“the”

Jerry R. Hobbs
Artificial Intelligence Center
SRI International
Menlo Park, California 94025
USA
hobbs@ai.sri.com

Abstract

The definite determiner “the” conveys a relation between the entity referred to by the noun phrase and the description provided by the noun phrase, and says that the entity is uniquely mutually identifiable in context by the speaker and hearer by virtue of that descripiton. This characterization splits into six different cases. Several hundred examples of definite noun phrases in a diverse corpus were analyzed from this perspective.

1 Introduction

The research described here is first effort to develop a neat formal account of the use of the determiner “the” in terms of the framework of “Interpretation as Abduction” (IA) (Hobbs et al., 1993). This assumes a style of representation that has been called “ontological promiscuity” (Hobbs, 1985), in which events and properties are reified and sets and typical elements of sets are first-class individuals. All morphemes are viewed as conveying a proposition which can be represented in first-order logic, and the logical form of a sentence is a flat conjunction of simple propositions, with roughly one proposition per morpheme.

The principal claim of the paper is that the word “the” conveys a relation between an entity x referred to by the noun phrase and a description p of the entity provided by the noun phrase. The information conveyed by “the” is that x is mutually identifiable in context by virtue of the property p.

In the IA approach the interpretation of a text is the least cost proof of its logical form, allowing assumptions at a cost for propositions that can't be proved. In choosing the least-cost proof we want to favor proof that use axioms that are currently salient, are shorter, maximize redundancy, minimize assumptions, and use the most recent propositions in the previous text or text structure.

For example, consider the text

> John bought a new car. The engine is already broken.

The existence of a car is assumed in interpreting the first sentence—$car(c)$. A part of the logical form of the second sentence is the propostion $engine(e, z)$ that there is an engine e of something z. Suppose in our knowledge base we have the fact that cars have engines.

$$(\forall\, x)[car(x) \supset (\exists\, y) engine(y, x)]$$

One interpretation is obtained by simply assuming $engine(e, z)$, that is, there is an engine of something. Another interpretation is obtained by backchaining on the axiom and assuming the engine e is the engine of some car. This is more expensive because it is longer. A third interpretation is obtained by using the fact $car(c)$ and the axiom to prove the existence of the engine. That is, the engine mentioned in the second sentence is the engine of the car mentioned in the first sentence. This proof is slightly longer, but it involves no assumptions, so it is the least-cost proof.

Now consider the text

> John bought a new car. I saw the red Honda yesterday.

Here the logical form of the second sentence included $red(h) \wedge Honda(h)$. Suppose we have an axiom that says that cars manufactured by Honda Corporation are Hondas.

$$\begin{aligned}&(\forall\, x)[car(x)\\ &\quad \wedge manufacture(HondaCorp, x)\\ &\quad \supset Honda(x)]\end{aligned}$$

Then we can find a partial proof of the existence of a red Honda, from the car mentioned in the first sentence. What is lacking in that proof is that that car is red and was manufactured by the Honda Corporation. But we can assume these two propositions, and still have the least-cost proof of the existence of the red Honda, so we do. These assumptions that the hearer makes in order to see the text as coherent are implicatures. It is new information.

It needs to be emphasized that we are seeking the best interpretation of the *whole* text, not just the definite noun phrases. In the text

> Go down Washington Street three blocks.
> Turn left.
> My house is the third one on the right across the street from the drugstore.

"the street" does not refer to Washington Street, but to the street you turned left onto in the second sentence. This is because we have to prove not only the existence of a street, but also the existence of relations between the events and properties described in the successive sentences.

What is missing in the above analyses is the information conveyed by the definite determiner. The word "the" in the first example conveys the information that the engine can be uniquely mutually identified in context by virtue of its description as an engine. In the second example the can be uniquely mutually identified in context by virtue of its description as a red Honda.

