Human and Machine Interaction with Knowledge-Bases

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Simon Bray, Dstl.

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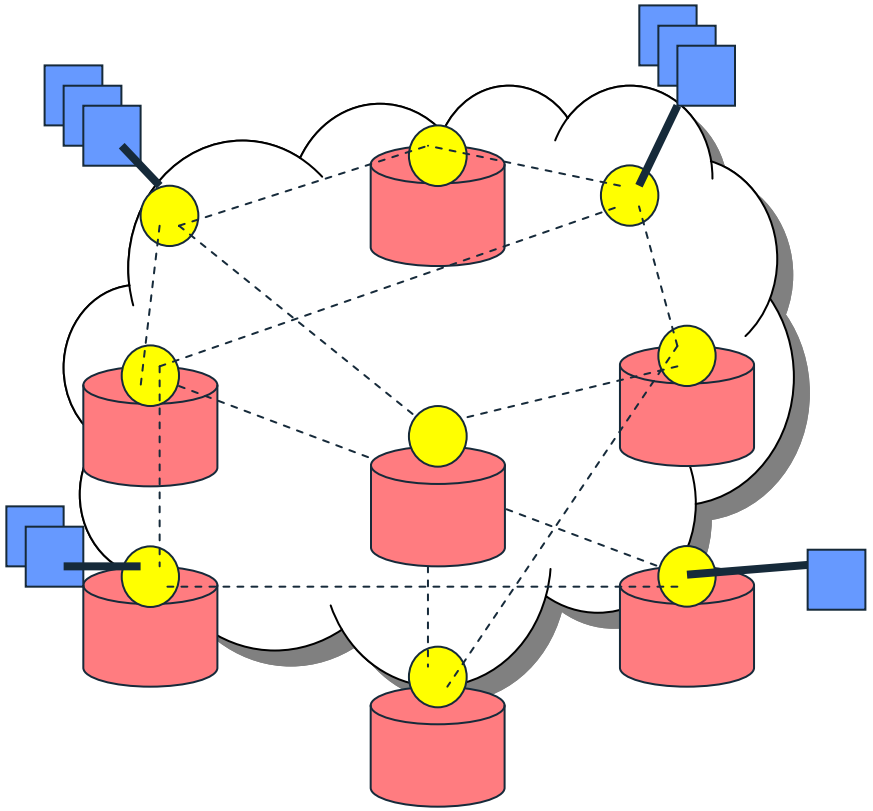
Virtual Knowledge Base Concept



Users

Storage of Information and “Known-facts”

Services

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The role of philosophy

Philosophy provides a consistent logical framework through which we choose to view the world. We need a philosophy …

- **Of Language**
  - **How do words/symbols/expressions acquire meaning?**
  - **What is information?**
- **Of Knowledge and Existence**
  - **What can we know, what is possible to exist, what is real, what else is there?**
  - **How do we represent knowledge?**
  - **What distinguishes sense from non-sense?**
  - **What is the difference between sense and significance?**
- **Of Truth**
  - **What is true? what is the difference between fact, opinion, and belief?**
- **Of Logic**
  - **How do we infer what is true and determine consequences?**

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Philosophical choices …

- There is no “right answer” to philosophy - which approach will enable the most useful military knowledge-bases to be built?
- No one philosophy meets the requirement. The solution proposed is to separate knowledge into 4 “Worlds” with different philosophies:
  - The Objective World (facts): – Logical Positivism (and Logical Atomism).
  - The Subjective World (opinions, motivations, …) – superficially like facts with significant differences in logic and truth.
  - Alternative Worlds – Either of the above with reference to a planned, or hypothetical situations rather than the real-world.
  - The Universal World (classes, what is necessarily so) – Ontological Nominalism

