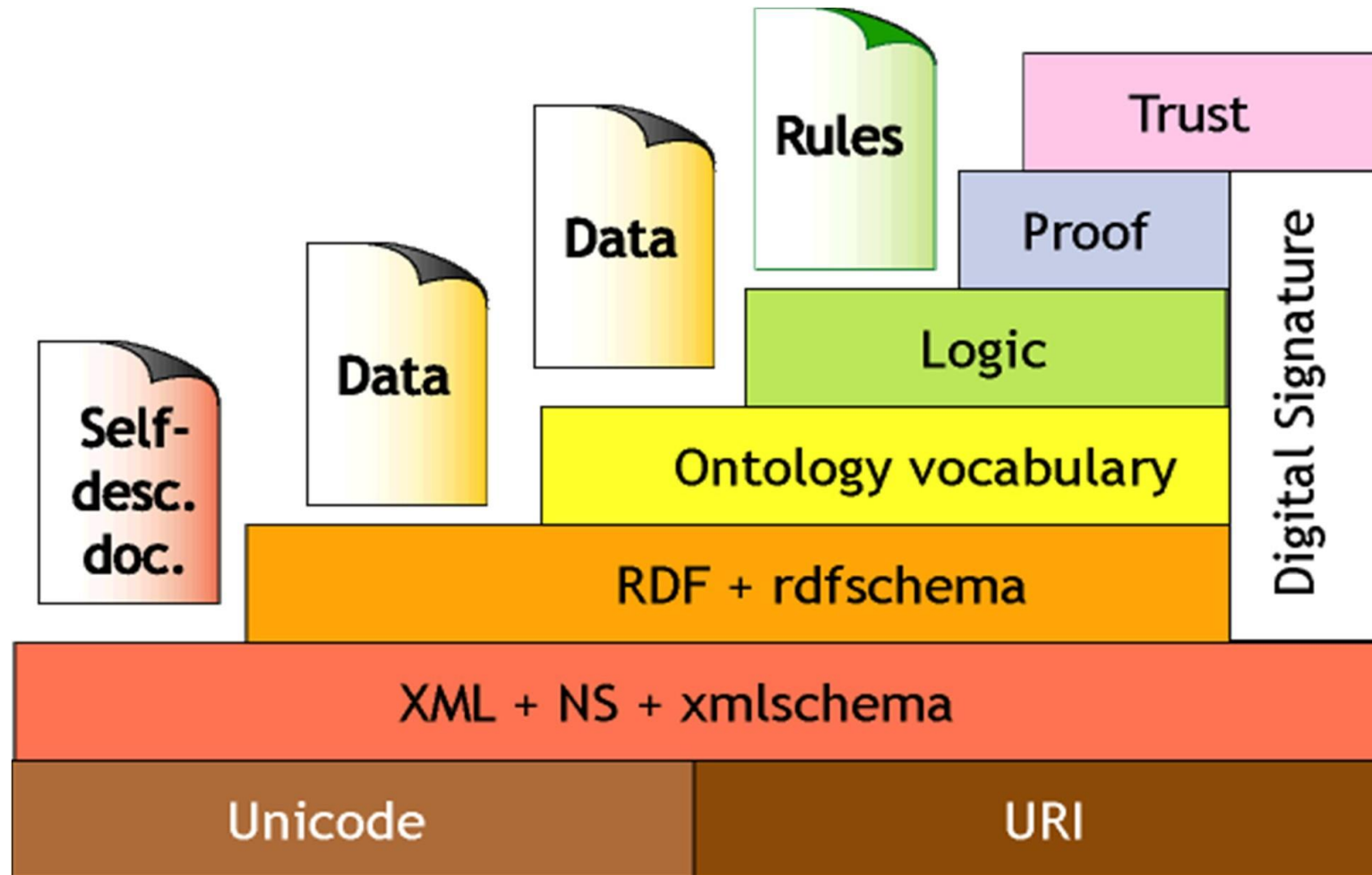
5. The proof layer

➤ Called proof / rule layer. [start to form rules]

➤ **What is the meaning of rule:**

- convert informal notion to a formal one in a way to use.

- Represent a new level of describing and formalizing the semantic knowledge over ontologies and logic.

- Rules are used to perform inference (استنتاجات) over ontologies and logic.

- Rules are a tool for capturing and formalizing further knowledge (which is not expressible in OWL ontologies and expressed in logic in random form)

The Semantic Web Structure

➢ The development of the Semantic Web proceeds in steps.

➢ Each step building a layer on top of another.

6. The Trust layer

- Semantic Web top layer:

- Support for provenance / trust of the data source originality.

- Provenance:
  - Where does the information come from?
  - How this information has been obtained?
  - Can I trust this information?
  - Who is the author of that information?

- No standardization effort.

The Semantic Web Structure

➢ The development of the Semantic Web proceeds in steps.

