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HOW DOES NATURAL LANGUAGE QUANTIFY?

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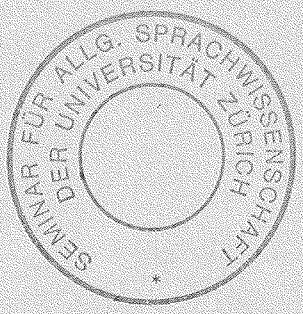

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HOW DOES NATURAL LANGUAGE QUANTIFY?

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ABSTRACT

It has traditionally been assumed that Natural Language uses explicit quantifier expressions (such as "all" and "most", "the" and "a") for the purpose of quantification. We argue that expressions of the first type are comparatively rare in real world Natural Language sentences, and that the latter (articles) cannot be considered straightforward quantifiers in the first place. However, practically all applications of Natural Language Processing require sentences to be quantified unambiguously. We list a few possible (syntactical, semantical, and "pragmatical") sources of "implicit" quantificational information in Natural Language; they combine in sometimes intricate ways to give a sentence a (more or less) unambiguous quantification.

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1. THE LACK OF EXPLICIT QUANTIFICATION IN NATURAL LANGUAGE

1.1 INTRODUCTION

The subject of the present paper is not strictly one of Computational Linguistics. Neither does it outline a working computer program, nor investigate a linguistic problem with the help of computational methods. Although the subject may be purely linguistic in character it is particularly relevant to Computational Linguistics. Moreover it seems to have been ignored by most non-computational linguists.

Computational as well as non-computational linguists agree that we have to represent Natural Language sentences as quantified logical sentences, either in a graphical variant of logic such as semantic networks, or in some other form of logic. However, non-computational linguists do not very often use real-world examples in their investigations; they create their own example sentences to make a certain point. Everything which is not in the primary focus of their interest is made so explicit as to become largely self-explanatory. They tend, for instance, to create only sentences where quantification is explicit. Computational linguists, on the other hand, have to use real world texts. They have to face certain nasty facts of life which they, too, would prefer to ignore. One of them concerns the way in which Natural Language quantifies.

1.2 THE TRADITIONAL POINT OF VIEW: QUANTIFIERS ARE EXPLICIT

Traditionally it has almost always been assumed that quantification is expressed in Natural Language by explicit means. The most traditional view had it that simple surface words correspond one-to-one to the two classical quantifiers: "every" and "all" stand for the universal quantifier, "some" for the existential quantifier:

every man is mortal
some gods are mortal

However, it has long been known that the overwhelming majority of real world sentences simply don't contain any of those explicit simple quantifier words.[1] For this reason (among others) Barwise and Cooper (1981) suggested that the concept of simple quantifiers should be extended to the concept of **generalised quantifiers**. They should take care of simple cases such as **most men** as well as of very complicated ones such as **more than half of John's arrows**. A generalised quantifer consists, in English, of a determiner (such as "most" or "more than half of") and a set expression in the form of a noun phrase (such as "men" or "John's arrows"). Determiners are *some, every, each, all, both, no, neither, many, few, most, a few, one,* etc. However, even now a sizeable majority of sentences in any real world text would appear to lack quantification. That's why the most obvious determiners, viz. *the* and *a* (plus *zero*) have to be included in this list. But that's also where a new set of problems originates. Articles have always caused problems when treated as quantifiers, and recently these problems have become increasingly more difficult to ignore (Kamp 1981).

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[1] or verb phrases such as "there is" - quite possibly the only "real" existential quantifier English has.

1.3 PROBLEMS WITH THE INTERPRETATION OF ARTICLES AS QUANTIFIERS

Again we start with the most traditional view of the question how articles could be interpreted as quantifiers. It saw **both definite and indefinite articles as existential quantifiers**, with some **additional information** in the case of the definite article. It was primarily this "additional information" which caused much discussion.

