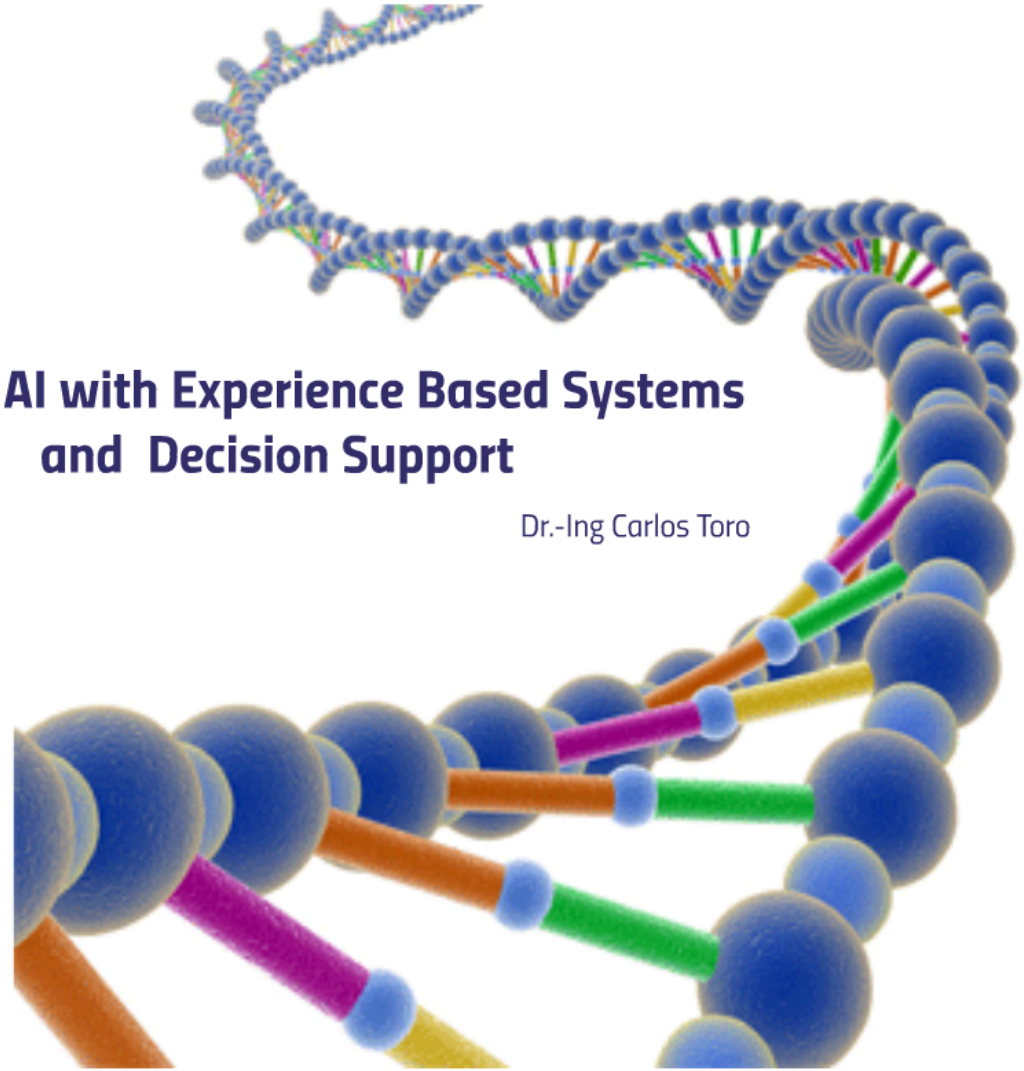
but let's get back to Intelligence



Evolving AI with Experience Based Systems and Decision Support

Dr.-Ing Carlos Toro

smart

/smɑ:t/

adjective

1. (of a person) clean, tidy, and well dressed.
   "you look very smart"
   synonyms: well dressed, well turned out, fashionably dressed, fashionable, stylish, chic, modish, elegant, neat, besuited, spruce, trim, dapper, debonair; More
2. *informal*
   having or showing a quick-witted intelligence.
   "if he was that smart he would never have been tricked"
   synonyms: clever, bright, intelligent, sharp, sharp-witted, quick-witted, nimble-witted, shrewd, astute, acute, apt, able; More

verb

1. (of part of the body) feel a sharp stinging pain.
   "her legs were scratched and smarting"
   synonyms: sting, burn, tingle, prickle; More

noun

1. sharp stinging pain.
   "the smart of the recent cuts"
2. NORTH AMERICAN *informal*
   intelligence; acumen.
   "I don't think I have the smarts for it"

intelligent

/ɪnˈtɛlɪdʒ(ə)nt/

adjective

having or showing intelligence, especially of a high level.
"Anna is intelligent and hard-working"
synonyms: clever, bright, brilliant, sharp, quick, quick-witted, quick on the uptake, smart, canny, astute, intuitive, thinking, acute, alert, keen, insightful, perceptive, perspicacious, penetrating, discerning; More

- (of a device or building) able to vary its state or action in response to varying situations and past experience.
  synonyms: robotic, automatic, self-regulating, capable of learning; More
- (of a computer terminal) incorporating a microprocessor and having its own processing capability.

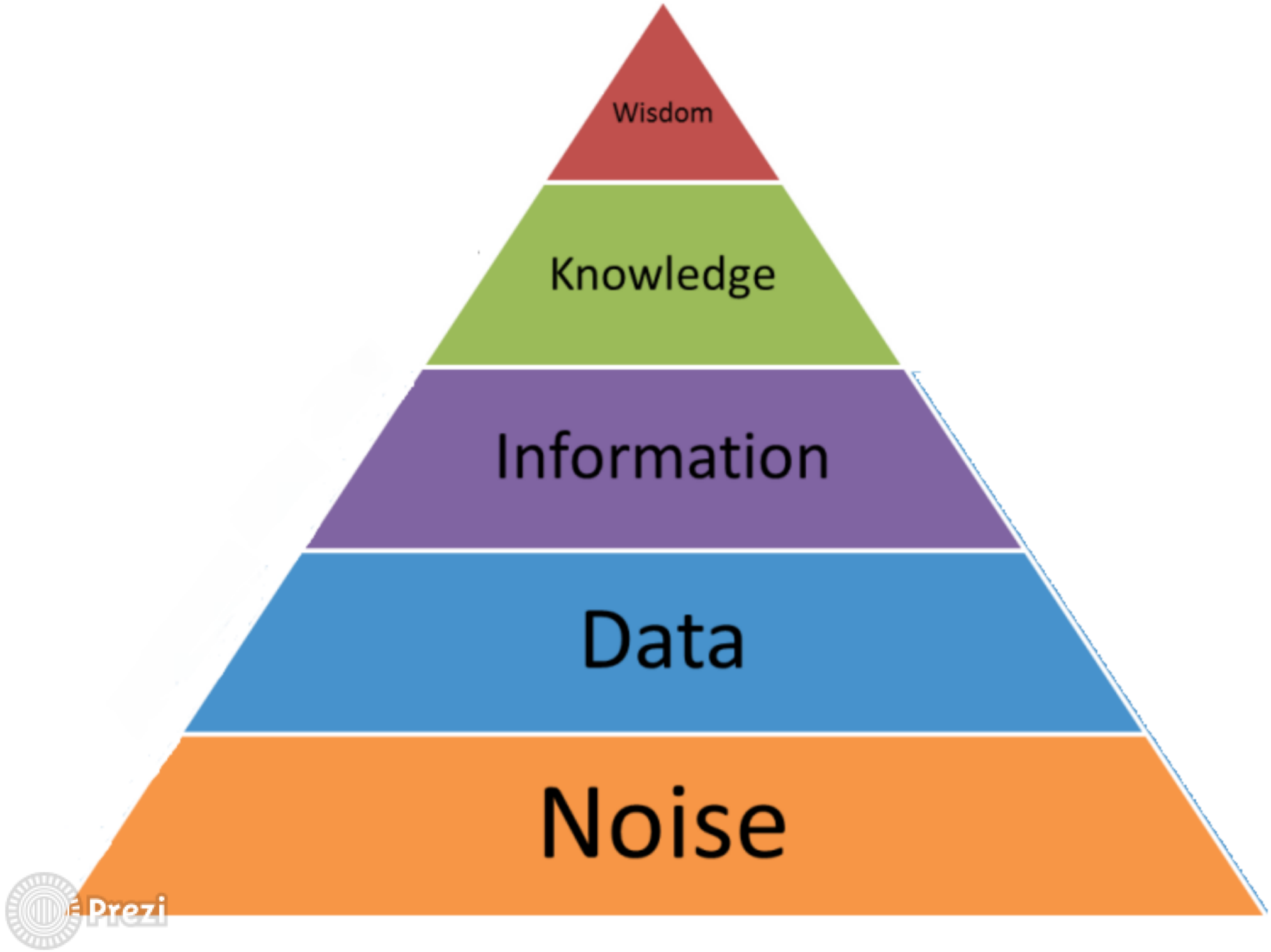
INTELLIGENCE

IS THE ABILITY

TO ADAPT TO

CHANGE

An intellegent/smart system should NOT replace a human operator!


Wisdom
Knowledge
Information
Data
Noise

Noise

Data

Information

Knowledge

Wisdom

but let's get back to Intelligence

colourized by pastincolour.com

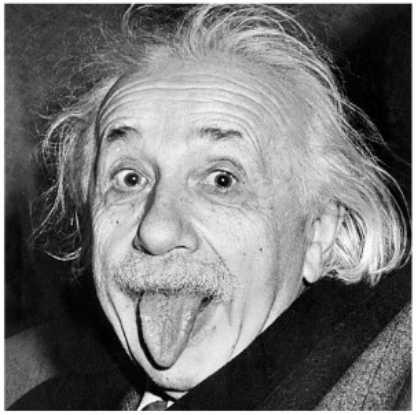
SOLVAY CONFERENCE 1927

A. PICARD E. HENRIOT P. EHRENFEST Ed. HERSEN Th. DE DONDER E. SCHRÖDINGER E. VERSCHAFFELT W. PAULI W. HEISENBERG R.H FOWLER L. BRILLOUIN

P. DEBYE M. KNUDSEN W.L. BRAGG H.A. KRAMERS P.A.M. DIRAC A.H. COMPTON L. de BROGLIE M. BORN N. BOHR

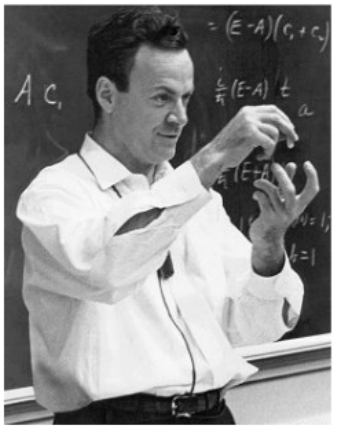
I. LANGMUIR M. PLANCK Mme CURIE H.A. LORENTZ A. EINSTEIN P. LANGEVIN Ch.E. GUYE C.T.R. WILSON O.W. RICHARDSON

