

# KBM - Knowledge

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# Intro systems - summary

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## Investigated

- Potential media systems and their challenges with respect to knowledge representation

## Findings

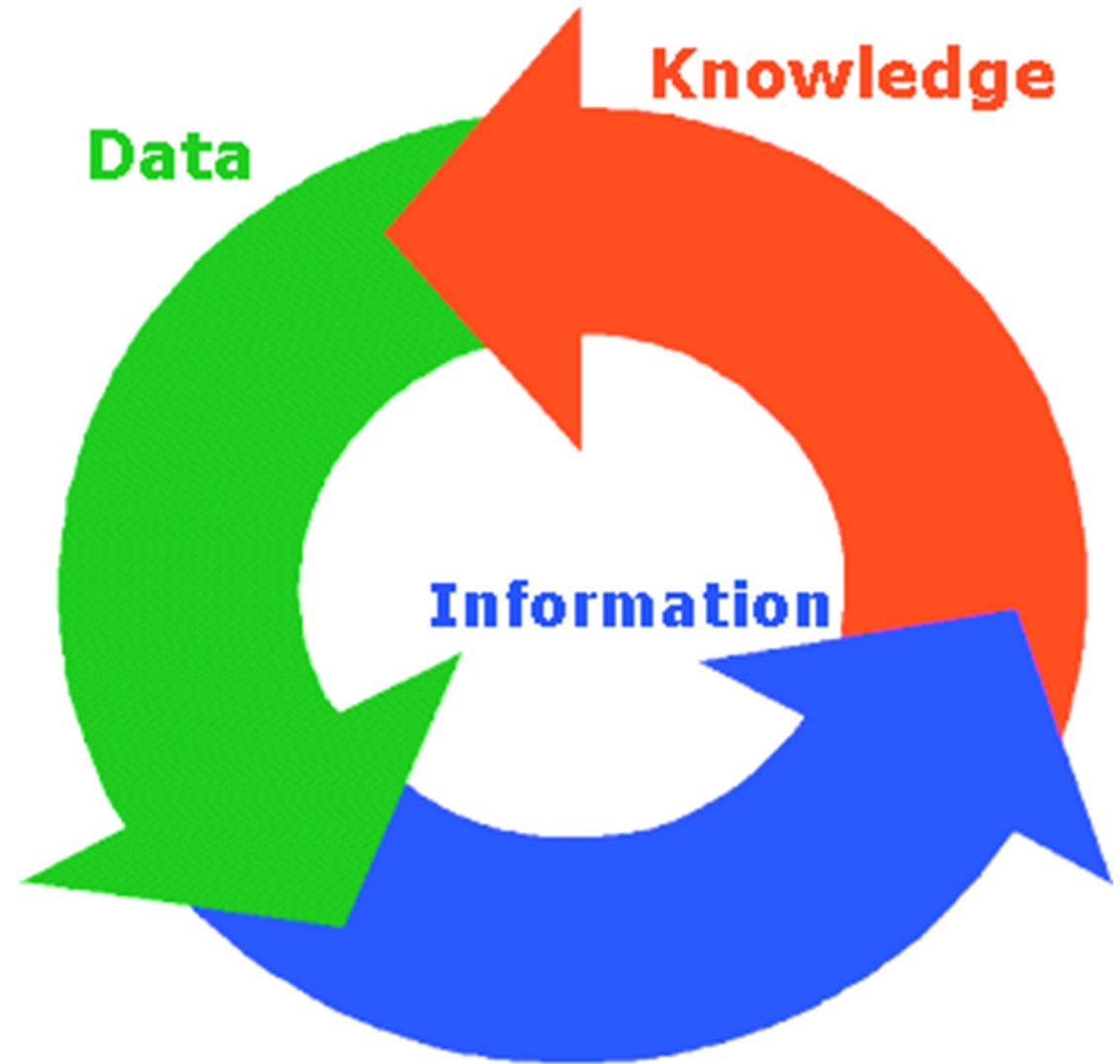
- Communication
  - is a process of transferring information from one entity to another
  - is sign-mediated interaction between at least two agents
  - both agents share a repertoire of signs and semiotic rules
- The key concepts with respect to modelling in KBMS are
  - Context
  - Interaction
  - Adaptation
  - Different media require different modelling approaches

# Groups

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<b>KGB</b>	Haitam Ben Yahia, Justin Sluijter, Tony Nguyen, Markus Pfundstein and <b>Thomas Meijers</b>
<b>Statisch Lokaal</b>	Bob Mulder, Rick Bruins, Daniel van Lier, Sybe Tigchelaar, <b>Iris Bosma</b>
<b>XXX</b>	Roderick van der Weerd, Jelmer Alphenaar, Joseph Weel, <b>Tjalling Haije</b>
<b>YYY</b>	<b>Rina Vaendel</b> , Maarten Sukel, Yaleesa Borgman , Kubilay Keser, Lina Blijleven
<b>Groot</b>	Amir Al Nomani, Jelle Koster, <b>Tim Groot</b> , Joris Timmer, Kah Ho Zheng
<b>Roommate</b>	<b>Sebastiaan Hoekstra</b> , Jeffrey Kuiken, Charlotte Hartman, Tjomme Schilstra, Minke Houthuesen

# Data, Information, Knowledge



# Data and Information

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## Data

refers to groups of information that represent the qualitative or quantitative attributes of a variable or set of variables => uninterpreted, raw (Schreiber et. al 1999)

## Information

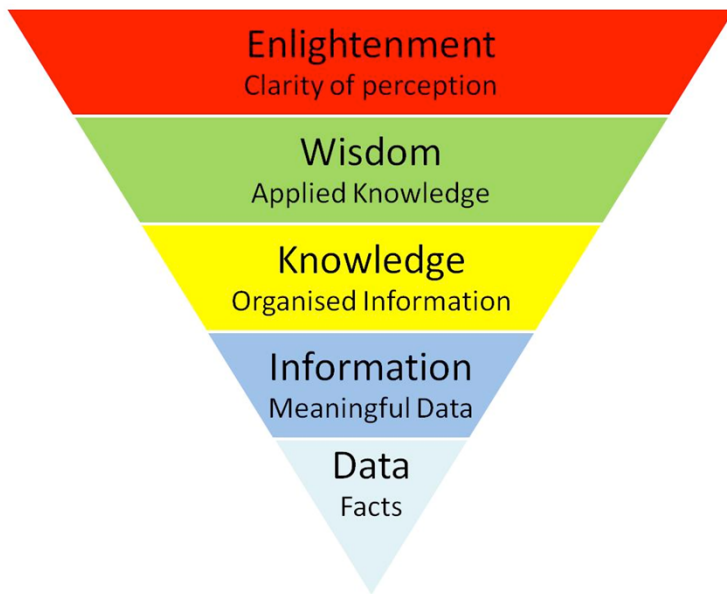
in its most restricted technical sense, is an ordered sequence of symbols => data equipped with meaning. As a multi-faceted concept of information in terms of signs and signal-sign systems it represents meaning in terms of four inter-dependent levels: pragmatics, semantics, syntax, and empirics.