➢ Each step building a layer on top of another.
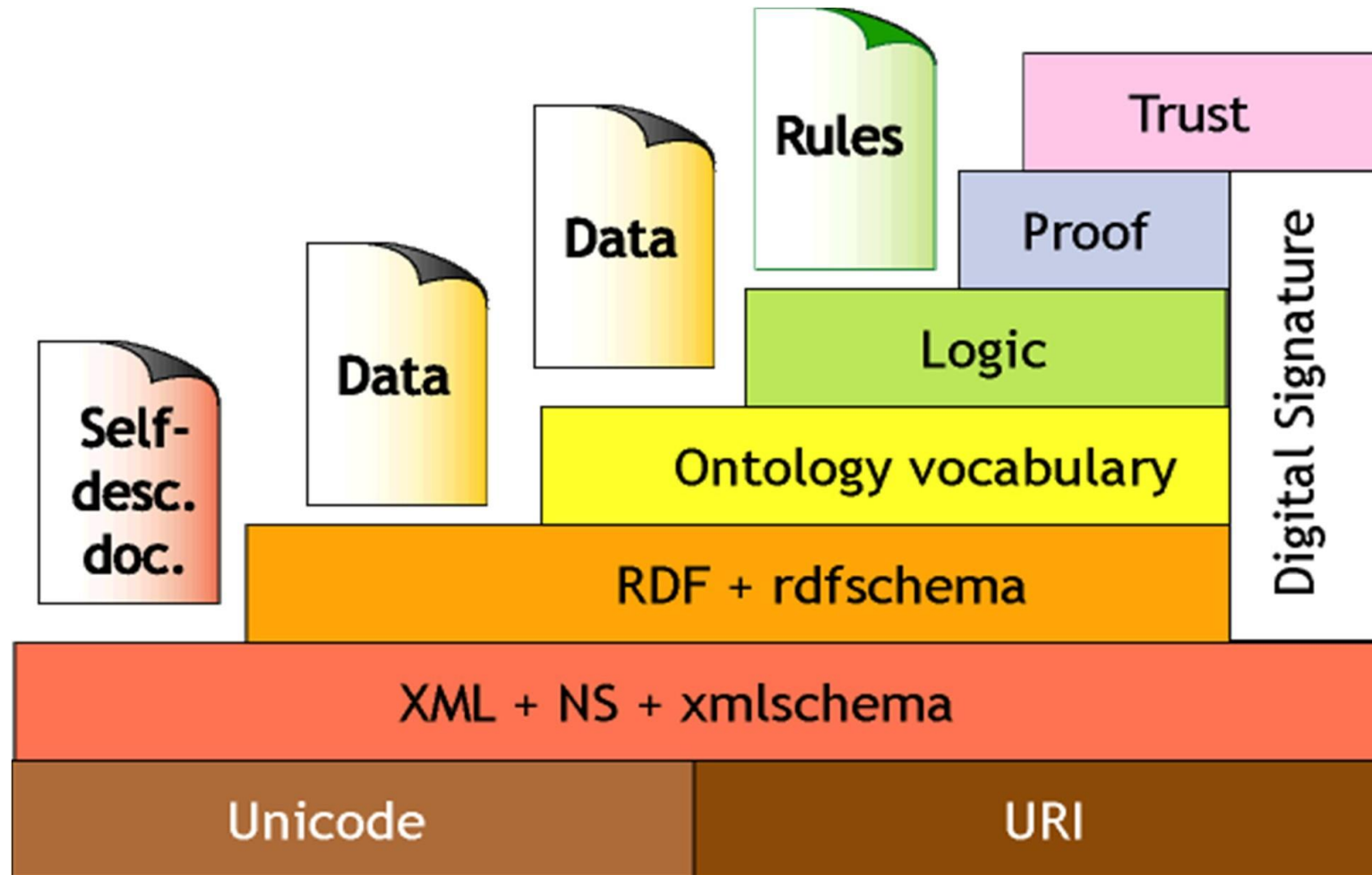
Semantic Web Layers Abstraction

➢ **XML layer**

  – Syntactic basis

➢ **RDF layer**

  – RDF basic data model for facts

  – RDF Schema simple ontology language for graphically relational databases.

➢ **Ontology layer**

  – More expressive languages than RDF Schema

  – Express semantic information about data and its relationships as descriptions.

  – Current Web standard: OWL

Semantic Web Layers Abstraction

➢ **Logic layer**

– enhance ontology languages further to build and generalize knowledge relationships.

– Application-specific declarative knowledge (uncover conclusion)

➢ **Proof layer**

– Rules generation, Rules exchange, Rules validation

➢ **Trust layer**

– Provenance of the data and its sources in addition to authenticity.

– recommendations, rating agencies ….

The Semantic Web: main steps through structure

- underlying web layer (URI, XML)
  - reusing and extending current web technologies
- basic conceptual modeling language (RDF and RDF Schema)
- ontology language (OWL)
- Logical conclusion for more knowledge connection
- Rules / proof
- reusing and extending database technologies
- Data integration
- reusing and extending AI technologies (agents)
  - knowledge representation
  - automated reasoning

Lecture 4 Outlines

➢ Current Web Technologies and their Problems.

➢ What is the solution?

➢ Design Principles of the Semantic Web.

