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Recognizing promises, advice, threats and warnings in natural language discourse

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Recognizing Promises, Advice, Threats and Warnings in Natural Language Discourse

by
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1. INTRODUCTION

1.1 PRACTICAL ARGUMENTS

Practical arguments (the term originates with Aristotle) are arguments whose conclusions specify an action to be performed by an agent and whose premises provide justification for that action. In the conversational mode, conclusions of practical arguments often take the form "Do X", although "I advise you to do X", I recommend X", "Why not do X?", "If I were you, I would do X", "You should do X", "I urge you to do X", and so on, are also common. Some examples.

I have never seen a stock with so much potential.
Buy as much as you can.

Salaries at the American University are high. But Lebanon is still unsafe.
I wouldn't accept their offer if I were you.

I know superior engineering when I see it.
I recommend the Yugo.

It's cold in here.
Would you close the window?

The roads are icy.
So drive carefully.

Conclusions of practical arguments encompass a wide range of speech acts including advising, recommending, requesting, warning, instructing, exhorting, and urging. Note that commanding and ordering are conspicuously absent from the list. Commands enjoin actions which are expected to be obeyed without further explanation or justification.

In the absence of a performative verb, e.g. "I advise, recommend, urge,...", the illocutionary force of a practical conclusion is - in a manner to be explained - a function of the

premises. Consider the utterance "Don't go near the stove". Is this a warning, an order, a request or perhaps an instance of some other speech act category? Apart from context, it is impossible to tell. Once context is supplied, however, the question all but answers itself.

1. If you touch the stove, you will burn yourself.
   So don't go near the stove.
   (warning)

2. When they are convinced that you are not going to feed them, they will leave.
   So don't go near the stove.
   (advice)

3. It's my turn to cook tonight.
   So don't go near the stove.
   (request)

4. I can't take another one of your casseroles.
   If you want to continue living, don't go near the stove.
   (threat)

5. If you can control your impulse to cook, I will take you out to dinner tonight.
   So don't go near the stove.
   (promise)

6. I'm in charge here.
   So don't go near the stove.
   (order)

In this thesis, I design a program which accepts practical arguments as input, paraphrases them intelligently, and identifies the principal speech act(s) performed by the speaker. Speech acts identified are advice, promises, warnings, and threats. For the most part, input for the program is of the form

"If X then Y. So (don't) do Z." For example, given the input

If you finish your homework before six then I will let you watch television. So start right now.

the program responds

S promised to let you watch television if you finish your homework before six. Starting right now will make it more likely that you will finish your homework before six.

And given the input

Real estate prices will fall if the college closes. So wait a year before buying a house in the area.

the program responds

S believes that if the college closes real estate prices will fall. With this in mind S has advised you to wait a year before buying a house in the area.

In chapter 4, I provide an account of the speech acts in question, and propose some data structures for the program. There is also a discussion of heuristics, followed by an outline of the program. Chapter 5 contains a program listing, and chapter 6 some sample runs.

1.2 INPUT

A fundamental assumption of this thesis is that arguments of the form "If X then Y. So (don't) do Z." comprise a small but important subset of practical arguments, for the reason that many if not all practical arguments can be recast in this form without

loss of meaning or structure. This assumption is based on the Aristotelian means-end model of practical arguments as deliberations which "assume the end (viz. a desire need, interest or goal of the agent) and consider how and by what means it is to be attained." (Nichomachean Ethics, 1112b15-31). Consider the following example.

The stove is hot.
So don't touch it.

While readily understandable, this argument is enthymematic. Fleshed out, it becomes

1. The stove is hot.
2. Hot things cause burns when touched.
3. So if you touch the stove, you will burn yourself. (1,2)
4. (But you wish to avoid burning yourself. (agent's assumed interests))
5. So don't touch the stove. (3,4)

In the short version, the hearer's interests as well as the implications of the stove's being hot are so obvious that they are not mentioned. Note that in the long version, (1) is not even a premise of the main argument. Its role is to provide evidence for (3). If, as I suspect, this example is typical, then the form "If X then Y. So (don't) do Z" may well capture the deep structure of a large class of practical arguments and so is not a bad place to start.

How does one go about reducing practical arguments to the form "If X then Y. So (don't) do Z"?. To continue the example, suppose "Hot things cause burns when touched" has been stored in the knowledge base. The reduction of "The stove is hot. So don't

touch it" can then be carried out as follows.

Algorithm 1

1. Assume that the real premise (RP) of the the argument is of the form "If X then Y where

X = the negation of the propositional content of the conclusion

Y = some as yet unspecified harm to H.

RP: If you touch the stove, <something bad will happen>

2. Also assume that the role of the stated premise (SP) is to provide evidence for RP.

3. The consequent of RP (viz. you will burn yourself) can now be deduced from SP and the known fact that hot things cause burns when touched.

Algorithm 1 applies to arguments in which an agent is being urged to do something in order to avoid an undesirable state of affairs. A slightly amended version applies to arguments in which an agent is being urged to do something in order to bring about a desirable state of affairs. Consider the following case.

Short Version

The movie is excellent.
So see it.

Long Version

1. The movie is excellent.
2. Excellent things are pleasing to see.
3. So if you see the movie, you will be pleased. (1,2)
4. (You want to be pleased. (agent's assumed desires))
5. So see the movie. (3,4)

Given that "Excellent things are pleasing to see" has been stored

in the knowledge base, the reduction proceeds as follows.

Algorithm 2

1. Assume that the real premise (RP) is of the form "If X then Y", where

X = the propositional content of the conclusion

Y = some as yet unspecified benefit to H.

RP: If you see the movie, <something good will happen>

2. Also assume that the role of the stated premise (SP) is to provide evidence for RP.

3. The consequent of RP (viz. "you will be pleased") can now be deduced from SP and the known fact that excellent things are pleasing to see.

Both of these algorithims are implemented in the program to be found in chapter 5. See speech-act (clause 2) and gen-prem. The reader may have noticed that two more variations on the algorithm are possible. Let us call them algorithms 3 and 4. In algorithm 3,

X = the negation of the propositional content of the conclusion

Y = some as yet unspecified benefit to H

while in algorhthm 4,

X = the propositional content of the conclusion

Y = some as yet unspecified harm to H.

There is nothing to be gained by implementing either of these algorithms, since there can be no cases to which they apply. This follows from a purely conceptual point about the nature of reasons. Consider the following argument schemata.

If you do X then Y.

So do X.

If you do X1 then Y1.
So don't do X1.

In the first instance, the fact that doing X will lead to Y is cited as a sufficient or decisive reason for you to do X. But that fact could not possibly count as a sufficient reason for you to do X unless Y is some desirable state of affairs. (Algorithm 4 is ruled out.) In the second instance, the fact that doing X1 will lead to Y1 is cited as a sufficient reason for you not to do X1. But that fact could count as a sufficient reason for not doing X1 only if Y1 is some undesirable state of affairs. (Algorithm 3 is ruled out.)

These last considerations form the theoretical basis for heuristics 1 and 2 of the program to follow. (See 4.3). They also explain why it is unnecessary to include a statement of the agent's interests among the premises of practical arguments. That information is already there implicitly.

1.3 WHY PRACTICAL ARGUMENTS?

Over any significant stretch of discourse, one finds a wide diversity of speech acts being performed. In many cases, these acts are embedded in practical arguments. The intent of this thesis is to develop data structures for representing promises, advice, threats and warnings, as well as mechanisms for recognizing these speech acts in their natural habitat.

But there is another goal. Communication between humans and machines is now possible to a limited extent. We are able to query machines for information, order them to perform certain

tasks, and enlarge their databases by feeding them new facts. This thesis is, I hope, part of a larger project to extend these communicative possibilities. Consider the following paradigmatic example of human communication.

Suppose that A has been given a task to perform and has mapped out a plan for carrying out that task. Suppose further that B, after inspecting the plan, concludes that it is inefficient or defective in some respect. Assuming that A and B enjoy a cooperative relation, one expects that B would warn A that the plan is deficient and if possible advise A as to how it might be improved. At this juncture, one expects that A would evaluate the advice and accept or reject it depending on its perceived merits.

To simulate A's role in this scenario, a machine must be capable of

1. constructing plans to achieve goals
2. recognizing and distinguishing speech acts such as advice and warnings
3. recognizing reasons (premises of practical arguments) given in support of advice (warnings, etc.)
4. evaluating those reasons
5. accepting or rejecting advice (warnings, etc.) in light of those evaluations.

The theory of planning is already well understood (Newell and Simon (1972), Fikes and Nilsson (1971), Hayes-Roth (1980)), and plan construction programs are now commonplace (e.g. WARPLAN, Warren, (1974)). This thesis addresses conditions 2 and 3. Conditions 4 and 5 suggest a natural and exciting extension of

the thesis. Note that success of the larger project presupposes that the structure of practical arguments is reasonably well known.

1.4 GLOSSARY

PRACTICAL ARGUMENT

an argument whose conclusion specifies an action to be performed and whose premises provide reasons for that action; e.g., "The stove is hot. So don't touch it."

SPEECH ACT

an act of asserting, asking, ordering, assuming, instructing, advising, warning, etc.

PROPOSITION

the subject-predicate component of a speech act. Different speech acts may have the same propositional content; e.g., "Sam smokes", "Does Sam smoke?", "Sam, smoke!".

!, W, A, ?

symbols for imperatives, warnings, assertions and questions.

!(Z)

the imperative "Do Z!", where Z is the propositional content and "!" the speech act indicator.

LANGUAGE DRIVEN SYSTEM

a natural language understanding system which depends primarily on syntactic, semantic and pragmatic information to process texts.

DOMAIN DRIVEN SYSTEM

a natural language understanding system which depends primarily on non-linguistic, domain specific information to

process texts.

X-POSITIVE LIST

a list of actions which facilitate the occurence of event X or make X more likely to happen.

X-NEGATIVE LIST

a list of actions which make event X less likely to occur.

BENEFIT LIST

Each benefit list contains (1) a state of affairs SA which from the speaker's point of view is in the best interests of the hearer, and (2) a set of actions and states of affairs which raise the benefit value of SA.

HARM LIST

Each harm list contains (1) a state of affairs SA which from the speaker's point of view is not in the hearer's best interests and (2) a set of actions and states of affairs which lower the harm value of SA.

2. UNDERSTANDING NATURAL LANGUAGE: RELATED RESEARCH

2.1 STORY UNDERSTANDING SYSTEMS

2.1.1 INTRODUCTION

Research efforts in this area have centered on the problem of designing systems which paraphrase stories and answer simple questions about their content. Consider this example, adapted from Schank and Abelson (1977, pg. 45).

John went to a restaurant. His hamburger was cold when the waitress brought it to him. He left her a very small tip.

A story understanding system should be able to answer questions such as the following.

Q: What did John order at the restaurant?

A: He ordered a hamburger.

Q: Why did he leave the waitress a small tip?

A: Because his hamburger was cold.

Q: Did he enjoy his meal?

A: Probably not.

Q: Why do you say that?

A: Because his hamburger was cold. Besides, he left the waitress a small tip.

Note that none of these questions address issues mentioned explicitly in the text. To answer them, the system must make reasonable inferences based on commonsense assumptions about how people may be expected to act in such situations. In this example, assumptions are that restaurant patrons normally order food before it is brought to them, that most people do not like cold hamburgers, and that small tips may be an indication of dissatisfaction with the service.

The example is by no means atypical. It has become axiomatic in the field that understanding stories requires not only syntactic and semantic competence, but a wide-ranging knowledge of the world and the ability to make inferences based on that knowledge. Indeed, theories of natural language story understanding can be categorized by the solutions they provide to the following problems:

1. What kinds of commonsense (non-linguistic) knowledge are required to understand natural language texts?
2. How is such knowledge to be represented in the system?
3. What inference mechanisms are required to access that knowledge?

2.1.2 RIEGER (1975)

In a pioneering effort, Rieger proposed sixteen inference classes which he believed necessary for understanding natural language texts. The following examples are discussed by Wilensky (1978, pg 7).

1. Resultative inference

   input : John gave Mary a car.

   inference: Mary has a car.

2. Motivational inference

   input : John hit Mary.

   inference: John probably wanted Mary to be hurt.

3. Functional inference

   input : John wants a book.

   inference: John probably wants to read the book.

4. Feature inference

input : Andy's diapers are wet.

inference: Andy is probably a baby.

Rieger's program, the MEMORY component of MARGIE (Schank, Abelson, et al.), had an inference procedure for every inference class. An input sentence was inspected by each procedure and whenever possible an inference was drawn. Inferences were then drawn from inferences. The problem was that to "understand" a story, as many as one thousand inferences had to be generated from each input sentence. Combinatorial explosions were guaranteed for any but the simplest texts.

2.1.3 SCHANK AND ABELSON (1977)

In an attempt to reduce the volume of inferences generated by Rieger's program, Cullingford (1978) developed SAM (Script Applier Mechanism). Here knowledge was represented in the form not of inference rules but of stereotypical sequences of actions and events. The theory was that much of the knowledge required to understand stories is of just this type (Schank and Abelson 1977). Consider the case of John and his cold hamburger in the light of the following "restaurant script" adapted from Schank and Abelson, Chapter 3, section 3.2.

EAT-AT-RESTAURANT-SCRIPT

1. enter restaurant
2. be seated
3. examine menu
4. order food
5. wait for food to be served
6. eat food

7. pay bill

8. leave tip

9. exit restaurant

Without knowledge of this familiar sequence of restaurant events, it is difficult to explain how an understander is able to recognize any relation between John's entering the restaurant, being brought a hamburger, and leaving a tip. The script provides a framework of expectations for the understander and allows him to organize otherwise unrelated events.

The script as background knowledge also explains how an understander is able to draw inferences from the story as given; for example, that John ordered the hamburger before it was brought to him, that he ate (or made an attempt to eat) the hamburger, that he paid for the hamburger and eventually left the restaurant. In SAM, such inferences are drawn automatically by assuming that all events listed in the stored script actually occur, unless there is explicit evidence to the contrary.

Frame based understanding systems such as SAM have proved effective in understanding highly structured newspaper accounts of terrorist attacks, armed robberies, and highway accidents. It seems unlikely, however, that such systems will ever evolve into general story understanders. Even if most stories do have a script-like structure, a doubtful assumption at best, the number of stored scripts required for such a system is incalculable. Existing scripts, becoming ever more bloated, would lose their stereotyped character as the system encountered unanticipated events forcing script updates. The combinatorial explosion which SAM was designed to avoid would reappear quickly

in another guise.

2.1.3.1 ADDITIONAL RESEARCH

The concept of a frame based system, of which SAM is an example, originated with Minsky (1975). For research on frame based systems, see Kuipers (1975), Bobrow and Winograd (1977), Fahlman (1975), Charniak (1978) and Brachman (1978).

2.1.4 WILENSKY (1977)

Wilensky's program PAM, or Plan Applier Mechanism, is an example of an explanation driven story understander. The assumption here is that understanding a story largely consists in understanding why the events and actions of that story took place. PAM explains actions in terms of the agents' goals, the role of actions in plans to achieve goals, and finally the themes which give rise to goals. Consider the following examples from Wilensky (1977, pg. 12)

1. John hated Mary. One day, John saw a truck coming down the street toward Mary. John ran up behind Mary and gave her a shove.

2. John loved Mary. One day, John saw a truck coming down the street toward Mary. John ran up behind Mary and gave her a shove.

The most reasonable account of story 1 is that John pushed Mary toward the truck. In story 2, it is likely that John pushed Mary away from the truck. As understanders, how do we intuitively draw such conclusions? According to Wilensky, and it is difficult to argue, such inferences are licensed by general rules of physical causality and human motivation known to all. In this case,

a. If X hates Y then X may want to harm Y.

b. If X loves Y then X will want to help Y if Y is endangered.

c. If X is hit by a heavy moving object then X will probably be hurt.

Goals, plans and themes, concepts familiar to readers of Schank and Abelson (1977), are cornerstones of Wilensky's account of understanding. Briefly, a goal is a state of affairs desired by an agent, a plan is a method for achieving a goal, and a theme is a state of affairs or attitude which gives rise to goals. In story 1, hatred of Mary is the theme, harming Mary the goal, and pushing Mary in front of a truck the plan. PAM's inferencing mechanism is a set of condition-action rules expressing causal relations between events and psychological relations among themes, goals and plans.

Pam stores plans in script-like data structures called plan-boxes, consisting of standard subgoals and actions for achieving high level goals. For example, if a highschool student intends to become a doctor, one would expect his plan to include subgoals of applying to college, majoring in premed, preparing intensively for medical school entrance exams, and so on.

What is distinctive about PAM is its innovative use of top-down and bottom-up processing. Bottom-up processing is used for initial story inputs and matches them to conditions in PAM's condition-action rules. Top-down processing comes into play when PAM has some idea of what the story is about. In story 1, PAM might match "John hated Mary" to rule a. Once the hate theme had been established, PAM would predict that an action

performed by John involving Mary might well be part of a plan to harm Mary. At this juncture, PAM would revert to the bottom-up mode, seeking matches between John's actions and the conditions of rules of the form

If X does A then A may be part of a plan P to achieve goal G

where the value of G has been determined in the top down phase.