C. E. Shannon's Information theory (1948) involving the quantification of information to find fundamental limits on signal processing operations such as compressing data and on reliably storing and communicating data. => Entropy

# Knowledge

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## Knowledge (Definitions)

Knowledge is the whole body of data and information that people bring to bear to practical **use in action**, in order to carry out tasks and create new information. Knowledge adds two distinct aspects: first a sense of **purpose**, since knowledge is the “intellectual machinery” used to achieve a goal; second, a **generative capability**, because one of the major functions of knowledge is to produce new information.

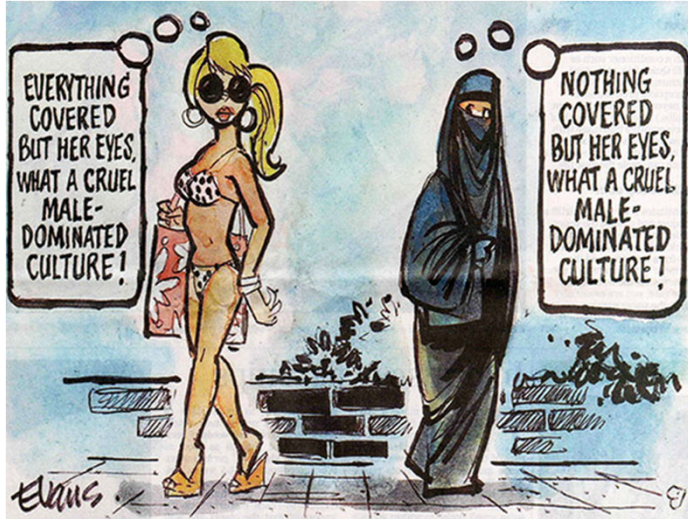
(Schreiber et. al 1999, p. 4)

Knowledge is stable because the essential properties of objects are knowable and relatively unchanging. The important metaphysical assumption of objectivism is that the world is real, it is structured, and that structure can be modelled for the learner. Objectivism holds that the purpose of the mind is to “mirror” that reality and its structure through thought processes that are analyzable and decomposable. The meaning that is produced by these thought processes is external to the understander, and it is determined by the structure of the real world.

(Jonassen 1991, p.28)



# Knowledge

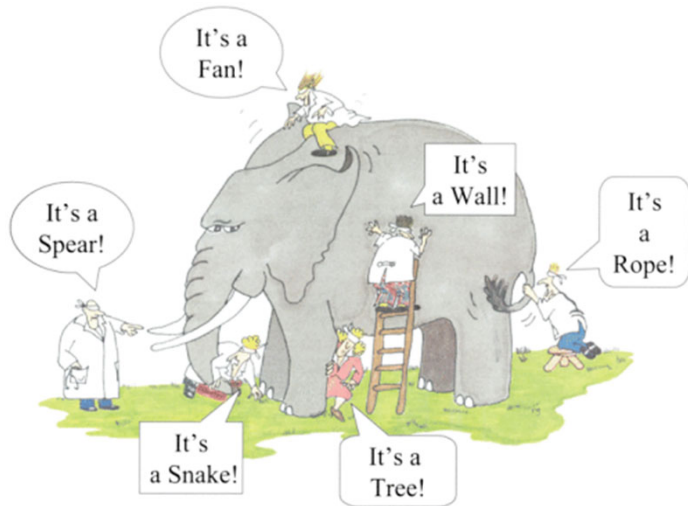


## Situated knowledge

Specific to a particular situation, based on

- trial and error
- learning from experience

=> often embedded in language, culture, or traditions

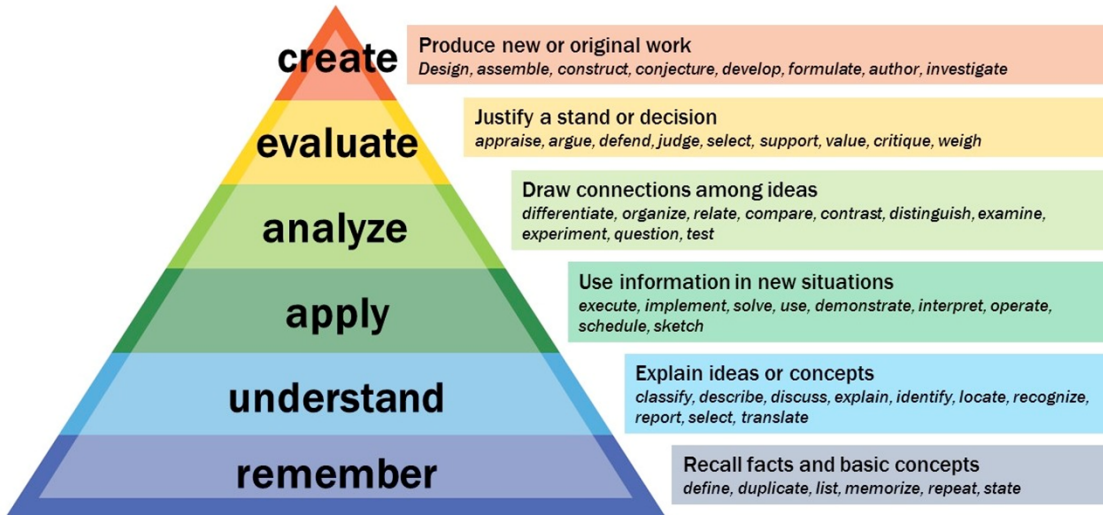


## Partial Knowledge

Knowledge is often not complete (partial). Most real problems have to be solved by taking advantage of a partial understanding of the problem context and problem data.

# Knowledge

## Bloom's Taxonomy



### Domain Knowledge

A specific (expert) knowledge valid for a pre-selected area (e.g. art, biology, surgery). The nature of such knowledge is usually declarative.