1.3.1 Is the Definite Article an Existential Quantifier?

Russell, in his classical analysis of the definite article (1905), maintained that a sentence such as

1) The President of France is bald

should be interpreted as follows

```
EXISTS X:(president_of_france(X)
          AND NOT(EXISTS Y:(president_of_france(Y) AND NOT(X=Y)))
          AND bald(X) )
```

Here the "additional information" is given in the universal statement that X is the one and only President of France. Strawson (1950) pointed out that sentences such as 2

2) The king of France is bald

would simply be false irrespective of whether a) there was exactly one king of France but he was not bald, b) there was no king of France to begin with, or c) there were several kings of France. Our intuition tells us that in case a) sentence 2 would certainly be "simply false" but in cases b) and c) it would be false "in a different way". Strawson argued that Russell hadn't made the distinction between a sentence as such and the statement made by the use of a sentence. Sentences such as example 2, **uttered at the present time**, and under condition a), were **non-evaluable** (not Strawson's term) rather than false. They may be evaluable, and even true, at other points in time (or space, we might add). A definite noun phrase, then, **does not assert the existence** of some object, it only **refers** to it, and in doing so it **presupposes** its existence. In the same sense it doesn't assert the uniqueness of the object referred to, either, it only presupposes it. Unfulfilled presuppositions don't make sentences false, they make them non-evaluable, i.e. the question of whether they are true or false doesn't arise. Whether the presuppositions of such a sentence are fulfilled depends on the concrete circumstances, given by the context.

Subsequently it was noticed that Strawson's analysis gave no satisfactory explanantion for cases such as 3, 4 and 5:

3) The unicorn is a mythical creature.
4) The lion is a dangerous animal.
5) The dog is barking.

In 3 we certainly **don't presuppose the existence of unicorns**, but the sentence makes nevertheless perfect sense. 4 is actually the same case although the fact that lions do exist may obscure this fact at first. We obviously **presuppose the existence of the concept of unicorns and lions** in the listener's mind, but not the existence of these animals in the real world.

Example 5 shows that definite noun phrases **don't presuppose uniqueness of real objects**, either. 5 makes perfect sense, in the appropriate context, but

nobody would presuppose that there is only one dog in the world. The suggestion that we could temporarily restrict the **universe of discourse** to the point that it contains only one dog, precisely the one that is barking, is hardly very convincing on intuitive grounds alone, and furthermore McCawley (1981:265) pointed out that it would make sentences 6 and 6a equivalent, which they definitely are not.

6) The dog likes all dogs.
6a) The dog likes itself.

It might be more appropriate to talk about uniqueness in a **contextual domain** (McCawley 1981:265, expanding on Karttunen 1976; also Platteau 1980, Kamp 1981, Frey/Reyle 1983) whose members are **created by the context**, and are not necessarily elementary real world objects (as in the universe of discourse) but can be sets of real objects, or possibly even purely notional objects such as concepts.

As the problems of definite reference are treated in-depth elsewhere in this volume (Berry-Rogghe) we will restrict ourselves to this very sketchy outline of the problem. The main point in this context is that any notion of the definite article having an existential quantifier as one of its components has evaporated along the way from Russell's analysis to contemporary views. Without additional sources of quantification a considerable proportion of real world sentences would now appear to be merely un-quantified, meaningless, expressions, which they certainly aren't. But it gets even worse.

1.3.2 Is the Indefinite Article an Existential Quantifier?

The indefinite article seems, on the surface, to cause much less trouble than the definite article. Its interpretation as an existential quantifier always looked quite straightforward. However, it was noticed (Kamp 1981) that indefinite articles sometimes must be represented as universal quantifiers. Prominent among these cases are the so-called donkey sentences, exemplified by sentences 7 and 8.

7) If Pedro owns a donkey he is rich.
8) If Pedro owns a donkey he beats it.

The traditional, and most natural, representation of 7 is 7a

7a) EXISTS X: (donkey(X) AND owns(pedro,X)) IMPLIES rich(pedro).

where the top-most syntactic connector of the English sentence, i.e. the conjunction "if", corresponds to the top-most connector of the logical form, i.e. the implication. However, if we apply the same schema mechanically to example 8 it will produce the non-sentence 8a:

8a) EXISTS X: (donkey(X) AND owns(pedro,X)) IMPLIES beats(pedro,X).