2.1.4.1 ADDITIONAL RESEARCH

Plans and goals are among the most thoroughly researched topics in the AI literature. For examples of hierarchical planners, or planning systems which produce a hierarchy of representations, see Sacerdoti, 1974 (ABSTRIPS), Newell and Simon, 1972 (GPS), Stefik, 1980 (MOLGEN), and Hart, 1975 (NOAH). Discussions of non-hierarchical planning systems, which rely on a single representation of a plan, are to be found in Fikes and Nilsson, 1971 (STRIPS), Sussman, 1975 (HACKER), and Tate, 1975 (INTERPLAN). Opportunistic planning systems, in which plans for subgoals are developed in the order in which they are needed, are discussed by Hayes-Roth, 1980.

2.1.5 COMPARISONS OF THE THREE SYSTEMS

It is useful at this point to compare the three story understanding systems considered thus far. In all three, it is assumed that a large store of extralinguistic knowledge is required for even minimal understanding of stories. Both Rieger and Wilensky embed that knowledge in condition-action rules, although PAM does include some script-like data structures. Schank and Abelson, on the other hand, rely on scripts to

represent the knowledge required for story understanding.

Rieger's program employs bottom-up processing exclusively, matching events against rules and generating as many inferences as possible. As an alternative to Rieger's brute force strategy, the Schank and Abelson system relies heavily on top-down processing. Once a script is invoked, SAM predicts precisely what events will occur and draws inferences only when script events are not encountered in the text. The price paid here is lack of flexibility. Since a story event is understandable to SAM only when it can be paired with a script event, novel events are beyond SAM's capacity to process.

The PAM system, it may be argued, is a major advance in efforts to develop an efficient story understander. Skillfully alternating bottom-up and top-down phases, PAM facilitates the processing of novel story events while at the same time constraining the number of inferences generated by the system. The next system to be examined employs bottom-up and top-down processing simultaneously.

2.2 DIALOGUE UNDERSTANDING SYSTEMS

2.2.1 ALLEN (1983)

Wilensky demonstrated that many intentional actions can be profitably viewed as constituents of plans. To understand those actions is to understand the agent's goals and the role his actions play in efforts to achieve those goals. As might be expected, speech acts are no exception to the rule. The immediate goal of a questioner is to obtain information, that of an orderer to get someone to do something, and that of an

adviser to apprise someone of his best interests.

Immediate goals of speech acts are often subgoals of larger plans. When asked where the restrooms are located, one may safely assume that the question is not prompted by idle curiosity. In such cases, knowledge of the speaker's extralinguistic goals is often a prerequisite for a cooperative response. Telling your male questioner where the ladies' room is located counts as an answer to his question, but not a particularly helpful one. In the same vein, if one happens to know that the men's room is out of order, it might be nice to pass this information along, even though it has not been specifically requested. Finally, intelligent interpretation of sentence fragments, e.g. "Restrooms?", and indirect speech acts, e.g. "Can you direct me to the restrooms?", often require that one have some idea of the speaker's plans.

ARGOT, a natural language dialogue system developed by Allen (1983), is based on just this view of speech acts.

> The fundamental assumption is that conversants in a dialogue are continually monitoring the goals of other participants. To do this they must have a rich body of knowledge about the goals and beliefs of the participants... Allen (1983a), abstract.

What is unique about ARGOT is that it actually participates in dialogue as a helpful, cooperative partner. Given a speech act, the system infers the speaker's extralinguistic goal, reconstructs the probable plan for achieving that goal, detects obstacles in the plan, i.e. subgoals "which cannot be achieved without assistance" (Allen, 1983a, pg.3), and plans a response which will remove those obstacles.

As yet, ARGOT's domain is severly circumscribed. The system simulates a clerk in an information booth at a train station and assumes that patrons have one of three goals, boarding a train, meeting a train, or some unspecified third goal. Given the input "When does the Montreal train leave?", ARGOT interprets the utterance as a request for the departure time of the Montreal train. ARGOT then infers the speaker's plan by searching for an inference path to the probable goal, boarding the train. (See diagram on following page.)

ARGOT then scrutinizes the plan for possible obstacles and discovers two, one obvious and the other probable. To execute the plan, the speaker needs to know the departure time and departure location of the Montreal train. Finally, ARGOT plans a speech act, "4:00 at gate 7" which removes those obstacles. As in this example, ARGOT often provides more information than was actually requested. ARGOT is also able to process sentence fragments, e.g., "Train to Montreal?", and indirect speech acts, e.g. "Can you tell me when the train to Montreal leaves?"

When inferring the agent's plan, ARGOT uses two inference mechanisms simultaneously. From top-level goals (boarding a train, meeting a train), plans are expanded downward via plan construction rules. At the same time, plans are expanded upward from the speech act via plan inference rules. Not surprisingly, plan inference rules are plan construction rules applied in reverse. For example, PLAN CONSTRUCTION RULE

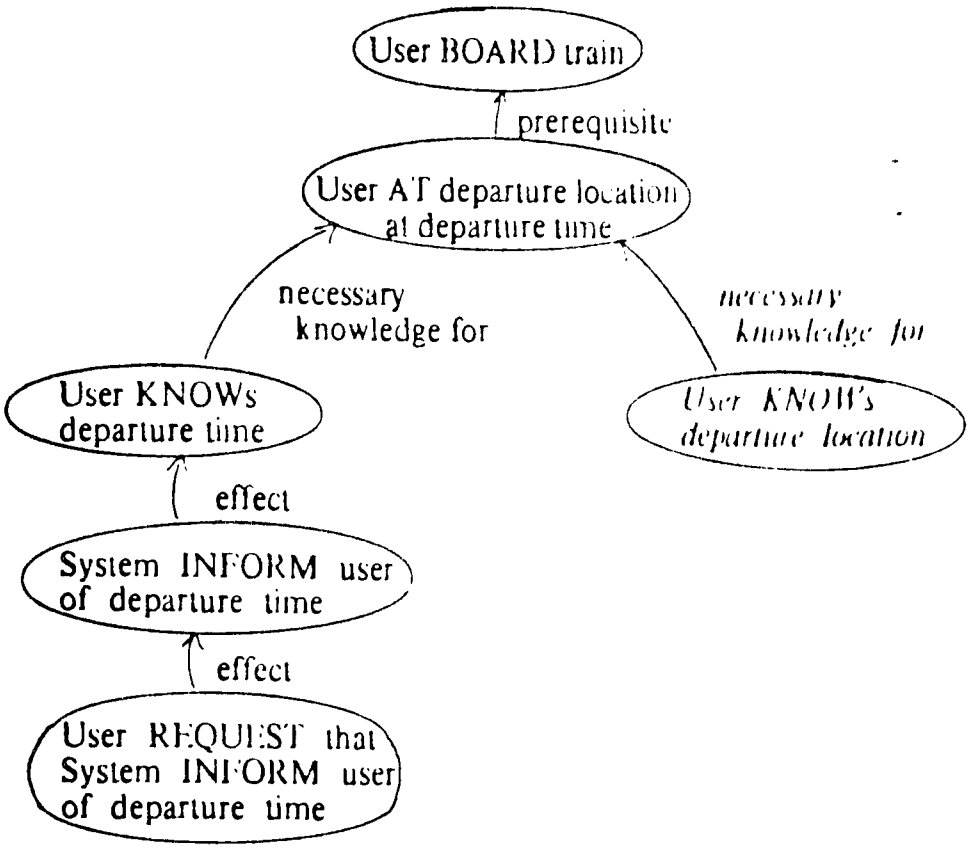

Figure 1: A Simple Plan Recognized from
"When does the Montreal train leave?"

If an agent wants to achieve a goal E and ACT is an action which has E as an effect, then the agent may want to execute ACT (i.e. achieve the execution of ACT) (pg. 112)

CORRESPONDING PLAN INFERENCE RULE
(S is inferring the agent's plan)

If S believes that A has the goal of executing action ACT, and ACT has an effect E, then S may believe that A has the goal of achieving E. (pg. 113)

Top-level goals and subgoals generated by plan construction rules are called expectations. Subgoals generated by plan inference rules are called alternatives. A plan is said to be identified when a match is found between an expectation and an alternative, completing an inference chain from the speech act to the speaker's presumed goal.

During the plan identification phase, heuristics are applied to each partial plan, or expectation-alternative pair, assigning a rating as to how likely it is to be the actual plan. The partial plan with the highest rating is then chosen for further expansion. Ratings reflect how well-formed the partial plan is and how closely the alternative meshes with the expectation. Below are two examples of heuristic rules.

Decrease the rating of a partial plan if it contains a pending or executing action whose effects are true at the time that the action commences. (Allen, 1983b, pg. 127)
(The plan is not well-formed.)

Increase the rating of a partial plan if an intersection is found between its alternative and expectation, i.e. they contain the same action or goal. (pg. 129)
(The alternative meshes with the expectation.)

When the rating of a partial plan exceeds that of all others (including the null plan) by some admittedly

arbitrary figure, the plan identification stage is completed. The plan is then examined for obstacles and an appropriate response is constructed.

2.2.1.1 MORE EXPLOSIONS?

As Berwick observes of ARGOT,

> The ability to reconstruct a questioner's beliefs and intentions from surface forms is quite remarkable. It is purchased at the price of severely restricting the planning alternatives that can be considered. If one can only board or meet trains, then the opportunity to go astray is slight. And a combinatoric explosion in inference unlikely. It is not clear whether the same approach would work in a more realistic setting where there were dozens or even hundreds of alternatives. (Berwick, 1983, pg. 76)

My own feeling is that Berwick's reservations are not as serious as they might appear. In the first place, the class of utterances for which Allen's impressive machinery is needed is quite limited. Secondly, for cases in which it is needed, heuristics can be applied to reduce drastically the number and kinds of planning alternatives to be examined.

Typically, the task of answering a question can be carried out without any knowledge of extralinguistic plans the speaker may happen to have. Once again, consider the question "When does the train to Montreal leave?". If the train leaves at 4:00 P.M., then that is the answer to the question, whatever the speaker's goals may happen to be. Whether the questioner wants to board the train, blow it up, remove himself from the premises before it leaves, or report its departure time to his employee is quite irrelevant to the question answering task. In some cases, speculation about the questioner's plans and goals is not only

unnecessary but actually rude or impertinent, as the following examples indicate.

1. I'm new in the area. Who is the best urologist in town?

2. Where is the nearest drug rehabilitation clinic?

3. Have you seen the man in the photograph?
(asked by a policeman)

Clearly, Allen's assumption that cooperative discourse requires that "conversants in a dialogue constantly monitor the goals of other participants" does not apply in these cases. And this is fortunate. Unlike ARGOT, a general dialogue system need infer the goals and plans of a questioner only when that is necessary to answer a question.

Sometimes the question answering task does fit Allen's model of cooperative conversation. Suppose one is asked for directions to a local museum. Several answers are possible, depending on the speaker's mode of transport. Does he plan to travel by foot, car, or public transportation? Here one must know the skeleton of the plan before one can formulate a helpful response. Note, however, that the number of plan alternatives to be considered in such cases is quite small, certainly not the dozens or hundreds feared by Berwick. Note also that in the absence of obvious cues, e.g, the speaker is riding a bicycle or standing at a bus stop, one would never blindly attempt to infer the speaker's travel plans. In general, when knowledge of a speaker's plans is required for a helpful answer to a question, and such knowledge is not readily inferrable from the context, conversants ask the speaker for clarification. There is no reason why a general system which simulates a participant in dialogue should not be

expected to do the same.

2.2.1.2 ADDITIONAL RESEARCH

For an excellent treatment of the theory of cooperative discourse underlying ARGOT, see Cohen (1978) and Cohen and Perrault (1979). Cohen argues that speech acts can be regarded as operators in a planning system and shows how "plans can link speech acts with non-linguistic behavior" (Cohen, 1978, pg. 3). A plan-based natural language system similar in many respects to ARGOT is being developed by Brachman et al. at Bolt Beranek and Newman. The system "recognizes indirect as well as direct requests by hypothesizing a plan that the user is trying to carry out" (Brachman, 1979, abstract). Formal planning theory itself is generally attributed to Ernst and Newell (1969) and Fikes and Nilsson (1973). Also see Newell and Simon (1972). The theory of speech acts was developed by Searle (1969, 1975).

2.3 LANGUAGE VS DOMAIN DRIVEN SYSTEMS

A language driven understanding system is one which depends primarily on syntactic, semantic and pragmatic information to process texts. By contrast, a domain driven system depends heavily on domain specific knowledge to accomplish the same task. (See Kaplan, 1983, for more on this useful distinction.) Domain driven systems, e.g. SAM (Schank and Abelson, 1977), PAM (Wilensky, 1983) and ARGOT (Allen, 1983) have achieved spectacular successes. As has been widely recognized, however, they are inherenently limited by the vast amounts of domain

specific knowledge they require to understand even the simplest texts.

The thesis I am proposing is a modest attempt to develop a small, reasonably efficient, language driven understanding system in which the need for domain specific knowledge is minimized. I suspect that linguistic cues play a more important role in language comprehension than has been commonly supposed. I also suspect that speech act analysis proves a useful tool for systematically investigating those cues.

As a preliminary illustration of how domain and language driven approaches to understanding might differ, consider the following story example from Wilensky, together with his commentary.

> One day John went through a red light and was pulled over by a cop. John had just gotten a summons for speeding the previous week, and was told that if he got another violation, his license would be taken away. Then John remembered that he had two tickets for the Giant's game on him. He told the cop that he would give them to him if he forgot the whole incident. The cop happened to be a terrific football fan. He took John's tickets and drove away.
>
> Q1 Why did John offer the cop a couple of tickets?
>
> A1 Because he was afraid he was going to lose his license if he got another summons. (1978, pgs. 2-3)

Wilensky has this to say about the story.

> Consider what is involved in making the inference that John offered the cop his football tickets to prevent the loss of his license. First, the reader would have to infer that the cop was going to give John a traffic ticket. This inference requires the knowledge that a policeman is supposed to ticket people who break traffic rules...
>
> Next, the reader must infer that John didn't want to lose his license. For this inference the reader needs to know the kinds of things people...might want to prevent from happening... Having inferred that John

> wanted to hang on to his license, the reader must then infer that preventing a cop from issuing a summons would prevent the authorities from taking away his license. This inference is based on the principle that if one event can cause another event, then a way to prevent the second us to prevent the first.
>
> Now the reader must interpret John's statement to the cop as an attempt to prevent him from giving him a ticket. To interpret this sentence as an offer, a reader must know that one way to prevent someone from doing something is to persuade him not to do it....by offering him something desirable in exchange for his cooperation. The understander can (then) infer that football tickets are desirable to a football fan, since football tickets are necessary for getting into a football game.

Wilensky, of course, is setting the table for a domain driven theory of understanding in which large stores of extralinguistic knowledge are required for story comprehension. Now consider the same story from a language driven perspective where the understander has little or no domain knowledge available to him.

1. One day A did B and was approached by C.

2. A had just been given a D for doing E the previous week, and was told that if he got another D, then F would happen.

3. Then A remembered that he had a G with him.

4. He told C that he would give him a G if C did not give him a D.

5. C wanted the G.

6. He took the G and did not give A a D.

A = John
B = ran a traffic light
C = cop
D = ticket
E = speeding
F = John loses his license
G = football tickets

An understander would make little headway with this version of the story until reaching statement 4, where it becomes

evident that A has either promised or threatened to give C a G. Since C wants a G (statement 5), there is a strong likelihood that A has conditionally promised C a G, although the remote possibility of an infelicitous threat remains. Given the purpose of conditional promises of this type (see 4.1.2), the understander can now conclude that A does not want C to give him a D. At this juncture it has been established that from A's point of view, getting another D is undesirable. Now some sense can be made of statement 2. There is the strong probability that the reason why getting another D is undesirable is because it would lead to F. So F too is most likely undesirable from A's perspective. The understander now knows all it needs to know about this schematic story to answer the sample question.

Q1 Why did A offer G to C?

A1 Because A was afraid that F would happen if C gave D to A.

This example suggests that understanding the general structure of such stories requires little if any domain specific knowledge. The necessary inferences can be made from semantic cues embedded in the text. Domain knowledge undoubtedly enriches and deepens comprehension. For human understanders, such knowledge expedites and may even be required for comprehension. But apparently, it is not as fundamental to the task of understanding as some researchers have suggested.

3. SPEECH ACTS: RELATED RESEARCH

3.1 LINGUISTIC MEANING

What is the meaning of a sentence? What is it for a sentence to have a meaning? Theories purporting to answer such questions fall for the most part into three categories - referential, ideational and behavioral accounts of sentential meaning.

Referential theories, favored by logicians, e.g. J.S. Mill (1906), Gottlob Frege (1952), Alonzo Church (1951) and C.I Lewis (1952), hypothesize that all linguistic expressions, including sentences, refer to (denote, designate, signify) something other than themselves. On this view, the meaning of a linguistic expression is to be identified with the relation between the expression and that to which it refers.