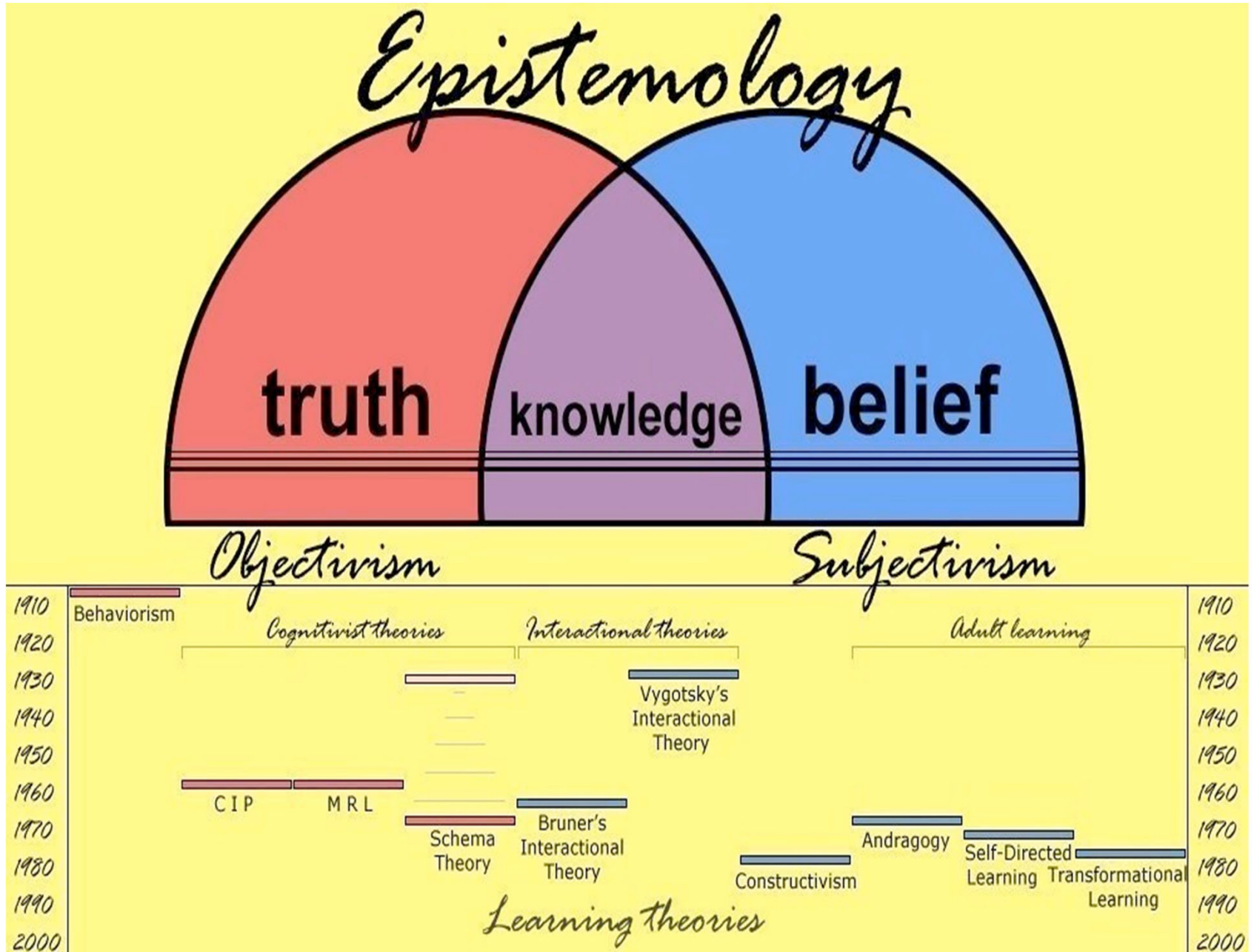


### Procedural Knowledge

Knowledge that is exercised in the accomplishment of a task, and thus includes knowledge which, unlike declarative knowledge, cannot always be easily articulated by the individual, since it is typically non-conscious.

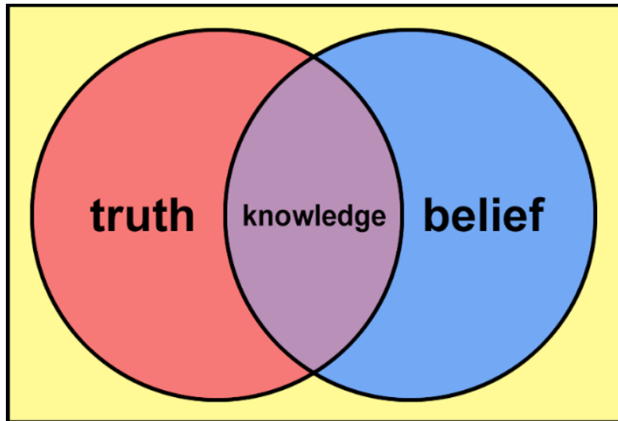


# Epistemology



# Belief and Truth

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**Epistemology** (Source of knowledge)

## **Belief**

The kind of belief usually addressed within epistemology is that when "to believe something" simply means any cognitive content held as true.

## **Truth**

Criteria of truth are standards and rules (verification tools) used to judge the accuracy of statements and claims.

# Internalism, Externalism, Justification

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**Epistemology** (source of knowledge)

## Internalism

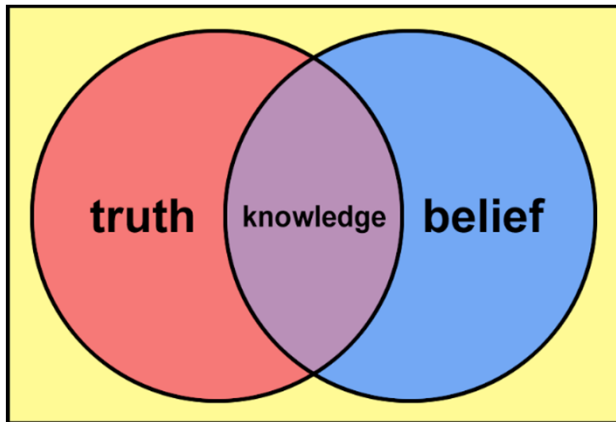
All knowledge-yielding conditions are within the psychological states of those who gain knowledge.

## Externalism

Factors deemed outside of the psychological states of those who gain knowledge.

## Justification

Knowledge is explained or defined in some way. According to the Socratic theory that knowledge is justified true belief, in order to know that a given proposition is true, one must not only believe the relevant true proposition, but one must also have a good reason for doing so.



# Regress problem

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Any justification itself requires support, since nothing is true “just because”.

## Answers

- Infitism

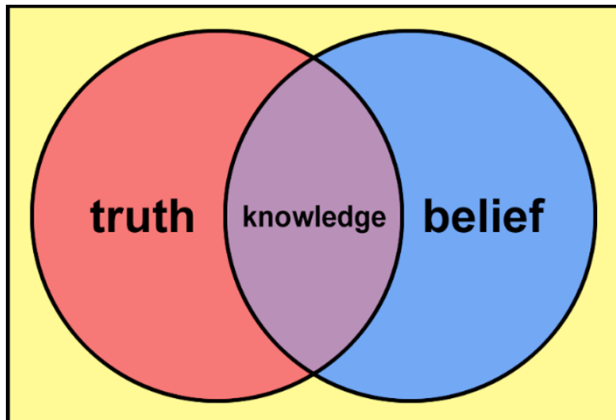
The infinite series is merely potential. The individual need only have the ability to bring forth the relevant reasons when the need arises.

- Foundationalism

Some beliefs that support other beliefs do not themselves require justification by other beliefs.

- Coherentism

An individual belief is justified circularly by the way it fits together (coheres) with the rest of the belief system of which it is a part.