Absents : Sir W.H. BRAGG, H. DESLANDRES et E. VAN AUBEL



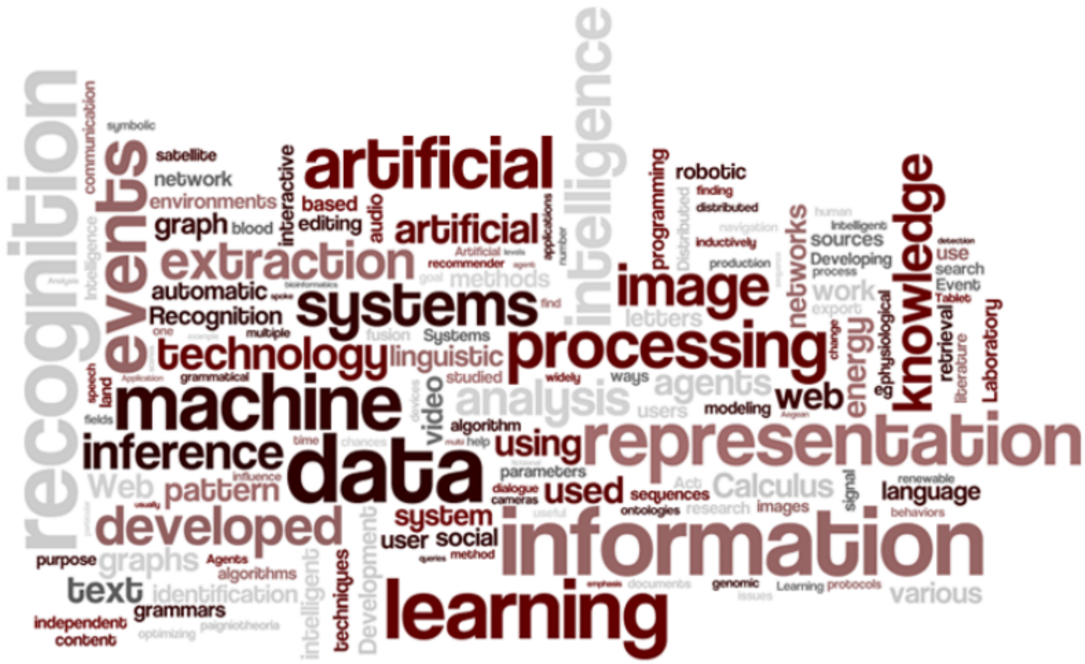
“The only source of true knowledge is experience.”

Albert Einstein



"I was born not knowing and have had only a little time to change that here and there."

Richard Feynman



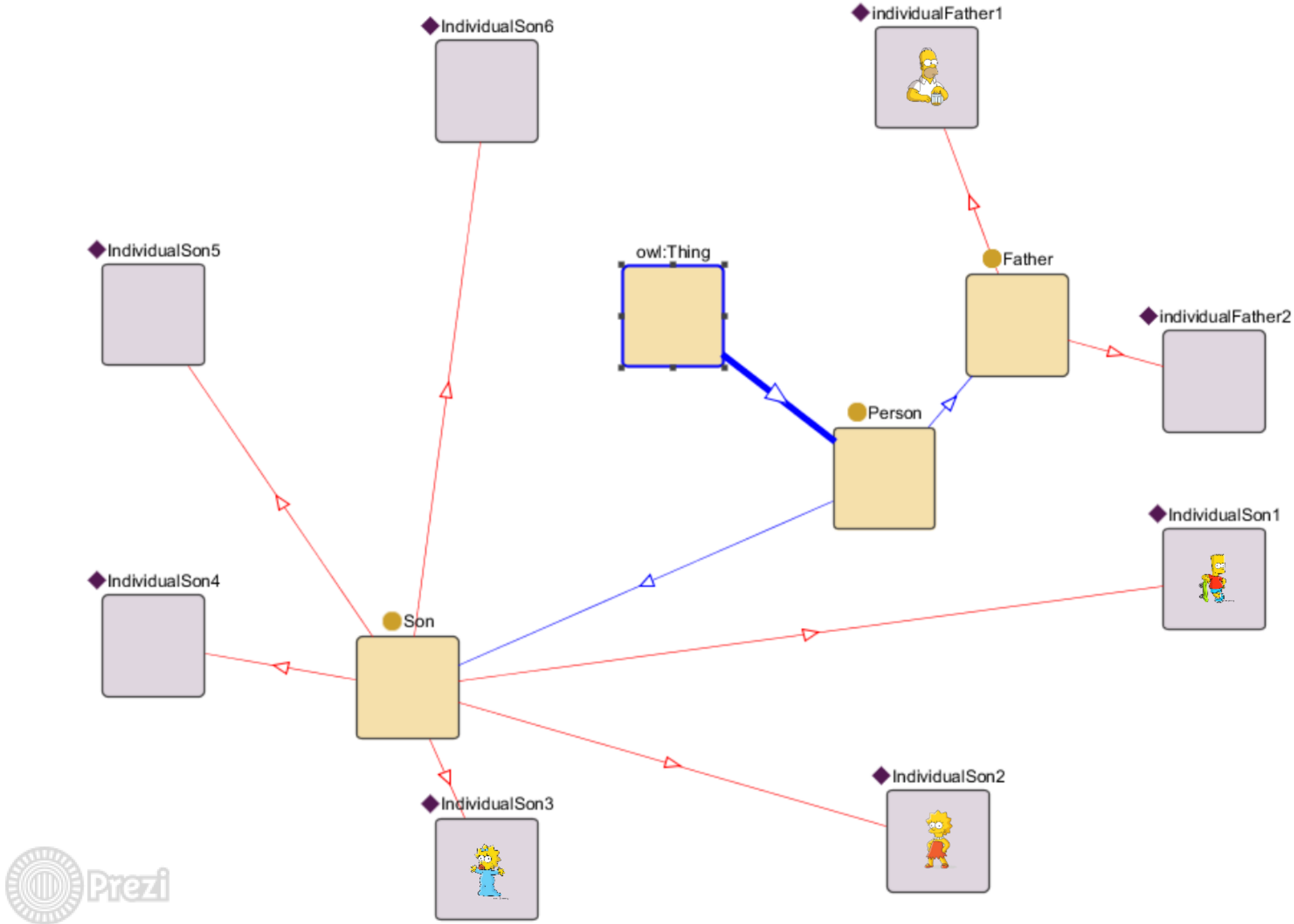
recognition
events
artificial
intelligence
artificial
extraction
systems
image
processing
knowledge
technology
machine
data
inference
representation
information
learning
developed
analysis
agents
linguistic
networks
energy
web
using
used
language
pattern
system
social
user
text
graphs
grammars
techniques
Development
intelligent
identification
independent
content
purpose
automatic
Recognition
graph
network
satellite
environments
based
editing
interactive
robotic
programming
Laboratory
retrieval
video
Calculus
Web
various
methods
work
sources
Developing
search
use
Event

An ontology

Is a formal and declarative representation which includes the vocabulary for referring to the terms in that subject area and the logical statements that describe what the terms are, how they are related to each other, and how they can or cannot be related to each other. [STA08]

"An ontology is the specification of a conceptualization" [Gru93].

Example please?

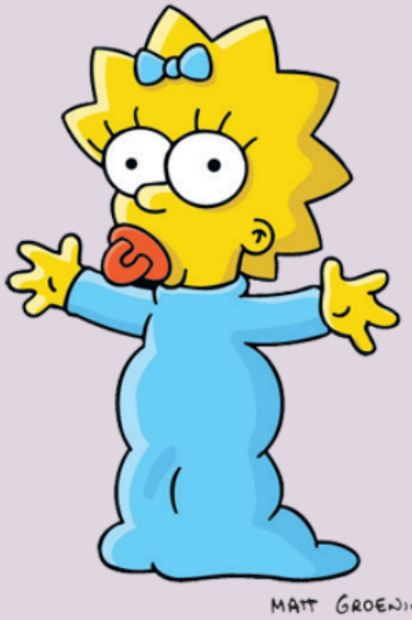

IndividualSon6
individualFather1
IndividualSon5
owl:Thing
Father
individualFather2
Person
IndividualSon1
IndividualSon4
Son
IndividualSon2
IndividualSon3

individualFather1

IndividualSon1

IndividualSon2

IndividualSon3



Why?

- To enable reuse of User and Domain Knowledge.
- To make User and Domain assumptions explicit.
- To separate User and Domain Knowledge from operational Knowledge.
- To share common understanding of the structure of information.
- To analyze User and Domain Knowledge (in order to make decisions).

Reflexive Ontologies is a technique that can be used to add sets of queries to ontologies.

The **enhancement** of having **a set of queries** relies on:

- The speeding-up of the query process
- The possibility of that the ontology itself adds new queries on individuals with the corresponding answers to such queries
- The self-containment of the enhanced Knowledge Structure in a single file

