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SPINOZA II:

CONCEPTUAL CASE-BASED NATURAL LANGUAGE ANALYSIS.

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1. Introduction

1.1 Goals

In order to expect to do really relevant work in computational linguistics it is necessary to design a computational linguistics model. This model would be a model of the human linguistic processing ability to as large an extent as is feasible, always utilizing the consideration that the model must be algorithmic in nature.

It seems clear that there is an underlying conceptual basis to natural language, and that this conceptual basis is the same in all languages. We can say that a model of this conceptual basis of language would be in fact a language-free representation of any linguistic input or potential output. A basis of this kind is necessary in order to account for the ability of humans to translate and paraphrase. That is, in order for a human to recognize that two linguistic inputs are equivalent, whether they are in different languages or not, he must process the meaning of these inputs in such a way as to render their content the same. The Conceptual Dependency model (see [7]) is intended as a simulative model for computational linguistics that will perform this task. The model contains as an inherent part the ability to perform various tasks that we recognize to be within a human's linguistic ability. That is, the model is not concerned with 'linguistic' problems such as acceptability or grammaticality but rather it is intended to model a human in a dialogue situation. Thus it considers all 'conceptually correct' input and is capable of interpreting a sentence if there is a missing word or the input is in a 'queer' form (that is, it does not correspond to certain grammatical rules). The model is thus concerned with 'understanding' rather than with 'accepting' a sentence.

It is reasonable therefore, to inquire what we know about a 'human parser'. First, he hears the sentence and may be said to understand it conceptually. That is, he has the ability to associate a linguistic input with some conceptual structure and to combine these conceptual structures in accordance with the grammar rules of the language, the language-free conceptualization rules, and his 'conceptual experience' or 'knowledge of the world'. Thus his 'understanding' finds a meaning for the sentence by discovering the propositions or beliefs expressed by that piece of discourse. This meaning expresses what has been said (as opposed to what to do with it) and has been checked against the human's knowledge of previous propositions. The new information has been verified as to its conceptual validity or if no valid alternative exists then the new information has been added to the experience.

We also know that a human finds only one analysis of a sentence when it is expressed within a discourse, but that he can find another if prompted to do so. Thus, he would find only one analysis of 'time flies like an arrow' given the usual context. We know in addition that his analysis can be based on the context of the previous discourse, the situation, and the identity of the speaker. Primarily, the 'human parser' is concerned with interpretation of an input rather than discovering hidden ambiguities.

Another important ability that a human has is the recognition of sentences that are 'laughers'. That is, certain constructions in a language lead to predictable blind alleys that nearly always provoke a laugh. In a sentence such as 'I saw the Grand Canyon flying to New York', it is this laughing likelihood that gives us an insight into the human processing of this sentence. We can see, for example that there is a predictable ordered processing here that causes one of the two possible grammar rules that apply to be tried first, producing the laugh. But from a conceptual point of view, we can predict this with a conceptually-based processor that is not bound by grammar rules.

The conceptual parser described here is intended to produce as output a language-free conceptual network representative of the meaning of the input. Such a network is potentially useful in translation, paraphrasing, and all computational work involving natural language. In order to achieve this goal we intend to simulate what we know exists, namely the human ability to understand. Thus, our simulative theory employs a world model, an interlingua, an ability to map into and out of that interlingua, and an ability to reject possible interpretations of an input on the basis of its linguistic and conceptual experience. Thus the model is stratified, with meaning at the highest level, employing syntax as a finder.

1.2. Conceptual Rule Parsing

The first version of Spinoza I* (see [9]) has made obvious some inconsistencies in the underlying theory as so far developed. Of primary importance in the consideration of revisions of Spinoza I is the desire to create any future version of this parser as one that more closely parallels a human parser.

The major theoretical discrepancy between Spinoza I as it now stands and our perception of a human involved in the same task is the reliance on realization rules. Since the realization rules may be construed to be the grammar rules of a language, it seems reasonable that a fluent

* Spinoza stands for 'Semantic Parser Involving Neo-stratificational OrganiZation And conceptual dependency heuristics.

speaker of a language is in full possession of these rules. It does not necessarily follow that he employs these rules in parsing. In fact, there is evidence that he does not. For example, we are familiar with the fact that it is much easier to understand a foreign language than it is to speak it. Whereas, we need the 'grammar' rules of a language to generate from our conceptual base, it seems plausible that the process of understanding can work sufficiently well with a knowledge of the words of this foreign language and a very few of the major realization patterns. This is because the conceptual base into which we are mapping during the process of understanding this foreign language is the same one as we ordinarily utilize. It has the same rules of organization of its parts (namely concepts). If we are aware of the word-concept couplings of this foreign language, we now only need to arrange these concepts according to our usual (i.e. language-free) manner. Thus, it would seem that humans can fare rather well without realization rules during parsing. If this is the case, we must require of any simulation that it do likewise.

Although the use of realization rules in Spinoza I works well enough there are more intuitive reasons for the elimination of the reliance on realization rules during the parse. Consider for example, the sentence:

(1) I saw the Grand Canyon flying to New York.

Spinoza I parses this sentence correctly by the use of two realization rules and the elimination of the inapplicable one by a check with the semantics.

$$(R_1)\quad PP_1 \; ACT_1 \; PP_2 \; ACT_2\text{ing} = PP_1 \Leftrightarrow ACT_1 \leftarrow \begin{array}{c} PP_2 \\ \Updownarrow^{2} \\ ACT_2 \end{array}$$

$$(R_2)\quad PP_1 \; ACT_1 \; PP_2 \; ACT_2\text{ing} = \begin{array}{l} PP_1 \Leftrightarrow ACT_1 \leftarrow PP_2 \\ \quad\quad \uparrow \text{while} \\ PP_1 \Leftrightarrow ACT_2 \end{array}$$

The conceptual dependency $PP_2 \Rightarrow ACT_2$, (Grand Canyon flies) derived from R_1 is eliminated from consideration by examination of the possible actions for a 'location'. Since 'fly' is not one of these, R_2 is tried and is successful. There is no reliable weighting system for realization rules in Spinoza I, so it is perfectly possible that R_2 would be selected first and R_1 would therefore never be tried. This element of randomness seems quite unlike a human in the same situation.

A second problem in the effective simulation of a human by Spinoza I is with regard to the conceptual semantics (see [6]). Again we are faced with the difference between generation and parsing of coherent discourse. Although these processes are similar enough to enable our system to be effective while making double use of certain features, it seems clear that there are exploitable differences. For example, in parsing 'green horse' it is unnecessary to know that 'horses' are not 'green' in order to deal with this construct. That is, while information of this kind is a necessary part of the random generation process, it has little to do with the problem of parsing except when there is a more attractive alternative parse for the same set of concepts.

Similarly, 'the park with the girl' is an acceptable possibility as a construction, and we would only want it to be ruled out of consideration conceptually in the view of more favorable alternatives. Thus, the sentence:

(2) 'I went to the park with a girl'.

will not utilize the dependent 'park' in its conceptual networks only be-

$\Uparrow$ with
girl

cause the available alternatives are more highly valued. That is, it is not the conceptual experience that should be ruling out this alternative. In any event, it would be rather difficult to have an experience file specify the things that a 'park' can be with, since this list is practically infinite.

But the mechanisms of the generative conceptual semantics must be employed in order to correctly differentiate the senses of 'with' in a 'boy with a knife' and a 'boy with a girl'. The information utilized in this differentiation process in Spinoza I must also decide between $\begin{array}{c}\text{'park'}\\ \Uparrow \text{with}\\ \text{girl}\end{array}$ and 'go $\xLeftarrow{\text{with}}$ girl'. However, while the modification $\begin{array}{c}\text{'I'}\\ \Uparrow \text{with}\\ \text{girl}\end{array}$ is incorrect because 'girl' is not a descriptor of 'I', the 'girl' in this sentence also 'went to the park' so it is necessary to introduce a notion of 'accompaniment' as a sense of 'with' which would function similarly to a logical 'and'.

$$\begin{array}{c}\text{I}\\ \wedge\\ \text{girl}\end{array} \Leftrightarrow \text{go} \xLeftarrow{\text{to}} \text{park}$$

Clearly, the 'go with girl' sense would only be acceptable only in the event that 'girl' functioned as an instrumental. Thus, we will also need information about possible instruments for various ACT's. This is exemplified by the problem presented in [7]:

(3) 'He hit the boy with long hair'.

(4) 'He hit the boy with a wrench'.

While these sentences are both ambiguous, it is unlikely that a human would notice that upon encountering them. Furthermore, the first analysis in each case is predictable and corresponds to the second analysis in the other sentence. We require that Spinoza be able to make the appropriate choice in each instance. This would have to be done by the establishment of an instrumental case dependent on the ACT.

A further problem for Spinoza I is presented by a sentence of the type 'he grew plants', where, in the most likely underlying conceptualization, it is the 'plants' that 'grew' and not 'he'. In order to recognize the problem here it is necessary to reorient the parser to be more dependent on the ACT, and in particular for English to have the system's linguistic experience file expressed as information in the form of expectations when certain verbs are encountered.

Thus, Spinoza II will be a system containing various levels of information. The parsing operation will function mainly using conceptual rules. The object of the conceptual rules will be to point the way to the underlying conceptual subject-verb-object (or actor-action-object) combinations present. The parser will look for these S-V-O constructions whenever possible, and check to see if they are in accord with the system's experience. We will not need to check the semantics unless we have a choice of rules, in other words, when a decision is to be made. This implies that the parser will never be able to make final decisions as to dependency since it may (as in the 'Grand Canyon' case), be searching for a part of the S-V-O that is more acceptable and thus would rewrite a piece of the old S-V-O. The discovery of a conflict of rules would indicate a need for resolution by the semantics.

The rest of this paper is concerned with changing the theory of Spinoza I such that Spinoza II will be a conceptual rule, verb-based parser that is concerned with case restrictions and a more realistic conception of semantics.

2. The Conceptual vs. the Linguistic

Consider the problem of 'Ken saw Larry in the park'. This sentence is unambiguously parsed by a human as opposed to the case of the sentence 'Ken saw the boy in the park'. The reason for this is 'boy' may have a descriptor whereas 'Larry' may not. Here 'Larry' identifies the object completely. Now certainly 'Larry' could have been 'in the park', but the conceptual apparatus that humans employ makes a distinction between decriptive information and additional information. This is seen in the difference between non-restrictive relative clauses and ordinary prenominal adjectives in English.

Thus, the point of $\leftarrow$ PA's and $\Leftarrow$ PP's (below the line) is to further describe a PP such as to explicate which of the set of PP's called by that name is the referent. A $\Leftrightarrow$ construction on the other hand is intended to provide additional information about the PP.

The theoretical point here is that there is a great deal of important information inherent in the words themselves that can aid in our conceptual expectations during the parse. Here, 'Larry' is the type of Noun (Proper) that tells us that conceptually we do not expect any descriptions. Then, if there are any descriptions present we can attach them elsewhere if there would have been an otherwise equally likely alternative.

This conceptual expectation ability is important at a deeper level in the parse. For example, (5) 'I am in love' presents this type of problem. 'Love' in the conceptual dependency framework is an ACT no matter what syntactic realizates are being used. (This is the case throughout. The assumption is that all syntactic forms of any concept have the same conceptual realizate.) Furthermore, 'love' is a transitive ACT. This is important in an expectation-oriented system. That is, if someone is the recipient of 'love' in all cases, then we can look for this recipient, or if none is to be found, at least know that some 'human' fits. Thus, the C-diagram of (5) is:

$$\text{I} \Leftrightarrow \text{love} \leftarrow \underset{\text{human}}{\text{PP}}$$

Clearly, it is necessary that this be the parse. Since the information that 'PP human' satisfies the conditions of the object had to come from looking up 'love', we can allow ourselves the luxury of picking up additional information by consulting the verb. In this case, we may pick up the advice that the PP on the left is commonly of a different sex than that on the right. This would allow us to 'guess' that 'Joan' in the sentence 'Joan is a darling girl' following (5) can be placed as the object in (5).

An intelligent parser needs to know what to expect at any point in the parse. If that information is there (that is, if humans would have some guesses as to what follows at a given point in a sentence) then we can provide some of that information to the parser.

A similar case can be found in the construct 'I ⇔ run'. The expectations to be found here are made clear by the seeming unacceptability of the simple realizate of this construct; (6) 'I run'. We would be more comfortable here if the sentence were: (7) ' I am running' $(\text{I} \underset{\substack{\uparrow \\ \text{now}}}{\Leftrightarrow} \text{run})$ or

(8) 'I run to the store on Tuesdays' $(\text{I} \underset{\substack{\uparrow \\ \text{Tuesday} \\ \uparrow \\ \text{each}}}{\Leftrightarrow} \text{run} \overset{\text{to}}{\Lleftarrow} \text{store})$

The discomfort caused by (6) is representative of an important facet of the concept 'run'. This concept implies a destination or at least a direction ('around the block') was part of the conceptualization. Similarly, conceptualizations that are formed from present-tense linguistic realizates that are not indicated as presently taking place (by '-ing' for example) require a time. In other words, there are certain characteristics of a conceptualization that we can expect to be mentioned in a discourse in some way. Furthermore, the verb used indicates certain dependent constructs that are always present in the underlying conceptualization even if they are not present in the sentence itself. This was the case with the expectation of the transitive ACT 'love' in that we required an object conceptually even though the language did not. For 'run' we may say for the moment that it is intransitive and takes dative case. Similarly, in the sentence 'I hit the boy', we can expect an instrument was present and we thus require that 'hit' take instrumental case. We thus establish a verb-dependent case system (with some similarity to Fillmore [4]). This will be delved into in further detail later in this paper.

3. The Semantics of English Verbs

3.1 Pseudo-state verbs

Underlying conceptual dependency theory is the notion that the 'true' meaning is being extracted from the linguistic construct. Clearly, if two sentences are equivalent in meaning, they should have the same C-diagrams. This notion, plus the assumption that multiple syntactic and semantic senses of a concept all have the same conceptual realizate, makes evident the problem of the verb 'to fly'. Consider the sentences:

(9) I flew to New York. and

(10) I went to New York by plane.

These are clearly paraphrases in ordinary usage. Certainly this ability can be accounted for by translating 'fly' as 'go $\overset{by}{\Leftarrow}$ plane' in all cases. However, this bypasses the problem of how we know which sense of 'fly' was intended. For 'humans' we know the intended sense because we know conceptually that 'people don't fly'. This is conceptual experience. There are, however, senses of 'fly' that make this analysis incorrect, for example, 'the pilot flew', which means 'cause the plane to fly'. Thus an initial check with the Conceptual Experience (Semantics) to see if 'humans ⇔ fly' is all right, must send us elsewhere in our experience, since all the information that we need to correctly parse this sentence is very likely already at hand.

We can posit a more fully developed dictionary, then. This would enable us to look under 'fly' and find that the word 'fly' is a realizate for a number of different conceptual constructions. The possible PP's (actors) of these conceptualizations are listed in this dictionary. Thus, 'man' is acceptable in both cases. But in the latter 'pilot' is the specific referent, although conceptually 'pilot' can also be the actor in the former case. Thus the dictionary must have a usualness of occurrence measure by which to choose between alternatives that are both conceptually acceptable.

Consider the example of (11) 'I flew the plane to New York'. Here, 'the plane' in the position of conceptual object, specifies which sense of 'fly' was intended. Previously we encountered a PP followed by an ACT (fly), looked the connection up in semantics and were directed to a new conceptual construction with a different ACT. But in sentences such as

(11) and (12)

(12) I grew plants.

we notice that it is the sentential object that is the conceptual actor for the ACT given. In addition, an unstated construction governing causally ($\Lleftarrow$) is the initial conceptualization. So we have the analysis:

$$\begin{array}{c} \text{I} \Leftrightarrow \text{do} \\ \Uparrow \\ \text{planes} \Leftrightarrow \text{fly} \end{array}$$

and

$$\begin{array}{c} \text{I} \Leftrightarrow \text{do} \\ \Uparrow \\ \text{plants} \Leftrightarrow \text{grow} \end{array}$$

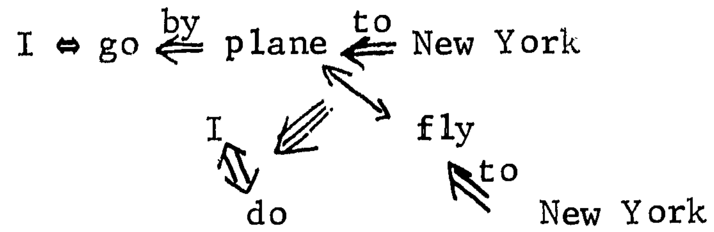
where the 'do' represents some unknown ACT and its dependents. However, when we look up 'fly' we discover 'go $\overset{\text{by}}{\Leftarrow}$ plane' in addition to the information that this kind of ACT will work as a dependent for its object but not its subject sententially. We thus have double the information, which yields:

$$\begin{array}{c} \text{I} \Leftrightarrow \text{do} \\ \Uparrow \\ \text{plane} \Leftrightarrow \text{fly} \end{array}$$

$\wedge$

$$\text{I} \Leftrightarrow \text{go} \overset{\text{by}}{\Leftarrow} \text{plane} \overset{\text{to}}{\Leftarrow} \text{New York}$$

which combines into:



for the parse of this sentence. (At this point we have made an inference and it is not clear that this is our purpose here. Thus, we might consider that only the first part of this construction is the correct analysis.)

3.2. Linguistic Experience

Consider the problem of the three extremely different parses of:

(13) I grew two feet.

```
(a) I ⇔ do
      ⇑
 feet ⇔ grow
   ↑
  two

(b)  I ⇔ grow
           ↑
      length > length
        ↑     ↑    ↑
    present  2'   past

(c)   I
      ⇓ on
 feet ⇔ grow
   ↑
  two
```

Whereas it is clear to us that (b) is probably the intended underlying conceptualization of (13), clearly the other two C-diagrams must be reckoned with since a C-diagram of type (a) would be produced by 'I grew plants' and (c) by 'I grew horns'.