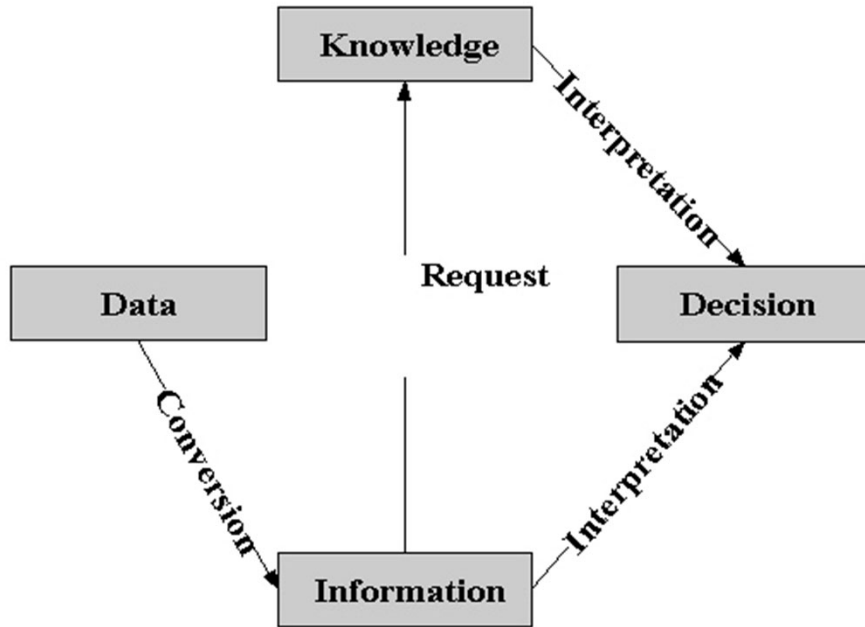
# Knowledge acquisition



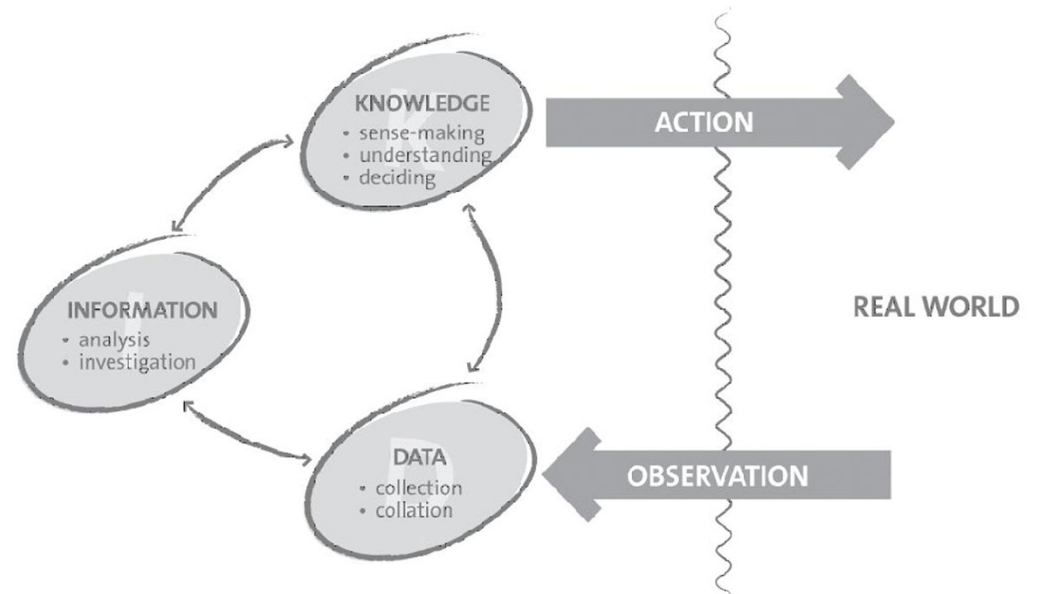
*"I expect you all to be independent, innovative, critical thinkers who will do exactly as I say!"*

- **A priori**  
knowledge that is gained independently of experience (non-empirical)
  - Authority
  - Intuition
  - Rationalism (acquired by processes, in the form of concepts not derived from experience).
- **A posteriori**  
knowledge that is known by experience
  - Empiricism (experimental inquiry based on perceptual observations by the five senses)
  - Constructivism (contingent on convention, human perception, and social experience).

# Knowledge acquisition



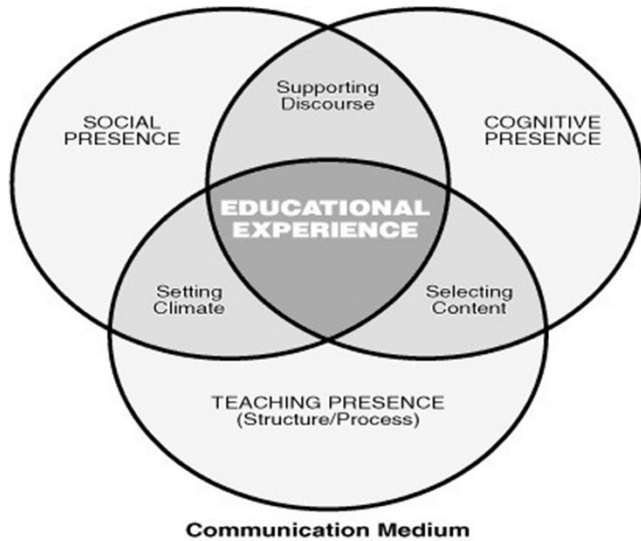
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[http://blog.jackvinson.com/images/amitchell\\_20DIK\\_20reality\\_20map.JPG](http://blog.jackvinson.com/images/amitchell_20DIK_20reality_20map.JPG)



# Constructivism – one approach on knowledge



Elements of an educational experience (Garrison, Anderson, & Archer, 2001).

**Constructivism** proposes a new paradigm for knowledge and truth, based on inter-subjectivity instead of the classical objectivity and viability of truth.

## Knowledge is subjective

And so is reality => Radical Constructivism

"To the constructivist, concepts, models, theories, and so on are viable if they prove adequate in the contexts in which they were created" (von Glaserfeld, 1995, p.7).

## Knowledge is situated

Knowledge is grounded in action (Brown et. al 1989)

Knowledge is co-constructed through social and cultural communities of practice (Lave & Wenger 1991)

People are situated, embodied agents (Brooks 1990)

# Constructivism – one approach on knowledge

**Constructivism** proposes a new paradigm for knowledge and truth, based on inter-subjectivity instead of the classical objectivity and viability of truth.

## Knowledge is distributed

Distributed cognition (Hutchins 1995, Norman 1993)

Belief Systems

Cultures

World knowledge (common sense knowledge)