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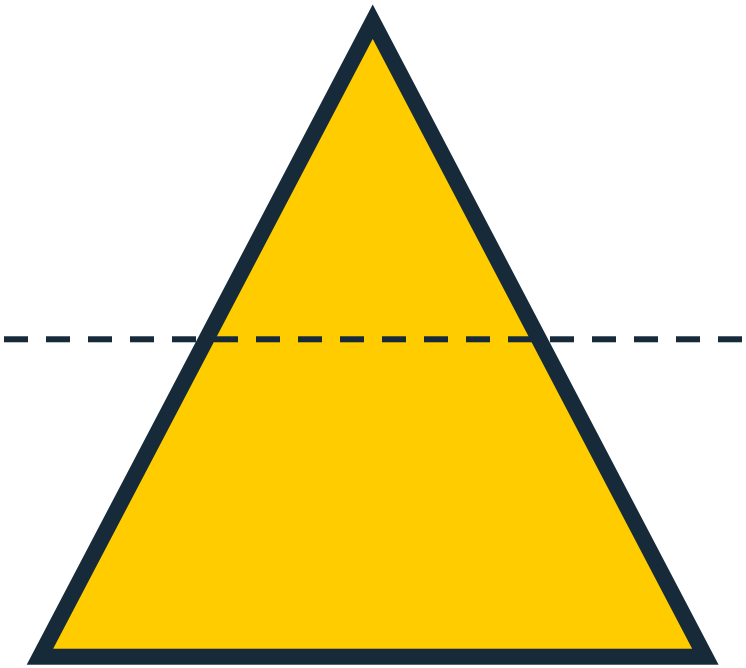
Logical Positivism / Logical Atomism

What is so in the world

Facts



External World

VKB

What we think we know about the world

Knowledge

What we are told about the world.

Information

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Simple Example

Conceptual Model

(Universal World)

Entities-classes:

-People

-Locations

Attributes:

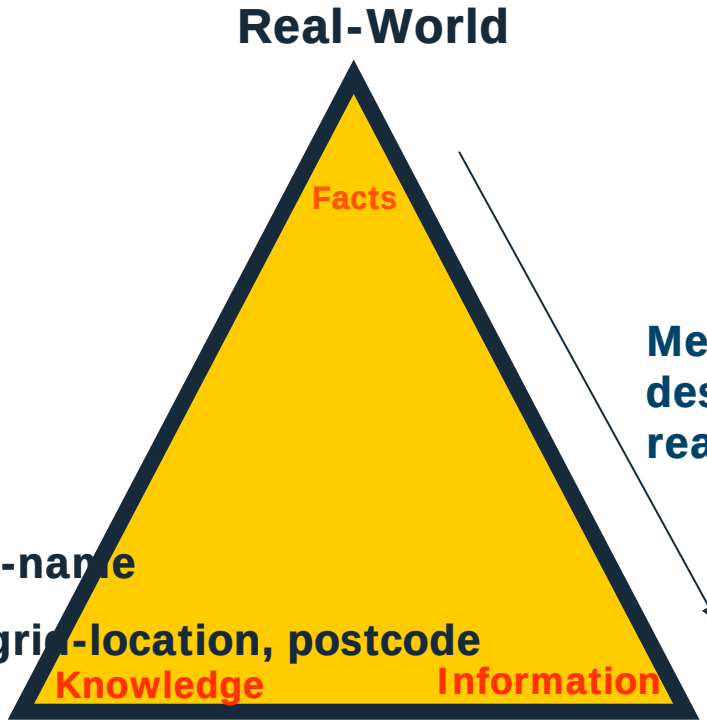
People: first-name, last-name

Location: place-name, grid-location, postcode

Relations:

person is-located-at location

person is-associate-of person



Message describing the real-world

Message-ID: ABC123hG23

From: Jo Bloggs

Date-20-Feb-2010

Time: 13:15

I saw Alex Carter talking to John Roberts in Rotherham at 11 am.

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Simple Example

"Known facts"
(Objective World)

arter is-an-associate-of John
s, True

arter is-located-at London, True

oberts is-located-at London, True

Message
describing the
real-world

Message-ID: ABC123hG23

From: Jo Bloggs

Date-20-Feb-2010

Time: 13:15

I saw Alex Carter talking to John Roberts in London at 11 am.

sing time
lification

Missing
provenance

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e role of language

A means of communicating.