To explicate a notion of "mutual identifiability" we need to spell out a core theory of mutual belief. The key features of such a theory would be the following:

1. If a set of agents mutually believe p then the individual agents believe p.
2. If a set of agents mutually believe p then they mutually believe they mutually believe p.
3. Agents can do logic inside mutual belief.
4. An agent's world knowledge is tagged by what groups of agents mutually believe it.
5. Copresence implies mutual belief in what is coperceived, so previous discourse is mutually believed.

An agent a identifies an entity x if a knows a property q that is true of x and of nothing else. Further constraints are generally required on the property q in various contexts. An entity x is identifiable by a by virtue of a property p if a's knowing p causes a to identify x. The simplest case is where the property p and the property q are the same; this is the case of mutually known entities. An entity x is mutually identifiable by a group s of agents by virtue of a property p if it is mutually believed by the agents in s that if any of the agents in s know p, that will cause the agent to identify x. To repeat what was said above, the word "the" conveys that the entity referred to by the noun phrase is mutually identifiable by virtue of the description provided by the noun phrase.

One way of being identifiable via a description is by being the unique entity of that description. Examples of this include known unique entities ("the world"), entities with a functional relation with another entity, either due to the function ("the top of the table") or due to the entity ("the engine of the car"), superlatives ("the tallest man in the room"), or sets described by plural noun phrases ("the men in the room").

More common are cases where the hearer will be able to identify the entity uniquely in the natural course of understanding the discourse. The use of the definite determiner here is an expression of confidence in the hearer. Speakers are always monitoring the hearer's understanding via some folk theory of discourse understanding. The word "the" conveys a predicate in that theory.

2 Categories of Uses for "the"

I have been examining several hundred examples of the use of "the" in a diverse corpus including a novel, business news, biomedical literature, equipment failure reports, poetry, song lyrics, and transcripts of decision-making meetings. These examples can be classified into six categories.

1. Mutually known entities: This category is for entities that are not previously mentioned or implied in the discourse but are part of the speaker's and hearer's mutual world knowledge. In

> a place that is estranged from all other places in *the world*

readers know that there is a uniquely salient world. In

> have *the secretaries* bring us some sandwiches

the participants know there is a unique set of secretaries for their group. In

> *the start air compressor lube alarm* sounded

the writer and intended reader know about the alarm. In

> When I have seen *the hungry ocean* gain
> Advantage on the kingdom of the shore

the writer and intended reader know there is a uniquely salient ocean; "hungry" is new information, determined by implicature.

2. Directly Anaphoric "the": This is the case where the definite noun phrase refers to something mentioned explicitly before and involves the same description of the entity that has been used before. Some examples are as follows:

> The town itself is dreary; ... Otherwise *the town* is lonesome, ...

> A federal agency has proposed a new standard for protecting the privacy of computer data, but the developers of a rival technique say *the standard* would allow ...

> We examine a mathematical model for viral multiplication ... *The model* shows ...

> It's not necessary that we do that before I give him the demo. I wouldn't mind doing *the demo* immediately.

The description in the definite noun phrase is often a truncated version.

In certain contexts there is a pretense of direct anaphoricity. If there is no previous mention, then the best interpretation often results from assuming the existence of the entity and assuming it is mutually known. This is common at the beginning of novels.

> *The town* itself is dreary; not much is there except *the cotton mill*, ...

Here the existence of the town and the cotton mill are implicatures.

3. Indirectly Anaphoric "the": This is the case where the definite noun phrase refers to something mentioned explicitly before but does so by means of a different description. In

> Paul Jain, Media Vision's founder and CEO, blamed *the company*'s problems on ...

the definite noun phrase "the company" refers to Media Vision, but via a different description.

4. Bridging: In this case the entity has not been referred to previously, but its existence can be inferred from something that has. This was called "bridging" by Clark (1975). The previous reference to the related entity may be in a noun phrase or in some other word or phrase. In

> not much is there except the cotton mill, the two-room houses where *the workers* live, ...

the existence of the workers can be inferred from the existence of the cotton mill. In

> After an individual is infected with HIV, virus is typically found in *the blood.*

an individual is a human and humans have blood. In

> When I have seen the hungry ocean gain
> Advantage on the kingdom of *the shore*

the shore is implied by the ocean. In

> If we get squeezed, I'll eat *the time that we lose*

if "squeezed" is interpreted correctly as having a smaller amount of time, then "the time that we lose" is inferable.

