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ABSTRACT

Using the term 'good' as an example, the effect of natural language input on an interviewing computer program is described. The program utilizes syntactic and semantic information to generate relevant plausible inferences from which statements for a goal-directed man-machine dialogue can be constructed.

Machine understanding of natural language remains a difficult problem,, No satisfactory general solution has been proposed. We prefer to speak of machine utilization of natural language expressions since we feel it is the purposive goals of a pragmatic context which are of overriding importance in any process which might be termed 'understanding' . Our goals for this computer program are (a) to participate in a natural language dialogue characteristic of diagnostic psychiatric interviewing and (b) to extract from this dialogue belief propositions about interpersonal relations. Using rough pattern-matching heuristics one can get somewhere with special words and phrases in this context (Colby and Enea, 1967). A limitation of this method is its lack of an extensive cognitive data-base made up of concepts, beliefs and implications, We shall discuss briefly how such a data-base of cognitive facts and rules furthers a program's realization of its goals,

Instead of the meaningless term 'meaning' we shall use the term 'effect' to indicate we are concerned with the effects of linguistic input on a program participating in a dialogue. As an illustration we will describe a short procedure (part of a larger program devoted to the simulation of belief systems) which deals with words whose effect in a given phrase depend on their combination with other words. As an example we shall use the common word 'good'. Complaints have been raised about its ambiguity and multimeanings (Ziff, 1960). Our claim is that all words are ambiguous and polysemic because they are appellations rather than names. By itself 'good' is a weak synonym for *excellent* . But in combinations with other words something else is involved, That is, the effect of the combination becomes paramount rather than the effect of the individual words in the combination.

Chomsky (1967) in discussing universal semantics writes: "It is, for example, a fact of English that the phrase 'a good knife' means 'a knife which cuts well'. Consequently the concept 'knife' must be specified in part in terms of features having to do with characteristic functions (not just physical properties), and in terms of an abstract 'evaluation feature' that is determined by such modifiers as 'good', 'terrible', etc." This seems a reasonable conclusion. While concerned with language, our goals differ from those of linguists interested in formation of isolated well-formed sentences rather than in the effects cf linguistic communication. The natural language found in everyday conversations is composed neither of isolated nor well-formed sentences, to say the least, Hence attempts to derive semantics solely from this type of syntax are hopeless. We are not concerned with language per se 'but in its use for communication in a particular context.

Our problem is how to write a program which could reply to a phrase such as 'a good knife' with a statement containing an appropriate inference, Such a statement would serve to continue a goal-directed dialogue which strives to gain specific information from the person involved, We do not assert that the following procedures for machine utilization of natural language input represent what happens in human heads during conversations, We are concerned here only with the goals of a computer program and the effects linguistic input from a person have on it,

Let us first define the terms appellation, name, concept, object, situation, proposition, belief and implication, (For a more detailed description see Tesler, Enea, Colby 1967). An appellation is a word which may have several referents., The word 'John' can refer to several different concepts. A concept is an abstract representation of a set having one or more members, Thus the appellation 'John' can refer to concepts of individual objects of the sets men, dogs, toiiets, etc. A name is unique to a concept, The names $JOHN_1$ (a friend), $JOHN_2$ (my uncle) and $JOHN_3$ (my dog) refer to specific concepts, The name DOG stands for the set of dogs while $JOHN_3$ stands for an individual member of the set, namely, 'my dog', A situation is described by a combination of concepts such as $\underline{JOHN_3}$ $\underline{IS}$ $\underline{A}$ $\underline{DOG}$, If a proposition is held as credible, it comprises a belief which has properties of charge (degree of interest or import) and credence (degree of credibility)., An implication,, containing formal as well as actual names, represents a relation between two beliefs, e.g. <u>IF</u> <u>X</u> <u>IS A</u> <u>DOG</u>, THEN X BARKS. Implications also possess the properties of charge and credence, In a cognitive data-base, beliefs serve as facts about properties, functions and relations while implications serve as rules of inference,

Taking Chomsky's example regarding a knife, we shall confine our attention to natural language expressions having the syntactic patterns:

(1) DETERMINER + 'GOOD' + NOMINAL

(2) DETERMINER + NOMINAL + LINKING VERB + 'GOOD'

Most uses of the word "good" in everyday conversation involve idioms (Good grief!) and these can be handled with a lookup routine for idioms, The more difficult problem lies with expressions such as:

(3) John owns a good knife

The phrase 'a good knife' matches the decomposition pattern (1) and stands for a single node (node A) in a directed graph representation as in Figure 1. Nodes B and C are named concepts while A is unnamed, The bond labelled e stands for 'is an instance of' and the bond labelled p stands for 'has as property'.

[Insert Figure 1 about here)

Thus node A can be read as "something which is an instance of Knife and has Good as a property,"

How might a machine be enabled to reply to expression (3) with a statement such as "The knife cuts well."? First the dictionary appellations must have pointers to all relevant subgraphs (beliefs and implications) in which the nodes named KNIFE and GOOD appear, In a cognitive data-base the following relevant beliefs (here written in English) might be found:

(4) Knives cut

(5) Knives have blades

(6) Knives are made of steel

The beliefs (4) (5) (6) are ordered according to charge, that is, the belief of greatest charge, say (4), is consulted first by this machine at this time,, We assume meta-rules for selection of relevant information to depend upon the interests of a particular system, The speaker of expression (3) might be emphasizing John's ownership while the program's interest as listener is focused, in this case, on the good knife, Speakers and listeners adjust their interests to one another in the flow of everyday conversation.

Likewise, starting from the appellation 'good', relevant implications are found, e.g.:

(7) If X is good, then X is satisfactory

(8) If X is good and X is a Y and Y does Z, then X does Z well

Implications are also ordered according to charge. In this case implication (7) is a weak synonymic meaning-rule of low charge while implication (8) is much stronger., Hence in combination with the highest charged fact, belief (4), implication (8) is tried first., Substituting actual for formal names (again writing in English for clarification) we obtain:

(9) If something is good and that something is a knife and knives do cut, then that something does cut well.

Having concluded that "something which is a good knife cuts well"', the relevant plausible inference:

(10) The knife cuts well

can be generated. The program for the steps in this procedure is written in M-LISP, an ALGOL-like language which translates into the S-expressions of LISP (Enea, 1967).

Offering a statement such as (10) as a dialogue reply may not constitute the 'best' reply in accordance with the goals of the program, Using facts and rules as outlined above, a list of inferences can be generated, Which one is selected for an output statement in the dialogue depends on other interviewing criteria which we shall not discuss here. Replying simply with the sufficiently relevant (10) would not be considered disruptive to a coherent conversation,

In summary, we have described how a computer program utilizes natural language input by combining syntactic and semantic information to yield relevant plausible inferences which can serve as the 'basis for appropriate statements in a particular type of dialogue. We want to emphasize that for any man-machine dialogue it is the pragmatic goals of a program which determine the effects of linguistic input. In speaking of the 'utilization' and 'effects' of language we are trying to be more explicit about processes conventionally and obscurely termed 'understanding' and 'meaning',

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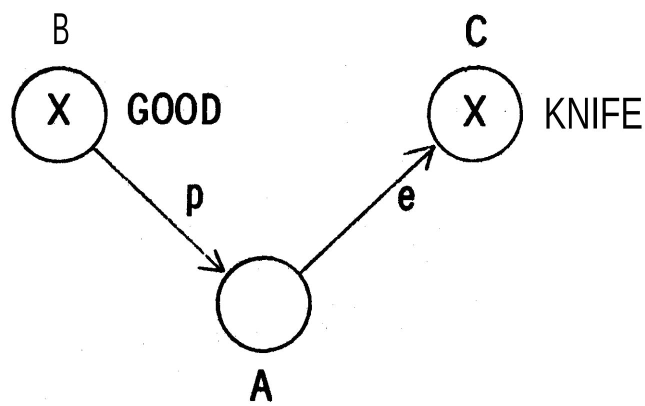

Figure 1