It seems reasonable that this problem can only be accounted for by rules specific to 'grow'. If this is the case, this information would be part of Linguistic Experience File. In fact, some of the more complex Realization Rules could be treated as a part of this file.

As an example of the place of linguistic experience in the treatment of a concept, we can view a given concept on all three levels: e.g.

Elephant

I. Conceptual Knowledge - animal

II. Conceptual Experience - size - large/unusual
color - grey/unusual
location - jungle

[the 'unusual refers to the probability of reference in a discourse]

III Linguistic Experience - move = charge
↑ ↖on
quick land

We would still be able to parse 'small pink elephant' for example, because without any ambiguity we need only check as far as the Conceptual Knowledge (which includes the category names of the Conceptual Experience without their specifics).

There is a difference between Conceptual Experience (CE) and Conceptual Knowledge (CK). In the parser we need only check Conceptual Knowledge to be able to make a correct parse. That is, the Conceptual Knowledge tells us that 'horses have color' and thus 'green → horse' is all right. It also lets us make 'baby' into 'human' since the CK allows

↑
young
↑
baby

babies to anything humans can do. Thus 'the baby drove the car' is acceptable from the CK's point of view and we would not want to parse this any other way. Similarly, the ← PP for 'eat' is 'any phys. obj.' according to the CK. This allows 'he ate the book' which is conceivable. This sentence does alter one's CE however. Now, we might want to add 'books' to the list of possible ← PP's for 'eat' in the Conceptual Experience, which previously had listed types of food. That is, we might now classify 'book' as food. The rating of usualness is part of the linguistic experience of the system. Thus, we check the experience according to a specified order.

For an ACT the three levels look as follows:

Grow

CK IACT (therefore takes no ← PP or ⇐PP)

CE living things ⇔ IACT (only living things do this)
IACT (can be modified by an amount)
↑
amount

LE the intransitive verb 'grow' takes a direct object in three circumstances:

1) direct object is an amount
2) direct object is what is: IACT-ing (I grew plants)
3) direct object is IACT-ing on the subject (I grew horns)

These items of information could take the form of realization rules but we can treat them as keying our search for correct conceptual combinations. The parser could then work from the conceptual rules downward without using realization rules by using the verb-subject information. In choosing between (2) and (3) for 'I grew two feet', our conceptual experience should tell us that 'plants grow on earth' not 'on I' whereas 'feet grow on animals'. (We note here that part of the reason for reworking this problem is to disallow word-senses as far as possible from the conceptual scheme. Rather, we are interested in the actual (usually unique) conceptual sense of the word.) There aren't as many concepts as word-senses (which could explain the human difficulty in naming word-senses).

4. The Parsing Theory

4.1 Attributes of Spinoza II

The basic assumption in the new parser is that conceptual rules are responsible for the bulk of the parsing. Furthermore, there is an assumption that there are PP ⇔ ACT clusters to be found in sentences from any language and that these clusters are identifiable through the use of certain heuristics. It is these clusters that enable the parser to build up networks. That is, the are the centers of various clumps.

The conceptual rules will account for the correct parse only by using certain stores of knowledge to eliminate wrong dependencies. A dependency can be found to be incorrect utilizing any of these possibilities:

1) syntactic restrictions eliminate this choice.

   e.g. C-rules alone will not parse

   'The red ball small Tom threw...' correctly without information about the syntax of English

2) checking attribute lists after preliminary RR's (not many of these) point out syntactic dependencies.

   Attribute semantics delimit the range of possible attributes according to absolute qualities, relative qualitives, and experential ratings of equalness or frequency of use of these attributes in a linguistic context.

3) utilizing the linguistic experience file as the 'where to find it' guide for the conceptual rules .

A correct dependency can be found by using the following parts of the Spinoza II system:

1) Conceptual rules

   a) predominance of PP ⇔ ACT clusters
   b) attribute searches

2) Conceptual cases

   a) predominance of the verb
   b) predominance of case requirements

3) Heuristics

   a) what to look for at any given point
   b) the direction in which to proceed

4) Association Matrix

a) find missing actions when actor and object appear
b) choose between alternate interpretations of PP⇖PP clusters

5) Usualness file

a) to select between alternatives caused by rewriting of abstracts
b) choose between cases
c) 2 possible C- rules
(only check under those circumstances)

6) Dictionary

a) rewrites into conceptual constructs
b) idioms

7) English information
(e.g. 'with' denotes instrument in certain instances)

In addition agreement rules (number, gender) will need to be called to supplement decisions. But priorities of occurrence must be established.

As an example of some English heuristics we have these:

1) before a PP is placed in the network, check to see if there is a PP following it

2) after finding ACT, immediately try to fill in cases with available information

3) never go by the first PP in the network (on the line) without going back to add dependents

4) if ACT is before the PP, its case objects are probably before too

5) in looking back, first look for cases, then look for PA's

6) between two choices for governor choose the one that was most recently looked at (depends on the reliability of the algorithm).

4.2. An Example

Consider parsing:

'The stupid heavy cigar smoker flew to New York while growing plants.'

First: look up terms in Dictionary at level (1) level (1) contains conceptual category and sem. cat. and any rewrite.

Store

the; stupid; heavy
det PA PA,AA

Place in network

cigar
PP

attempt to attach PA's
check attributive semantics

cigar ← PA

weight unusual (heavy is looked for by its sem. cat.)

(That is, we are trying to make something a relative PA that is an Abs PA as far as the system's experience knows.)

Heuristic: If assisting category dependence is marked as unusual, look for another governor near by.

Thus, we cannot attach either PA, so we go on. Smoker is in list as:

human ⇔ smokes ← x

where x is $\begin{cases} \text{cigar} \\ \text{cigarette} \\ \text{pipe} \\ \text{pot} \end{cases}$

so we have:

cigar human
⇕
smokes

Heuristic: If you need an x, look for it.

human
⇕
smokes
↖
cigars

Try and attach previously stored stuff: stupid is OK but PA heavy attaches to 'human' and AA heavy attaches to 'smokes'. There is no way to make the choice so we guess.

```
            human
          ↗      ⇅
    stupid        smokes
                ↗        ↖
          heavy           cigars
```

We look up fly and attempt to attach it to human. Look in Conceptual Experience (That is semantics for PP ⇔ ACT).

List of things that humans do does not contain 'fly'.

Thus we go to the dictionary:

---

fly

level 1 IACT

level 2 plane
bird ⇔ ACT

level 3 x fly = x ⇔ go $\overset{by}{\Leftarrow}$ plane
x fly y = x ⇔ do
$\Uparrow$
y ⇔ fly

level 4 phys. obj. ⇔ ACT

At level 2 we see what things can 'fly'. At level 4 are listed those things that might possibly be able to do this according to conceptual knowledge. We obtain the possible PP's and look for them in the network already created (and perhaps glance ahead at part of the sentence yet to come.) Since they are not there, we skip to level 3. We only go to the CK's version of fly (level 4) if we are prompted by the speaker.

Level 3 gives us the network piece to be inserted:

human ⇔ go $\overset{by}{\Leftarrow}$ plane $\overset{to}{\Leftarrow}$ New York.

We add $\overset{to}{\Leftarrow}$ New York by checking the semantics for plane $\Leftarrow$ PP and go$\Leftarrow$ PP, rejecting the first.

while; is written in the dictionary as:

T-conceptualization follows, dependent on another conceptualization.

If no PP is available as actor, use PP from governing conceptualization.

'Grow' is looked up and checked and we have:

$$\begin{array}{l} \text{human} \Leftrightarrow \text{grow} \\ \qquad\quad \downarrow \\ \text{human} \Leftrightarrow \text{go} \end{array}$$

Here we must use an expectation table which tells us what to look for in the next words in terms of a conceptual category. Since 'grow' is an IACT we are not expecting anything but an AA or a new conceptualization.

Since 'plants' has nothing following it, this is ruled out and we must go back and find out what to do.

Heuristic: If you are confused, go to deeper levels of the last ACT encountered.

grow

level 1 IACT

level 2 living things $\Leftrightarrow$ IACT

level 3 1) IACT amount = $\begin{array}{c} \text{grow} \\ \uparrow \\ \text{amount} \end{array}$

2) x IACT y = $\begin{array}{l} x \Leftrightarrow \text{do} \\ \quad \Uparrow \\ y \Leftrightarrow \text{IACT} \end{array}$

3) x IACT y = $y \overset{x}{\underset{\Downarrow\ \text{on}}{\Leftrightarrow}}$ IACT

(1) does not apply since there is no 'amount' word present.

We can choose between (2) and (3) by utilizing the PP$\Leftarrow$ PP semantics.

(That is, we can eliminate the ACT that goes between (giving a kind of association matrix)). Under 'plants $\overset{on}{\Leftarrow}$ ' we do not find 'human' so we choose (2). (If we had 'horns' we would find

horns

on - animals

and we would choose this interpretation).

This gives:

plants $\Leftrightarrow$ grow

$\Downarrow$

human $\Leftrightarrow$ do

$\downarrow$

human $\Leftrightarrow$ go $\overset{by}{\Leftarrow}$ plane $\overset{to}{\Leftarrow}$ New York.

$\nearrow$ $\nwarrow\!\searrow$

stupid smokes

$\nearrow$ $\nwarrow$

heavily cigars

The reason we can eliminate 'grow' is that the PP $\Leftarrow$ PP semantics have an implied 'BE' between them. Since 'grow' is an IACT, it is also the verb between them. Furthermore, in this case, the LOC permits the avoidance of the ACT since there is not actually a dependency between them.

We want 'plants' to be able to be 'on' any physical object but the CE tells us what has been found to be the usual case. Thus,

grow - on- $|\overset{CE}{\text{earth}}|$ any $\overset{CK}{\text{phys}}$. obj.

This 'on' is really 'on and into' a different conceptual preposition. This eliminates problems stemming from 'plants grew on the table'.

Consider parsing with the new method:

'I saw the Grand Canyon flying to New York.'

Previously, there were two Realization rules which applied and we chose the one that was semantically correct. But without using realization rules the parse is done as follows:

'I ⇔ saw'

is as before

then, I ⇔ saw ← Grand Canyon

the ACT - 'fly' can be connected to the Grand Canyon but level 2 of the dictionary entry for 'fly' disallows that (again, if prompted we could get to level 4 and OK this).

Heuristic: If an ACT exists and there is o place to attach it, it is part of 'while' construction, therefore go to 'while' procedure.

This gives:

$$\begin{array}{l} \text{I} \Leftrightarrow \text{saw} \leftarrow \text{Grand Canyon} \\ \;\uparrow \text{while} \\ \\ \text{I} \Leftrightarrow \text{go} \overset{\text{by}}{\Leftarrow} \text{plane} \overset{\text{to}}{\Leftarrow} \text{New York} \end{array}$$

Previously, we had used sense information present, to disambiguate constructions such as:

I saw the birds flying to the convention.

We were able to get the correct parse since the sense of 'fly' for birds did not take 'to the convention'. This necessitated having semantics for the multiple senses of 'fly' (and every word) and left us without the conceptual similarities present between these sense. In using only one conceptual 'fly' we apparently lose the ability to disambiguate this sentence however:

I ⇔ saw ← bird

Now we can attach 'fly' to 'bird'. However, 'fly' is really an IACT since now one can no longer 'fly' anything. This indicates that (as in the 'grow' example) the PP $\Leftarrow$ PP semantics can function across the IACT.

In fact, the conceptual prepositions of which we have been speaking can be considered to be IACT relations between PP's. Thus under

bird
    to - phys. obj.; location

we do not find 'convention' so we disallow this parse. The previous heuristic provides the correct parse. We can see that the CE could be altered to allow this parse if need be. Most importantly, we are proceeding in a human-like manner. We first try 'bird ⇔ fly' which is most reasonable until the later information is added. This enables us to parse:

'I saw the bird flying to the tree'

correctly, and gives the better constructed parse for,

'I saw the bird flying to New York'.

Similarly, other motion verbs such as 'ride' in 'He rides a bicycle' can be handled correctly so as to produce the parse

he ⇔ rides $\overset{on}{\Leftarrow}$ bicycle.

ride

1. SACT
2. any phys. obj. ⇔ ride   CE
3. x rides y = x ⇔ rides $\overset{on}{\Leftarrow}$ y   LE
4. CE   CK

Note that 'rides' is to 'rides on' as 'pilots' is to 'flies' as 'drives' is to 'drives in':

he flew a plane
(piloted)

(1) he ⇔ do
$\Uparrow$
plane ⇔ fly

(2) he ⇔ go $\overset{by}{\Leftarrow}$ plane

We are again faced with the problem of the infinite reduction of a set of properties into a smaller set. So we can legislate that we will use 'plane ⇔ fly' but 'car ⇔ go' whereas we might just as well have said 'plane ⇔ go' and 'car ⇔ go'. The rule-of-thumb is that we rewrite con-

$$\text{'plane} \underset{\substack{\Uparrow \text{ in} \\ \text{air}}}{\Leftrightarrow} \text{go'} \quad \text{'car} \underset{\substack{\text{on } \Uparrow \\ \text{land}}}{\Leftrightarrow} \text{go'}$$

cepts to get at the true conceptual sense of a word (i.e. such that there is only one conceptual action called 'fly') but not to simply substitute one concept that is a breakdown of another. The only reason for such a breakdown is paraphrase or translation and there our limits are whatever will work. Thus,

$$\text{he drives a car} = \text{he} \Leftrightarrow \text{ride} \overset{\text{in}}{\Longleftarrow} \begin{array}{c}\text{car}\\ \Updownarrow \\ \text{go}\end{array} \Rightarrow \begin{array}{c}\text{he}\\ \Updownarrow \\ \text{do}\end{array}$$

$$\text{he drives to work} = \text{he} \Leftrightarrow \text{ride} \overset{\text{in}}{\Longleftarrow} \text{car} \overset{\text{to}}{\Longleftarrow} \text{work}$$

$$\text{and maybe } \begin{array}{c}(\text{he} \Leftrightarrow \text{do})\\ \Uparrow \\ \text{car} \Leftrightarrow \text{go}\end{array}.$$

drive

1. $\text{SACT} = \begin{array}{c}x \Leftrightarrow \text{do}\\ \Uparrow \\ x \Leftrightarrow \text{go}\end{array}$

2. human ⇔ SACT

3. a) $x \text{ drives } y = \begin{array}{c}x \Leftrightarrow \text{do}\\ \Uparrow \\ y \Leftrightarrow \text{go}\end{array}$ (where y is car unless otherwise stated)

   b) $x \text{ drives} = x \Leftrightarrow \text{rides} \overset{\text{in}}{\Longleftarrow} \text{car}$

There are 2 LEF listings in (3) for drive. Since the first implies the second; both conceptualizations are the realizate of the left half of (a). (b) is only possibly realized with the (a) realizate in addition to its own.

Conceptually, most verbs are often not what they seem, and we have in addition to the class of pseudo-state verbs a set of verbs whose conceptual realizates are complex and require a look-up in the dictionary as to conceptual category and linguistic experience before proceeding with any conceptual mapping. For example:

1) he wrote a book

```
                          by   he
he ⇔ create ← book  ⇐        ⇕
                              writes
```

2) he asked Fred to go home

```
he ⇔ requested
         ↑
    Fred ⇔ go  ⇐to  house
                      ⇑  of
                     Fred
```

3) he desired Martha in the morning

```
he ⇔ want
      ↑
   he ⇔ have ← Martha
      ↑
  morning
```

4) he doubted his wife

```
    he ⇔ doubt
            ↑
         x ⇔ true
         ↓
wife ⇔ say
 ⇑   of
he
```

5. The Use of Case in Conceptual Dependency

5.1. Conceptual Prepositions

Perhaps the largest stumbling block to the clear understanding of the use of prepositions to indicate an indirect or prepositional dependency in our work has been the lack of differentiation between the prepositions used between ACT⇐ PP and between PP⇐ PP.

The first thing that needs to be done is the elimination of the use of the same descriptions for both bonds. Clearly the 'with' of ACT$\Leftarrow$PP is altogether different from the 'with' of PP$\Leftarrow$PP. This is the case with other prepositions as well.

The ACT$\Leftarrow$PP 'with' seems to be representative in English of the instrumental case. It can always be paraphrased by 'using'. Furthermore, it is vitally important that the semantics reflect this difference. In

(1) 'I hit the boy with long hair'

and

(2) 'I hit the boy with a stick'

it is quite clear that both (1) and (2) are ambiguous but it would be a mistake for any parser to treat these sentences in any but unique ways. We can do this by allowing for an instrumental case, i.e., ACT $\xleftarrow{\text{inst}}$ PP. We can thus list possible (or experienced) instruments for each ACT. Thus, we might have 'weapon' listed for 'hit' and a classification of the set 'weapon' elsewhere which would allow 'stick' but not 'hair'. Now, of course, either of these sentences could have had the opposite interpretation. But we would only want to discover these upon prompting.

Similarly a case system for ACT$\Leftarrow$PP allows for the resolution of the ambiguity in a joke sentence like

'Do you serve crabs?'

where the answer

'We serve anybody.'

can come as a result of the ambiguity in English of a certain class of verbs which take a recipient (or dative) case. The ambiguity is resolvable by the semantics where under 'serve' is the information that it's recipient case takes 'human PP's' whereas the ACT $\Leftarrow$ PP requires 'food' or 'drink'.

We had been writing prepositions over the prepositional dependency link, thus creating essentially as many links as there are prepositions, although these links are all of the same class. Clearly, there is a great deal of redundant information here, particularly in the creation of the semantic files to go along with these prepositions. While attempting to create 'conceptual prepositions' with the purpose of first sorting the prepositions that are exactly the same but semantically different (e.g. 'of' meaning containment versus 'of' meaning possession) and second combining prepositions with identical conceptual meanings (e.g. the 'of', 'with' and ''s' that all mean 'possession'), certain very interesting things fell into place. The most important of these for the practical problem of creating a parser was the fact that the prepositions combined well enough to drastically reduce the amount of semantic information necessary in order to parse. Another important reduction in the amount of necessary information was caused by the realization that the number of conceptual preposition or categories of prepositions was sharply divided between those that are attributive (below-the-line dependency) and those that were dependent on the action of the conceptualization. We will concentrate our discussion on the on-the-line conceptual prepositions.