In many cases part of a description is inplied by a previous mention, and part of the information must be assumed. This is the case of bridging with implicature. In

> The town itself is dreary; not much is there except the cotton mill, *the two-room houses* where the workers live, ...

the houses can be inferred from the town; towns have houses. But the fact that the house have only two rooms is new information that must be assumed as an implicature. In

> After an individual is infected, ... viran antigens are often undetectable during *the long but variable incubation period.*

the incubation period can be inferred from the infection, but the fact that it is long but variable is new information that must be assumed.

5. Determinative Definite Noun Phrases: These constitute the very common case where the existence of the entity can be inferred from the complete noun phrase that describes it. In

> *the incubation period* of AIDS

we know that AIDS is a disease and hence has an incubation period. The full noun phrase itself contains all the information required to infere the existence of the referent. In

> *the process* of acquiring speech

acquiring is a process and the "of" is the "of" of identity. In *the very center* of town

a town is a region and hence has a center. In

the developers of a rival technique

we know about techniques that they have developers.

Determinative definite noun phrases can involve implicature as well. In

the tenants from the nearby farms

a tenant is a farmer that rents. Farms have farmers. The fact that those farmers rent is assumed rather than proved. In

explain *the variable likelihood* of transmission

transmission being an event has a likelihood. The fact that it is variable has to be assumed. In

the kingdom of the shore

a kingdom is a region ruled by a king, A shore is a region. The (metaphorical) fact that this region is ruled by a king is assumed as an implicature.

6. Generic Definite Noun Phrases: In this case the definite noun phrase provides a property and refers to the typical element of the set of all entities having that property, and is consequently uniquely mutually identifiable. Examples are as follows:

The normal human being is predestined to walk.

The consumer is making out like a bandit.

the suppressing capacity of *the immune system*

How many lambs might *the stern wolf* betray

An examination of 238 examples from this corpus showed that the distribution was as follows:

Known:	10%
Directly Anaphoric::	26%
Indirectly Anaphoric::	9%
Bridging::	17%
Determinative::	36%
Generic::	2%

There were slight genre differences. About 12% of the examples involved some sort of implicature.

3 Conclusion

The English determiner 'the' can be characterized as conveying a relation between an entity and a description, where the relation is that the entity can be uniquely mutually identifiable in context by the speaker and hearer. This allows room for some of the information conveyed by the noun phrase to be new and resulting from implicature, or assumption, in the interpretation process. The various ways an entity can be mutually identifiable were catalogued. This should provide a good starting point for the commonsense theory of discourse processing that an account of mutual identifiability must tap into.

In a follow-up study I will examine the counterpart hypothesis, that the indefinite determiners, including “a” for singular count nouns and the empty string for plurals and singular mass nouns, also conveys a relation between the entity the noun phrase refers to and the property is expresses. This relation is that the entity is *not* mutually identifiable by virture of the property.

Acknowledgments

This research was funded in part by the Advanced Research and Development Agency.

References

Clark,Herbert, 1975. “Bridging”. In R. Schank and B. Nash-Webber (Eds.), *Theoretical Issues in Natural Language Processing*, pp. 169-174. Cambridge, Massachusetts.

Hobbs, Jerry R. 1985. “Ontological Promiscuity.” *Proceedings, 23rd Annual Meeting of the Association for Computational Linguistics*, pp. 61-69. Chicago, Illinois, July 1985.

Hobbs, Jerry R., Mark Stickel, Douglas Appelt, and Paul Martin, 1993. “Interpretation as Abduction”, *Artificial Intelligence*, Vol. 63, Nos. 1-2, pp. 69-142.