The system of transparent intensional logic (TIL) introduced by Pavel Tichý is used as a framework for a description of knowledge representation in man-machine communication. A detailed exposition of TIL can be found in /1/.

A language expression denotes an object by expressing its construction. The syntactic structure of the expression reflects the structure of the corresponding construction (thus obeying Frege's principle of compositionality). To analyze an expression semantically means to determine the construction it expresses. Ordinary language expressions have often more than one analysis.

The analyses of language expressions (i.e., constructions) can be represented by \( \lambda \)-expressions. This representational language has the same expressive power (within the framework of TIL) as the natural language, but has no ambiguities. The inference rules of TIL serve as a theoretical foundation for the inference necessary in knowledge representation.

The infinite hierarchy of types in TIL makes it possible to work with properties of properties or with relations between an individual and a proposition in the same way as the first order theories work with relations between individuals. Thus, TIL can be considered to be a limit case of the theories of order \( n \).
A system for knowledge representation, based on TIL, is presently under development. Its knowledge base contains a special atom representing the system itself, and certain procedures allow the system to determine the truth-value of propositions concerning its knowledge (this can be considered as a rudimentary form of self-reflection). This feature allows the system to infer correct answers e.g. in the following conversation, where $x, y$ are variables for individuals and $p$ is a variable for properties; replies from the system are marked by >>>:

1. John is a boy and Paul is a boy. >>> Hm.
2. Is Tom a boy? >>> I don't know.
3. If $x$ is a boy then you know that $x$ is a boy. >>> Hm.
4. Is Tom a boy? >>> No.
5. $x$ is omniscient with respect to $p$ iff
   (if $y$ instantiates $p$ then $x$ knows that $y$ instantiates $p$).
   >>> Hm.
6. With respect to which property are you omniscient?
   >>> Boyhood.

Note: Before the start of the conversation, the system is in the initial state, where basic inference rules have been programmed and grammar and a dictionary have been introduced, but no factual knowledge. The dictionary entries contain in most cases only a word, its class and the type of the object it denotes.

The self-referential capacity is one of the strong features of natural language (thus allowing the linguist to describe the object of his study). This capacity leads to the possibility of paradoxical assertions (the Liar paradox - as far as a modification for artificial intelligence is concerned, see Cherniavsky /2/, Havel /3/). In the following example, the system is ordered to believe a proposition (8), which is easily performed (9). Nevertheless, if the attempt to believe a proposition (12), although it is "known" to be true (11).
(7) Tom says that the Earth is round. >>> Hm.
(8) Believe the proposition which Tom says! >>> OK.
(9) Which property does the Earth have? >>> Roundness.
(10) Paul says that you do not believe the proposition which
     Paul says. >>> Hm.
(11) Is the proposition which Paul says true? >>> Yes.
(12) Believe the proposition which Paul says!
     >>> Sorry I cannot.

Note: In this example, to "believe" is interpreted in such a
way that the system "believes" a proposition by actual stor-
ing its representation. Thus, the positive answer to question
(11) does not imply that the system "believes" the proposi-
tion. Diverse interpretations of "believe" are possible.

The "the" in (8), (10) - (12) is interpreted locally,
i.e. in the context of the knowledge base of the system. Thus,
if the system knows only one of the propositions which Tom
says, then this proposition is the proposition which Tom says.

The problem of analysis of language expressions (i.e.
of determining the constructions expressed by them) is not
the main goal of our research. Nevertheless, a restricted sub-
set of scientific English (see sentence (5) above) has been
described by a grammar, which is "almost SLR(0)". (The stack
automaton accepting the language has some states with shift-
reduce and/or reduce-reduce conflicts.) The analyzer gives
all possible analyses of the input sentence, taking into
account both the ambiguities of the syntactic structure of
the sentence and the ambiguities of the individual words. The
second case is illustrated by the following example:

(13) John has a ball.
(14) John has every good property which Paul has.
(15) John has a brother.

The sentences can be rephrased as
(13') John owns a ball.
(14') John instantiates every good property which Paul
instantiates.

(15') There is x such that x is a brother of John.

The word "have" in (13) and (14) denotes the objects
(i.e. relations) denoted by "own" and "instantiate" in (13')
and (14'), respectively. (The relation in (15') is difficult
to denote by a single word.) Thus, the analyses of sentences
(13) - (15) are:

(13') λw. Some λx. And ([Ball w] x) Λ [Own w] John x
(14') λw. Every λp. Cond
   [And [Property p] Λ And [Good w] p]...
   [Instantiate w] Paul p [Instantiate w] John p
(15') λw. Some λx. [Brother w] x John

Note: The information of the different analyses of "have" has
had to be stored in the dictionary. Here, to own is a relation
between individuals, to instantiate is a relation between an
individual and a property, and in (15) and (15'), a relation
between an individual and a relation is mentioned (since
brotherhood is a relation between individuals). Thus, ambigu-
ities of this sort may be resolved by examining, whether the
type of the denoted object "fits" into the types of objects
denoted by other words in the sentence.

The system is being programmed in LISP and the current
version has some 2500 lines of source code. The quoted examp-
les (including the inference of answers (1) - (12)) have been
processed by the system.

The aim of the present paper is to demonstrate that TIL
forms a suitable framework for a description of natural lan-
guage semantics, since

1) the language of λ - expressions is sufficiently rich but
disambiguated
2) the translation of natural language expressions into these
"semantic representations" is relatively straightforward
3) the inference necessary in language understanding can be performed using the inference rules of TIL

References:

/1/ Tichý, P.: Foundations of partial type theory. Reports on Mathematical Logic 14
/2/ Cherniavsky, V.S.: On limitations of artificial intelligence. Information Systems, 6, 1980
/3/ Havel, I. M.: Truth-reaction paradox and limitations of artificial intelligence. (manuscript in preparation)