SENTENCE ADVERBIALS IN A SYSTEM OF QUESTION ANSWERING WITHOUT A PREARRANGED DATA BASE

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Abstract

In the present paper we provide a report on a joint approach to the computational treatment of sentence adverbials (such as surprisingly, presumably or probably) and focussing adverbials (such as only or at least, including negation (not) and some other adverbial expressions, such as for example or inter alia) within a system of question answering without a prearranged data base (TIBAQ).

This approach is based on a joint theoretical account of the expressions in question in the framework of a functional description of language; we argue that in the primary case, the expressions in question occupy, in the underlying topic-focus articulation of a sentence, the focus-initial position, extending their scope over the focus, or the new information, of a sentence, thus specifying, in a broad sense of the word, how the new information of a sentence holds. On the surface the expressions in question are usually moved to scope-ambiguous positions, which can be analyzed by means of several general strategies.

1. Introduction

The present paper provides a report on the integration of sentence adverbials (such as surprisingly, presumably or probably) and focussing adverbials (such as only or at least, including negation (not) and certain other adverbial expressions, such as for example or inter alia) into a system of question answering (factual information retrieval) without a prearranged data base, i.e. with a data base consisting only of input technical texts in natural langage (TIBAQ). (Throughout this paper, the expressions in question will be jointly referred to as CA expressions.)

The presence of CA expressions in natural-language sentences (the functioning of these expressions being closely connected with the topic-focus articulation, or communicative perspective, of a sentence) is one of the outstanding features in which natural-languge-sentences differ from their corresponding logical formulas (or their equivalents in various knowledge-representation systems), marking the dynamic and pragmatically based character of verbal communication, in contradistinction to the static, inventory-like character of logical formulas.

In the present paper we propose to treat CA-expressions on a joint syntactico-semantic account, namely in terms of a single adverbial complementation (Complementation of Attitude), by means of which it is possible to economically account for all of the properties which they share from the viewpoint of the synthesis and analysis of sentences: essentially, we argue that the scope of CA expressions extends primarily over the focus, or the new information, of a sentence, and that CA expressions are usually moved on the surface to various scope-ambiguous positions, which can be disambiguated by several general strategies concerning the topic-focus articulation of a sentence (these strategies are used in the algorithm of analysis of CA expressions). The class of CA expressions is supposed to be open-ended, but the majority of them can be listed.

2. Computational and Theoretical Background

2.1 Computational background.
The experimental system of automatic question-answering TIBAQ (Text-and-Inference Based Answering of Questions, cf. Sgall 1982, Hajicova and Sgall 1984) has no prearranged data base, its input consisting only of natural language sentences (statements) from technical texts. The inference rules of the system are quite simple and operate on the automatically gained underlying representations of sentences; on the one hand, they are intended to account for slightly different formulations of statements and questions, and on the other, for an enrichment of the data base by new, derived statements; in this sense, TIBAQ should be viewed as a system where the stock of data is compiled and updated automatically, without specific human efforts and without the necessity to employ the knowledge of the extralinguistic reality corresponding to the statements (cf. also D. Hays' notion of automatic encyclopedia).

The major challenge of TIBAQ consists in removing the necessity for the user "to cope with the computer system", whereby the burden of the communication between man and computer is shifted closer to the computer. The system is based on the universal expressive power of natural language rather than on domain-specific phenomena; the first experiments dispense with the analysis of the factual knowledge corresponding to the sentences of the input text, thus not being committed to the "actual" structure of the world.

There are four major procedures in TIBAQ: a liguistic analysis of the inference rules operating on the output of the linguistic analysis; a look-up for appropriate answers, and a synthesis of answers. Every underlying representation of a sentence corresponds to a relativey independent piece of information, which makes it possible to

account for the scoping properties of operator-like expressions (ranging from many to CA expressions) in a uniform way; the interconnections between the single underlying representations are assured by means of pointers in the lexicon, and registers.

In the look-up for the appropriate answer, a key role is played by the topic-focus articulation of both the statements and the questions, since only such a statement which coincides with the question inter alia in its topic-focus articulation can provide a full answer; otherwise (in case the topic-focus articulation of the statement is "reverse" to that of the question) the answer is considered as partial, and is prefixed with "I only know that..." (this asymmetry between topic and focus being due to the "exhaustive-listing" character of the information conveyed by the focus).