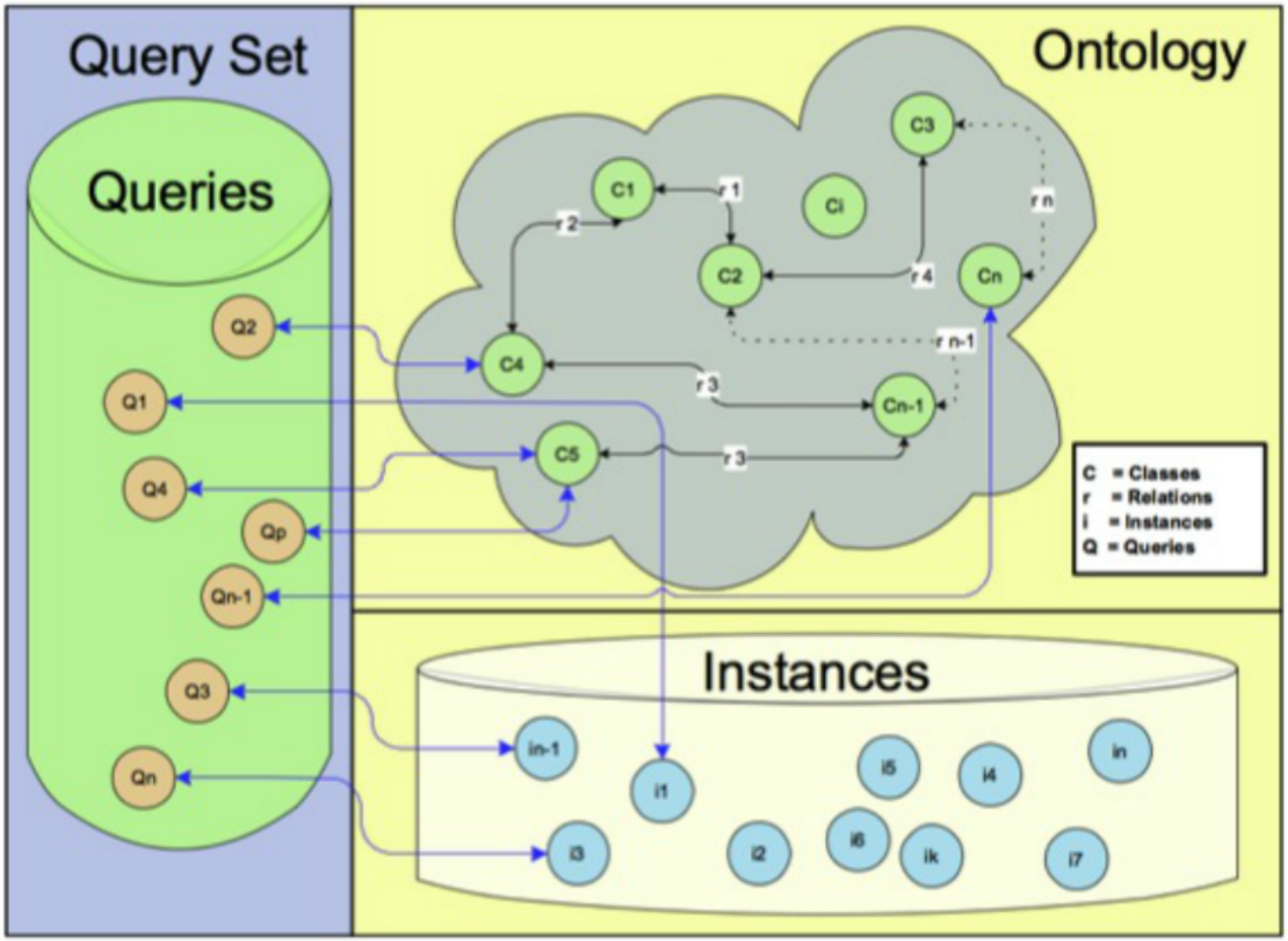
How this was born

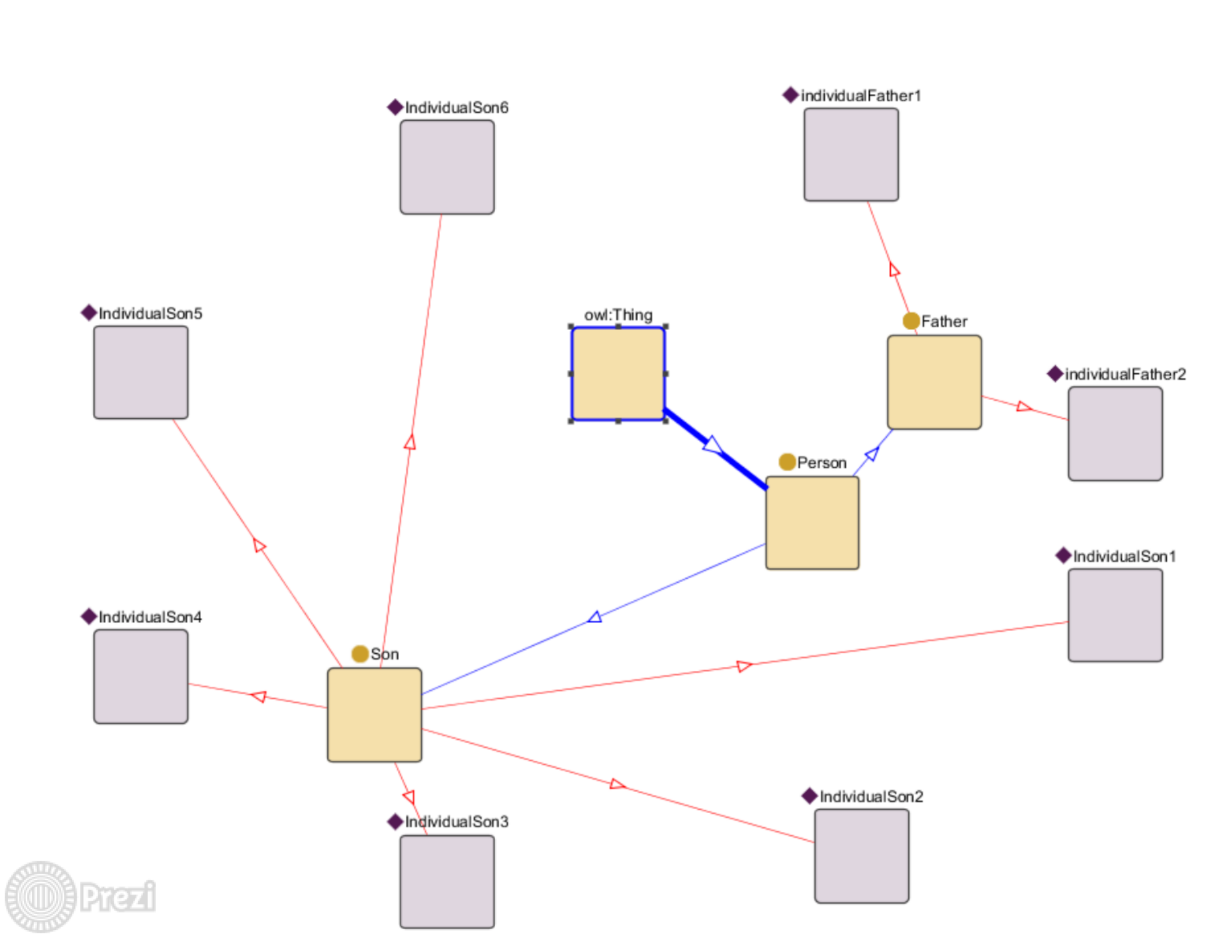
three different aspects

Mathematical: As a relation between sets.

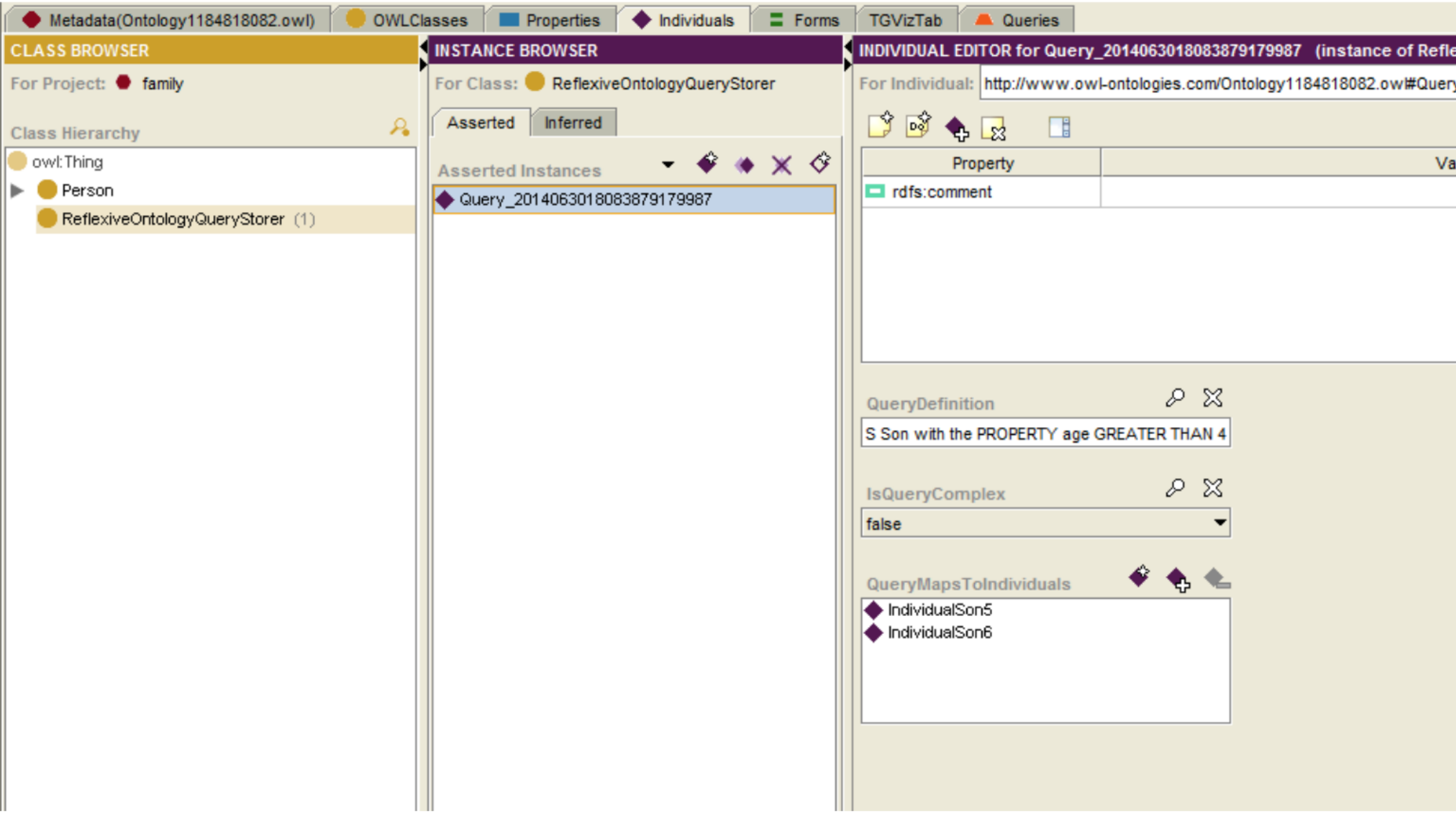
Sociological: The action of self-referencing, it addresses and affects the subject by means of examining or acting upon the object itself.

Biology (Autopoiesis): A system which is able to create and destroy elements of the system itself in response to perturbations in the environment.

