

WELCOME: DAY 2

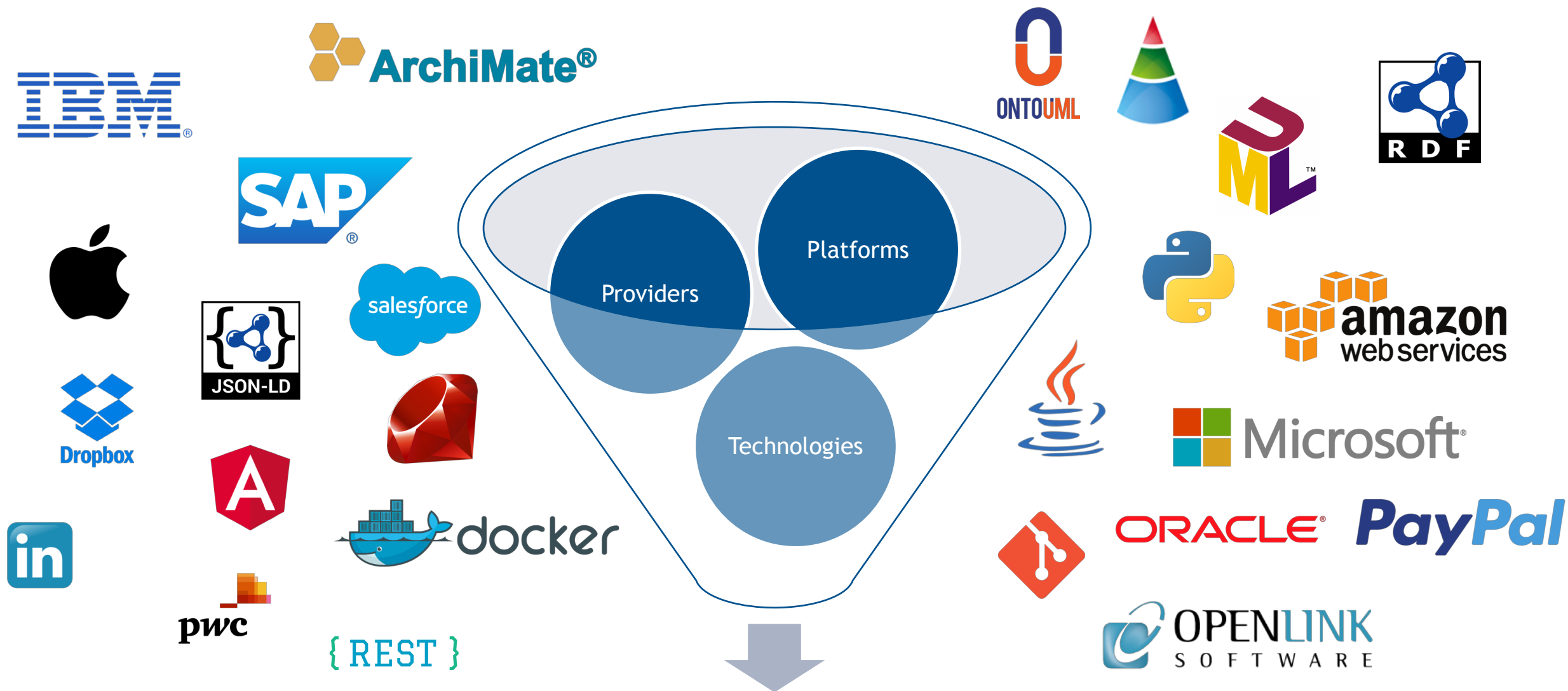
Session 1

Introduction to Semantics and Ontologies

FAIR DATA STEWARDSHIP COURSE

TOWARDS A GO FAIR READINESS PROGRAM

REALITY → HETEROGENEITY



Integrated organisation

SEMANTIC INTEROPERABILITY

WHAT IS INTEROPERABILITY?

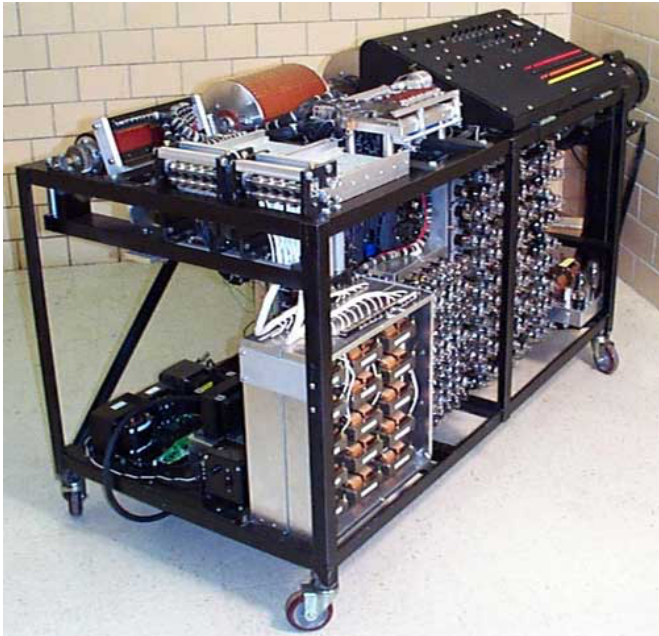
- The ability of independently-developed components to interact and cooperate with each other
- The ability of components to exchange data and services



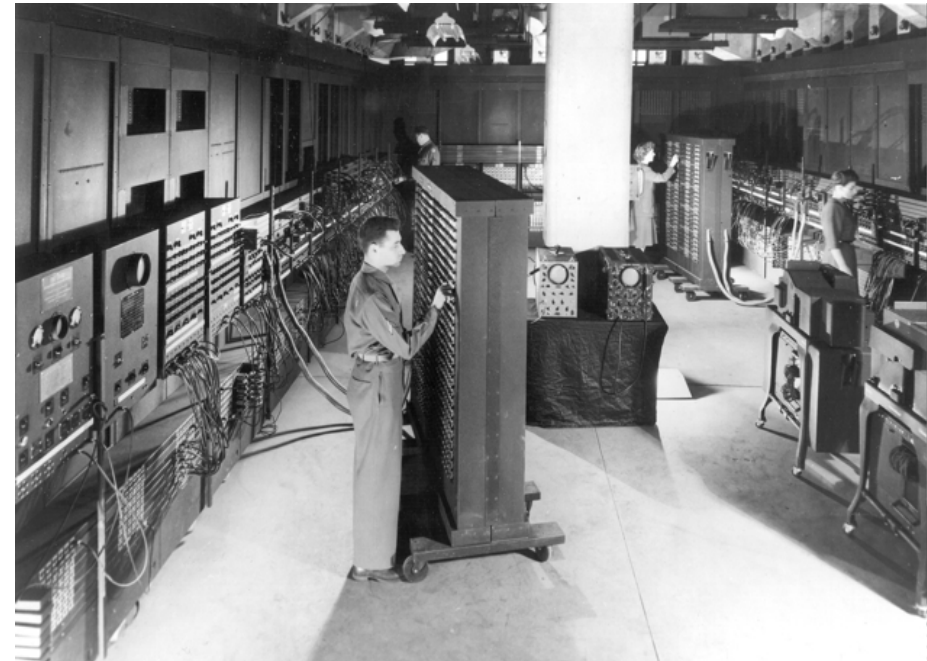
Interoperability is becoming the most relevant challenge in modern organizations

COMPUTER INTEROPERABILITY THROUGH TIME

Components running on different hardware platforms



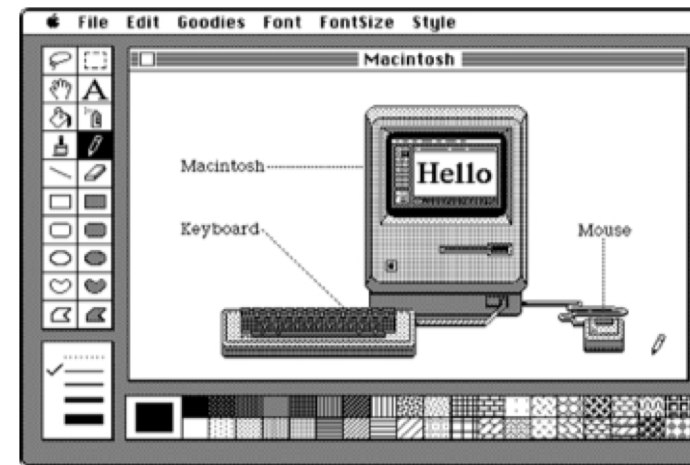
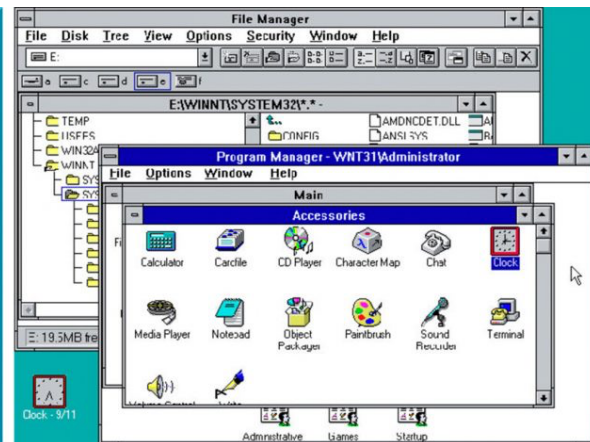
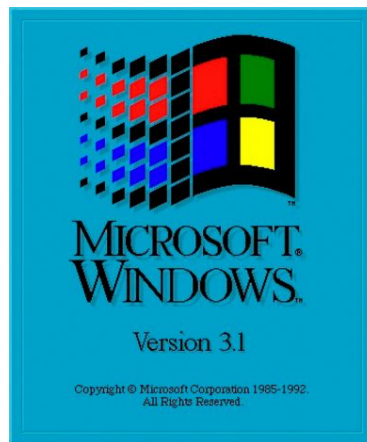
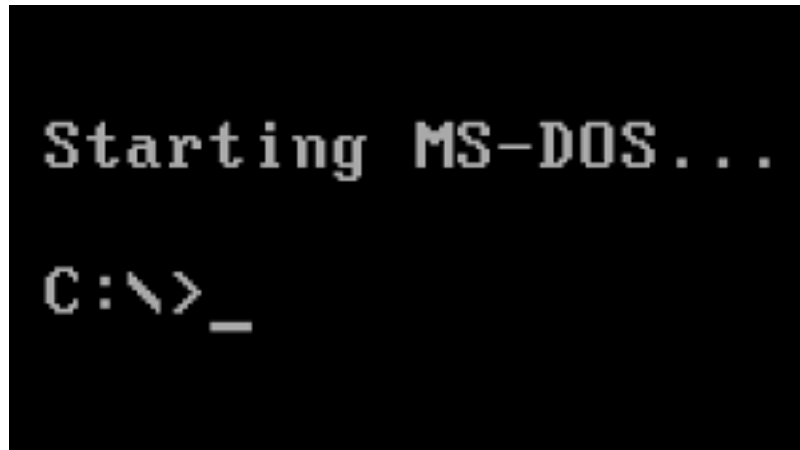
1996 replica of the 1942 ABC computer



ENIAC 1945

COMPUTER INTEROPERABILITY THROUGH TIME

Components running on different operating systems



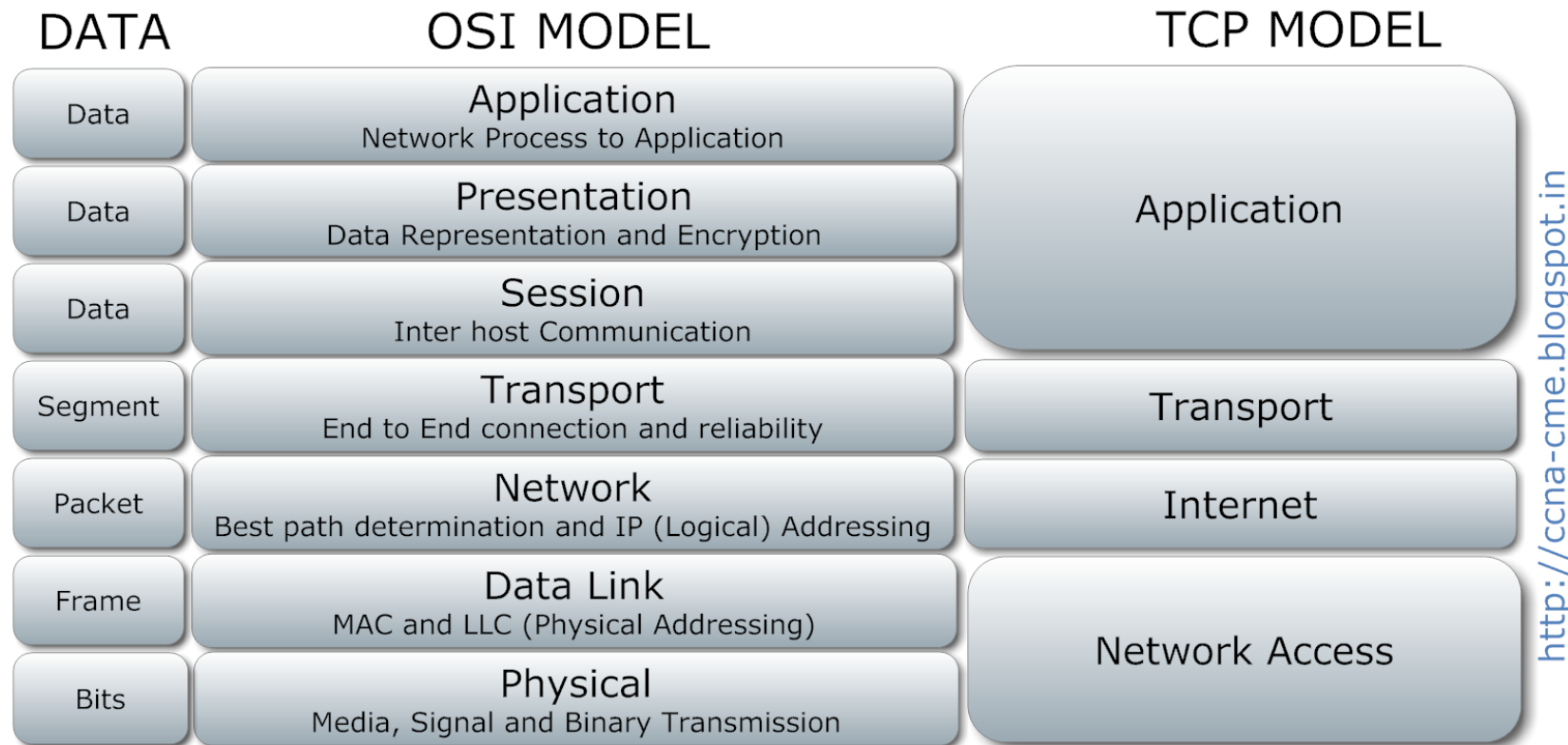
COMPUTER INTEROPERABILITY THROUGH TIME

Components running on different network infrastructure



COMPUTER INTEROPERABILITY THROUGH TIME

Components running on different communication protocols



<http://ccna-cme.blogspot.in>

COMPUTER INTEROPERABILITY THROUGH TIME

Components using different data representations



Components using different control models

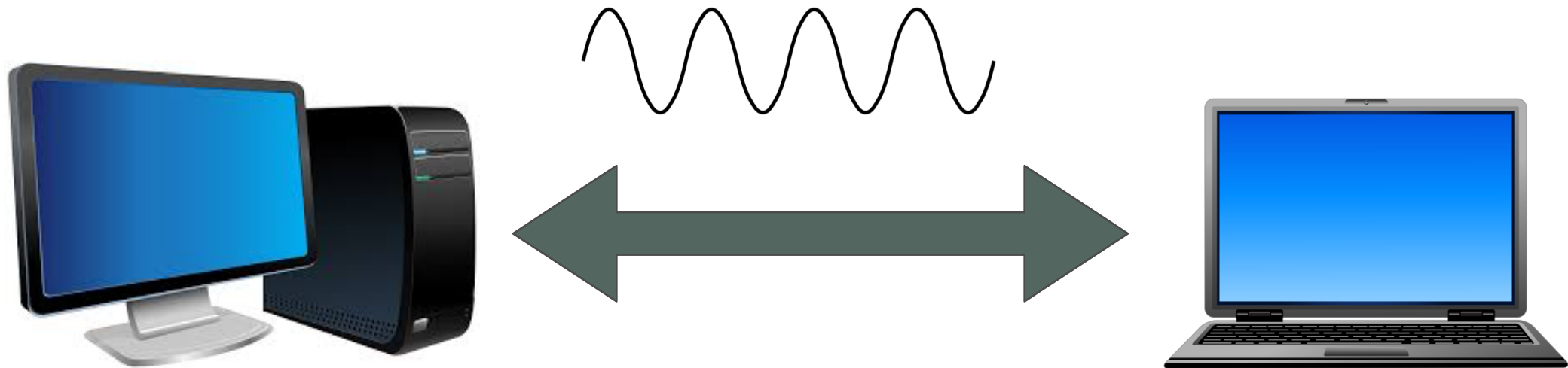


Components implementing different semantics or semantic interpretations

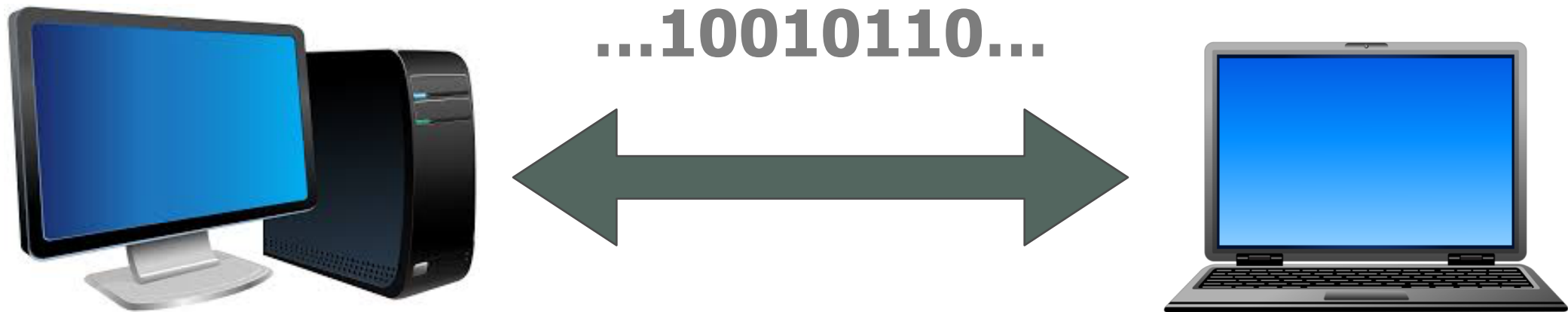
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<student>  
  <name>Mary</name>  
  <birthDate>01/13/1980</birthDate>  
  <gender>Female</gender>  
</student>
```