Consciousness

Subconscious processing essential for functioning

Emotion/affect

Emotion and cognition are intertwined

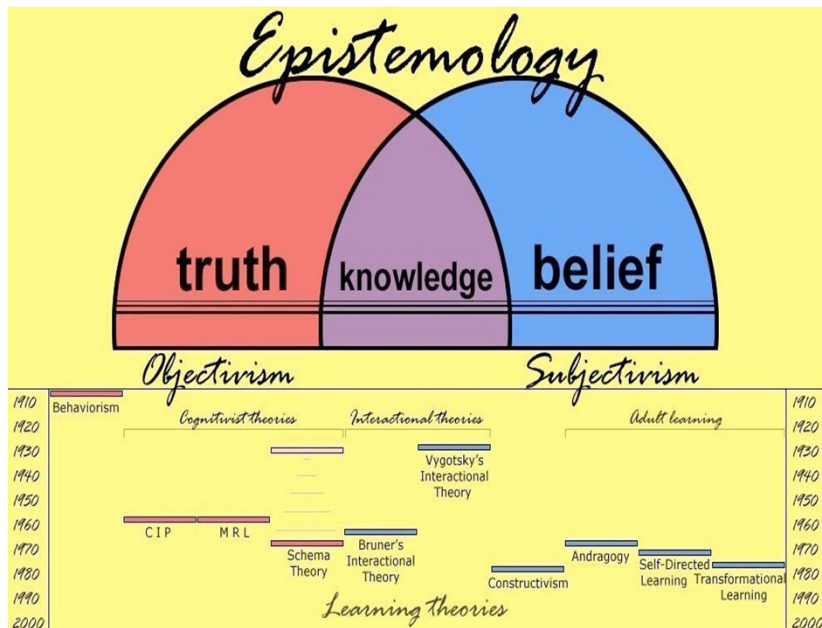
Stories and narratives

Interaction

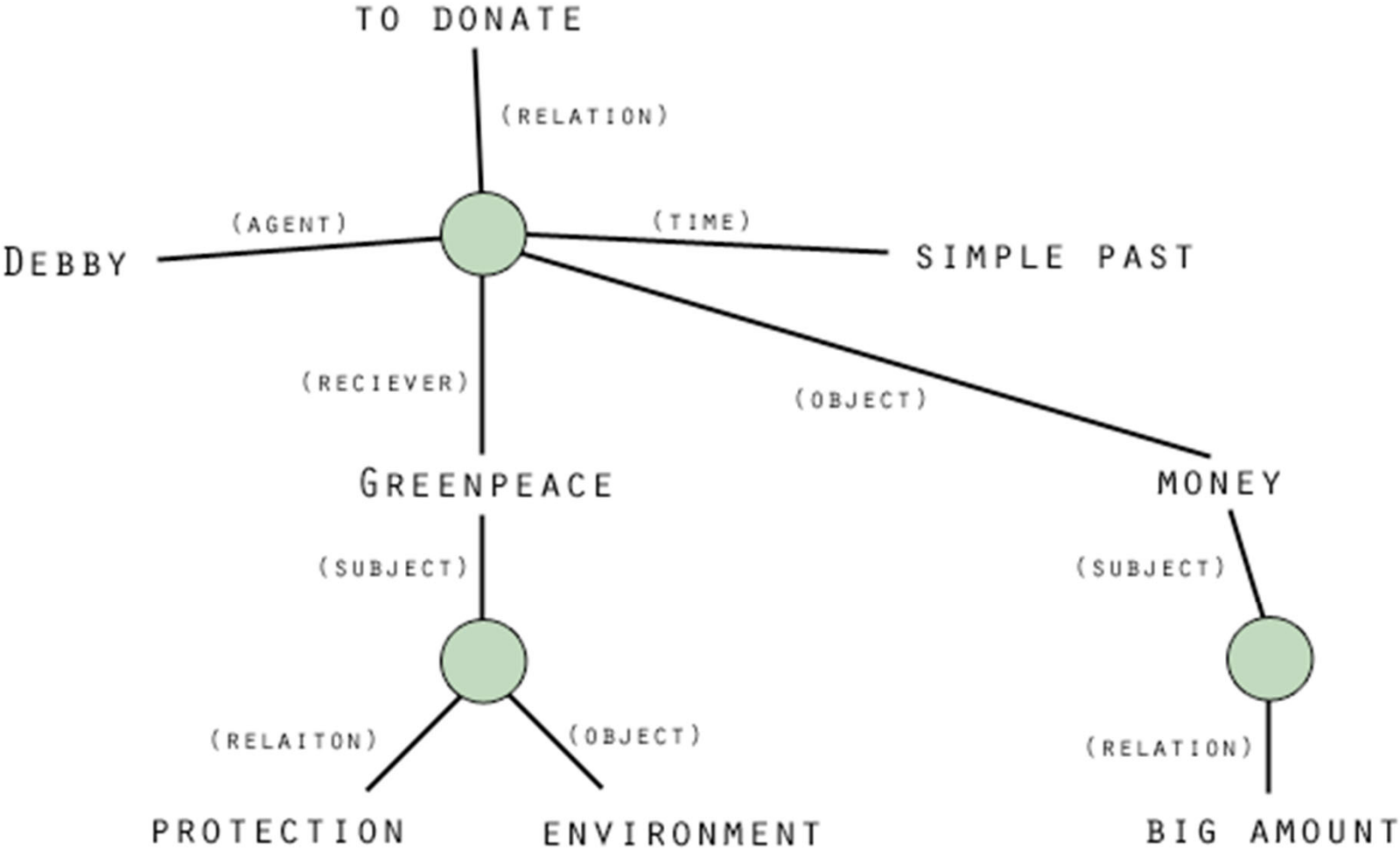
Social animal

Embodied in the world

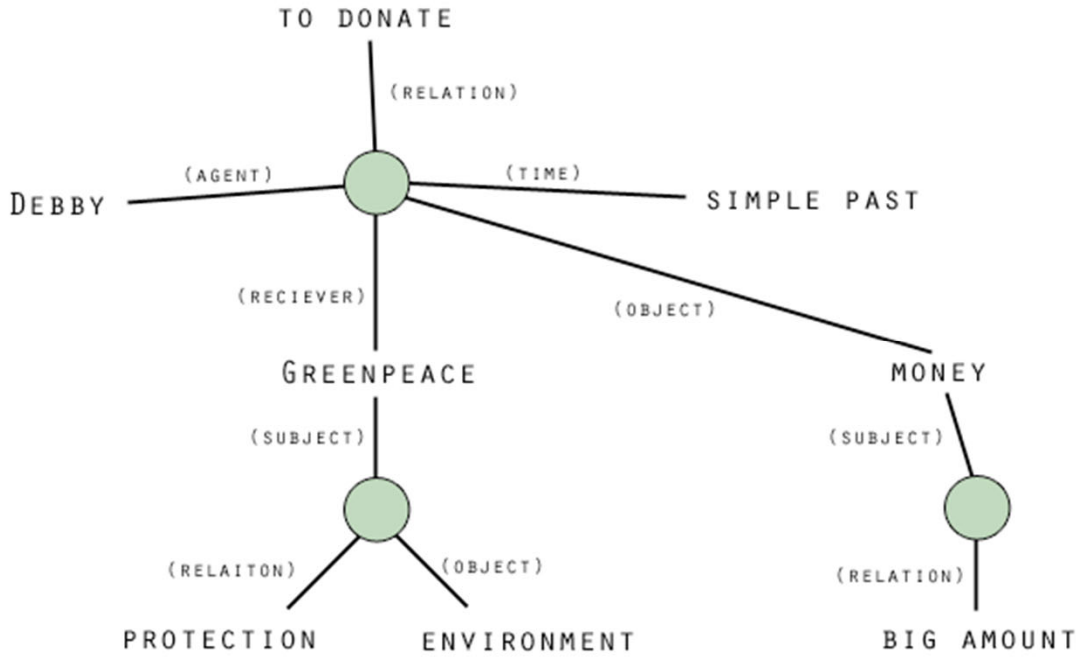
**Social constructivism**– unifying heterogeneous knowledge sources (Vygotsky 1978, Piaget 1970)