This is not a logical sentence because the variable "X" in the consequent is outside the scope of the existential quantifier and remains unbound. 8 must therefore be represented as 8b

8b) ALL X: ((donkey(X) AND owns(pedro,X)) IMPLIES beats(pedro,X))

where the indefinite article is now represented as a universal quantifier. Now we are in the most unsatisfactory situation that we have to represent two syntactically very similar surface sentences by two radically different logical sentences, and that the same noun phrase has to be mapped into an existential quantifier one time, into a universal quantifier another time.

If we try to consistently represent indefinite articles as universal quantifiers we get 7b as representation for 7

7b) ALL X: ((donkey(X) AND owns(pedro,X)) IMPLIES rich(pedro)) .

which is indeed logically equivalent to 7a, but on purely formal grounds. The scope has been artificially extended to span over terms without any variables, which certainly runs very much against our intuition about the meaning of the original sentence. The conclusion cannot be avoided that even the seemingly innocuous indefinite article cannot be represented as a straightforward existential quantifier.

1.4 COUNTEREXAMPLES: MOST QUANTIFIERS ARE IMPLICIT

However, if articles are no longer available as explicit quantifiers we are in real trouble: Either all those Natural Language declarative sentences that do not contain any of the explicit quantifier expressions ("most", "some", "there is" etc.) cannot be represented as logical sentences at all for their lack of quantification, or else we have to find sources of quantificational information other than explicit quantifier expressions. Now, if we look at sentences 9 to 14 we have to admit a) that they are reasonably normal sentences, b) that they contain no explicit quantifier expressions, and c) that our intuition tells us nevertheless that they are unambiguously quantified.

9) A dog is eating meat.
10) A dog eats meat.
10a) Dogs eat meat.
11) A man who loves a woman is happy.
12) A man who loves a woman respects her.
13) A man who loves a woman will give her a ring.
14) A man who loves a woman will defend her against an attacker.

We think, therefore, and try to show in this paper, that there must be many more sources of quantificational information in NL than just the traditional, explicit, cases. But the information is scattered over whole sentences, or even paragraphs, and must be combined to get a (more or less) reliable quantification for a sentence.

This is a rather unattractive state of affairs: Traditionally, it was assumed that at least the **form** of quantifiers in NL sentences was unproblematical, and that we could concentrate right away on the questions of their scope, monotonicity etc., difficult enough in their own right. If our diagnosis is correct, this is not so. In the rest of the paper we will try to list some of the other possible sources of quantificational information in NL. None of them will be of the "on/off"-variety; they are all more like interacting forces resulting in a net force tipping the balance one way or the other. We will go through all the examples listed above, considering slightly more complex cases as we go along, and try to show how different these seemingly similar examples really are as far as their quantification is concerned.

2. SOURCES OF IMPLICIT QUANTIFICATION IN NATURAL LANGUAGE

2.1 SYNTACTIC MEANS TO EXPRESS QUANTIFICATION

2.1.1 Verbal Form

The most important way to determine the quantification of a sentence by syntactic means is through the choice of the verb form. This becomes particularly clear when we look at examples 9 to 10a. They are striking cases in that 9 is a prototypical case of an assertion about an individual event and 10 and 10a are equally prototypical universal rules. However, it could be argued that the mass noun used ("meat") unnecessarily complicates the situation. So let's replace these sentences with the perfectly regular examples 15 to 18.[2]

15) A text editor *makes* modifications to a text file.

16) A text editor *is making* on modifications to a text file.

17) A text editor *made* modifications to a text file.

18) A text editor *has made* modifications to a text file.

In example 15 we say that a text editor makes modifications to a text file **in general**, almost by definition. We might read this sentence in a system manual. In 16 to 18 we say, on the other hand, that **there is**, or was, a case of a text editor making modifications to a text file. These remarks might be made by a system operator, watching his screen. In 16 to 18 we express, of course, additional information about the temporal relationships involved, but we will ignore them in the present context.[3] Sweeping under the carpet the question of how we would have to represent the sentence predicate we could, as a very first approximation, represent the example with the verb in the present tense, 15, as 15a and the examples with verbs in either the past tense or in the perfective or progressive aspect, 16 through 18, as 16a:

15a) ALL T:(text_editor(T) IMPLIES makes_modifications_...(T))
16a) EXISTS T:(text_editor(T) AND makes_modifications_...(T)).