```
<dalta>  
  <ainm>Maria</ainm>  
  <dataBreithe>01/13/1980</dataBreithe >  
  <inscne>Bean</inscne>  
</dalta>
```

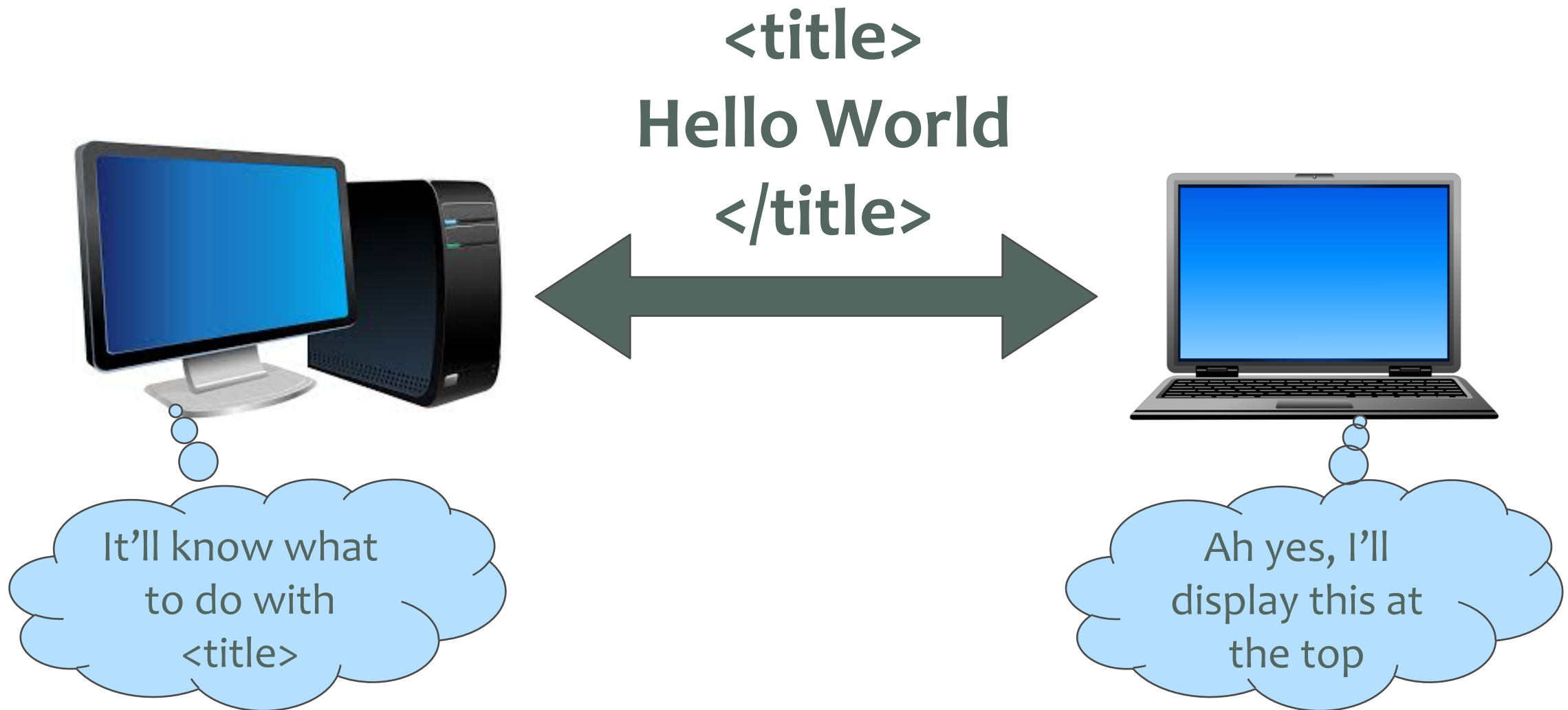
FROM SIGNALS...



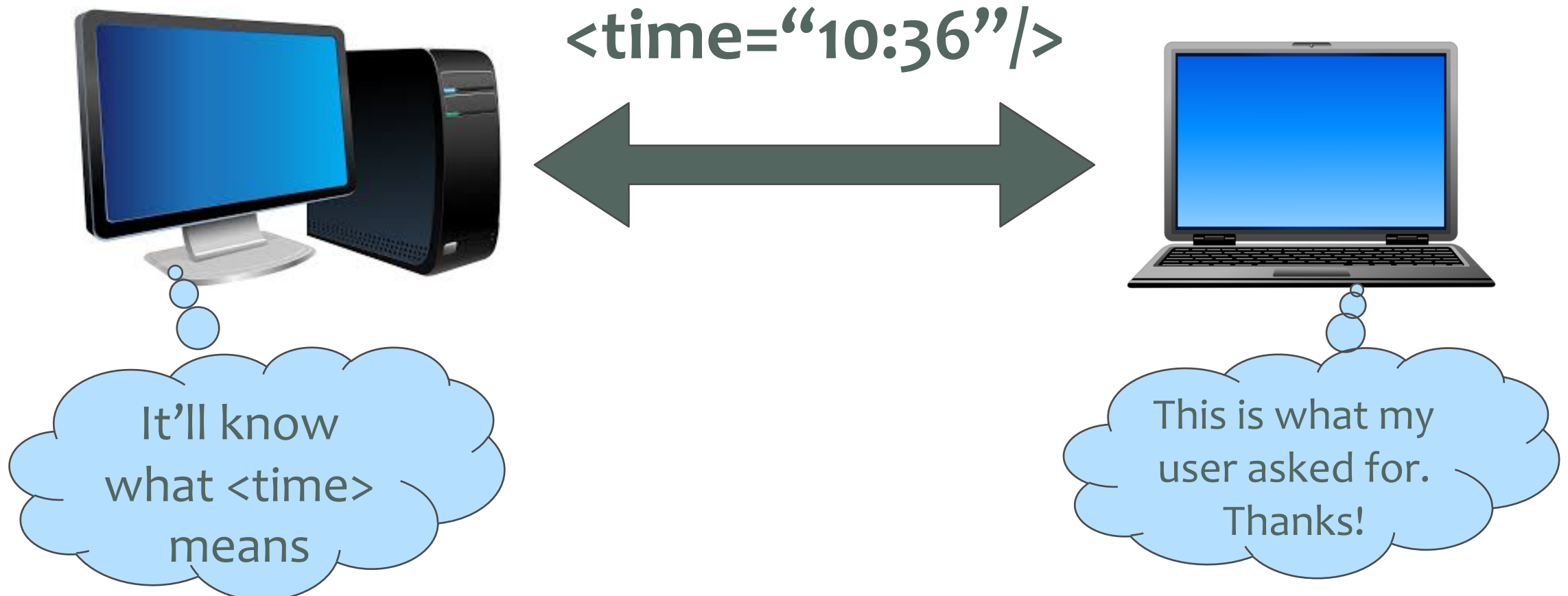
TO BINARY...



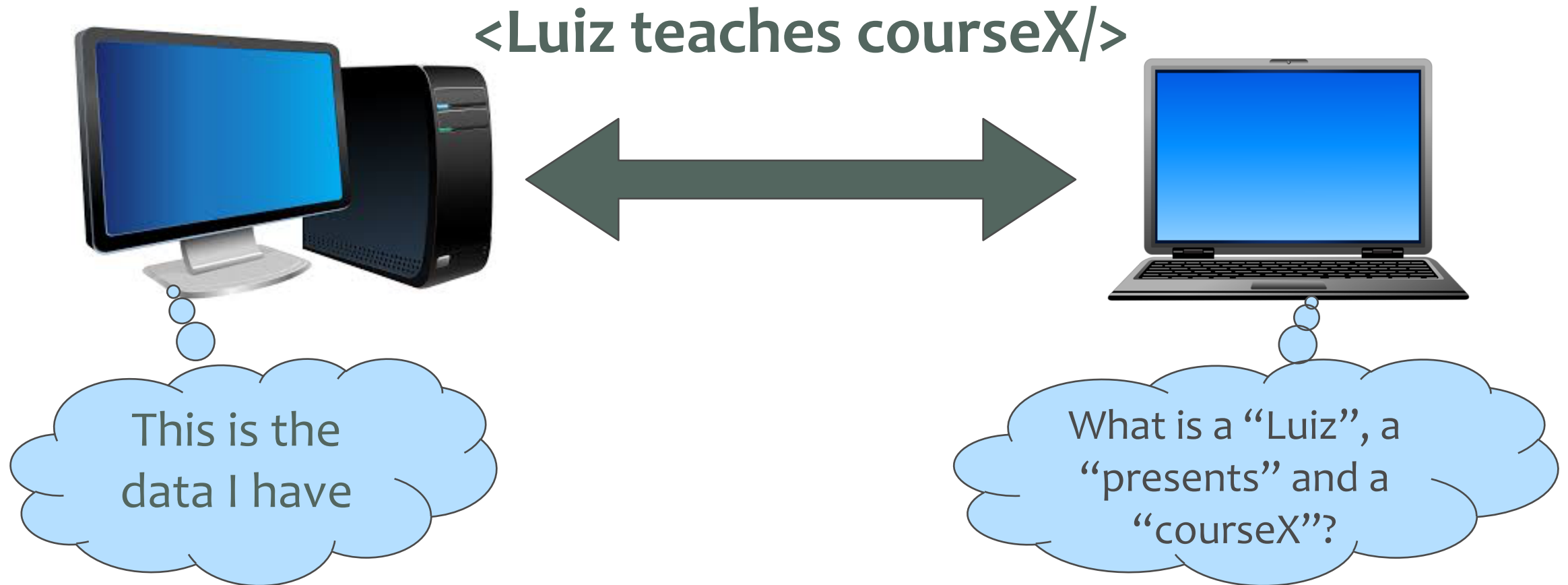
TO DOCUMENT MARKUP (HTML)...



TO DATA MARKUP ...



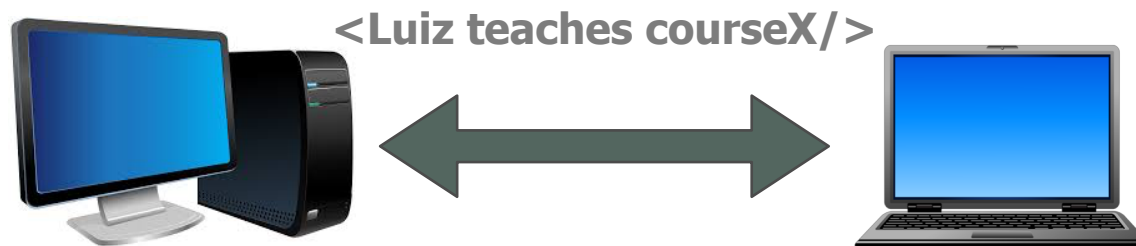
TO ARBITRARY INFORMATION EXCHANGE



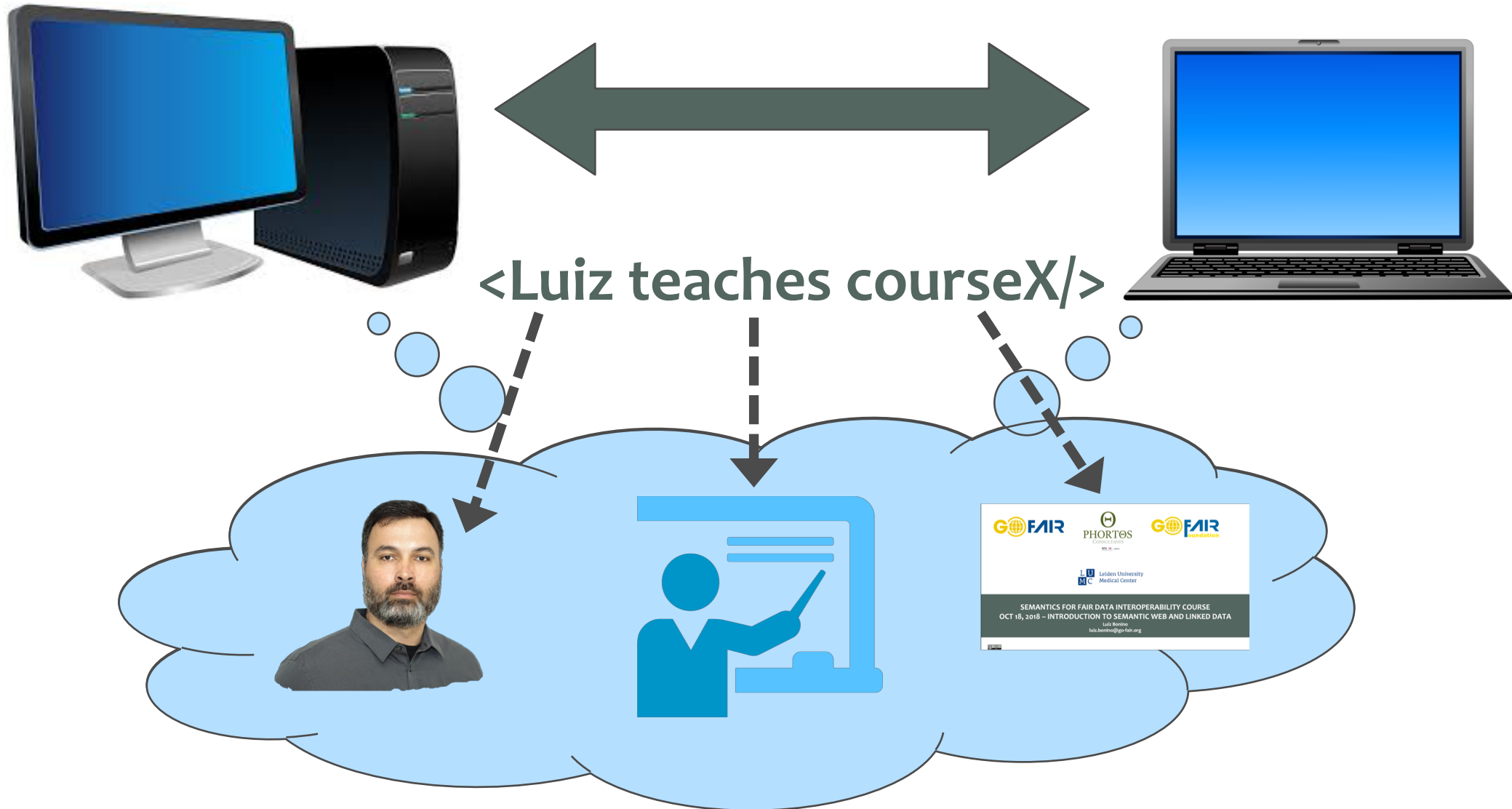
ARBITRARY DATA/INFORMATION EXCHANGE

We need:

- Common data model for encoding data (triples);
 - Common ways of serializing data (syntaxes);
 - Well-defined languages for saying what terms mean (semantics)
 - Common ways to query data (query languages)
 - Web standards!
-
- Make data machine-readable



SYNTAX TO SEMANTICS / TERMS TO ENTITIES



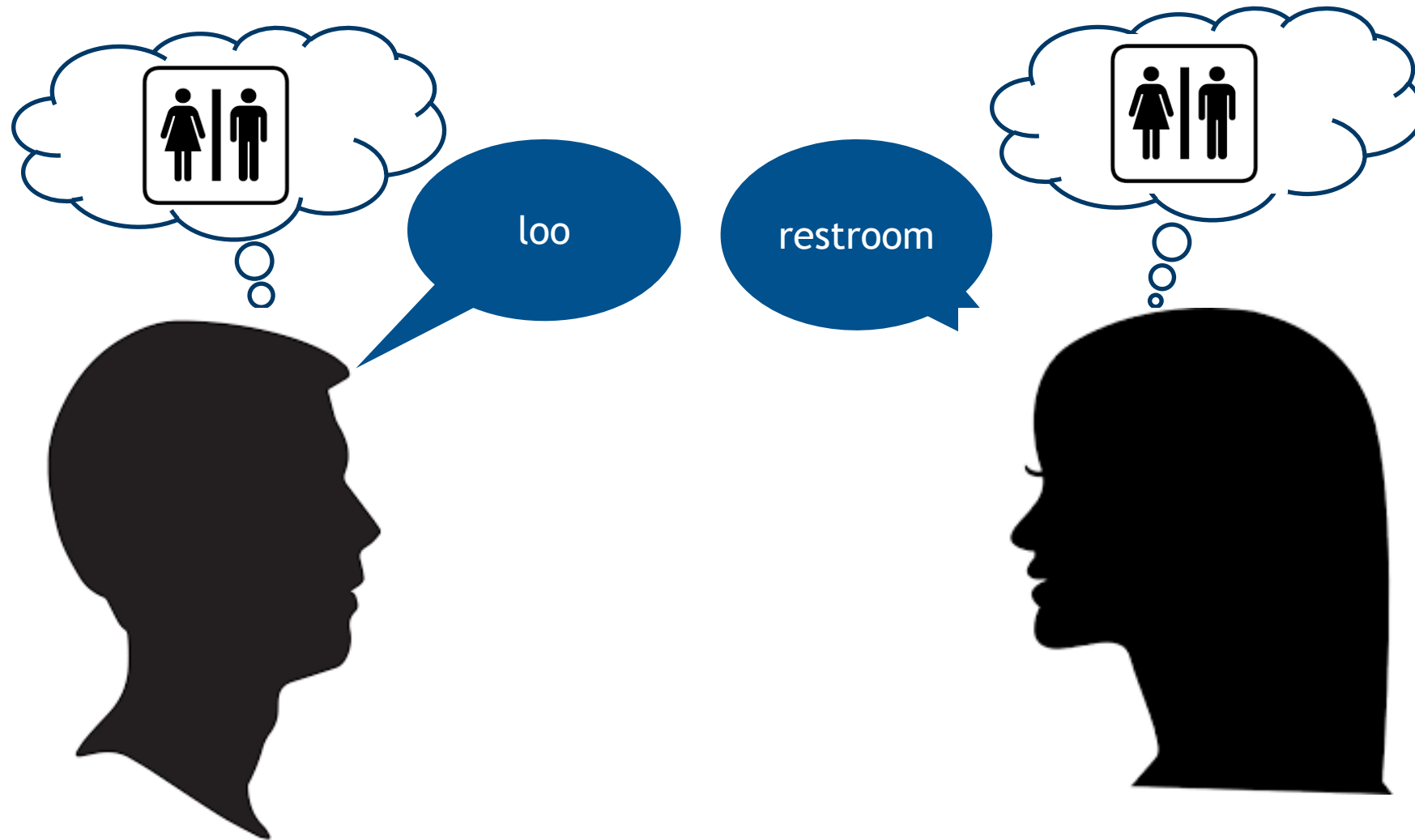
SEMANTIC INTEROPERABILITY

- Semantic interoperability enables organizations to *process information from external sources* in a meaningful manner.
- It ensures that the *precise meaning* of exchanged information is *understood and preserved* throughout exchanges between parties.
- Benefits of semantic interoperability are:
 - Reduction of errors
 - Management of costs
 - Monitoring and responding to trends and problems
 - Expanding knowledge
- Semantic interoperability is about the *meaning of data elements and the relationship between them*.

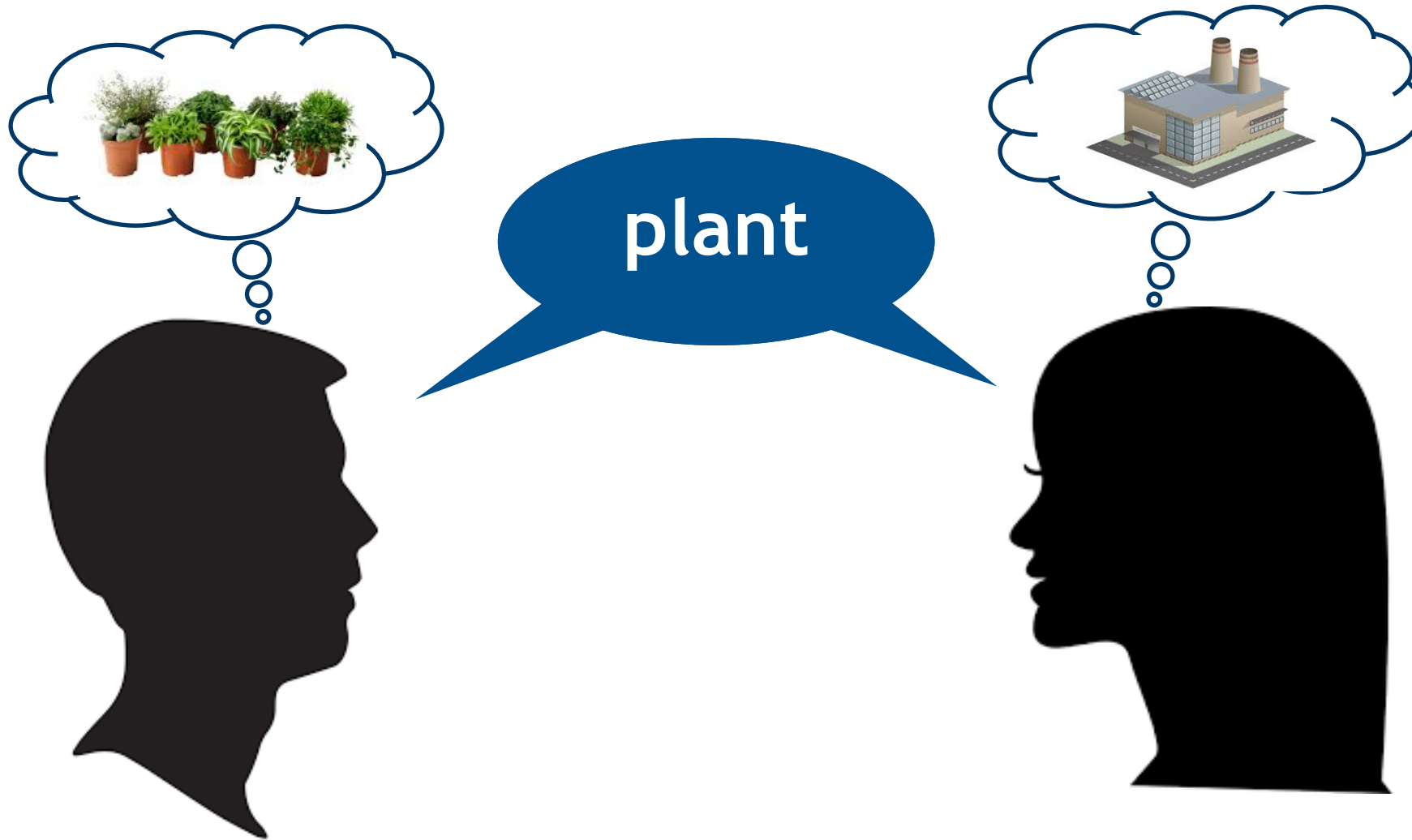
Source: EIF, http://ec.europa.eu/archives/isa/documents/isa_annex_ii_eif_en.pdf

Semantic Interoperability is considered to be ***the problem of this decade...*** [currently] costing productivity, lives and billions of dollars annually... the overall human and financial cost to society from our ***failure*** to share and reuse information is ***many times the cost of the systems' operation and maintenance*** [OMG, SIMF]

SEMANTIC INTEROPERABILITY



SEMANTIC INTEROPERABILITY

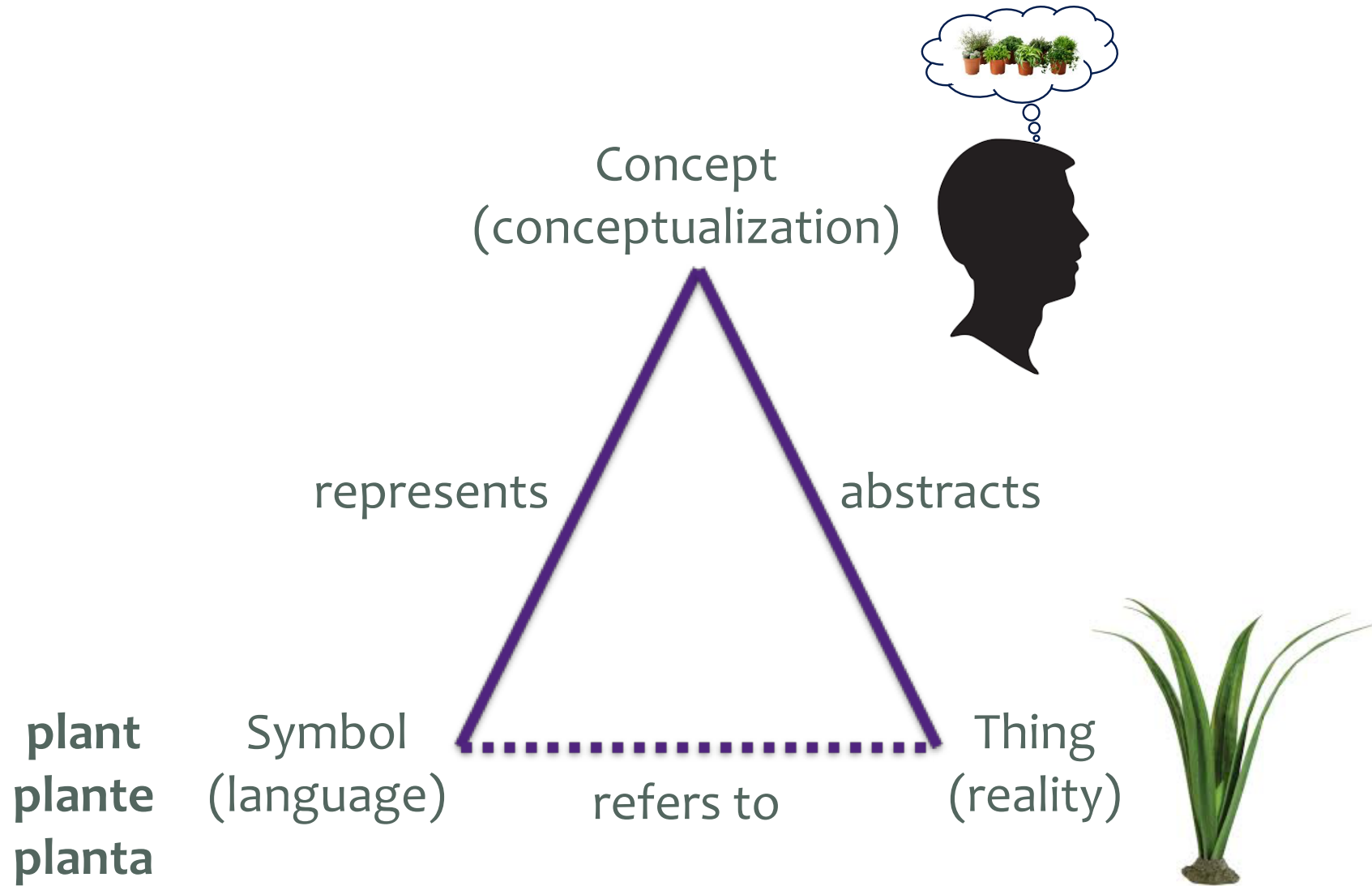


Semantic Interoperability

=

relating different *worldviews*, i.e.,
different *conceptualizations* of
reality

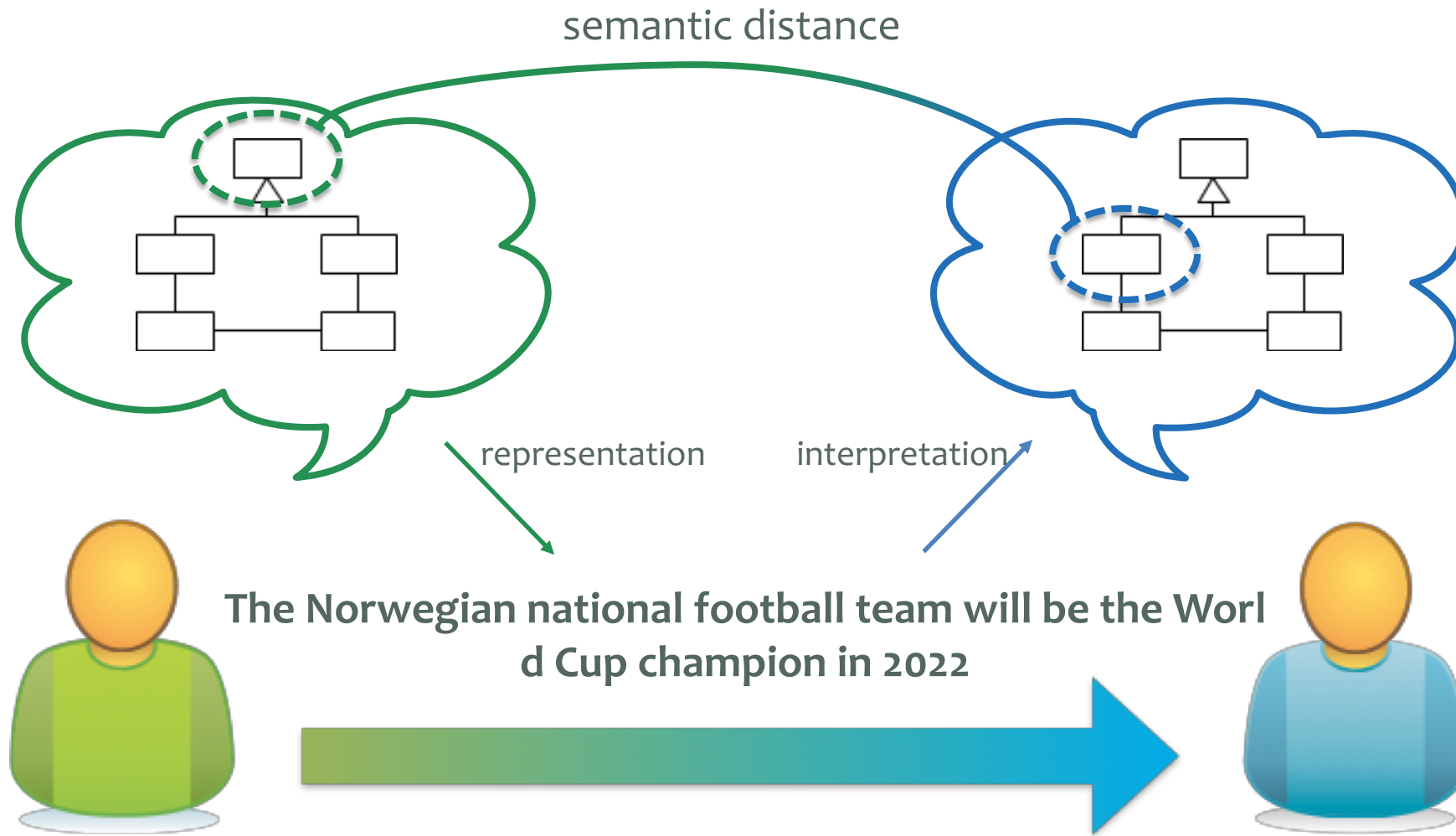
ULLMAN'S TRIANGLE



- Every language has its own *Syntax* and *Semantics*
- *Syntax* is the study of grammar, how to say something
