Vague, Incomplete, Uncertain, And Context-Dependent Information

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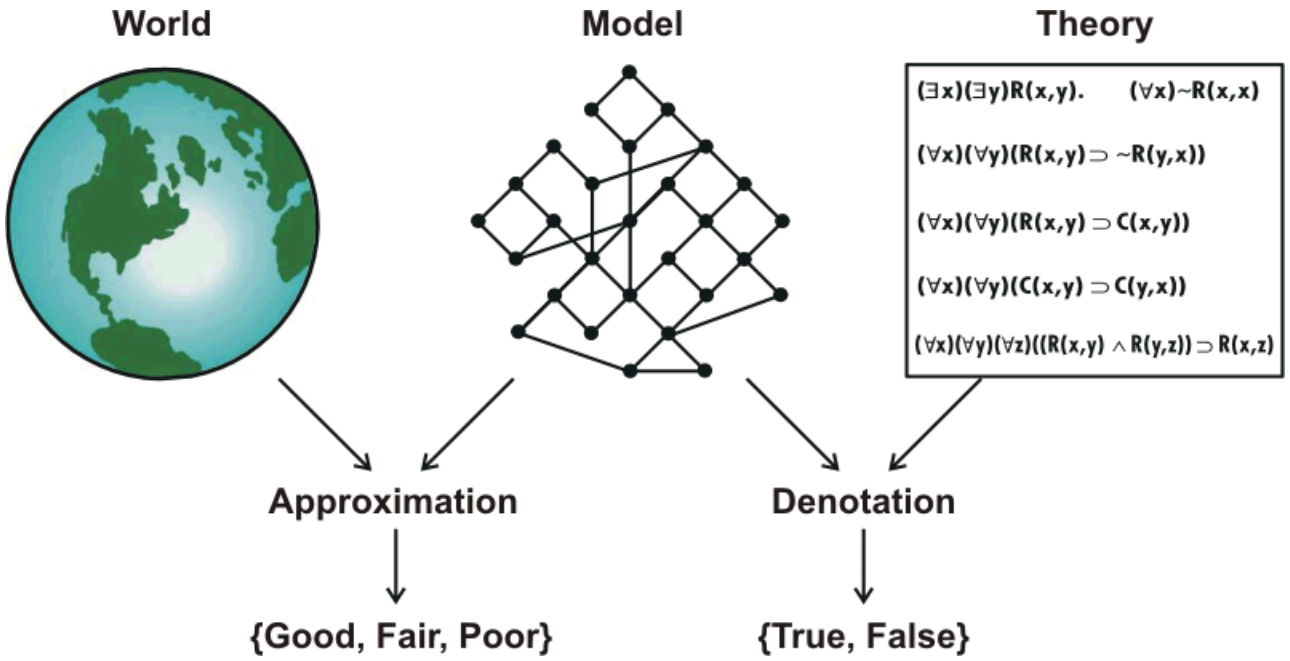
Model-Theoretic Semantics



In his first book, Wittgenstein assumed that the world and the model of the world are identical: ***"The world is everything that is the case."***

Therefore: ***"Everything that can be said can be said clearly... Whereof one cannot speak, thereof one must be silent."***

Wittgenstein's later philosophy is very similar to the engineers':

"All models are wrong. Some are useful."

Some Quotations

Immanuel Kant:

"Since the synthesis of empirical concepts is not arbitrary but based on experience, and as such can never be complete (for in experience ever new characteristics of the concept can be discovered), empirical concepts cannot be defined. Thus only arbitrarily made concepts can be defined synthetically... This is the case with mathematicians."