The ideational theory of meaning, associated with the 17th century philosopher John Locke, assumes a sharp distinction between the public realm of language and the private domain of thoughts and ideas. On this view, "The use of words...is to be the sensible marks of ideas and the ideas they stand for are their proper and immediate significance" (Locke, Section 1, Chapter 2, Book iii). In more contemporary versions of the theory, meaning is defined in terms of the dispositions of expressions to produce psychological effects in the hearer (Stevenson, 1944; Grice, 1957).

Behavioral theories of meaning are motivated to a large extent by the successes of behavioral psychology. The

unobservable mental events posited by ideational accounts are here replaced by overt behavior (Bloomfield, 1935) or behavioral dispositions (Morris, 1946). According to Bloomfield, the "meaning of a linguistic form..." is to be defined in terms of "...the situation in which the speaker utters it and the response which it calls forth from the hearer" (Bloomfield, p.139). This view is developed and refined in a classic article by C.C. Fries (1951). Charles Morris argues that it is an integral part of the meaning of an expression such as "Come into the house now" that if the hearer is inclined or strongly disposed to obey the speaker, he will in fact come in the house. Other variants of the behavioral theory are to be found in the works of W.V.O. Quine (1960) and Paul Ziff (1960).

The theory of speech acts is a recent addition to the field and to some extent defies categorization. Heavily influenced by the work of Wittgenstein (1953), Austin (1962), Alston (1964) and Grice (1957), it has gained an audience among linguists, cognitive psychologists and philosophers. John Searle's SPEECH ACTS (1969) is the single most influential publication to date in this area.

An assumption, tacit or otherwise, of any viable theory of meaning is that not only the syntax but the meaning of linguistic expressions is rule governed. Much of the interest in Searle's work can be attributed to the fact that it is arguably the first serious attempt in the literature systematically to investigate this assumption and its consequences. If the meaning of linguistic expressions is rule governed and if such rules can be formulated and systematized,

it follows that semantics is indeed a proper area of scientific inquiry.

3.2 SEARLE (1965)

The hypothesis on which Searle's theory is based is stated in chapter 1 of SPEECH ACTS (1969, pg .16).

> (S)peaking a language is performing speech acts such as making statements, giving commands, asking questions, making promises, and so on...(T)hese acts are in general made possible by and performed in accordance with certain rules for the use of linguistic elements.

The following example, borrowed from Alston (1964, ch 2) will serve as a focal point for our discussion as to how this hypothesis is to be fleshed out. Suppose that a speaker S utters a sentence St, "Please open the door". Is S requesting that some hearer H open a door? Not necessarily. S, for example, may be reciting a line in a play or engaged in a language lesson. When S's utterance is intended as a serious request, there are at least six situational features that are normally present.

1. There is a hearer(s) H.
2. There is a door which is singled out by the context.
3. The door is not already open.
4. It is possible for H to open the door.
5. S has some interest in getting H to open the door.
6. the words are uttered in an attempt to get H to open the door.

Note that these situational features together serve as a template or schema for non-defective requests to open a particular door. In situations in which one or more of these

features are not present, the request misfires. If, for example, there are two closed doors in the room (feature 2), H cannot know precisely what he is being asked to do. If there is a single door, but it is already open (feature 3), the request is pointless and unsatisfiable. If H has left the room and is out of earshot (condition 1), it is doubtful that a request has been made at all. On the other hand, in circumstances in which all six features are present, the request is clear, unambiguous and satisfiable.

On the speech act theory, given a sentence and the speech act which is performed when that sentence is uttered seriously and literally, the set of situational features or conditions under which that speech act is performed non-defectively are in some sense relevant to the meaning of that sentence. Actually, the claim is much stronger than that. According to Searle, those conditions constitute and fully specify the meaning of the sentence.

To appreciate the stronger claim, it will be helpful to consider Searle's distinction between regulative and constitutive rules. Certain sets of rules regulate antecedently existing behavior. The rules of etiquette, for example, regulate social interactions which would take place with or without those rules. Other sets of rules, as well as regulating certain activities, create their very possibility. The classic example here are the rules of chess, which define the game as well as regulate its play. Should one change those rules by allowing rooks to move diagonally, pawns to move backwards, and so on, one would no longer be playing chess. The rules of chess are constitutive,

that is, they create the possibility of playing the game called chess.

Searle's contention amounts to this. The set of conditions C under which a speech act Sp is performed non-defectively create the possibility of performing Sp by serving as its set of constitutive rules.

Assume for the moment that this is true. For what reasons are such conditions thought to be relevant to the meaning of sentences? Consider our sample sentence St, "Please close the door". Intuitively, one feels that the literal meaning or function of St is to perform a speech act, the act of using words to request someone to open a door. If the conditions under which that act can be performed non-defectively actually define the act being performed by serving as its constitutive rules, it is reasonable to conclude that those conditions do in fact specify the meaning of St.

The central question, then, is whether such conditions plausibly can be regarded as constitutive rules for non-defective speech acts in the same way, for example, that a certain set of rules can be regarded as the constitutive rules of chess. Searle and other proponents of speech act theory advance two related considerations in support of their constitutive rule thesis, both heavily dependent on the analogy between language and chess.

In the first place, we are told that just as one cannot modify the rules of chess without creating a new, albeit related, boardgame which cannot be equated with chess, one cannot modify the conditions under which a speech act is non-defective without changing the type of speech act being performed. Suppose that

the following condition is added to our example set.

7. H's refusing to open the door would count as an act of disobedience.

Now when S utters the words "Please open the door" the speech act being performed is clearly a command, not a request. Modifying the conditions, then, brings about a substantive change in the nature of the speech act being performed, which is just what we would expect if those conditions were truly constitutive.

Secondly, and to continue the analogy, speech act theorists ask us to consider the fact that playing the game of chess as opposed to some other boardgame involves acknowledging the legitimacy and authority of its constitutive rules. The important point here is that having the appropriate attitude towards those rules is not just a matter of good sportsmanship, but is a necessary condition of playing the game. If players are told that a particular move is forbidden by the rules of chess and choose to ignore this admonition or regard it as irrelevant, it is clear that they are not playing chess but some other game. Here note the contrast with cases in which the regulative rules of chess are violated or ignored. However boorish he may be, the player who distracts his opponent, even after being told that this is a violation of the rules, is still playing chess.

If the set of conditions under which a speech act is performed non-defectively is constitutive of that speech act, one would expect the speaker who performs that speech act to acknowledge the legitimacy and relevancy of those conditions. And indeed this expectation does appear to be satisfied to a large extent. Imagine that H is under the impression that S has

asked him to open a particular door in a room. H notices that all the doors are closed and brings this to S's attention (condition 3 is unsatisfied). S replies that however interesting that may be, it has nothing to do with the matter at hand. The only conclusion left open to H is that he has misinterpreted S, that S did not perform the speech act that H thought he had performed.

Thus far, we have confined the discussion to consideration of a single speech act, that of requesting someone to open a door. But the theory can quite naturally be generalized to cover a large range of speech acts. A program which recognizes promises, advice, threats and warnings is outlined in some detail in chapter 4.

3.2.1 ADDITIONAL RESEARCH

For useful discussions of speech act theory, see Fingarette (1967), Davis (1979), Bird (1981), Vanderveken (1983) and Roulet (1984). For analyses of individual speech acts, see Peetz (1977, promises and threats), Bird (1981, warnings), and Stewart (1978, advice). The taxonomy of speech acts is still unclear, although advances have been made by Searle (1975 (2)) and Fraser (1975). The analysis of indirect speech acts is a subject of heated controversy in linguistics where competing theories abound. See Gordon and Lakoff (1975), Herringer (1972), Sadock (1970), as well as Searle (1969, 1975).

4. PROJECT DESCRIPTION

4.1 SPEECH ACTS AND PRACTICAL ARGUMENTS

4.1.1 ADVICE

Following Searle (Speech Acts, 1969, pg. 67), I take it that a speaker's utterance counts as advising the hearer to do A if

1. the propositional content of S's utterance is a future act A of H (viz. "H will do A")
2. S believes that A is in H's best interests
3. the speaker's utterance is an undertaking to the effect that A is in H's best interests.

Condition 1 is clearly necessary. One cannot advise someone to do what has already been done. Strictly speaking, condition 2 is not necessary, since insincere advice is possible. The program will assume sincerity on the part of the speaker. It would be convenient if 1 and 2 implied 3, but they do not, as the following example illustrates.

1. Doing A would certainly improve your finances.
2. However, it would wreak havoc with your home life.

Given the context, this is clearly not an instance of advising H to do A, even though condition 1 and possibly 2 are satisfied. What is needed is some clear contextual indication that all things considered, doing A is in the best interests of H from S's point of view. For example,

1. Doing A would improve your finances.
2. However, it would wreak havoc with your homelife.
3. Personally, I (don't) think it is worth it.

3'.If I were in your position, I would (not) do A.

What is needed, in other words, is the conclusion of the practical argument of which 1 and 2 are premises.

4.1.2 PROMISES

For an extended discussion of promising, see Searle (Speech Acts, Ch 3). Here it is sufficient to note the conceptual relation between promising and obligation. The speaker who promises to do A not only indicates his intention to do A but voluntarily undertakes an obligation to do A. Unless there are serious extenuating circumstances, the agent who fails to keep a promise opens himself to criticism on moral grounds.

In the absence of performative expressions such as "I promise to...", "You have my word that...", etc., promises are notoriously difficult speech acts to identify. Was MacArthur's "I shall return" a prediction, an expression of intention, or a promise? When it is important to make such distinctions, we often resort to interrogating the speaker; "Is that a promise?", "Do I have your word on that?"

The program I am proposing will process arguments of the form "If X then Y. So (don't) do Z". For this limited class of cases, the problem of recognizing promises appears tractable. When Y is of the form "I will do A" and when the speaker's doing A would benefit the hearer, it is natural to regard "If X then Y. So (don't) do Z as a promise. For example,

If you get an A on your exam, I will take you to a movie tonight.
So study hard and get an A.

In such cases, the speaker strikes a bargain with the hearer and so incurs an obligation to live up to the terms of the bargain. Bargains, agreements, deals, etc., are species of promises. In the limited context of the proposed program, then, the conditions under which "If X then Y" counts as a promise are:

1. the propositional content of Y is a future act A of S (or state to be brought about by S)
2. S believes that A will benefit H
3. A condition of S's doing A is that H (not) perform some action A'. (optional)

4.1.3 WARNINGS

Searle (Speech Acts, pg67) analyzes warnings as follows. S's utterance constitutes a warning if

1. the propositional content of the utterance is a future event, state, etc. E.
2. S believes that E will occur and is not in H's best interests
3. S's utterance counts as an undertaking to the effect that E is not in H's best interests.

Searle comments that this is an account of "categorical not hypothetical warnings. Most warnings are probably hypothetical: 'If you do not do A then Y will occur'".

Here is a preliminary attempt to adapt Searle's account to hypothetical warnings. An utterance of the form "If X then Y" constitutes a warning if

1. the propositional content of Y is a future event, state, etc. E.
2. the propositional content of X is a future action A of H.

3. S believes that E will occur if H does A.

4. S believes that E is not in H's best interests.

5. S's utterance counts as an undertaking to the effect that E is not in H's best interests.

Conditions 1 and 2 are too strong, as illustrated by the following cases.

If the plant closes, real estate values will be halved. Don't buy a house anywhere near that town.

(Condition 2 is unsatisfied.)

If the reports are accurate, the ship sank with no survivors. So don't get your hopes up.

(Conditions 1 and 2 are unsatisfied.)

The following revisions seem in order. An utterance of the form "If X then Y" constitutes a warning if

1. the propositional content of Y is some event, state, etc. E.

2. S believes that if X is true E will occur (has occured).

3. S believes that E is not in the best interests of H.

4. S's utterance counts as an undertaking to the effect that E is not in H's best interests.

Collectively, conditions 1 through 4 are sufficient to establish that S has warned H that if X then Y. But obviously more is required to establish that S has warned H (not) to do Z. Condition 5 seems to do the trick.

5. The propositional content of the imperative conclusion is a future action, viz., H's (not) doing Z.

4.1.4 THREATS

A curious fact about threats is that an utterance may be accurately characterized as a threat even though it was not intended as a threat. Assume that H is three months behind in his car payments.

S: If you can't pay us something, we will have to repossess the car.

H (later): They are threatening to repossess the car if we don't come up with some money.

S may have intended his remark as a point of information and nothing more; that is, he was not trying to frighten or coerce H into making his car payments. Nonetheless, there is nothing misleading or inaccurate about H's characterization of S's utterance as a threat. (Warnings are similar to threats in this respect. In the case of unintentional warnings, S warns H without intending to warn him or even being aware that he is warning him.)

Apparently, an utterance of the form "If X then Y" is INTENDED as a threat if

1. the propositional content of Y is a future act A of S (or a state to be brought about by S).
2. S believes that A is not in H's best interests.
3. S's utterance counts as an attempt to frighten H, to overpower H, to coerce H into performing some action, etc.

Yet accurately characterizing utterances of that form as threats requires only that conditions 1 and 2 be satisfied. Since it is difficult to imagine how a natural language processing system could test condition 3, this is indeed fortunate.

4.2 THE PARAPHRASER

4.2.1 FIVE RELATIONS

Practical arguments of immediate interest are of the form

If X then Y
So (don't) do Z

An intelligent paraphraser will recognize that in all such cases the premise is being advanced as a sufficient or decisive reason for the hearer (not) to do Z. In addition, the paraphraser should be able to distinguish five possible relations between X, Y, and Z. The first two relations assume that the propositional content of Y is some event or state E which is in the hearer's best interests.

Relation 1: H's (not) doing Z will accomplish, facilitate, or make it more likely that X.

Examples:

If the company chooses this location, property values will soar.
So do what you can to influence the board to choose this location.

If we win tomorrow, we will be league champions.
So let's give it all we've got.

Relation 2: H's (not) doing Z will enhance the value of E or will allow H to take full advantage of E.

Examples:

If the company chooses this location, real estate values will soar.
So don't sell your house just yet.
(So buy as much land as you can within the next month.)

The next pair of relations assume that E is not in the

hearer's best interests.

Relation 3: H's (not) doing Z will make it less likely that X or will bring about a state of affairs which is incompatible with X.

Example:

If you move to Manitoba, you will be isolated from the civilized world.
So refuse their offer.

Relation 4: H's (not) doing Z will minimize or eliminate the negative impact of E.

Example:

If they close the plant, property values will fall.
So sell your house now before it's too late.

The last relation requires no assumptions about E. E may benefit H, harm H, or have no direct bearing on H's interests.

Relation 5: Since Y if X, H's (not) doing Z will facilitate or make it more likely that D where D is some desirable event or state of affairs.

Examples:

If the master was murdered, there should be evidence of foul play.
Search the grounds.

D = determining the fate of the master

If the fugitive is still in the area, he will probably contact his girlfriend.
So put a tail on Sweet Sue.

D = determining whether the fugitive contacts his girlfriend.

If we don't provide assistance, thousands of Africans will die.
So give generously.

D = saving lives (morally desirable end)

Arguments which instantiate relation 5 are beyond the scope of the proposed program.

4.2.2 DATA STRUCTURES FOR THE FIVE RELATIONS

Data Structure for R1:
X-POSITIVE LISTS - actions which if performed would facilitate or make it more likely that X. Lists are maintained for all actions and states of affairs to which the speaker makes reference.

Data structure for R3:
X-NEGATIVE LISTS - actions which if performed would make it less likely that X. Lists are maintained for all actions and states of affairs to which the speaker makes reference.

Data structure for R2:
BENEFIT LIST - Each benefit list contains

1. a state of affairs SA which from S's point of view is in the best interests of H

2. a set of actions and states of affairs which would increase the benefit value of SA, or allow H to take full advantage of SA.

Since few SA's are unconditionally in an agent's best interests, lists may contain states of affairs which are necessary or sufficient conditions of SA's being in H's best

interests. For example, the fact that property values in your neighborhood are rising is in your best interests only if you own a house. Having money is useful only if you have an opportunity to spend it, and so on.

Data Structure for R4:

HARM LIST - each harm list contains

1. a state of affairs, SA, which from the speaker's point of view is not in the hearer's best interests

2. a set of actions or states of affairs which decrease or eliminate the harm value of SA.

Again, since few SA's are unconditionally not in an agent's best interests, lists may contain actions or states of affairs which are incompatible with necessary or sufficient conditions of SA's being harmful to H. For example, the prospect of falling property values in your neighborhood poses a problem for you only if you own a house. Selling the house solves the problem.

Data structure for R5: none

4.3 SOME HEURISTICS

Heuristic 1

1. If you finish your homework, I will give you some more castor oil to drink.
So finish your homework.

2. If you don't finish your homework, I will give you some more castor oil to drink.
So finish your homework.

In neither case is there any difficulty in deducing S's views on castor oil. In the first example, it is promised as a reward; and in the second is threatened as a punishment. What makes these deductions possible is the relationship between the propositional contents of the imperative and the antecedent of the conditional. In the first instance they are identical; in the second, the one is the negation of the other. The paraphraser should utilize this heuristic when identifying speech acts and building BENEFIT and HARM lists.

