Logical Polysemy and Subtyping*

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Abstract. This paper aims at providing a type-theoretical analysis of accidental/logical polysemy with a solution to the problems of copredication constructions discussed in Asher (2011). The main idea consists of 1) a generalization of subtyping which denotes an injection and allows it to be used in functional composition rules, as in CCG, and 2) a certain interaction between subtyping and type polymorphism which plays an important role in achieving compositionality.

1 Accidental and Logical Polysemy

Lexical ambiguity is known to fall into two categories: accidental/logical polysemy [1]. The sentences in (1) exemplify accidental polysemy with two different usages of the common noun “bank”.

(1) a. The bank closes at 18:00. (the bank as Office)
   b. The bank is slippy and muddy. (the bank as Land)

In (1a), “the bank” denotes some office (type Office), while in (1b) it denotes some land (type Land). The “bank” in (1a) and the “bank” in (1b) should be regarded as different words, i.e., different lexical items, since the following sentences, which include the case of copredication, are unacceptable.

(2) a. *The bank closes at 18:00, and is slippy and muddy.
   b. *[The bank], closes at 18:00, and it, is slippy and muddy.
   c. *Every bank which is slippy and muddy closes at 18:00.

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The sentences in (3) are examples of logical polysemy, in which the common noun “book” shows its different aspects: in (3a), “the book” denotes some information (type Info), whereas in (3b) it denotes some physical object (type PhyObj).

(3)  
   a. John memorized the book. (the book as Info)  
   b. John burned the book. (the book as PhyObj)  

Logical polysemy is different from accidental polysemy in that it allows copredication, as the sentences in (4) show.

(4)  
   b. John memorized [a book], and burned it.  
   c. John burned every book that he memorized.  

The contrast between (2) and (4) indicates that in (2) one simply refers to two different objects, while in (4) one refers to two different aspects of the same object: no single bank has both the Office aspect and Land aspect, while every book has both the Info aspect and the PhyObj aspect.

A closer look at real-text corpora reveals that most common nouns are used in a polysemous way, and thus logical polysemy is a phenomenon that should be considered from both theoretical and practical perspectives, which lies at the boundary between formal semantics, lexical semantics and natural language processing.

Historically, polysemy has been discussed mainly in the field of lexical semantics. However, [1] pointed out that most analyses, including those in [2][7][8][3][9], fail to give a proper explanation for sentences such as those in (4).

2 Subtyping

Type theory with subtyping is a suitable tool for analyzing polysemy ([4][5][6][1], among others). In general, a type theory with subtyping is a type theory extended with a formula of the form \( \tau \subseteq \sigma \) (namely, \( \tau \) is a subtype of \( \sigma \)) for any types \( \tau, \sigma \), and the following subtype elimination rule: namely, if a term \( M \) is of type \( \tau \) and \( \tau \) is a subtype of \( \sigma \), then \( M \) is of type \( \sigma \) as well.

\[
\frac{M : \tau \quad \tau \subseteq \sigma}{M : \sigma} \quad (\subseteq E)
\]

In this paper, we use the following more general form, where a subtype relation is represented as an injection \( i \) (in most cases, it is simply an identity function \( id \), in which case \( i(M) \) is simply \( M \)) that sends an element of subtype \( \tau \) to itself, which is regarded as an element of the super type \( \sigma \). Then, this is not a separate rule but just an instance of the implication-elimination rule.

\[
\frac{M : \tau \quad i : \tau \to \sigma}{i(M) : \sigma} \quad (\to E)
\]