➢ Semantic Web Technologies.

- Semantic Web Structure and layers.
- Ontologies.
  - Ontologies definition.
  - Components of Ontologies.
  - Ontologies Languages.
    - ✓ RDF Schema.
   - ✓ OWL .

➢ Semantic Web Agents.

Software Agents

➢ Software agent is a computer program that is in the relationship of agency with a user or other program, which performs (to do task): a specific agreement to act on.

Software Agents

- A personal agent on the Semantic Web will:

  – receive some tasks and preferences from a person or user.

  – request information from Web sources, and communicate with other agents.

  – compare information about user requirements and preferences, and make certain choices.

  – give answers to the user.

Intelligent Personal Agents
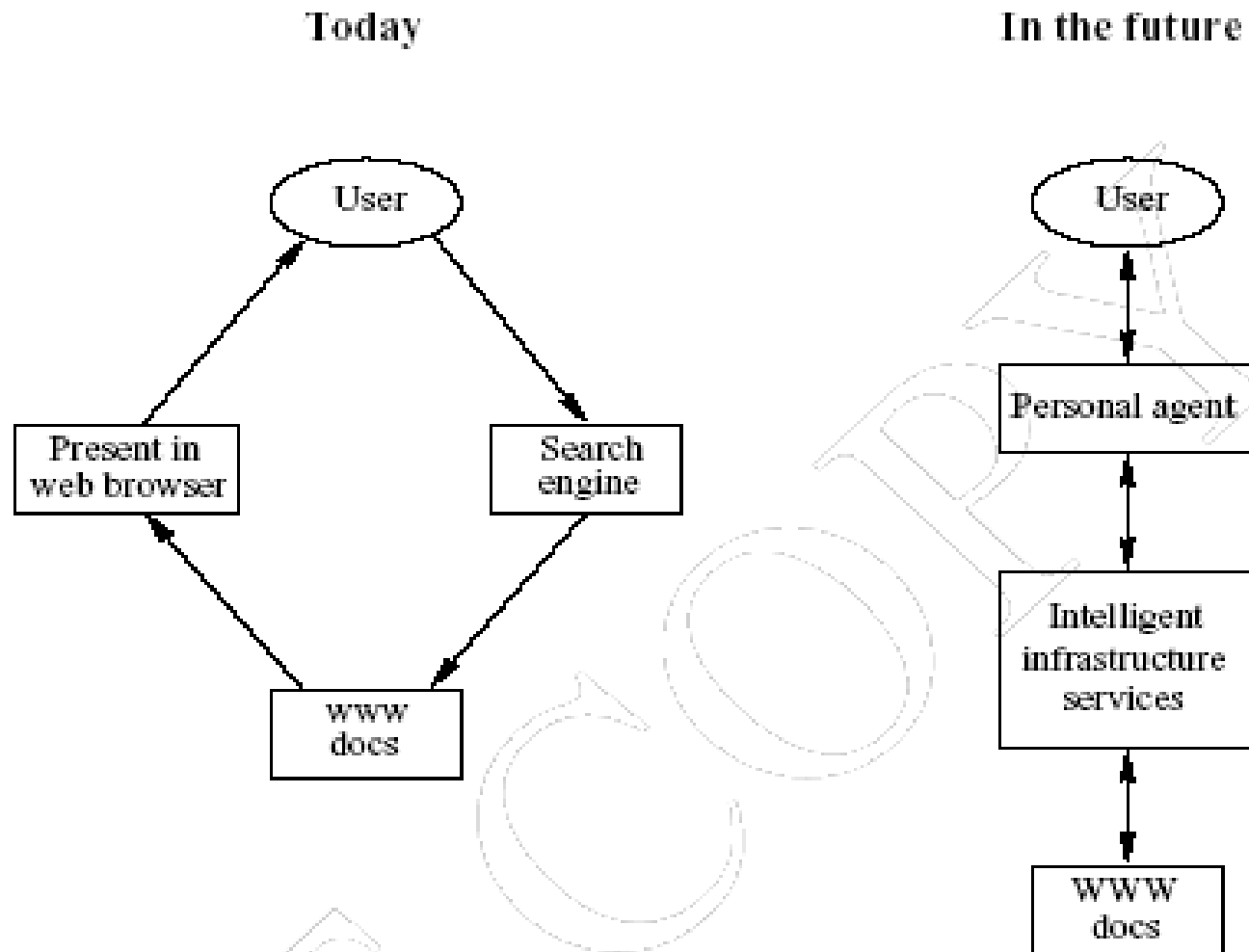
Semantic Web Agent Technologies to be used

➢ Metadata

  – Identify and extract information about data in Web sources

➢ Ontologies

  – Web searches, interpret retrieved information

  – Communicate with other agents

➢ Logic

  – Process retrieved information, draw final conclusions

Semantic Web Agent Technologies

➢ Further technologies (will develop to the Semantic Web technologies)

- − Agent communication languages.

- − Formal representation of rules and desires of agents

- − Creation and maintenance of user models.

Thank you

Prof. Khaled Wassif