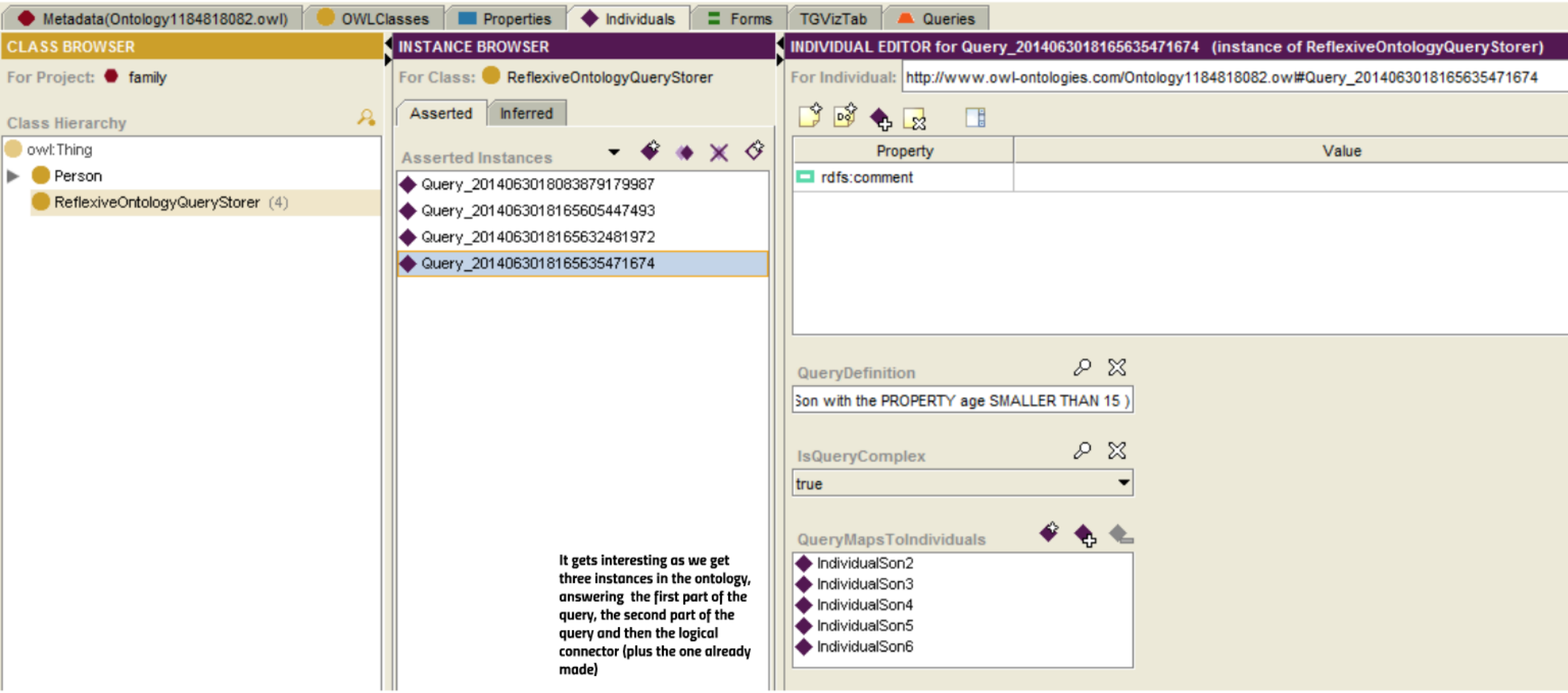

Query Set
Queries
Q2
Q1
Q4
Qp
Qn-1
Q3
Qn
Ontology
C3
C1
r 1
Ci
r n
r 2
C2
r 4
Cn
r n-1
C4
r 3
Cn-1
C5
r 3
C = Classes
r = Relations
i = Instances
Q = Queries
Instances
in-1
i1
i5
i4
in
i3
i2
i6
ik
i7


IndividualSon6
individualFather1
IndividualSon5
owl:Thing
Father
individualFather2
Person
IndividualSon1
IndividualSon4
Son
IndividualSon2
IndividualSon3

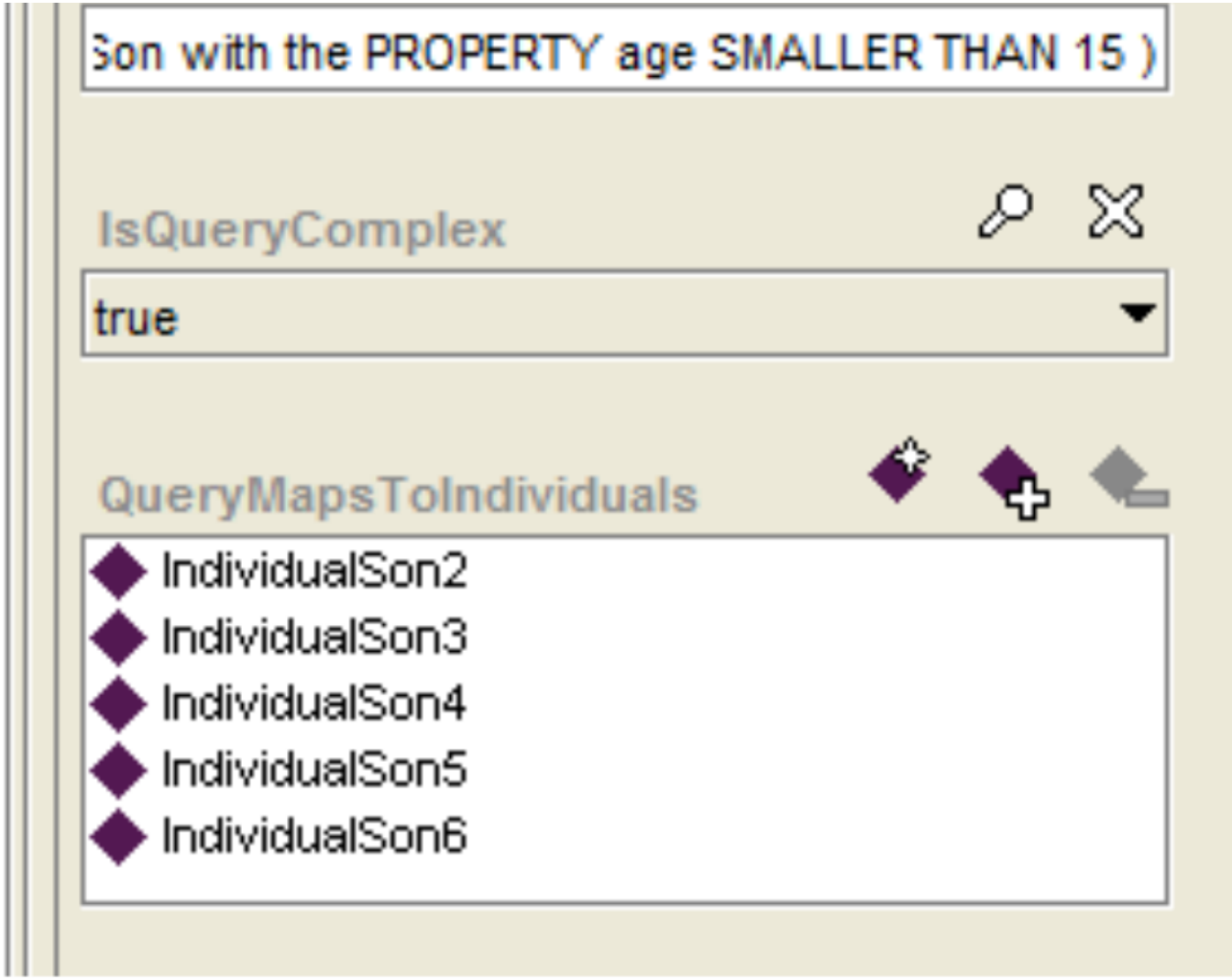
"CLASS Son with the PROPERTY age GREATER THAN 4"


Metadata(Ontology1184818082.owl)
OWLClasses
Properties
Individuals
Forms
TGVizTab
Queries
CLASS BROWSER
For Project: family
Class Hierarchy
owl:Thing
Person
ReflexiveOntologyQueryStorer (1)
INSTANCE BROWSER
For Class: ReflexiveOntologyQueryStorer
Asserted
Inferred
Asserted Instances
Query_20140630180838791799 87
INDIVIDUAL EDITOR for Query_20140630180838791799 87 (instance of Refle
For Individual: http://www.owl-ontologies.com/Ontology1184818082.owl#Query
Property
Va
rdfs:comment
QueryDefinition
S Son with the PROPERTY age GREATER THAN 4
IsQueryComplex
false
QueryMapsToIndividuals
IndividualSon5
IndividualSon6

"(CLASS Son with the PROPERTY age GREATER THAN 1) AND
"(CLASS Son with the PROPERTY age SMALLER THAN 15)"


Metadata(Ontology1184818082.owl)
OWLClasses
Properties
Individuals
Forms
TGVizTab
Queries
CLASS BROWSER
For Project: family
Class Hierarchy
owl:Thing
Person
ReflexiveOntologyQueryStorer (4)
INSTANCE BROWSER
For Class: ReflexiveOntologyQueryStorer
Asserted
Inferred
Asserted Instances
Query_20140630180838791799 87
Query_2014063018165605447493
Query_2014063018165632481972
Query_2014063018165635471674
It gets interesting as we get three instances in the ontology, answering the first part of the query, the second part of the query and then the logical connector (plus the one already made)
INDIVIDUAL EDITOR for Query_2014063018165635471674 (instance of ReflexiveOntologyQueryStorer)
For Individual: http://www.owl-ontologies.com/Ontology1184818082.owl#Query_2014063018165635471674
Property
Value
rdfs:comment
QueryDefinition
Son with the PROPERTY age SMALLER THAN 15)
IsQueryComplex
true
QueryMapsToIndividuals
IndividualSon2
IndividualSon3
IndividualSon4
IndividualSon5
IndividualSon6

It gets interesting as we get three instances in the ontology, answering the first part of the query, the second part of the query and then the logical connector (plus the one already made)



Decision Support Systems

Challenges

- Computerization of DSS
- Timely advice
- Maintainability and extensibility
- Workflow integration
- Architecture for DSS

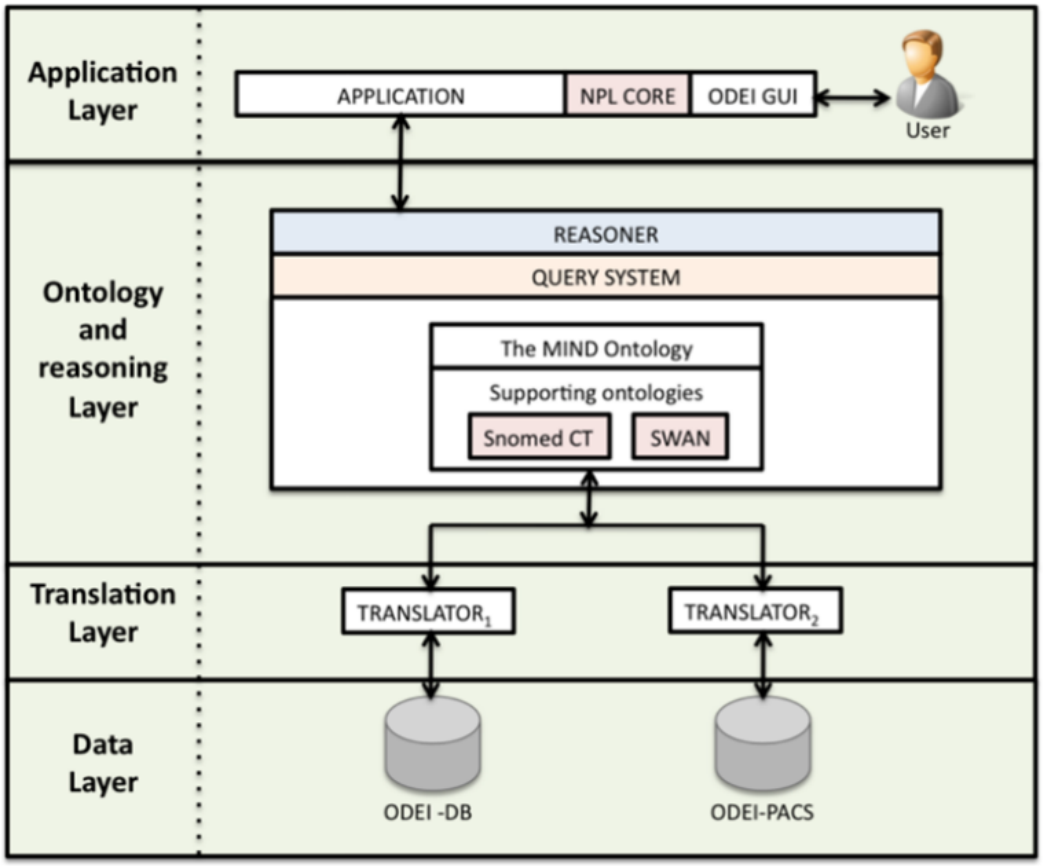
Research project MIND

Cooperation: Industry/Hospital/Research centers
Biomarkers for the Early Diagnosis of Alzheimer's Disease

