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Instructor:
Nick Cercone - CSBldg 105
902-494-2832 - nick@cs.dal.ca

Winograd, Schank and Wilks

1.0 Some brief comments on the work of these guys

Winograd's (1972) language program endorses the procedural meaning representation for knowledge due to Hewitt (1971). In this way factual and heuristic information are combined to promote more efficient (w.r.t. processing time) use of the factual information. Nevertheless, the visual suggestiveness inherent in network oriented representations, which leads to efficient processing algorithms, is lost. More importantly, this approach to representation (the procedural embedding of knowledge) runs into difficulties when contexts shift. Different heuristics and processing methods are then appropriate. Winograd's system combines many fascinating techniques to produce spectacular results. In his system, semantic analysis takes place before syntactic processing is complete. If semantic analysis fails for the structure built thus far, a backtrack mechanism allows the parsing to be redirected along more promising lines. This was the first true integration of syntactic and semantic analyses with good results.

PROGRAMMAR, a language for writing grammars, was developed by Winograd in order to get systemic grammar into a usable form (for LISP programming). Winograd found systemic grammar more amenable for finding meaning related structural units in natural language as opposed to the traditional syntactic use of formal grammars, for example, phrase structure and transformational grammars. Systemic grammar is a non-formal grammar that produces parse trees with few, but complex, nodes.

Criticisms that might be leveled at Winograd's system include the following. First, his semantics are tied to the simple referential blocks world without a method to make the semantics extensible to any general real world situation. For example, Winograd's system would be unable to correctly decide between alternative word meanings in any given context. It is just plain difficult to set up new “microworlds” in which understanding would take place, even if one were so inclined. Secondly, the use of MICROPLANNER as a deductive mechanism can be criticized because of MICROPLANNER's use of blind backtracking to handle errors (although it should be noted that no better working implementation of a deductive system was available at the time). Finally, the use of procedures as meaning representations is acceptable in some cases but awkward in many cases where a “static” representation would be sufficient.

Schank's (1972) conceptual dependency theory is the basis of a system developed over about six years culminating in the MARGIE system by Schank et al. (1973). It is a system rich in semantic representation designed to provide a representation of meaning in terms of which paraphrase, inference, and machine translation could be carried out. Schank has succeeded to some extent with the first of these two aims. MARGIE operates in two modes: the paraphrase mode and the inference mode. Following is a sample output from those two modes.

INFERENCE MODE

INPUT: John told Mary that Bill wants a book.
OUTPUT: A book about what?
Mary knows that Bill wants a book.
Bill wants to come to have a book.
Bill wants someone to cease to have a book.
Bill wants to read a book.

PARAPHRASE MODE

INPUT: John killed Mary by choking Mary.
OUTPUT: John strangled Mary.
John chocked Mary and she died because she could not breathe.
Mary died because she was unable to inhale some air and she was unable to inhale some air because John grabbed her neck.

Schank uses a graphical notation consisting of items from four conceptual categories to represent meaning structures. These categories are picture producers [PP], picture aiders [PA], action aiders [AA], and actions [ACTS] and they correspond closely to nouns, adjectives, adverbs, and verbs, respectively.

The smallest structural unit that Schank deals with is the conceptualisation. Conceptualisations are graphical structures that link together conceptual categories using a variety of graphical symbols conceptual tense markers, conceptual cases (analogous to and certainly influenced by the linguistic case structure of Fillmore, 1968), and primitive actions.

Schank uses four cases which serve as subgraphs in conceptualisations. These cases include the objective case, which relates an objective PP to an ACT; the recipient case, which relates a donor PP and a recipient PP to an ACT; the directive case, which relates direction (to and from) to an ACT; and the instrumental case, which links conceptualisations instrumental to an ACT to a conceptualisation containing the ACT. In addition to conceptual cases, Schank makes use of only fourteen primitive actions through which he expresses all other actions. These primitive actions are: PROPEL, MOVE, INGEST, EXPEL, GRASP, PTRANS, MTRANS, ATRANS, SMELL, LOOK-AT, LISTEN-TO, CONC, and MBUILD. I wish to defer a further discussion of Schank's system at this time. It is sufficient to say that I consider it one of the very few natural language processing systems that may truly fall into the category of understanding systems.