- *Semantics* is the study of meaning
- Different *syntaxes* may have the same *semantics*:
 - $x += y$
 - $x = x + y$

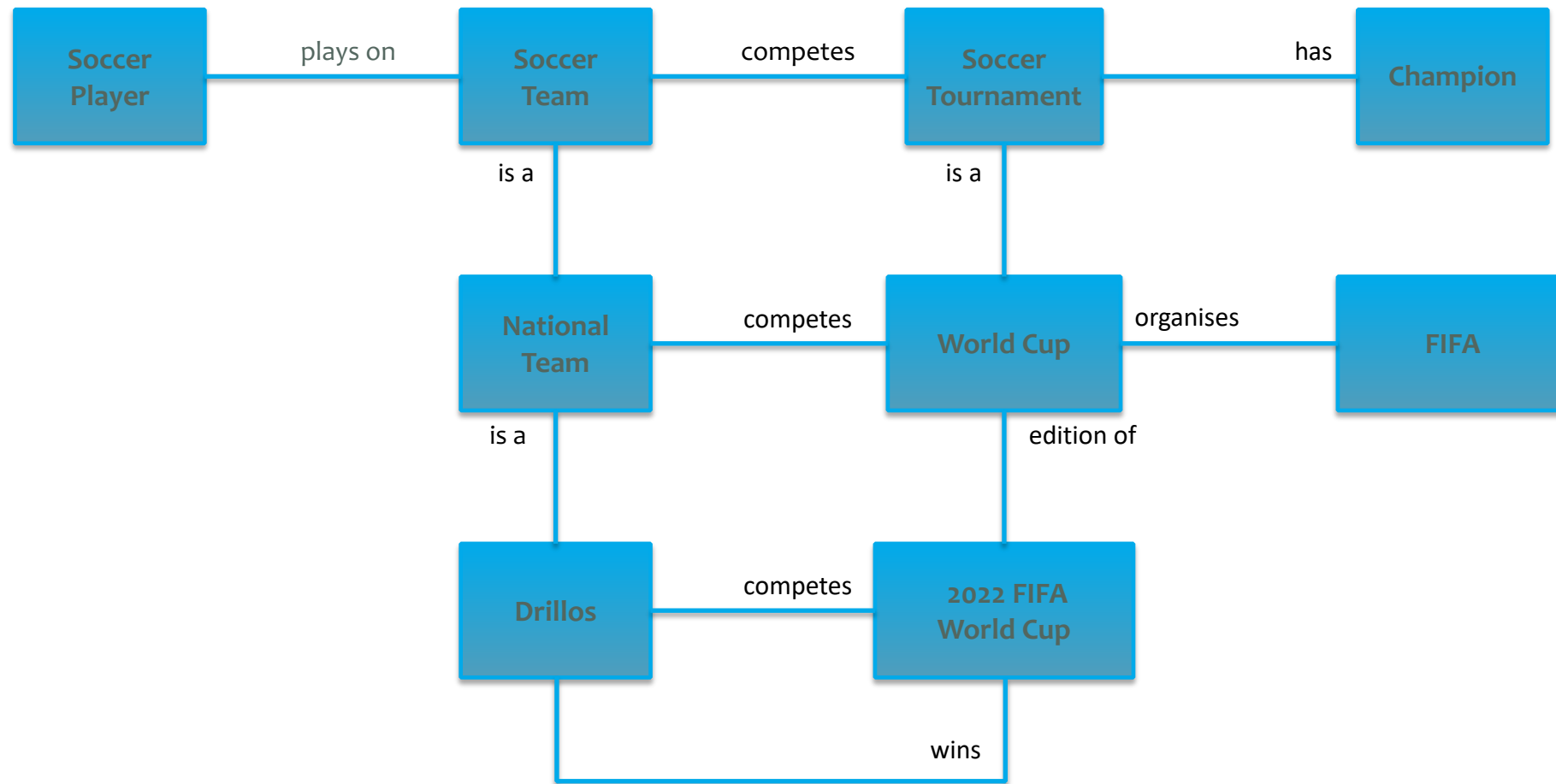
Syntax and semantics are all about **COMMUNICATION**

COMMUNICATION PROCESS



COMMUNICATION PROCESS

“The Norwegian national football team will be the World Cup champion in 2022”



Conceptualization (mental model) used to understand the sentence

COMMUNICATION PROCESS

- How can we communicate?
 - We share mental models
 - We are able to learn
 - We are able to negotiate meaning
- When do we have communication problems?
 - Big semantic distance
 - False agreement (Guarino, 1998):
 - *The problem is not to disagree, it is to agree when, in fact, we disagree.*

WHAT IS CONCEPTUAL MODELING?

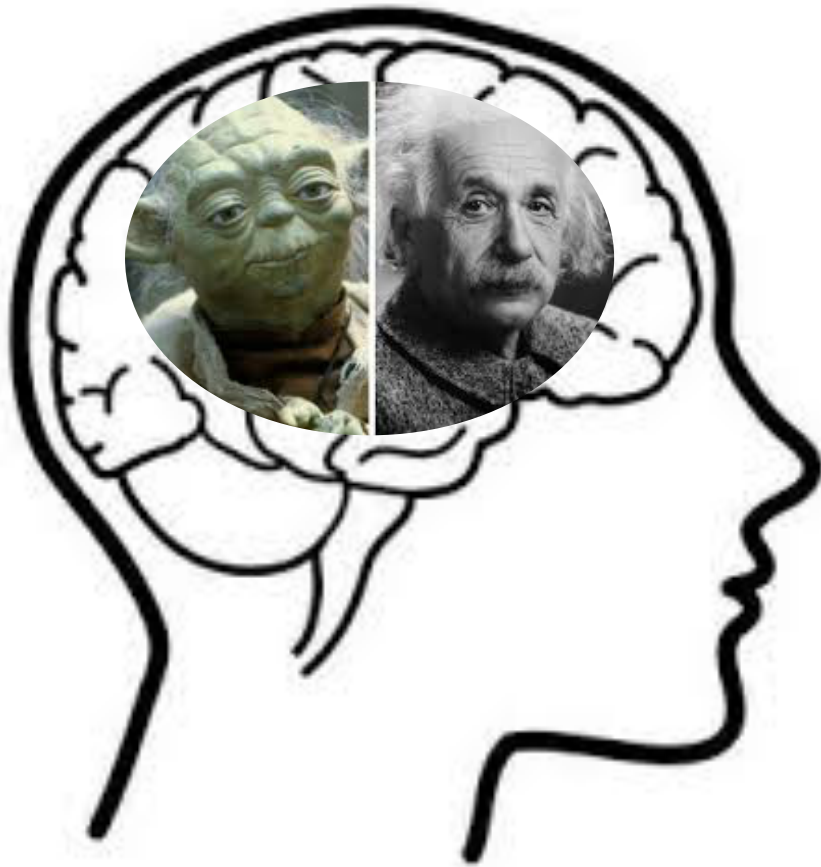
“Conceptual Modeling is the activity of describing aspects of the physical and social world for the purpose of understanding and communication... the adequacy of a conceptual modeling notation rests in its ability to promote understanding about that world among its human users”

(John Mylopoulos, Conceptual Modeling and Telos, 1992)

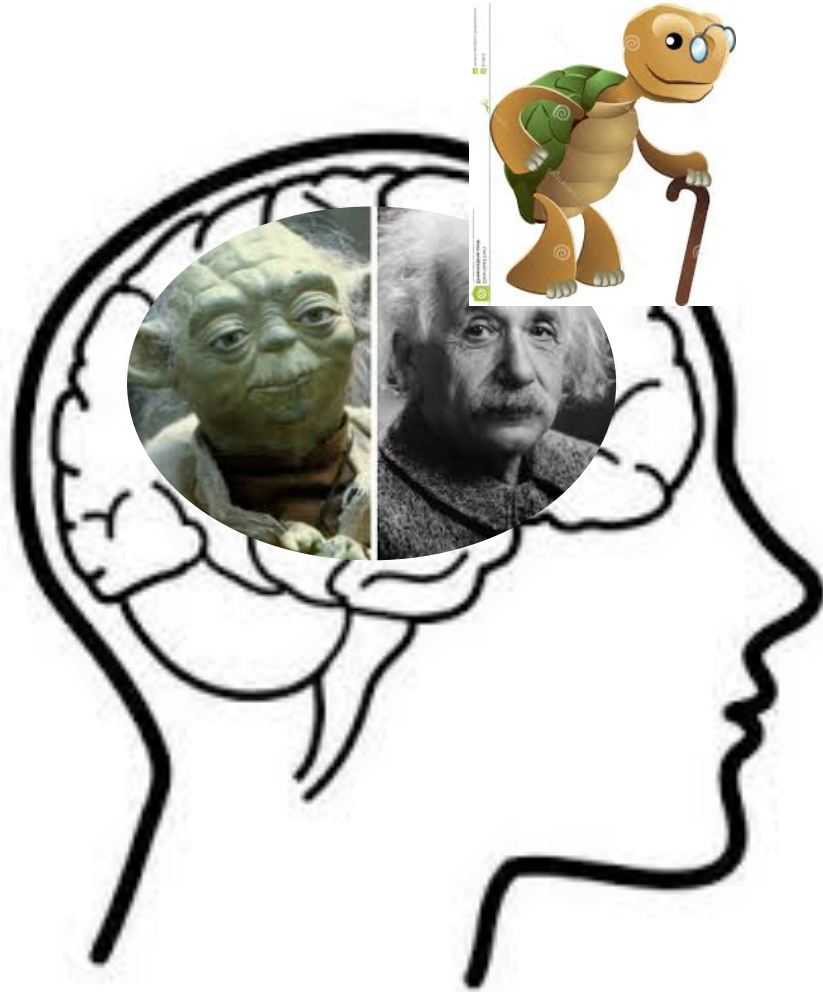
SOLUTION?



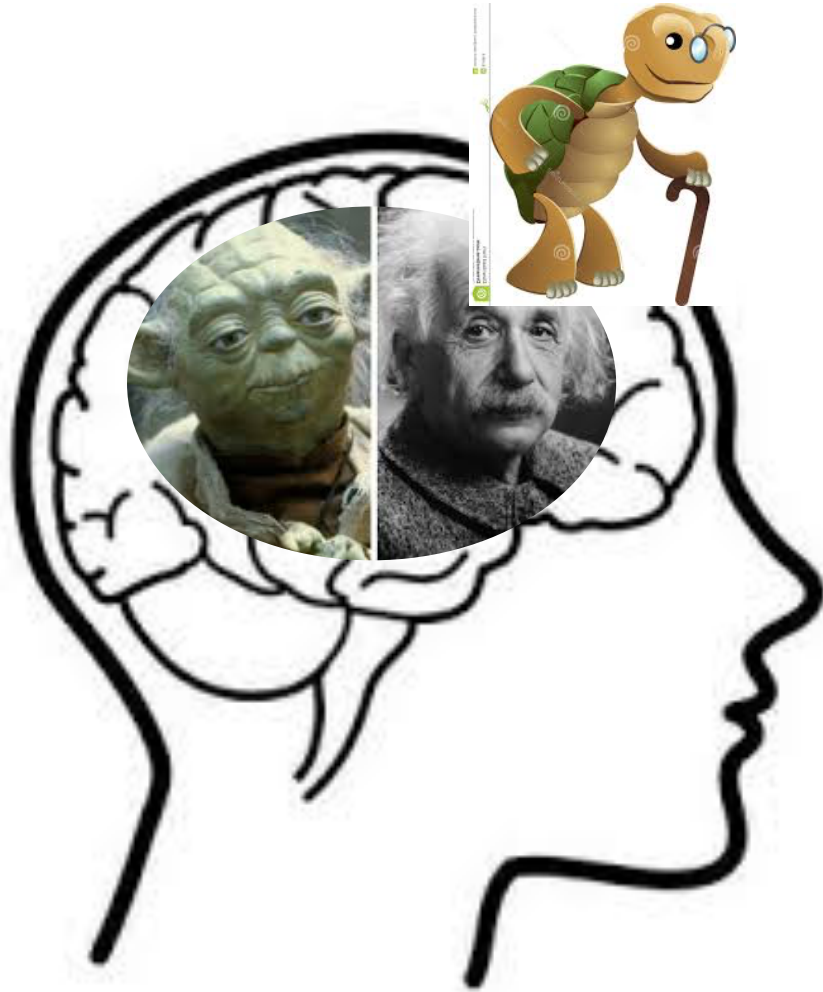
SOLUTION?



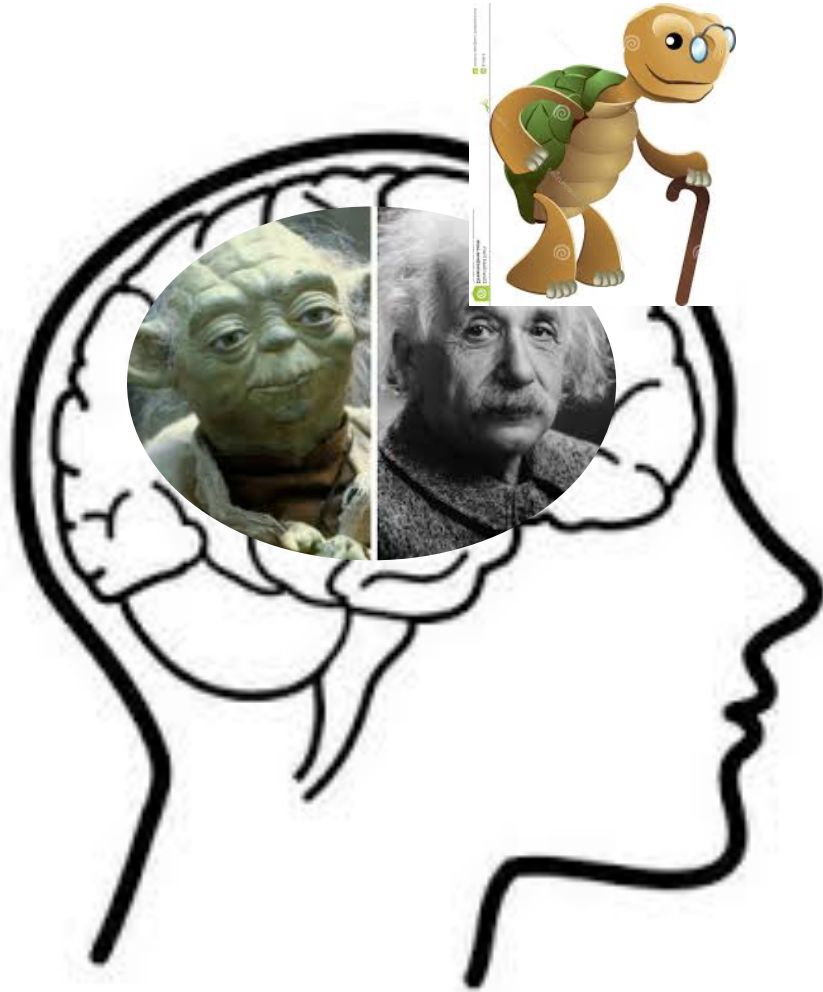
SOLUTION?



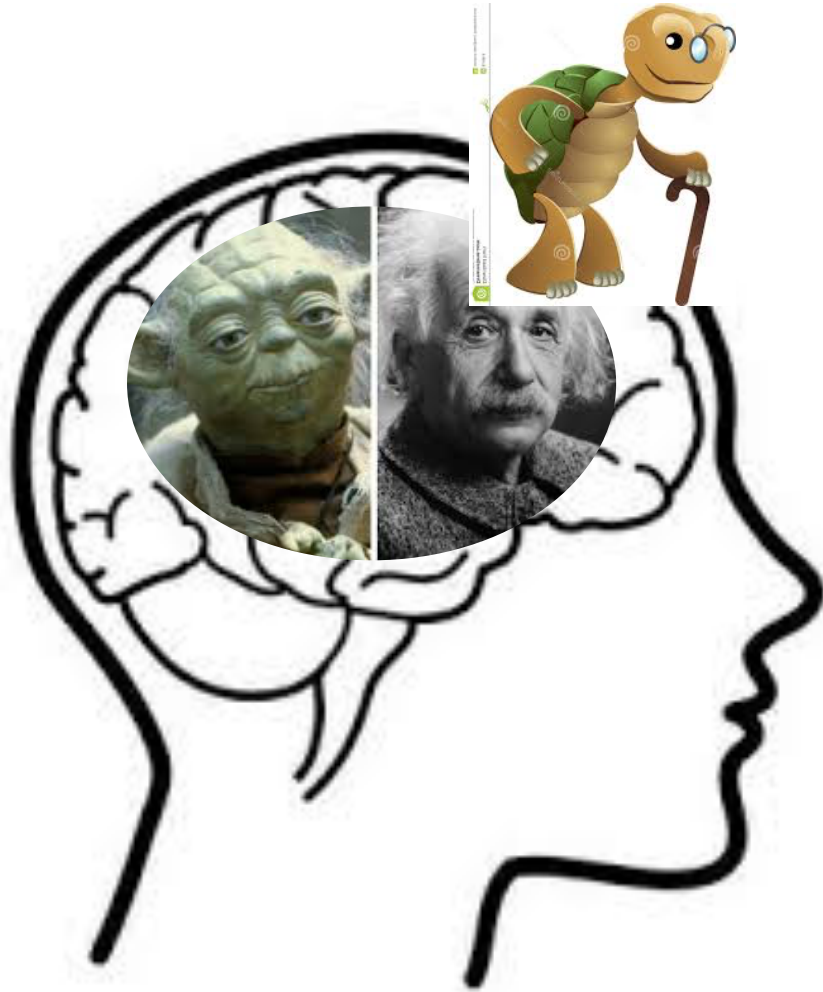
SOLUTION?



SOLUTION?



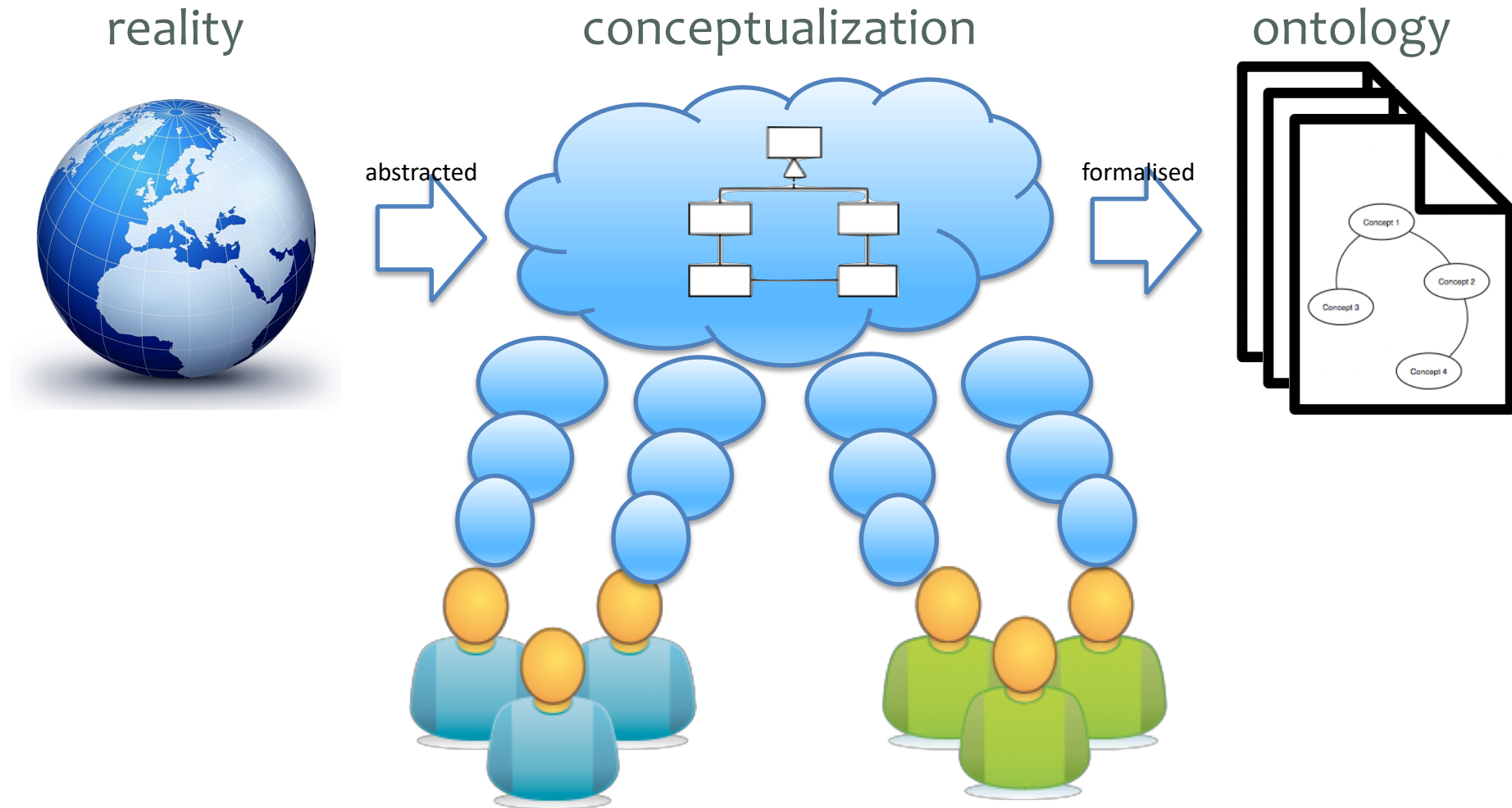
SOLUTION?



SOLUTION?

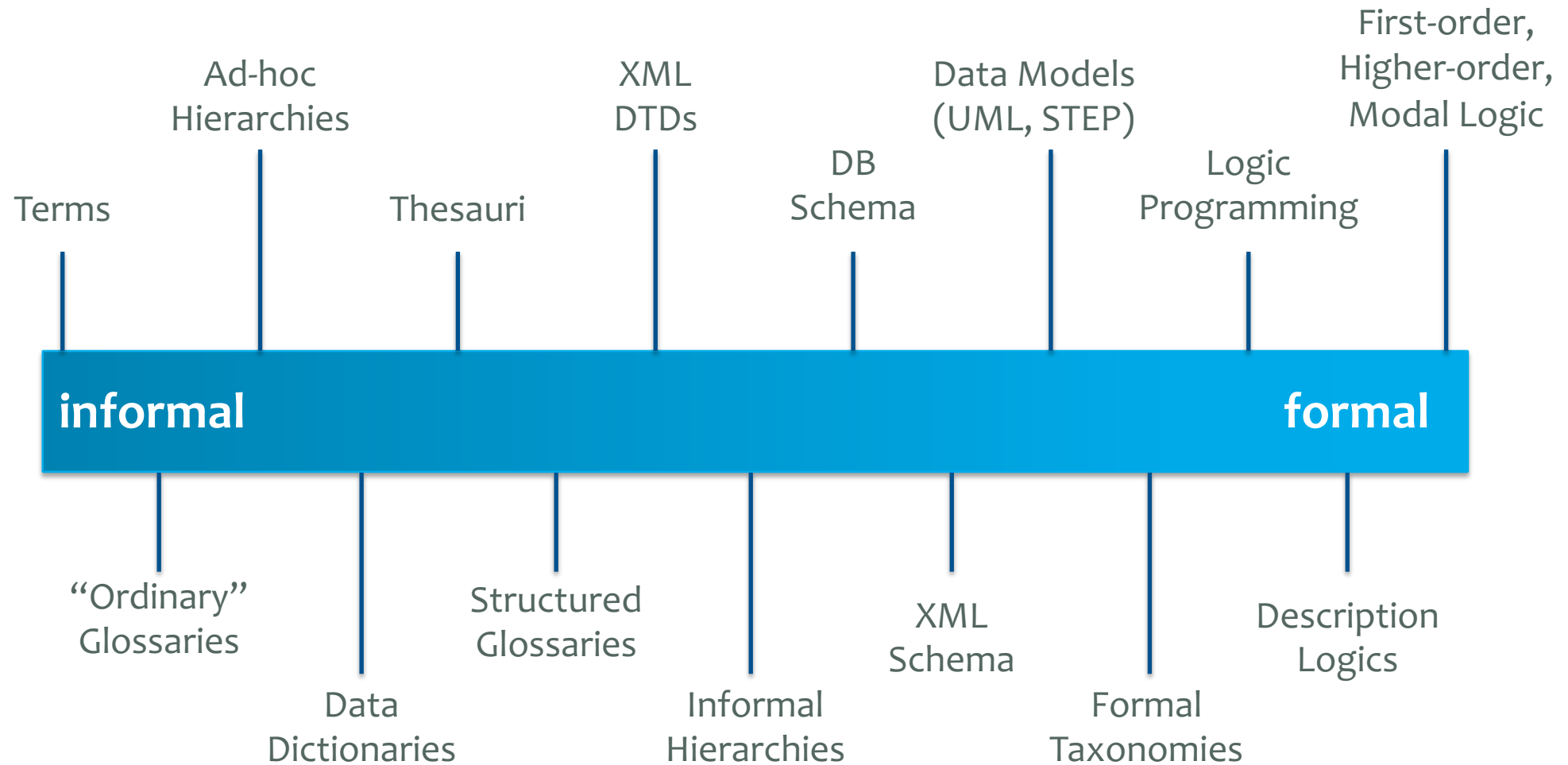


WHAT IS ONTOLOGY

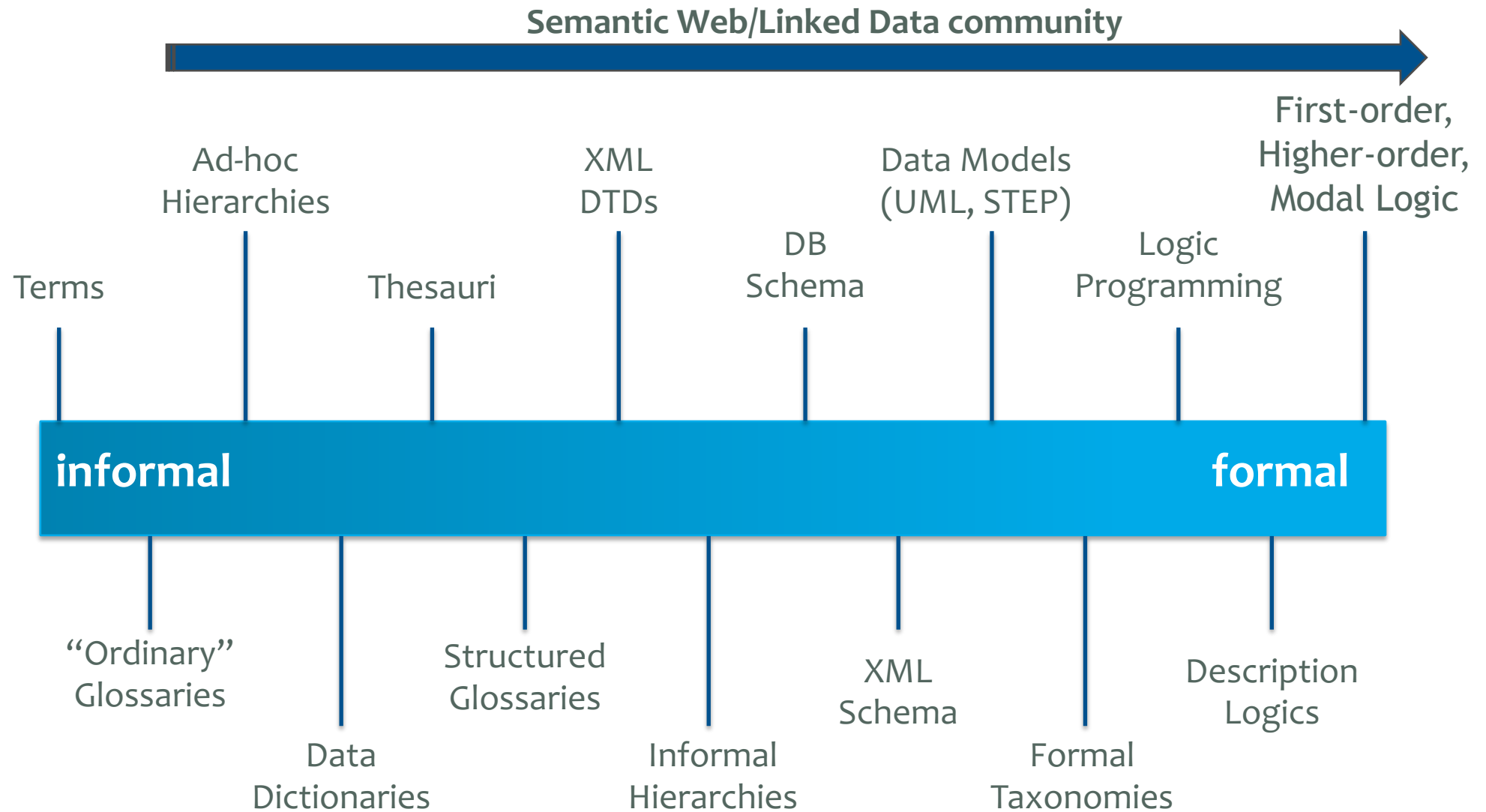


”... explicit specification of a conceptualization” (Gruber, 1993)
”... formal specification of a shared conceptualization” (Borst 1997)

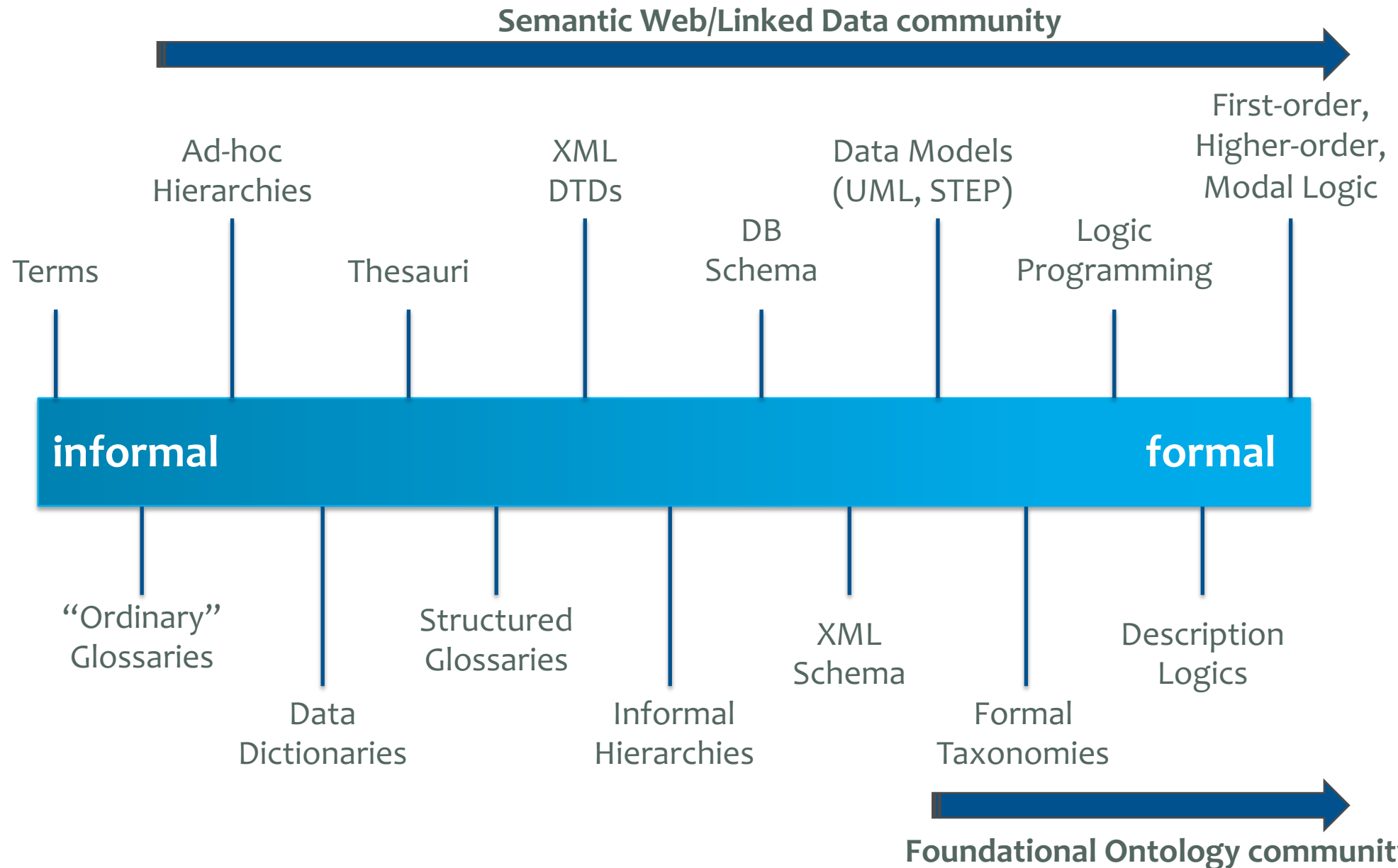
REPRESENTATION SPECTRUM



REPRESENTATION SPECTRUM



REPRESENTATION SPECTRUM



Real World (Ontological) Semantics Vs Formal Semantics

Formal semantics is not enough. Mathematics (Logics, Algebra, Set Theory) gives us the tools to calculate the consequence of our **ontological choices** but does not offer us any help in making those choices in the first place.

There are **multiple views on reality** that can conflict and unless we are fully aware of their distinctions, we cannot safely harmonize those views