Consider the sentence,

'I went with the girl to the park'.

If we desire to parse this with conceptual rules only we are faced with the problem of how to treat each prepositional phrase (this problem would probably not be simplified at all using realization rules).

To see some of the problems that this sentence creates we can contrast it with the following:

1) I went with the book to the park.
2) I went with the girl from the park.
3) I fought with the girl in the park.
4) I hit the boy with the girl in the park.
5) I hit the boy with the bat in the park.

While it may be possible to parse some of these sentences unambiguously using a rather detailed semantics, it is clear that certain things are operating here that are out of the realm of semantic considerations but rather serve as conceptual case indicators. For example, the most obvious case is the difference between sentence (4) and (5). Although the construction of these is superficially the same the meaning differs greatly. This is caused by the conceptual cases that are present on the conceptual level and the confusing use of prepositions to denote these cases in English. Fillmore [4] goes into the matter of case in great detail and it is not necessary to duplicate his arguments here. We take exception to the number of cases proposed by Fillmore, but this is in keeping with the attempt to present a semantic network that is conceptual in basis with no syntactic considerations. So, whereas there well may be as many syntactic cases in English as Fillmore projects, it seems clear that conceptually the story is different.

In sentence (5) then we may say that there is an instrument of the action and that this instrument is denoted by the noun following 'with'. Furthermore, we can predict from the ACT of the conceptualization that there was an instrument of that action whether or not that instrument was stated in the sentence. Thus we can predict from the ACT certain properties of the conceptualization.

The semantic ramifications are clear. We can list according to semantic category the possible instruments for an action, again according to usualness. These semantic files then are simply probabilistic usualness files. And we can predict what instruments we might expect. In sentence (4) it is safe to assume that 'girl' does not belong to the 'weapon' category that 'hit' would require. There is an additional safeguard built in here, in our probabilistic choice, in that if 'girl' is not an instrument it must be something else. We can then check its probability of occurrence in any new slot. In this instance, 'with' can be treated as a command to test the PP following as a potential actor in the conceptualization. This, of course is unique to the preposition 'with'. In (1), this check would fail which would require a check for a possessive connection, with the first available PP, in this case 'I', which would be acceptable.

Similarly, there is a conceptual directive case which would enable us to parse (1) with a direction modification on the conceptualization, whereas (2) would have the construct 'from the park' as a possible attribute of 'girl'. Thus, we eliminate a check with the semantics and thus uncomplicate the semantics, by translating 'to' directly as a conceptual case maker, while 'from' would ambiguously refer either to a case or an attribute.

Presently we allow four conceptual cases denoted by the following prepositions:

OBJECTIVE - (none)

RECIPIENT - to, from

INSTRUMENTAL - with, by -_ing

DIRECTIVE - to, from, towards

Similarly, there are 'attributive cases' of conceptual prepositions:

POSSESSION - of, with

LOCATION - near, at, by, in, before

CONTAINMENT - in, of

These conceptual prepositions are often realized in English by verb constructions such as: 'have', 'located', and 'contained'.

As far as the conceptual cases are concerned, their use allows us to orient the parser in a more verb-governed manner. That is, we will be able to map the 'to' in (1) directly into the directive case since the ACT that governs that constituent cannot take the recipient case. By this method then, we allow for a categorization of all the ACT's of the system by potential cases, thus creating an effective and useful classification schema.

One of the most important things that the establishment of a conceptual case system allows us is the opportunity to accurately predict information that we don't know or haven't yet received at any point in the parse. For ambiguity at the sentence or paragraph level this is extremely important. Thus in addition to our ability to ask when and where about every conceptualization, we will now be able to ask of: 'I ⇔ go', 'to where?' (Direction), and 'how' (instrument); for 'I ⇔ gave', 'what?' (Objective), 'to whom?' (Recipient), 'how?' (Instrument) and so on for every ACT in the dictionary. This predictive ability coupled to the already present one available from the attributive semantics allows us an enormous amount of information about a very uninformative sentence. For example, the system will now know, when it hears 'the boy ate', that it does not know and has the potential to find out about, the following things:

OBJECTIVE - what did he eat?, SEMANTICS - what type of food?

INSTRUMENT - what did he use to eat it?, SEMANTICS - which kitchen utensil?

$\leftarrow$PA size - how tall is the boy?

$\leftarrow$PA age - now old is the boy?

LOC - where was he when he did this?

T - when did this happen?

and a great deal more information. Clearly, this is extremely important, especially if a potential ambiguity can be resolved by our expectations. That is, we will always be expecting something by relying on our knowledge of the situation with which we are dealing. In some sense then, the parser will be intelligent.

5.2 The Particular Cases

5.2.1 The Instrumental Case - This case (denoted by $\overset{I}{\leftarrow}$ in the conceptual network) can very often be taken as being part of the actual action. That is, some ACT's predict very closely what kind of Instrument could have been used. For example, 'see' requires an instrument of 'eyes' and a possible addition to 'eyes' of 'glasses' or 'telescope'. Similarly 'shoot' requires 'gun' or something of the genre. This is true of a whole class of ACT's and we may label them temporarily as instrumental ACT's. It seems that a conceptual instrument is present every time there is a conceptual object.

5.2.2 The Recipient Case - We denote recipient case by $\overset{R}{\leftarrow}$. However, the class of ACT's that take Recipient turn out to be of a special variety. They are unique in that all the ACT's of this category express a certain type of relation, namely a transition. Since a transition has a beginning and an end, we can consider the recipient case to be two-pronged, denoted: $\xleftarrow{R}\left[\begin{array}{l} \to \text{to} \\ \leftarrow \text{from} \end{array}\right.$.

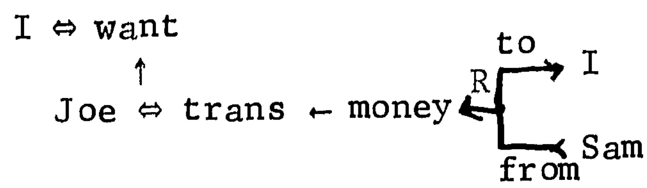
Thus, 'I want money' would have as its C-diagram the PP ⇔ SACT combination (since 'want' is an SACT) and an objectively dependent conceptualization expressing the desired transitory relation. The following might do:

$$\begin{array}{l} \quad I \Leftrightarrow \text{want} \\ \qquad\quad \uparrow \\ \text{money} \Leftrightarrow \text{go} \xLeftarrow{\text{to}} I \end{array}$$

However, this would not express the full power of what has been said. In addition, the notion of 'money' as an actor does not fit in with our conceptual schema. The actual actor is unnamed but is either a human or human institution since those are the possible holders of 'money'. We might express the ACT in this conceptualization as 'give' but this is not necessarily a warranted assumption. The ACT that we do know to be taking place here is one of 'transfer' or 'transition' but more particularly of 'active transition'. That is, this ACT does take an object, in this case 'money'. We can hypothesize a conceptual action called 'trans' then, with the required properties and use it in the object conceptualization under consideration:

$$\begin{array}{l} \qquad\quad I \Leftrightarrow \text{want} \\ \qquad\qquad\quad \uparrow \\ \text{someone}_1 \Leftrightarrow \text{trans} \leftarrow \text{money} \xleftarrow{R} \left[\begin{array}{l} \xrightarrow{\text{to}} I \\ \xleftarrow[\text{from}]{} \text{someone}_2 \end{array}\right. \end{array}$$

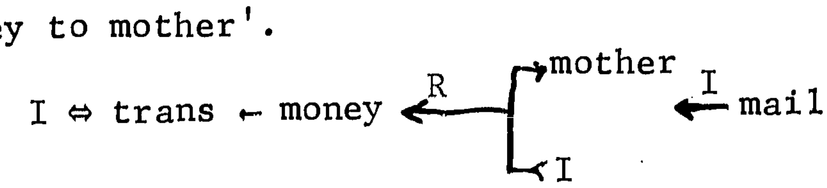
Here, the two-pronged recipient case expresses the beginning and end points of the transition. The two 'someones' are not necessarily the same one. In fact, the actual English realizate used in this situation is determined by the identity or lack of it with respect to the two 'someones'. If they are the same, the English realizate is 'give'. If 'someone,' is 'I' then the English realizate is 'take' (or perhaps 'take illegally' i.e. 'steal'). If all three PP's are different then the realizate is both 'give' and 'take'! Thus,



would be realized as

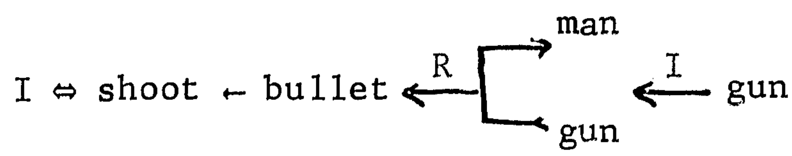
'I want Joe to take money from Sam and give it to me'.

'Give' and 'take' then are always instances of the ACT 'trans' and will be treated as such by the parser. Similarly a verb such as 'send' is also a 'trans' but a more complicated one demanding an I-case. Consider 'I sent money to mother'.

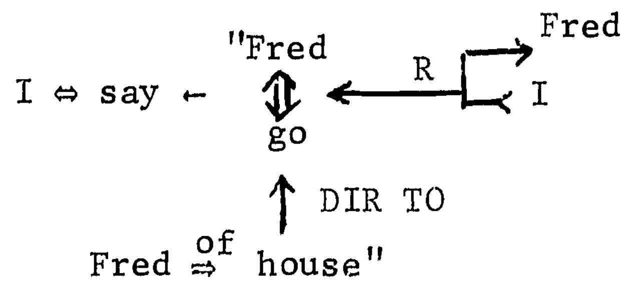


Here then, we have a verb whose conceptual realizate demands a certain specific item at its I-case. As Fillmore notes we can have only one instrumental for a verb. Here we see that we might not expect the verb 'send' to take instrumental case since its conceptual realizate could provide one.

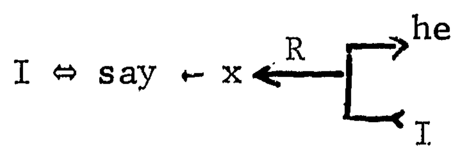
The ACT 'shoot' is another interesting example. Consider 'I shot the man'. Here the ACT 'shoot' requires objective case as well as recipient case and instrumental case. Furthermore, if no more information is present, an extremely well warranted assumption that we would require our parser to make (except perhaps in the case where photography was the context) is that the C-diagram given is as follows:



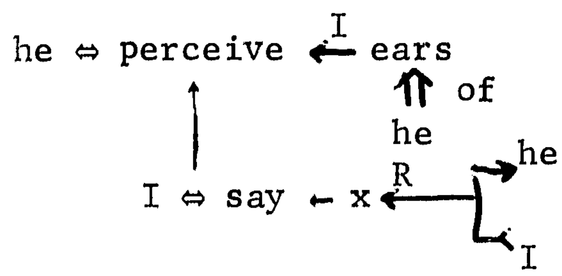
Other verbs that require this recipient case would probably include most 'speech-type' verbs. For example, 'I told Fred to go home' would be



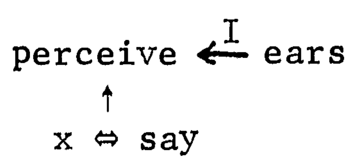
Similarly 'I talked to him' would be:



'He heard me' would be realized as:

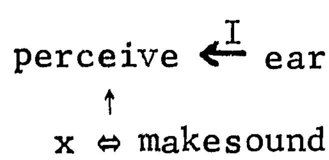


Parsing into this construction would not be difficult since 'hear' can be directly realized as either the complex construction



where x is human

or



where x is not human

Thus the reliance on the conceptual dictionary will be heavy.

5.2.3 The Objective Case

Since objects have been in use for a long time in these analyses, it is perhaps more illuminating in a discussion of Objective case to point out some examples of what we do not consider to be a conceptual object:

An item is considered to be objectively dependent if it is the thing acted upon by the ACT, thus, in 'he shot the boy', the objectively dependent item is likely to be 'bullets' but it is not 'boy'. 'Boy' is the recepient case in this instance, which necessitates having the ACT be 'shoot at'. Thus, a paraphrase might be, 'he shot bullets at to the boy'. The oddity of this sentence sententially does not negate its conceptual meaningfulness.

Deciding that an item is objectively dependent is a question of whether the construction can more meaningfully be realized some other way. For example, in 'I killed John', it is true that 'John was killed' but it is further the case that 'John is dead'. Therefore, the analysis is

$$\begin{array}{c} \text{I} \Leftrightarrow \text{do} \\ \Uparrow \\ \text{John} \Leftrightarrow \text{die} \end{array}$$

This is satisfying because the actual ACT (represented by the transitive dummy 'do') is unknown in this case. In the parser the information that allows for this kind of analysis is represented in the verb-ACT dictionary. Similarly, in 'I write books', 'books' is not objectively dependent on 'write' but this is due to the character of 'write'.

As elsewhere, when an ACT takes an objective case it is the function of the semantics to fill it in it it has remained unspecified. Thus, 'I ate' would be expanded in its conceptual analysis to include its object which would be some type of 'food'. In this instance the sentence might be short for a number of conceptualizations involving multiple eating actions. If the sentential object were 'dinner' the only allowable analysis would then be:

$$\begin{array}{l} I \Leftrightarrow \text{ate} \leftarrow x \text{ (food)} \\ \qquad\qquad\quad \Lleftarrow \text{dinner} \\ \qquad\qquad\qquad \Uparrow \text{of} \\ \qquad\qquad\qquad \text{me} \end{array}$$

While, the Objective case is often concrete and predictable from the ACT, often it takes the form of a conceptualization or a linguistic utterance. For example, in 'I told John to go home', 'John' is the recepient of the ACT 'say'. The object of that ACT consists of what was said, which in this instance is the conceptualization

$$\begin{array}{l} I \Leftrightarrow \text{want} \\ \qquad\ \uparrow \\ \text{John} \Leftrightarrow \text{go} \xleftarrow{D} \begin{cases} \rightarrow \text{house} \overset{\text{of}}{\Longleftarrow} \text{John} \\ \leftarrow \text{here} \end{cases} \\ \qquad\ \ f \end{array}$$

This entire construction then is the conceptual object of the ACT. In 'I told John, 'Mary is fat'', the quoted phrase is the conceptual object of 'say' but it's underlying conceptualization is not. That is, the words themselves satisfy the requirements of the Objective case.

Thus the Objective case can have a concrete PP or a conceptualization as its member but these are always objects of the ACT's with which they are associated and conform semantically to that requirement.

5.2.4 The Directive Case

The Directive case is the most complex of the cases. This is perhaps another way of saying that we do not understand its operation too well. Presently, we are using a two-pronged arrow to denote the beginning and end of the traveling (that is, the 'to' and 'from'). (For an example, see the dependent of 'go' in the last C-diagram.) However, the direction of an action is certainly more complex than is denoted by these two prepositions. Since the recipient case is strikingly like the directive case in at least one of its forms, there has been a fair amount of discussion of the fact that recipient case is only a special instance of directive case. That possibility is certainly extant.

Linda Hemphill [5] has suggested that the directive case is applicable with the realization of the following set of 'trans'-type verbs:

1) reflexive transitory verbs with the action directed to a place location.
2) reflexive transitory verbs that take objective case that are directed to a place location, where the focus is placed on the object motion rather than the subject motion.
3) non-reflexive transitory having an object directed to a place location.

Hemphill notes that there is a fourth category of non-reflexive verbs that correspond to the ACT labeled 'trans' in section 5.2.2.

For example, some of the verbs in the first category are: go, fly, move, drive, climb. . . In the second category are the transitive counterparts of these verbs: move, drive, take . . . These verbs fit the form of:

x verb-ed y to the z .

The third category includes the following verbs: hit, shoot, kick, knock over . . .

In the first category, it is possible to consider these verbs to be realizations of the ACT 'trans_2' where there is an AA modifying each of these according to the definition of the verb. A possible modification grouping might be:

$$\text{climb} = \underset{\substack{\uparrow \\ \text{up}}}{\text{trans}_1}$$

$$\text{go} = \underset{\substack{\uparrow \\ \text{horizontal}}}{\text{trans}_1}$$

$$\text{fly} = \underset{\substack{\uparrow \\ \text{trajectory}}}{\text{trans}_1}$$

By creating four classes of 'trans' verbs we gain a tremendous amount of versatility due to these generalizations. The primary problem is getting the original verb back after rewriting it in terms of some 'trans' ACT. That is, if the sense of 'hit' in the following sentence were treated as a 'trans$_3$' with a 'trajectory' modification; it would appear as: John hit the ball over the fence

$$\text{John} \Leftrightarrow \underset{\substack{\uparrow \\ \text{trajectory}}}{\text{trans}_3} \leftarrow \text{ball} \overset{D}{\longleftarrow} \begin{cases} \rightarrow \underset{\substack{\Uparrow \text{LOC} \\ \text{beyond fence}}}{\text{place}} \\ \leftarrow \underset{\substack{\Uparrow \text{LOC} \\ \text{near side of fence}}}{\text{place}} \end{cases}$$

In order to realize this construction as 'hit' again, we would have to define 'hit' in terms of its AA, ACT realizate, and Instrument. That is, we would determine the possible instruments for this verb based on the experience file and this information would be part of the conceptual instrument for the conceptualization even if it were unstated in the sentence.

What we would be doing then is reducing the actual set of ACTs to a very small number thus allowing for a more conceptual system. If machines are ever to translate it would seem that this type of analysis would be a prerequisite.

5.3 A Word About Case

The relevance of case in our system then is in its ability to account for the conceptual relations on the main line of a conceptualization in some general way. In addition, the cases provide a classificatory power with respect to the ACT's as will be seen in the next section. What we choose to regard as a conceptual case and we choose to place elsewhere is significant. As far as conceptual dependency is concerned, locative is not a case. With the possible exception of 'timeless' utterances, all conceptualizations are modified by a LOC. That is, any conceptualization that takes a T also takes a LOC. This is not too different from noting that any conceptualization can be causally dependent ($\Leftarrow$) on another conceptualization. That is, there is an important distinction between cases and relations between conceptualizations. LOC, T, and causality are examples of relations and not conceptual cases.