We must qualify these statements at once.

1. In many cases the **future tense** is preferred over the present tense for the kind of general statements given in example 15. 19 is definitely more acceptable than 20:

   19) A man who loves a woman will stroke her.

   20) A man who loves a woman strokes her.

   Dynamic verbs, such as "to stroke", seem to call for the future tense, whereas static verbs, such as "to respect", seem to go better with the present tense. The reason for this seems to be that static verbs do not require the future tense to express their permanent validity, as

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[2] Here, and in all the other examples used, the indefinite singular could be replaced by the plural without any change in quantification. We will, for reasons of simplicity, use only singular examples.

[3] See des Tombe et al., in: Dahl/Saint-Dizier 1985, for a thorough treatment of the problems connected with the representation of temporal information.

their very meaning as verbs of disposition etc. already conveys this connotation. Many other verbs go either with the present or with the future tense: "Oil **floats** on water" is as acceptable as "Oil **will float** on water".

2. The past tense can express a universally quantified assertion, as in "A student **read** books *when I was young*", contrary to what we said above. However, for this universal quantification to be possible the sentence requires a spatial or temporal postmodifier, as the one printed in italics. The universal quantification is then not contributed by the verbal form but rather by the postmodifier; the present tense of the verb merely admits it.

3. The progressive aspect can express universal quantification, as in "John **is** *always* **coming** late". Again, this is only possible if the quantification proper is contributed quite explicitly by phrases such as "always", "in general", "regularly" etc. The sentence is more emotional than the version in the present tense.

Ignoring all these exceptions we can formulate the tentative rules R1 and R2 to sum up what the examples considered so far seem to suggest.

R1) The subject of a sentence is existentially quantified if the VP is

1. in the past tense,
2. in the progressive aspect, or
3. in the perfective aspect.

R2) Otherwise the subject is universally quantified, in particular if it is

1. in the present tense or
2. in the future tense.

2.1.2 Restrictive Constructions

Once we have determined the quantification of the sentence subject we have to do the same thing for all other sentential components. Examples 11 and 12 for instance, repeated here for convenience,

11) A man who loves a woman is happy.
12) A man who loves a woman respects her.

are variants of the donkey-sentences quoted above (7 and 8). There we had the problem that the object of the restrictive relative clause ("a donkey") had to be quantified existentially in the first case, and universally in the second, syntactically very similar, case. Analogously, we must now determine how "a

woman" is to be quantified. Again, intuition tells us that it is to be quantified existentially in example 11 but universally in example 12. However, how could we derive this fundamentally different quantification from the syntactically similar surface sentences?

It's an intriguing observation that a simple change in notation will make the problem go away. Instead of the Predicate Calculus representation 11a and 12a with their different explicit quantifiers

11a) ALL M:(man(M) AND EXISTS W:(woman(W) AND loves(M,W))
IMPLIES happy(M))
12a) ALL M:(man(M) IMPLIES (ALL W:(woman(W)
AND loves(M,W)) IMPLIES respects(M,W))

we represent 11 and 12 in **Horn-Clause logic** as 11b and 12b:

11b) happy(M) :- man(M), woman(W), loves(M,W).
12b) respects(M,W) :- man(M), woman(W), loves(M,W).

Under the standard interpretation of Horn-clauses (as in Prolog) a variable is implicitly universally quantified if it appears on the left hand side of a clause, but existentially quantified if it appears **exclusively** on the right hand side. The interesting fact is that the Horn-clause representations of the surface sentences are structurally as similar to each other as the surface sentences are, and they differ exactly in the same way the sentences do. The seemingly minor change from a intransitive verb phrase ("he is happy") to a transitive verb phrase referring to an element of the antecedent ("he respects **her**") turns an existential quantification ("any man is happy if **there is** a woman he loves") into a universal quantification ("any man respects **any** woman he happens to love"). And this is the quantification which virtually "falls out" of the Horn-clause representation of theses sentences.