Heuristic 2

3. If you finsh your homework, I will give you some more castor oil to drink.
So get started.

4. If you don't finish your homework, I will give you some more castor oil to drink. So get started.

Since getting started on a project increases (dramatically) the likelihood of finishing it, it is obvious that example 3 is a promise and example 4 a threat. The paraphraser, then, should be able to make similar deductions based on the contents of its X-POSITIVE and X-NEGATIVE lists. This is another way in which speech acts can be identified and new items added to the BENEFIT and HARM lists.

Heuristic 3

5. If you buy that stock and hang on to it, you will be rich within six months.
So listen to your broker.

6. If you buy that stock and hang on to it, you will be poor within six months.
So listen to your broker.

Since being rich is in H's interests and being poor is not, in both examples we know exactly what the broker has advised H to do. In general, when the state of affairs described in the consequent is known to be or not to be in H's best interests, one is able to narrow the range of possible relations to two: R1 and R2 or R3 and R4. In example 5, listening to his broker would make it more likely that H would buy the stock (R1); in example 6 less likely (R3). The paraphraser should make similar deductions based on the contents of its BENEFIT and HARM lists.

Heuristic 4

7. If you studied for the test then you will pass.
So relax.

8. If you didn't study for the test then you will fail for sure.
So resign yourself to the inevitable.

In both 7 and 8, the verb in the antecedent is in the past tense. So in neither case are relations R1 or R3 a possibility. The relation must be R2 or R4. If it is known that passing is in the agent's interests and failing is not, the exact relation can be deduced: R2 in example 7, and R4 in 8. The paraphraser should make similar deductions.

4.4 PROGRAM OUTLINE

```
X, Y, Z : propositions
XS      : subject of proposition X
XV      : predicate of proposition X


INPUT   : If X then Y
          So !(Z)

          where "!(Z)" is an imperative of the form "ZV!"


(* Cases 1 - 4 exploit a syntactic relation between X an Z.
Heuristic 1 *)

1. If X = Z
      YS = speaker
      tense of YV is future
      mood of YV is active
   then assume R1 promise: goto 11

2. If X = Z
      then assume R1 advise: goto 11


3. If X = -Z
      YS = speaker
      tense of YV is future
      mood of YV is active
   then assume R3 threat: goto 11


4. If X = -Z
   then assume R3 warning: goto 11


(* In the interests of readability, the remaining cases are
outlined in somewhat less detail. *)


(* In cases 5 & 6, there is no obvious syntactic relation between
X and Z. *)

(* Promise or Advise *)

5. If Z is a member of the X-positive list
      then assume R1 (promise or advise): goto 11
      else if Z is a member of the Y-benefit list
         then assume R2 (promise or advise): goto 11
      else if XV is in the past tense and there is a Y-benefit
```

```
list
          then assume R2 (promise or advise): goto 11.

(* Threat or warning *)

6. If Z is a member of the X-negative list
       then assume R3 (threat or warning): goto 11
       else if Z is a member of the Y-harm list
          then assume R4 (threat or warning): goto 11
       else if XV is in the past tense and there is a Y-harm list
          then assume R4 (threat or warning): goto 11.

(* Give up and start asking questions *)


7. WHICH OF THE FOLLOWING MOST ACCURATELY DESCRIBES S'S VIEW OF
H'S SITUATION?

A. Y IS IN H'S INTERESTS
B. Y IS NOT IN H'S INTERESTS
C. Y DOES NOT AFFECT H'S INTERESTS ONE WAY OR THE OTHER

case:
a. start a benefit list for Y: goto 8

b. start a harm list for Y: goto 9

c. advise the user that the text is beyond the scope of the
   program.


(* Promise or advise *)

8. WHICH OF THE FOLLOWING MOST ACCURATELY DESCRIBES S'S VIEW OF
H'S SITUATION?

A. H SHOULD DO ZV IN ANTICIPATION OF Y
B. H'S DOING ZV WOULD INCREASE THE LIKELIHOOD OF X
C. NEITHER OF THE ABOVE

case:

a. Z is added to Y-benefit list: goto 5

b. Z is added to the X-positive list and not-Z to the
   X-negative list: goto 5

c. advise the user that the text is beyond the scope of the
   program.


(* Threat or warning *)

9. WHICH OF THE FOLLOWING MOST ACCURATELY DESCRIBES S'S VIEW OF
H'S SITUATION?
```

A. H SHOULD DO ZV IN ANTICIPATION OF Y
B. H'S DOING ZV WOULD DECREASE THE LIKELIHOOD OF Y
C. NEITHER OF THE ABOVE

case:

a. Z is added to the Y-harm list: goto 6

b. Z is added to the X-negative list and not-Z to the X-positive list: goto 6

c. advise the user that the text is beyond the scope of the program.

11. Paraphrase the input

(* Ask for confirmation *)

12. HAS THE TEXT BEEN ACCURATELY PARAPHRASED?

If no, goto 7

If yes,

case:

R1(promises and advise):

Ensure that

1. there is a Y-benefit list

2. there is an X-benefit list

(* X's benefit value is inherited from Y *)

3. there is a Z-benefit list

(* Z's benefit value derives from the fact that Z makes X more likely *)

R3 (threats and warnings):

Same as R1 except substitute "harm" for "benefit" and "less likely" for "more likely": also negate Z before inserting it in a harm list.

R2 (promises and advice):

Ensure that

1. Z is a component of the Y-benefit list

2. there is an X benefit list

(* X's benefit value is inherited from Y *)

R4 (threats and warnings):

(Same as R2 except substitute "harm" for "benefit"

R5: (nothing required)

4.5 FUTURE ENHANCEMENTS

Inputs for the program outlined in this proposal are simple practical arguments with one premise and an imperative conclusion. A more sophisticated version of the program would be capable of processing arguments

1. with multiple premises, e.g.,

   If you do A then B will occur.
   And if B occurs then C will occur.
   So do A.

2. with compound conclusions, e.g.,

   If you do A then B will occur.
   But if B occurs then C will occur unless you do D.
   So do D and then do A.

3. with conclusions expressed in moods other than the imperative, e.g.,

   If I were you, I would do A.
   I warn you not to do A.
   Why don't you do A?

4. with a greater range of speech acts embedded in conclusions, e.g., requests, pleas, admonitions, instructions, exhortations, etc., as well as promises, advice, threats and warnings.

For additional enhancements, see section 1.3.

4.6 LIBRARY SEARCH

Principle sources for the library search were

1. THE SCIENTIFIC DATALINK INDEX TO ARTIFICIAL INTELLIGENCE
2. INTERNATIONAL JOINT CONFERENCE ON AI (IJCAI)
3. AMERICAN ASSOCIATION FOR ARTIFICIAL INTELLIGENCE (AAAI)
4. THEORETICAL ISSUES IN NATURAL LANGUAGE PROCESSING (TINLAP)
5. ASSOCIATION FOR COMPUTATIONAL LINGUISTICS (ACL)
6. THE HANDBOOK OF ARTIFICIAL INTELLIGENCE
7. PHILOSOPHER'S INDEX

4.7 LANGUAGE

The program is rule based. So I chose PROLOG.