6. Conceptual ACT Categories

by Sylvia Weber

It is possible, on the basis of some of the considerations made heretofore, to distinguish certain types of categories for the ACTs. The distinctions will depend on the configuration of cases which an ACT can conceptually take. Another way of looking at this more or less systematic classification is that it is an attempt to identify universal relation-object dependencies, about which assertions can be made to give us "sentences."[1]

The fact that we set "assertions" apart from "relations" underlies the primary distinction which we make between verbs. The first group we call SACTs; they serve to subjectivize the conceptualization (usually introduced by the word 'that') which follows. For example, we have 'I know that the earth is pear-shaped'. (Of course, the conceptualization "related to" by the subject (actor) may in turn be subjectivized; 'I know he thinks that he understands that <conceptualization>.) Since SACTs "stand outside of" the conceptualization involving objects of the real world, we consider them as "meta-verbs"; they can have as subjects only conscious beings, since no other elements of the world can deal with conceptualizations which are the "objects" of the SACTs. Thus SACTs do not take any case at the "real-world" level, although it would be interesting to consider whether there is an analogous scheme of "cases" at the "meta-level."

1. We will assume that a sentence in its most general form has a struclike that of Fillmore's "Modal-Auxiliary-Proposition" [3]. That is, any proposition may be prefaced by some condition on its truth. This preface, however, never involves what we would consider a verb except for the "act" of existence, and is irrelevant to the present discussion. The only point of interest we shall make is that such modals or negations (and perhaps sentence connectives) can be considered as "operators", rather than as the "relations" which are our chief concern here.

In considering SACTs, we are faced with the problem of explaining such sentences as 'I know him', where there does seem to be a concrete objective case associated with 'know', and 'I think with my brain', where there seems to be a concrete instrumental case. These apparent deviations are reflections of the fact that human beings (as "subjects" or "objects") and the acts they are capable of performing have both a physical and a mental (concrete and abstract) component. Speakers of English often use the same word for both of these senses. In the case of 'think' as mentioned above, this usage does not seem to be conceptually justified. That is, when ones says 'I think that ...', he usually means not that he is presently engaged in the process of thinking, but rather that he holds a certain opinion. Thus we will accept two senses of 'think', only one of which (the latter) is an SACT.

The verb 'know' on the other hand, seems to be a purely abstract phenomenon rather than an activity in any sense (one says 'I am thinking' but not 'I am knowing'). Thus there are no grounds for distinguishing two senses of 'know' on this basis. We might ask, then, whether the statement 'I know that he rides a pogostick' really implies a different categorization for the word 'know' than does the statement 'I know him'. The first point to be made is that 'know' as a purely abstract verb can relate only abstract components of its subject and object. We could not, for instance, meaningfully say 'I know the wastebasket'. When we say 'I know him', 'him' is a kind of "abbreviation" for 'his behavior', 'the way that he is', or 'that he is x,y,z ...'.

Similarly, 'I understand him' means 'I understand why he is x,y,z ...', and 'I know physics' means 'I know that force is dependent upon mass and acceleration' etc. A sentence such as 'I know that he rides a pogostick' then appears as a specific instance of the sentence 'I know him'. When we "abbreviate" the former sentence by saying 'I know that fact', the similarity becomes more noticeable. The progression 'I know him' - 'what do you know about him?' - 'I know that he rides a pogostick' also supports the notion that the same "sense" of 'know' is being used in each case. This sequence also incidentally tells us that the construction 'about x' has nothing to do with case as discussed here, but rather is an abbreviation or a "slot" which can be filled in by a fact or situation in which 'x' occurs.)

Having concluded that the conceptual object of a verb such as 'know' must be abstract, we are nevertheless faced with the "inconvenient" reality that when an animate being is relating to some sort of information (as opposed to asserting it), the superficial object of the conceptualization involved is often the PP, human or abstract, which seems to be respectively either the focus of or the name given to the object conceptualization. We therefore assign the ACT 'know' as used in 'I know him' to a new category, which is considered to operate on the relational level and includes all verbs which exibit a certain relation to an object fitting the above description. ACTs of this category are typified by attitudes toward or reactions to a conceptualization (conversely, the effect of a conceptualization on an animate being). We could also view some of these ACTs as a (unary) adoption of a certain state of an animate being as a result of a conceptualization, rather than as a (binary) relation between the animate being and the conceptualization. (The change-of-state aspect is discussed in some detail in section 8.5.1 and will not be emphasized in this chapter.)

These ACTs of (usually emotional) effect we call EACTs.

EACTs differ somewhat according to the type of conceptualization related to and the circumstances of its occurrence. An example in which an attitude (i.e. a continued reaction) toward some activity is expressed would be 'I enjoy cooking', where the actor 'I' of the object conceptualization must be filled in. In other cases, other components of the object conceptualization must be supplied, as in 'I enjoy (I watch) movies' (see section 8.2 on "associations"). In both of these examples, the activity has a certain effect on 'I'.

It is, however, not always obvious whether it is the <u>character</u> of the activity or its <u>existence</u> which affects the subject in such a sentence. For instance, consider 'John's love for Mary disturbed her parents'. This is either equivalent to a) 'the fact that John loved Mary disturbed her parents' or e.g. b) 'That John's love for Mary was insincere disturbed her parents'. We would like to assign similar conceptual structures to these two sentences with a variable component to account for each of the meanings. At this point we consider the conceptual meaning of the word 'fact'. We have said that every proposition is at least implicitly prefaced by an indication as to its truth value. When we deal with propositions in our speech in general, we are dealing with <u>possibilities</u> (e.g. 'That all dogs dislike water is true, doubtful, etc.'). The word 'fact' is equivalent to the assumption that the subsequent proposition is <u>true</u>. (Thus we might think of a conceptualization as an <u>assumed</u> proposition.) In sentence (b) above, it is assumed that John loves Mary; 'being disturbed' refers to the insincerity of this relation between him and Mary. Thus that to which Mary's parents are relating is represented as:

John
⇕ ⇔ insincere
love
↑
Mary

For the first half of sentence (a) we have, correspondingly,

John be
⇕ ⇔
love
↑
Mary

(The proposition 'that John might love Mary (disturbed her parents)' would be represented as

John possibly be
⇕ ⇔
love
↑
Mary

This consideration of propositions also enters into another problem, namely, that the verb 'fear', which as an emotion seems to be an EACT, is also used to express propositions and thus shares a property of the SACTs. We have, for example,

a) 'I fear mountain-climbing' and
b) 'I fear getting caught in a blizzard'

In (a), 'fear' is an EACT in the sense that 'enjoy' is an EACT. In (b), 'fear' performs the same function in one interpretation of the sentence, but in an alternate interpretation the object of 'fear' is 'that I will get caught in a blizzard'. In other words, the object is only a possibility which the verb 'fear' must postulate as a "future fact", i.e. predict, if it is also to express misgivings with respect to the situation.

We have been discussing with reference to EACTs mainly "attitudes", i.e. "habitual reactions". A different meaning is produced when the same

EACT is used to describe a reaction to a specific event. The following examples respectively illustrate these two meanings:

a) 'Maids knocking disturbed him before he got used to it'
b) 'The maids knocking disturbed him before he was ready to get up'

Since this difference is only a matter of tense (here applied to a cause-effect situation), it does not complicate the notion of an EACT in any way.

EACTs may be considered to be verbs which describe "static" abstract relations between an animate being and some at least partly abstract object. The remaining abstract verbs describe "dynamic" relations; i.e. they involve the basic concept of transfer. Such acts fall into categories reflecting two attributes characteristic of human beings.

The first such category we call "communication acts" or CACTs. These acts bear some resemblance to SACTs in that they take assertions or facts as "objects"; they differ from these however, in that a CACT is an (essentially human) activity itself rather than just a context for an idea. The abstract object of this activity (often "named" or "abbreviated" as 'idea', 'word', 'thought', etc.) is transferred to another (perceiving) animate being, which is thus in the "recipient" case. As a partly physical activity, a CACT can be expected to take instrumental case (the object here being restricted to instruments of communication). Thus we have, for example, a) 'He announced his ideas to the group with (through) a microphone'. The sense of 'think' which was rejected as an SACT above is included in this category. It represents communication with oneself.

It is interesting to note that the sentence 'I read this book to you' is analogous to 'I spoke these words to you' and is thus both an "abstract" and a "concrete" sentence. Our minds do not confuse these two components within the sentence; the sentence evokes an image <u>either</u> of eyes scanning the printed page at the physical level <u>or</u> of the consciousness absorbing the material the author wishes to convey at the mental level. Thus the implications of the sentence 'She reads with glasses' do not prompt us to ask what 'she' derives from reading intellectually, but rather whether she has poor eyesight (a physical attribute).

Communication, however, is a two-way process; we must therefore include in this category as a separate group acts of perception, such as 'hear'. Such acts will take the same objects as the expressive-type CACTs mentioned above, as well as instrumental case. However, since perception corresponds to the "receiving" aspect of communication, we can expect that 'from' rather than 'to' will be the preposition relating to the other person. We thus have, as an analogy to a) above, the sentence b) 'He heard those words from him with his hearing aid' (where 'words' is an "abbreviation" for 'that which he said').

The second, somewhat analogous category of transfer-verbs involves transfer of possession. ACTs of this category are called TACTs and, again, generally involve a human actor, take instrumental case and exhibit the 'to'-'from' relationship to an animate recipient of the object. It is chiefly in the nature of this object that TACTs differ from CACTs; the object is concrete rather than abstract. The following matrix summarizes the case possibilities for representatives of verbs of both categories:

	COMMUNICATION	TRANSFER	DONOR-RECIPIENT CASE
"active"	speak	give	(to) animate
"passive"	hear	receive	(from) animate
Objective case	conceptualization	PP	
Instrumental case	PP	PP	

The second major group of "relational acts" involve physical interaction. Corresponding to EACTs in the abstract group, we have PACTs, which consist of physical action of an animate actor upon a concrete object, excluding transferral of that object. A voluntary physical action involves (explicitly or implicitly) some means to accomplish the action, i.e. takes instrumental case. Verbs of physical contact generally fall into this category:

a) He hit the boy with a rock
b) He hit the boy (with his hand)

The second group of concrete ACTs, corresponding to the abstract, transfer ACTs, includes those ACTs which involve simple physical transfer of an object. These ACTs take the directive case rather than the recipient case, since location rather than possession is relevant here. There remains nonetheless a similarity between the two cases; the recipient case is a kind of abstract directive case. Thus the recipient case is realized with the words 'to' and 'from', whereas the directive case includes these words plus a part of the object. (We note that a phrase such as 'to the north' is really an adverbial expression specifying geographical direction and has little to do with case.) The two categories of this group are illustrated by the following:

a) He walked into the barn → He walked to the inside of the barn
b) She placed the wineglass on the car → She moved the wineglass to the top of the car.

Here 'place' is an example of a <u>DACT</u>, and 'walk' of an <u>RACT</u>. They are conceptually similar, the only difference being that an RACT is reflexive; i.e. the object of the action is oneself ('He moved himself into the barn'). Examples (a) and (b), however, do not account for ACTs used with prepositions such as 'over', 'across' and 'near', where no physical part of the destination object is identified in the sentence. However, if we include the vicinity of an object as one of its properties and include as relevant to direction not only the goal of the transferred object but also its location in transit, there is no problem. Thus,

c) 'He threw the ball over the fence' becomes 'He threw the ball to <u>the opposite side of the fence</u> via (a point) <u>above</u> the fence';

d) 'He drove from <u>one side</u> of the country to <u>the other side</u> of the country via <u>the surface</u> of the country';

e) 'He threw the frisbee near the fence' becomes 'He threw the frisbee to <u>the vicinity</u> of the fence'.

(For more extensive discussion on prepositional dependencies see section [illegible].)

Several points can be made regarding these examples. First, as with the recipient case, there is both an initial point and a destination point for the object involved. In the case of (c) and (e), there is an implicit 'from the point (location) of himself'. Second, if we distinguish transit location from goal location, we have <u>some</u> idea of how many or what kind of directive case(s) to expect for an ACT. We would not expect an ACT to have more than one goal and normally not more than one transit location. For instance we might expect 'He threw the coffeepot over the fence into the flowerbed' but not 'He threw the pot over the fence into the flowerbed near the chickencoop' <u>where 'near the chickencoop' is a goal of the pot rather than the location of the flowerbed</u>.

We would also not usually expect 'He threw the pot over the fence over the dog's head into the flowerbed', and certainly not 'He threw the pot over the fence under (through, across) the fence into the flowerbed'. This idea seems to hold also for locations: 'He went to N. Y. via Chicago via New Orleans' sounds strange and would be taken to be equivalent to 'He went to N.Y. via Chicago <u>and</u> New Orleans', in which Chicago and New Orleans would either seem to specify parts of the same route, or would suggest that two separate trips were made. We note that with respect to the analogy between the dative-recipient and directive cases, both have a static, non-transfer form which seems to be universal, i.e. 'x is with or belongs to y '('y has x') and 'x is at y' respectively. (Such a treatment of the verb 'to have' is given by Fillmore [3].)

There remains with respect to verb calssification one more identifiable major group. These correspond to a certain group of the "intransitive" verbs; they specify the state of an object rather than evoke any image of true action, whether physical or mental. Such verbs, then, take no case (with one possible exception to be examined later), as they describe an object in terms of its own properties rather than of its relation to any other object. In general, these verbs define a) the existence or non-existence of an object ('be', 'remain'), b) a change of one of these states into another ('die', 'appear') or c) an increase or decrease of some characteristic of the object in its state of existence ('grow', 'fall'). We note that "state" may be a state of motion, in which case the state is both a state of transition and a transition from one state to another.

The resemblance of apparently different types within this class of verbs is noticeable in the following pattern:

$state_x \rightarrow$	$transition_{xy} \rightarrow$	$state_y \rightarrow$	$transition_{yz} \rightarrow$	$state_z$
a) not be	start to be	be	cease to be	not be
b) not live	be born	live	die	not live
c) high	start falling	be falling	cease falling	low

Here 'falling' represents a change from stationary state$_x$ to stationary state$_z$ (change of location), but a more immediate change of state is represented by the change from stationary state$_x$ to motion state$_y$ (change of motion).

Since "motion" is one of the possible states of an object, we recognize that a directive case is possible (e.g. 'The tree fell onto the tent'). Such motion-state verbs we call <u>MACTs</u>; the remaining verbs of this class, which take no case, we call <u>IACTs</u>.

We might point out here the difference between 'fall', an MACT, and 'walk', an RACT. By walking, an actor is causing himself to change state by means of a voluntary physical process (picking up his feet, etc). He may require an external instrument, such as a crutch. Falling involves no such conscious activity.

We have somewhat facilitated our treatment of motion-states by considering a "negative-type" verb such as 'fall' as representative. The word 'rise' presents a more interesting problem. Consider the sentences:

a) The moon rises
b) The man rose with a crutch
c) Hubert rose with the balloon

The sense of 'rise' in (a) is a motion-state (MACT), that in (b) is a physical activity (RACT), but that in (c) is not as obviously either of these to the exclusion of the other. The confusion occurs because humans <u>usually</u> engage in some sort of conscious physical activity when changing state, as in the case of 'walk', so that one tends to expect that any "positive-type" change of state by a human would involve such activity. In sentence c) this is not case; conceptually we have nothing more than a motion-state. The balloon plays an accompanying rather than an instrumental role as far as the verb is concerned (although this example certainly points out the strong association between the notions "accompaniment" and "instrument"). Whether or not Hubert intended to use the balloon or whether the balloon in some way "caused" Hubert to rise is a question not directly relevant to the conceptual structure underlying the sentence.

The ACTs we have discussed are classifiable as to case because they are in a sense "elementary"; the case dependencies associated with them reflect relations that are rather easily conceived of. The categorization scheme presented is of course not considered to be conclusive; it is rather an indication of what are thought to be valid lines along which some sort of conceptual categorization might occur. One of the problems which invites further thought lies with the criteria for ACTs which relate to conceptualizations. That is, perhaps the analogy to ACTs involving objects should be realized, so that, for example, the present SACT would be considered a "static" version of the present CACT, which involves transfer. Thus we would consider both of these categories to be grouped together with a possible recipient at the meta-level and find some other way of designating those ACTs involving expression and perception as mediums for asserting and accepting facts. For example, the true perceptive ACT 'hear' would have as its objects sounds such as "water dripping" rather than the fact 'that water was dripping'.

Closer attention to analogies between the physical and abstract levels, (or perhaps even according to several "frameworks" as suggested by Tesler in section 9) might also be fruitful. For example, the present

PACT category, which includes the ACTs 'hit' and 'touch', represents only those non-directive physical relations in which one PP is acting upon another, and thus does not correspond to the present EACT category (which is dominated by ACTs which seem to be relations rather than acts) to any satisfying degree. It seems that we need, first, a static category on the physical level including the verbs 'inhabit', 'be touching', 'surround' ('The garden surrounded the house'), etc., which would correspond to EACTs such as 'love'. We then would need a change-of-relation category on the abstract level including verbs of the type 'fall in love with', which would correspond to the PACT category, containing 'enter', 'touch', 'surround' ('The enemy surrounded the fort in five minutes'), etc.

A final word relates to verbs which do not seem to fit neatly into any of the categories suggested. These are mainly verbs such as 'organize', 'study', and 'demonstrate (against)', and other "complex" verbs having conceptual or semantic components which are not immediately obvious. Many of them are probably culture-dependent; that is, a verb consisting of an (arbitrary) arrangement of components at various (perhaps arbitrary) levels of abstraction should not be expected to have a direct counterpart in another culture. Such verbs will probably prove to be the most interesting with respect to correspondence of their components to the suggested categorization or motivation for its revision.