It will be obvious that other restrictive constructions have to be treated the same way. Whether we say "a man **loving** a woman repects her" or "a woman **loved** by a man adores him" or "a man respects a woman **provided** he loves her" - in each case we will have to represent these restrictive expressions as right hand terms, as additional conditions on the values of the corresponding variables. We could therefore sketch the following **informal translation correspondences**:

1. the main verb (or the predicatively used noun or adjective, if the verb is "to be"), i.e. the grammatical predicate of the sentence becomes the logical predicate constituting the clause head;

2. an indefinite NP becomes a predicate on the right hand side of the the clause;

3. pronominal reference is represented by the use of the same variable name within one clause;

4. restrictive phrases (restrictive relative clauses, restrictive adjectives, conditional clauses) become additional terms on the right hand side of the clause.

Using these straightforward translation rules, we get a representation of surface sentences where the correct quantification, in many cases, "falls out" of the Horn-clause representation. In these cases we can then say that an indefinite noun phrase corresponds neither to a universal nor to an existential quantifier but that its quantification is a function of its position in the sentence. We will soon see that this kind of nice one-to-one mapping is possible

only in a few, simple, cases.[4]

If we try to sum up what we gleaned from examples 11 and 12 we could sketch a rule R3:

> R3) In a restrictive noun phrase those of its arguments are universally quantified that are referred to by the main verb; otherwise they are existentially quantified.

If we combine restrictive constructions with "existentially quantifiying" verb forms, as in example 21

21) A text editor which made modifications to a text file erased it.

we notice that the quantification imposed by the main verb overrides the quantification suggested by the restricitve construction. Example 21 would have to be represented somehow along the lines of 21a:[5]

```
21a) text_editor(editor1).
     text_file(file1).
     modifies(editor1,file1,time1).
     erases(editor1,file1,time1).
     before(time1,now).
```

We thus have to modify R1 to the effect that the main verb form enforces its quantification for **all** dependent values.

2.1.3 Non-restrictive Constructions

Nearly all restrictive constructions of the type mentioned in the last section have their non-restrictive counterparts. The restrictive relative clause in example 22 has its counterpart in example 23, where an additional pair of commas is the only syntactic difference, although the meaning of the two relative clauses differs fundamentally.

22) Swap space which is used for storing editor programs is kept small.
23) Swap space, which is used for storing editor programs, is kept small.

In 22, the restrictive relative clause adds, of course, one more restriction. In 23, the non-restrictive relative clause **asserts additional information**. The author wants to make sure that the reader is aware of these facts, and that he absorbs the information if it's new to him before he goes on reading. Accordingly we would have to represent these examples as 22a and 23a

```
22a) kept_small(S) :- swap_space(S), used_for_storing_editors(S).
23a) kept_small(S)                  :- swap_space(S).
     used_for_storing_editors(S):- swap_space(S).
```

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[4] We do not propose that all natural language sentences can be represented as (the Horn-clause version of) First Order Predicate Calculus sentences. But it seems a sensible idea to start our search for sources of implicit quantificational information with those simple cases where it is possible.

[5] Existentially quantified variables not in the scope of a universal quantifier are represented in Horn-clause logic as a system-generated constant, a so-called Skolem-constant, such as "file1".

We used the verb in the present tense to keep the situation as simple as possible. If we now consider the other possible case, with the verb in the past tense or in one of the marked aspects, we will note that 24 is odd to the point of being ungrammatical, while 25 is perfectly normal.

24) A text editor, used for making modifications to a text file, brought the system to a standstill.
25) A text editor used for making modifications to a text file brought the system to a standstill.

We can consequently outline rule R4

> R4) Non-restrictive constructions translate into additional, universally quantified, assertions.

Apart from the relative clauses and the reduced relative clauses in the preceding examples we can find non-restrictive constructions in the following cases:

1. Present participle:

   26) A text editor corrupting text files is utterly useless.
   27) A text editor, making it easy to modify text files, is eminently useful.

2. Appositive constructions:

   28) A message that deleted files will be expunged by the system will be displayed five minutes before expunging takes place.
   29) Another kind of message, that the system is about to crash, will be displayed about one millisecond before it actually happens.
   30) My friend Peter was here last night.
   31) My friend, Peter, was here last night.
   32) A command to delete a file will be executed with priority.
   33) Another type of command, to save a file, will be postponed for a few minutes.
   34) The decision whether to save or delete a file is normally made by the user.
   35) Another decision, whether to crash or not to crash, normally isn't.