- How can we make communications “machine understandable”?
- Why do we communicate? (how much is implicitly stated?)

A means of knowledge representation.

- How can we record “known-facts” in a manner that is unambiguous, with as much “context” as is necessary to prevent misinterpretation?.
- How can we do this in a way that supports machine-reasoning (as well as human reasoning, and hybrid human-machine teams)?

either case we need to understand how the words and symbols used quire their meaning.

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Why do we communicate?

Information-Exchange Types) After Searle: Speech-Acts

- Inform (the input of newly extracted “known-facts” into a knowledge-base)
- Know (the opposite of inform: the export of information derived from the knowledge-bases’s internal representation of “known-facts”).
- Query – Response & Question – Answer
- Mediated Information Exchange:
  - Propose - approve/reject/counter-propose
  - Command –Acknowledge (with implied commitment)/ Clarify
  - Request – Response
  - Transaction (an atomic commitment to a set of changes, not necessarily related to the exchange of goods for money)
  - Poll
  - Vote
  - Auction
- Knowledge-Base Directive
- Notify
- Synchronisation

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ow can we make communications “machine nderstandable”?

Using “propositions” as the basis for forming expressions.

A proposition is here defined as a statement that can true of false.

Not all sentences are propositions: but all can be expressed as roposition(s) plus a pragmatic element. The pragmatic element defines what the recipient is supposed to do with the propositions, which can be efined for each information-exchange-type.

- E.g. The Command: “Unit X go to location Y at date-time Z” can be re-expressed as:
- Proposition: “Unit X, at-location Y, at date-time Z, True”
- Pragmatic element: “Make the above proposition so (in the real world)”.
- This pragmatic element is common to all information-exchanges of the type “Command”, and can be represented by a standardised token.

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ow can we record “known-facts” in a manner that is unambiguous, th as much “context” as is necessary to prevent misinterpretation?

All “known-facts” can be represented as propositions, and propositions about propositions (and having this common-basis for the anguage of communication and the language of knowledge representation is ssential).

Every proposition in a knowledge-base needs to be “qualified” to void ambiguity.

- This is a consequence of pooling knowledge extracted from information-exchanges: the meaning of a proposition can be dependent on the context of its being said.
- Take the proposition: “Unit X, at-location Y, at date-time Z, True”
- Is this a reported observation or declaration of intent?

stinctions to be recorded for every known-fact:

ue / False / Possible / Impossible (handles conflicting views of truth)

ypothetical / Asserted / Declared (handles authority & confidence)

ategorical/ Probabilistic / Implication (handles uncertainty*)

mple / Alternate / Combined (handles ambiguity & logic*)

storical/ Latest/ Future/ Defined (handles time)

bjective / Subjective / Alternative / Universal Worlds (handles mes of reference, including hypothetical situations/ plans /options)

babilities and logical combinations are defined in associated 2nd-order propositions.