2.2 Theoretical background

The linguistic-theoretical background of TIBAQ is provided by the Functional Generative Description (FGD) as elaborated by the linguistic team of the Faculty of Mathematics and Physics of Charles University in Prague (cf. Sgall et al. 1969; Hajicova and Sgall 1980; Sgall et al. in press). FGD can be characterized as follows:

(i) FGD is a multilevel (stratificational) system of explicit description of language, consisting of a generative component and of several levels of description, which are ordered from meaning to sound and related by a complex interplay of cases of homonymy (ambiguity) and synonymy on the basis of the asymmetric dualism between form and function.

(ii) The conception of linguistic meaning in FGD is narrow (literal meaning; cf. Sgall 1978 and 1983), providing a general (universal) basis for different applications. In FGD, only those distinctions are taken into account which are supposed to be directly structured by the system of natural language (cf. de Saussure' s and Hjelmslev' s "form of content"), and they are kept apart from the distinctions of the domain of the extralinguistic, cognitive (ontological) content.

(iii) The conception of meaning in FGD involves also certain pragmatic distinctions. Most important of them is the topic-focus ariculation (TFA) of a sentence, which includes the partitioning of a sentence into topic (conveying the old/given/salient/presupposed/contextually bound information) and focus (conveying the new/contextually non-bound information), and the deep word-order of a sentence, which is formally accountable for by the left-to right ordering of the nodes of the underlying dependency tree. TFA is connected with the organization of human memory, or with the stock of knowledge shared by the speaker and the hearer at a given point of discourse (the stock is supposed to be changing even during a single discourse, cf. Hajicova and Vrbova 1982).

We assume that by means of the deep word-order of a sentence (i.e. without taaking recourse to salva veritate paraphrasing or to such devices as prenex quantifiers) it is possible to directly describe the scoping properties of natural-language quantifiers (such as many) as well as of CA expressions: generally, the expressions standing in the underlying representation of a sentence to the left exhibit wide scope over the expressions standing to the right.

3. Underlying Properties of CA Expressions

3.1 The unmarked case.

We argue that in the unmarked case, CA expressions (which can be viewed as specifying, in a broad sense of the word, how the information conveyed by the focus holds - e.g. it surprisingly holds, it probably holds, it does not hold, it for example holds) occupy the focus-initial position, extending their scope over the rest of the focus of the sentence (this "rest of the focus" may consist of syntactically different elements, e.g. it may but need not contain the verb, it may contain one or more complementations, etc.; for example, if there are four elements in a sentence (the verb and three complementations), they can be arranged into 15 different distributions of elements in the topic and the focus of the sentence).

Our basic claim can be illustrated by the surface sentence 1 as derived from the simplified underlying representation 1a, where the slash (/) indicates the topic-focus boundary of the sentence and the arrow indicates the scope of the CA expression in question (probably).

1 This train will go probably to York.
1a This train will-go / probably to York.

3.2 Marked cases.

In addition to the unmarked case, CA expressions may occur in several marked cases of underlying occurrence and scope interpretation, cf. (i)-(vii) below.

(i) In the topic of a sentence, CA expressions occur very rarely and exhibit idiosyncratic scoping properties; for example, not has in is scope usually the verb (belonging to the topic), while the other focussing adverbials (such as only have in their scope the immediately following (noun) phrase (belonging to the topic). If there occurs another CA expression in a sentence, we speak of the topic-focus occurrence of CA expressions in a sentence, in which case the scopes of the two CA expressions do not overlap. In this case, it is possible that a single CA expression occurs twice in a sentence, cf Only Terry is preoccupied only with computers.

(ii) Certain CA expressions (such as also or again) can occur both in the focus-initial posiion as the only element of the focus of a sentence, exhibiting an underlying backward scope which extends over

(contrastive elements of the topic), cf. Terry has a minicomputer also. In answers to yes-no questions, practically any CA expression may occur as the only element of the focus, cf. Will Terry come? - Oh yes, (he will come) certainly.

(iii) In wh-questions, the wh-element (which is supposed to belong always to the focus, though it need not necessarily occur as the most communicatively dynamic element of the focus) stands in the scope of the CA expression which stands on the surface immediately before or after it, cf. Where exactly are you going?.

(iv) In case of coordination of CA expressions, all of the CA expressions involved are assumed to have the same scope, cf. The last attempt, unexpectedly and frustratingly, has failed.