3. Prepositional phrases:

   36) A backup file on disk is immune from the effects of system crashes.
   37) A backup file, on disk, is immune from the effects of system crashes.

   In this case the non-restrictive variant, 37, has a strong connotation of causality: " **As** the file is now on disk, it is immune from the effects of crashes".

In all these cases the non-restrictive construction asserted additional universally quantified information, although the appositive constructions seem to cause more problems than the other cases.

2.1.4 Adjectives as Object Complements

If the verb of a sentence is a causative verb we can express the quantification of its argument values by the choice of the appropriate object complement. Example 38 is ambiguous as far as the quantification of "a bold-faced character" is concerned (the two readings are "will print **some** bold-faced character", 38a, and "will print **any** bold-faced character" it gets, 38b), whereas in 39 and 40 the same expression is unambiguously quantified; both 39 and 40 are mapped into 39a, meaning "will print in boldface **any** character" it gets.[6]

38) A Centronics printer will print a bold-faced character whenever it receives an escape sequence.
39) A Centronics printer will print a character bold-faced whenever it receives an escape sequence.
40) A Centronics printer will print a character in boldface whenever it receives an escape sequence.

```
38a) prints(P,skl(P,E))    :- centronics_printer(P), escape_sequence(E),
                              receives(P,E).
     bold_faced(skl(P,E)) :- centronics_printer(P), escape_sequence(E),
                              receives(P,E).
     character(skl(P,E))   :- centronics_printer(P), escape_sequence(E),
                              receives(P,E).
38b) prints(P,C) :- centronics_printer(P), character(C), bold_faced(C),
                    escape_sequence(E), receives(P,E).

39a) prints(P,C)    :- centronics_printer(P), character(C),
                       escape_sequence(E), receives(P,E).
     bold_faced(C) :- centronics_printer(P), character(C),
                       escape_sequence(E), receives(P,E).
```

In spoken language we could distinguish between the two readings of sentence 38 by means of stress: The second reading (38b) could be enforced by stress on the verb ("A Centronics printer will PRINT a bold_faced character") while an even stress distribution on the whole verb phrase ("... will PRINT A BOLD_FACED CHARACTER") would make the first reading (38a) far more probable. In written language we could resort to topicalizers such as "even": "A Centronics printer will even print a bold-faced character ...". It is interesting to note that even in examples 39 and 40 which are quantificationally unambiguous for syntactic reasons alone (39a) the stress is evenly distributed on the verb "print" and the adjective "bold-faced" (or on the adverbial "in boldface", respectively). As a matter of fact we could say that stress in English virtually marks certain words of a sentence as "to be represented as clause heads" in the Horn-clause translation of the sentence, with the consequences for their quantification we just outlined.[7]

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[6] Existentially quantified variables in the scope of a universal quantifier are represented as system-generated functions, so-called Skolem-functions, whose arguments are the variables over which these universal quantifiers range.

[7] Phenomena such as the topic/focus-distinction and stress/intonation are often considered as purely stylistic in character. The examples used will show that this view is often unjustified. The Prague school has,of course, always emphazised that these linguistic means are often much more than "style". See the most recent contribution by the Prague school, Sgall 1984.

2.1.5 Conjunctions

In the examples 38 to 40 we used the conjunction "whenever" instead of the neutral "if". This isn't quite unproblematical, as the choice of a conjunction may well have its own influence on the quantification of some of the values in the sentence(s) involved. However, the precise character of this influence is unclear to us at the present time. In example 41 the noun phrase "a student" somehow seems to have a "higher content" of universal quantification than 42.

41) If a student knows the words of a text he can translate it.
42) When a student knows the words of a text he can translate it.

But the two subtly different interpretations seem to be possible only because both "he knows" and "he can" are ambiguous: In 41 they can be read as "he already knows" and "he is capable of, knows how to", whereas in 42 they can be read as "has looked up/has found out" and "he may".

2.2 SEMANTIC MEANS TO EXPRESS QUANTIFICATION

2.2.1 Meaning and Type of the Verb

Although the syntactic means to express quantification can explain quite a few cases of "implicit" quantification there are cases where they are not sufficient. Two such cases are examples 43 and 44.