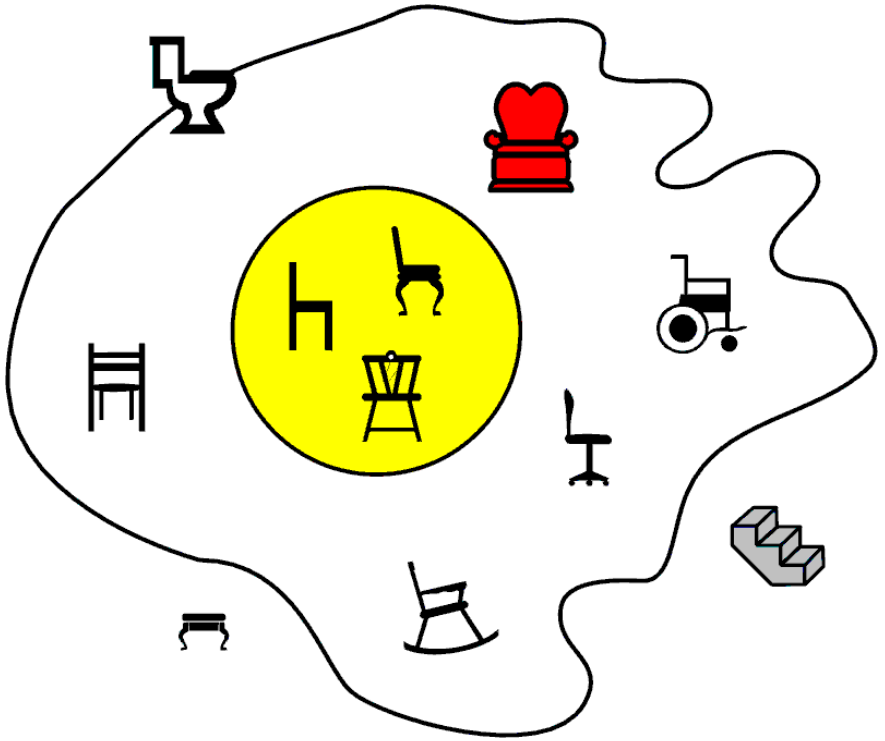
Charles Sanders Peirce:

"It is easy to speak with precision upon a general theme. Only, one must commonly surrender all ambition to be certain. It is equally easy to be certain. One has only to be sufficiently vague. It is not so difficult to be pretty precise and fairly certain at once about a very narrow subject.."

Alfred North Whitehead:

"Human knowledge is a process of approximation. In the focus of experience, there is comparative clarity. But the discrimination of this clarity leads into the penumbral background. There are always questions left over. The problem is to discriminate exactly what we know vaguely."

What is a Chair?



An egg-yolk diagram puts typical examples in the yolk and less common variants in the egg white. (Lehmann & Cohn 1994)

The boundaries resemble the *level cuts* of fuzzy set theory: the fuzzy value 0.9 could be the boundary for the yolk, and 0.7 for the egg white.

But the reasons for the variations are more significant than the numbers that are assigned to the boundaries.

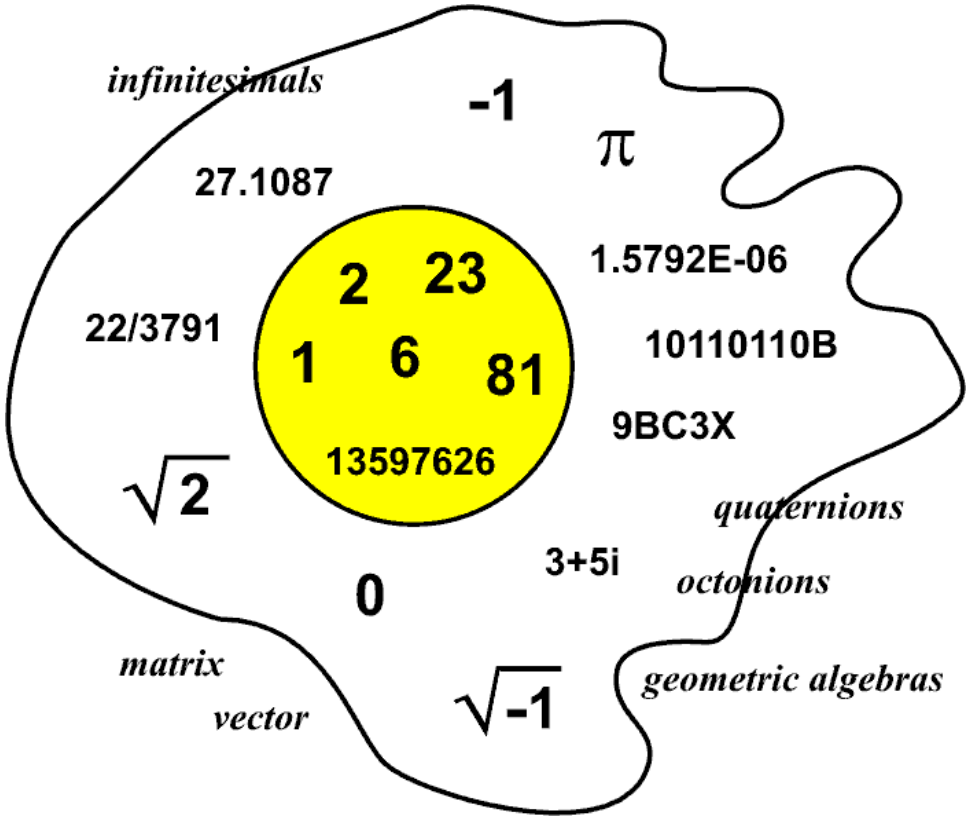
Is it a Chair? Art? Humor? Fantasy?