7. The Parser

7.1 Introduction

The case system presented here provides the opportunity to build Spinoza II. In developing the work under discussion we have spoken in ambiguous terms about both the theory and the parser. That is, while Conceptual Dependency is a theory of language in its own right, to some extent the validity of a theory depends upon its usefulness. Here its usefulness lies in the fact that it is also a theory of computational linguistics. Thus it explains how one might expect to be able to use natural language in a computer program, given that all possible good things were to come to pass. But machines are not infinitely large in actuality. Furthermore, while the demand for an effective natural language 'understander' is great, it is possible to pacify the demanders while still being true to our theoretical goals. We therefore have undertaken the building of a parser which is capable of doing a part of the overall task. This part however is a very important part and an easy one to do. Furthermore this parser is practical and useable by programs that need to interact with humans. But perhaps the largest consideration in the building of this parser is the realization that much of the work that it is necessary to do in order to build it, is precisely the same work as needs to be done in beginning to build any future version of the parser.

The central part of the parser is the dictionary of verbs. In the verb dictionary we can expect to find the two types of information that were mentioned earlier. The linguistic experience information points out the expected syntactic patterns that have been known to accompany this verb. And, the conceptual information explains what kinds of things we can expect to be in relation to the conceptually-realized verb.

Thus, the task of the parser is mainly to discover the verb, and then to find the information that is expected syntactically and conceptually based upon the syntactic and conceptual categories associated with that verb. Furthermore, the parser must choose between senses of the verb based upon the available semantic information. But the primary task remains finding the verb. In order to do this we make use of inflection and agreement information about English. This process has its parallel on the conceptual level in the heuristics that the parser employs based on certain conceptual information. Thus, we can view the parser as employing two basic operations on two different levels of analysis. On the sentential level we use agreement information to get us looking in the right places and syntactic information about the verb to permit us to make certain educated guesses about what we are likely to find and where we will find it. The third part of the process on this level involves what are often called selectional restrictions. This 'semantic' type information will further confirm our syntactic expectation in terms of actual meaning.

It is very satisfying to note that these three basic operations have their realizates on the conceptual level. (Of course, since Conceptual Dependency is a stratified linguistic system we might have expected that this would happen, but since we were really not trying to make it so, it is nice that it worked out anyway.) The conceptual category information will point out which cases are expected to be utilized, and will allow us to know what we are looking for. The possible combinations of conceptual categories have their selectional restrictions also. This is 'semantic'-type information at the conceptual level and delimits the conceptual possibilities of combinations in accord with experience. The analog of agreement rules are the heuristics. That is, we have a set of rules at the conceptual level that explain what we should do at certain points in the parse, given a certain set of circumstances. These rules are partially dependent on the language concerned, and thus are the interface between the two levels. Similarly, the agreement rules of the sentential level are at the lowest level of the analysis. (This means that in generation, they are the last ones applied.)

Thus, the parsing process consists of searching for a certain element at both levels (the verb sententially, and the PP $\Leftrightarrow$ ACT conceptually given that these exist); then taking the information provided as to what we will now expect to find and searching for that.

7.2. The Verb-ACT dictionary

The primary element in the Parser is the verb-ACT dictionary. The information in this dictionary consists of the following parts:

a) verb category - we recognize the following syntactic categories of verbs:

vi - intransitive verb: The parser expects to find no sentential object for this verb. Examples - sleep, die

vt - transitive verb: The parser expects a direct object. Examples - hit, like, want

vio - indirect object verb: The parser expects no direct object but a possible indirect object. Example - go

vp - pseudo-state verb: The parser expects a direct object which it will then treat conceptually as the actor (y) in the construction:

$$\begin{array}{c} x \Leftrightarrow \text{do} \\ \Uparrow \\ y \Leftrightarrow \text{ACT} \end{array}$$

where x is the sentential subject and y is the sentential object. Examples - break, grow, open vx - double object verb: The parser expects to find two objects that have no preposition in front of them in which case the first object is conceptually the recipient and the second is conceptually the object. Alternatively, these objects could be in reverse order with a 'to' separating them. Examples - give, buy, call

vy - double subject verb: The parser expects to find either two subjects and no sentential direct object, or on ordinary transitive relationship with a verb which may end in 'with', where the conceptual realizate is actually two conceptualizations each with opposite ACTOR-OBJECT order. Examples - fight, communicate, sleep with

vs - state verb: The parser expects to see a 'that' following the verb or else a noun verb combination as object (possibly separated by a 'to'). Examples - think, see, allow

Thus, the syntactic category takes care of a good deal of the parsing procedure. The conceptual parse is partially completed based on the syntactic verb category. In the cases of vi, vt and vio, the conceptual realizates are straightforward by definition, for example, the sentential subject and object of a vt are often the conceptual ACTOR and OBJECT when the ACT is a direct realizate of the verb.

Clearly, most English verbs have many possible syntactic categories in the sense just defined. Even the examples given are only true for one sense of that verb. The next major problem is choosing between these possible senses. This is done by the use of semantic information for this level.

b) syntactic selectional restrictions - Often we are given many alternative syntactic categories for a verb and we are faced with the problem of selecting between them. Also it is common for one syntactic category of the verb to have many different meanings. The selectional information, or 'sentential semantics' is used to make the choice. Thus in the dictionary for 'expect' we find:

expect		subj(x)	obj(y)
vs	Expect 1	human	
vt	x ⇔ expect 1. ↑ y ⇔ go 1 $\xleftarrow{D}$ here F	human	vehicle human
vt	x ⇔ expect 1 ↑ one ⇔ $trans_1$ ← y $\xleftarrow{R}$ x / one	human	phys.obj.
vt	x ⇔ expect 1 ↑ ⇔	human	any

We choose the sense of the verb based on the surrounding syntactic categories first, and then on the surrounding semantic categories. So if 'that' follows 'expect' or if 'N to V' or 'to/V' follows 'expect' we recognize that it is the vs instance and proceed from there to the ACT definition for 'expect 1'. However, if a noun or noun phrase follows 'expect' we must choose between the possible vt's. This is done on the basis of the lowest leveled category (in the semantic tree, see [6]) that applies. Thus, if the noun following 'expect' is John, the first vt applies (i.e. 'I expect that John will come here', is the underlying conceptualization in 'I expect John'). If an abstract noun appears, it is of the class 'any' and will be rewritten as a conceptualization dependent on 'expect' (e.g. 'I expect an accident' is 'I expect that something will occur accidentally'.)

In all these cases the conceptual 'expect' that applies is 'expect 1' which we define elsewhere as an SACT that takes 'human' actors.

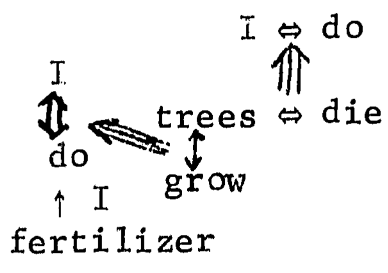
(It is worth mentioning here that this parser is intended to be practical and practicable. Therefore, whereas exceptions to each rule that we have just proposed do exist, their frequency of occurence does not warrant complicating mechanisms that will work as is most of the time.)

c) conceptual category - We have already dealt with the possible ACT categories. One of these categories is assigned to the unique sense of the ACT in question. There is not a one-to-one correspondence between verbs and ACT's. That is, there are many more verbs than ACT's in the system. For example, most of the verbs that are realizates of TACT's are realization of '$trans_1$' and some defined set of circumstances in the concomitant cases. This is true of most motion verbs (DACT's) which are derivable from 'go 1'. The verb 'come' for example looks as follows:

come		subj (x)
vio	$x \Leftrightarrow$ go 1 $\xleftarrow{D}$ [$\rightarrow$ here, $\leftarrow$]	human
vio	one $\Leftrightarrow trans_1 \leftarrow x$	phys.obj.

d) conceptual level semantics - The conceptual semantics have been dealt with extensively elsewhere [7] and need not be reviewed here. In the actual implementation of this semantics we utilize the usualness of various items in the cases assigned to each ACT. Thus there is an instrumental semantics which would use 'weapon' for 'hit'.

The separation of the semantics into two levels is significant for a number of reasons. Consider the sentence 'I killed the trees that I grew with fertilizer'. The correct parse of this sentence is:



The placement of the semantic restrictions on both levels enables us to correctly parse this sentence. The conceptual semantics are of no help in determining where the instrument is to be attached since the right answer is the second 'do' and 'do' is just a dummy action. This dummy action could take any instrument and its semantics are not helpful. However, the verb 'grow' can take an instrument of which 'fertilizer' is certainly one. In fact, it is precisely the construction 'do $\xleftarrow{I}$ fertilize' that can be realized as 'grow' in English. However the ACT 'grow' is an IACT which takes no instrument as it is the vp character of grow and the acceptable instrumental semantics of the verb that allows us to know that this is the instrument conceptually of the 'do' associated with the conceptual 'grow'.

7.3. Operation of Spinoza 1.2

To expedite implementation of an intermediate version of the parser, it was created as a major revision of Spinoza I instead of as an entirely new program. As a result, it preserves many of the idiosyncrosies of the earlier program. The main change is the use of the verb file instead of realization rules to discover main-line constituents.

The parser scans the input stream from left-to-right, backing up only rarely when it finds itself misled by ambiguity. When a word is read, the following conditions are tested:

(1) Does it form an idiom with the next word?

(2) Will it serve as a main-line constituent for a partial conceptualization that is waiting for completion?

(3) Together with the immediately preceding words in the "hooks" list of live words (words that either need a governor or can still govern more words), does it match a realization rule?

Presently, there are 21 realization rules, accounting for most of the categorical syntax of English; the syntax of connectives like prepositions, relative pronouns, and conjunctions is specified in the lexicon. Twelve of these rules specify categories of modifying words that lexically pre-cede their syntactic governors:

adverb-verb	negative-auxiliary	quantifier-noun
adverb-adjective	negative-noun/verb/adjective	number-noun
adjective-adjective	auxiliary-auxiliary	noun-noun
adjective-noun	auxiliary-verb	determiner-noun

Two rules specify categories of modifying words that can lexically follow their syntactic governors:

verb-adverb

noun-"right" adjectives/participles

The last seven rules list some realizations of the main-line of a conceptualization, may specify which concept governs the auxiliary, and must specify the permutation of the constituents to put them in declarative order for indexing into the verb file. Each rule has two parts: recognizer and chart. In the chart, a "2" means the second item in the recognizer; "Gov x y" means that item x governs item y; "Svo x y z" means the declarative order of the clause is x followed by y followed by z. "0" means a constituent not found in the recognizer.

recognizer	chart
(noun or pronoun) (verb)	Svo 1 2
FOR_1 (noun or pronoun) TO_1 (verb)	Svo 2 4
TO_1 (verb)	Svo 0 2
(common noun) (noun or pronoun) (verb)	Svo 2 3 1
(noun or pronoun) (passive verb)	Svo 0 2 1
(begin sentence) (verb)	Svo YOU_1 2 [Imperative]
(auxiliary) (noun or pronoun) (noun or pronoun, verb or adjective)	Gov 3 1 Svo 2 3 [Interrogative]

recognizer	chart
(noun or pronoun) (auxiliary) (noun, pronoun or adjective)	Gov 3 2 Svo 1 3

The parser discovers vertical dependency links from the first fourteen rules, and sets up conceptualizations (most involving the verb file) from the last seven.

Clearly, the drastic reduction in the amount of realization rules is extremely satisfying. Continuing revisions of the program will rely on organization of the information such that the actual parsing process is more in line with a hearer's intuition.

8. Etcetera

In attempting to write a theory and a program to deal with all of natural language, it is frequently necessary to ignore a great many aspects of the problem in order to effectively deal with what are considered to be more important aspects. In this section, we will briefly mention some problems that we have been ignoring and some tentative solutions that we have proposed.

8.1. Attribute Statements and Tense Modifications

We now defferentiate between conceptualizations and attribute statements, denoting the former by $\Leftrightarrow$ and the latter by $\boldsymbol{\Leftrightarrow}$. In addition, $\boldsymbol{\Leftrightarrow}$ takes three forms, two for PP $\boldsymbol{\Leftrightarrow}$ PA and one for PP $\boldsymbol{\Leftrightarrow}$ PP. We denote the sensing part of the attribute statement with 's' written over the link. This is used in statements such as 'I am hot'. For 'I am tall' we use a 'b' to denote the 'being' aspect. PP $\boldsymbol{\Leftrightarrow}$ PP can be read as 'the former is an instance of the latter'.

Thus, we are proposing that all statements can be described in terms of either feeling, being, or doing. This conception has its philosophical overtones. It is of course, not too surprising to discover that this work might have ramifications in other fields.

All of these links can be modified by a 't' denoting a transition. Thus, 't' is the conceptual realizate of 'become' or 'grow'. We denote the conceptual 'begin' and 'end' by subscripting the 't' with 't_s' and 't_f' respectively. In addition, we recognize a continuant tense for continuing action (often realized as '-ing' in English) and denote it by 'k'. We also denote a 'tenseless' statement (a 'truth') by a Δ. Absence of a time marker denotes present tense.

Using these modifications on tenses we graph the following sentences so:

'I am taking pills'

$$I \overset{k}{\Leftrightarrow} \text{ingest} \leftarrow \text{pills}$$

'I have been taking pills'

$$I \overset{pk}{\Leftrightarrow} \text{ingest} \leftarrow \text{pills}$$

'I started taking pills'

$$I \overset{t_s{}^p}{\Leftrightarrow} \text{ingest} \leftarrow \text{pills}$$

'I will start taking pills'

$$I \overset{t_s{}^f}{\Leftrightarrow} \text{ingest} \leftarrow \text{pills}$$

'I will be continuing to try to stop taking pills'

$$\begin{array}{l} I \overset{t_f}{\Leftrightarrow} \text{try} \\ \qquad\quad \uparrow \\ \qquad I \underset{t_f f}{\Leftrightarrow} \text{ingest} \leftarrow \text{pills} \end{array}$$

'I grew to be tall'

$$I \overset{pt_f}{\Leftrightarrow} \text{tall}$$

'I am becoming happy'

$$I \overset{kt}{\Leftrightarrow} \text{happy}$$

Similarly, we account for the following auxiliaries by the following tense combination.

he has written	t_f
he had written	$t_f p$
he $\left\{\begin{matrix}\text{will}\\ \text{shall}\end{matrix}\right\}$ write	f
he can write	he $\overset{\Delta}{\Leftrightarrow}$ wrote
he could write	he $\overset{c\Delta}{\Leftrightarrow}$ write
he should write	$\begin{array}{c}\text{he} \Leftrightarrow \text{ought}\\ \uparrow\\ \text{he} \Leftrightarrow \text{write}\end{array}$ $\quad \begin{array}{c}\text{one} \Leftrightarrow \text{went}\\ \uparrow\\ \text{he} \Leftrightarrow \text{write}\end{array}$
he must write	$\begin{array}{c}\text{he} \Leftrightarrow \text{have}\\ \uparrow\\ \text{he} \Leftrightarrow \text{write}\end{array}$ $\quad \begin{array}{c}\text{one} \Leftrightarrow \text{require}\\ \uparrow\\ \text{he} \Leftrightarrow \text{write}\end{array}$
he is writing	k pr (pr denotes present tense)
he did write	p
he $\left\{\begin{matrix}\text{might}\\ \text{may}\end{matrix}\right\}$ write	c
he should have written	p (on second link)
he $\left\{\begin{matrix}\text{should}\\ \text{may}\\ \text{can}\end{matrix}\right\}$ be writing	k (on second link)

8.2. Associations

Another item of research that needs to be done in order to create an effective conceptual parser is in the realm of some type of associative storage of concepts. For example, the construction 'I like PP' should be parsed as

$$(1)\quad \begin{array}{c}\text{I} \Leftrightarrow \text{like}\\ \uparrow\\ \text{I} \Leftrightarrow \text{ACT} \leftarrow \text{PP}\end{array}$$

where the ACT would come from an association with the given PP. This might be 'look at' for 'pictures'; 'read' for 'books'; 'eat' for any type of food; or ambiguously 'play' and/or 'watch' for 'baseball'. Similarly in 'I fear bears' a correct parse might be

(2) I ⇔ fear

bears ⇔ harm ← I

In (1) and (2) we know that 'like' and 'fear' are ACT's that require an entire conceptualization as an object. Therefore it is clear that an ACT is missing and must be discovered. An associative file that is capable of relating the 2 PP's that we know to be the actor and object of this conceptualization would have to be called into use in order to provide the most likely ACT for the appropriate slot. Thus we could say that 'humans' and 'books' are most likely related by 'read' and that only 'human' could be the actor. But in (2) 'bears' would be the actor. The conceptual semantics for delimiting possible actor-action combinations, coupled with the associative file, would help determine this. That is, the ACT's would also need to be associatively related such that 'fear' would relate to 'harm' and then 'harm' could relate to 'bears' as an actor. This associative store would also be employed in the disambiguation of certain other types of construction. For example, in 'I saw birds flying to the convention', a parser that makes use of only one conceptual sense of 'fly' would be likely to have the 'birds' do the 'flying' here. But it is the lack of association between 'animal' and 'human institution' that would question this decision. The more likely association between 'human' and 'human institution' would take precedence.

We expect that it may be feasible to eliminate a great deal of the information that would need to be present in the linguistic experience by use of the associative store. This will be made possible by the considerations derived from the ACT categorizations. As we have seen in section 6, the various ACT's fall into a number of groups which is far less than their possible combinations. These groups are based on the possible conceptual cases that an ACT can take. It has turned out that there are groups of ACT's that take certain combinations of cases. For example, any ACT that takes a recipient case can also potentially have an instrumental. Furthermore, this instrumental is often defined by the ACT itself e.g. 'send' is a 'transfer-type' ACT with 'mail' or 'messenger' as its instrument.