43) A man who loves a woman will defend her against an attacker.
44) A millionaire who is concerned about his afterlife will donate part of his money to a charity.

It is intuitively quite certain that we have to represent these sentences in a fundamentally different way, namely as 43a and 44a.

43a) `defends_against(M,W,A) :- man(M), woman(W),loves(M,W), attacker(A,W).`

44a)
```
donates_to(M,sk1(M),sk2(M)) :- millionaire(M),
                               concerned_about_one's_afterlife(M).
part_of_money(sk1(M)) :-       millionaire(M),
                               concerned_about_one's_afterlife(M).
charity(sk2(M))       :-       millionaire(M),
                               concerned_about_one's_afterlife(M).
```

The very meaning of "to defend" seems to enforce an universal quantification for both of the two object values, whereas the meaning of "to donate" seems to create an existential quantification for its two object values. We could, as a matter of fact, paraphrase 44 as "If you want to find a charity, or if you want to see some money, all you have to do is to find a millionaire with pangs of religion, and eventually you will see him give money to a charity". The meaning of "to donate" implies that the person donating something already has, or can easily get, whatever he donates; he does not have to wait for it to come his way. Equally, the meaning of the verb implies that it will be a trivial task to find a taker for the donation. The meaning of "to defend", on the other hand, implies that the integrity of someone or something is defended against any conceivable threat, but only if and when a threat becomes visible. The same thing applies to the person etc. defended, hence both object values are universally quantified (provided, of course, the form of the main verb permits it).

2.2.2 Type of Direct Object

There are relatively few cases where the meaning of a verb will unambiguously determine the quantifiaction of its argument values. One verb where this is certainly not the case is "to give". It has (among others) the meaning of "to pass on something if and when one gets it" and "to hand over something one already has" (in this sense it is almost equivalent to "to donate"). It's these two readings which are unambiguously chosen in examples 45 and 46, respectively, as is made clear in their clausal representations 45a and 46a.

45) Decent people will give lost and found property to the police.
46) Decent people will give presents to their poor relatives.

45a) give(D,P,police) :- people(D), decent(D),lost_property(P),found(P).

46a) give(D,skl(D,R),R) :- people(D), decent(D), relatives(R,D), poor(R).
presents(skl(D,R)) :- people(D), decent(D), relatives(R,D), poor(R).

Again, we can say that the very meaning of the noun phrase "lost and found property" excludes an existential quantification. You simply cannot find something intentionally. On the other hand, a present is, by definition, something you make or buy, i.e. you virtually bring it into local (to the recipient) existence, unless, of course, you pass on a present you got, which is considered in poor taste in our societies. This last point brings us to yet another source of implicit quantificational information: Pragmatic information, including world knowledge, situation and discourse context.

2.3 PRAGMATIC MEANS TO EXPRESS QUANTIFICATION

Here we will look at the last remaining example of the original collection, viz.

13) A man who loves a woman will give her a ring.

Here, the meaning of the direct object "a ring" is not sufficient to determine its quantification. A ring could be found and passed on to someone one loves, as well as been bought and given away. However, our **world knowledge** (rather than our language knowledge) tells us that a man doesn't normally have to wait until he finds a ring if he really wants to give one to a cherished person. He can go and buy one; there are rings affordable to just about anyone. That's why 13a would be heavily favoured over 13b.

13a) gives(M,skl(M,W),W) :- man(M), woman(W),loves(M,W).
ring(skl(M,W)) :- man(M), woman(W),loves(M,W).

13b) gives(M,R,W) :- man(M), woman(W),loves(M,W), ring(R).

Similarly, discourse and situation context can determine the quantification in otherwise ambiguous sentences, such as 47.

47) This printer will print a bold-faced character if you hit this key here.

Here the situation context, as referred to by the three demonstratives, seems to impose an existential quantification on "a character". The sentence clearly means that pressing the key referred to will immediately result in the creation of a character, which will also be in boldface.

3. CONCLUSION

There are quite a few sources of "implicit" quantification in English, most of them syntactic, some semantic, and a few pragmatic in character. Some of them fall into the category of linguistic means often considered purely stylistic, such as the topic/comment-distinction and stress/intonation.

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