Training for Ontologists

Translating Language to Logic

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Skills Required for Ontology

Gottfried Wilhlem Leibniz, mathematician and philosopher:

> ***"The art of ranking things in genera and species is of no small importance and very much assists our judgment as well as our memory... And those who have laid out all sorts of notions under certain headings or categories have done something very useful."***

Charles Sanders Peirce, pioneer in logic and an associate editor of the *Century Dictionary*:

> ***"The task of classifying all the words of language, or what's the same thing, all the ideas that seek expression, is the most stupendous of logical tasks. Anybody but the most accomplished logician must break down in it utterly; and even for the strongest man, it is the severest possible tax on the logical equipment and faculty."***

Edsger W. Dijkstra, pioneer in computer science:

> ***"Besides a mathematical inclination, an exceptionally good mastery of one's native tongue is the most vital asset of a competent programmer."***

Qualifying Exam at Cycorp

Doug Lenat required every candidate for a job at Cycorp to take a simple exam:

- **Translate a few sentences from English to first-order logic.**
- **One candidate had a PhD in logic and taught courses in logic.**
- **Lenat apologized for giving him such an elementary exam, but explained that it was company policy.**
- **Unfortunately, the candidate failed the exam.**
- **He complained, "That's not what we teach in our courses."**
- **That may be true. But it's not an excuse.**

Typical Error

What is wrong with the following syllogism?

*** Elephant is a species.**

*** Clyde is an elephant.**

*** Therefore, Clyde is a species.**

Is the problem caused by the logic? By the English? Or both?

Little Words Mean a Lot

The indefinite article 'a' is a clue:

- **'Elephant is a species' means that the word 'elephant' is the name of a species.**
- **'Clyde is an elephant' means that the individual named 'Clyde' is a member of the species named 'elephant'.**
- **These two sentences do not imply that Clyde is a species.**

The error in the previous slide was caused by a failure to distinguish individuals and types.

In this example, English provides some helpful clues.

For more clues, look up the words in a good dictionary.

Dictionaries

A good dictionary is indispensable for ontology and knowledge representation.

Knowledge engineers should have a decent dictionary on their desks.

Unabridged dictionaries are even better, and specialized dictionaries are important for each subfield.

Quick definitions found in online dictionaries are not as good. Even the Mirriam-Webster web site doesn't give as much detail as their collegiate dictionary.

Nevertheless, even the biggest and best dictionaries designed for human use aren't sufficiently precise or detailed for ontology.

Final Exam

Translate the following sentences to first-order logic using your favorite notation.

1. **Every student who finishes the homework for a course passes the course.**

2. **On Fridays, Bob drives his Chevy to St. Louis.**

3. **Sue gives every child in her class a new book.**

4. **If you watch a pot, it will not boil.**

5. **A watched pot never boils.**

6. **If a guest with a guaranteed reservation at a hotel does not arrive at the hotel on the date of the reservation and does not notify the hotel before 4 pm on that date, then the hotel charges that guest for one night's rent.**

The translations of these questions to predicate calculus and Common Logic in both the CLIF and CGIF notations will be posted at http://www.jfsowa.com/talks/oanswers.htm

Some Hints for a Simple Ontology

The hardest part of translating English to logic is defining an ontology for representing each word as a logical expression.

Following are some ways of mapping English phrases to CLIF expressions. These mappings use a very simple ontology.

1. **Define "x finishes y" as (Finishes x y).**

2. **Define "x drives y to z on t" as (Drives x y z t).**

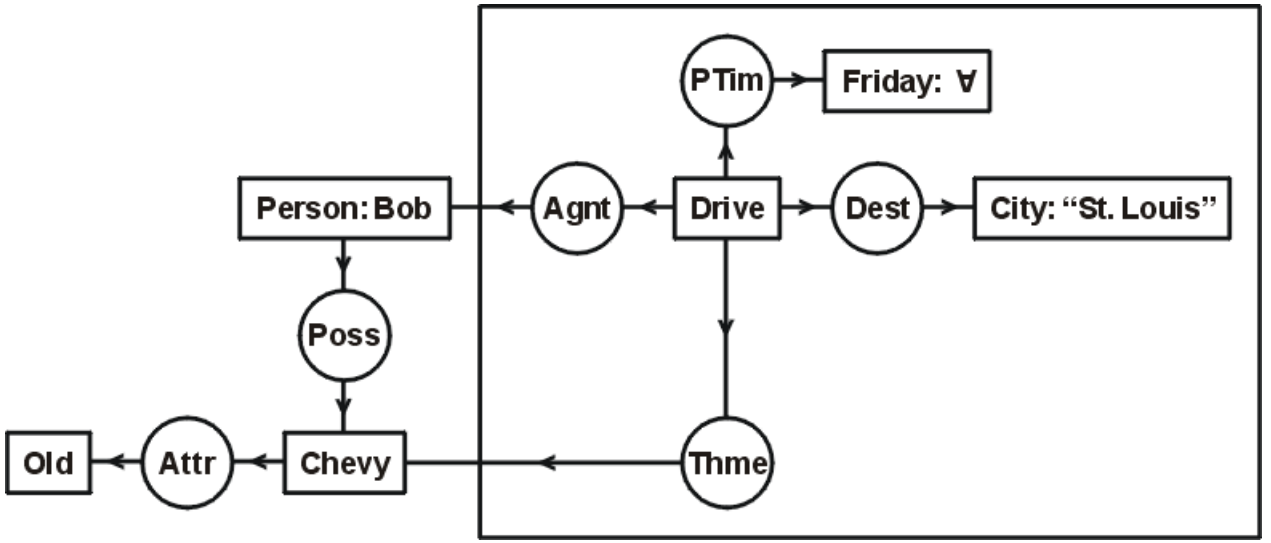
3. **Define "x gives y to z" as (Gives x y z).**

4. **Define "x watches y" as (Watches x y).**

5. **Define "some watched y" as (exists (x) (Watches x y)).**

6. **Define "x arrives at y on t" as (Arrives x y t).**

Using a Richer Ontology



English: ***Bob has an old Chevy, and on Fridays he drives it to St. Louis.***

Typed predicate calculus:

$$(\exists x1{:}Chevy)(\exists x2{:}Old)(Person(Bob) \wedge Poss(Bob,x1) \wedge Attr(x1,x2)$$
$$\wedge (\forall x3{:}Friday)(\exists x4{:}Drive)(City("St.\ Louis") \wedge PTim(x4,X3)$$
$$\wedge Agnt(x4,Bob) \wedge Thme(x4,x1) \wedge Dest(x4,"St.\ Louis")))$$

Related Readings

A Guided Tour of Ontology,
http://www.jfsowa.com/ontology/guided.htm

Controlled Natural Languages for Semantic Systems,
http://www.jfsowa.com/talks/cnl4ss.pdf

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

Conceptual Graphs,
http://www.jfsowa.com/cg/cg_hbook.pdf

ISO/IEC standard 24707 for Common Logic,
http://standards.iso.org/ittf/PubliclyAvailableStandards/c039175_ISO_IEC_24707_2007(E).zip