Alzheimer's Disease: Neurodegenerative disease, its cause and mechanisms still unknown

Challenges:

- Discovery of new knowledge
- Knowledge handling


Application Layer
APPLICATION
NPL CORE
ODEI GUI
User
Ontology and reasoning Layer
REASONER
QUERY SYSTEM
The MIND Ontology
Supporting ontologies
Snomed CT
SWAN
Translation Layer
TRANSLATOR1
TRANSLATOR2
Data Layer
ODEI -DB
ODEI-PACS

Demo

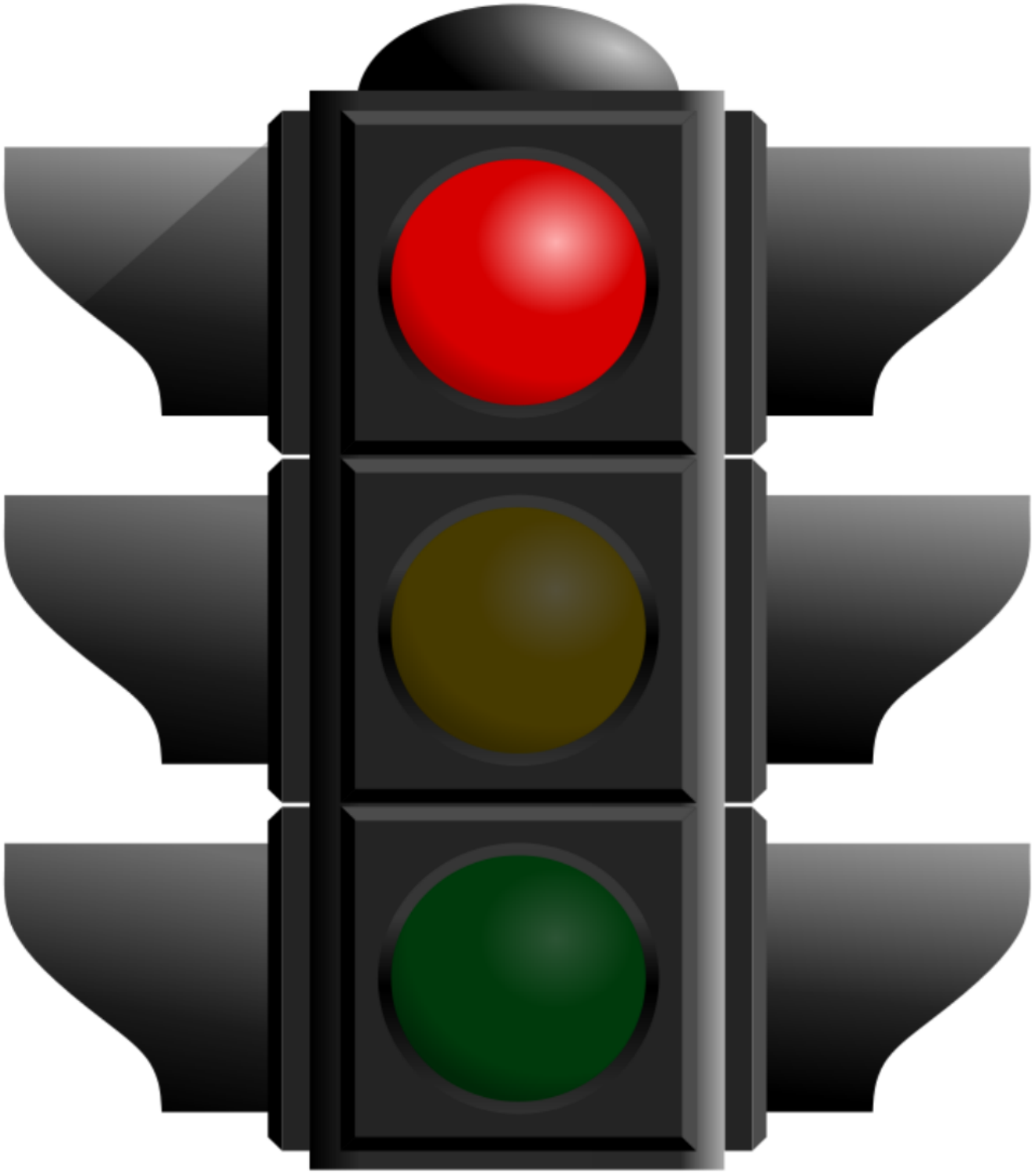
experience

my life has become this one big "I DON'T KNOW"

We usually learn by experience and then we create our own mental models

DON’T TOUCH

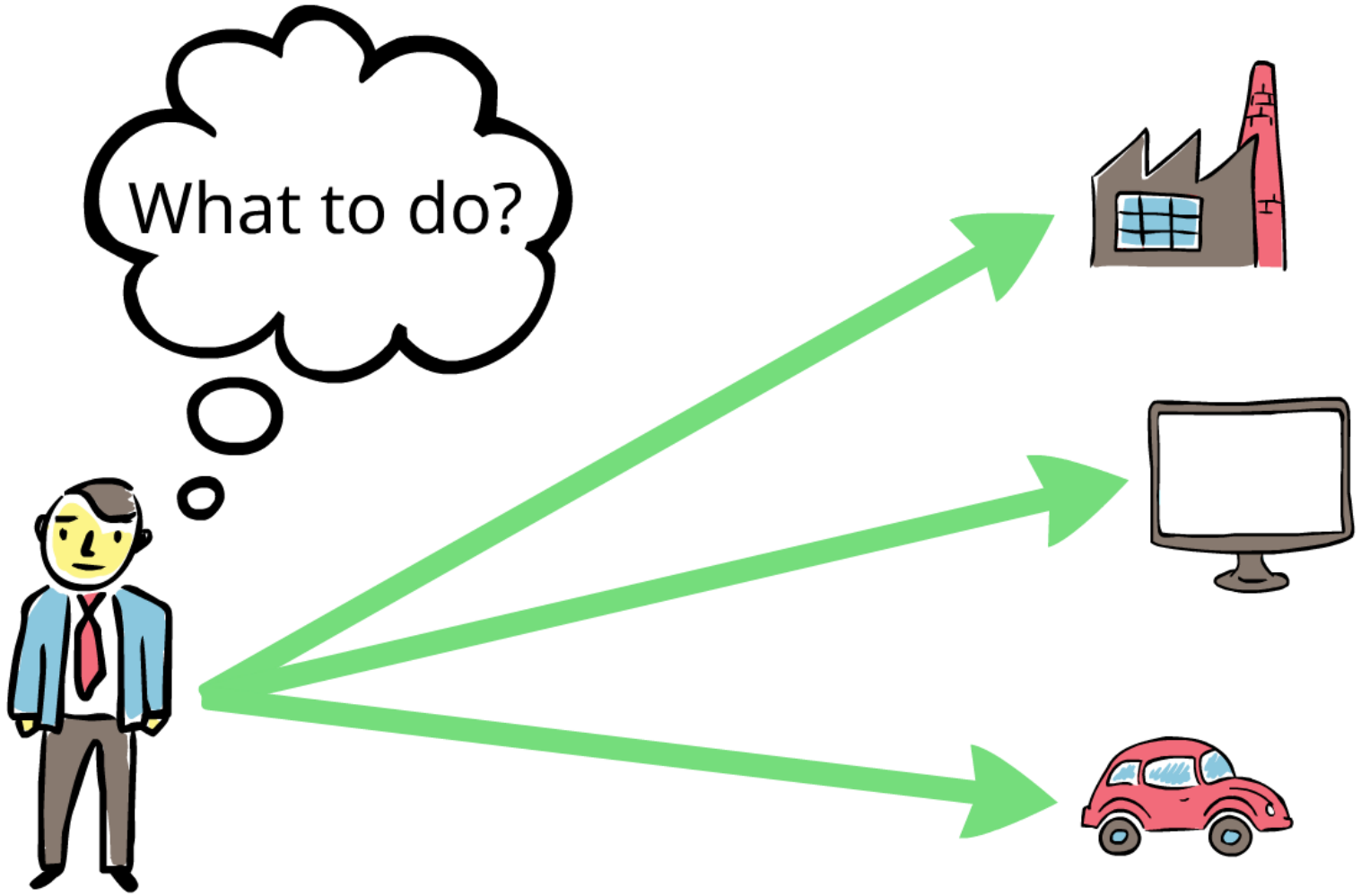

STOP



In most situations, how is a decision made, is usually disregarded once such decision is reached.

What to do with the experience gained on making decisions?

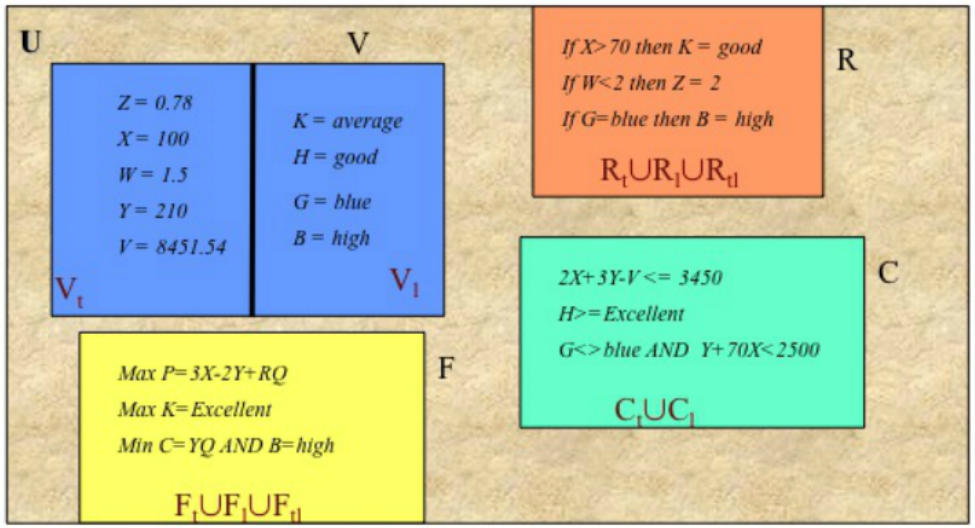
A decision event is a decision occurrence, which was executed following strict procedures and under a given context.