The final system I wish to discuss might also fall into this category, that is, Wilks' (1973) preference semantics system. Wilks' system, like Schank's has a uniform representation in terms of structures of primitives for representing the meaning content of natural language. Unlike Schank, Wilks has concentrated on machine translation, from English to French, of small input paragraphs and he has reported reasonably good translation. His system does not operate in paraphrase or inference modes.

Wilks' system makes use of formulas, one for each meaning sense of a word. These formulas are based on the (binary) decomposition trees developed by Lakoff (1972). The formula is a tree structure of semantic primitives interpreted formally using dependency relations. A typical formula for the action of "drinking" is as follows

((ANI SUBJ)((FLOW STUFF) OBJ)(SELF IN)((THIS(ANI(THRU PART))) TO)(MOVE CAUSE))

The rightmost element is called the head. Template structures, that actually represent sentences, are built up as networks of formulas. These templates always consist of an agent node, an action node, and an object node, as well as any other nodes that may depend on these three formulas. Formulas dictate how other places in the template should be filled. Thus "drink" would prefer a FLOW STUFF as object and an ANIM as subject. Prefer is the correct word to use since if either a non ANIM subject or a non FLOW STUFF object are the only choices available, the utterance will still be recognized (metaphorically). The template finally established for a fragment of text is the one in which most formulas have their preferences satisfied. This very simple device is able to do most of the work of a syntax and word sense ambiguity resolving program.

After the agent-action-object templates have been set up locally for fragments of input text, Wilks' system attempts to tie these templates together to provide an overall meaning structure for the input. To accomplish this, Wilks makes use of paraplates attached to formulas for English prepositions. These paraplates range across two, not necessarily contiguous, templates. Thus far the structure of mutually connected templates comprises a semantic block. This is all done in what Wilks terms his basic mode.

Whenever sentences cannot be successfully resolved into a semantic block in the basic mode, Wilks employs another mode, the extended mode, which makes use of common sense inference rules. This mode attempts, by a simple strategy, to construct the shortest possible chain of rule-linked template forms from previous text containing one of its possible referents. This chain then represents the solution to the ambiguity problem. After constructing a semantic block, French generation proceeds by "unwrapping" the block. There is no deepening of the representation by the generation routines.

The conceptual dependency approach of Schank (1972, 1973a, 1973b) and Schank et al. (1973) and the preference semantics approach of Wilks (1973a, 1973b, 1973c) exemplify what I believe to be the correct approach to the problem of representing the conceptual content of natural language utterances in terms of meaning structures. Specific criticisms of their respective approaches have been given elsewhere, see Cercone and Schubert (1974). Nevertheless, these two related approaches have the following desirable features regarding knowledge representation. The meaning structures corresponding to natural language utterances are formed according to simple structural rules. Powerful heuristic criteria, based on the central role of verbs and on preferred semantic categories for the subjects and objects of verbs, guide each choice in the creation of meaning structures. Interpretation of utterances then takes on a "slot and filler" character, rather than requiring extensive trial and error search. In ordinary discourse it would be absurd not to accept "ungrammatical" constructions like dangling participles or fanciful locutions such as metaphor.

Neither preference semantics nor conceptual dependency imposes a syntactic straightjacket on admissible utterances. Therefore the abnormal is not excluded as it is in many linguistic systems. A major part of our interpretative effort in understanding natural language is focused on events, that is, time-dependent relationships. By contrast, "static" relationships in the world are relatively easy to understand. Therefore the search for fundamental semantic structures and primitives should concentrate on the representation of events.

Both Schank and Wilks have shown that there does exist a small, more or less adequate, set of actions through which a surprisingly large number of action concepts can be expressed. Using this minimal set of actions it is relatively easy to use the meaning representations in a language (and paraphrase) independent way. Relatively few inference mechanisms will then be required. An important by-product of the notion of semantic preference, used in setting up meaning representations, is the disambiguation of certain classes of anaphoric reference. An example of one type of anaphora that is directly accommodated by Wilks' representation (a denser network of links accompanies the correct referent) is given by the sentence: "Often union workers go on strike knowing they are not good for the economy. Most probably they need the money."