Since these ACT categories do not appear to be too numerous they are very useful in directing the parser as to its expectations. Therefore if we find an apparent contradiction between linguistic input and the conceptual schema, we can rely on the conceptual schema to point out the correct parse. An associative store could thus provide a needed connection between 'fly' and 'planes' given that 'planes' was present in the input and that the semantics had made obvious an inconsistency between the input and the underlying representation. An analysis of this kind is dependent on the notion that we know how each PP and ACT will relate in a conceptualization. Thus in the sentence 'Nixon frightens me', the correct analysis would be built as follows:

when 'frighten' is encountered it is rewritten as 'animal ⇔ fear' by the verb-ACT dictionary. Since 'fears' is an SACT we are now looking for two things, the first is the 'animal' in the first conceptualization, and the second is the conceptualization that is dependent on 'fear'. The first problem is accounted for by the syntactic criteria associated with 'frighten' that are found in the verb-ACT dictionary. This leaves only one other item in the sentence that is unused, namely 'Nixon'. Therefore 'Nixon' is the action of the dependent conceptualization. The ACT is unknown so we use a 'do'. We now have

```
      I ⇔ fear
          ↑
  Nixon ⇔ do
```

But this is certainly incomplete since the association from 'fear' to 'harm' allows us to uncover the essence of this conceptualization. That is, there is a causal dependent with the ACT as 'harm' and the object as 'I'. We now have:

```
          I ⇔ fear
              ↑
      Nixon ⇔ do
              ⤊
  something ⇔ harm ← I
              p
```

Suppose that this sentence were 'I am afraid that Nixon will raise the draft call'. We would have:

```
          I ⇔ fear
              ↑
      Nixon ⇔ do
              ⤊
       army ⇔ draft ← men      (the 'more' is a shorthand for another
              ⤊        ↑         comparative conceptualization)
                      more
  something ⇔ harm ← me
```

Now we can make some guesses as to what the something is in the last conceptualization. These guesses might be made in an interviewing situation based on the interviewer's knowledge of the subject. If we know, for example, that the subject is 19 years old and draftable, then the last conceptualization might be:

```
  army
   ⇕ ⇔ harm ← I
  draft
   ↑
   I
```

Or, if the subject is a mother perhaps we might guess that the conceptualization is:

```
army
 ⇕  ⇔ harm ← I
draft
  ↑    of
 son ⇐ I
```

Or, if the subject is an anti-war type we might have:

```
U.S.
 ⇕  ⇔ harm ← I
war against
 ↑
someone
```

The point here is merely that in an interviewing program we are constantly concerned with what it is that we do not know but can ask about. Clearly, if we have a blank 'do' in our analysis, we can ask a question such as, 'what are you afraid that Nixon will do?'. It seems that the associations of which we have been talking are a definite part of the language understanding process, and to not deal with them in a conceptual dependency analysis would clearly be a mistake.

8.3. Have

We have had some problem in trying to account for the English verb 'have' or the notion of possession in our schema. It has become clear that this is the case because of the complexity of the notion of possession. Consider however, the sentence 'John gave Fred a book'. This is analyzed as:

```
                           R  ┌→ Fred
John ⇔ trans ← book  ←────┤
                              └← John
```

Clearly, 'Fred' now has the book. Thus, we can define 'have' as being the relation between the receiver of the Recipient case and the item in the objective case. This leaves open the actor in that conceptualization. We have come to think of the actor as being irrelevant, but often we do remember how we came to 'have' a certain 'object'. (It should be clear that this discussion relates only to alienable possession). Thus, 'I have a car' might be:

$$I \Leftrightarrow \text{trans} \leftarrow \text{money} \xleftarrow{R} \begin{cases} \rightarrow \text{car dealer} \\ \leftarrow I \end{cases}$$

$$\text{car dealer} \overset{}{\underset{t_F}{\Leftrightarrow}} \text{trans} \leftarrow \text{car} \xleftarrow{R} \begin{cases} \rightarrow I \\ \leftarrow \text{car dealer} \end{cases}$$

but we can content ourselves with not being too concerned with the origin of the possession (or transfer of possession) and thus the actual computer analysis is:

$$\text{someone} \overset{t_F}{\Leftrightarrow} \text{trans} \leftarrow \text{car} \xleftarrow{R} \begin{cases} \rightarrow I \\ \leftarrow \text{someone} \end{cases}$$

Paraphrases of this are 'I've been given a car' and 'I've gotten a car' and 'I've got a car', the last of which is a common variant of 'I have a car'.

8.4. Causation

It has come to our attention that the causal link ($\Uparrow$) is similar to the two-way dependency link in that it is capable of being modified. Actually its modification is limited to other causal links and time modification. Consider the sentence:

'Smoking causes cancer'

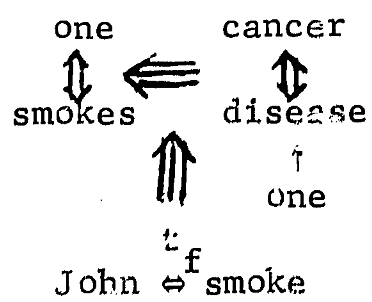
It would be possible to diagram this sentence without modifying the causal link as follows:

$$\begin{array}{c} \text{one} \Leftrightarrow \text{smokes} \\ \Uparrow \\ \text{cancer} \Leftrightarrow \text{diseases} \leftarrow \text{one} \end{array}$$

However, the sentence,

'Since smoking causes cancer, John stopped smoking'

is a comment on the causation. That is, it is the cause that has effected the new conceptualization. Therefore we can diagram this as follows:

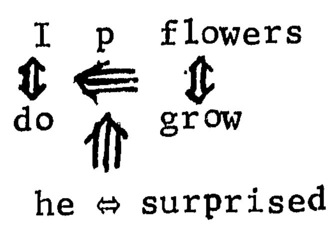


The time modification of the horizontal causal link would be 'tenseless' (denoted ^) in this case. That is, because the first connection is always true, the second happened.

Another example of this is given in the sentence:

'He was surprised that what I did caused the flowers to grow'.

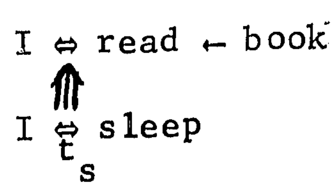
The diagram of this sentence must emphasize that 'he was surprised' because of the causation connection. Thus we have:



8.5. Some Funny Words

8.5.1. ZPA's

Consider the sentence 'The book lulled me to sleep'. In the framework that we have been using, 'books' are not permitted to be actors in a conceptualization that takes Objective case. From association criteria, we would expect that a good analysis of this sentence would be:



Now consider 'The book comforted me'. While it is easy to take 'comfort' as an ACT in the underlying conceptualization, we aver that this actually is not an ACT at all, but rather a special kind of PA. The first conceptualization in the C-diagram must be the same as in the one above, and thus to treat 'comfort' as an ACT would require an actor which is unknown. Short of writing 'inner spirits' or the like for the actor we choose to treat 'comfort' as what we will call a ZPA which can be the right half of a $\overset{s}{\Leftrightarrow}$ link. But in this case it is a 'mental sensing' so we use an 'm' on the two-way link. Thus we have:

$$\begin{array}{l} I \Leftrightarrow \text{read} \leftarrow \text{book} \\ \quad \Uparrow \\ I \underset{ms}{\Leftrightarrow} \text{comfortable} \\ \qquad t_F \end{array}$$

Similarly 'Racism disturbs me', would be diagrammed:

$$\begin{array}{l} \text{one} \Leftrightarrow \text{racist} \\ \qquad \Uparrow \\ \quad I \underset{ms}{\Leftrightarrow} t_F \text{ disturbed} \end{array}$$

A problem that occurs here is that these ZPA's still have to be written in their past participle form since we have no other way of representing them in English. In some instances this is not the case, for example:

'I enlarged the balloon'

$$\begin{array}{l} \quad I \Leftrightarrow \text{do} \\ \qquad \Uparrow \\ \text{balloon} \Leftrightarrow \text{big} \\ \qquad t_F \end{array}$$

Here we see that in terms of the relation between conceptual and syntactic categories, the opposite of what has been happening with abstract nouns and adjectives occurs. Previously, we had noted that the majority of abstract nouns in English were ACT's conceptually. Now we notice that many verbs are really PA's conceptually (we treat ZPA as an instance of PA).

As an example of the rewriting of abstracts and verbs that are ZPA's consider the following sentence:

'A new love is consolation for a broken hearted man'

$$\begin{array}{l} \quad\quad\quad t \\ \quad\quad\quad \Delta^{s} \\ \quad\quad \text{one} \Leftrightarrow \text{love} \leftarrow \text{man} \\ \quad\quad\quad \Uparrow \text{mp} \\ \quad\quad \text{man} \Leftrightarrow \text{consoled} \\ \text{ms} \ \swarrow\!\!\nearrow \\ \text{brokenheartead} \end{array}$$

8.5.2. Relative Adjectives

Some adjectives are really only true with respect to some person. 'Advantageous' for example implies 'advantageous to someone'. Similarly, 'disturbing' must also be 'disturbing to someone'. Therefore the re-writes of these adjectives must include a PP as an intrinsic part. Thus, 'Flying is advantageous' is graphed:

$$\begin{array}{l} \text{one} \Leftrightarrow \text{fly} \\ \quad\ \Uparrow \\ \text{one} \Leftrightarrow \text{advances} \end{array}$$

and 'Fighting is disturbing' is:

$$\begin{array}{l} \text{one}_1 \leftarrow \\ \quad\quad\quad \Rightarrow \text{fight} \\ \text{one}_2 \leftarrow \\ \quad\quad \Uparrow \\ \text{one} \Leftrightarrow \text{disturbed} \end{array}$$

It remains an open question at this point as to what the relation between IACT's and ZPA's is. We are inclined to believe that they are in fact the same and distinguished by their syntactic derivation. Clearly though, they represent a middle ground between regular PA's and regular ACT's.

9. New Approaches to Conceptual Dependency Analysis

by Larry Tesler

Conceptual dependency theory is continually amended to incorporate new insights into language. Presently, there are several areas of secondary importance in which there is indecision about what stand the theory should take. In this chapter will be presented possible changes in notation and classification, and some ideas new to the theory.

9.1. Types of Conceptualizations; Instruments; Stations

We have so far distinguished conceptualizations with and without an action. Those with an action may or may not take an object and possible instrument and may or may not take recipients or directions. Those without an action may have either a PP or a PA instead.

It may alternatively be considered that directions are the same as recipients, differing only in the frame of reference (see 9.8, Frameworks); directions are physical locations and recipients are social possessors. Furthermore, the instrumental case may be dispensable at the conceptual level; an instrument is itself an actor made to act by another actor. Finally, a conceptualization can be restricted to not have both an object (patient) and recipients (or directions): the motion of an object would be stated separately from the cause of its motion. (It is unclear, according to Schank, whether the simplifications resulting from an analysis of this kind, justify allowing inanimate objects to be actors with actions of other than the class of PACTs and IACTs.)

This position leads to an eight-way classification of conceptualizations: attributive, classificational, behavioral, motive, operative, *mutual*, *hypothetical*, and *causal*.

In an *attributive* conceptualization (graphed $PP \leftrightarrow PA$) something is observed to exist (*be*), to have certain attributes (*tall*), or be in a certain motionless state (*depressed*, *asleep*).

In a *classificational* conceptualization (graphed $PP \Longleftrightarrow PP$), something is identified as being the same as something else or an instance of some intensional class.

In a *behavioral* conceptualization (graphed $PP \Leftrightarrow ACT$) something is observed to be behaving in a way which does not involve a change of state, victim, goal, or direction, e.g. *rotate*, *dance*.

In a *motive* conceptualization (graphed $PP \Leftrightarrow ACT \leftarrow \left[\begin{array}{l} \to PP \\ \leftarrow PP \end{array}\right.$), something is observed to be in motion, or in transit, from one station to another. The apparent destination and apparent origin may be locations, possessors, or conceptualizations expressing mental state. In any case, they are called *stations*. The actor may move voluntarily or involuntarily; if it is known to be voluntary, a "V" is written on the main link.

In an *operative* conceptualization (graphed $PP \Leftrightarrow ACT \leftarrow PP$), something active does something to something passive. The actor may or may not act voluntarily. The patient may be doing a lot, but is not performing the specific action observed in the conceptualization.

In a *mutual* conceptualization (graphed $\begin{array}{l} PP \\ PP \end{array}\!\!\Big\} \!\Rightarrow ACT$), two or more actors interacting actively perform an action which could not be observed to be performed just by observing one of them. The ACT's are "YACTs", e.g. *fight*.

In a hypothetical conceptualization (graphed $\begin{array}{c} PP \Leftrightarrow ACT \\ \qquad\quad \uparrow \\ \qquad\quad CP \end{array}$), where CP means "conceptualized picture" and can be any type of conceptualization, same actor has an attitude towards an issue (hypothesis) stated in a second conceptualization. The attitude may be more or less voluntary and more or less vocal (<u>say</u>, <u>claim</u>, <u>know</u>, <u>fear</u>, <u>hear</u>).

In a <u>causal</u> conceptualization (graphed $\overset{CP}{\underset{CP}{\Uparrow}}$), the upper conceptualization is regarded as making the lower conceptualization happen. The causation may or may not be intentional; intent is indicated by a qualifier on the causal arrow (U = unintentional; unmarked = intentional).

These conceptualizations are suffcient to represent events which would otherwise require an object and a direction together or which would require an instrument. The sentence, 'I push the car to Cleveland', expresses two actions: 'I push the car' and 'The car goes to Cleveland' and connects them causally"

$$\begin{array}{l} \text{I} \overset{V}{\Leftrightarrow} \text{push} \leftarrow \text{car} \\ \quad \Uparrow \\ \text{car} \Leftrightarrow \text{go} \leftarrow \begin{cases} \rightarrow \text{Cleveland} \\ \leftarrow \end{cases} \end{array}$$

The sentence: 'I hit the boy with a stick' says that the stick, not I, actually made contact with the boy, but that the stick did not do it voluntarily, but because of something (what?) I did to it:

$$\begin{array}{l} \text{I} \overset{V}{\Leftrightarrow} \text{?} \leftarrow \text{stick} \\ \quad \Uparrow \\ \text{stick} \Leftrightarrow \text{hit} \leftarrow \text{boy} \end{array}$$

note: "?" is the same as "do" in section 8.

These two examples could be paraphrased: 'I push the car to make it go to Cleveland' and 'What I did to the stick made it hit the boy'.

By not caring whether the actor acts voluntarily or not, we are able to graph the motive act "come" with

$$PP_1 \Leftrightarrow \text{go} \leftarrow \begin{cases} \rightarrow \text{here} \\ \leftarrow PP_2 \end{cases}$$

whether PP_1 is a human or a gift.

Breaking down an event into its component actions can easily be carried too far. The event 'He drank some water' could be graphed as a causal string of actions including nerve impulses, tongue, lip, and throat motions, the motion of the water, etc. However, it is not necessary to know what each of these things did during the event. The utterance discusses only "he" and "water", and no other objects are implied or needed. Thus, 'I hit the boy' is graphed:

$$I \overset{V}{\Leftrightarrow} \text{hit} \leftarrow \text{boy}$$

when no instrument is mentioned. It is by use of a rule about voluntary operative conceptualizations that a question-answer system can ask whether the actor used any tools in the action.

Most transitive verbs do not correspond to ACTs in operative conceptualizations. "Hit" is one of the few common ACTs that does. Similarly, "go" is one of the few physical motive ACTs. The elementary conceptualization:

$$\begin{array}{c} I \Leftrightarrow \text{hit} \leftarrow \text{object} \\ \Uparrow \\ \text{object} \Leftrightarrow \text{go} \leftarrow\!\begin{smallmatrix}\rightarrow\\ \leftarrow\end{smallmatrix}_{I} \end{array}$$

is a basic heuristic used in dealing with the physical world. It involves a force (hit), a mass (object), and an acceleration, $(\text{go} \leftarrow\!\begin{smallmatrix}\rightarrow\\ \leftarrow\end{smallmatrix}_{I})$, and thus corresponds to the physical quantitative formula, $F = ma$. This is irrelevant but interesting.

This representation presently lacks indicators of linguistic focus ("conceptual subject") and theme.

9.2. Vehicles

Like instruments, vehicles may not be objects of an ACT. The vehicle in which motion is accomplished could be regarded as the <u>location</u> of the conceptualization.

'We drove from Boston to Salem.'

```
         car
         I↕S        ┌→Salem
     We ⇔ ride ←────┤
          V         └─Boston
```

note: I↕S means "inside"

Since the geographic location of the actor changes in a motive conceptualization, it can not be the conceptualization's location. Rather, the vehicle, which is constant, is the location.

9.3. Time

In an attempt to reduce the number of "prepositional" links and to aim for language-independence, the following arrows serve to indicate the time of a conceptualization by connecting it to an absolute-time concept or to another conceptualization:

B before   A after

U until   S since

D during

Simple tenses can use these links with the "absolute"-time concept <u>now</u>:

'I broke the bat.'

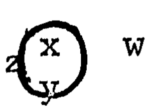
```
     now
      B
   I ⇔ ?
      ⇑
 bat ⇔ broken
```

There is a similarity between time links and the causal link which has not been explored extensively.

9.4. Location

In an attempt to obtain a language-free analysis of spatial relations, we have to be logical without departing from intuitive concepts. One proposal we have developed does not stretch the intuition inordinately (compared to, say, Cartesian coordinates). It is a topological scheme, and is presented here.