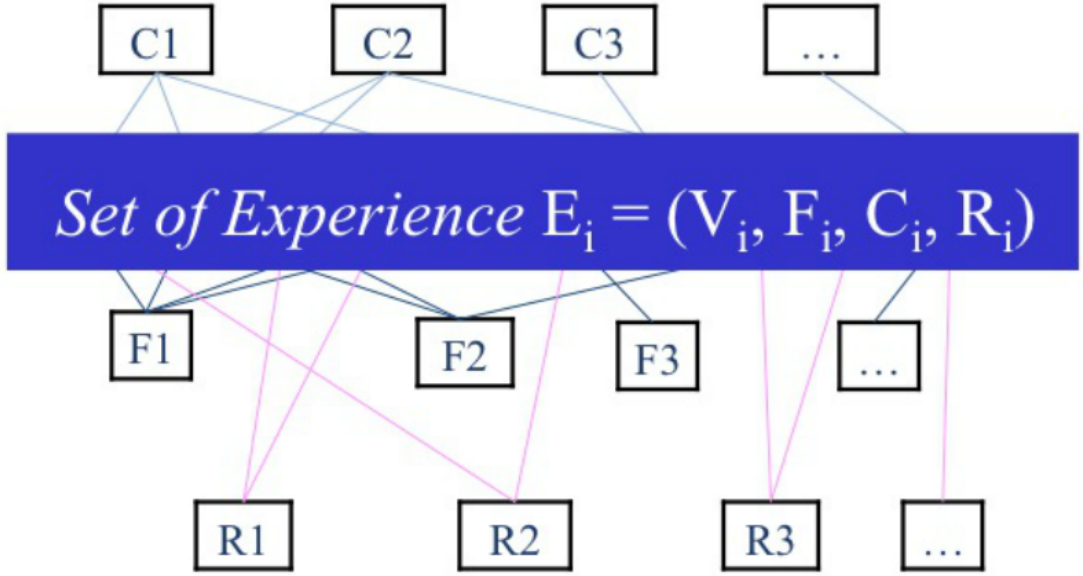
The Decisional DNA and the Set of Experience Knowledge Structure (SOEKS)

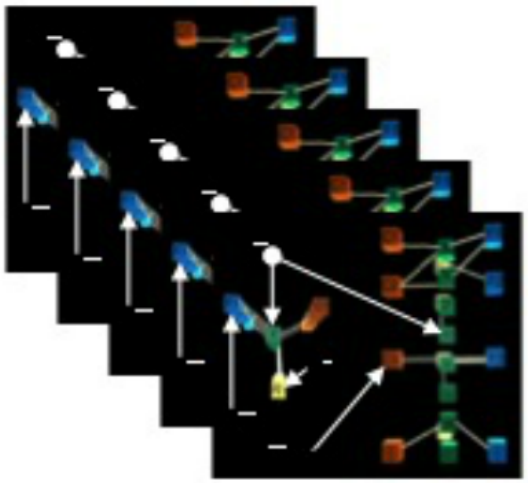
Formal decision event

Their four components are variables, functions, constraints, and rules,

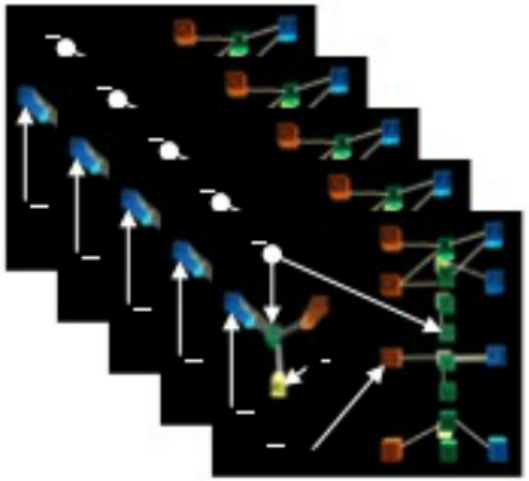


Graphic idea:

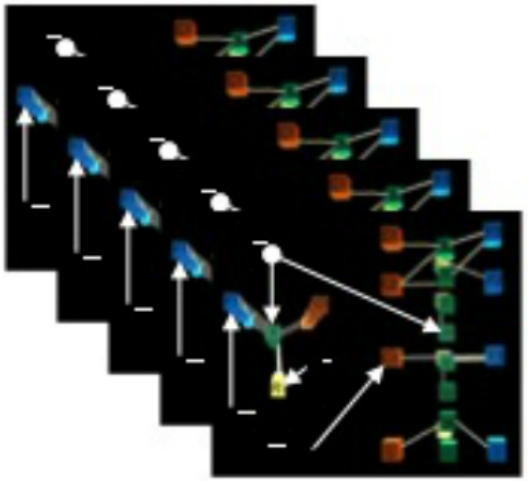




Set of Experience 1



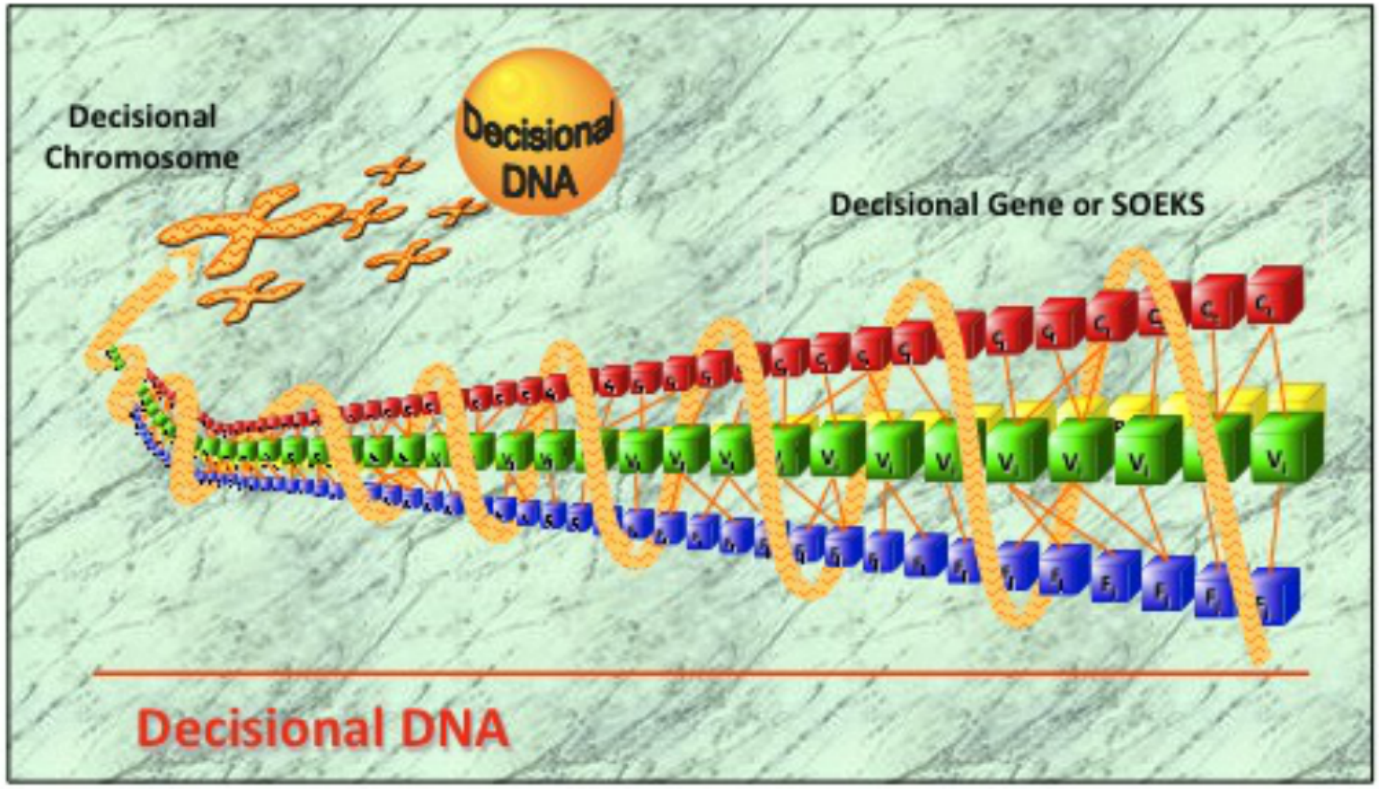
Set of Experience 2



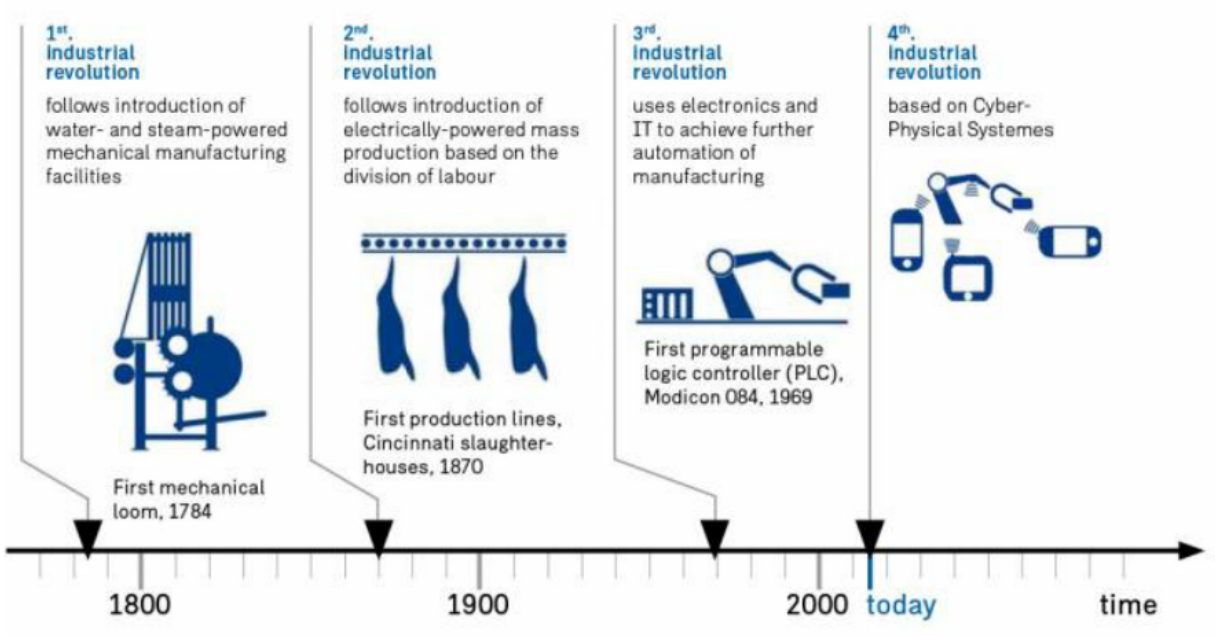
Set of Experience 3

SOEKS are grouped according to their phenotype creating **Decisional Chromosomes**.

Groups of chromosomes construct the **Decisional DNA**.