5. PROGRAM

```
isis!hkd4302[30] date
Sun Mar 16 17:19:57 EST 1986
isis!hkd4302[31] cat searleprog1


/* Main */

talk :-
    nl,start(Sent,Nextsent).

/* Read a text, paraphrase its meaning and identify the
principal speech act. */

start(Sent,Nextsent) :-
    doit(Sent,Nextsent),
    speech_act(Code,Act,Rel),
    output(Code,Act,Rel),
    clean_up(Code),
    (Sent == [bye,.];
    start(Sent1,Nextsent1)).

/* Read a sentence and enter its propositional content(s)
in the database */

doit(Sent,Nextsent) :-
    read_in(Sent,Nextsent),
    build_subj(Sent,[[],s],Ans,1,Rest),
    abolish(after_verb,1),
    addterm(Ans,Ans1),
    rev(Ans1,Ans2),
    prop_cont(Ans2,More).

/*****************************/

/* Read a sentence - Clocksin & Mellish, pg. 87 */

/*****************************/

read_in([Word|Ws],Nextsent) :- set0(C), readword(C,Word,C1),
restsent(Word,C1,Ws,Nextsent).

restsent(W,_,[],[]) :- lastword(W),!.
restsent(W,_,[W1|Ws],[W1|Ws]) :-
    lastword(W),!.
restsent(W,C,[W1|Ws],Nextsent):-
     readword(C,W1,C1),restsent(W1,C1,Ws,Nextsent).

readword(C,W,C1) :- single_character(C), !, name(W,[C]),
set0(C1).
readword(C,W,C2) :-
        in_word(C,NewC), !,
```

```
        set(C1),
        restword(C1,Cs,C2),
        name(W,[NewC|Cs]).
readword(C,W,C2) :- set0(C1), readword(C1,W,C2).

restword(C, [NewC|Cs], C2) :-
        in_word(C,NewC), !,
        set0(C1),
        restword(C1,Cs,C2).
restword(C,[],C).

single_character(44).                          /* , */
single_character(59).                          /* ; */
single_character(58).                          /* : */
single_character(63).                          /* ? */
single_character(33).                          /* ! */
single_character(46).                          /* . */

in_word(C,C) :- C>="a", C=<"z".                /* a,b,...,z */
in_word(C,L) :- C>="A", C=<"Z",
                L is C-"A"+"a".                /* A,B,...,Z */
in_word(C,C) :- C>="0", C=<"9".                /* 1,2,...,9 */
in_word(39,39).                                /* ' */
in_word(45,45).                                /* - */

lastword('.').
lastword('!').                                 /* sentence
terminators */
lastword('?').

/***********************************************/

/* Reverse a list - Clocksin & Mellish, pg. 41 */

/***********************************************/

rev(L1,L2) :-
     revzap(L1,[],L2).

revzap([X|L],L2,L3) :-
     revzap(L,[X|L2],L3).

revzap([],L,L).

/************************/

/* Write a sentence */

/************************/

write_sent([]) :- nl.

write_sent([First|Rest]) :-
    cap(First,CapFirst),
    write(CapFirst),
```

```
    write_rest(Rest).

write_rest([]) :- nl.

write_rest([Next|Rest]) :-
    punctuation(Next),!,
    write(Next),
    write_rest(Rest).

write_rest([Next|Rest]) :-
    tab(1),
    write(Next),
    write_rest(Rest).

cap(Word,CapWord) :-
    name(Word,[First|Rest]),
    caplet(First,NewFirst),
    name(CapWord,[NewFirst|Rest]).

caplet(C,MapC) :-
    C >="a",C=<"z",!,
    MapC is C - "a"+"A".

caplet(C,C).

punctuation(',').
punctuation(';').
punctuation(':').
punctuation('?').
punctuation('!').
punctuation('.').

/*******************************************************/

/* Build-subject identifies the nounphrase subjects of
propositions. For example, assume the sentence to be
processed is: <if, the, celtics, win, then, the, citizens,
of, boston, will, celebrate,.>.  Build-Subject (in
conjunction with rev) will return <if, <np, <celtics, the>>,
win, then, <np, <boston, of, citizens, the>>, will,
celebrate, .>. */

/*******************************************************/

build_subj([],_,_,_,_).


build_subj([bye,.],[S,s],[.,bye],Level,Rest).

build_subj([.|_],[S,U],S,Level,[.|_]).

build_subj([.|_],[S,U],S,Level,Rest).
build_subj([H|T],[S,p],[S,p],Level,[H|T]) :-
    is_a(H,verb,_),
    build_subj(T,[[H|S],U],Ans,Level,Rest).
```

```
build_subj([H|T],[S,U],Ans,Level,Rest) :-
     is_a(H,conn),
    abolish(after_verb,1),
    build_subj(T,[[H|S],U],Ans,1,Rest).

build_subj([H|T],[S,P],[S,P],Level,[H|T]) :-
    is_a(H,verb,_),
    after_verb(Level).

build_subj([F|[X|T]],[S,U],Ans,Level,Rest) :-
    (is_a(F,verb,_),
    not(is_a(X,verb,_)),
    assertz(after_verb(Level));
    P == P),
    findnp([F|[X|T]],[np,[]],Result,S,U,Ans,Level,Rest).

build_subj([H|T],[S,U],Ans,Level,Rest) :-
    build_subj(T,[[H|S],U],Ans,Level,Rest).

/*****************************************************/

/* Find the nounphrase subject of the proposition */

/*****************************************************/

findnp([H|T],[np,Np],Result,S,U,Ans,Level,Rest) :-
    is_a(H,pronoun),
    Y is Level + 1,
    build_subj(T,[[H],P],Ans1,Y,Rest),
    retract(after_verb(Y)),

findnp(Rest,[np,[Ans1|Np]],[np,[Ans1|Np]],S,U,Ans,Level,Rest1).

findnp([H|T],[np,Np],Result,S,U,Ans,Level,Rest) :-
    not(after_verb(Level)),
    not(is_a(H,adj)),
    not(is_a(H,adv)),
     not(is_a(H,verb,_)),
    not(is_a(H,neg)),
    not(is_a(H,aux_verb,_)),
    not(is_a(H,conn)),
    not(is_a(H,term)),
    (after_verb(Level),
    not(is_a(H,prep));
    not(after_verb(Level))),
    findnp(T,[np,[H|Np]],[np,[H|Np]],S,U,Ans,Level,Rest).

findnp([H|T],[np,Np],Result,S,U,Ans,Level,Rest) :-
    not(Np == []),
    build_subj([H|T],[[Result|S],U],Ans,Level,Rest).

/*****************************************************/

/* If Code is instantiated, the text has been processed.
```

```
Clean up the database before reading another text. */

/*****************************************************/

clean_up(Code) :-
    nonvar(Code),
    abolish(prop,5).

/* Read another sentence before processing the text. */

clean_up(Code).

/* End the sentence with a terminal */

addterm(A,[.|A]).

/*****************************************************/

/* Propositional-content functions as follows. Texts read
into this program are of the form "If X then Y. So Z." and
"D (declarative). So Z.", where X, Y, D, and Z are
placeholders for propositions. Prop-cont identifies
propositions and their modalities (positive or negative),
categorizes them as type X, Y, D, or Z, and asserts them
in the database. The data structure is "prop(Type, Subj,
Pred, Tense, Mod)."
     Each clause in prop-cont attempts to match a syntactical
pattern in a sentence. Variations on the text "If you study
then you will pass. So study." are used below for purposes
of illustration. */

/*****************************************************/

prop_cont([],More).

prop_cont([.|Rest],More) :-
    prop_cont(Rest,More).

prop_cont([bye,.,.],More).

/*  If you study then ....  */

prop_cont([if|[[np|[Subj]]|[Verb|Rest]]],More) :-
    is_a(Verb,verb,Tense),
    build_pred(Rest,[Verb],then,Pred,More),
    update_db(x,Subj,Pred,Tense,pos),
    prop_cont(More,More1).

/* If you do not study then...  */

prop_cont([if|[[np|[Subj]]|[Aux|[Neg|[Verb|Rest]]]]],More) :-
    is_a(Aux,aux_verb,Tense),
    is_a(Neg,neg),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],then,Pred,More),
```

```
    update_db(x,Subj,Pred,Tense,neg),
    prop_cont(More,More1).

/*  ... then you will pass.  */

prop_cont([then|[[np|[Subj]]|[Aux|[Verb|Rest]]]],More) :-
    is_a(Aux,aux_verb,Tense),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(y,Subj,Pred,Tense,pos),
    prop_cont(More,More1).

/*  ...  then you passed.  */

prop_cont([then|[[np|[Subj]]|[Verb|[H|Rest]]]],More) :-
    not(is_a(H,neg)),
    is_a(Verb,verb,Tense),
    build_pred(Rest,[Verb],.,Pred,More),
update_db(y,Subj,Pred,Tense,pos),
    prop_cont(More,More1).

/*  You will pass if ...  */

prop_cont([[np|[Subj]]|[Aux|[Verb|Rest]]],More) :-
    is_a(Aux,aux_verb,Tense),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],if,Pred,More),
    check(More),
    update_db(y,Subj,Pred,Tense,pos),
    prop_cont(More,More1).

/*  ... then you will not pass.  */

prop_cont([then|[[np|[Subj]]|[Aux|[Neg|[Verb|Rest]]]]],More) :-
    is_a(Aux,aux_verb,Tense),
    is_a(Neg,neg),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(y,Subj,Pred,Tense,neg),
    prop_cont(More,More1).


/* You will not pass if ...  */

prop_cont([[np|[Subj]]|[Aux|[Neg|[Verb|Rest]]]],More) :-
    is_a(Aux,aux_verb,Tense),
    is_a(Neg,neg),
    build_pred(Rest,[Verb],if,Pred,More),
    check(More),
    update_db(y,Subj,Pred,Tense,neg),
    prop_cont(More,More1).


/*  You passed if ...  */
```

```
prop_cont([[np|[Subj]]|[Verb|[H|Rest]]],More) :-
    not(is_a(H,verb,_)),
    is_a(Verb,verb,Tense),
    build_pred(Rest,[Verb],if,Pred,More),
    check(More),
    update_db(y,Subj,Pred,Tense,pos),
    prop_cont(More,More1).

/*  You will pass.  */

prop_cont([[np|[Subj]]|[Aux|[Verb|Rest]]],More) :-
    is_a(Aux,aux_verb,Tense),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(d,Subj,Pred,Tense,pos),
    prop_cont(More,More1).

/*  You will not pass.  */

prop_cont([[np|[Subj]]|[Aux|[Neg|[Verb|Rest]]]],More) :-
    is_a(Aux,aux_verb,Tense),
    is_a(Neg,neg),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(d,Subj,Pred,Tense,neg),
    prop_cont(More,More1).

/*  You passed.  */

prop_cont([[np|[Subj]]|[Verb|Rest]],More) :-
    is_a(Verb,verb,Tense),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(d,Subj,Pred,Tense,pos),
    prop_cont(More,More1).

/*  Study your lesson.  */

prop_cont([Verb|Rest],More) :-
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(z,[you],Pred,f,pos),
    prop_cont(More,More1).

/*  So study your lesson.  */

prop_cont([so|[Verb|Rest]],More) :-
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(z,[you],Pred,f,pos),
    prop_cont(More,More1).

/*  Do not study your lesson  */

prop_cont([Aux|[Neg|[Verb|Rest]]],More) :-
    is_a(Aux,aux_verb,_),
```

```
    is_a(Neg,neg),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(z,[you],Pred,f,neg),
    prop_cont(More,More1).

/*  So do not study your lesson  */

prop_cont([so|[Aux|[Neg|[Verb|Rest]]]],More) :-
    is_a(Aux,aux_verb,_),
    is_a(Neg,neg),
    is_a(Verb,verb,_),
    build_pred(Rest,[Verb],.,Pred,More),
    update_db(z,[you],Pred,f,neg),
    prop_cont(More,More1).

/* Is the first word "if"? */

check([H|T]) :-
    H == if.

/*****************************************************/

/* Build-predicate forms the predicate of a proposition
by building a list whose first member is the main verb.
The list is complete when the appropriate marker (e.g.,
if, then, .) is encountered. */

/*****************************************************/

build_pred([],Pred,Marker,Pred,[]).

build_pred([Head|Tail],Pred,Marker,Pred,[Head|Tail]) :-
    (Head == Marker;
    Head == .).

build_pred([Head|Tail],P,Marker,Pred,More):-
     build_pred(Tail,[Head|P],Marker,Pred,More).

/*****************************************************/

/* Speech-act identifies the major speech act being performed
by the speaker.  Possibilities are promises, threats, advice,
and warnings. */

/*****************************************************/

/* The text is in "normal form", viz. "If X then Y. So Z." */

speech_act(Code,Act,Rel) :-
    prop(x,_,_,_,_),
    prop(y,_,_,_,_),
    prop(z,_,_,_,_),
    (pro_or_adv(Code,Act,Rel);
    thr_or_war(Code,Act,Rel);
```

```
    other).

/* More information is needed. Query the user. */

other :-
    menu(1).

/* The text is of the form "D. So Z."; e.g., "The stove is hot.
So don't touch it".  Since the argument is an enthymeme,
try to generate the missing premise by searching the knowledge
base. If successful, call speech-act again. */

speech_act(Code,Act,Rel) :-
    prop(d,Subj,Pred,_,M),
    prop(z,_,P,_,M1),
    gen_prem(Subj,Pred,M,P,M1),
    speech_act(Code,Act,Rel).

/* Not enough information to identify the major speech act.
Go back and read another sentence of the text. */

speech_act(Code,Act,Rel).


/*****************************************************/

/* Update-database asserts the proposition in the database
as well as new entries for xpos and xneg lists if necessary. */

/*****************************************************/

update_db(Type,Subj,Pred,Tense,M) :-
    rev(Subj,Subj1),
    rev(Pred,[V|Rest]),
    asserta(prop(Type,Subj1,[V|Rest],Tense,M)),
    (xpos([[V,pos]|_]);
    asserta(xpos([[V,pos]]))),
    (xneg([[V,neg]|_]);
    asserta(xneg([[V,neg]]))).

/*****************************************************/

/* Change positive to negative or vice versa  */

negate(M,neg) :-
    M == pos.

negate(M,pos) :-
    M == neg.

/* X is a member of list Y. Clocksin & Mellish, pg. 45 */

member(X,[X|_]).

member(X,[_|Y]) :-
```

```
    member(X,Y).

/*  Instantiate Code, Act and Rel(ation) */

code(Code,Code,Act,Act,Rel,Rel).

/*****************************************************/

/* Promise-or-advice uses heuristics 1, 2, and 4 - outlined
in section 4.3 - to determine whether the major speech act is
promising or advising. Possible relations are 1 and 2.
(see section 4.2 for discussion of relations) */

/*****************************************************/

/* Heuristics 1 & 2 - XV is positive - Relation 1 */

pro_or_adv(Code,Act,Rel) :-
     prop(x,S,[V|_],_,pos),
     prop(z,S1,[V1|_],_,N),
     xpos([[V,pos]|Rest]),
     member([V1,N],[[V,pos]|Rest]),
     (V == V1,
     S == S1,
     pos == N,
     prop(y,S2,_,f,_),
     S2 == [i],
     code(1,Code,promised,Act,1,Rel);
     V == V1,
     S == S1,
     pos == N,
     code(2,Code,advised,Act,1,Rel);
     prop(y,S2,_,f,_),
     S2 == [i],
     code(3,Code,promised,Act,1,Rel);
     code(4,Code,advised,Act,1,Rel)).

/* Heuristics 1 & 2 - XV is negative - Relation 1 */

pro_or_adv(Code,Act,Rel) :-
     prop(x,S,[V|_],_,neg),
     prop(z,S1,[V1|_],_,N),
     xneg([[V,neg]|Rest]),
     member([V1,N],[[V,neg]|Rest]),
     (V == V1,
     S == S1,
     neg == N,
     prop(y,S2,_,f,_),
     S2 == [i],
     code(1,Code,promised,Act,1,Rel);
     V == V1,
     S == S1,
     neg == N,
     code(2,Code,advised,Act,1,Rel);
     prop(y,S2,_,f,_),
```

```
    S2 == [i],
    code(3,Code,promised,Act,1,Rel);
    code(4,Code,advised,Act,1,Rel)).

/*  Relation 2 */

pro_or_adv(Code,Act,Rel) :-
    prop(y,S,[V|Rest],T,M),
    prop(z,S1,[V1|_],_,N),
    benefit([[V,M]|Rest1]),
    member([V1,N],Rest1),
    (S == [i],
    T == f,
    code(5,Code,promised,Act,2,Rel);
    code(6,Code,advised,Act,2,Rel)).

/*  Heuristic 4 - Relation 2 */

pro_or_adv(Code,Act,Rel) :-
    prop(x,S,P,past,M),
    prop(y,S1,[V|Rest],T1,M1),
    benefit([[V,M1]|Rest1]),
   (S1 == [i],
    T1 == f,
    code(5,Code,promised,Act,2,Rel);
    code(6,Code,advised,Act,2,Rel)).


/*****************************************************/

/* Threat-or-warning uses heuristics 1, 2, and 4 - outlined in
section 4.3 - to determine whether the major speech act is
a threat or a warning. Possible relations are 3 and 4
(see section 4.2 for discussion of relations) */

/*(Substitute backslash for & when running) */

/*****************************************************/

/* Heuristics 1 & 2 - XV is positive - Relation 3 */

thr_or_war(Code,Act,Rel) :-
    prop(x,S,[V|_],_,M),
    M == pos,
    prop(z,S1,[V1|_],_,N),
    xneg([[V,neg]|Rest]),
    member([V1,N],[[V,neg]|Rest]),
    (V == V1,
    S == S1,
    M  &== N,
    prop(y,S2,_,f,_),
    S2 == [i],
    code(1,Code,threatened,Act,3,Rel);
    V == V1,
    S == S1,
```

```
    M &== N,
    code(2,Code,warned,Act,3,Rel);
    prop(y,S2,_,f,_),
    S2 == [i],
    code(3,Code,threatened,Act,3,Rel);
    code(4,Code,warned,Act,3,Rel)).

/* Heuristics 1 & 2 - XV is negative - Relation 3 */

thr_or_war(Code,Act,Rel) :-
    prop(x,S,[V|_],_,M),
    M == neg,
    prop(z,S1,[V1|_],_,N),
    xpos([[V,pos]|Rest]),
    member([V1,N],[[V,pos]|Rest]),
    (V == V1,
    S == S1,
    M &== N,
    prop(y,S2,_,f,_),
    S2 == [i],
    code(1,Code,threatened,Act,3,Rel);
    V == V1,
    S == S1,
    M &== N,
    code(2,Code,warned,Act,3,Rel);
    prop(y,S2,_,f,_),
    S2 == [i],
    code(3,Code,threatened,Act,3,Rel);
    code(4,Code,warned,Act,3,Rel)).

/*  Relation 4 */

thr_or_war(Code,Act,Rel) :-
    prop(y,S,[V|Rest],T,M),
    prop(z,S1,[V1|_],_,N),
    harm([[V,M]|Rest1]),
    member([V1,N],Rest1),
    (S == [i],
    T == f,
    code(5,Code,threatened,Act,4,Rel);
    code(6,Code,warned,Act,4,Rel)).

/* Heuristic 4 - Relation 4 */

thr_or_war(Code,Act,Rel) :-
    prop(x,S,P,past,M),
    prop(y,S1,[V|Rest],T1,M1),
    harm([[V,M1]|Rest1]),
    (S1 == [i],
    T1 == f,
    code(5,Code,threatened,Act,4,Rel);
    code(6,Code,warned,Act,4,Rel)).

/*****************************************************/
```

```
/* gen-prem generates missing premises of practical arguments
and asserts their propositional contents in the database.
Two examples below. */

/*****************************************************/

/* Hot things cause burns when touched. */

gen_prem(Subj,Pred,pos,[touch|Rest],N) :-
    negate(N,N1),
    member(hot,Pred),
    asserta(prop(x,[you],[touch|Rest],f,pos)),
    asserta(prop(y,[you],[be,burned],f,N1)).

/* Excellent things are pleasing to see */

gen_prem(Subj,Pred,pos,[see|Rest],N) :-
    (member(excellent,Pred);
    member(good,Pred)),
    asserta(prop(x,[you],[see|Rest],f,pos)),
    asserta(prop(y,[you],[be,pleased],f,N)).

/*****************************************************/

/* Output generates paraphrases of texts. */

/*****************************************************/

/* Is Code instantiated? If not, go back and read
another sentence. */

output(Code,Act,Rel) :-
    var(Code).

/*  Promise or threat - Heuristic 1 - relation 1 or 3 */

output(1,Act,Rel) :-
    nl,
    prop(x,Subj,Pred,Tense,M),
    prop(y,Subj1,Pred1,Tense1,M1),
    pn2(M,U),
    pn1(M1,V),

make_sent([[s],[Act],V,[to],Pred1,[if],Subj,U,Pred,[.]],[],Respons
e),
    write_sent(Response),nl,
    confirm(Rel).

/* Advice or warning - Heuristic 1 - Relation 1 or 3 */

output(2,Act,Rel) :-
    nl,
    prop(x,S,P,T,M),
    prop(y,S1,P1,T1,M1),
    prop(z,S2,P2,T2,M2),
```

```
    pn1(M,U),
    pn1(M2,W),
    pn2(M,U1),
    pn1(M1,V),

make_sent([[s],[Act],[you],W,[to],P2,[since,if,you],U1,P,S1,[will]
,V,P1,[.]],[],Response),
    write_sent(Response),
    confirm(Rel).

/* Promise or threat - Heuristic 2 - Relation 1 or 3 */

output(3,Act,Rel) :-
    nl,
    quantity(Act,Q),
    prop(x,S,P,T,M),
    prop(y,S1,P1,T1,M1),
    prop(z,S2,[H|R],T2,M2),
    pn2(M,U),
    pn1(M1,V),
    pn1(M2,T10),
    pn1(M,W),
    combine(H,ing,H1),
     rev(S,S3),
    make_sent([[s],[Act],V,[to],P1,[if,you],U,P,[.]],[],R1),

make_sent([T10,[H1],R,[will,make,it],Q,[likely,that],S3,[will],W,P
,[.]],[],R2),
    write_sent(R1),
    write_sent(R2),
    confirm(Rel).

/* Advice or warning - Heuristic 2 - Relation 1 or 3 */

output(4,Act,Rel) :-
    nl,
    quantity(Act,Q),
    prop(x,S,P,T,M),
    prop(y,S1,P1,T1,M1),
    prop(z,S2,[H|R],T2,M2),
    combine(H,ing,H1),
    rev(S,S3),
    pn1(M,T10),
    pn2(M,U),
    pn1(M1,V),
    pn1(M2,W),
    make_sent([[s],[Act],[you],W,[to],[H|R],[.]],[],R1),
    make_sent([[if,you],U,P,S1,[will],V,P1,[.]],[],R2),

make_sent([W,[H1],R,[will,make,it],Q,[likely,that],S3,[will],T10,P
,[.]],[],R3),
    write_sent(R1),
    write_sent(R2),
    write_sent(R3),
    confirm(Rel).
```

```
/* Promise or Threat - Relation 2 or 4 */

output(5,Act,Rel) :-
    nl,
    prop(x,S,P,T,M),
    prop(y,S1,[H|R],T1,M1),
    prop(z,S2,P2,T2,M2),
    rev(S,S3),
    (T == past,
    pn3(M,U);
    pn2(M,U)),
    pn1(M1,V),
    pn1(M2,W),
    make_sent([[s],[Act],V,[to],[H|R],[if],S3,U,P,[.]],[],R1),

make_sent([[for,this,reason,'S',has,suggested,that,you],W,P2,[.]],
[],R2),
    write_sent(R1),
    write_sent(R2),
    confirm(Rel).

/* Advice or warning - Relation 2 or 4 */

output(6,Act,Rel) :-
    nl,
    prop(x,S,P,T,M),
    prop(y,S1,[H|R],T1,M1),
    prop(z,S2,P2,T2,M2),
    rev(S,S3),
    (T == past,
    pn3(M,U);
    pn2(M,U)),
    pn1(M1,V),
    pn1(M2,W),

make_sent([[s,believes,that,if],S3,U,P,S1,[will],V,[H|R],[.]],[],R
1),

make_sent([[with,this,in,mind,'S',has],[Act],[you],W,[to],P2,[.]],
[],R2),
    write_sent(R1),
    write_sent(R2),
    confirm(Rel).

/*****************************************************/

/* Make_sent changes a list of lists (e.g. [[a,a],[b,b],[c]])
into a list of atoms (e.g. [a,a,b,b,c]).  Calls are from
output clauses.  */

/*****************************************************/

make_sent([],List,List).
```

```
make_sent([F|Rest],L,List) :-
    append(L,F,L1),
    make_sent(Rest,L1,List).

/*******************************************************/

/* Append(X,Y,Z) appends list Y to list X to form list Z.
Clocksin & Mellish, pgs. 55-56. */

/*******************************************************/

append([],L,L).

append([X|L1],L2,[X|L3]) :-
    append(L1,L2,L3).

/*******************************************************/

/* Confirm asks the user whether the paraphrase is accurate.
If it is, new information is asserted in the database. If not,
the user is queried. */

/*******************************************************/

confirm(Rel) :-
    nl,
    write('Is this correct?'),nl,
    read_in(Q,R),
    (Q == [yes,.],
    new_facts(Rel);
    menu(1)),
    (not(prop(_,_,_,_,_));
    nl,write('*'),nl,nl).

/*******************************************************/

/*  Combine(X,Y,Z) combines atoms X and Y to form atom Z.
Trailing e's are eliminated. */

/*******************************************************/

combine(X,Y,Z) :-
    name(X,L1),
    name(Y,L2),
    rev(L1,[H|T]),
    name(e,E),
    ([H] == E,
    rev(T,L3);
    rev([H|T],L3)),
    append(L3,L2,L4),
    name(Z,L4).

/*******************************************************/

/* New-facts updates the benefit and harm lists when a
```

```
paraphrase has been confirmed by the user. */

/*****************************************************/

/* Promise or advice - Relation 1 */

new_facts(1) :-
     prop(x,_,[V|R],_,M),
     prop(y,_,[V1|R1],_,M1),
     prop(z,_,[V2|R2],_,M2),
     (benefit([[V,M]|Rest]);
     asserta(benefit([[V,M]]))),
     (benefit([[V1,M1]|Rest1]);
     asserta(benefit([[V1,M1]]))),
     (benefit([[V2,M2]|Rest2]);
     asserta(benefit([[V2,M2]])));.

/* Promise or advice - Relation 2 */

new_facts(2) :-
     prop(x,_,[V|R],_,M),
     prop(y,_,[V1|R1],_,M1),
     prop(z,_,[V2|R2],_,M2),
     benefit([[V1,M1]|Rest1]),
     (member([V2,M2],Rest1);
     retract(benefit([[V1,M1]|Rest1])),
     asserta(benefit([[V1,M1]|[[V2,M2]|Rest1]]))),
     (benefit([[V,M]|Rest]);
     asserta(benefit([[V,M]])));.

/* Threat or warning - Relation 3 */

new_facts(3) :-
     prop(x,_,[V|R],_,M),
     prop(y,_,[V1|R1],_,M1),
     prop(z,_,[V2|R2],_,M2),
     (harm([[V,M]|Rest]);
     asserta(harm([[V,M]]))),
     (harm([[V1,M1]|Rest1]);
     asserta(harm([[V1,M1]]))),
     negate(M2,M3),
     (harm([[V2,M3]|Rest2]);
     asserta(harm([[V2,M3]])));.

/* Threat or warning - Relation 4 */

new_facts(4) :-
     prop(x,_,[V|R],_,M),
     prop(y,_,[V1|R1],_,M1),
     prop(z,_,[V2|R2],_,M2),
     harm([[V1,M1]|Rest1]),
     (member([V2,M2],Rest1);
     retract(harm([[V1,M1]|Rest1])),
     asserta(harm([[V1,M1]|[[V2,M2]|Rest1]]))),
     (harm([[V,M]|Rest]);
```

```
    asserta(harm([[V,M]])).

/*****************************************************/

/* Menu queries the user for additional information when
the program (1) has inaccurately paraphrased a text or
(2) has been unable to paraphrase at all. Information
elicited is recorded in the database and a new paraphrase
is attempted. */

/*****************************************************/

/* If Y is in the hearer's interests, update the benefit lists
and goto menu(2). If Y is not in the hearer's interests,
update the harm lists and goto menu(3). Otherwise, advise
the user that the text is beyond the scope of the program.  */

menu(1) :-
    nl,write('Let Y be the state of affairs described in the
consequent of the premise.'),nl,
    write('Which of the following most accurately describes the
viewpoint of the speaker?'),nl,nl,
    write('A.  Y is in the interests of the hearer.'),nl,
    write('B.  Y is not in the interests of the hearer.'),nl,
    write('C.  Y does not affect the interests of the hearer one
way or the other.'),nl,nl,
    prop(y,_,[V|Rest],_,M),
    read_in(Q,R),
    (Q == [a,.],
    (benefit([[V,M]|R1]);
    asserta(benefit([[V,M]]))),
    menu(2);
    Q == [b,.],
    (harm([[V,M]|R1]);
    asserta(harm([[V,M]]))),
    menu(3);
    bad_text).

/* Promise or advise - Heuristic 3.
Ask whether the relation is 2, 1, or 5. If 2, update the
benefit list. If 1, update the xpos and xneg lists. In either
case, invoke promise-or-advise. If 5, advise the user that
the text is beyond the scope of the program. */

menu(2) :-
    nl,
    write('Let X be the state of affairs described in the
antecedent of the '),
    write('premise and Z the action specified in the conclusion.
'),
    write('Which of the following most accurately describes the
'),
    write('viewpoint of the speaker?'),nl,nl,
    write('A.  The hearer should do Z in anticipation of Y.'),nl,
    write('B.  By doing Z the hearer would increase the
```

```
likelihood of X.'),nl,
    write('C.  Neither of the above.'),nl,nl,
    prop(x,_,[V|R],_,M),
    prop(y,_,[V1|R1],_,M1),
    prop(z,_,[V2|R2],_,M2),
    read_in(Q,R3),
    (Q == [a,.],
    (benefit([[V1,M1]|Rest]),
    member([V2,M2],Rest);
    retract(benefit([[V1,M1]|Rest])),
    asserta(benefit([[V1,M1]|[[V2,M2]|Rest]]))),
    pro_or_adv(Code1,Act1,Rel1),
    output(Code1,Act1,Rel1),
    clean_up(Code1);
    Q == [b,.],
    (xpos([[V,pos]|Rest]),
    member([V2,M2],[[V,pos]|Rest]),
    bad_text;
    (M == pos,
    retract(xpos([[V,pos]|Rest])),
    asserta(xpos([[V,pos]|[[V2,M2]|Rest]])),
    negate(M2,N2),
    retract(xneg([[V,neg]|Rest2])),
    asserta(xneg([[V,neg]|[[V2,N2]|Rest2]]));
    retract(xneg([[V,neg]|Rest])),
    asserta(xneg([[V,neg]|[[V2,M2]|Rest]])),
    negate(M2,N2),
    retract(xpos([[V,pos]|Rest2])),
    asserta(xpos([[V,pos]|[[V2,N2]|Rest2]]))),
    pro_or_adv(Code1,Act1,Rel1),
    output(Code1,Act1,Rel1),
    clean_up(Code1));
    bad_text).

/* Threat or warning - Heuristic 3.
Ask whether the relation is 4, 3, or 5. If 4, update the
harm list. If 3, update the xpos and xneg lists. In either
case, invoke threat-or-warning.  If 5, advise the user that
the text is beyond the scope of the program */

menu(3) :-
    nl,
    write('Let X be the state of affairs described in the
antecedent of the '),
    write('premise and Z the action specified in the conclusion.
'),
    write('Which of the following most accurately describes the
'),
    write('viewpoint of the speaker?'),nl,nl,
    write('A.  The hearer should do Z in anticipation of Y.'),nl,
    write('B.  By doing Z the hearer would decrease the
likelihood of X.'),nl,
    write('C.  Neither of the above.'),nl,nl,
    prop(x,_,[V|R],_,M),
    prop(y,_,[V1|R1],_,M1),
```

```
    prop(z,_,[V2|R2],_,M2),
    read_in(Q,R3),
    (Q == [a,.],
    (harm([[V1,M1]|Rest]),
    member([V2,M2],Rest);
    retract(harm([[V1,M1]|Rest])),
    asserta(harm([[V1,M1]|[[V2,M2]|Rest]]))),
    thr_or_war(Code1,Act1,Rel1),
    output(Code1,Act1,Rel1),
    clean_up(Code1);
    Q == [b,.],
    (xneg([[V,neg]|Rest]),
    member([V2,M2],[[V,neg]|Rest]),
    bad_text;
    (M == pos,
    retract(xneg([[V,neg]|Rest])),
    asserta(xneg([[V,neg]|[[V2,M2]|Rest]])),
    negate(M2,N2),
    retract(xpos([[V,pos]|Rest2])),
    asserta(xpos([[V,pos]|[[V2,N2]|Rest2]]));
    retract(xpos([[V,pos]|Rest])),
    asserta(xpos([[V,pos]|[[V2,M2]|Rest]])),
    negate(M2,N2),
    retract(xneg([[V,neg]|Rest2])),
    asserta(xneg([[V,neg]|[[V2,N2]|Rest2]]))),
    thr_or_war(Code1,Act1,Rel1),
    output(Code1,Act1,Rel1),
    clean_up(Code1));
    bad_text).


/*****************************************************/

/* Bad-text informs the user that the text is beyond the
scope of the program and retracts all propositions */

/*****************************************************/

bad_text :-
    nl,
    write('In addition to assertions, this program recognizes
only four '),
    write('types of speech acts - promises, threats, advice, and
'),
    write('warnings.  The text falls under none of these
categories.'),
    clean_up(1),
    nl,nl,write('*'),nl,
nl.

/*****************************************************/

/* Positive-or-negative assigns the empty list or a negative
to the second argument. These clauses are invoked by output. */
```

```
pn1(pos,[]).
pn1(neg,[not]).

pn2(pos,[]).
pn2(neg,[do,not]).

pn3(pos,[]).
pn3(neg,[did,not]).

/* Quantity assigns "more" or "less" to the second argument.
These clauses are invoked by output. */

quantity(promised,[more]).
quantity(advised,[more]).
quantity(threatened,[less]).
quantity(warned,[less]).

/*******************/

/* Data Base */

/*******************/

/* Verbs */

is_a(study,verb,pr).
is_a(pass,verb,pr).
is_a(finish,verb,pr).
is_a(let,verb,pr).
is_a(fail,verb,pr).
is_a(think,verb,pr).
is_a(relax,verb,pr).
is_a(give,verb,pr).
is_a(ground,verb,pr).
is_a(be,verb,pr).
is_a(overstudy,verb,pr).
is_a(hit,verb,pr).
is_a(smoke,verb,pr).
is_a(go,verb,pr).
is_a(take,verb,pr).
is_a(discontinue,verb,pr).
is_a(change,verb,pr).
is_a(will,verb,f).
is_a(save,verb,pr).
is_a(help,verb,pr).
is_a(overstudied,verb,past).
is_a(resign,verb,pr).
is_a(start,verb,pr).
is_a(insist,verb,pr).
is_a(buy,verb,pr).
is_a(choose,verb,pr).
is_a(make,verb,pr).
is_a(closes,verb,pr).
is_a(fall,verb,pr).
```

```
is_a(sell,verb,pr).
is_a(wait,verb,pr).
is_a(is,verb,pr).
is_a(touch,verb,pr).
is_a(see,verb,pr).
is_a(won,verb,past).
is_a(have,verb,pr).
is_a(studied,verb,past).
is_a(feel,verb,pr).
is_a(enjoy,verb,pr).

/* Auxiliary Verbs */

is_a(is,aux_verb,pr).
is_a(did,aux_verb,past).
is_a(are,aux_verb,pr).
is_a(has,aux_verb,pr).
is_a(was,aux_verb,past).
is_a(will,aux_verb,f).
is_a(do,aux_verb,pr).
is_a(does,aux_verb,pr).
is_a(have,aux_verb,pr).

/* Prepositions */

is_a(to,prep).
is_a(by,prep).
is_a(on,prep).
is_a(of,prep).
is_a(in,prep).

/* Adjectives */

is_a(hot,adj).
is_a(excellent,adj).
is_a(good,adj).

/* Adverbs */

is_a(very,adv).
is_a(quite,adv).

/* Terminators */

is_a(.,term).
is_a(?,term).
is_a(!,term).

/* Connectives */

is_a(if,conn).
is_a(then,conn).
is_a(so,conn).

/* Negation */
```

```
is_a(not,neg).

isis!hkd4302[34]
```