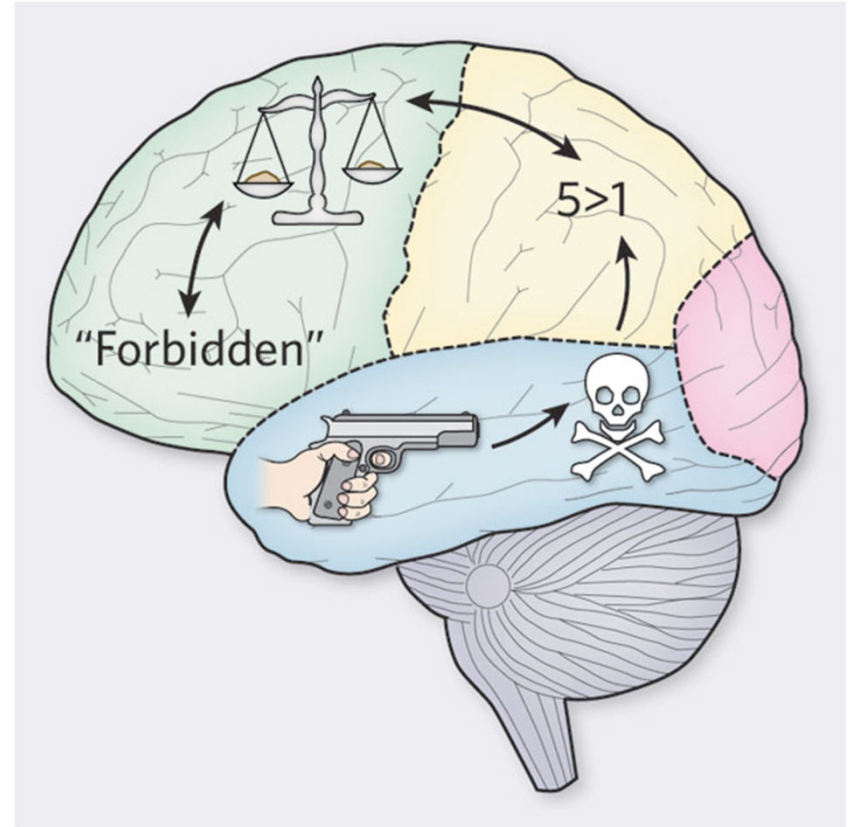
# Knowledge Representation



# Knowledge Representation

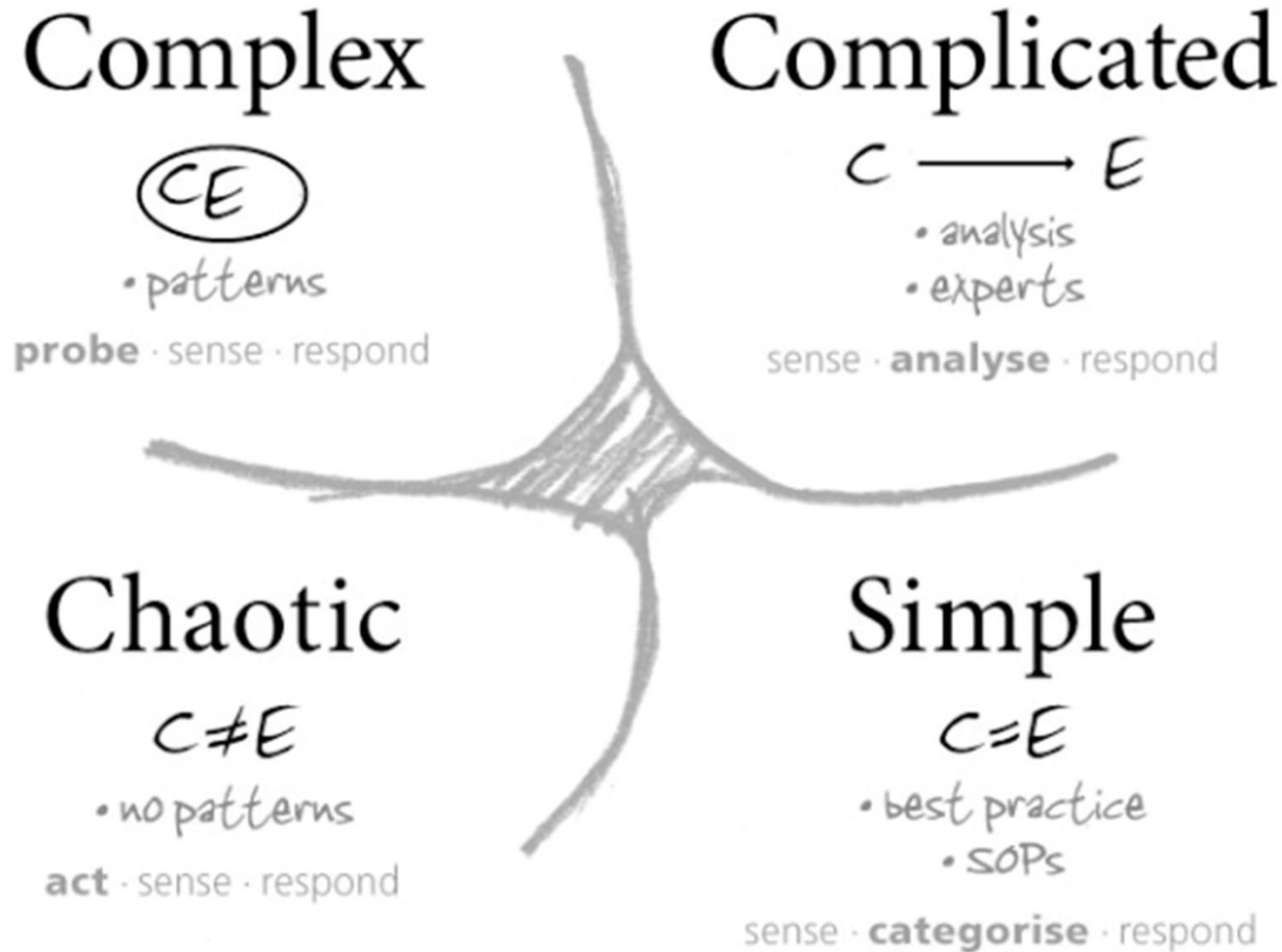


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[http://www.nature.com/nature/journal/v460/n7252/fig\\_tab/460190a\\_F4](http://www.nature.com/nature/journal/v460/n7252/fig_tab/460190a_F4)

# Knowledge representation

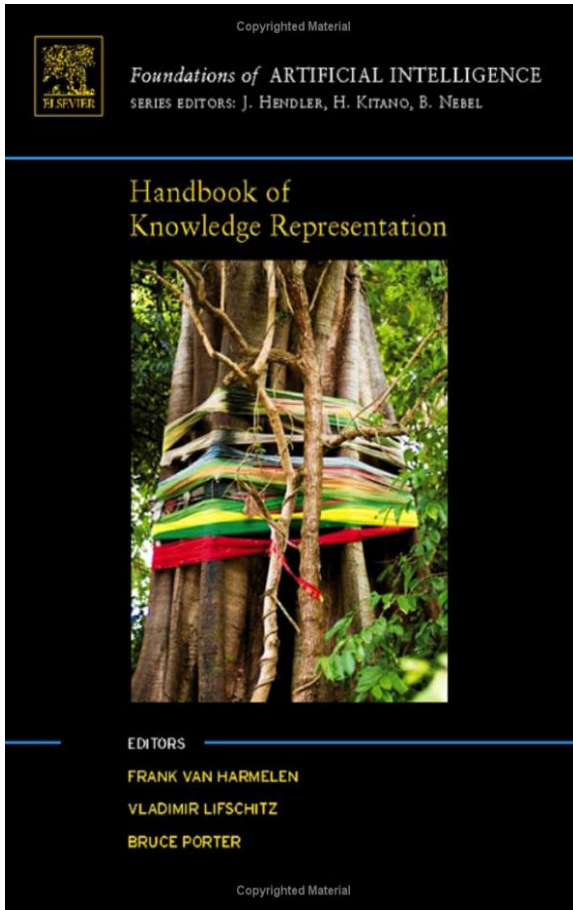


The **Cynefin framework**: describe a perspective on the evolutionary nature of complex systems, including their inherent uncertainty. (Snowden et al. 2007)

[www.anecdote.com](http://www.anecdote.com)

See also : <http://www.youtube.com/watch?v=5mqNcs8mp74&feature=email>

# Knowledge representation



van Harmelen, F., Lifschitz, V., and Porter, B. (2007). Handbook of Knowledge Representation, Elsevier.