(v) CA expressions frequently occur on the multiple occurrence (cluster) with the hierarchical type of scope interpretation, where every of the CA expressions involved has in its scope, on a recursive principle, the rest of the focus, cf. The train goes surprisingly probably only to York.

(vi) CA expressions occur also on the multiple occurrence (cluster) with the intracluster type of scope interpretation, where the CA expression to the left has in its scope the CA expression to the right, cf. This train goes not surprisingly to York.

(vii) CA expressions occur also in parenthetical chunks of sentences ("afterthoughts", which do not belong to the basic structure of a sentence, being detached from it by a comma, semicolon, hyphen, brackets, or even fullstop), irrespective of whether there occur any CA expressions in the basic structure, cf. Terry likes to play especially basketball - especially on Sundays.

4. Surface Properties of CA Expressions and the Analysis of Their Scopes

In this section, we describe the cases of scope-unambiguous and scope-ambiguous surface positions of CA expressions in a sentence, and there will be also proposed strategies of the analysis of the scope of CA expressions, especially in cass of the scope-ambiguous surface positions.

4.1 Scope-unambiguous positions.

We assume that, in English, all postverbal positions of CA expressions are scope-unambiguous, indicating the topic-focus boundary of a sentence (as placed immediately before the CA expression) and simultaneously also the scope of the CA expression (as extending forward, over the expressions which follow it on the surface, usually up to the end of a sentence), cf. 1 as derived from 1a (see 3.1).

This strategy of resolving the scope of CA expressions in such a straightforward way is applicable also in case of the occurrence of two (lexically distinct) CA expressions in a sentence. If the CA expressions stand side by side, first of all their type of scope interpretation should be specified (cf.4.3), but if one of them occurs in a scope-the relatively new elements of the topic unambiguous (= postverbal) position and the other in a scope-ambiguous position (such as the sentence-initial or the preverbal position, cf. 4.2), the multiple occurrence of CA expressions on the hierarchical scope interpretation is involved, the scope of the CA expression in the scope-unambiguous position
being resolved in a straightforward way, and the scope of the CA expression in the scope-ambiguous position (hierarchically) extending over the CA expression in the scope-unambiguous position plus the following expression(s), cf. 2 and 3 as unambiguously derived from 2a.

2 Probably, the train collided only with a truck.
3 The train probably collided only with a truck.
2a The train collided / probably only with a truck.

The only exception to this strategy is constituted by the topic-focus occurrence of CA expressions as mentioned in (i) of 3.2.

4.2 Scope-ambiguous positions.

In English, there are several types of surface movement of CA expressions to scope-ambiguous positions; these types can be combined to yield cases of complex scope-ambiguity, and a single surface position may be ambiguous between two or more types of surface movement. Moreover, the multiple ocurrence of CA expressions involves the ambiguity of surface clusters of CA expressions between the hierarchical and the intracluster scope interpretations (cf.4.3).

The types of surface movement of CA expressions can be described as follows:

(i) The movement (from any underlying position) to the surface sentence-initial position, to the preverbal position or to the
sentence-final position, cf. 4, 5 and 6, each of which is derivable from 4a, 4b or 4c.

4 Probably, train 2178 goes to York.
5 Train2178 probably goes to York.
6 Train 2178 goes to York, probably.
4a / Probably train 2178 goes to York.
4b Train 2178 / probably goes to York.
4c Train 2178 goes / probably to York.

(ii) The movement of every CA expression of a cluster on the hierarchical type of scope interpretation to different scope-ambiguous surface positions, cf. 7 as derived e.g. from 7a.

7 Surprisingly, train 2178 probably goes to York.
7a Train 2178 goes / surprisingly probably to York.

The whole cluster of CA expressions on the hierarchical type of scope interpretation (unlike the clusters on the intracluster type of scope interpretation) essentially cannot be moved as a whole, cf. 8 (as hypothetically derived e.g. from 8a).

8 *Probably only, train 2178 goes to York.
8a Train 2178 goes / probably only to York.