6. PROGRAM OUTPUT

6.1 HEURISTIC 1

INPUT IS OF THE FORM "IF X THEN Y. SO DO Z. HEURISTIC 1 IS EMPLOYED FOR UTTERANCES IN WHICH X = Z OR X = -Z, WHERE "=" IS TO BE READ AS "SUBSTANTIALLY IDENTICAL TO".

```
isis!hkd4302[22] prolog
C-Prolog version 1.4
| ?- [searle2].
searle2 consulted 33004 bytes 7.449997 sec.


yes
| ?- talk.

HEURISTIC 1 - PROMISES

|: If you finish your homework then I will let you watch
television. So finish that math.

S promised to let you watch television if you finish your
homework.


Is this correct?
|: yes.

*

|: I will give you five dollars if you do not fail your exam. So
do not fail.

S promised to give you five dollars if you do not fail your exam.


Is this correct?
|: yes.

*

HEURISTIC 1 - THREATS

|: I will ground you for a week if you fail the test tomorrow. So
do not fail.

S threatened to ground you for a week if you fail the test
tomorrow.


Is this correct?
|: yes.
```

*

!: Finish your homework. I will not let you watch television if you do not finish.

S threatened not to let you watch television if you do not finish.

Is this correct?
!: yes.

*

HEURISTIC 1 - ADVISE

!: If you study for the exam then you will pass. So study hard.

S advised you to study hard since if you study for the exam you will pass.

Is this correct?
!: yes.

*

!: If you do not smoke then you will be healthier. So do not smoke.

S advised you not to smoke since if you do not smoke you will be healthier.

Is this correct?
!: yes.

*

!: You will feel better if you do not smoke. So do not smoke cheap cigars.

S advised you not to smoke cheap cigars since if you do not smoke you will feel better.

Is this correct?
!: yes.

*

HEURISTIC 1 - WARNINGS

!: Do not overstudy for the test. You will be too tired to take the exam if you overstudy.

S warned you not to overstudy for the test since if you overstudy you will be too tired to take the exam.

Is this correct?
!: yes.

*

!: If you do not study at all then you will fail. So study at least an hour.

S warned you to study at least an hour since if you do not study at all you will fail.

Is this correct?
!: yes.

*

THE FOLLOWING CASES STRIKE ONE AS ODD SINCE THEY CLASH WITH CONVENTIONAL VALUES. THE PARAPHRASES CAPTURE THE ODDNESS AND TO SOME EXTENT EXPLAIN IT.

!: If you finish your homework then I will ground you for the weekend. So finish your homework.

S promised to ground you for the weekend if you finish your homework.

Is this correct?
!: yes.

*

!: If you pass your exam then I will give you five dollars. So do not pass your exam.

S threatened to give you five dollars if you pass your exam.

Is this correct?
!: yes.

*

!: If you study for the test then you will pass for sure. So do not study for even fifteen minutes.

S warned you not to study for even fifteen minutes since if you study for the test you will pass for sure.

Is this correct?
!: yes.

*

IN THE NEXT THREE EXAMPLES, THE SPEECH ACTS IN QUESTION ARE BEYOND THE SCOPE OF THIS PROGRAM. THE ILLOCUTIONARY FORCE IS THAT OF REQUEST IN THE FIRST TWO EXAMPLES AND MORAL APPEAL IN THE THIRD. NOTE THAT THE ACCURACY OF A PARAPHRASE DEPENDS ON THE CONTEXT OF THE UTTERANCE. ONE CAN EASILY IMAGINE CONTEXTS IN WHICH THE PROGRAM'S PARAPHRASES WOULD BE RIGHT ON TARGET.

I: Help me with this stuff. I will pass the test if you help.

S promised to pass the test if you help.

Is this correct?
I: no.

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

I: C.

In addition to assertions, this program recognizes only four types of speech acts - promises, threats, advice, and warnings. The text falls under none of these categories.

*

I: Help me with this material. I will fail the test if you do not help.

S threatened to fail the test if you do not help.

Is this correct?
I: no.

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

I: C.

In addition to assertions, this program recognizes only four

types of speech acts - promises, threats, advice, and warnings.
The text falls under none of these categories.

*

|: If you give to the relief fund then you will save African lives. So give generously.

S advised you to give generously since if you give to the relief fund you will save african lives.

Is this correct?
|: no.

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

|: C.

In addition to assertions, this program recognizes only four types of speech acts - promises, threats, advice, and warnings.
The text falls under none of these categories.

*

|: bye.

yes
| ?-

6.2 HEURISTICS 2 AND 3

HEURISTIC 2 IS EMPLOYED FOR ARGUMENTS IN WHICH Z (THE ACTION MENTIONED IN THE CONCLUSION) WOULD, IF PERFORMED, EITHER INCREASE OR DECREASE THE LIKELIHOOD OF X (THE EVENT MENTIONED IN THE ANTECEDENT OF THE PREMISE). TO PROCESS SUCH CASES, THE PROGRAM MUST FIRST BE TAUGHT THE APPROPRIATE RELATION BETWEEN X AND Z.

*isis-hkd4302[2] prolog
C-Prolog version 1.4
| ?- [searle2].
searle2 consulted 32944 bytes 6.999996 sec.

yes
| ?- talk.

HEURISTIC 2 - PROMISES
IN THIS CASE, THE PROGRAM FIRST HAS TO BE TAUGHT THE RELATIONSHIP BETWEEN STARTING AND FINISHING A PROJECT.

!: Start on your math right away. I will let you watch television tonight if you finish all your homework before six.

USING HEURISTIC 3 THE PROGRAM NOW NARROWS THE POSSIBILITIES.

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

!: A.

THE RELATION IS EITHER 2, 1, OR 5 - BUT WHICH ONE?

Let X be the state of affairs described in the antecedent of the premise and Z the action specified in the conclusion. Which of the following most accurately describes the viewpoint of the speaker?

A. The hearer should do Z in anticipation of Y.
B. By doing Z the hearer would increase the likelihood of X.
C. Neither of the above.

!: B.

S promised to let you watch television tonight if you finish all your homework before six.
Starting on your math right away will make it more likely that you will finish all your homework before six.

Is this correct?
!: yes.

*

THE PROGRAM NOW KNOWS WHAT IT NEEDS TO KNOW IN ORDER TO PARAPHRASE SIMILAR CASES.

!: Start your essay. I will let you go to the show tonight if you finish your homework this afternoon.

S promised to let you go to the show tonight if you finish your homework this afternoon.
Starting your essay will make it more likely that you will finish

your homework this afternoon.

Is this correct?
!: yes.

*

!: If you finish your homework before six then they will give you more work to do. So do not start until five forty five.

S warned you not to start until five forty five.
If you finish your homework before six they will give you more work to do.
Not starting until five forty five will make it less likely that you will finish your homework before six.

Is this correct?
!: yes.

*

!: If you do not finish studying for the test then you will fail for sure. So start studying as soon as possible.

S warned you to start studying as soon as possible.
If you do not finish studying for the test you will fail for sure.
Starting studying as soon as possible will make it less likely that you will not finish studying for the test.

Is this correct?
!: yes.

*

!: Do not start your homework until nine. If you do not finish before nine thirty then they will help you do it.

S advised you not to start your homework until nine.
If you do not finish before nine thirty they will help you do it.
Not starting your homework until nine will make it more likely that you will not finish before nine thirty.

Is this correct?
!: yes.

*

!: If you do not finish your homework then I will discontinue your allowance. So start right now.