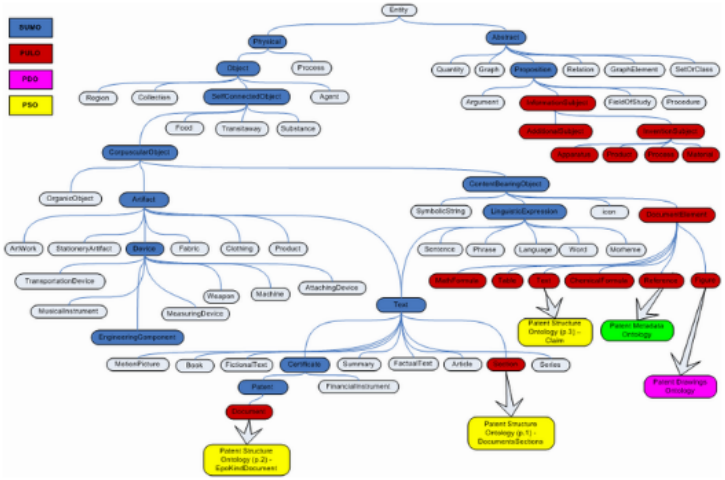


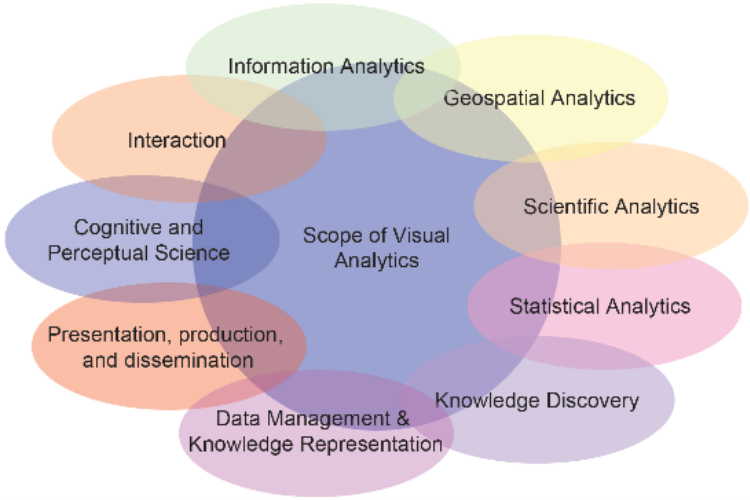
How to use experience based systems in an industrial context?


1st. industrial revolution
follows introduction of water- and steam-powered mechanical manufacturing facilities
First mechanical loom, 1784
2nd. industrial revolution
follows introduction of electrically-powered mass production based on the division of labour
First production lines, Cincinnati slaughter-houses, 1870
3rd. industrial revolution
uses electronics and IT to achieve further automation of manufacturing
First programmable logic controller (PLC), Modicon 084, 1969
4th. industrial revolution
based on Cyber-Physical Systemes
1800
1900
2000
today
time

Cyber-Physical Systems (CPS) are integrations of computation, networking, and physical processes. Embedded computers and networks monitor and control the physical processes, with feedback loops where physical processes affect computations and vice versa.

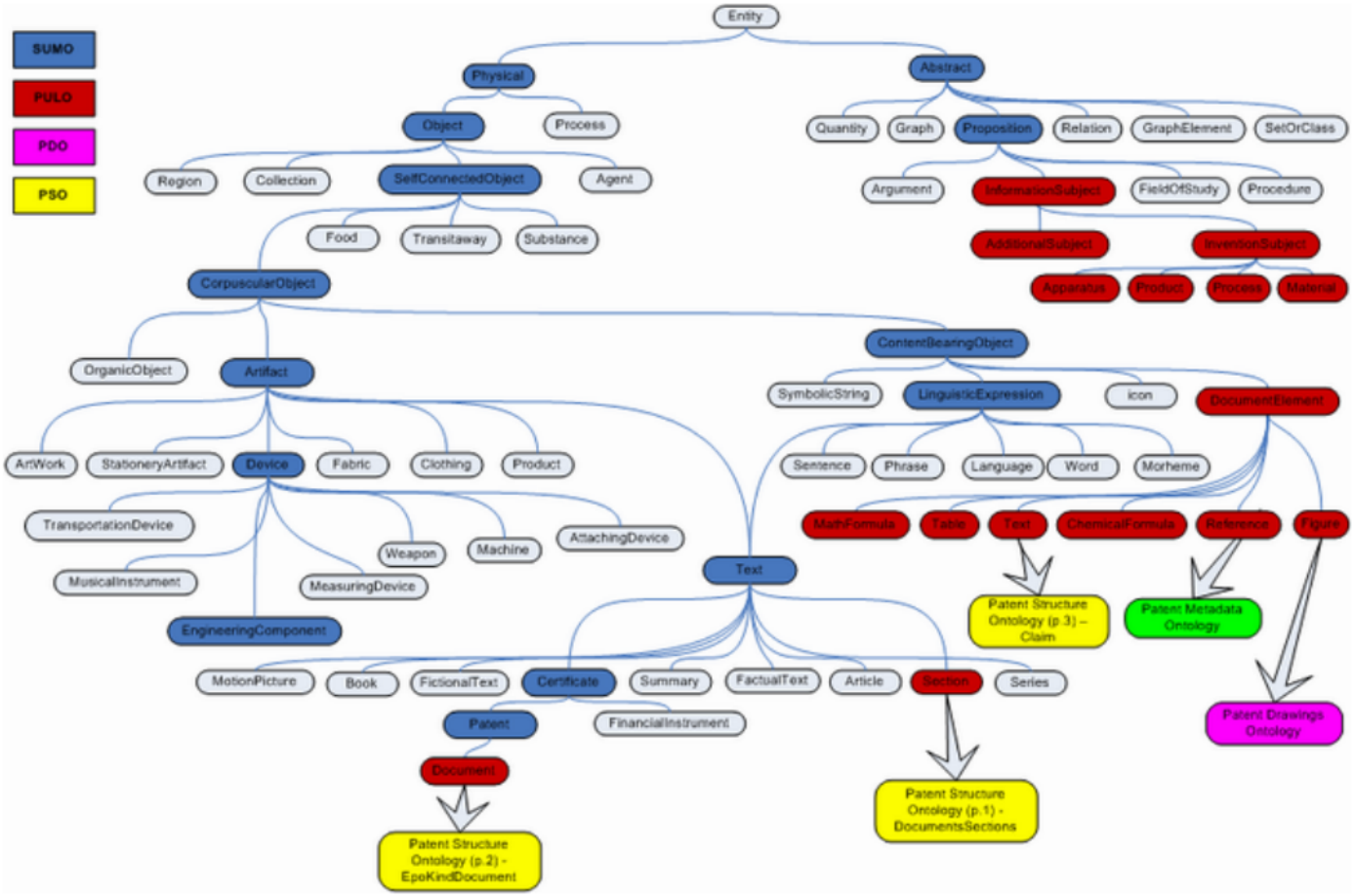
Our approach uses state of the art technologies for predicting, analyzing and re-use industrial knowledge:

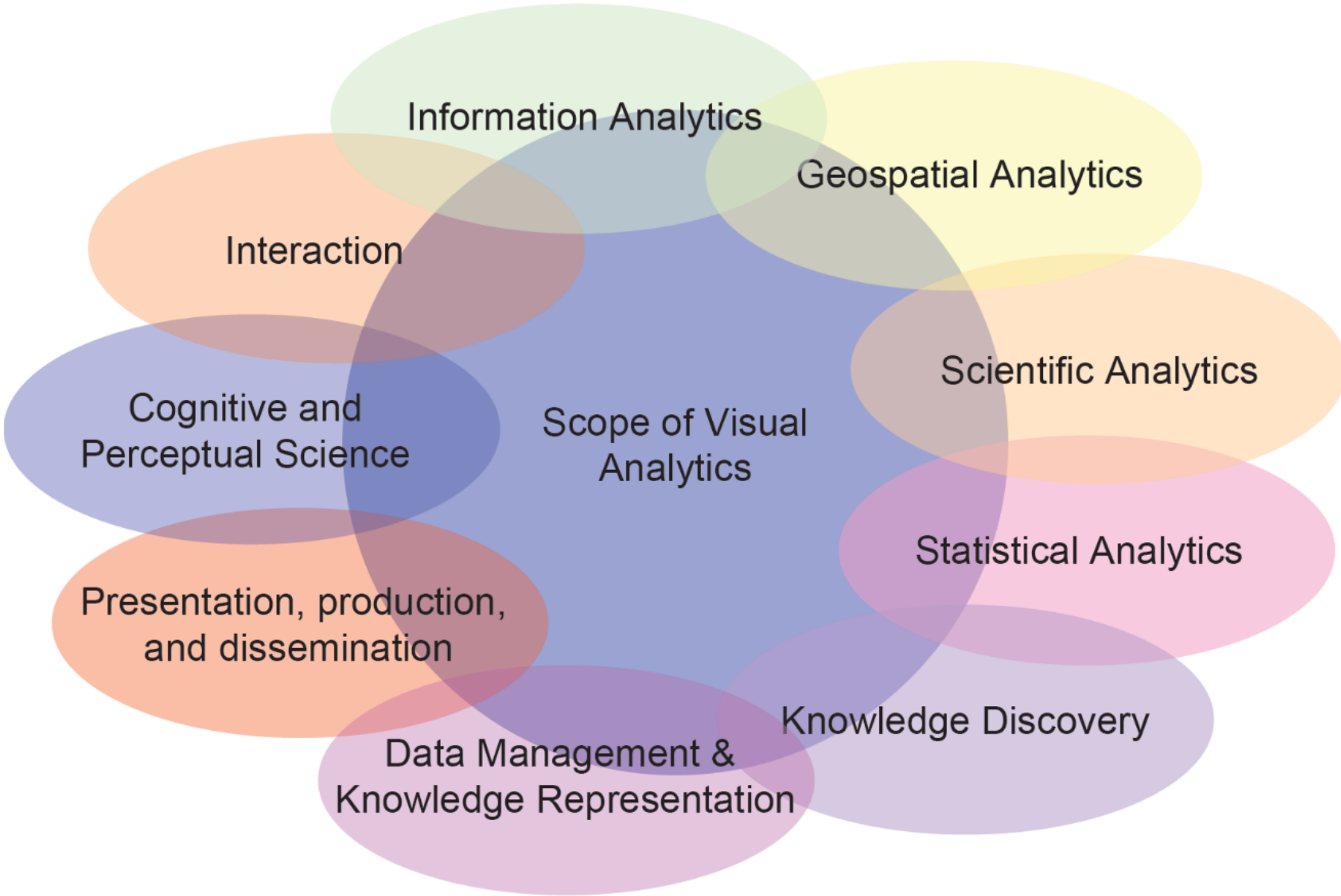




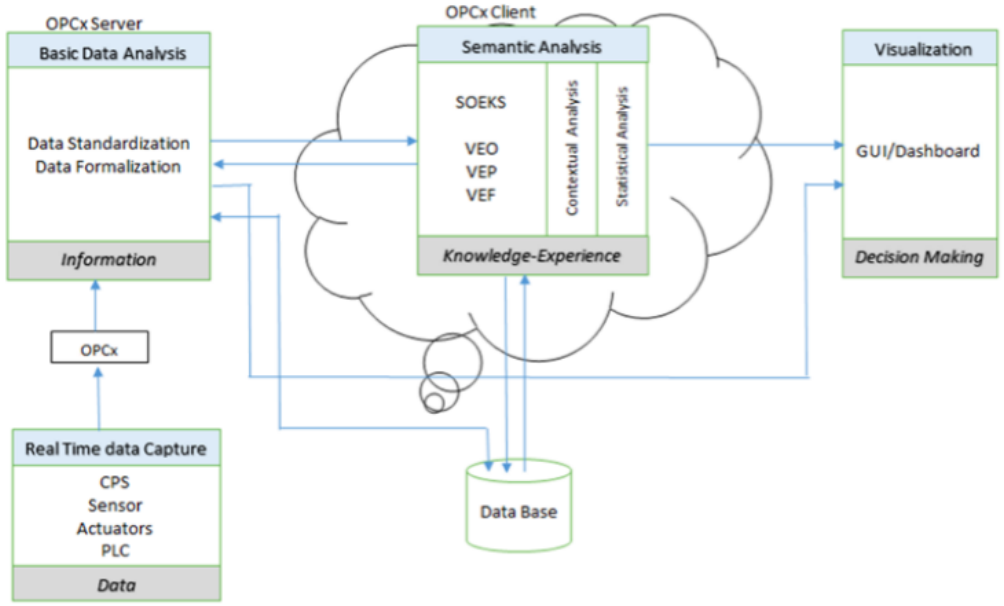

OPC
OLE for Process Control


Preprocessing
Data Input
Data Mining Process
Analysis
Validation
System
Optimization
Information