Whatever it is, we call it a chair.

There is no limit to the number and kinds of variations.

Claw and Ball Chair by Jake Cress. At the Smithsonian Renwick Gallery.

What is a Number?



Concepts in science and mathematics grow and change.

Consider the evolution in the basic terms of physics during the past century: *mass, energy, force, momentum, space, time, gravity, light, heat.*

Engineers often use different definitions of those terms for different components of the same system.

Microsenses

The linguist Allen Cruse coined the term *microsense* for a specialized sense of a word in a particular application.

Examples of microsenses:

- **The many kinds of chairs or numbers in the egg whites.**
- **The kinds of balls in various ball games: baseball, basket ball, billiard ball, bowling ball, football, golf ball, softball, tennis ball.**
- **Computer science requires precise definitions, but the definitions change whenever programs are revised or extended.**
- **Consider the term *file system* in Unix, Apple OS X, Microsoft Windows, and IBM mainframes.**

No finite set of words can have a fixed, precise set of mappings to a dynamically changing world.

Vagueness results from leaving the exact sense undetermined.

Using Background Knowledge

People resolve ambiguities and choose the correct microsenses by using background knowledge about the options.

Choosing the microsense: ***My dog bit the visitor's ear*****.**

- **From knowledge about the size of dogs, one might assume it was more likely to be a doberman than a dachshund.**
- **But if the listener knew the visitor was in the habit of bending over to pet a dog, it might even be a chihuahua.**

Resolving an ambiguous parse: ***The chicken is ready to eat*****.**

- **Since chicken is a typical food, it is probably cooked as a meal.**
- **If the word *chicken* were replaced with *dog*, one might assume the dog is begging for food.**
- **But people in different cultures may make different assumptions.**

The many microsenses and the dependence on background knowledge require highly flexible methods of reasoning.

“I don’t believe in word senses.”