S threatened to discontinue your allowance if you do not finish your homework.
Starting right now will make it less likely that you will not finish your homework.

Is this correct?
|: yes.

*

|: bye.

yes

| ?-

| ?- talk.

HEURISTIC 2 - THREATS
IN THE FOLLOWING SEQUENCE, THE PROGRAM FIRST LEARNS THE RELATIONSHIP BETWEEN HITTING PEOPLE AND BEING NEAR THEM.

|: I will not let you watch television tonight if you hit your sister. So do not go near her.

USING HEURISTIC 3, THE PROGRAM NARROWS THE POSSIBILITIES

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

|: B.

THE RELATION IS 4, 3, OR 5. BUT WHICH ONE?

Let X be the state of affairs described in the antecedent of the premise and Z the action specified in the conclusion. Which of the following most accurately describes the viewpoint of the speaker?

A. The hearer should do Z in anticipation of Y.
B. By doing Z the hearer would decrease the likelihood of X.
C. Neither of the above.

|: B.

S threatened not to let you watch television tonight if you hit your sister.

```
Not going near her will make it less likely that you will hit
your sister.

Is this correct?
!: yes.

*

THE PROGRAM NOW KNOWS WHAT IT NEEDS TO KNOW IN ORDER TO
PARAPHRASE SIMILAR CASES.

!: I will not let you watch television tonight if you hit your
sister. So do not go near her.

S threatened not to let you watch television tonight if you hit
your sister.
Not going near her will make it less likely that you will hit
your sister.

Is this correct?
!: yes.

*

!: I will let you watch television tonight if you do not hit your
sister. So do not go near her.

S promised to let you watch television tonight if you do not hit
your sister.
Not going near her will make it more likely that you will not hit
your sister.

Is this correct?
!: yes.

*

!: If you do not hit your brother then he will not hit you back.
So do not go near him for the rest of the day.

S advised you not to go near him for the rest of the day.
If you do not hit your brother he will not hit you back.
Not going near him for the rest of the day will make it more
likely that you will not hit your brother.

Is this correct?
!: yes.

*

!: If you hit your brother then he will hit you back. So do not
go near him.

S warned you not to go near him.
If you hit your brother he will hit you back.
```

Not going near him will make it less likely that you will hit your brother.

Is this correct?
|: yes.

*

|: If you do not hit your brother then he will think that you are ignoring him. So go near him.

S warned you to go near him.
If you do not hit your brother he will think that you are ignoring him.
Going near him will make it less likely that you will not hit your brother.

Is this correct?
|: yes.

*

|: If you hit your bother then he will not hit you back. So go near him.

S advised you to go near him.
If you hit your bother he will not hit you back.
Going near him will make it more likely that you will hit your bother.

Is this correct?
|: yes.

*

|:

HEURISTIC 2 - ADVICE
IN THIS SEQUENCE, THE PROGRAM IS TAUGHT THE RELATIONSHIP BETWEEN STUDYING FOR AND PASSING AN EXAM.

isis!hkd4302[13] prolog
C-Prolog version 1.4
| ?- [searle2].
searle2 consulted 32904 bytes 6.883331 sec.

yes
| ?- talk.

|: If you pass your exams then your mother will buy you a stereo. So study hard.

Let Y be the state of affairs described in the consequent of the premise.

Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

!: a.

Let X be the state of affairs described in the antecedent of the premise and Z the action specified in the conclusion. Which of the following most accurately describes the viewpoint of the speaker?

A. The hearer should do Z in anticipation of Y.
B. By doing Z the hearer would increase the likelihood of X.
C. Neither of the above.

!: B.

S advised you to study hard.
If you pass your exams your mother will buy you a stereo.
Studying hard will make it more likely that you will pass your exams.

Is this correct?
!: yes.

*

THE RELATIONSHIP HAS BEEN LEARNED. SIMILAR CASES CAN NOW BE PROCESSED.

!: Study hard. If you pass your exams then your mother will buy you a stereo.

S advised you to study hard.
If you pass your exams your mother will buy you a stereo.
Studying hard will make it more likely that you will pass your exams.

Is this correct?
!: yes.

*

!: I will buy you a bright new yoyo if you pass at least one of your tests. So study up.

S promised to buy you a bright new yoyo if you pass at least one of your tests.
Studying up will make it more likely that you will pass at least one of your tests.

```
Is this correct?
!: yes.

*

!: If you do not pass your exams then I will ground you for the
weekend. So study as much as you can.

S threatened to ground you for the weekend if you do not pass
your exams.
Studying as much as you can will make it less likely that you
will not pass your exams.

Is this correct?
!: yes.

*

!: If you do not pass your tests then your mother will take
unspecified action against you. So study very hard for those
exams.

S warned you to study very hard for those exams.
If you do not pass your tests your mother will take unspecified
action against you.
Studying very hard for those exams will make it less likely that
you will not pass your tests.

Is this correct?
!: yes.

*

!: If you pass all your tests then your mother will ground you
for the weekend. So do not study at all.

S warned you not to study at all.
If you pass all your tests your mother will ground you for the
weekend.
Not studying at all will make it less likely that you will pass
all your tests.

Is this correct?
!: yes.

*

!: ^D
```

HEURISTIC 2 - WARNING
IN THIS SEQUENCE, THE PROGRAM LEARNS THE RELATIONSHIP BETWEEN TAKING BETTER CARE OF SOMEONE AND CHANGING ONE'S ATTITUDE.

```
isis!hkd4302[8] prolog
C-Prolog version 1.4
| ?- [searle2].
searle2 consulted 32856 bytes 6.916664 sec.

yes
| ?- talk.

!: If you do not take better care of your sister then she will
insist on having a babysitter while we are gone. So change your
attitude.

Let Y be the state of affairs described in the consequent of the
premise.
Which of the following most accurately describes the viewpoint of
the speaker?

A.  Y is in the interests of the hearer.
B.  Y is not in the interests of the hearer.
C.  Y does not affect the interests of the hearer one way or the
other.

!: B.

Let X be the state of affairs described in the antecedent of the
premise and Z the action specified in the conclusion.  Which of
the following most accurately describes the viewpoint of the
speaker?

A.  The hearer should do Z in anticipation of Y.
B.  By doing Z the hearer would decrease the likelihood of X.
C.  Neither of the above.

!: B.

S warned you to change your attitude.
If you do not take better care of your sister she will insist on
having a babysitter while we are gone.
Changing your attitude will make it less likely that you will not
take better care of your sister.

Is this correct?
!: yes.

*

THE RELATIONSHIP HAS BEEN LEARNED.

!: Change your ways. She will insist on a babysitter if you do
not take better care of her.

S warned you to change your ways.
If you do not take better care of her she will insist on a
babysitter.
Changing your ways will make it less likely that you will not
```

take better care of her.

Is this correct?
!: yes.

*

!: If you take better care of your sister then she will not insist on having a babysitter. So change your attitude.

S advised you to change your attitude.
If you take better care of your sister she will not insist on having a babysitter.
Changing your attitude will make it more likely that you will take better care of your sister.

Is this correct?
!: yes.

*

!: I will discontinue your allowance if you do not take better care of your brother. So change your attitude.

S threatened to discontinue your allowance if you do not take better care of your brother.
Changing your attitude will make it less likely that you will not take better care of your brother.

Is this correct?
!: yes.

*

!: I will give you five dollars if you take good care of your brothers while I am away. So change your attitude.

S promised to give you five dollars if you take good care of your brothers while i am away.
Changing your attitude will make it more likely that you will take good care of your brothers while i am away.

Is this correct?
!: yes.

*

!: I will give you five dollars if you take care of your sister for the rest of the day. So change your surly ways.

S promised to give you five dollars if you take care of your sister for the rest of the day.
Changing your surly ways will make it more likely that you will take care of your sister for the rest of the day.

Is this correct?
!: yes.

*

!: I will give you five dollars if you do not take better care of your pets. So do not change your attitude.

S promised to give you five dollars if you do not take better care of your pets.
Not changing your attitude will make it more likely that you will not take better care of your pets.

Is this correct?
!: yes.

*

!:

IN THE FOLLOWING SEQUENCE, S BELIEVES THAT IT IS POSSIBLE THAT X AND THAT IF X THEN Y. THE HEARER IS URGED TO DO Z IN ANTICIPATION OF Y. TO PARAPHRASE SUCH CASES, THE PROGRAM MUST FIRST LEARN THE APPROPRIATE RELATION BETWEEN Y AND Z.

PROMISES

!: Choose what kind of stereo you want. If you pass all your exams then I will buy you a stereo.

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

!: A.

Let X be the state of affairs described in the antecedent of the premise and Z the action specified in the conclusion. Which of the following most accurately describes the viewpoint of the speaker?

A. The hearer should do Z in anticipation of Y.
B. By doing Z the hearer would increase the likelihood of X.
C. Neither of the above.

!: A.

S promised to buy you a stereo if you pass all your exams.

For this reason S has suggested that you choose what kind of stereo you want.

Is this correct?
!: yes.

*

!: I will buy you a box if you pass your courses. Choose what kind you want.

S promised to buy you a box if you pass your courses.
For this reason S has suggested that you choose what kind you want.

Is this correct?
!: yes.

*

ADVICE

!: If you pass your test then your uncle will buy you a bike. Choose a bright shiny one.

S believes that if you pass your test your uncle will buy you a bike.
With this in mind S has advised you to choose a bright shiny one.

Is this correct?
!: yes.

*

THREATS

!: If you do not pass your exams then I will ground you. So do not make any plans for the weekend.

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

!: B.

Let X be the state of affairs described in the antecedent of the premise and Z the action specified in the conclusion. Which of the following most accurately describes the viewpoint of the speaker?

A. The hearer should do Z in anticipation of Y.
B. By doing Z the hearer would decrease the likelihood of X.
C. Neither of the above.

!: A.

S threatened to ground you if you do not pass your exams.
For this reason S has suggested that you not make any plans for the weekend.

Is this correct?
!: yes.

*

!: If you do not pass your year then I will ground you indefinitely. So do not make any plans for the next six weeks or so.

S threatened to ground you indefinitely if you do not pass your year.
For this reason S has suggested that you not make any plans for the next six weeks or so.

Is this correct?
!: yes.

*

WARNING

!: Your mother will ground you forever if you do not pass the quiz tomorrow. So do not make any plans until you reach adulthood.

S believes that if you do not pass the quiz tomorrow your mother will ground you forever.
With this in mind S has warned you not to make any plans until you reach adulthood.

Is this correct?
!: yes.

*

FALLING PRICES CAN BE AN ADVANTAGE OR A DISADVANTAGE DEPENDING ON ONE'S CIRCUMSTANCES. IN THE NEXT SEQUENCE, BOTH CASES ARE ILLUSTRATED.

!: If the college closes then real estate prices will fall. So sell your house as soon as you can.

Let Y be the state of affairs described in the consequent of the premise.

Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

!: B.

Let X be the state of affairs described in the antecedent of the premise and Z the action specified in the conclusion. Which of the following most accurately describes the viewpoint of the speaker?

A. The hearer should do Z in anticipation of Y.
B. By doing Z the hearer would decrease the likelihood of X.
C. Neither of the above.

!: A.

S believes that if the college closes real estate prices will fall.
With this in mind S has warned you to sell your house as soon as you can.

Is this correct?
!: yes.

*

!: Real estate prices will fall if the college closes. Sell your property quick.

S believes that if the college closes real estate prices will fall.
With this in mind S has warned you to sell your property quick.

Is this correct?
!: yes.

*

!: Real estate prices will fall if the college closes. Wait a year before buying a house in the area.

Let Y be the state of affairs described in the consequent of the premise.
Which of the following most accurately describes the viewpoint of the speaker?

A. Y is in the interests of the hearer.
B. Y is not in the interests of the hearer.
C. Y does not affect the interests of the hearer one way or the other.

!: A.

Let X be the state of affairs described in the antecedent of the premise and Z the action specified in the conclusion. Which of the following most accurately describes the viewpoint of the speaker?

A. The hearer should do Z in anticipation of Y.
B. By doing Z the hearer would increase the likelihood of X.
C. Neither of the above.

!: A.

S believes that if the college closes real estate prices will fall.
With this in mind S has advised you to wait a year before buying a house in the area.

Is this correct?
!: yes.

*

!: Real estate prices will fall if the college closes. Wait a year before buying.

S believes that if the college closes real estate prices will fall.
With this in mind S has advised you to wait a year before buying.

Is this correct?
!: yes.

*

!:

6.3 HEURISTIC 4

FOR UTTERANCES IN WHICH HEURISTIC 4 PLAYS A ROLE, (1) THE EVENT SPECIFIED BY X IS IN THE PAST AND (2) THE EVENT SPECIFIED BY Y IS KNOWN TO BE EITHER ADVANTAGEOUS OR DISADVANTAGEOUS TO THE HEARER. WITH THIS INFORMATION, THE PROGRAM MAKES THE APPROPRIATE DEDUCTIONS.

IN THE FOLLOWING SEQUENCE, THE FIRST FOUR TEXTS ARE USED TO INFORM THE PROGRAM THAT PASSING TESTS AND BEING GIVEN MONEY ARE IN THE HEARER'S INTERESTS; AND THAT FAILING TESTS AND BEING GROUNDED ARE NOT.

isis!hkd4302[21] prolog

```
C-Prolog version 1.4
| ?- [searle2].
searle2 consulted 33004 bytes 7.399998 sec.

yes
| ?- talk.

|: If you study for the test then you will pass. So study.

S advised you to study since if you study for the test you will
pass.

Is this correct?
|: yes.

*

|: If you do not study then you will fail. So study for the test.

S warned you to study for the test since if you do not study you
will fail.

Is this correct?
|: yes.

*

|: If you study for the test then I will give you five dollars.
So study.

S promised to give you five dollars if you study for the test.


Is this correct?
|: yes.

*

|: If you do not study then I will ground you for the weekend.
|: So study.

S threatened to ground you for the weekend if you do not study.


Is this correct?
|: yes.

*

THE PROGRAM CAN NOW MAKE USE OF HEURISTIC 4 TO PARAPHRASE THE
FOLLOWING UTTERANCES.

|: If you studied for the test then you will pass. So relax.

S believes that if you studied for the test you will pass.
```

With this in mind S has advised you to relax.

Is this correct?
|: yes.

*

|: Resign yourself to the inevitable. If you did not study for the test then you will fail.

S believes that if you did not study for the test you will fail.
With this in mind S has warned you to resign yourself to the inevitable.

Is this correct?
|: yes.

*

|: If you studied for the test then I will give you five dollars. So start celebrating.

S promised to give you five dollars if you studied for the test.
For this reason S has suggested that you start celebrating.

Is this correct?
|: yes.

*

|: If you did not study for the test then I will ground you indefinitely. Give that a thought or two.

S threatened to ground you indefinitely if you did not study for the test.
For this reason S has suggested that you give that a thought or two.

Is this correct?
|: yes.

*

|: bye.

yes
| ?-

6.4 ENTHYMEMES

IN ATTEMPTING TO PARAPHRASE, THE PROGRAM FINDS THAT IT MUST FIRST GENERATE HIDDEN PREMISES.

I: The stove is hot. So do not touch the stove.

S warned you not to touch the stove since if you touch the stove you will be burned.

Is this correct?
I: yes.

*

I: It is hot. Do not touch it.

S warned you not to touch it since if you touch it you will be burned.

Is this correct?
I: yes.

*

I: Touch it. It is not very hot.

S advised you to touch it since if you touch it you will not be burned.

Is this correct?
I: yes.

*

I: See the exhibition. It is excellent.

S advised you to see the exhibition since if you see the exhibition you will be pleased.

Is this correct?
I: yes.

*

I: Do not see the movie. It is not very good.

S warned you not to see the movie since if you see the movie you will not be pleased.

Is this correct?
I: yes.

*

The production is, I would say, somewhat less than excellent. Do not see it.

S warned you not to see it since if you see it you will not be pleased.

```
Is this correct?
|: yes.
```

6.5 INTERRUPTIONS

INTERRUPTIONS IN THE DIALOGUE -
CAN THE PROGRAM FOCUS ON THE RELEVANT UTTERANCES?

```
isis!hkd4302[13] prolog
C-Prolog version 1.4
| ?- [searle2].
searle2 consulted 32804 bytes 6.949997 sec.

yes
| ?- talk.

|: If you study then you will pass. The Royals won the pennant
last year. So study for at least two hours.

S advised you to study for at least two hours since if you study
you will pass.

Is this correct?
|: yes.

*

|: The Royals won the pennant last year. If you finish your
homework then I will let you fool around this afternoon. The
Yankees won the year before. So finish up.

S promised to let you fool around this afternoon if you finish
your homework.


Is this correct?
|: yes.