In cases (i) and (ii), but also in cases (iii), (v), (vi) and (vii), as we shall see below, a common strategy of the analysis of the CA expressions involved should be used, which is based on the determining of the elements of the topic of the sentence by means of certain crieria. The rest of the elements of the sentence should be considered as belonging to the focus,i.e. as standing in the scope of the (rightmost) CA expression of the sentence. This strategy is based on the following principle: if the words or phrases under examination (typicaly, the verb or a complementation consisting of a simple (noun) phrase) are contextually bound, i.e. if they refer to an entity which has been relevantly mentioned in the previous co-text, or if they are connected by associative links to previously mentioned entities, or if they exhibit general lexical meaning, or if they are permanently activated in the memory of the speaker and the hearer(s), they probably belong to the topic of the sentence, from which it follows that they stand outside the scope of the CA expression in question. Otherwise they belong to the focus and stand in the scope of the CA expression in question. Let us refer to this strategy as the contextual strategy (for a more exact formulation of such a strategy, cf. Hajicova, Sgall and Vrbova 1984).

(iii) If a CA expression has in its scope the focus of an embedded clause, it may be moved within the embedded clause, or it may be "raised" to the beginning of the complex sentence, cf. 9 as derived from 9a.

9 Probably, Terry wants to earn money so that he could buy a minicomputer.
9a Terry wants to arn money so that he could buy / probably a minicomputer.

Also in this case, the scope of the CA expression in question should be resolved by means of the contextual strategy as described above in (ii).

(iv) The whole focus (consisting of a focussing adverbial and an expressions standing in its scope) may be moved to the beginning of the sentence, especially if the focussing adverbial extends over the Subject of the sentence, cf. 10 as derived from 10a.

10 Only Terry will run through a tunnel.
10a Through a tunnel will-run / only Terry.

In this case the scope of the CA expression in question can be resolved by means of taking into account the lexical type of the CA expression involved (focussing adverbial) and its surface position (sentence-initial position not detached by a comma from the rest of the sentence) as extending over the immediately following (noun) phrase. Let us refer to this strategy as the lexical-positional strategy (for another variant thereof, cf. (v) below).

(v) Focussing CA expressions may be moved to the postphrasal position, i. e. after the phrase which stands in their scope. In this case, the CA expression in question may occupy either the sentence-final position (cf. 11 as derived from 11a), or, in case the whole focus has been moved to the beginning of the sentence, a sentence-medial position (after the Subject noun phrase).

11 Terry has a dog for his pleasure only.
11a Terry has a dog / only for his pleasure.

In the former case, the scope of the CA expression in question can be resolved again by a variant of the lexical-positional strategy (a focussing adverbial standing in the sentence-final position not detached by a comma from the rest of the sentence has in its scope the immediately preceding (noun) phrase).

In the latter case, the scope of the CA expression in question can be generally resolved by means of the contextual strategy, with one exception: if there ocurs an auxiliary in the sentence, a clue for the resolution of the scope of the CA expression is provided by the fact that in this case the CA expression stands immediately after the Subject noun phrase, i.e. before the auxiliary (in contrast to the scope-ambiguous preverbal position of CA expressions), cf. 12 vs. 13.

12 John particularly will like these rituals.
13 John will particularly like these rituals.

(vi) The scope of the CA expressions also and again if they stand alone in the focus (cf. (ii) of 3.2) should be resolved by means of the contextual strategy, with the exception that there is sought a relatively new element of topic of the the sentence, cf. the second sentence of 14 as derived from 14a.

14 Terry has a minicomputer. But Henry has a minicomputer also.
14a Henry has a minicomputer / also.

(vii) It should be brought to attention that every of the cases (i)-(vi) should be considered as multiply ambiguous if a complex (noun) phrase standing in the scope of a CA expression is involved, namely in that the scope of the CA expression may extend over the whole complex (noun) phrase, or over a subconstituent thereof embedded at any depth of the complex phrase, yielding an embedded focus. In this case, the CA expression is obligatorily moved before the whole complex phrase.

4.3 Resolving multiple occurrence.

(i) If there occur in a sentence two occurrences of a single CA expression (such as not, only, especially) as not standing side by side, or if there occurs not as not immediately preceding another CA expression, the topic-focus occurrence of CA expressions is involved (cf. (i) of 3.2).

If there occur in a sentence two or more lexically different CA expressions, out of which at least one is moved to a scope-ambiguous position (i.e. which is not standing side by side with the other CA expressions), the multiple occurrence of CA expressions with the hierarchical scope interpretation is involved (cf. 2 and 3 of 4.1 and 7 of 4.2).