## What is a knowledge representation (KR)

(Davis, Shrobe, and Szolovit 1993)

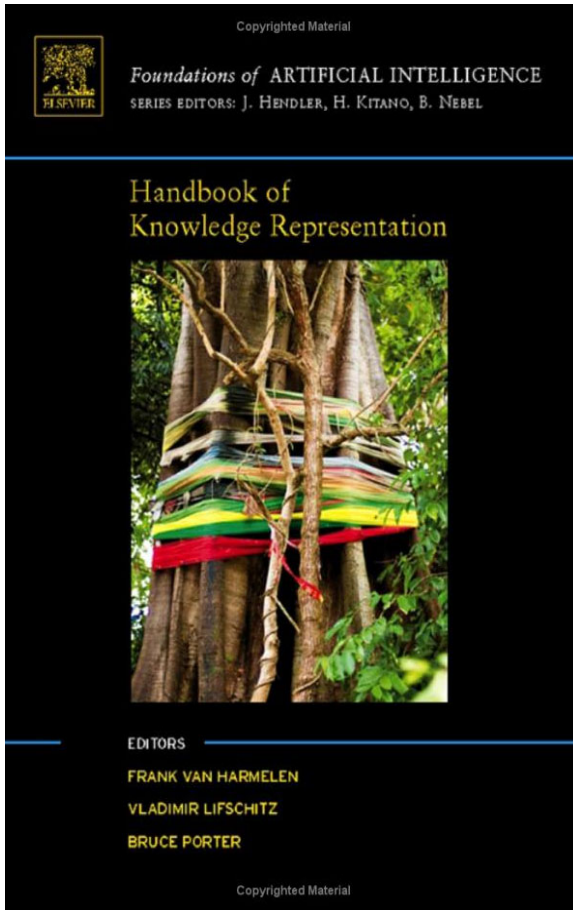
A knowledge representation is fundamentally a **surrogate**, a substitute for the thing itself, used to enable an entity to determine consequences by reasoning about the world rather than taking action in it.

It is a medium of human expression, i.e., a language in which we say things about the world.

It is a set of ontological commitments, i.e., an answer to the question: In what terms should I think about the world?



# Knowledge representation



van Harmelen, F., Lifschitz, V., and Porter, B. (2007). Handbook of Knowledge Representation, Elsevier.

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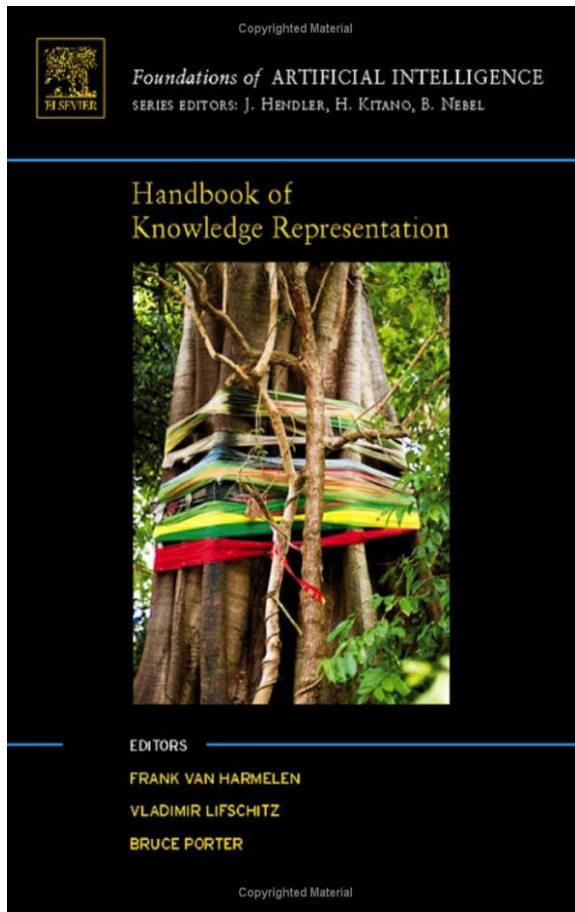
It is a medium for pragmatically efficient computation, i.e., the computational environment in which thinking is accomplished.

It is a fragmentary theory of intelligent reasoning, expressed in terms of three components:

- the representation's fundamental conception of intelligent reasoning;
- the set of inferences the representation sanctions;
- the set of inferences it recommends.

# Knowledge representation

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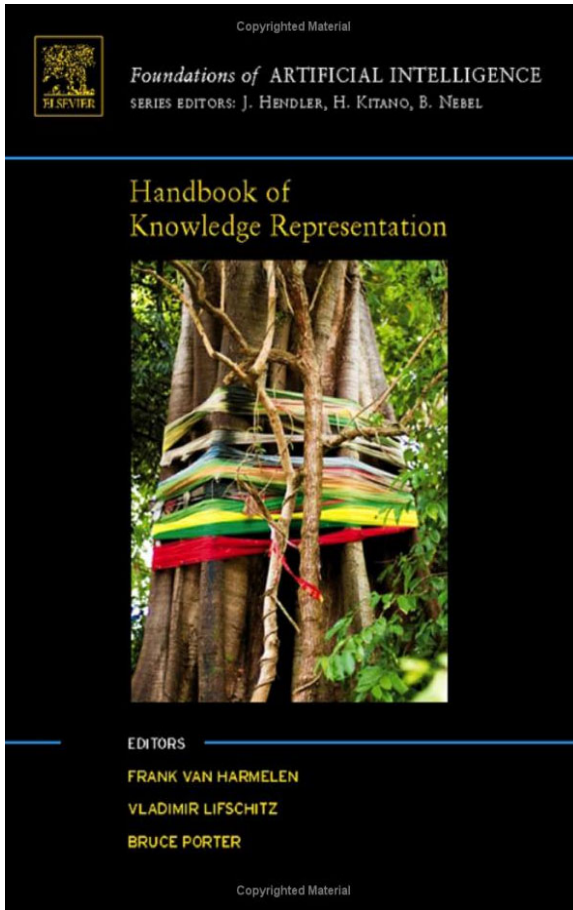
General methods