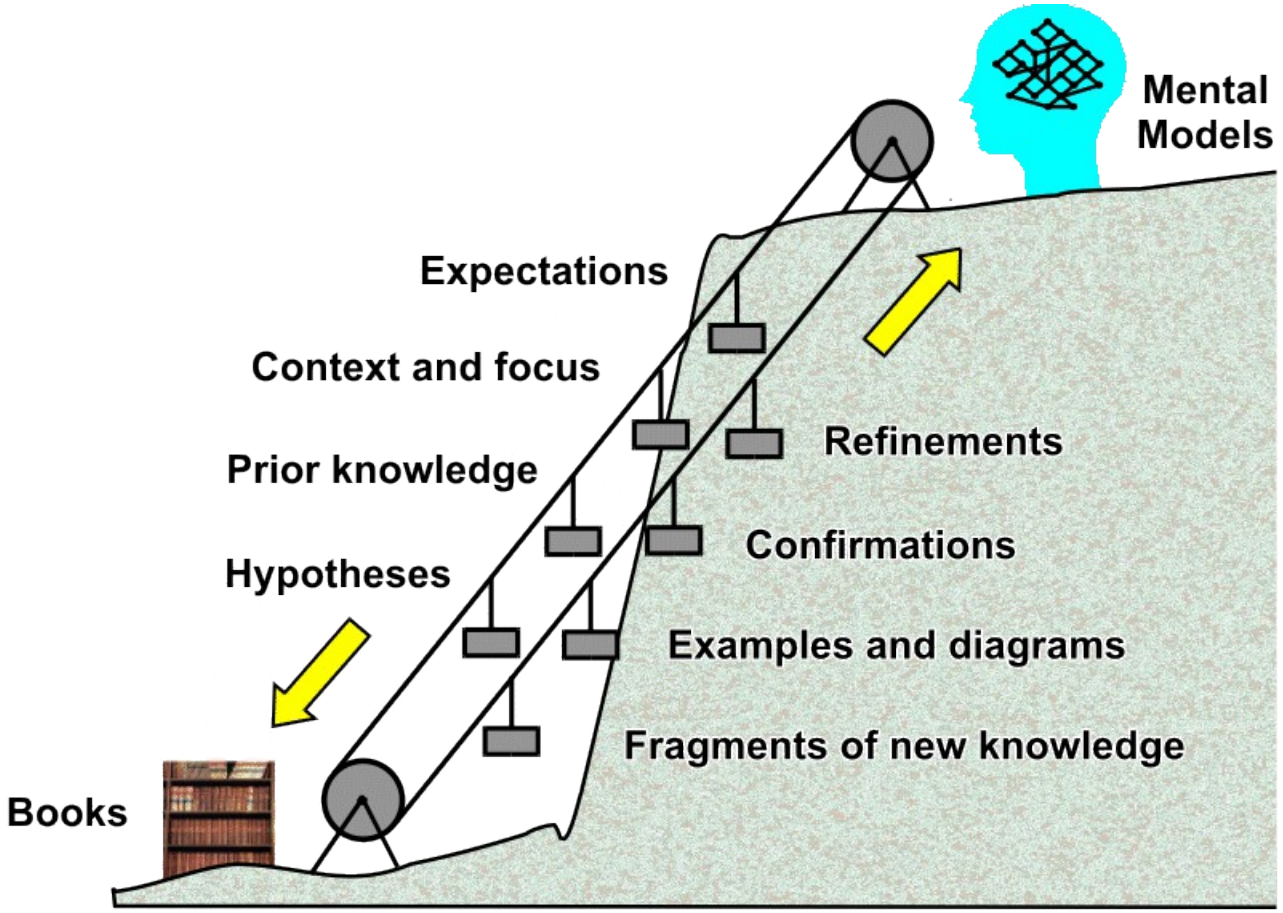
The title is a quotation by the lexicographer Sue Atkins, who devoted her career to writing and analyzing word definitions.

In an article with that title,* Adam Kilgarriff observed that

- **“A task-independent set of word senses for a language is not a coherent concept.”**
- **Basic units of meaning are “occurrences of a word in context.”**
- **“There is no reason to expect the same set of word senses to be relevant for different tasks.”**
- **Professional lexicographers are aware of these limitations.**
- **The word senses selected for a dictionary are based on editorial policy and assumptions about the readers’ expectations.**
- **“The set of senses defined by a dictionary may or may not match the set that is relevant for an NLP application.”**

*** See http://www.kilgarriff.co.uk/Publications/1997-K-CHum-believe.pdf**

Reading is More Than a Translation to Logic



Reading a book is an interactive process that constructs mental models from information in the text, prior knowledge, and the evolving context.

A system for machine reading should implement equivalent processes.

Diagram adapted from Peter Clark, et al., Reading to learn, in *Proc AAAI 2007 Spring Symposium on Machine Reading*, 2007. Slides: http://www.cs.utexas.edu/users/pclark/papers/ss07.ppt

Conclusions

The mapping from language to the world depends on every aspect of human intelligence and experience.

The model-theoretic semantics for logic is much simpler:

- **A fixed set of symbols with precise definitions.**
- **Two-valued denotations {T, F}.**
- **A formal procedure for computing them.**

A fixed set of word senses can be useful for a specialized task.

But no fixed set of senses defined by a fixed ontology can support the flexibility of human language.

Even a fuzzy range of approximations is too limited.

Dynamic methods for creating new microsenses are necessary.

Wittgenstein called them *language games*, but implementing them is still a major research problem.

Related Readings

A larger set of slides that cover many related issues,
http://www.jfsowa.com/talks/goal.pdf

Future directions for semantic systems,
http://www.jfsowa.com/pubs/futures.pdf

Role of Logic and Ontology in Language and Reasoning,
http://www.jfsowa.com/pubs/rolelog.pdf

Fads and Fallacies About Logic,
http://www.jfsowa.com/pubs/fflogic.pdf

From Existential Graphs to Conceptual Graphs,
http://www.jfsowa.com/pubs/eg2cg.pdf

Peirce's tutorial on existential graphs,
http://www.jfsowa.com/pubs/egtut.pdf