This case should be distinguished from the case of the occurrence of a parenthetical chunk of the sentence containing a CA expression in addition to the occurrence of a CA expression in the basic structure of the sentence (cf. (vii) of 3.2).

(ii) In case of the occurrence in the sentence of two or more CA expressions standing side by side, the type of their multiple occurrence should be resolved according to the following strategy:

(a) If the leftmost CA expression is a focussing or likelihood CA expression followed by a sentence adverbial, the multiple occurrence with the intracluster interpretation is involved, cf. not surprisingly, at least probably, probably correctly.

(b) Otherwise the multiple occurrence with the hierarchical scope interpretation is involved, cf. surprisingly not (to Brooklyn), probably at least (Terry), not only (computers).

(For lack of space we cannot present here the algorithm of analysis.)

6. Lexical Properties of CA Expressions

The class of CA expressions should be considered as open-ended due to the existence of the productive (morphological and syntactic) means for the formation of new CA expressions (cf. e.g. the adverbial ending -ly or the formation of new CA expressions by syntactic derivation: to my surprise, to the surprise of my brother, etc.), similarly as the classes of expressions of other complementations (Time, Place, Manner) are open-ended, with the exception that the majority of CA expressions can be listed (we have empirically listed over 300 of CA expressions, but the list canot be presented here for lack of space). Thus, Complementation of Attitude should be viewed as one of the finite tools of natural language by means of which it is possible, in a functional description, to economically account for the infite and changing reality of natural language.

The (open-ended) class of CA expressions can be divided into two immediate subclasses (namely, sentence adverbials and focussing adverbials), each of which can be further divided into several groups (for example, sentence adverbials can be divided into style disjuncts, factive and non-factive attitudinal disjuncts, and expressions of likelihood). Sentence adverbials semantically differ from focussing adverbials essentially in the following respects:

(i) Sentence adverbials, unlike focussing adverbials, essentially exhibit full lexical semantics, being salva veritate paraprasable by means of clauses containing lexically corresponding adjectives or verbs (cf. surprisingly - it is surprising that). Out of focussing adverbials, only not is so paraphrasable (cf. it is not the case that). Such paraphrases should be viewed as scope-ambiguous in the same way as CA expressions standing in the surface sentence-initial position.

(ii) Sentence adverbials (with the exception of non-factive attitudinal disjuncts and expressions of likelihood) can be salva veritate omitted from a sentence, while the other CA expressions cannot: their omission would at least partly change the truthconditional character of the sentence, cf. the necessity to use such "hedges" as mostly, mainly, not only, at least, paartly, first of all, etc. in answers to questions like Is Pretoria inhabited by black people? - Yes, mostly/not only/first of all.).

(iii) The distribution of sentence adverbials is restricted: they esentially cannot occur in yes-no questions and commands, and they cannot occur in every type of embedded (dependent) clauses (e.g. in restrictive relative clauses, in conditonal clauses, etc.).

(iv) On the multiple occurrence of CA expressions with the hierarchical and intracluster scope interpretations, sentence adverbials and focussing adverbials exhibit reverse scoping relations. For example, with the hierarchical scope interpretation, style disjuncts exhibit wide scope over factive attitudinal disjuncts, which in turn exhibit wide scope over non-factive attitudinal disjuncts, which in turn exhibit wide scope over expressions of likelihood, etc. With focussing adverbials, for example at least exhibits wide scope over almost, etc.

7. Conclusion

In the present paer we have described the initial stage of the work on the integration of about three hundred adverbial expressions (such as surprisingly, probably, briefly, only, not, at least, for example etc., specifying, in a broad sense of the word, how the focus, or the new information of a sentence, holds) into the analysis and synthesis of sentences within a system of automatic question-answering without a prearranged data base (TIBAQ), connected with the Functional Generative Description of language.

In particular, we have argued that the expressions inquesion occupy, in the primary case, the focus-initial position and that their scope extends over the rest of the focus, or the new information, of a sentence, their behaviour being economically accountable for in terms of a common type of

adverbial complementation (Complementation of Attitude) as embodying the open-ended character of the class of these expressions. On the surface, these expressions exhibit surface movement to scope-ambiguous positions (typically, to the sentence-initial or to the preverbal position), which makes it possible to propose several general strategies for the analysis of these expressions as concerns their scope.

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