There is no experiment that can be done to settle these conflicts. It can only be solved by ***conceptual clarification*** and ***meaning negotiation*** relying on ***aprioristic*** system of categories

When “carving up reality” we need to
guarantee *intra-worldview consistency* and
inter-worldview interoperability

Ontologies as a set of well-tested, logically
sound reusable ***patterns of information
structuring***

A discipline aiming at developing ontology-based methodologies, computational tools and *modeling languages* for the area of Conceptual Modeling

The opposite of Ontology is not Non-Ontology, is Bad Ontology!

“We have made enormous progress in solving the measurement problem but that progress depended on **conceptual clarity**... high resolution **data are of no use without a theory**. When we have **substantive theories** – together with the **sophisticated concepts**.. testing these theories may require **Big Science**. But we cannot expect the theories and concepts to somehow emerge from Big Science”

(Ned Block, Consciousness, Big Science and Conceptual Clarity, 2015)

“**Concepts** without **Data** are empty. **Data** without **Concepts** are blind; only through their unison knowledge can arise”

(Kant *paraphrased*)

TYPES OF ONTOLOGIES

- There are many types of ontologies
- In literature they are commonly classified according to:
 - Language: expressivity x tractability
 - Modeling domain: generality x particularity
 - Application: IS x Semantic Web x Community

IMPORTANT

- ✓ Choose the appropriate language for your problem
 - ✓ Use tools that are adequate to your context

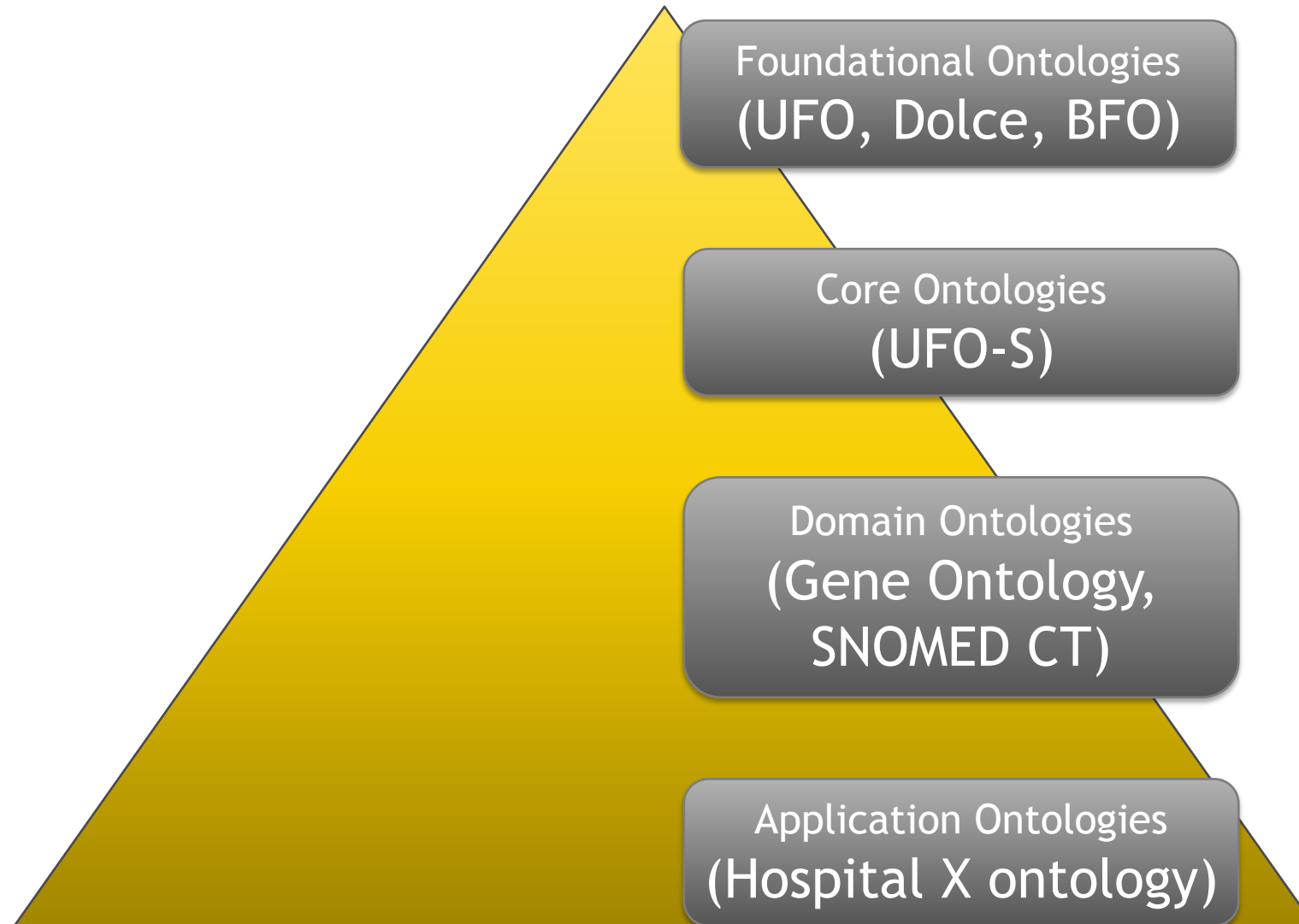
Reference Model

- Focus: expressivity
- User: human
- Technology: independent
- Ex.: OntoUML, BFO

Implementation Model

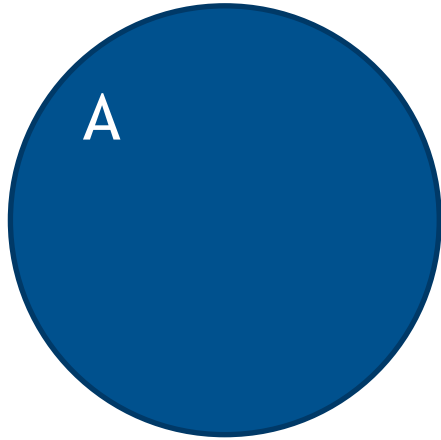
- Focus: tractability
- User: computer
- Technology: dependent
- Ex.: OWL, RDF

TYPES OF ONTOLOGIES - DOMAIN

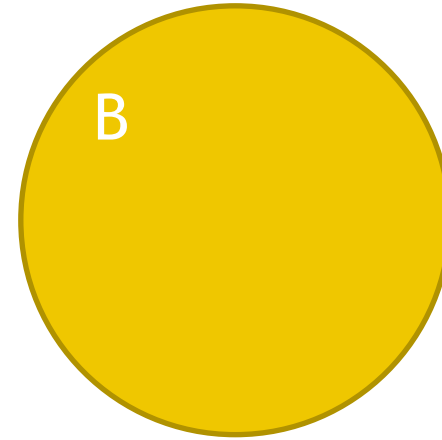


INTRODUCTION TO ONTOLOGY ENGINEERING

ONTOLOGY ADEQUACY

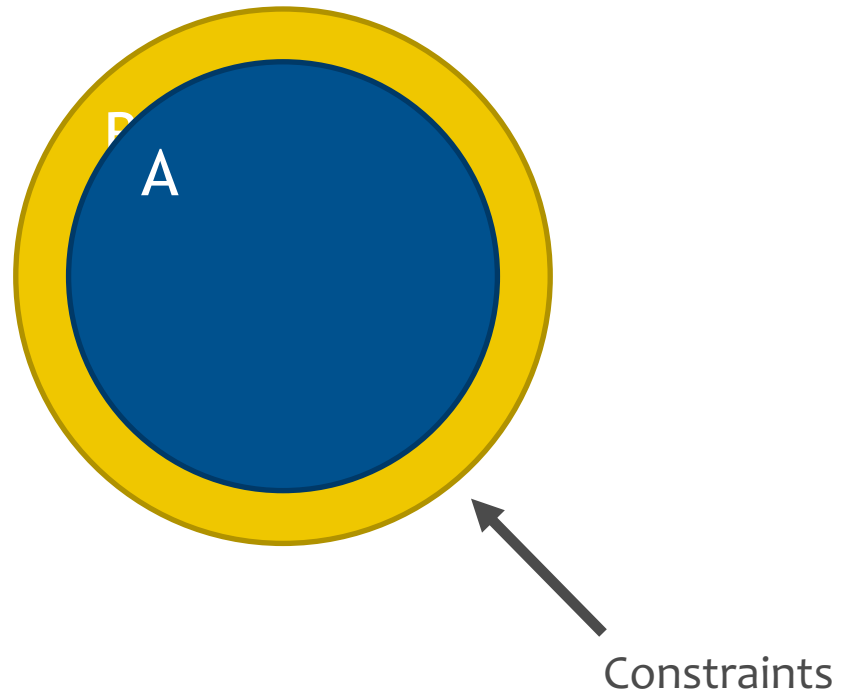


Valid state of affairs
according to the representation

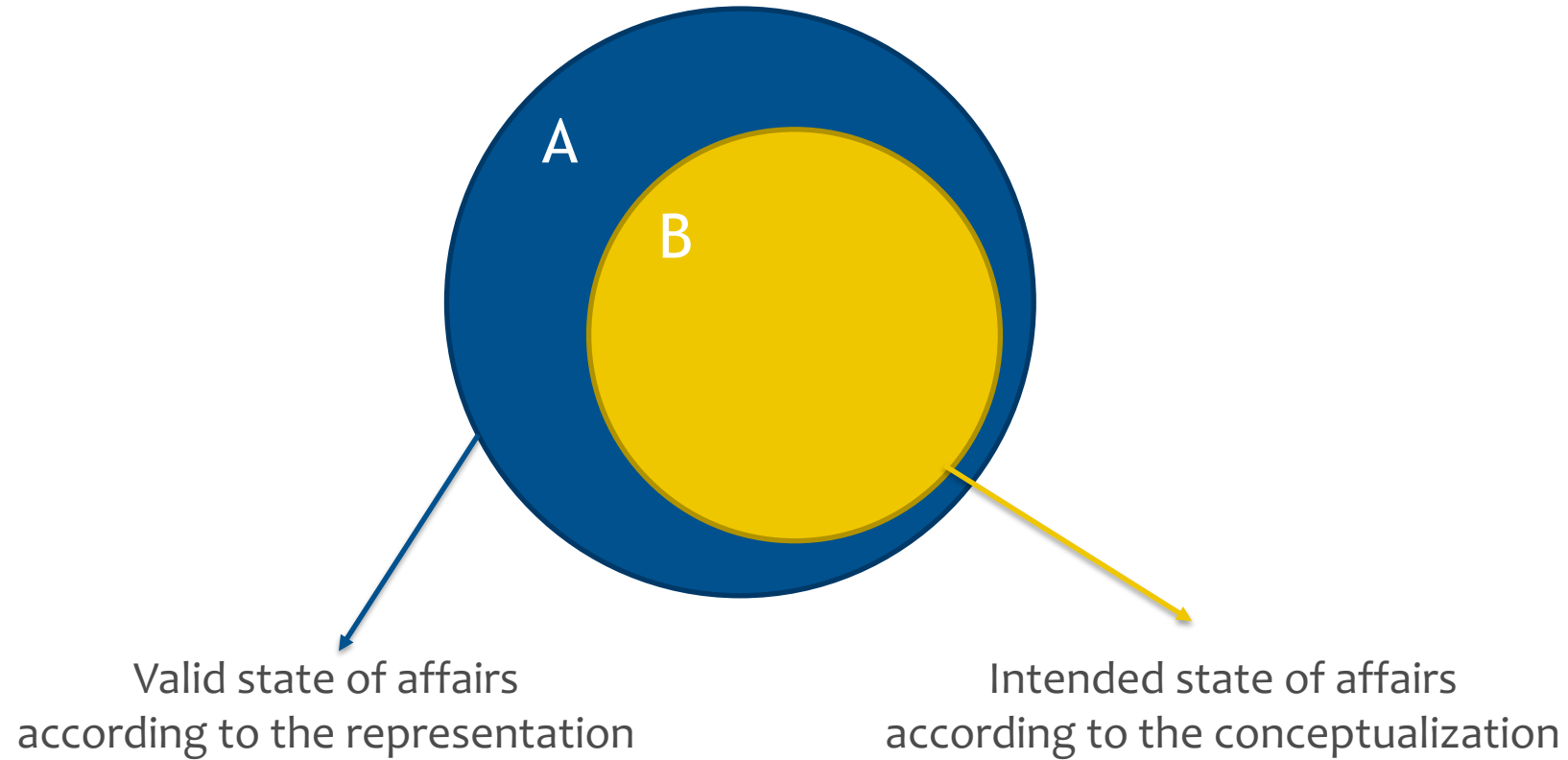


Intended state of affairs
according to the conceptualization

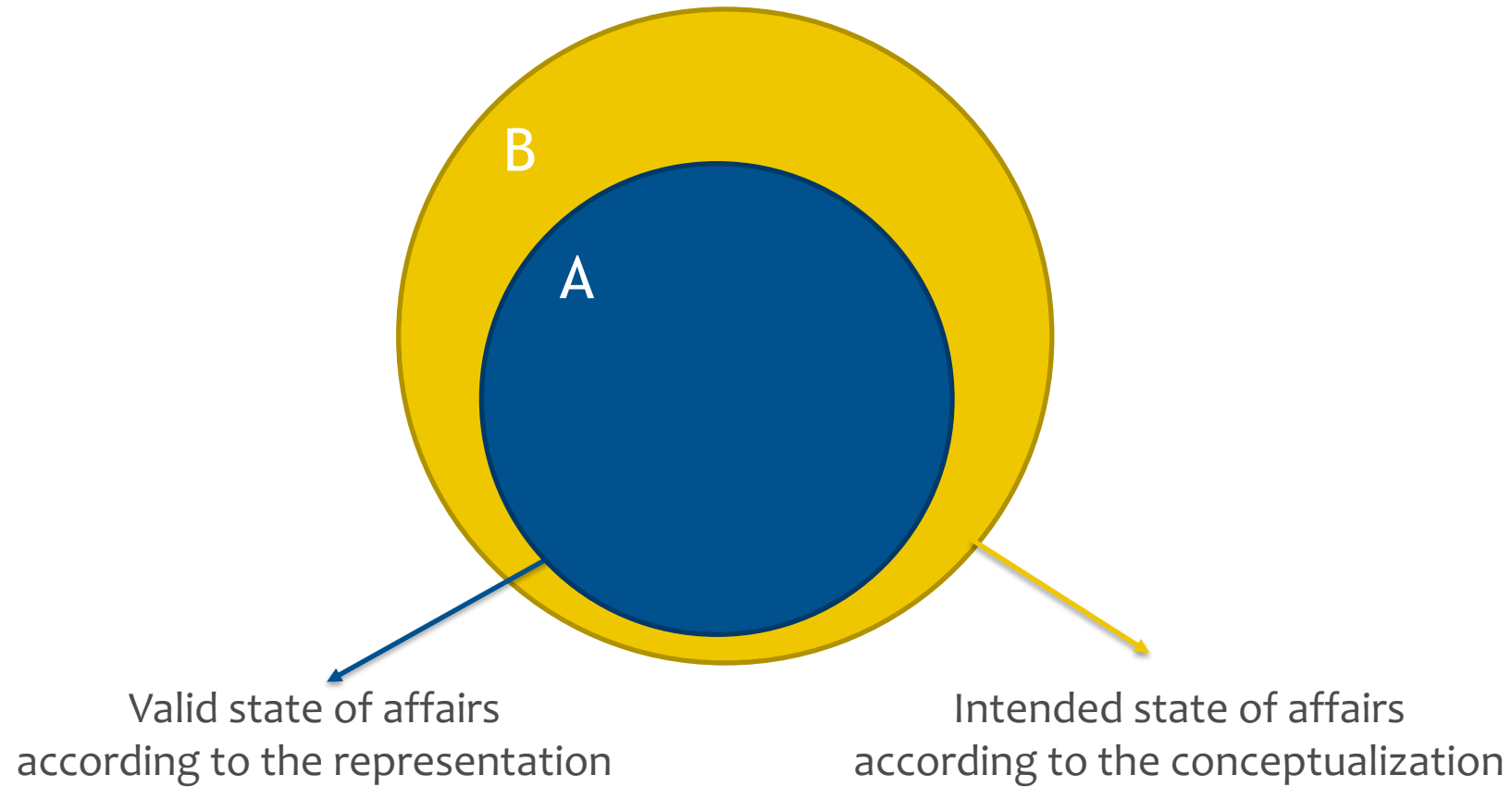