*
```

IN THE FOLLOWING CASE THE PROGRAM WAS INITIALLY MISLED BY THE FIRST TWO SENTENCES AND TRIED TO GENERATE A MISSING PREMISE. THIS IS INTERESTING BECAUSE HUMANS ARE OFTEN GARDEN-PATHED UNDER THE SAME CIRCUMSTANCES.

```
|: The Royals won the pennant. Study for the test. If you study
then you will pass.

S advised you to study for the test since if you study you will
pass.
```

```
Is this correct?
|: yes.

*

|: bye.

yes
| ?-
```

7. BIBLIOGRAPHY

Key to technical reports:

BBN Bolt Beranek and Newman
CM Carnegie-Mellon University I and II
IS ISI
MIT MIT
PE University of Pennsylvania
RO University of Rochester
RU Rutgers University
SRI SRI International
SA Stanford--SAIL
Y Yale

7.1 NATURAL LANGUAGE PROCESSING AND COMPUTATIONAL LINGUISTICS

Agar, Michael, and Hobbes, Jerry R., "Interpreting discourse: coherence and the analysis of ethnographic interviews", SRI225, August, 1980.

Allen, James F. (1), "A plan-based approach to speech act recognition", Ph.D Thesis, University of Toronto, 1979.

Allen, James F. (2), and Perrault, C.R., "Analyzing intention in utterances", ARTIFICIAL INTELLIGENCE, 15,3, 1980.

Allen, James F. (3), "What's necessary to hide? :modelling action verbs", PROCEEDINGS, 19TH ANNUAL MEETING, ASSOCIATION FOR COMPUTATIONAL LINGUISTICS, 1981.

Allen, James F. (4), Frisch, A.M. and Litman, D.J., "ARGOT: The Rochester dialogue system", PROCEEDINGS OF THE NATIONAL CONFERENCE ON ARTIFICIAL INTELLIGENCE, Pittsburgh, PA, August, 1982.

Allen, James F. (5), "ARGOT: A system overview", RO101, April 1982; "Special issue on computational linguistics", INTERNATIONAL JOURNAL OF COMPUTERS AND MATHEMATICS 9-1, 1983a.

Allen, James F. (6), "Recognizing intentions from natural language utterances", in COMPUTATIONAL MODELS OF DISCOURSE, ed. by M. Brady (Cambridge, MA: MIT Press, 1983b).

Appelt, D.E., "Planning natural language utterances to satisfy multiple goals", Ph.D Thesis, Stanford University, 1981.

Barr, Avron, and Feigenbaum, Edward, (eds.), THE HANDBOOK OF ARTIFICIAL INTELLIGENCE VOL I, (Stanford, CA.: Heuristech Press, 1981).

Bertram, Bruce C., "Belief systems and language understanding",

RU64, January 1975.

Berwick, R.C., "Computational Aspects of discourse" in COMPUTATIONAL MODELS OF DISCOURSE, ed. by M. Brady (Cambridge, Mass.: MIT Press, 1983).

Bobrow, D.G., and Winograd, T., "An overview of KRL, a knowledge representation language", COGNITIVE SCIENCE, 1, 1977).

Brachman, Ronald J., "A structural paradigm for representing knowledge", Rep. No. 3605, BBN, Cambridge Mass., 1978.

Brachman, Ronald J. (1), and Woods, William A., "Research in natural-language understanding, No 7", BBN4190, May, 1979.

Brachman, Ronald J. (2), Bobrow, Robert J., Cohen, Philip R., Klovstad, John W., Nash-Webber, Bonnie L., and Woods, William A., "Research in natural-language understanding, Annual Report, 1979", BBN4274, August, 1979.

Bruce, B. and Newman, D., "Interacting plans", COGNITIVE SCIENCE, 2,3, 1978.

Bullwinkle, Candice, "Level of complexity in discourse for reference disambiguation and speech act interpretation", MIT413, May, 1977.

Carbonell, Jaime G., "Metalanguage utterances in purposive discourse", CM489, June, 1982.

Charniak, Eugene, "With spoon in hand this must be the eating frame", TINLAP-2, 1978.

Charniak, Eugene and McDermott, Drew (Eds.), INTRODUCTION TO ARTIFICIAL INTELLIGENCE (Reading, MA: Addison Wesley, 1985).

Cohen, Philip R. (1), "Planning speech acts", Ph.D Thesis, University of Toronto; TR118, 1978.

Cohen, Philip R. (2), and Perrault, C. Raymond , "Elements of a plan-based theory of speech acts", BBN4057, September 1979; COGNITIVE SCIENCE, 3,3, 1979.

Cohen, Philip R. (3), and Perrault, C. Raymond, "It's for your own good: a note on inaccurate reference", BBN4723, July, 1981.

Cullingford, R.E., "Script Application: Computer understanding of Newspaper stories", Y116.

Deutsch, B.G., "The structure of task oriented dialogues" in PROCEEDINGS OF THE IEEE SYMPOSIUM ON SPEECH RECOGNITION (Pittsburgh, PA: Carnegie-Mellon University, 1974).

Fahlman, S.E., "Symbol Mapping and Frames", SIGART NEWSLETTER, 53, 1975.

Fikes, D.e., and Nilsson, N.J., "STRIPS: A new approach to the application of theorem proving to problem solving", ARTIFICIAL INTELLIGENCE, 2, 1971.

Frisch, Alan M., and Allen, James F., "Knowledge representation and retieval for natural-language processing", R0104, December, 1982.

Grosz, B.J. (1), "The representation and use of focus in dialogue understanding", SRI151, July, 1977.

Grosz, B.J. (2), "Discourse knowledge", Section 4 in UNDERSTANDING SPOKEN LANGUAGE, ed. by D.E. Walker (New York: North Holland, 1978).

Grosz, B.J. (3), "Utterance and objective: issues in natural language communication", PROCEEDINGS OF THE 6TH INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, August, 1979.

Haas, A., "Mental states and mental actions in planning", Ph.D Thesis, Computer Science Dept., University of Rochester, 1982.

Harris, Mary Dee, INTRODUCTION TO NATURAL LANGUAGE PROCESSING (Reston, Virginia: Reston Publishing Co.,1985).

Hart, P.E., "Progress on a computer based consultant", INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, 4, 1975.

Hayes-Roth, B., "Human planning processes", Rep. no. R-2670-ONR, Rand Corp., Santa Monica, CA., 1980.

Hobbs, J.R., and Agar, M., "Text plans and world plans in natural discourse", PROCEEDINGS, 7TH INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, Vancouver, B.C., August, 1981.

Horrigan, M.K., "Modelling simple dialogues", PROCEEDINGS OF THE 5TH INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, MIT, 1977.

Johnson, P.N., and Robertson, S.P., "MAGPIE: a goal-based model of conversation", Y206, May, 1981.

Joshi, Aravind K., and Rosenschein, Stanley J., "A formalism for relating lexical and pragmatic information: its relevance to recognition and generation", PE76-19, June, 1975.

Kaplan, Jerrold, "Cooperative Responses from a portable natural language database query system", in COMPUTATIONAL MODELS OF DISCOURSE, ed. by M. Brady (Cambridge, Mass.:MIT Press, 1983.

Kuipers, B., "A frame for frames: representing knowledge for recognition" in REPRESENTATION AND UNDERSTANDING: STUDIES IN

COGNITIVE SCIENCE, ed. by D.G. Bobrow and A. Collins (New York: Academic Press, 1975).

Levy, D.M., "Communicative goals and strategies: between discourse and syntax", in SYNTAX AND SEMANTICS, ed. by T. Givon (New York: Academic Press, 1979b.

Litman, Diane J., "Discourse and problem solving", RO130, October 1983.

Mann, William C. (1), "Toward a speech act theory for natural language processing", IS79-75, March 1980.

Mann, William C. (2), Moore, J.A., and Levin, J.A., "A comprehensive model for human dialogue", PROCEEDINGS OF THE 5TH INTERNATIONAL CONFERENCE ON ARTIFICIAL INTELLIGENCE, 1977.

Martin, Paul A., "Integrating local information to understand dialog", SA348, October, 1982.

McDermott, Drew, "Planning and acting", COGNITIVE SCIENCE, 2, 1978.

Minsky, Marvin, "A framework for representing knowledge" in PSYCHOLOGY OF COMPUTER VISION, ed. by P.H. Winston (New York: McGraw Hill, 1975).

Moore, Robert, "Reasoning about knowledge and action", SRI191, 1980.

Mostow, D. Jack, "A problem solver for making advice operational", PROC. AIII 3, 1983.

Newell, A., and Simon, H.A., HUMAN PROBLEM SOLVING (Englewood Cliffs, N.J.: Prentice Hall, 1972).

Perrault, C.R., and Allen, J.F., "A plan-based analysis of indirect speech acts", AMERICAN JOURNAL OF COMPUTATIONAL LINGUISTICS, 6, 3, 1980.

Reichman, R., "Conversational coherency", COGNITIVE SCIENCE 2, 1978.

Rieger, C., "Conceptual Memory" in CONCEPTUAL INFORMATION PROCESSING, ed. by R.C. Schank (Amsterdam: North-Holland, 1975).

Sacerdoti, E.D., "Planning in a hierarchy of abstraction spaces", ARTIFICIAL INTELLIGENCE, 5, 1974.

Sacerdoti, E.D., "A structure for plans and behavior", Ph.D Thesis, SA109, August, 1975.

Schank, Roger C., and Abelson, R.P., SCRIPTS, PLANS, GOALS, AND UNDERSTANDING (Hillsdale, NJ: Lawrence Erlbaum Associates, 1977).

Schmidt, C.F., Sridharan, N.S. and Goodson, J.L., "The plan recognition problem: an intersection of psychology and artificial intelligence", ARTIFICIAL INTELLIGENCE 11, 1978.

Sidner, C., Goodman, B., Haas, A., Moser, M., Stallard, D., and Vilain, M., "Research in knowledge representation for natural language understanding", BBN5694, September, 1984.

Stefik, M.J., "Planning with constraints", Rep. no. 80-784, Computer Science Dept., Stanford University, 1980 (Doctoral Dissertation).

Steinberg, Lewis I., "A dialogue moderator for program specification dialogues in the PSI system", RU184, August, 1980.

Sussman, G.J., A COMPUTER MODEL OF SKILL ACQUISITION (New York: American Elsevier, 1975).

Tate, A., "Interacting Goals and their use", INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, 4, 1975.

Walker, D.E., UNDERSTANDING SPOKEN LANGUAGE (New York: North Holland, 1978).

Warren, D.H.D., "WARPLAN - a system for generating plans", DGL Memo 76, University of Edinburgh, 1974.

Wilensky, Robert (1), "Understanding goal-based stories", Ph.D Thesis, Y140, September 1978.

Wilensky, Robert (2), PLANNING AND UNDERSTANDING (Reading, MA: Addison Wesley, 1983).

Winograd, Terry, UNDERSTANDING NATURAL LANGUAGE (London: Academic Press, 1982).

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7.2 PHILOSOPHY AND THEORETICAL LINGUISTICS.

Alston, William P. (1), PHILOSOPHY OF LANGUAGE (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1964).

Alston, William P. (2), "Linguistic acts", AMERICAN PHILOSOPHICAL QUARTERLY, 1, April, 1964.

Andersson, Jan S., HOW TO DEFINE "PERFORMATIVE" (Uppsala: University of Uppsala Press, 1975).

Aristotle, ETHICA NICHOMACHEA, in THE WORKS OF ARISTOTLE TRANSLATED INTO ENGLISH, vol. ix, translated by W.D. Ross

(London: Oxford University Press, 1915).

Austin, John, HOW TO DO THINGS WITH WORDS (London: Oxford University Press, 1962).

Bach, Kent, and Harnish, Robert M., LINGUISTIC COMMUNICATION AND SPEECH ACTS (Cambridge, MA: MIT Press, 1982).

Bird, Graham, "Analyzing speech acts", ARISTOTELIAN SOCIETY: SUPPLEMENTARY VOLUME, 55, 1981. (Warnings)

Black, Max, "Austin on performatives", PHILOSOPHY, 38, 1963.

Bloomfield, Leonard, LANGUAGE (George Allen and Unwin, Ltd., 1935).

Church, Alonzo, "The need for abstract entities in semantic analysis", PROCEEDINGS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, 80, 1951.

Cohen, L. Johnathan, "Searle's theory of speech acts", PHILOSOPHICAL REVIEW, 79, 1970.

Davis, Steven, "Speech acts, performance and competence", JOURNAL OF PRAGMATICS, 3, 1979.

Davison, Alice (1), "Indirect speech acts and what to do with them" in SYNTAX AND SEMANTICS VOL.3 SPEECH ACTS, ed. by Peter Cole and Jerry Morgan (New York: Academic Press, 1975).

Davison, Alice (2), "On the semantics of speech acts", JOURNAL OF PRAGMATICS, 3, 1979.

Ferrara, A., "Appropriateness conditions for entire sequences of speech acts", JOURNAL OF PRAGMATICS, 4, 1980.

Fingarette, Herbert, "Performatives", AMERICAN PHILOSOPHICAL QUARTERLY, 4, 1967.

Fraser, Bruce, "Hedged performatives" in SYNTAX AND SEMANTICS VOL. 3 SPEECH ACTS, ed. by Peter Cole and Jerry Morgan (New York: Academic Press, 1975).

Frege, Gottlob, "On sense and reference" in PHILOSOPHICAL WRITINGS, ed. by Peter Geach and Max Black (Oxford: Basil Blackwell, 1952).

Fries, C.C., "Meaning and linguistic Analysis", LANGUAGE, 30 (1950).

Gordon, David, and Lakoff, George, "Conversational postulates" in SYNTAX AND SEMANTICS VOL 3 SPEECH ACTS, ed. by Peter Cole and Jerry Morgan (New York: Academic Press, 1975).

Grice, H.P., "Meaning", PHILOSOPHICAL REVIEW, 66 1957.

Gunderson, Martin, "Threats and coercion", CANADIAN JOURNAL OF PHILOSOPHY, 9, 1979.

Herringer, J., "Some grammatical correlates of felicity conditions and presuppositions" in WORKING PAPERS IN LINGUISTICS, NO. 11 (Columbus: The Ohio State University, Department of Linguistics, 1972).

Lewis, C.I., "The modes of meaning" in SEMANTICS AND THE PHILOSOPHY OF LANGUAGE, ed. by Leonard Linsky (Urbana, Illinois: University of Illinois Press, 1952).

Locke, John, ESSAY CONCERNING HUMAN UNDERSTANDING, ed. by Peter H. Nidditch (Oxford: Clarendon Press, 1975). See Section 1, Chapter 2, Book III.

Mill, J.S., A SYSTEM OF LOGIC, Bk 1 (London: Longmans, Green and Co., Ltd, 1906).

Morris, Charles, SIGNS, LANGUAGE AND BEHAVIOR (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1946).

Peetz, V., "Promises and threats", MIND, 86, 1977.

Quine, W.V.O., WORD AND OBJECT (New York: John Wiley and Sons, Inc., 1960).

Roulet, Eddy, "Speech Acts, discourse structure and pragmatic structures", JOURNAL OF PRAGMATICS, , 8, 1984.

Russell, Bertrand, PRINCIPLES OF MATHEMATICS (London: Cambridge University Press, 1903).

Sadock, J.M. (1), "Whimperatives" in STUDIES PRESENTED TO ROBERT B. LEES, ed. by J.M. Sadock and A. Vanek (Edmonton: Linguistic Research, Inc., 1970).

Sadock, J.M. (2), TOWARD A LINGUISTIC THEORY OF SPEECH ACTS (London: Academic Press, 1974).

Searle, John (1), "Meaning and speech acts", PHILOSOPHICAL REVIEW, 71, 1962.

Searle, John (2), SPEECH ACTS (Cambridge: Cambridge University Press, 1969).

Searle, John (3), "Indirect speech acts" in EXPRESSION AND MEANING, Searle (Cambridge: Cambridge University Press, 1975).

Searle, John (4), "A taxonomy of speech acts" in EXPRESSION AND MEANING, Searle (Cambridge: Cambridge University Press, 1975).

Searle, John (5), "Speech acts and recent linguistics" in EXPRESSION AND MEANING, Searle (Cambridge: Cambridge University

Press, 1975).

Sesonke, Alexander, "Performatives", JOURNAL OF PHILOSOPHY, 62, 1965.

Skinner, B.F., VERBAL BEHAVIOR (New York: Appleton-Century-Crofts, Inc., 1957).

Stampe, Dennis W., "Meaning and truth in the theory of speech acts" in SYNTAX AND SEMANTICS VOL 3 SPEECH ACTS, ed. by Peter Cole and Jerry Morgan (New York: Academic Press, 1975).

Stevenson, C.L., ETHICS AND LANGUAGE (New Haven, Conn.: Yale University Press, 1944).

Stewart, J.W., "An analysis of 'advising'", EDUCATIONAL THEORY, 28, 1978.

Strawson, P.F., "Intention and convention in speech acts", PHILOSOPHICAL REVIEW, 73, 1964.

Urmson, J.O., "Performative utterances", MIDWEST STUDIES IN PHILOSOPHY, 2, 1977.

Vanderveken, Daniel, "Semantics for illocutionary forces", LOGIQUE ET ANALYSE, 26, 1983.

Wittgenstein, Ludwig, PHILOSOPHICAL INVESTIGATIONS tr. G.E.M. Anscombe (Oxford: B. Blackwell, 1953).

Ziff, Paul, SEMANTIC ANALYSIS (Ithica, N.Y.: Cornell University Press, 1960).