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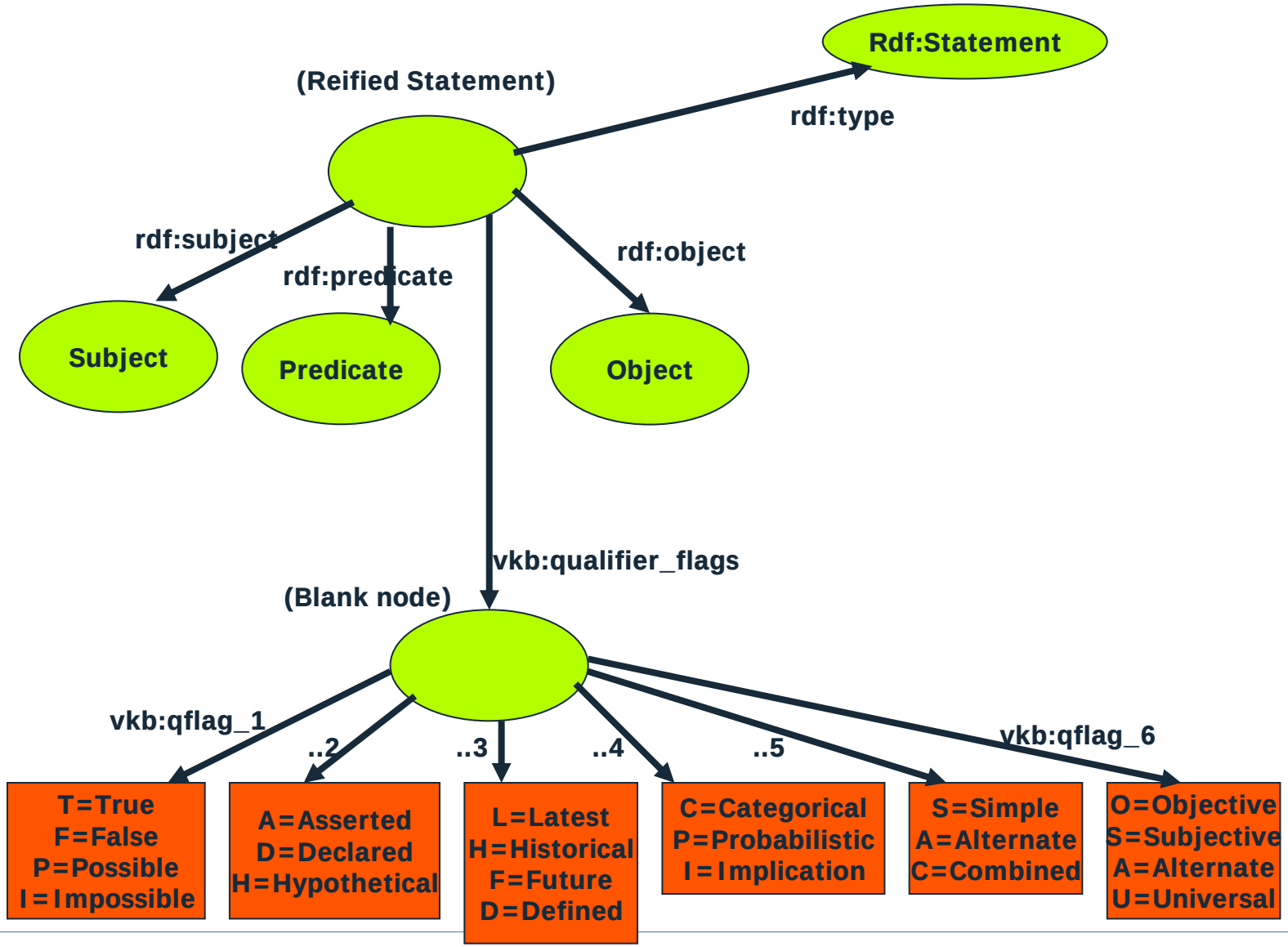
An “atom” of knowledge – a “proposition”



ome Uses of 2nd-Order Propositions

- provide additional information about the referenced first-order opositions(s), e.g. its provenance, perishability, sensitivity, accuracy, and y confidence-level (or probability).
- describe the conditions under which the referenced first-order oposition(s) are valid.
- link statements qualified as being “Alternative World” with a specific stance of such a world as an object, upon which other facts can be edicated including labels (e.g. Plan-A, Plan-B), provenance etc.
- affirm that a given person, group/community, or automated assessment ocess, believes the referenced first-order proposition to be so or not-so, with without a level of confidence.
- record other “attitudes” (other than belief) towards a proposition by meone, e.g. “A hopes that xyz” where xyz is a 1st-order proposition.
- form a logical combination of first-order propositions, e.g. to express that oposition A OR Proposition B is true.
- link an Implied 1st order statement to its operands (the statements from hich it is implied, and the logic operator(s) used to form the implication).

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g it all together – human and machine interaction with knowledge-bases