ONTOLOGY ADEQUACY



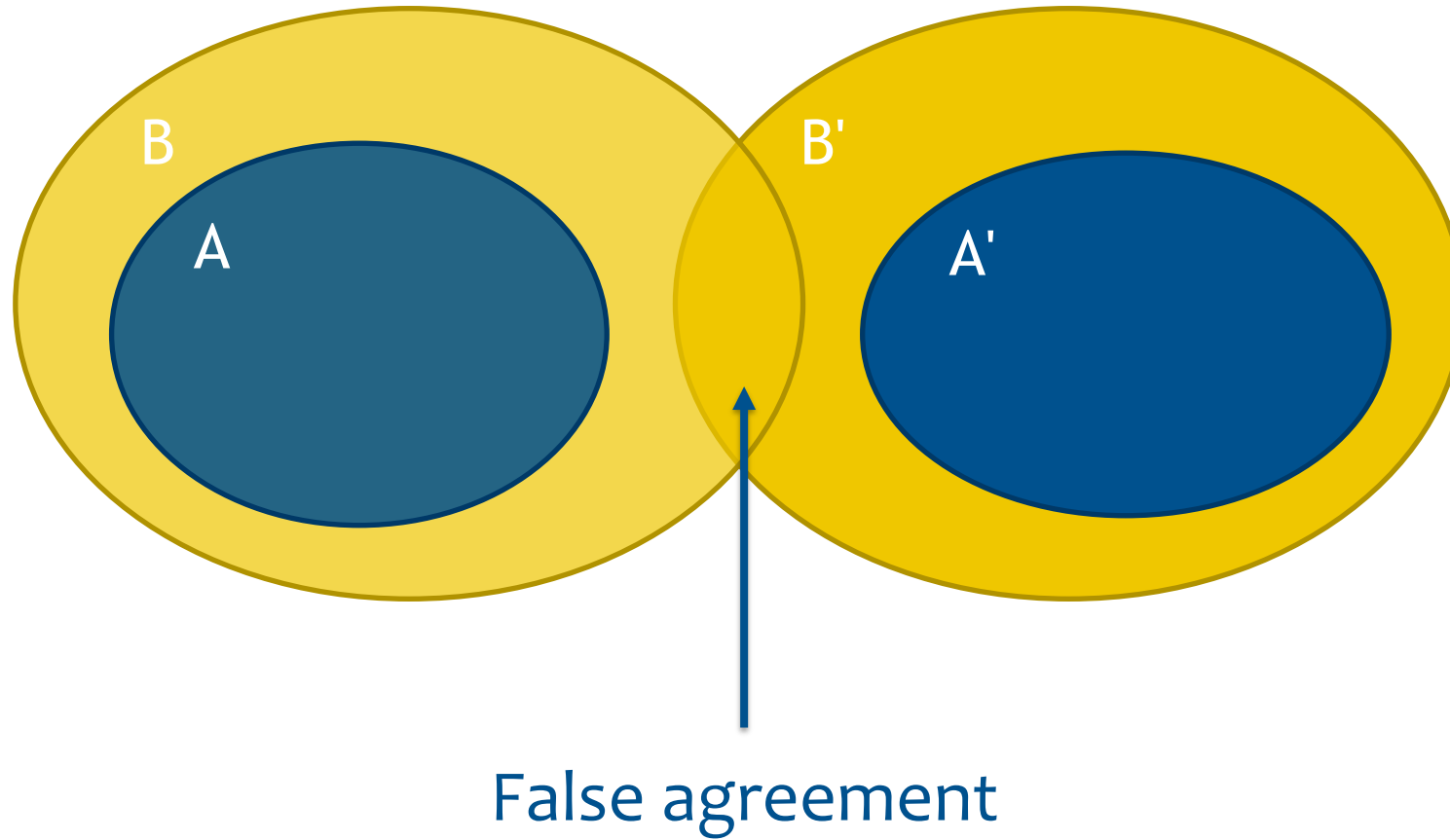
UNDER-CONSTRAINING



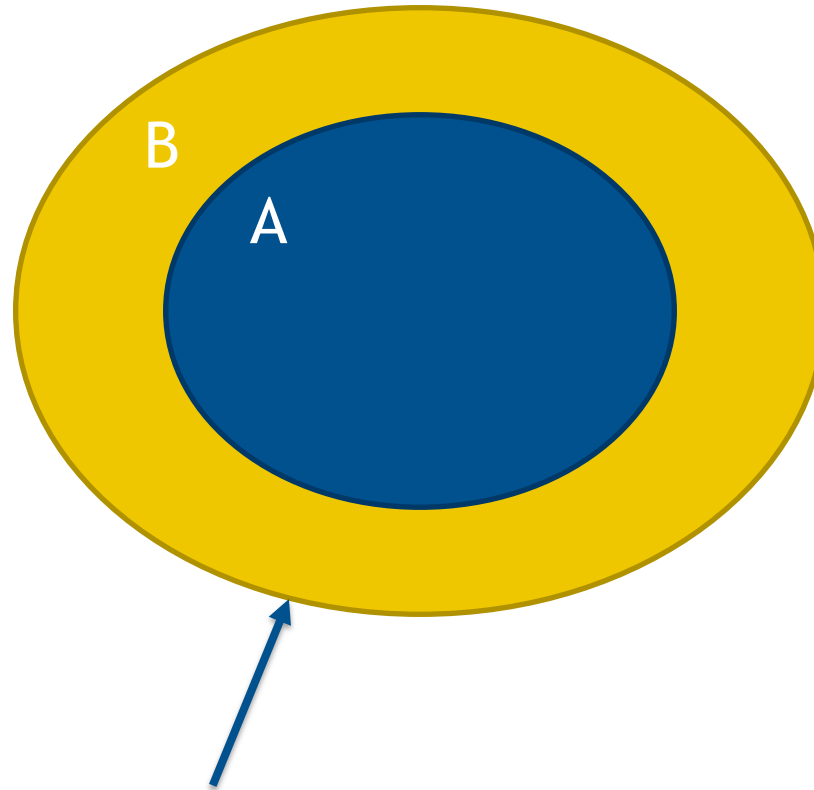
OVER-CONSTRAINING



FALSE AGREEMENT



CONSTRAINTS



Goal: reduce the constraints to
match the conceptualization

TYPES AND INDIVIDUALS

What kind of information the sentences below convey?

“Humans are mammals.”

“Protein is a gene product.”

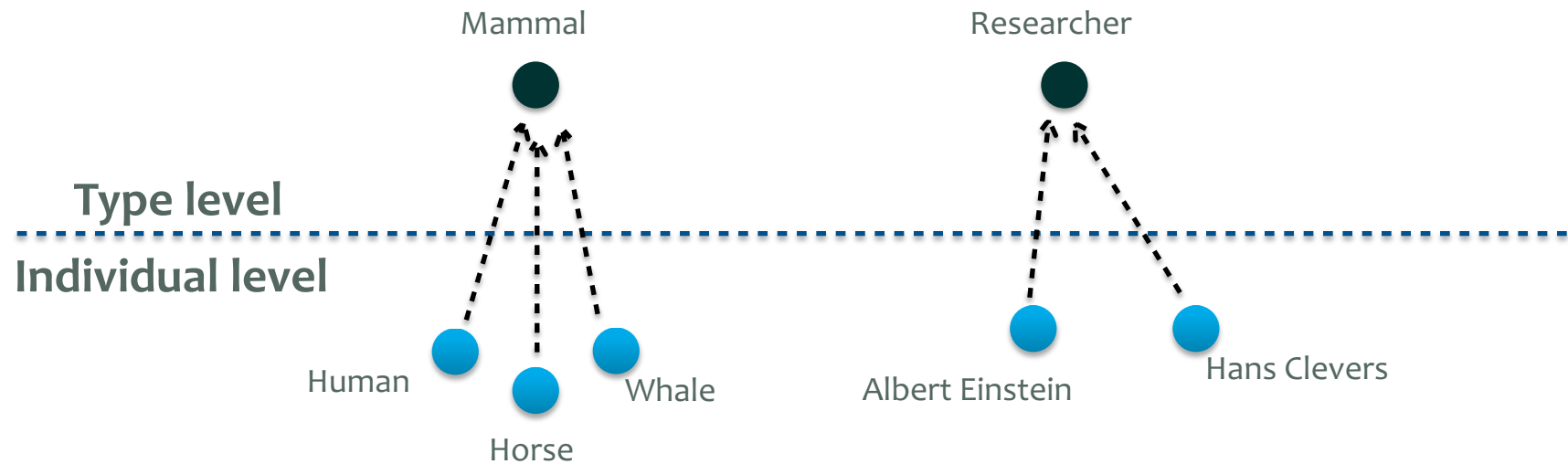
“Albert Einstein was a physicist.”

TYPES AND INDIVIDUALS

- **Fundamental concepts**
- **Type (or class):**
 - Abstraction of reality, type of thing
 - Define common characteristics of a set of things
 - Ex.: mammal, researcher, gene product
- **Individual (or instance):**
 - Particular things
 - Exemplification of a class
 - Ex.: Albert Einstein, protein, human

TYPES AND INDIVIDUALS

- The relation between an individual and its type is *instantiation*.
 - Every individual must be an instance of at least one type
 - A type describes an individual; an individual exemplifies a type



*What are the relations between Person,
Researcher and Physicist?*

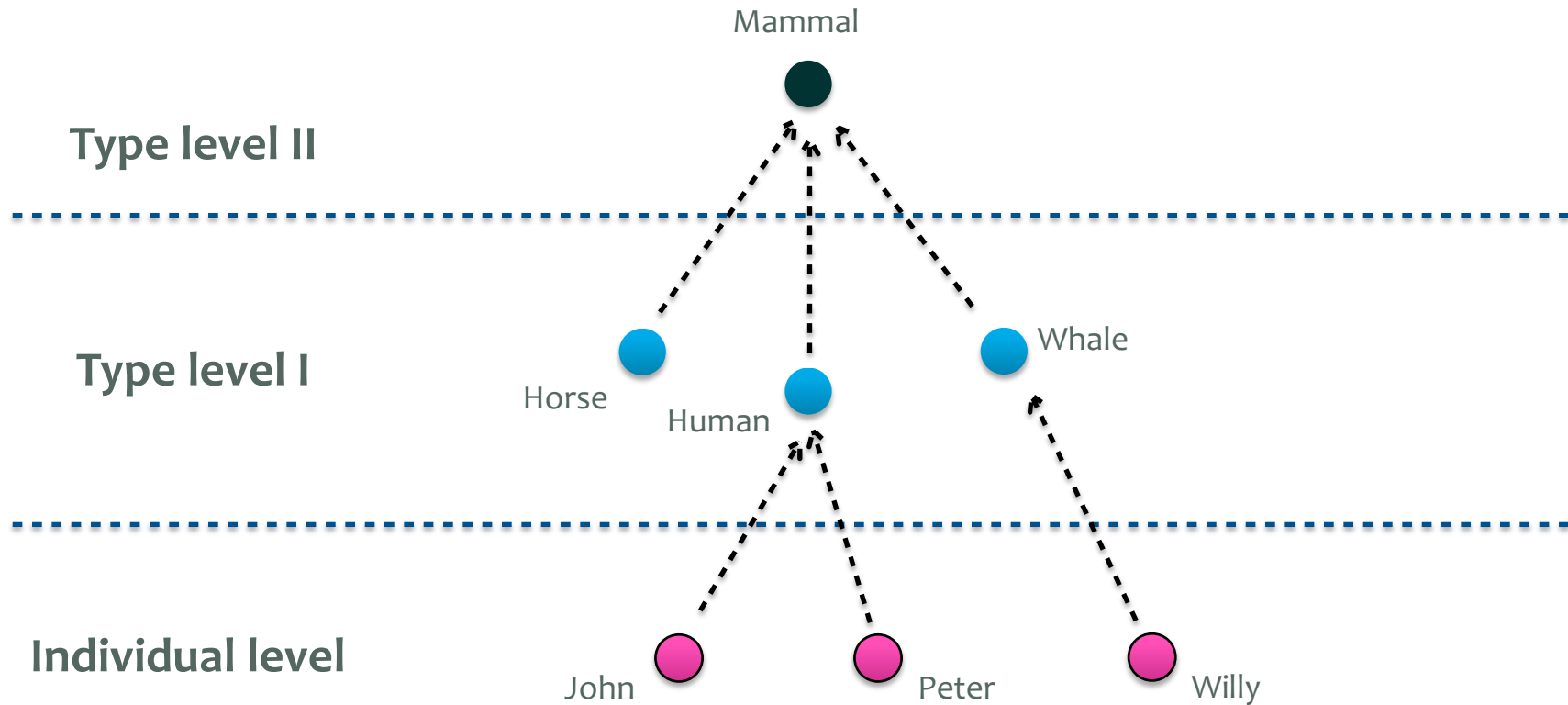
- The relation is *generalization* (or *specialization*).
- *Physicist* is a **subtype** of *Researcher*, which is a **subtype** of *Person*.
- This implies that:
 - Every Physicist is a Researcher.
 - Every Researcher is a Person.
 - There are People that are not Researchers.
 - There are Researcher that are not Physicists.

GENERALISATIONS

- Used to aggregate new characteristics to a subset of the instances of a type.
- The subtypes inherit all characteristics of the super type.
- Example:
 - **Every Person has a name.**
 - **Every Researcher studies in at least a knowledge field.**
 - **Physicists study physics.**

TYPES OF TYPES

- Some types have as instances other types.
- The idea is similar to UML PowerType



Categoris of object types

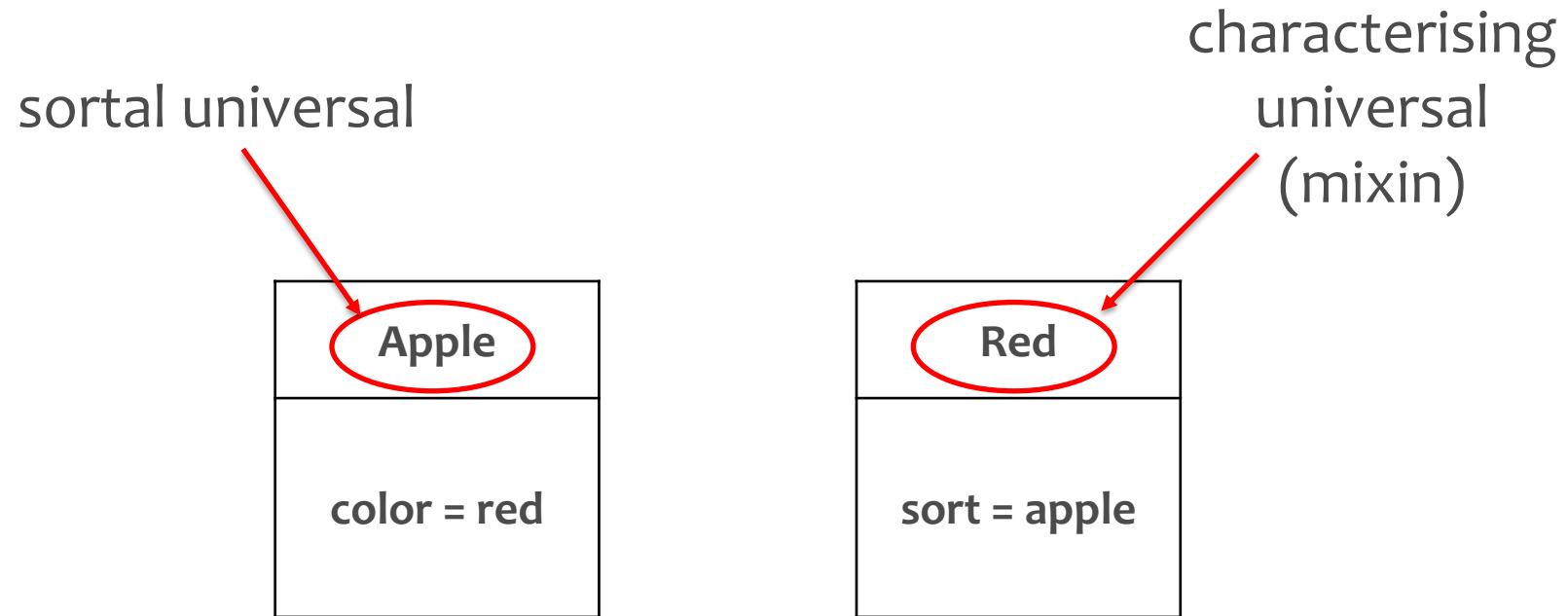
$$\exists x \textit{Apple}(x) \wedge \textit{Red}(x)$$

THE EPISTEMOLOGICAL LEVEL

Apple
color = red

Red
sort = apple

THE ONTOLOGICAL LEVEL

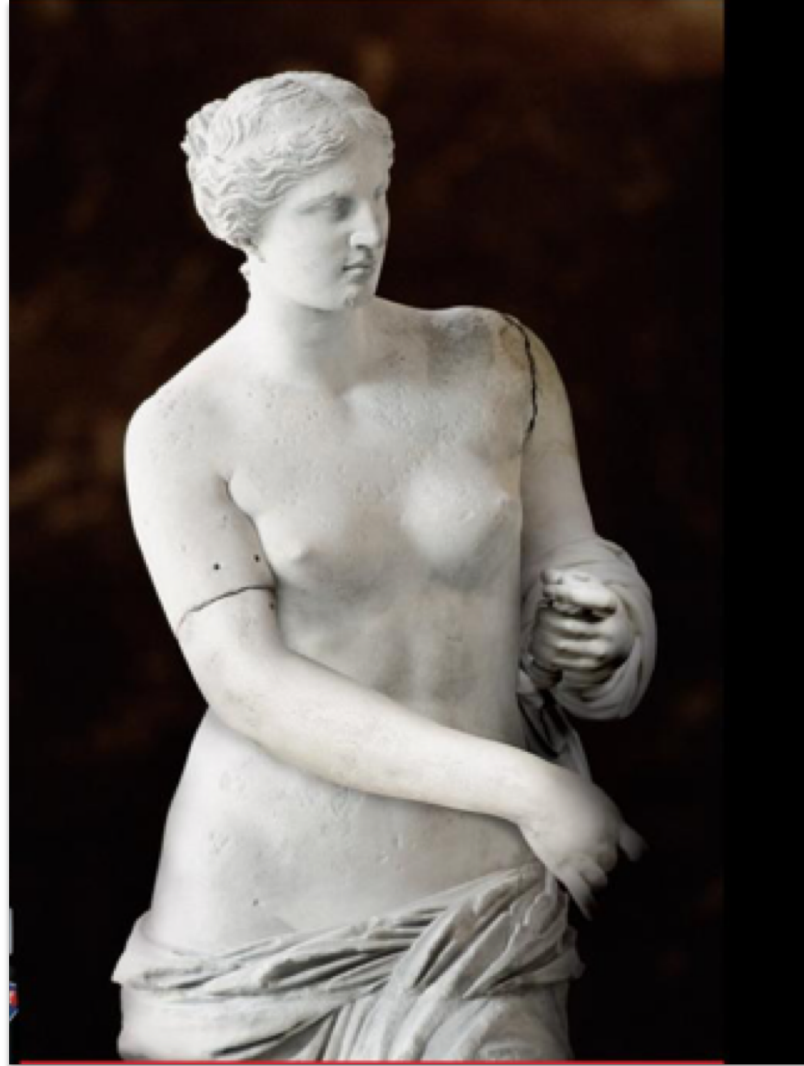


- We can only make identity and identification statements with the support of a Sortal, i.e., the identity of an individual can only be traced in connection with a Sortal type, which provides a principle of individuation and identity to the particulars it collects.