Specialised representations

Knowledge applications

# Knowledge representation

## General methods



**Classical logic** (propositional, first and second order, theorem proving, etc.)

**Semantic networks and frames** (set of terminals to which other structures can be attached)

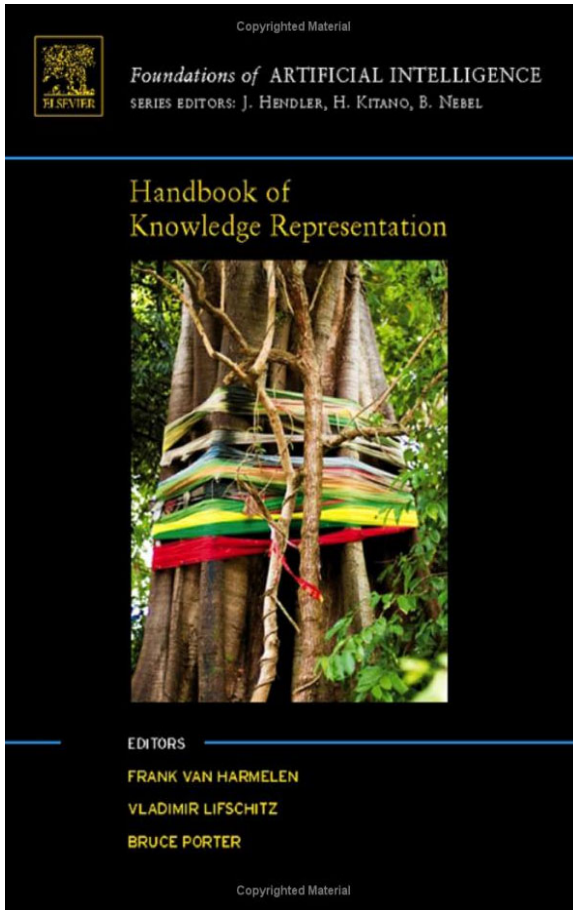
**Description logics** (concept description of a domain, atomic concepts and atomic roles)

**Constraints satisfaction** (a set of variables, each with some domain values, a set of relations (constraints) on a subset of these variables)

**Conceptual graphs** (a graph representation for logic based on semantic networks and Peirce's existential graphs)

**Belief revision** (beliefs are represented as sentences of a formal language and belief sets as theories of this language)

# Knowledge representation



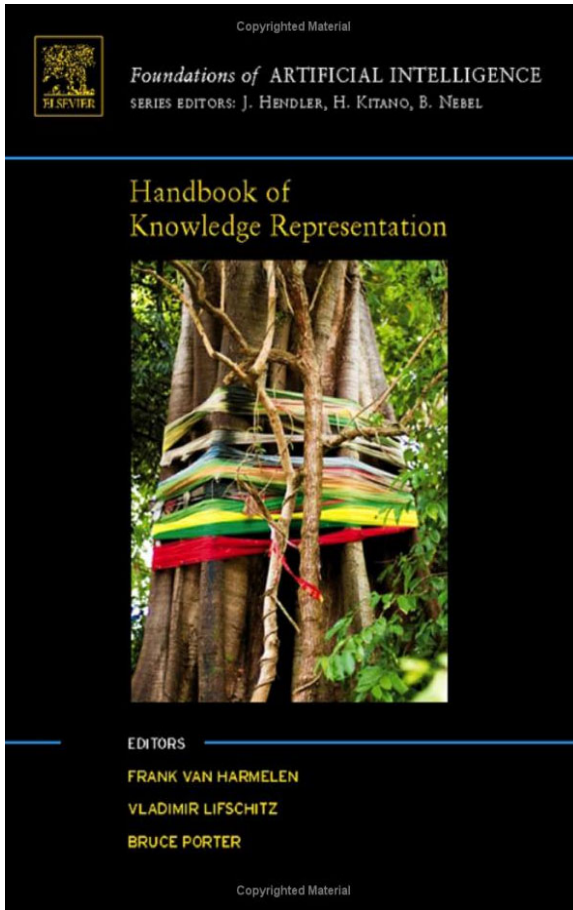
## General methods

**Qualitative modelling** (representation and reasoning about continuous aspects of motion, space and time – common sense modelling)

**Baysian networks** (a probabilistic graphical model that represents a set of random variables and their conditional independencies via a directed acyclic graph).

**Scripts and cases** (stereotypical representations of situations and problems)

# Knowledge representation



## Specialised representations

**Temporal representations** (e.g. Allen's temporal logic)

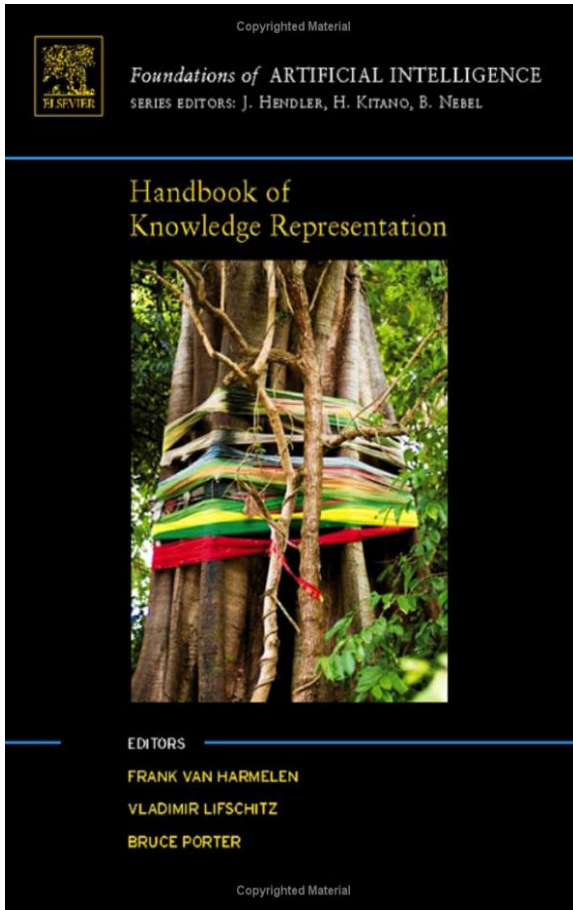
**Qualitative spatial representations** (symbolic representations of spatial entities, shapes and their parts - mereology)

**Situation calculus** (a logical language for representing changes)

**Event calculus** (a formalism for reasoning about action and change)

**Case-based reasoning** (a formalism that allows to solve new problems by adapting solutions that were used to solve old problems).

# Knowledge representation



## Knowledge applications

**Question answering** (templates, grammars, cases, etc.)

### Semantic web

**Planning** (process that chooses and organises actions by anticipating their expected effects => domain, goals, problem)

**Agent and multi-agent systems** (formalisms to describe the cognitive state of rational agents and then to make an agent act)

**Knowledge engineering** (theory, methods and tools for developing knowledge intensive applications => tasks, problem solving and ontologies)



# Intro – Knowledge representation in AI

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## Knowledge applications

Interactive narrative

Ambient computing

Pervasive computing

Information visualisation

# Intro – summary

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- Knowledge representation has to cover reliable, situated and partial knowledge
- A knowledge representation is a surrogate that provides a set of ontology commitments so that humans have a language in which they state things about the world.
- Communicating knowledge is mainly symbolic but can be performed in a variety of techniques.
- Knowledge communication has to bridge the gap between internal and external factors
- There are already a large variety of knowledge representation techniques available, of which most follow the epistemological understanding of knowledge by focussing on propositional representations.

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