SUMO
PULO
PDO
PSO
Entity
Physical
Abstract
Object
Process
Quantity
Graph
Proposition
Relation
GraphElement
SetOrClass
Region
Collection
SelfConnectedObject
Agent
Argument
InformationSubject
FieldOfStudy
Procedure
Food
Transitaway
Substance
AdditionalSubject
InventionSubject
Apparatus
Product
Process
Material
CorpuscularObject
ContentBearingObject
OrganicObject
Artifact
SymbolicString
LinguisticExpression
icon
DocumentElement
ArtWork
StationeryArtifact
Device
Fabric
Clothing
Product
Sentence
Phrase
Language
Word
Morheme
TransportationDevice
MathFormula
Table
Text
ChemicalFormula
Reference
Figure
Weapon
Machine
AttachingDevice
Text
MusicalInstrument
MeasuringDevice
Patent Structure Ontology (p.3) – Claim
Patent Metadata Ontology
EngineeringComponent
MotionPicture
Book
FictionalText
Certificate
Summary
FactualText
Article
Section
Series
Patent
FinancialInstrument
Patent Drawings Ontology
Document
Patent Structure Ontology (p.1) - DocumentsSections
Patent Structure Ontology (p.2) - EpoKindDocument

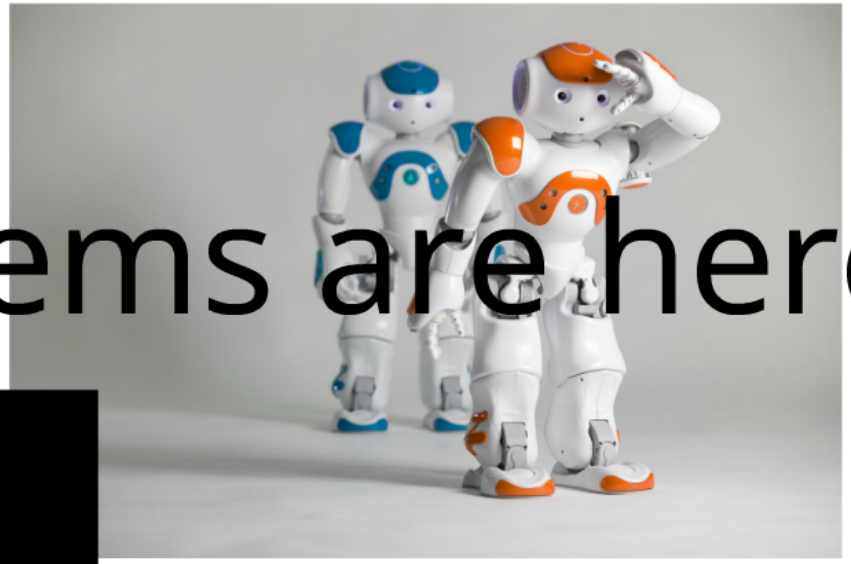

Information Analytics
Geospatial Analytics
Interaction
Scientific Analytics
Cognitive and
Perceptual Science
Scope of Visual
Analytics
Statistical Analytics
Presentation, production,
and dissemination
Knowledge Discovery
Data Management &
Knowledge Representation

We use a series of novel concepts called: VEO (Virtual Engineering Objects), VEP (Virtual Engineering Process) and VEF (Virtual Engineering Factory)




Demo

Concluding remarks



Smart systems are here!

Smart systems are knowledge aggregators

$$\frac{d}{dx}\left[x^2+x^3\right]=\frac{d}{dx}\left[x^2\right]+\frac{d}{dx}\left[x^3\right]=2x+3x^2$$

$$\frac{d}{dx}\left[x^2+\sin x\right]=\frac{d}{dx}\left[x^2\right]+\frac{d}{dx}\left[\sin x\right]=2x+\cos x$$

$$\frac{d}{dx}\left[x+\cos x+\ln x\right]=\frac{d}{dx}\left[x\right]+\frac{d}{dx}\left[\cos x\right]+\frac{d}{dx}\left[\ln x\right]$$

$$=1+\sin x+\frac{1}{x}$$

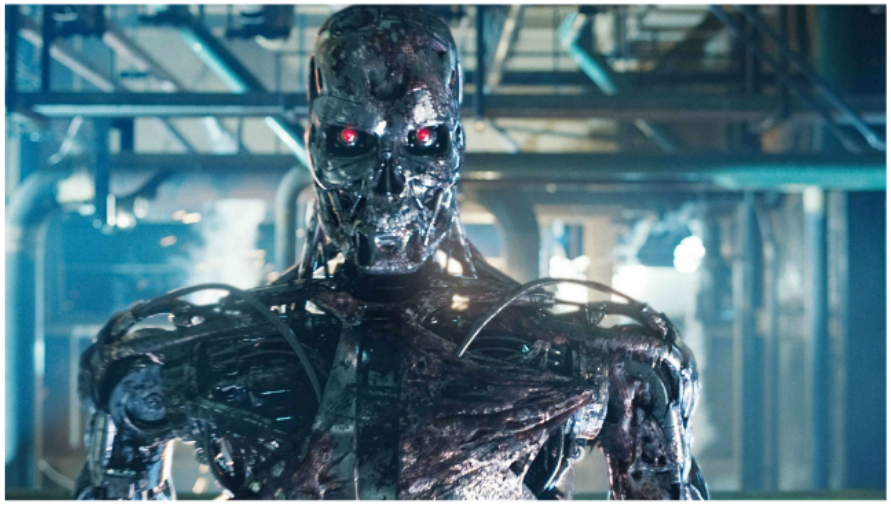
$$\frac{d}{dx}\left[x^7+e^x+\sin x+\cos x\right]$$

$$=\frac{d}{dx}\left[x^7\right]+\frac{d}{dx}\left[e^x\right]+\frac{d}{dx}\left[\sin x\right]+\frac{d}{dx}\left[\cos x\right]$$

$$=7x^6+e^x+\cos x-\sin x$$

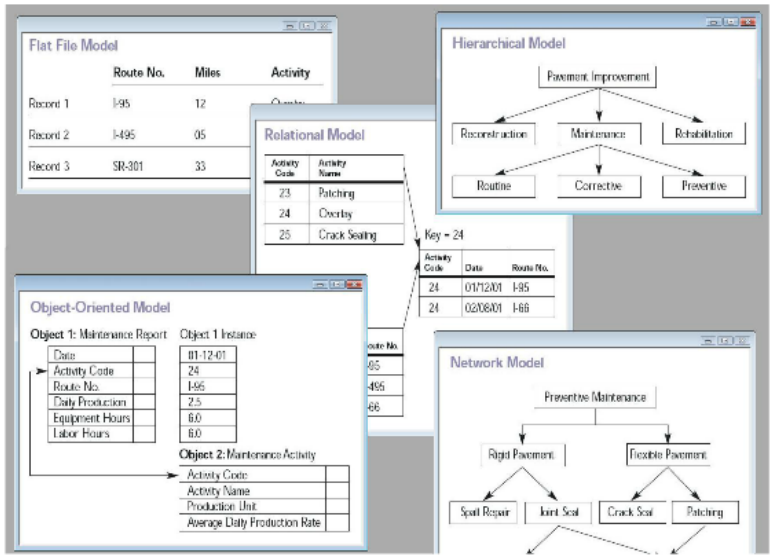
$$\frac{d}{dx}\left[\sin x+\cos x\right]=\frac{d}{dx}\left[\sin x\right]+\frac{d}{dx}\left[\cos x\right]=\cos x-\sin x$$

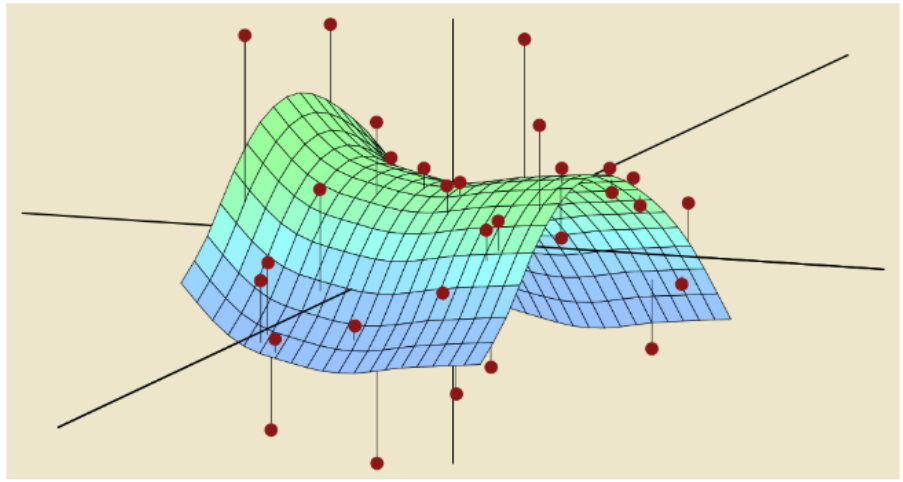
Smart systems serve for decision support, not decision making



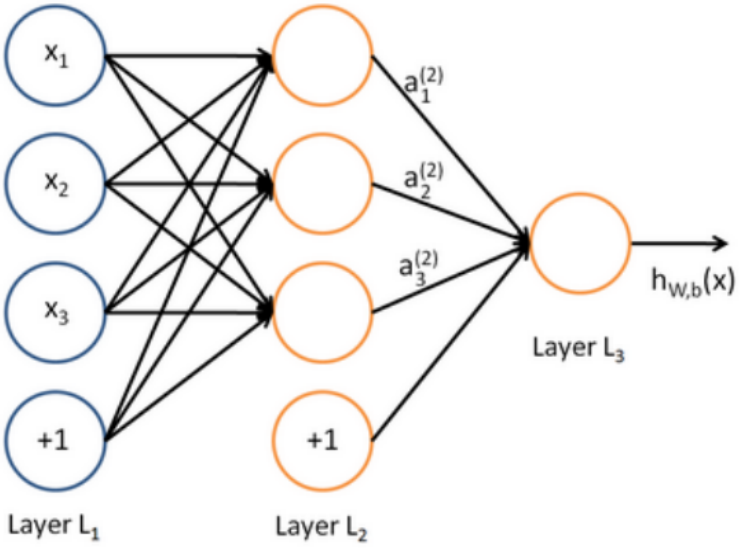
Smart systems are part of the next industrial revolution (Industrie 4.0)

Industrie 4.0





Smart Systems are complementary to classical AI approaches



BUT BE AWARE!!!!!!

DANGER

“Real stupidity beats artificial intelligence every time.”

— Terry Pratchett, Hogfather