Every Object in a conceptual model (CM) of the domain must be an instance of a class representing a sortal type

Ontological Principle of identity

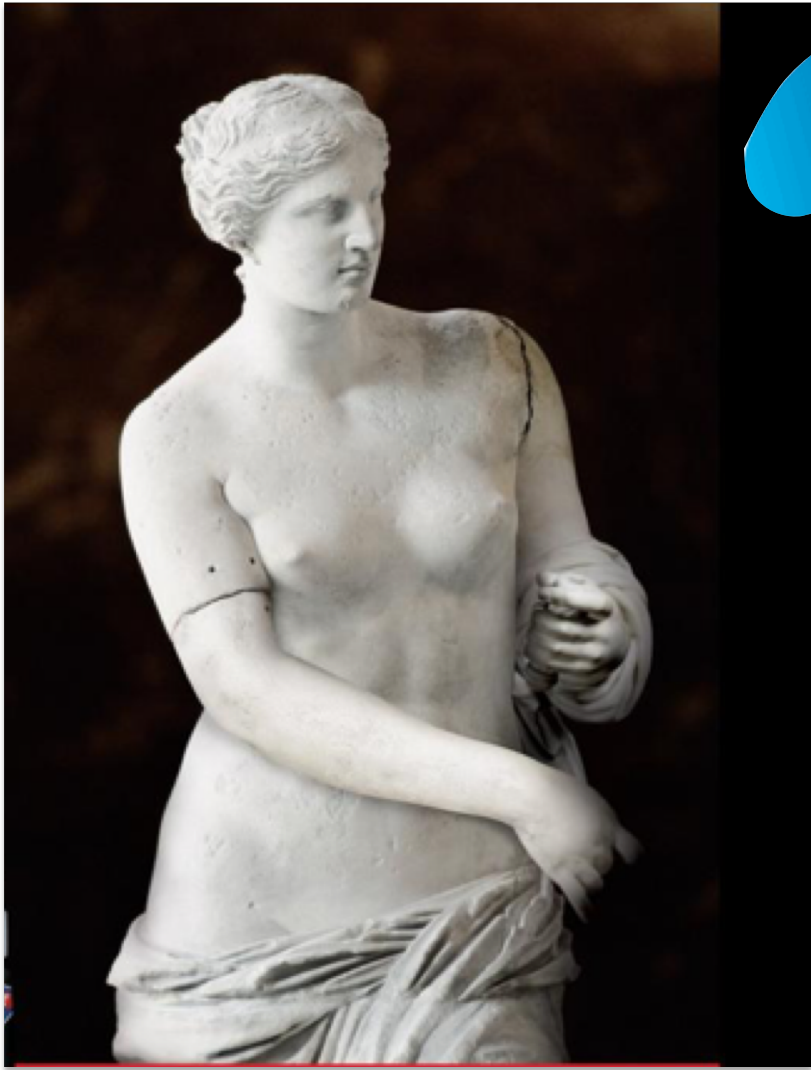
PRINCIPLE OF IDENTITY



PRINCIPLE OF IDENTITY



PRINCIPLE OF IDENTITY



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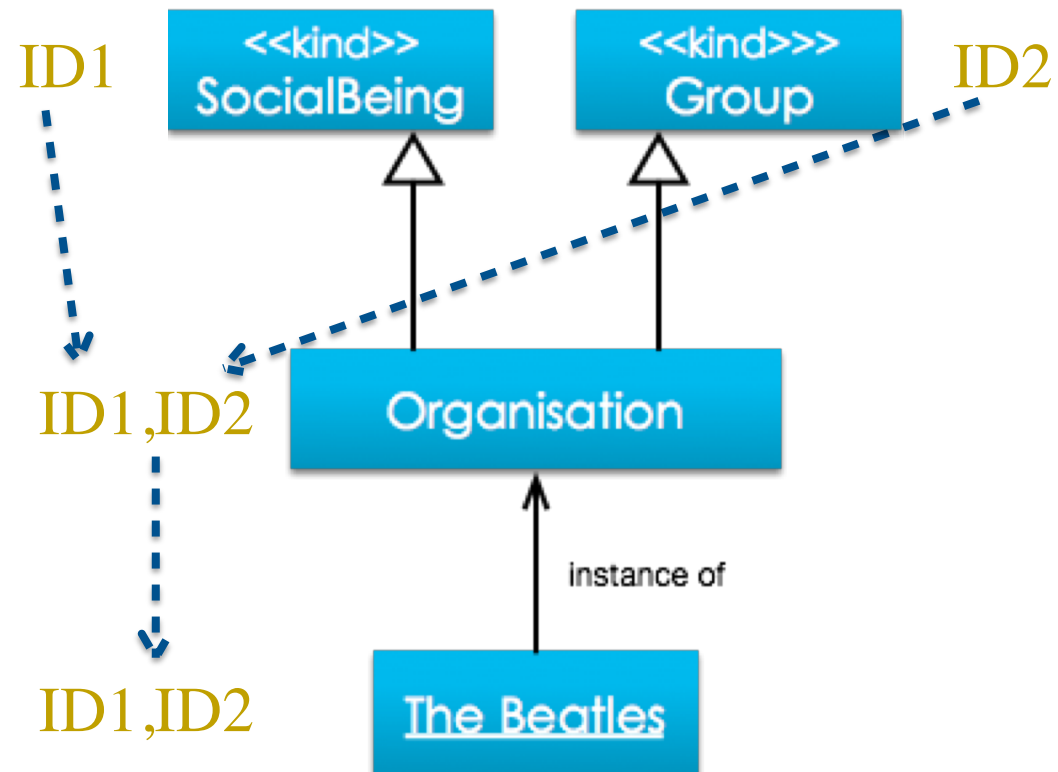


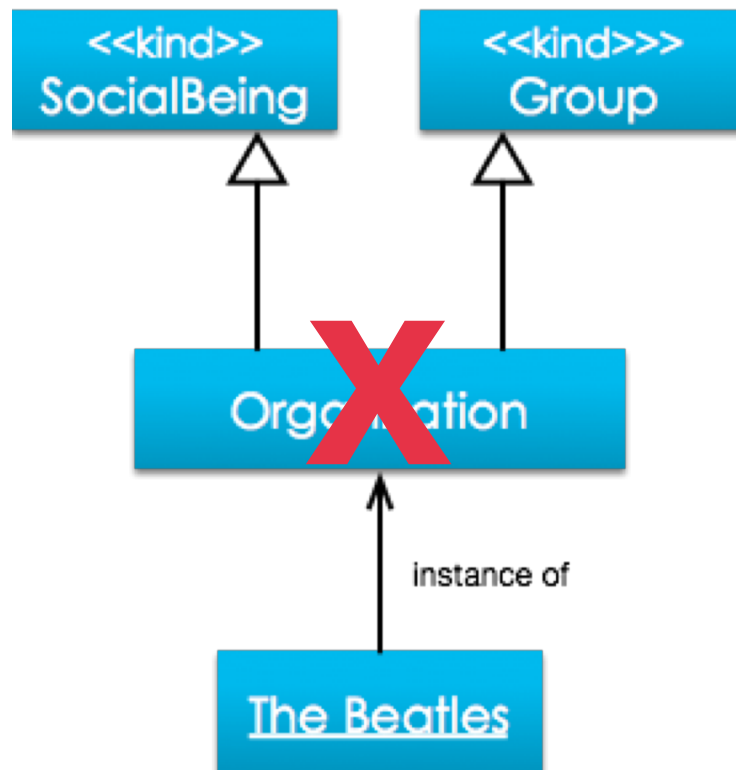
PRINCIPLE OF IDENTITY

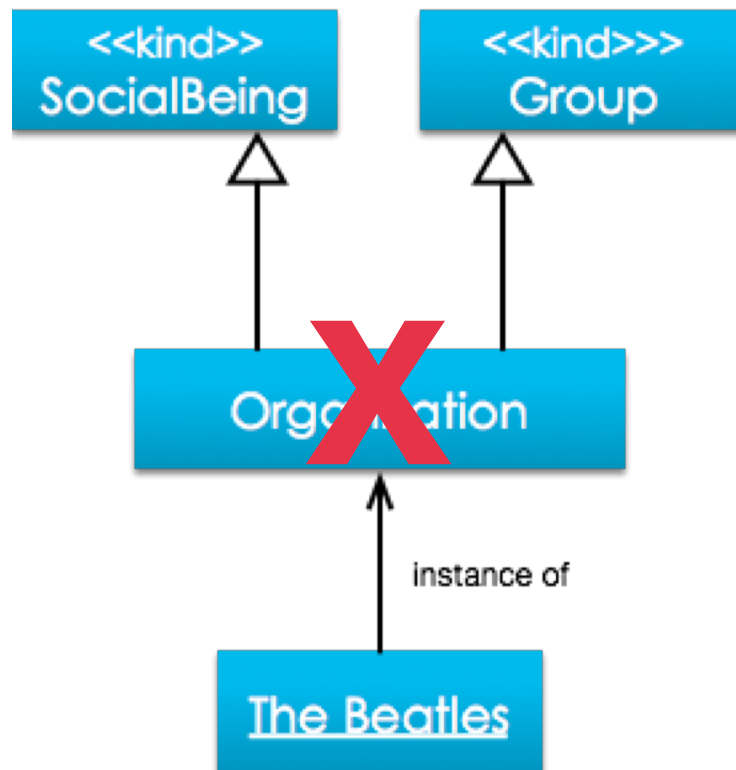
- A principle of identity support the judgment of whether two particulars are the same.
- Every object in a conceptual model of the domain must be an instance of a class representing a sortal type.
- "No entity without identity" (Quine, 1969)
- An individual cannot obey incompatible principles of identity. Some types determine the principle of identity, others do not.

- Since the unique principle of identity supplied by a Kind is inherited by its subclasses, we have that:
 - An Object in a conceptual model of the domain cannot instantiate more than one ultimate *Kind*

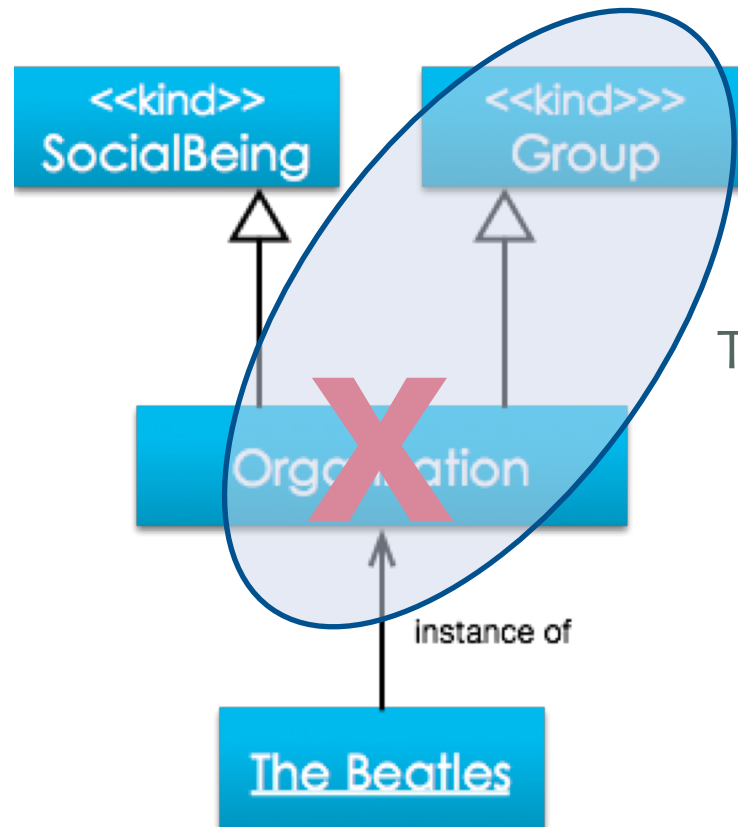






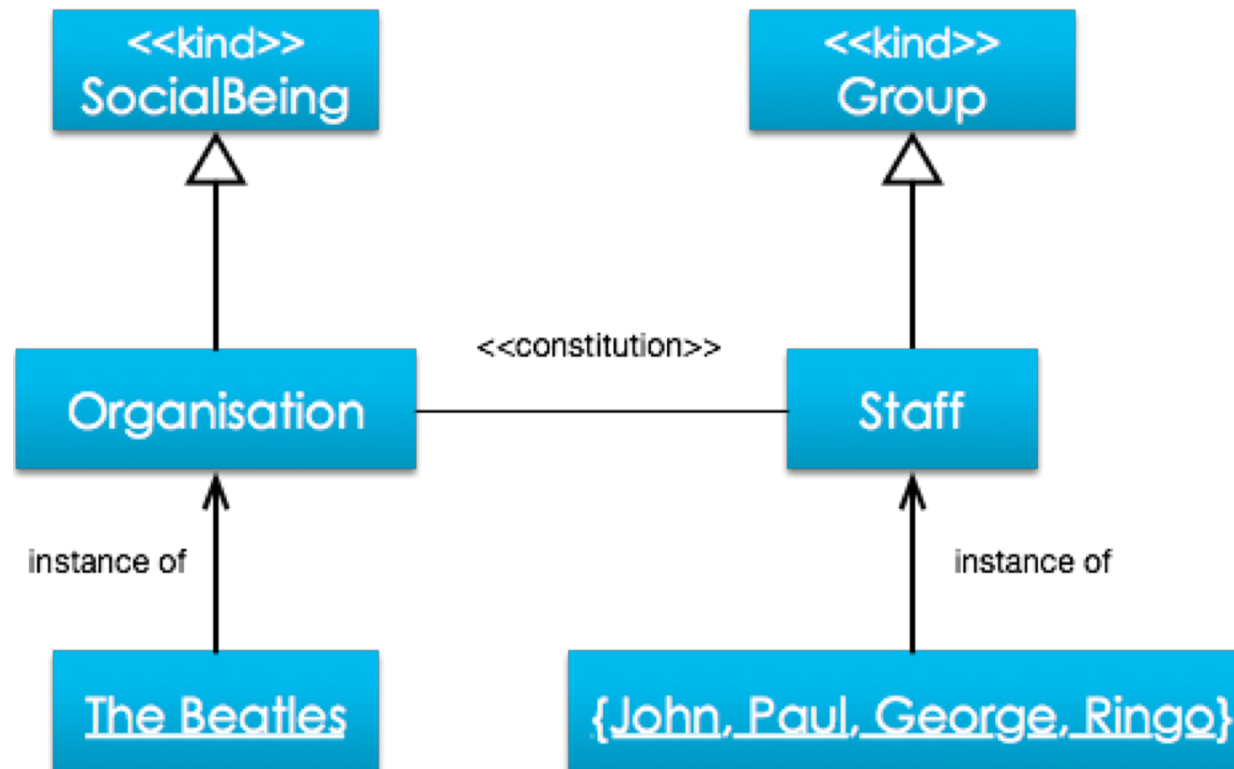


Model extracted from CyC!



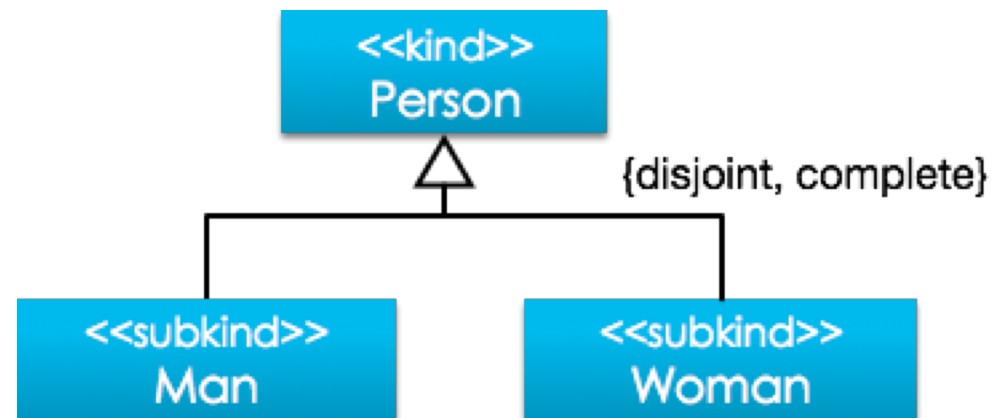
This fragment also
present in FOAF

Model extracted from CyC!



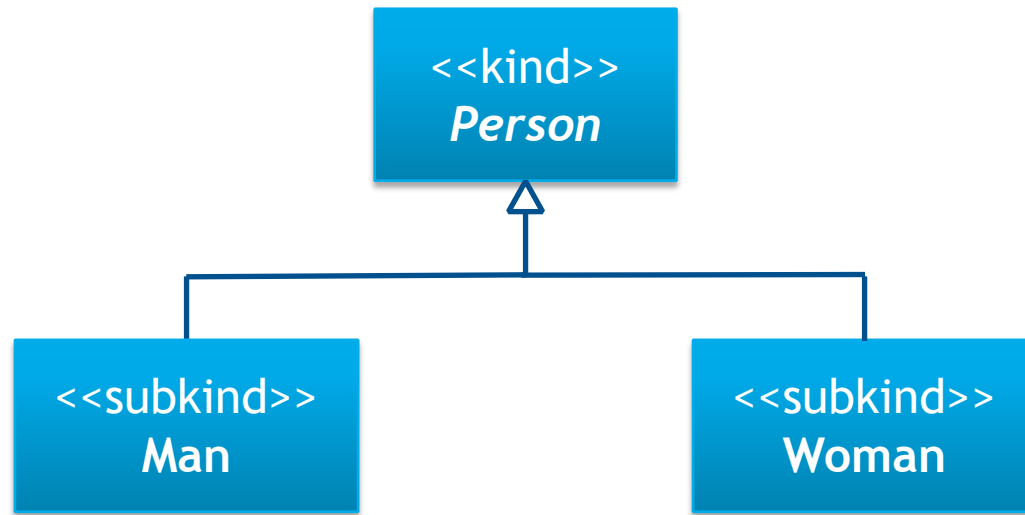
SUBKIND PARTITIONS

- It is typical that subkinds are defined in structures called Subkind Partitions
- These are not always partitions in the strong sense, i.e., they are defined as disjoint but rarely complete generalisation sets



GENERALISATION SETS

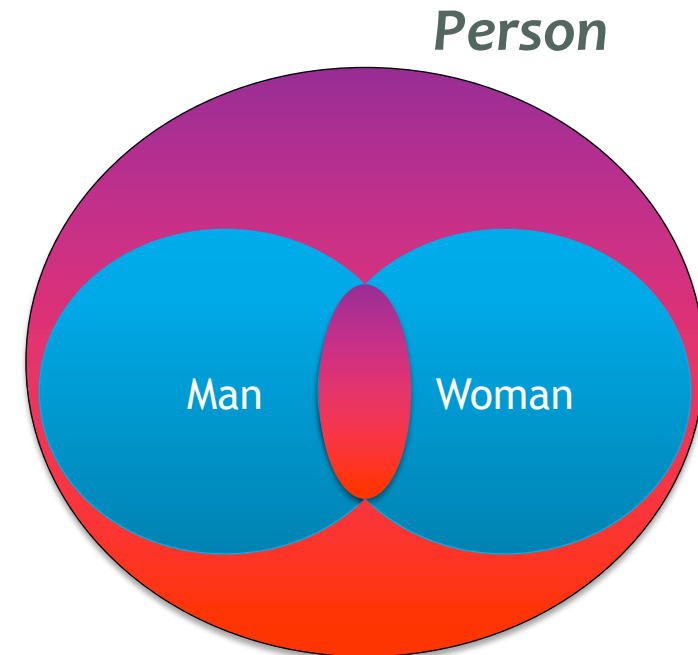
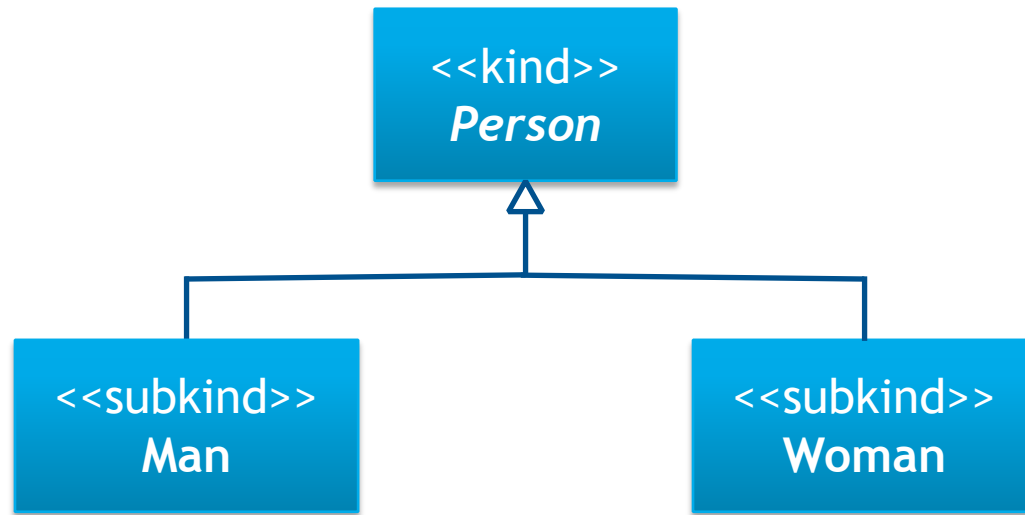
- Meta-properties
 - isDisjoint (*disjoint*): **false**
 - isComplete (*complete*): **false**



GENERALISATION SETS

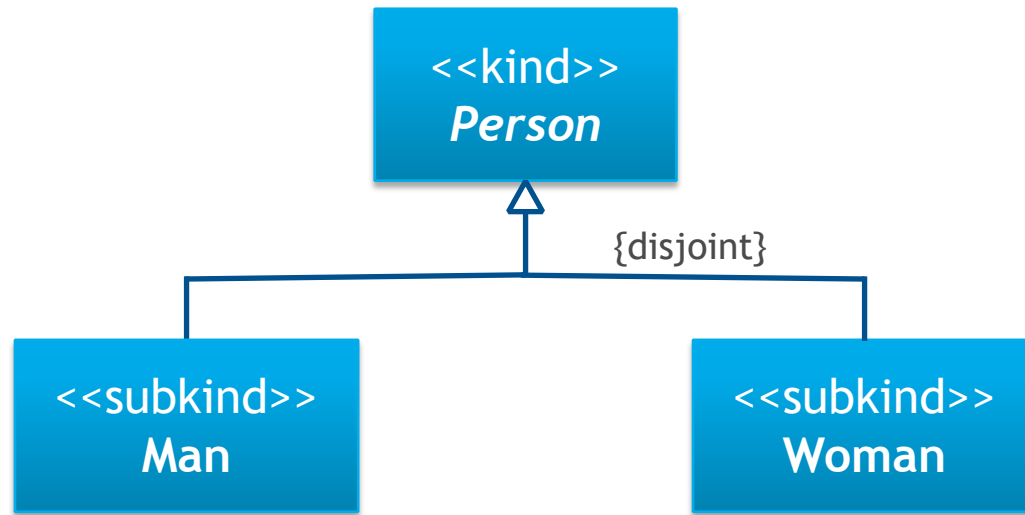
- Meta-properties

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- isComplete (*complete*): **false**



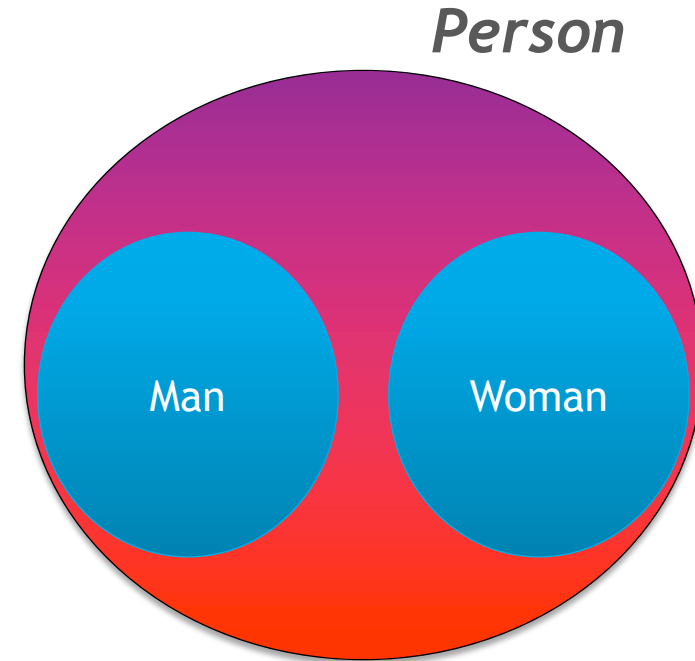
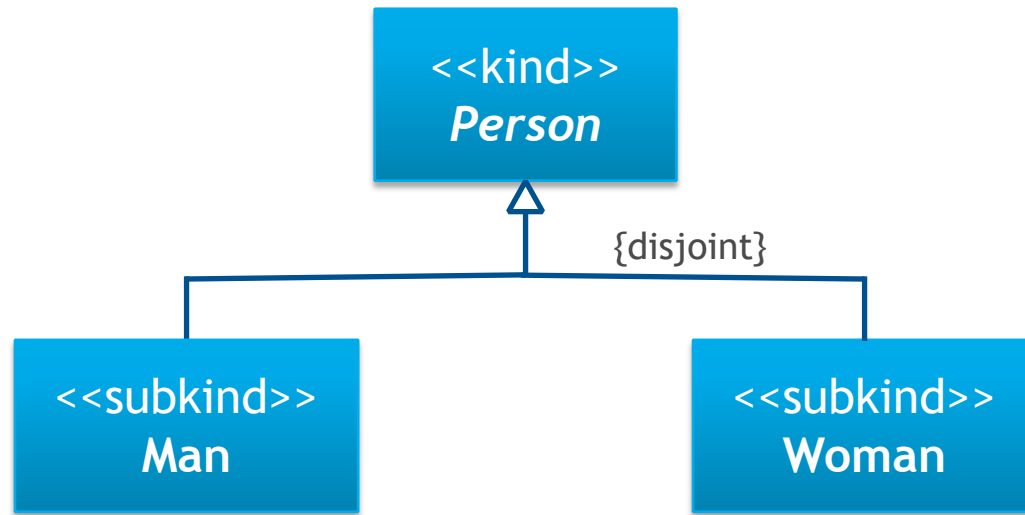
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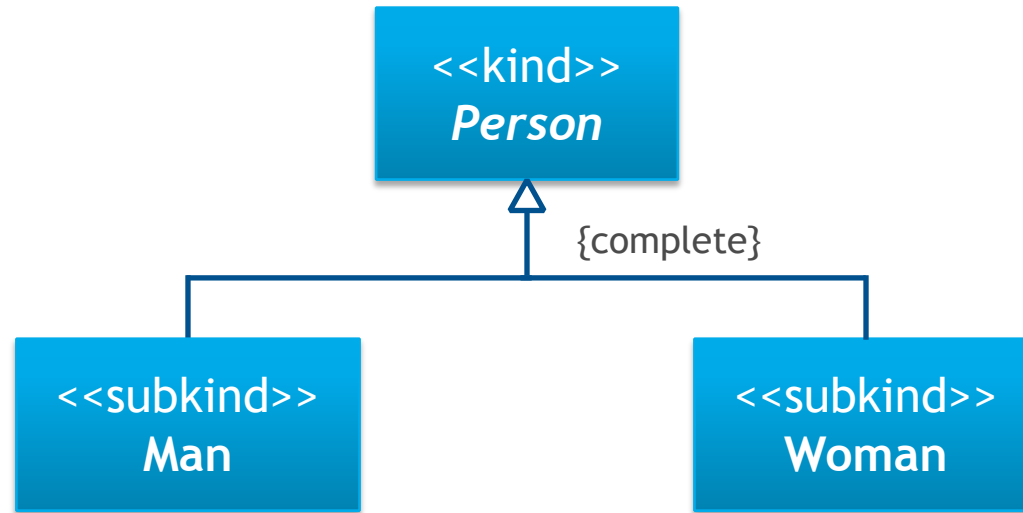
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GENERALISATION SETS

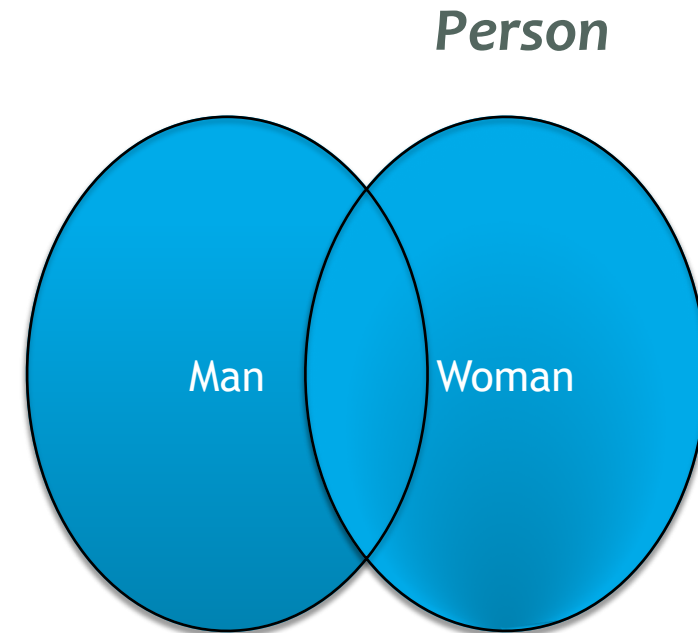
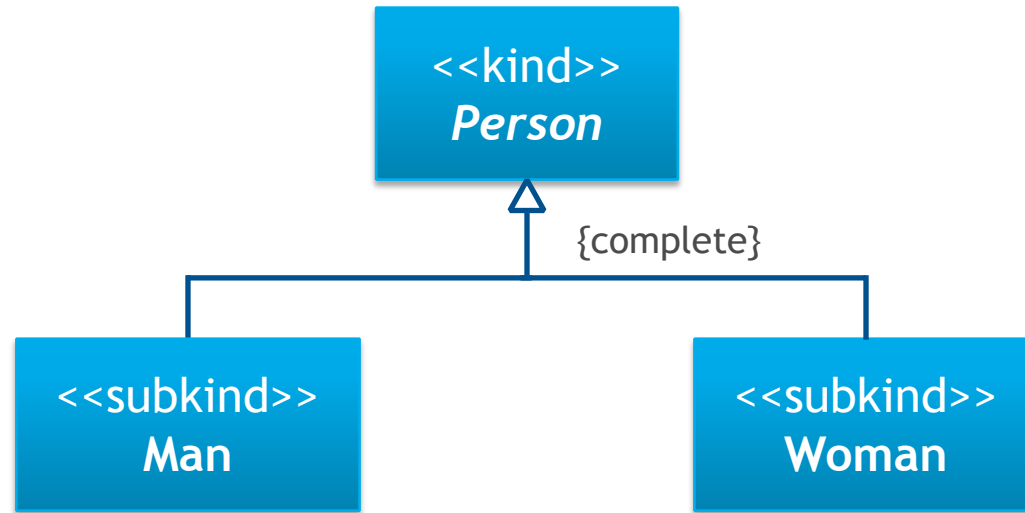
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GENERALISATION SETS

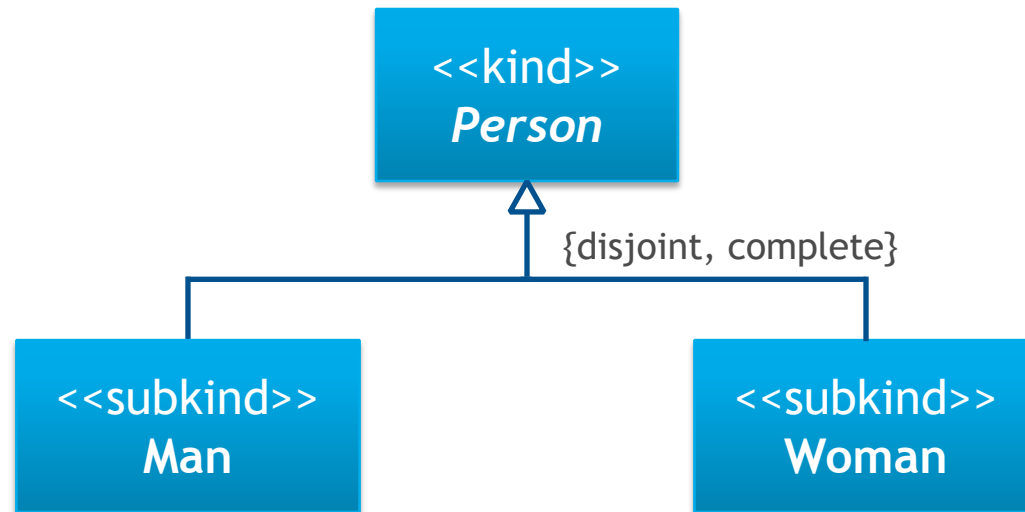
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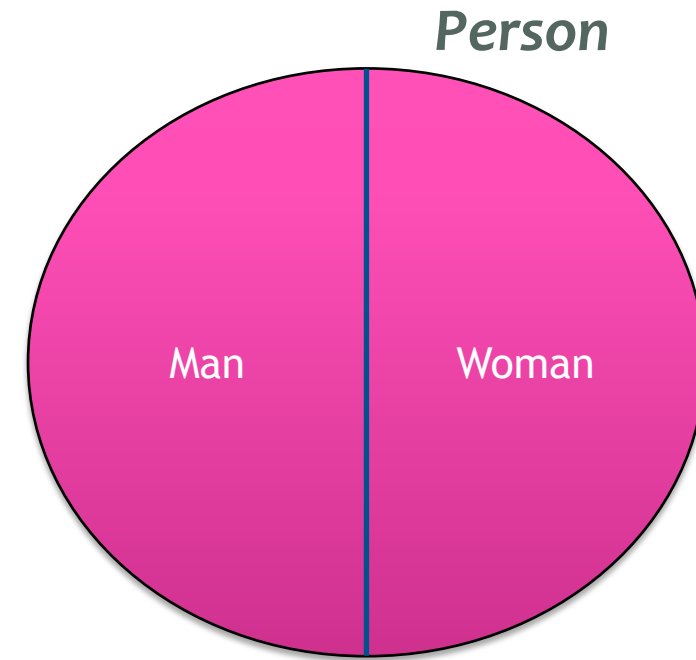
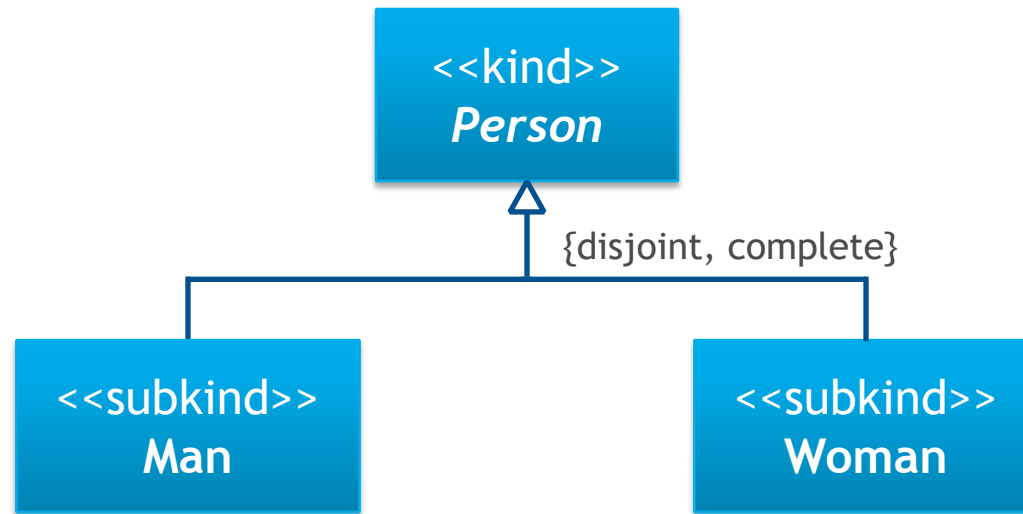
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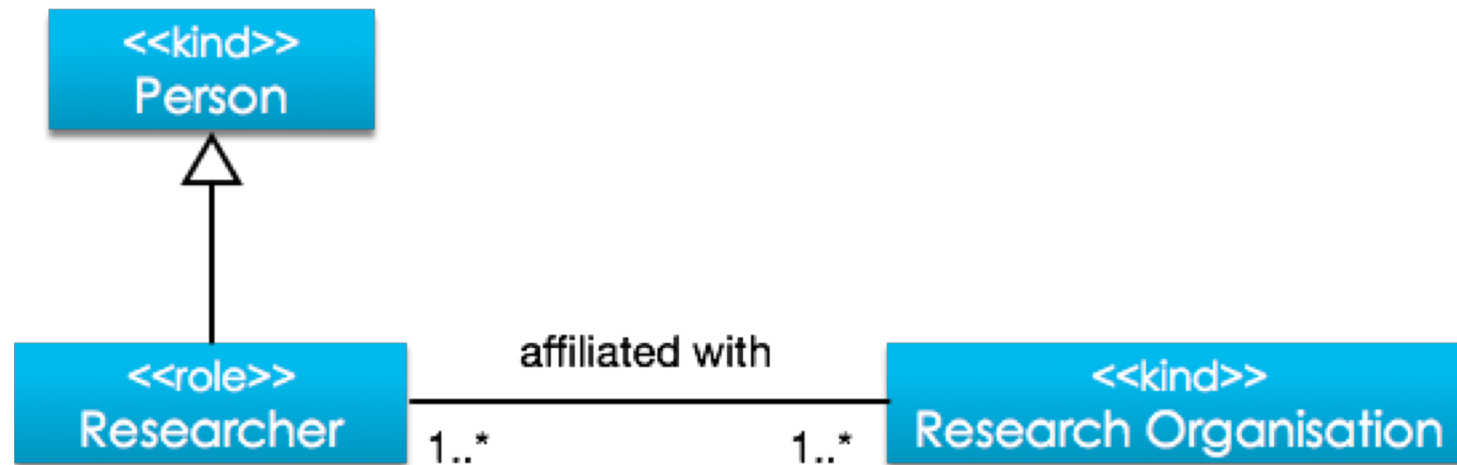
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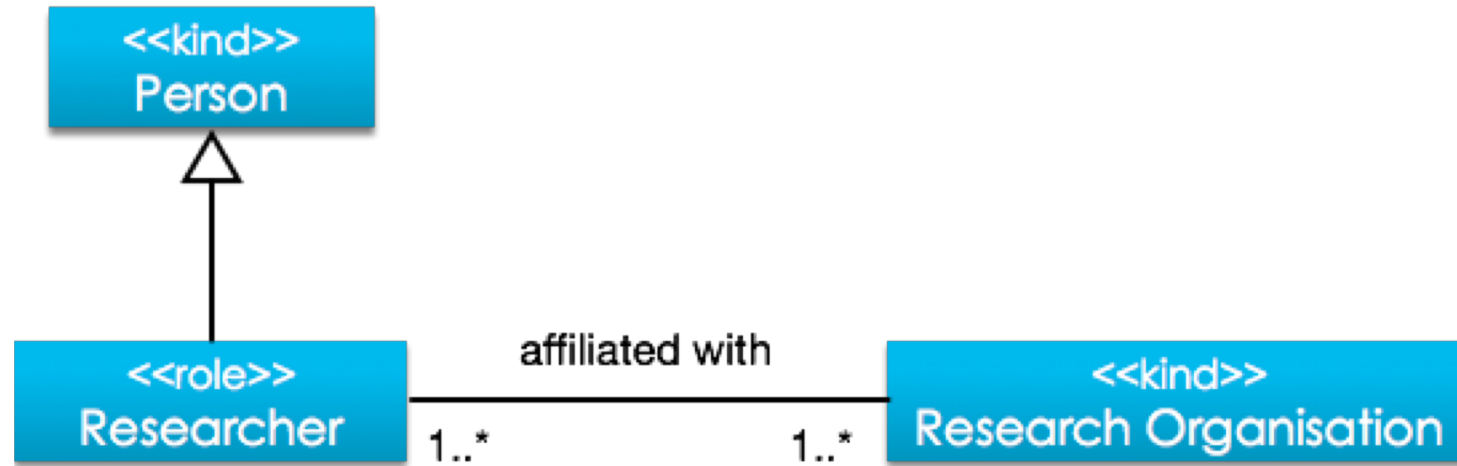


ROLES

- Defined as a (anti-rigid) specialisation of a kind such that the specialisation condition is a relational one (correlated with derivation by participation)

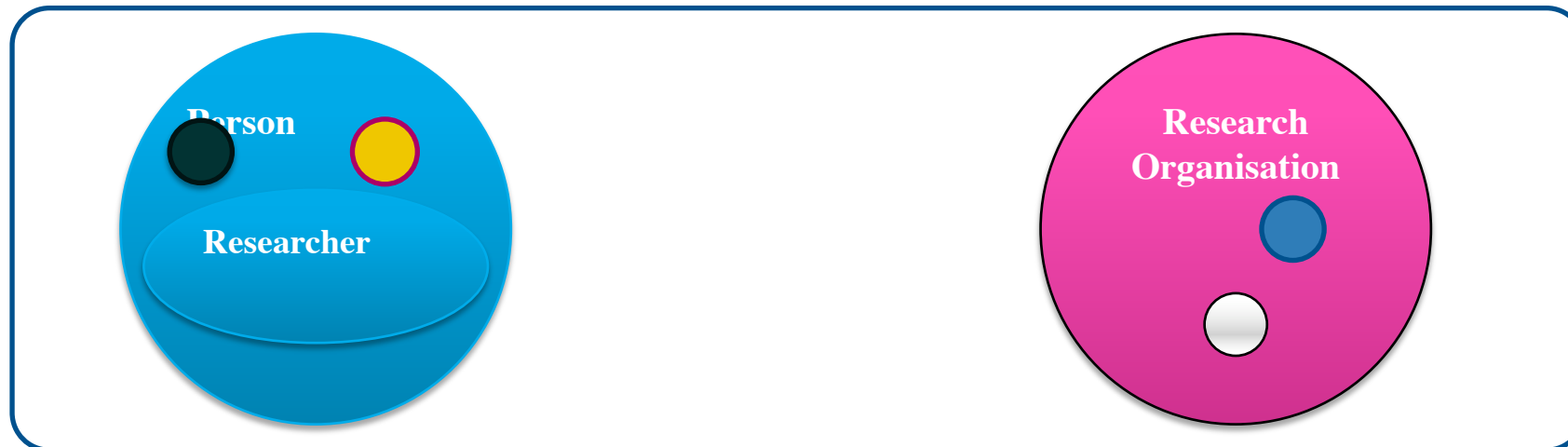
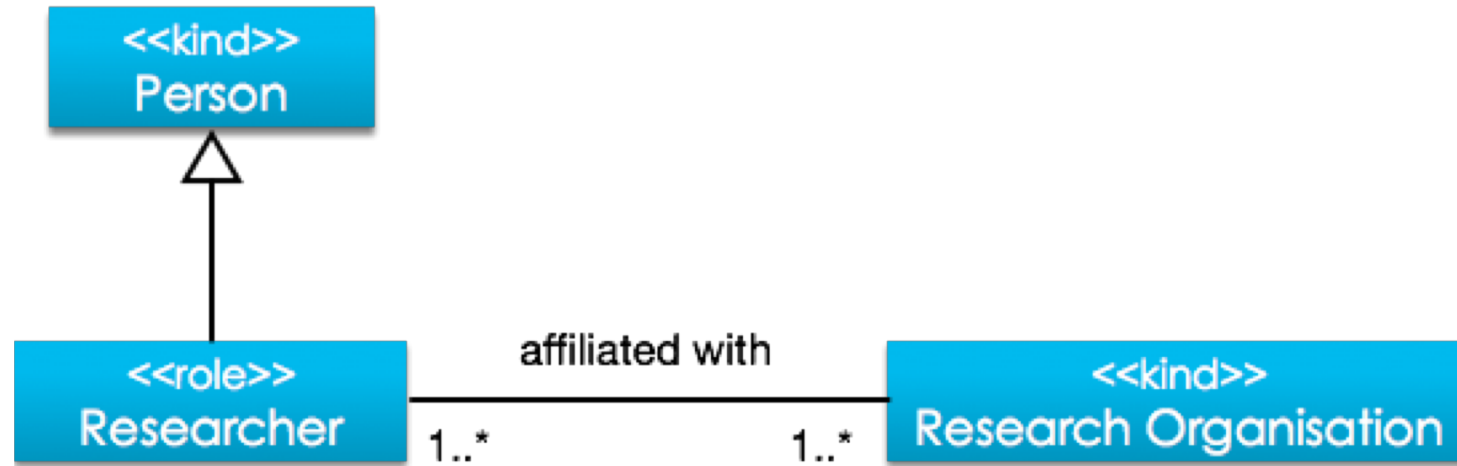


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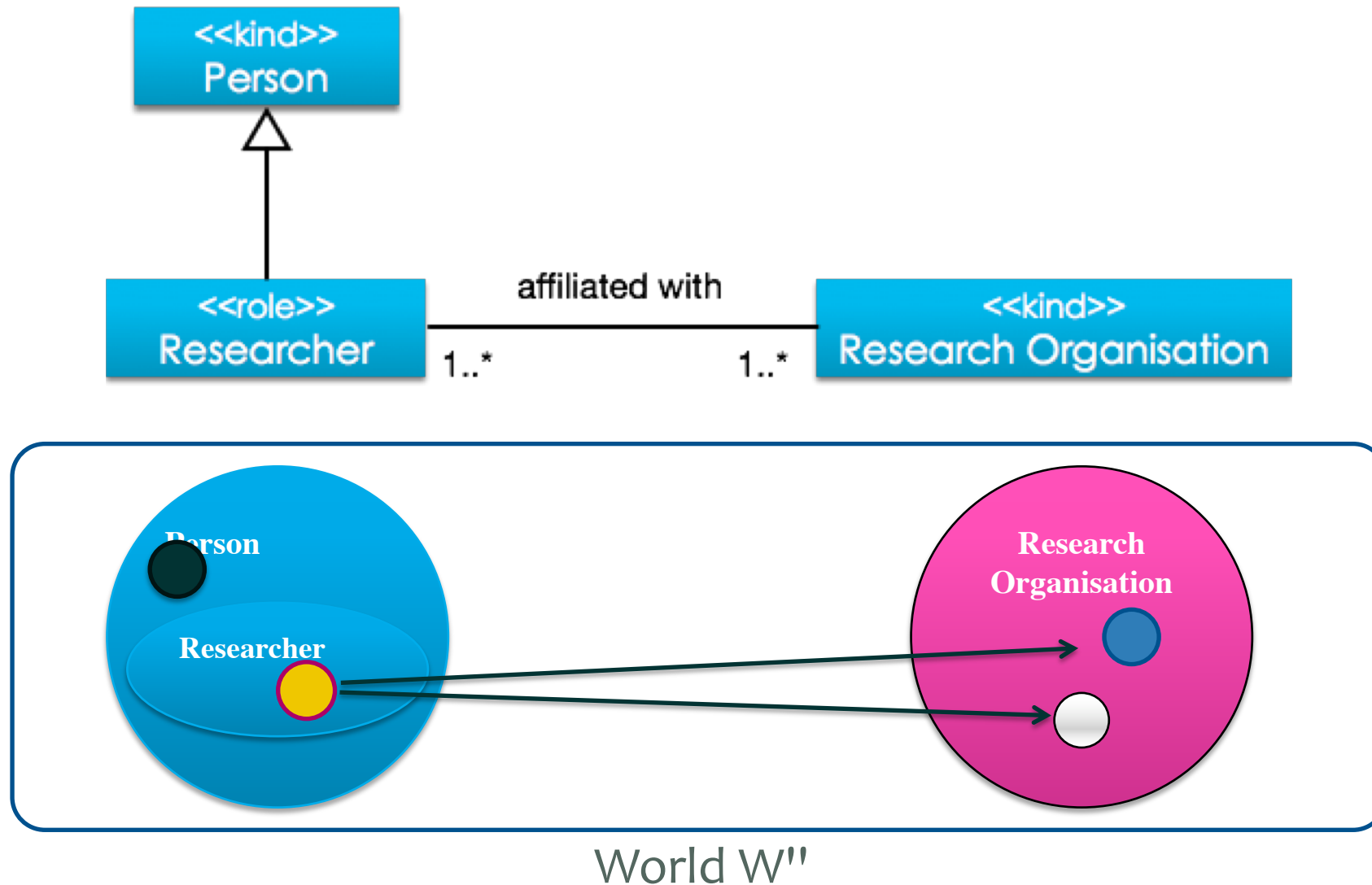
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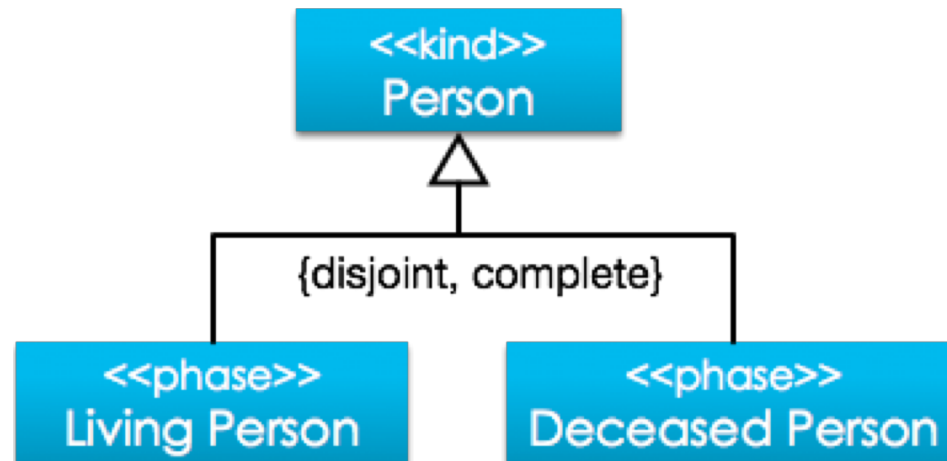
ROLES



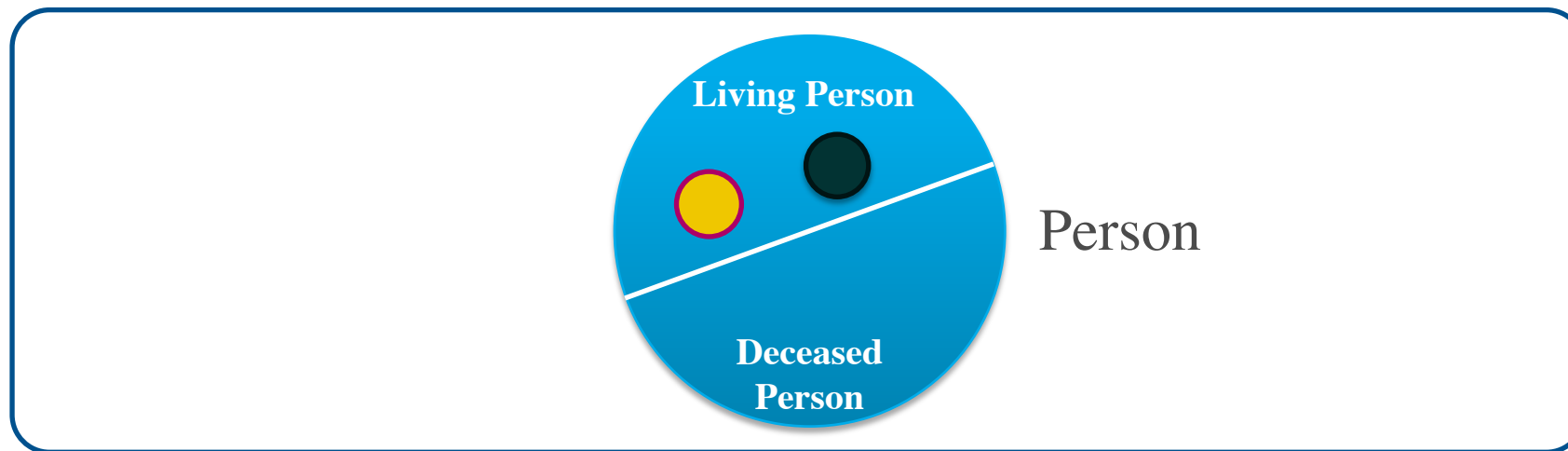
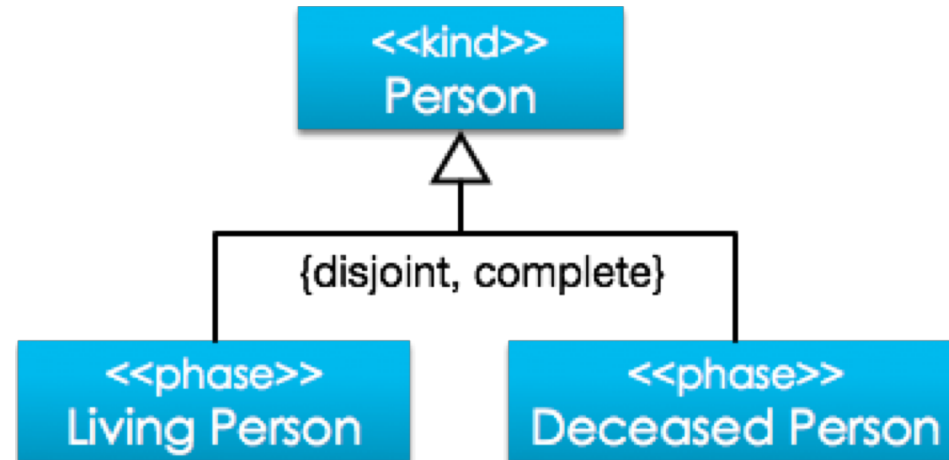
Source: Giancarlo Guizzardi

PHASES

- Defined as a (anti-rigid) specialisation of a kind such that the specialisation condition is an intrinsic one
- Phases are **always** defined in a so-called **Phase Partition**
- Phase Partitions are partitions in strong sense, i.e., they are disjoint and complete generalization sets

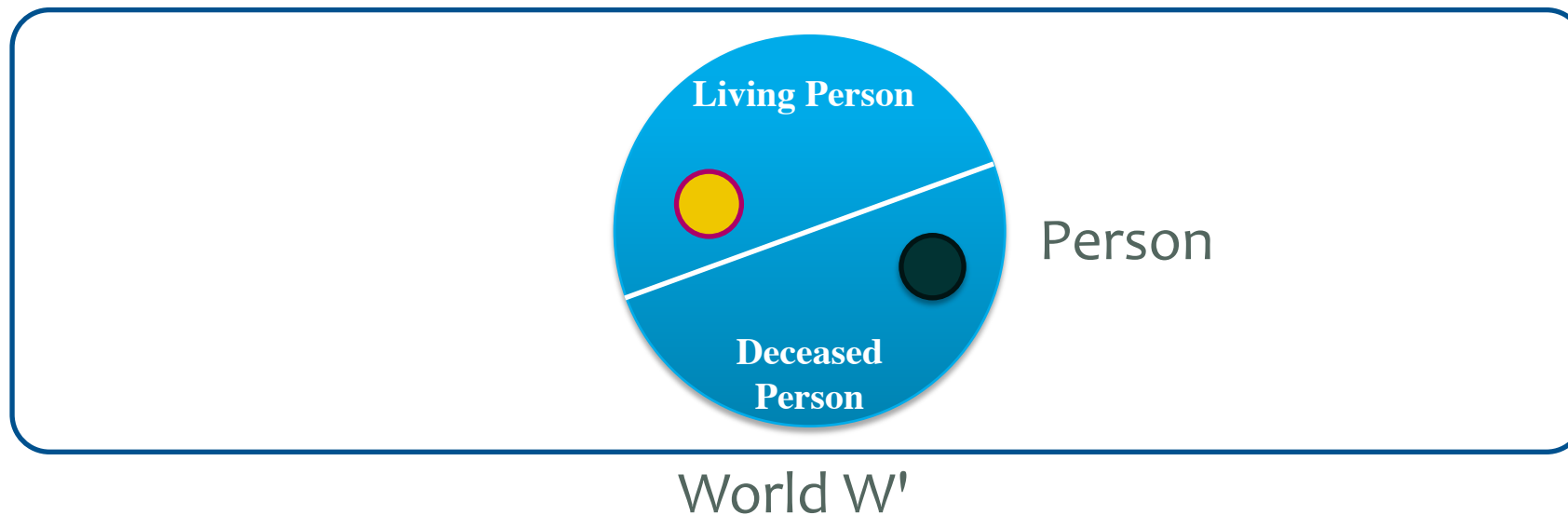
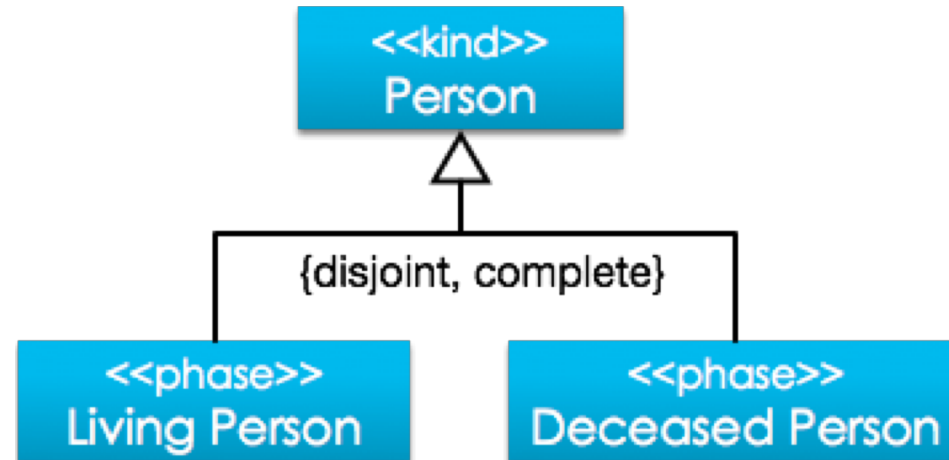


PHASES



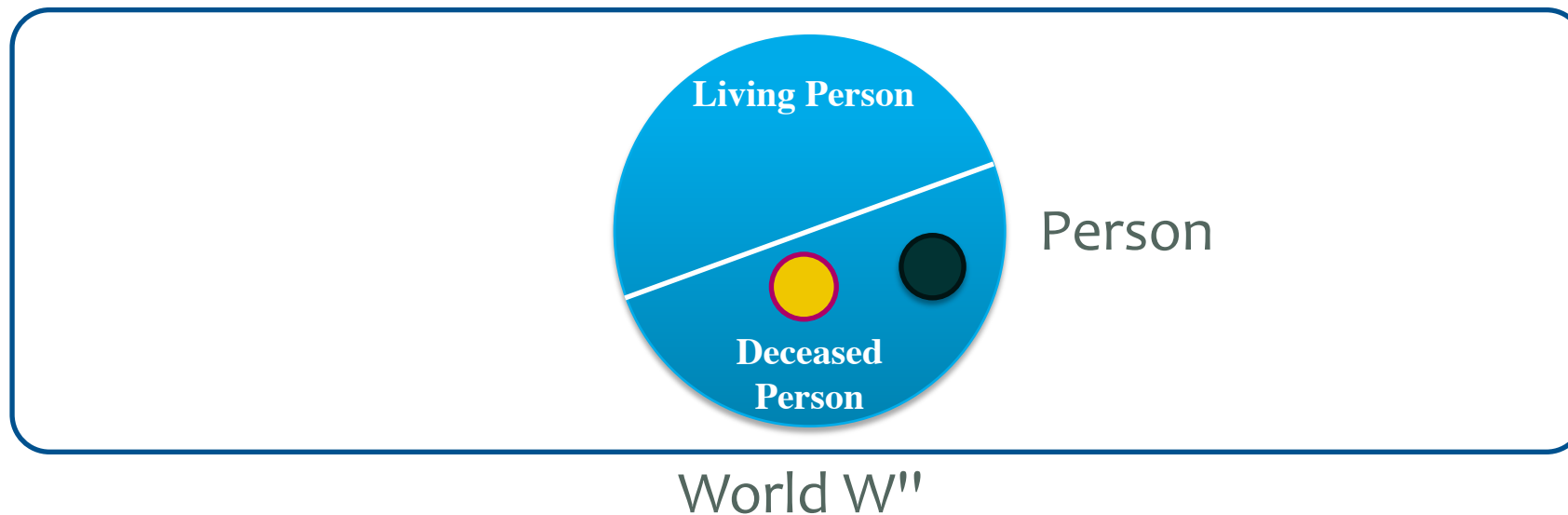
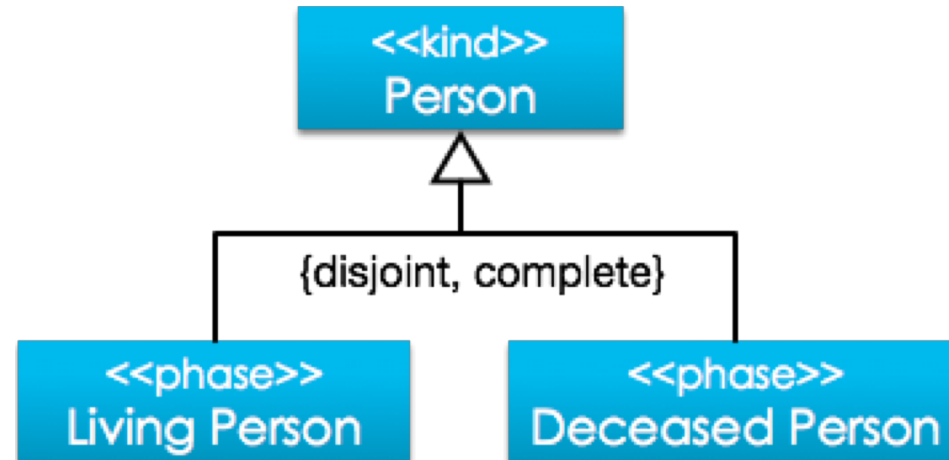
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PHASES

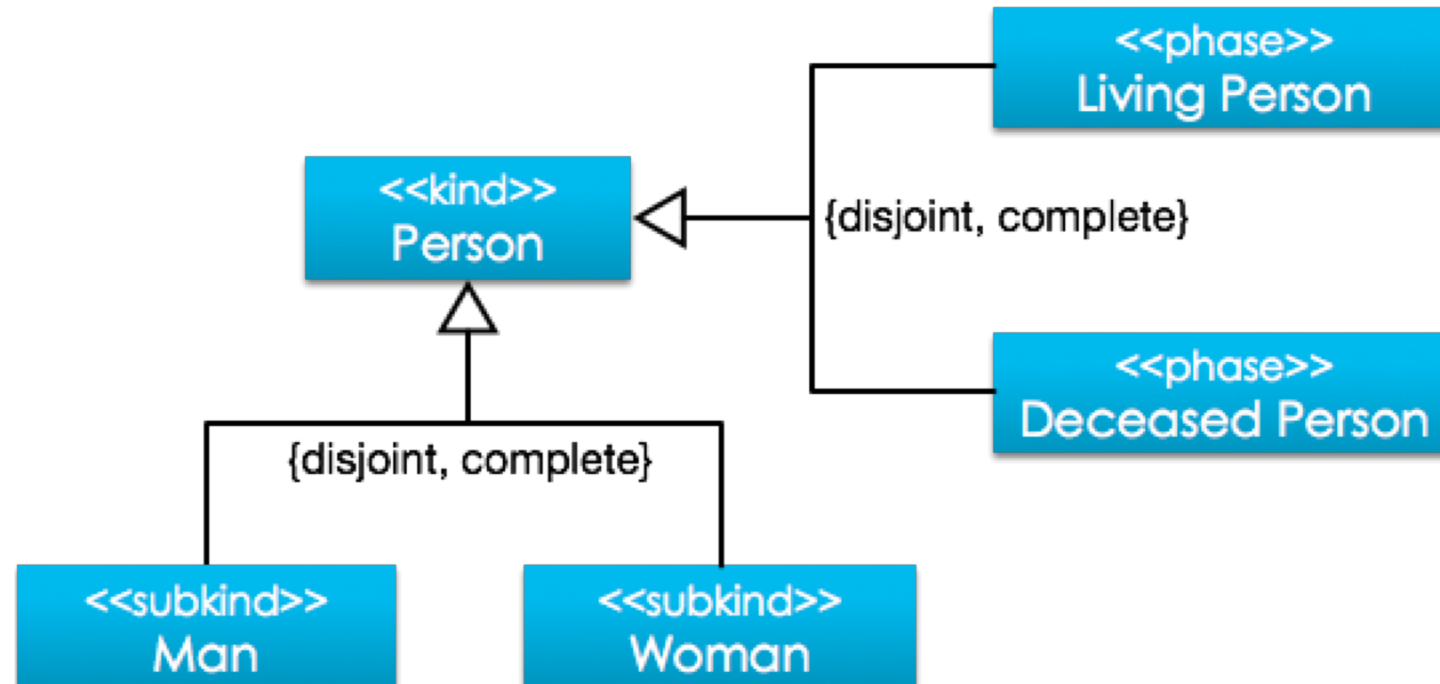


Source: Giancarlo Guizzardi

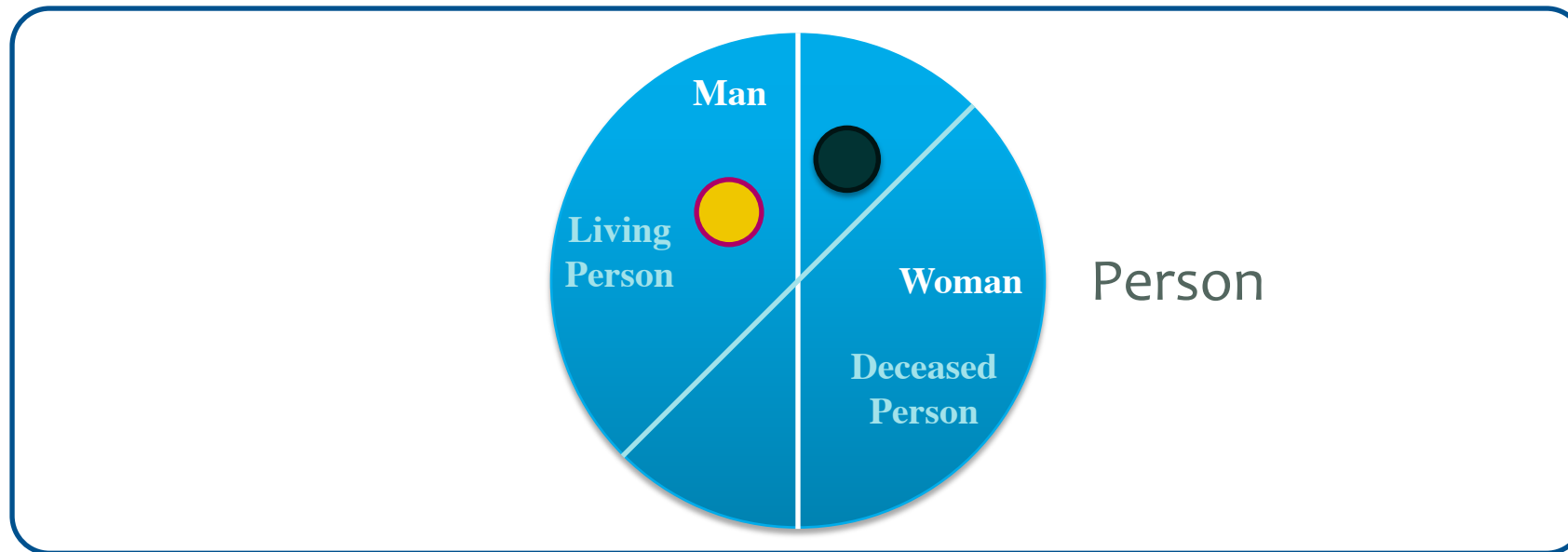
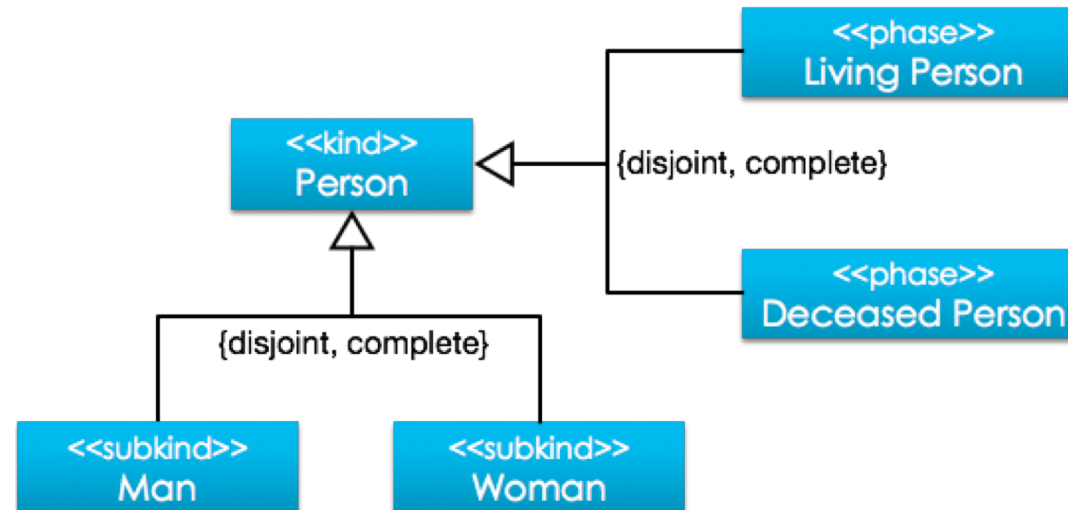
PHASES



PHASES

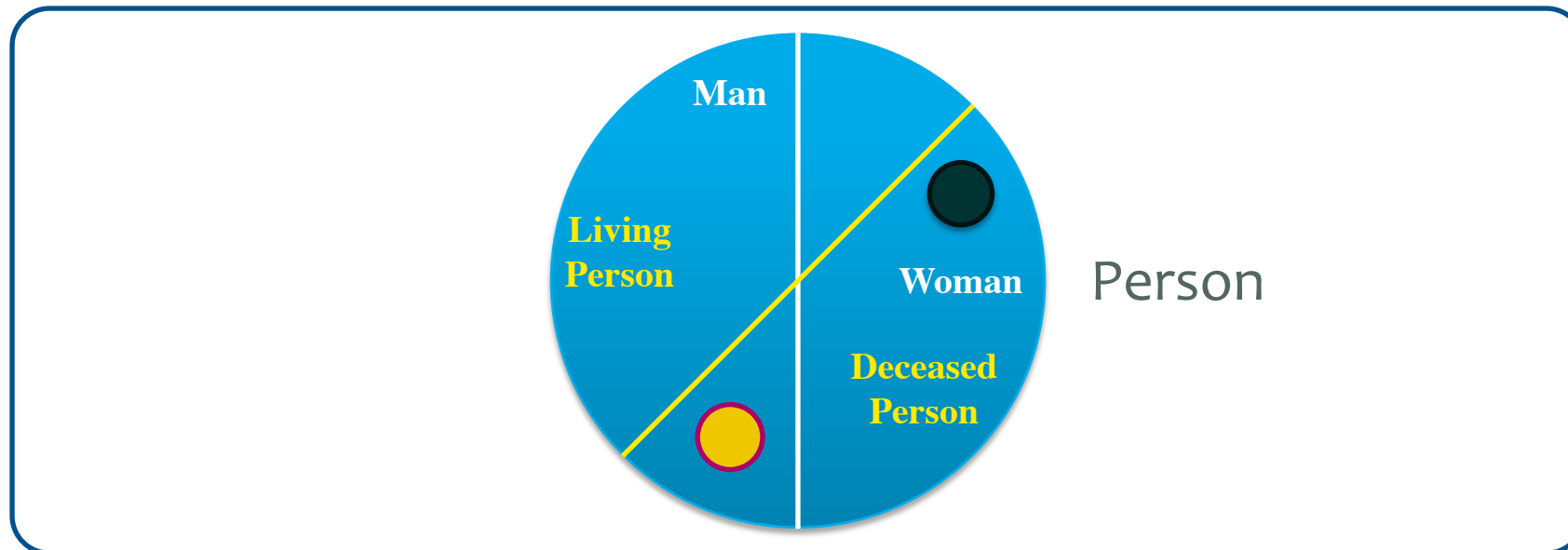
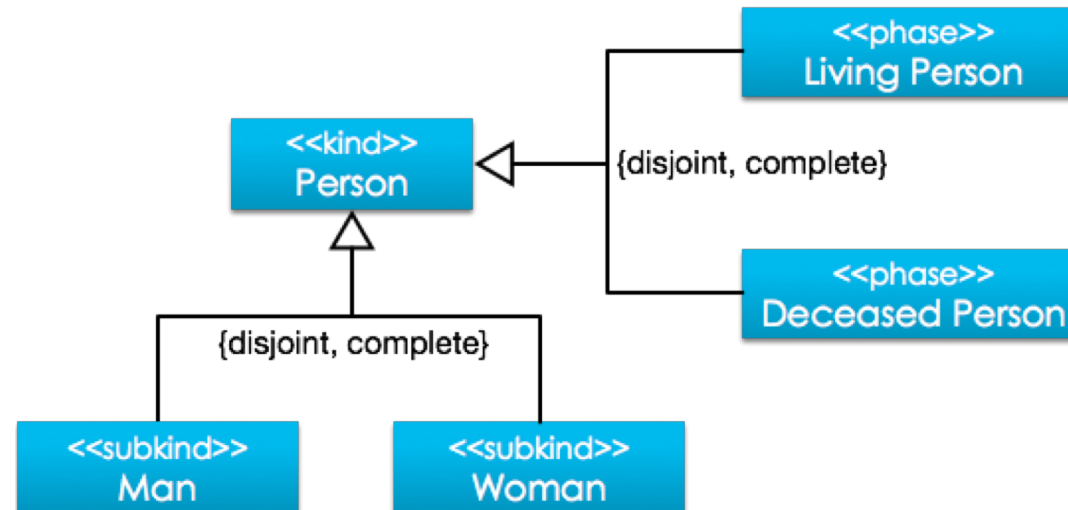


PHASES



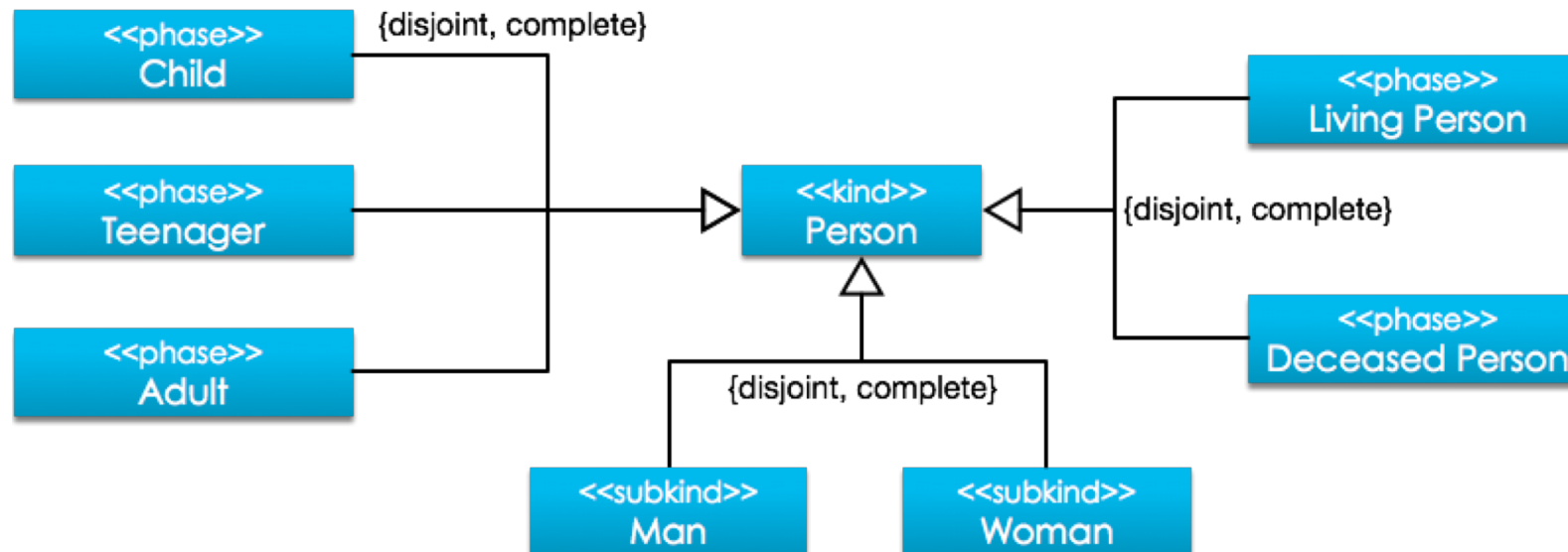
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PHASES

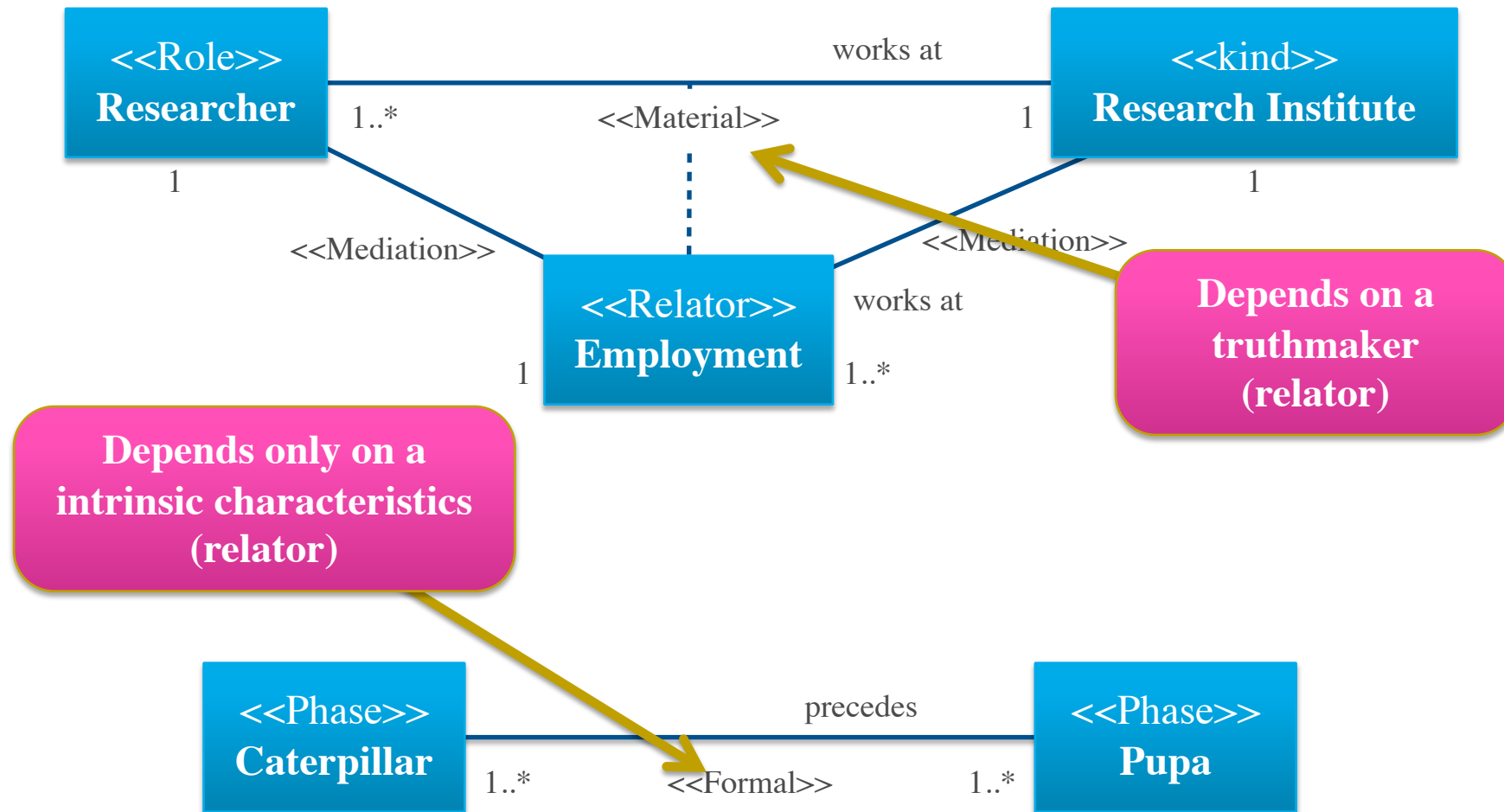


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PHASES



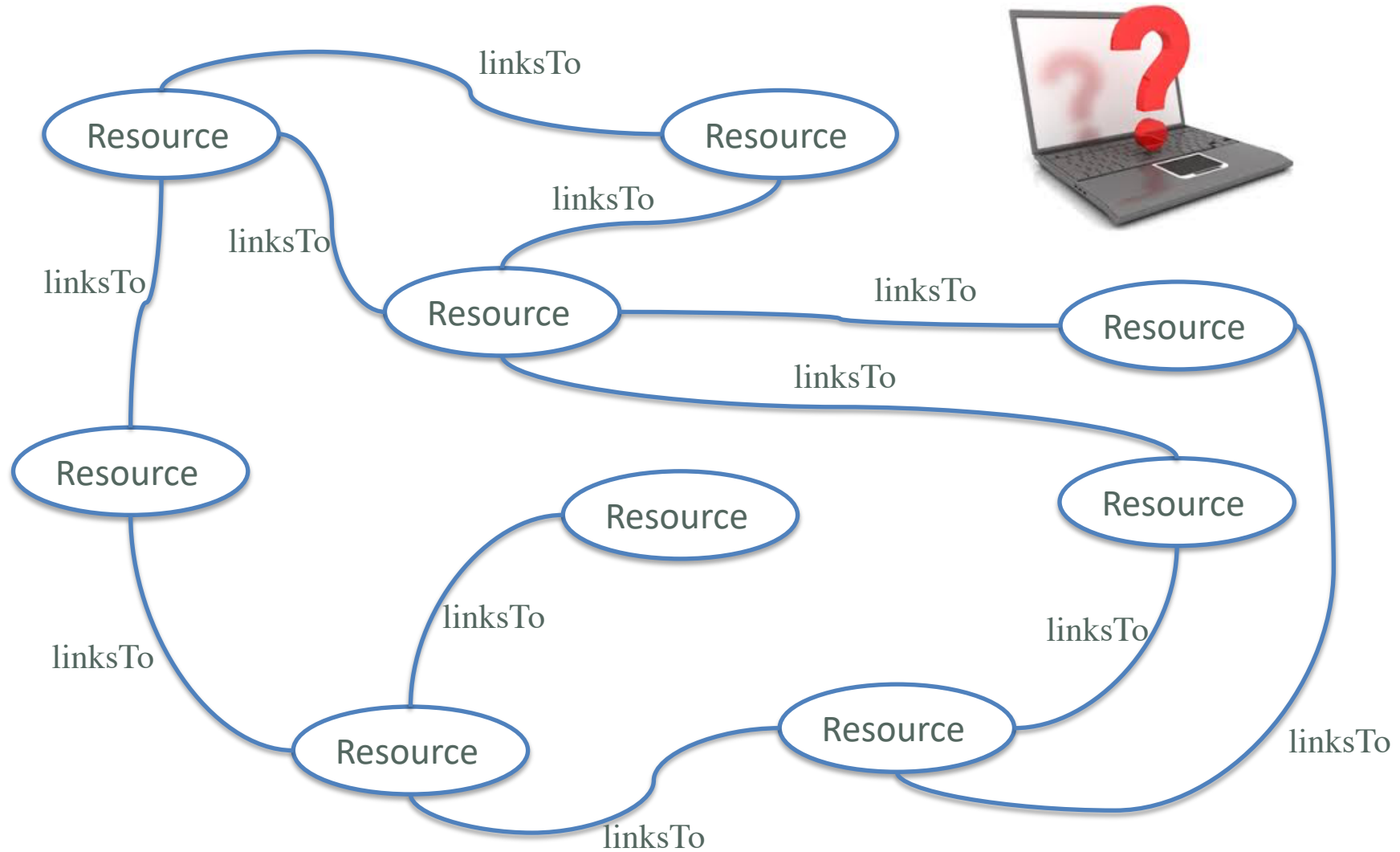
FORMAL AND MATERIAL RELATIONS



Tim Berners-Lee:

- "The Semantic Web is an extension of the current web in which **information** is given **well-defined meaning**, better enabling **computers and people** to work in cooperation."
- Ontologies will be used by publishers "to **explicitly define** their words and concepts...".

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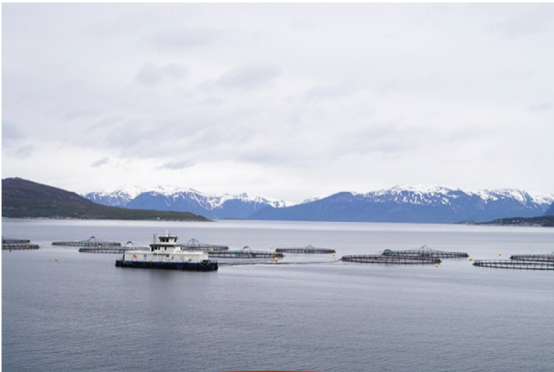
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promille enkelt
Nøyaktige målinger til lav pris.
Krever ikke dyr kalibrering
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A salmon farm in a Norwegian fjord typically comprise a series of anchored, round pens. Photo: Gerd Meissner / Pixabay

POSTED BY: PIETER WIJNEN 24. MARCH 2019

Is farmed salmon safe and healthy?


The next time you're near the meat counter or looking at a seafood restaurant menu, consider ordering fish, especially salmon. Unless a restaurant menu expressly labels its salmon as "wild caught," it undoubtedly was raised and harvested from a fish farm. You may not know that for the last 20 years, salmon fish farming exceeds commercial fishing. If you're in Europe considering this choice, there's a good chance the salmon was farmed in Norway, or possibly Scotland. In North America, farmed salmon in restaurants and grocery stores comes from Maine, Washington, Canada (especially British Columbia), or Chile.

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Farmed salmon are almost exclusively Atlantic salmon. Norwegians pioneered the contemporary technique of salmonid aquaculture using floating sea cages. Fish is Norway's

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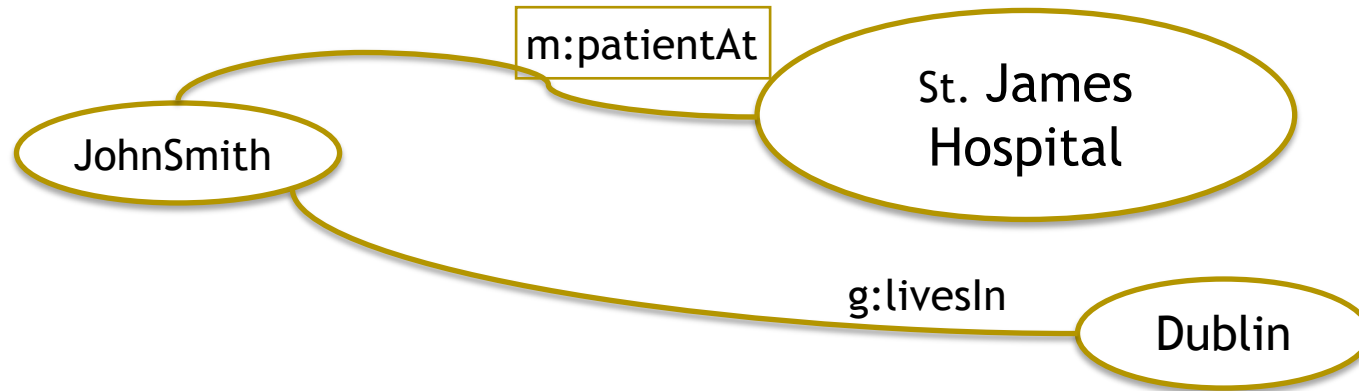
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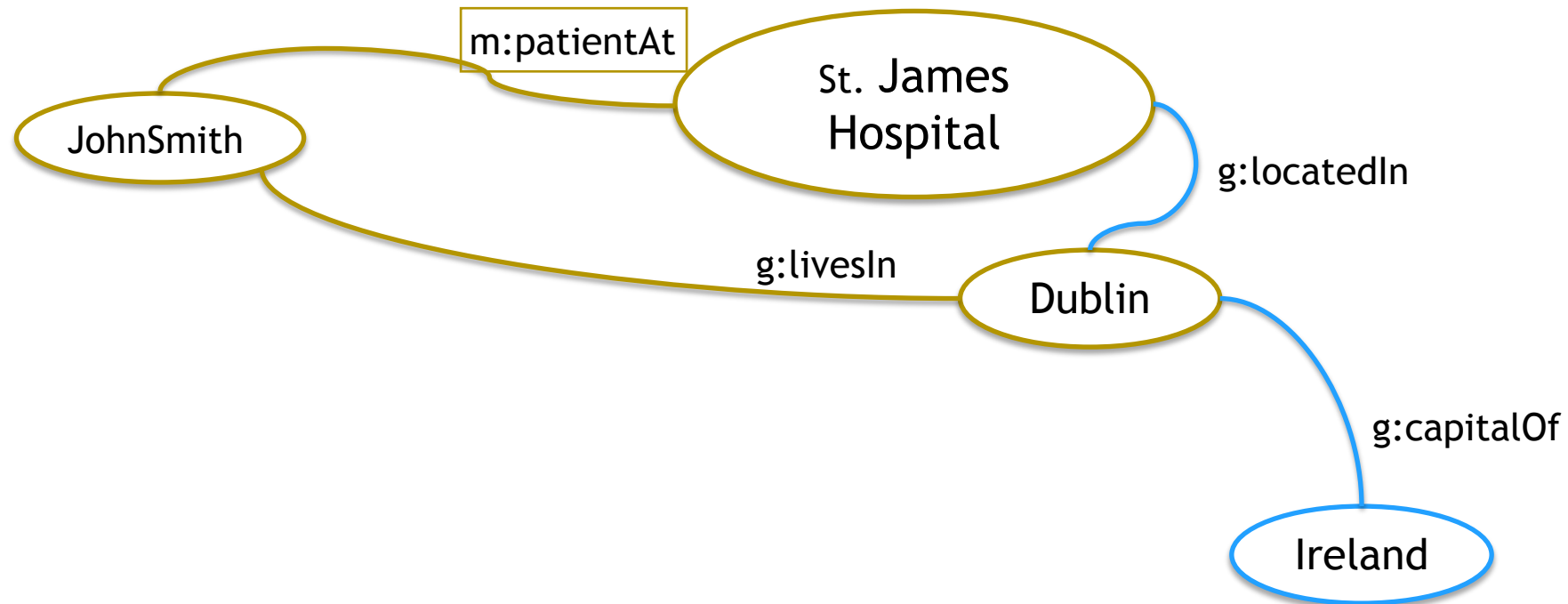
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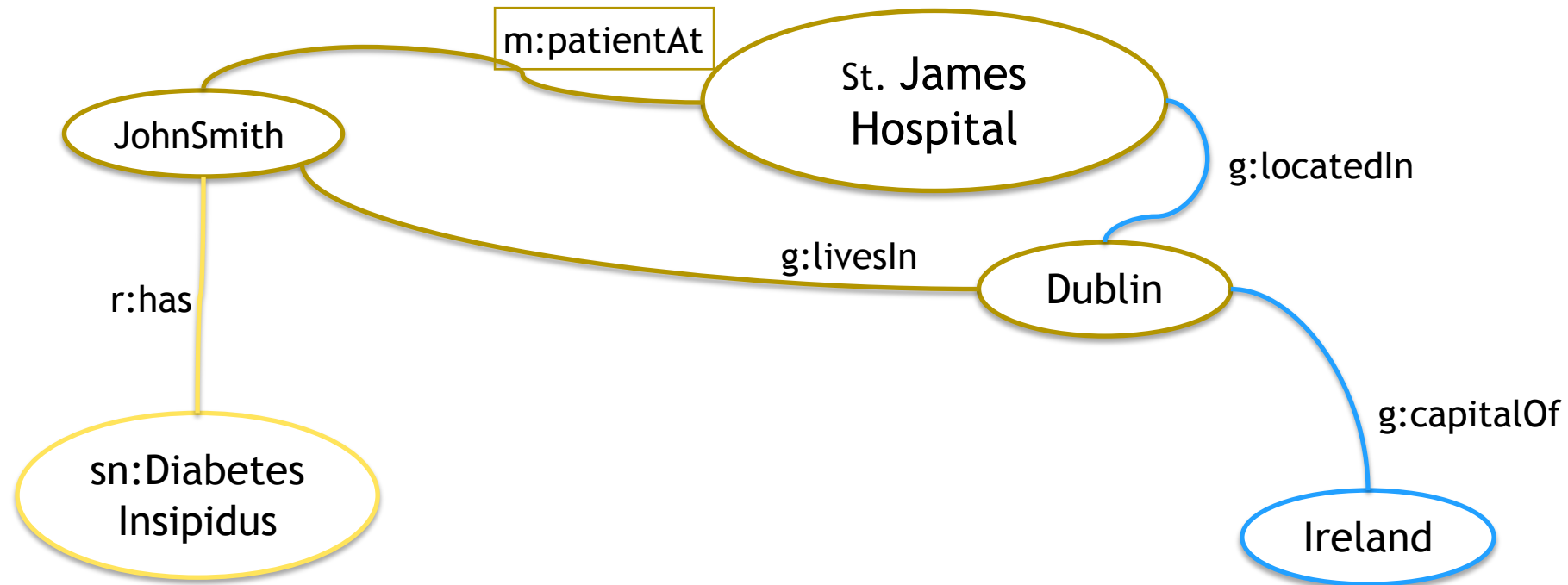
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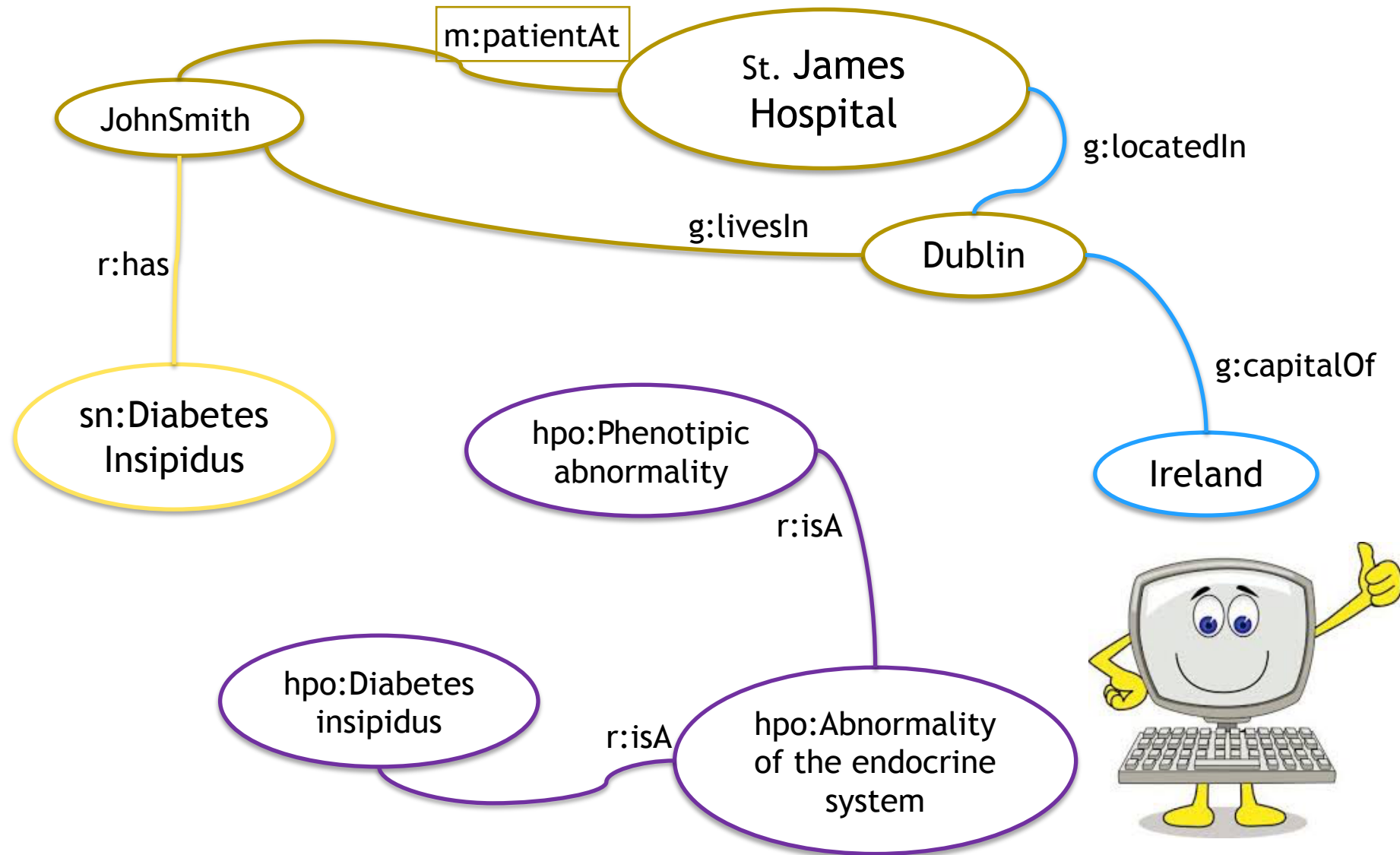
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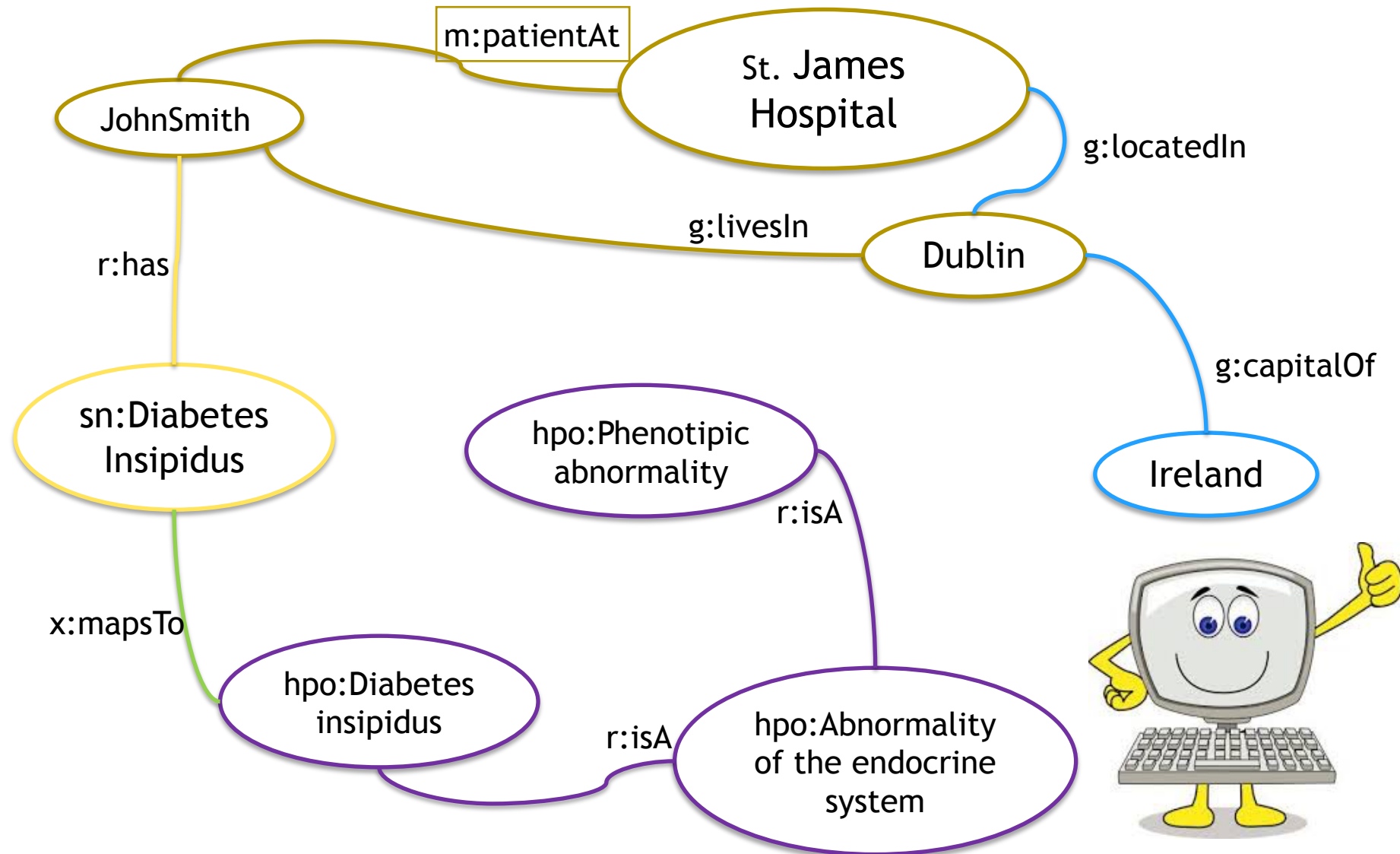
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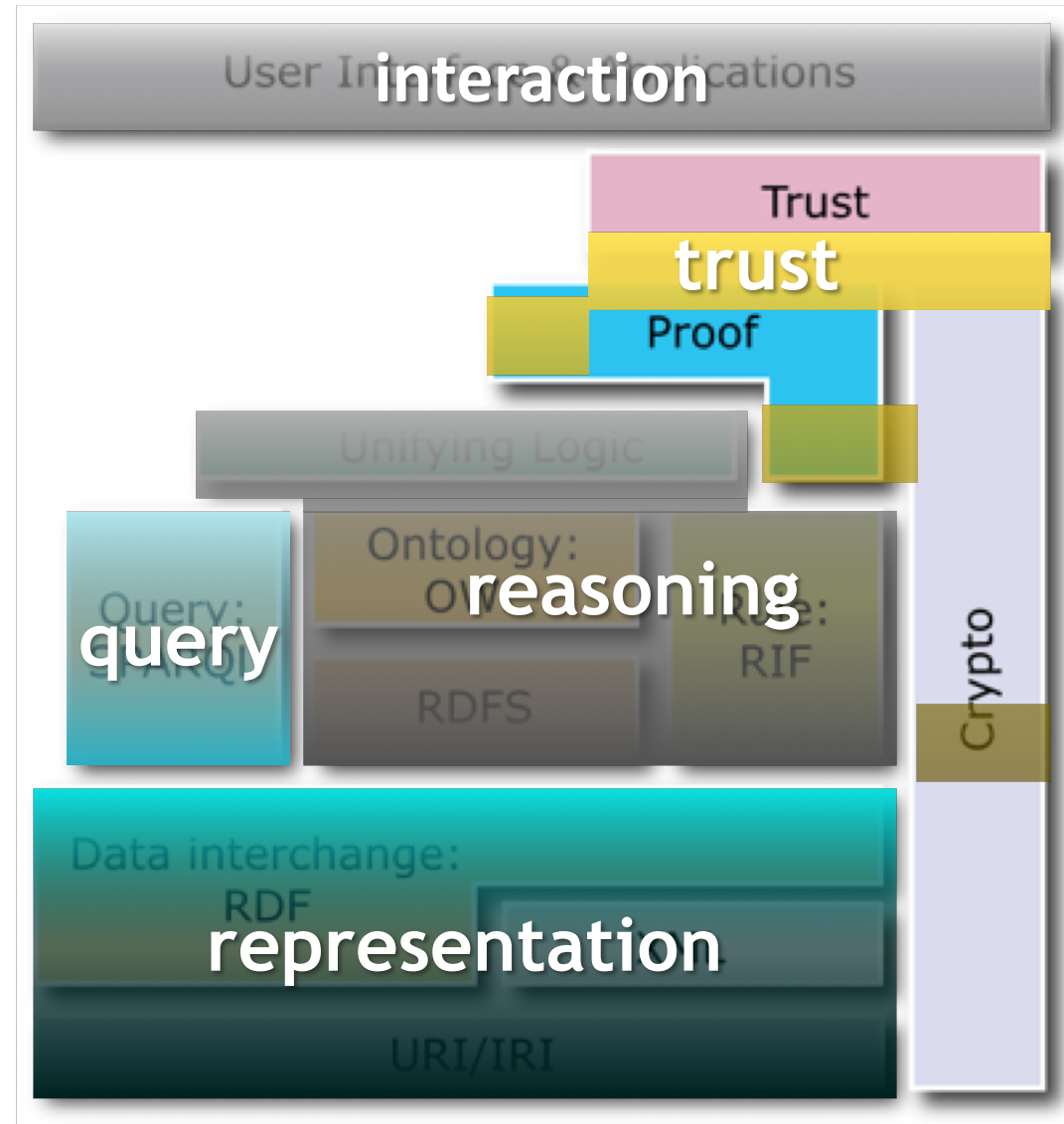
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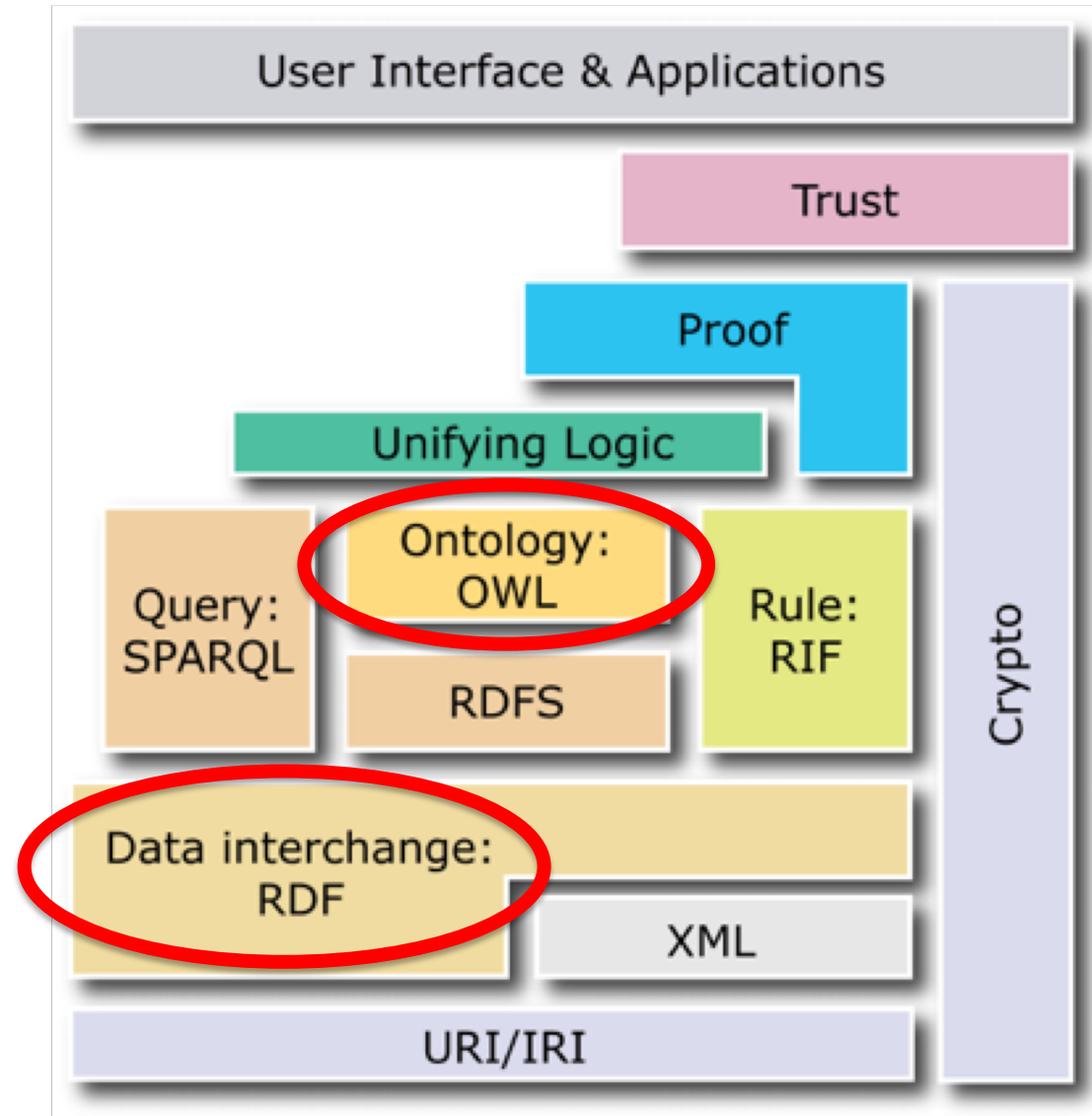
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