Every object is presumed to have an inside and an outside, separated by an edge. A location can be designated as being in the inside space (I-S) or outside space (O-S) of an object, or more particularly as being on the inside edge (I-E) or outside edge (O-E) of an object. These relations are represented by the arrows I↑S, O↑S, I↑E, and O↑E, in which the governor is a mainlink or a concept like <u>place</u>, and the dependent is an object (or some portion of an object which can be viewed as an object).



x	w	y	z
I↑S	O↑S	I↑E	O↑E
O	O	O	O

A portion of an object is specified by using a <u>localizing</u> link, written ⌒ . The portion-name is written below, and the object-name above. Thus "table top" is represented by:

table
⌒
top

We use "top" as a topological concept such that its outside is "above" it and its inside is "below" it. "Bottom", "left", "right", "front", and "back" are used in analogous ways. Thus, "above the table" and "on top of the table" are represented by:

O↑S	O↑E
table	table
⌒	⌒
top	top

To represent "near" and "far", we define a portion-name "nearspace" such that

$$\begin{array}{c} \text{object} \\ \frown \\ \text{nearspace} \end{array}$$

is a volume containing all points and only points that would be said to be "near" the object. Thus, 'near the boat' and 'far from the boat' are represented by:

$$\begin{array}{c} I\uparrow S \\ \text{boat} \\ \frown \\ \text{nearspace} \end{array} \qquad \begin{array}{c} O\uparrow S \\ \text{boat} \\ \frown \\ \text{nearspace} \end{array}$$

To represent "between" and "among", we define a portion-name "betweenspace" including points that are in the space enclosed by several objects, and a portion-name "amongspace" including points that are in the space dominated by several objects. Thus, 'between the table and the wall' and 'among the trees' are reprsented by:

$$\begin{array}{c} I\uparrow S \\ \text{table:wall} \\ \frown \\ \text{betweenspace} \end{array} \qquad \begin{array}{c} I\uparrow S \\ \text{tree} \\ \text{indef} \; \frown \\ \text{amongspace} \end{array}$$

note: "indef" means "an indefinite number"

To represent "along" and "around", we observe that "along" means "near the outside" of an elongated object, and "around" means "near the outside" of a convex object. Thus, 'along the river' and 'around the table' are graphed:

$$\begin{array}{c} I\uparrow E \\ \text{river} \\ \frown \\ \text{nearspace} \end{array} \qquad \begin{array}{c} I\uparrow E \\ \text{table} \\ \frown \\ \text{nearspace} \end{array}$$

9.5. Modifiers

Instead of "simple" (↑) and "prepositional" (⇑) below-the-line dependency, we could relegate many of their uses to locational links and localizing links (section 9.4), and distinguish three further kinds of dependency: *qualifying*, *extending*, and *associating*.

Qualifying dependents specify which of several members of an intensional class is/are meant by demonstration (*this*, *that*), ordination (*third* (3)), attribution (*big*), or relative subordination (*who*..., *that*..., which...). The ↑ arrow is used:

"this boy"

boy
↑
this

"third boy"

boy
↑
3

"big boy"

boy
↑
big

"the boy who saw me"

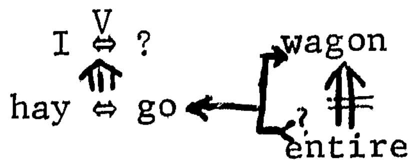
boy (α)
↑
α ⇔ see
↑
I ↔ be

In relative subordination, Greek letters are used for conceptual anaphora; in the last example, "α" is the boy.

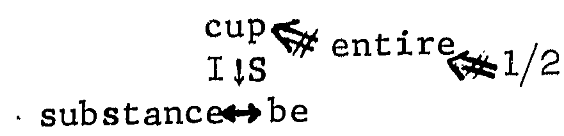
Extending dependents tell how much or how many of something is meant. The ⇞ arrow is used.

"two boys"	"many boys"	"half the boys"	"very hot"
boy ⇞ 2	boy ⇞ many	boy ⇞ all ⇞ 1/2	hot ⇞ very

'I loaded the wagon with hay.'

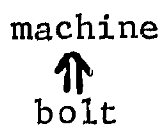


'The cup is half full.'



An associating dependent is related in some yet unspecified way to its governor. The ⇑ arrow is used.

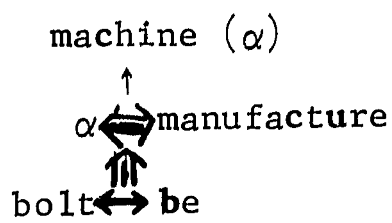
"bolt machine"



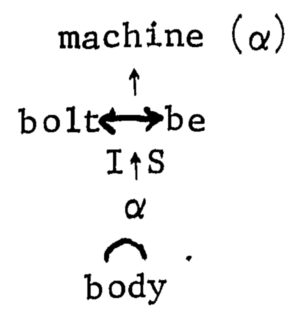
"sperm whale"

Such a relationship is not entirely understood. It would be rewritten when the relationship was better understood.

'machine that makes bolts'

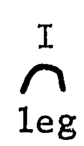


'machine made of bolts'



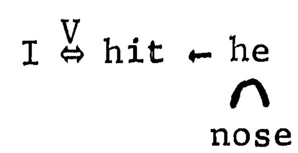
Localizing dependents (∩) may be used for other portions of objects than "top", "nearspace", and the like:

"my leg"



"end of the story"

'I hit him in the nose.'



9.6. Conjunction

A conjunction can connect conceptualizations or concepts. In the latter case, an unnamed concept is defined in terms of other concepts. Many cases of lexical conjunction of words do not serve this function and are graphed as conjunctions of conceptualizations.

cup

"cup-and-saucer" $\wedge$

saucer

'I broke a cup and a saucer.'

$$
\begin{array}{c}
I \overset{V}{\Leftrightarrow} ? \\
\Uparrow \\
\text{cup} \leftrightarrow \text{broken} \\
\wedge \\
\text{saucer} \leftrightarrow \text{broken}
\end{array}
$$

Conjunction ($\wedge$) and disjunction ($\vee$) are distinguished, and both of these types are subdivided according to whether the concepts are joined ($\wedge$,$\vee$), one is emphasized over the other ($\overset{\leftarrow}{\wedge}$,$\overset{\leftarrow}{\vee}$), or one is presented as a contrast to the other ($\overset{\nleftarrow}{\wedge}$,$\overset{\nleftarrow}{\vee}$).

$\wedge$ And, both-and

$\overset{\rightarrow}{\wedge}$ Moreover, also, with

$\overset{\nrightarrow}{\wedge}$ Yet, but, nevertheless

$\vee$ Or, either-or

$\overset{\leftarrow}{\vee}$ Rather than

$\overset{\nrightarrow}{\vee}$ Whether-or

9.7. Comparison

An alternative method of representing comparatives is inspired by Clark [2]. We recognize a dimension as a qualifier of an object (or other concept) and view such a qualifier as a mathematica object with length only (a line). To name the dimensions we use positive PA's: length, height, age, weight, intelligent, difficult. A dimension line x can be localized to its length using:

$\underset{\text{amount}}{\overset{x}{\frown}}$ for "absolute" length, $\underset{\text{inch}}{\overset{x}{\frown}}$ for length in some unit

This scalar can be compared with other scalars, or can be qualified as

<u>small</u>, <u>medium</u>, or <u>big</u>.

'The desk is 30 inches high.'

desk $\Leftrightarrow$ high
$\frown$
inch
$\#$
30

'The man is short.'

man $\leftrightarrow$ high
$\frown$
amount
$\uparrow$
small

'The desk is shorter than the man.'

desk $\leftrightarrow$ high
$\frown$
amount $<$ amount (α)
$\uparrow$
man $\leftrightarrow$ high
$\frown$
(α)

The comparison arrows are $<$, $>$, $\leq$, $\geq$, $=$, $\neq$, and (for approximation) $\approx$.

9.8. Frameworks

We use the same language to deal with both physical and mental phenomena. At times, the same verb can be used to denote a mental or a physical action:

to have a book; to have an idea
to change cars; to change plans
to hurt his hand; to hurt his feelings
to go to Chicago; to go to extremes

In some cases, mental usage of physically-defined concepts is idiomatic. However, such usage generally can be shown to be metaphorical in a systematic way. The psyche not only models the physical world; powers of the physical world are attributed to the psyche. Emotional states are considered analogous to locations; to change states your psyche "moves". Knowledge is possession of information rather than objects. Methods are like paths; plans like vehicles; senses like organs.

To account for such usage, we distinguish several frameworks in which phenomena can be conceptualized. Celce and Schwarz [1] argue well for the mental-physical distinction ('The book is witty' vs 'The book is torn'). We admit to additional frameworks--social and spiritual--and it seems likely that the human mind can devise arbitrary frames of reference to deal with concepts.

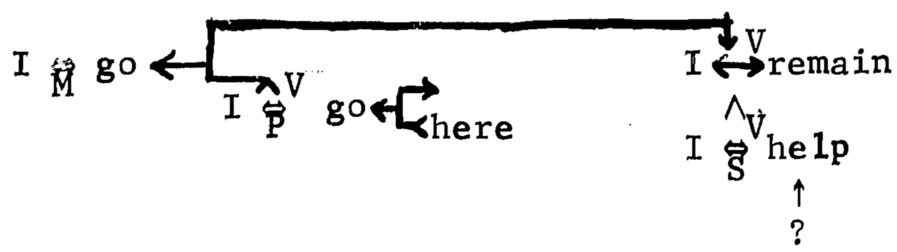
The social framework is used to discuss relationships which exist neither in the physical world nor in the psyche of a single individual, but rather by social agreement. Such concepts as ownership, commerce, and politics are conceptualized in this framework. The spiritual framework is used to discuss metaphysical problems, and its recognition refutes positivist arguments that metaphysical statements have no meaning.

The framework of a conceptualization is indicated by a mark under the two-way link:

P	physical
M	mental
S	social
W	spiritual

Where there is no mark, all frameworks are involved or it is unimportant or unclear.

Of particular interst is the use of frameworks in motive conceptualizations. 'The ball goes to the wall' is physical; 'My thoughts ran from leaving altogether to staying and helping' is mental:



"to be sold to" is social, and "to go to heaven" is spiritual. Go denotes a change of possession; first, the origin "has" the actor, then the destination does. Have is used in several frameworks in at least two senses:

	$Have_1$	$Have_2$
Physical	hold	incorporate
Mental	think	know
Social	own	include

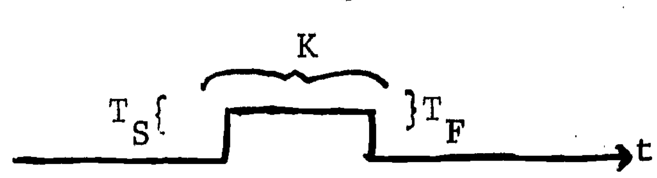
Of course, many concepts are used in only one or two frameworks.

Metaphor can be regarded as the process of defining a concept in one framework and then using it in another.

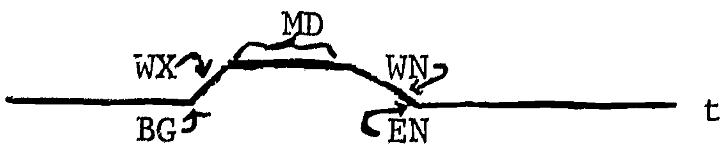
9.9. Transition

Transition is used mainly to indicate a phase of an action. When the entire action is of interest, no transition mark is used. Schank distinguishes T (transition), T_S (transition - start), T_F (transition - finish), and K (continuing [progressive]).

If an action is thought of as taking a certain amount of time, its occurrence can be diagrammed on a time line:



However, transition can be used also to indicate a phase of being in some state (relaxed), having some attribute (old), or having an attitude (fear). It is common in discourse to discuss more phases of these states than just T_s, K, and T_F. The diagram might look like this:



	BG	beginning (T_s)
	WX	waxing
	MD	midst (K)
	WN	waning
	EN	ending (T_F)
also	CH	changing (WX or WN)

Examples:

'I am getting sleepy.'

$$\begin{array}{l} I \overset{WX}{\Leftrightarrow} \text{want} \\ \;\;P \qquad \uparrow \\ \qquad I \leftrightarrow \text{asleep} \end{array}$$

'I am learning to drive.'

$$\begin{array}{l} I \underset{\nabla}{\Leftrightarrow} \text{operate} \leftarrow \text{car} \\ \quad \updownarrow WX \\ \quad\; \text{Possible} \end{array}$$

'San Jose is becoming less beautiful.'

$$SJ \xleftrightarrow{WN} \text{beautiful}$$

'Stop hitting me.'

$$\begin{array}{c} ! \\ \text{you} \overset{EN}{\underset{\nabla}{\Leftrightarrow}} \text{hit} \leftarrow I \end{array}$$

9.10. Remarks

The variety of possible representations for many conceptualizations may be disturbing because they seem ad hoc and almost arbitrary. However, where we lack an experimental foundation we can only enumerate the logical and intuitive possibilities. It is a credit to a method of representation if it can adapt readily to new outlooks. It it also true that language and thought provide multiple forms of expression and modes of processing information, and that a model should preserve that flexibility. It is only when one attempts to pin down a "deep structure" that it seems necessary to know the "right" choice of form. Lacking proof of a universal base for all languages, or even for all speakers of the same language, or even for all conceptualizations of the same speaker, for the time being we feel satisfied with a representation that points out conceptual relations in a discourse and removes the ambiguity of lexicalization.

10. End

This memo is intended to be a progress report to those that have been following our work. It there is anything to conclude from all this it is that to regard the basis of language as a process that is as 'conceptually pure' as possible, simplifies the linguistic problem.

It seems clear to us that there are probably a good many philosophical and psychological implications of the statements and work presented here. However we have no particular axe to grind in either field so we have done what seemed right without any predisposition as to how things should be. We leave our formulations to those that may like to deal with them (including perhaps ourselves).

APPENDIX I - The verb-ACT dictionary

The verb-ACT dictionary uses the following format: verbs are defined by a verb category followed by its conceptual realizate followed by the semantic categories denoting the syntactic selectional restrictions by which the appropriate sense of the verb is chosen; concepts have subscripts; ACT's are defined in the same manner as verbs using conceptual information.

We use the following words to denote the dependency links:

$\Leftrightarrow$ = MAIN
$\Uuparrow$ = CAUSAL
$\leftarrow$ = OBJ
$\xleftarrow{I}$ = OBJI
$\xleftarrow{R}$ = OBJR
$\xleftarrow{D}$ = OBJD
$\uparrow$ = QUAL
$\Uparrow$ = QUALPR
$\leftrightarrow$ = THAT
$\boldsymbol{\Leftrightarrow}$ = BE

```
(ACCEPT
      (S AGREE1 HUMAN)
      (T (X MAIN PERMIT1 OBJ (Z MAIN TRANS1 OBJ Y OBJR X Z)) HUMAN ANY HUMAN)
      (T (X MAIN AGREE1 OBJ (Y BE (B) ACCEPTABLE)) HUMAN HUMAN)
   )
(ACCOMPLISH
      (T DO1 HUMAN ANY)
   )
(ACHE
      (I (X MAIN PAINS1 OBJ (DEP X POSS)) BODYPART)
   )
(ADVISE
      (S ADVISE1 HUMAN)
      (T ADVISE1 HUMAN HUMAN)
   )
(AGGRAVATE
      (T ≠PA HUMAN HUMAN)
   )
(AGREE
      (S AGREE1 HUMAN)
      (I AGREE1 HUMAN)
   )
(ALLOW
      (T PERMIT1 HUMAN ANY)
      (S PERMIT1 HUMAN)
   )
(ANSWER
      (S ANSWER1 HUMAN)
      (T ANSWER1 HUMAN HUMAN)
      (T ANSWER2 HUMAN (PHONE1 TELEPHONE1))
      (T (X MAIN DO1 CAUSAL (Y BE (B) FULFILLED1)) HUMAN ANY)
      (T (ONE1 MAIN TRANS1 OBJ X OBJR (DEP Y POSS) ONE1) ANY ANY)
   )
(ARRIVE
      (IO ARRIVE1 HUMAN)
      (IO (ONE1 MAIN TRANS1 OBJ X) PHYSOBJ)
   )
(ASK
      (T ASK1 HUMAN HUMAN)
      (S ASK1 HUMAN)
      (I ASK1 HUMAN)
      (T ASK1 HUMAN QUESTION1)
   )
(ATTACK
      (T ATTACK1 HUMAN ANY)
   )
(ATTEMPT
      (S TRY1 HUMAN)
   )
(BEAT
      (T BEAT1 HUMAN ANIMAL)
      (T DRUM1 HUMAN DRUM2)
```

```
        (T (X COMP Y BE (B) VICTORIOUS1) (HUMAN HUMINST) (HUMAN HUMINST))
      )
    (BEGIN
        (TS)
      )
    (BELIEVE
        (S BELIEVE1 HUMAN)
        (T (X MAIN BELIEVE OBJ (SOMETHING1 THAT (Y MAIN SAY1) BE (B) TRUE1)) HU
      )
    (BITE
        (T BITE1 ANIMAL (FOOD ANIMAL))
      )
    (BREAK
        (I BREAK1 PHYSOBJ)
        (P BREAK1 ANIMAL PHYSOBJ (I= (WEAPON BODYPART)))
      )
    (BRING
        (X TRANS1 HUMAN HUMAN PHYSOBJ (I=VEHICLE))
        (T (X MAIN DO CAUSAL Y) ANY ANY)
      )
    (BUY
        (X BUY1 HUMAN HUMAN PHYSOBJ)
      )
    (CALL
        (X CALL1 HUMAN PHYSOBJ NAME)
        (X (X MAIN SAY1 OBJ (Y BE (B) Z)) HUMAN HUMAN (HUMAN PA))
        (T (X MAIN ASK1 OBJ (Y MAIN GO1 OBJD HERE1)) HUMAN ANIMAL)
      )
    (CARE-FOR
        (T CARE-FOR1 HUMAN (CHILD ANIMAL PLANT))
        (T LIKE1 HUMAN HUMAN)
        (T (X MAIN LIKE2 OBJ (X MAIN Y)) HUMAN CON)
        (T (X MAIN LIKE2 OBJ (X MAIN DO1 OBJ Y)) HUMAN PHYSOBJ)
      )
    (CAUSE
        (T (X MAIN DO1 CAUSAL Y) HUMAN CON)
        (S (X MAIN DO1 CAUSAL (Y MAIN Z)) HUMAN ANY ANY)
        (T (X MAIN DO1 CAUSAL (Y MAIN Z)) HUMAN HUMAN ANY)
      )
    (CHANGE
        (I (X MAIN DO1 CAUSAL (X MAIN CHANGE1)) HUMAN)
        (T EXCHANGE1 HUMAN PHYSOBJ)
        (T (X MAIN CHANGE1 OBJ (X BE (B) Y)) HUMAN (CON QUALPR X))
        (P CHANGE1 HUMAN HUMAN)
        (P CHANGE1 HUMAN PHYSOBJ)
      )
    (CLOSE
        (I CLOSE1 PHYSOBJ)
        (P CLOSE1 HUMAN PHYSOBJ)
        (T (X MAIN DO1 CAUSAL (Y MAIN END1)) HUMAN CON)
      )
    (COME
```

```
        (IO (X MAIN GO1 OBJD HERE1) HUMAN)
        (IO (ONE1 MAIN TRANS1 OBJ X) PHYSOBJ)
        (I COME1 HUMAN)
    )
   (COMFORT
        (T ≠PA HUMAN HUMAN)
    )
   (COMMUNICATE
        (Y COMMUNICATE1 HUMAN HUMAN)
        (T SAY1 HUMAN SPEECH)
    )
   (CONFUSE
        (T ≠PA HUMAN HUMAN)
        (T ≠PA HUMAN CON)
    )
   (CONSOLE
        (T ≠PA HUMAN HUMAN)
    )
   (CRY
        (I CRY1 HUMAN)
    )
   (CUT
        (T CUT1 HUMAN PHYSOBJ)
        (T (X MAIN (N) GO1 OBJD Y) HUMAN (CLASS1 SCHOOL1))
        (T ELIMINATE1 HUMAN (CON NAME))
    )
   (DECIDE
        (S DECIDE1 HUMAN)
        (I DECIDE HUMAN)
    )
   (DESCRIBE
        (T DESCRIBE1 HUMAN ANY)
        (S DESCRIBE1 HUMAN)
        (T (ONE MAIN DESCRIBE1 OBJ Y OBJI X) (BOOK1 STORY1 PICTURE1) ANY)
    )
   (DESIRE
        (T WANT1 HUMAN ANY)
        (S WANT1 HUMAN)
    )
   (DESTROY
        (T (X MAIN DO1 CAUSAL (Y MAIN DIE1)) HUMAN ANIMALS)
        (T (X MAIN DO1 CAUSAL (Y BE (S) USELESS)) HUM HUMAN)
        (T (X MAIN DO1 CAUSAL (Y MAIN (N) BE1)) HUMAN ANY)
    )
   (DIE
        (I DIE1 ANIMAL)
    )
   (DISTURB
        (T ≠PA HUMAN HUMAN)
        (T (Y MAIN DO1 OBJ X CAUSAL (Y BE (B) DISTURBED1)) PHYSOBJ HUMAN)
        (T (X CAUSAL (Y BE (B) DISTURBED1)) ANY HUMAN)
    )
```

```
(DIVORCE
     (Y DIVORCE1 HUMAN HUMAN)
   )
(DOUBT
     (S (X MAIN (N) BELIEVE) HUMAN)
     (T (X MAIN (N) BELIEVE OBJ (SOMETHING1 THAT (Y MAIN SAY1) BE (B) TRUE1)) HU
   )
(DREAM
     (S DREAM1 HUMAN)
   )
(DRINK
     (T DRINK1 HUMAN BEVERAGE)
     (I DRINK2 HUMAN)
   )
(EMPLOY
     (T (X MAIN EMPLOY1 OBJ (Y MAIN DO1)) (HUMAN HUMINST) HUMAN)
   )
(END
     (P END1 HUMAN ANY)
     (I END1 ANY)
   )
(ENJOY
     (T (X MAIN ENJOY1 OBJ (X MAIN DO1 OBJ Y)) HUMAN ANY)
     (S ENJOY1 HUMAN)
   )
(EAT
     (T EAT1 ANIMAL FOOD)
     (I EAT1 ANIMAL)
   )
(EXPECT
     (S EXPECT1 HUMAN)
     (T (X MAIN EXPECT1 OBJ (Y MAIN (F) GO1 OBJD HERE1)) VEHICLE HUMAN)
     (T (X MAIN EXPECT1 OBJ Y) HUMAN ANY)
     (T (X MAIN EXPECT1 OBJ (ONE1 MAIN (F) TRANS1 OBJ Y OBJR X ONE1)) HUMAN PHYSO
   )
(FEAR
     (S FEAR1 HUMAN)
     (T (X MAIN FEAR1 OBJ (Y MAIN (F) DO1 CAUSAL (Y BE (B) HURT))) HUMAN ANY)
   )
(FEEL
     (S THINK1 HUMAN)
     (T FEEL1 HUMAN PHYSOBJ)
     (I (X BE (S) Y (PA)) HUMAN)
   )
(FIGHT
     (Y FIGHT1 ANIMAL ANIMAL)
     (T FIGHT2 HUMAN HUMINST)
   )
(FIND
     (S FIND1 (HUMINST ANIMAL))
     (T (X MAIN FIND1 OBJ (Y MAIN (QUALPR Z) BE1)) ANIMAL ANIMAL)
   )
```

```
(FLY
        (I FLY1 (BIRD PLANE INSECT))
        (P FLY1 HUMAN PLANE)
        (IO (GO1 OBJI PLANE1) ANIMAL)
    )
(FORGIVE
        (S FORGIVE1 HUMAN)
        (T FORGIVE1 HUMAN HUMAN)
    )
(GET
        (T (ONE1 MAIN TRANS1 OBJ Y OBJR X ONE1) HUMAN PHYSOBJ)
        (I T PHYSOBJ PA)
        (T (ONE1 MAIN DO1 OBJ X) HUMAN ANY)
    )
(GIVE
        (X TRANS1 HUMAN PHYSOBJ PHYSOBJ)
        (X (X MAIN DO1 CAUSAL (Y MAIN HAVE2 OBJ Z)) HUMAN HUMAN ANY)
    )
(GO
        (IO GO1 ANIMAL (I=VEHICLE))
    )
(GROW
        (I GROW1 (ANIMAL PLANT))
        (P GROW1 HUMAN PLANT (I=AGRIC))
        (T (Y MAIN (QUALPR X) GROW1) BODYPART ANIMAL)
    )
(GUESS
        (S GUESS1 HUMAN)
        (T (X MAIN GUESS1 OBJ (Y BE (B) SOMETHING)) HUMAN ANY)
    )
(HAVE
        (T (ONE1 MAIN TRANS1 OBJ Y OBJR X ONE1) HUMAN PHYSOBJ)
        (T HAVE2 ANIMAL DISEASE)
        (T (X MAIN Y) HUMAN ANY)
        (T (X BE (S) Y) HUMAN ANY)
    )
(HATE
        (T HATE1 HUMAN PHYSOBJ)
        (S HATE2 HUMAN)
    )
(HELP
        (T HELP1 HUMAN ANIMAL)
        (S HELP1 HUMAN)
    )
(HOPE
        (S HOPE1 HUMAN)
    )
(HIT
        (T HIT1 HUMAN HUMAN)
        (T HIT2 ANIMAL ANIMAL)
        (T HIT3 HUMAN PHYSOBJ)
    )
```

```
(HURT
      (P HURT1 ANIMAL ANIMAL)
      (I HURT1 ANIMAL)
      (P UPSET1 HUMAN (HUMAN FEELINGS1))
   )
(HOPE
      (S HOPE1 HUMAN)
   )
(IMAGINE
      (S IMAGINE1 HUMAN)
   )
(INSULT
      (T (X MAIN SAY1 OBJ SOMETHING1 OBJR Y X CAUSAL (Y BE (S) INSULTED1)) HUMAN
      (T (X MAIN SAY1 OBJ (Y BE (B) SOMETHING1) (THAT BAD1) OBJR ONE1 X) HUMAN HU
   )
(INTEND
      (S INTEND1 HUMAN)
   )
(INTEREST
      (T (Y MAIN INTEREST-IN1 OBJ X) ANY HUMAN)
      (T (Y MAIN INTEREST-IN2 OBJ X) HUMAN HUMAN)
   )
(KILL
      (T (X MAIN DO1 CAUSAL (Y MAIN DIE1)) ANIMAL ANIMAL)
      (T (ONE1 MAIN DO1 OBJI X CAUSAL (Y MAIN DIE1)) WEAPON ANIMAL)
      (T (X MAIN BE1 CAUSAL (Y MAIN DIE1)) ANY ANIMAL)
   )
(KISS
      (Y KISS1 HUMAN HUMAN)
      (T KISS1 HUMAN PHYSOBJ)
   )
(KNOW
      (T UNDERSTAND2 HUMAN HUMAN)
      (S KNOW1 HUMAN)
      (T KNOW2 HUMAN HUMAN)
      (T UNDERSTAND3 HUMAN (PHYSOBJ ACADSUBJ))
   )
(LAUGH
      (I LAUGH1 HUMAN)
   )
(LET
      (S PERMIT1 HUMAN)
      (T RENT1 HUMAN HOUSETERM)
   )
(LICK
      (T LICK1 ANIMAL BODYPART)
      (T BEAT-UP1 ANIMAL ANIMAL)
   )
(LIE
      (S (X MAIN SAY1 OBJ (CON THAT BE (B) FALSE1)) HUMAN)
      (I (X MAIN SAY1 OBJ (CON THAT BE (B) FALSE1)) HUMAN)
      (I LIE-DOWN1 HUMAN)
```

```
    (I BE2 PHYSOBJ)
  )
(LEAVE
    (T (X MAIN GO1 OBJD SOMEPLACE1 Y) (HUMAN VEHICLE) LOC)
    (T SEPARATE-FROM1 HUMAN (HUMAN HUMINST))
    (T ((X MAIN GO1 OBJD SOMEPLACE) AND (ONE1 MAIN (N) TRANS1 OBJ Y OBJR ONE2)) H
  )
(LEARN
    (S LEARN1 HUMAN)
    (T STUDY1 HUMAN ACADSUBJ)
  )
(LEARN-TO
    (T (X MAIN (T) ABLE1 OBJ Y) HUMAN ANY)
  )
(LIKE
    (T LIKE1 HUMAN HUMAN)
    (T (X MAIN LIKE2 OBJ (X MAIN Y)) HUMAN CON)
    (T (X MAIN LIKE2 OBJ (X MAIN DO1 OBJ Y)) HUMAN PHYSOBJ)
    (T (X MAIN ENJOY1 OBJ (Y MAIN BE1)) HUMAN (HUMINST ANIMAL))
  )
(LISTEN-TO
    (T HEAR1 HUMAN PHYSOBJ)
  )
(LIVE
    (I LIVE1 (ANIMAL PLANT))
  )
(LOOK
    (I (X MAIN APPEAR1 OBJ (X BE (B) Y)) HUMAN)
  )
(LOOK-AT
    (T SEE1 (INTENTIONALLY) HUMAN PHYSOBJ)
  )
(LOVE
    (T LOVE1 HUMAN HUMAN)
    (T (X MAIN LOVE2 OBJ (ONE1 MAIN TRANS1 Y OBJR X)) HUMAN PHYSOBJ)
    (T (X MAIN LOVE2 OBJ (Y MAIN BE1)) HUMAN ANY)
  )
(MAKE
    (T CREATE1 HUMAN PHYSOBJ)
    (T SCREW1 HUMAN HUMAN)
    (T EARN1 HUMAN MONEY1)
    (S (X MAIN DO1 CAUSAL (Y MAIN Z)) HUMAN HUMAN CON)
  )
(MARRY
    (Y MARRY1 HUMAN HUMAN)
    (P MARRY1 HUMAN (HUMAN AND HUMAN))
  )
(MOVE
    (IO (RESIDENCE1 (QUALPR X) MAIN (T) Y) HUMAN LOC)
    (P MOVE1 HUMAN PHYSOBJ)
    (ZPA HUMAN HUMAN)
    (T (X CAUSAL (Y MAIN MOVED2)) ANY HUMAN)
```

```
 )
NEED
    (S NEED1 HUMAN)
    (T (X MAIN NEED1 OBJ (ONE1 MAIN TRANS1 OBJ Y OBJR X ONE1)) HUMAN PHYSOBJ)
    (T (X MAIN NEED1 OBJ (ONE1 MAIN DO1 OBJ X)) HUMAN CON)
    (T (SPEAKER1 MAIN WANT1 OBJ (ONE1 MAIN DO1 OBJ X)) PHYSOBJ CON)
    (T (SPEAKER1 MAIN WANT1 OBJ (ONE1 MAIN TRANS1 OBJ Y OBJR X ONE1)) PHYSOBJ PHYS
 )
OBJECT
    (S (X MAIN (N) WANT1) HUMAN)
 )
OFFER
    (X (X MAIN OFFER1 OBJ (X MAIN TRANS1 OBJ Z OBJR Y X)) HUMAN HUMAN PHYSOBJ)
    (S OFFER1 HUMAN)
 )
OPEN
    (P OPEN1 HUMAN PHYSOBJ)
    (I OPEN1 PHYSOBJ)
    (I (X MAIN (TS) DO1) HUMINST)
 )
OWN
    (T (X MAIN TRANS1 OBJ MONEY1 OBJR ONE1 X CAUSAL (ONE1 MAIN TRANS1 OBJ Y OBJR X
 )
PLAN
    (S PLAN1 HUMAN)
    (T ORGANIZE1 HUMAN CON)
 )
(PLEASE
    (T ZPA HUMAN HUMAN)
    (T (Y MAIN DO1 OBJ X CAUSAL (Y BE (S) PLEASED1)) PHYSOBJ HUMAN)
 )
(PRAY
    (S (X MAIN SAY1 OBJ SOMETHING1 OBJR GOD1 X) HUMAN)
 )
(PRAY-FOR
    (T (X MAIN SAY1 OBJ (X MAIN WANT1 OBJ (GOD1 MAIN HELP1 OBJ (Y BE (B) SATISFIED

N)
    (T (X MAIN SAY1 OBJ (X MAIN WANT1 OBJ (Y MAIN BE1)) OBJR GOD1 X) HUMAN CON)
 )
(PUNISH
    (T (X MAIN DO1 OBJ Y CAUSAL (Y BE (S) PUNISHED1)) HUMAN HUMAN)
 )
(REGRET
    (S REGRET1 HUMAN)
    (T REGRET1 HUMAN CON)
 )
(REMAIN
    (IO (X MAIN (N) GO1 OBJD SOMEPLACE1 Y) HUMAN LOC)
    (I (X BE (B K) Y (PA)) HUMAN)
 )
(REMIND
```

```
      (T (X MAIN SAY1 OBJ (Y MAIN REMEMBER1 OBJ Z) OBJR Y X) HUMAN HUMAN)
      (T (Y MAIN DO1 OBJ X CAUSAL (Y MAIN REMEMBER1 OBJ Z)) PHYSOBJ HUMAN)
   )
(REMEMBER
      (S REMEMBER1 HUMAN)
      (T (X MAIN REMEMBER1 OBJ (X MAIN KNOW2 OBJ Y)) HUMAN HUMAN)
   )
(REWARD
      (T ZPA HUMAN ANIMAL)
   )
(SAY
      (S SAY1 HUMAN)
      (T SAY1 HUMAN ANY)
   )
(SEE
      (I UNDERSTAND1 HUMAN)
      (T (X MAIN PERCEIVE1 OBJ Y OBJI EYES1 (QUALPR X)) HUMAN ANY)
   )
(SHOOT
      (T (X MAIN SHOOT-AT1 OBJ BULLETS1 OBJI GUN1 OBJR Y GUN1) HUMAN ANIMAL)
   )
(SHOW
      (X (X MAIN SHOW-TO1 OBJ Z OBJR Y) HUMAN HUMAN PHYSOBJ)
      (X (X MAIN DEMONSTRATE1 OBJ (ONE1 MAIN DO1)) HUMAN HUMAN ANY)
   )
(SIT
      (I SIT1 ANIMAL)
   )
(SPEAK
      (I SAY1 HUMAN)
   )
(SPEAK-TO
      (T (X MAIN SAY1 OBJ CON OBJR Y X) HUMAN HUMAN)
   )
(STAND
      (I STAND1 ANIMAL)
   )
(START
      (I (X MAIN (TS) DO1) MACHINE)
      (I (X MAIN (TS) DO1) HUMINST)
      (P (X MAIN DO1 CAUSAL (Y MAIN (TS) DO1)) HUMAN MACHINE)
      (T (X MAIN (TS) ATTEND1 OBJ Y) HUMAN HUMINST)
   )
(STAY
      (I REMAIN1 ANIMAL)
   )
(STUDY
      (T (X MAIN PERCEIVE1 (QUAL CAREFUL1) (QUAL INTENTIONAL1) OBJ Y OBJI EYES1)
      (T STUDY1 HUMAN (ACADSUBJ PHYSOBJ))
   )
(SUSPECT
      (S BELIEVE1 HUMAN)
```

```
     (T (X MAIN BELIEVE1 OBJ (Y MAIN DO1)) HUMAN HUMAN)
   )
(TAKE
     (X (X MAIN TRANS1 OBJ Z OBJR Y X) HUMAN HUMAN PHYSOBJ)
     (T (X MAIN TRANS1 OBJ Y OBJR X Z) HUMAN PHYSOBJ HUMAN)
     (T INGEST1 HUMAN MEDICATION)
   )
(TALK
     (IO SAY1 HUMAN)
     (Y COMMUNICATE1 HUMAN HUMAN)
   )
(TELL
     (T (X MAIN SAY1 OBJ SOMETHING1 OBJR Y X) HUMAN HUMAN)
     (S UNDERSTAND1 HUMAN)
   )
(THINK
     (S BELIEVE1 HUMAN)
     (I (X MAIN SAY1 OBJ SOMETHING1 OBJR X X) HUMAN)
   )
(TROUBLE
     (T ZPA HUMAN HUMAN)
     (T ZPA CON HUMAN)
     (I (CON CAUSAL (X MAIN TROUBLED1)) HUMAN)
   )
(TRY
     (S TRY1 HUMAN)
   )
(UNDERSTAND
     (S UNDERSTAND1 HUMAN)
     (T UNDERSTAND2 HUMAN HUMAN)
     (T UNDERSTAND3 HUMAN (PHYSOBJ ACADSUBJ))
     (I SYMPATHIZE-WITH1 HUMAN)
   )
(USE
     (T (X MAIN DO1 OBJI Y) HUMAN PHYSOBJ)
     (T (X (AND Y) MAIN DO1 CAUSAL (X MAIN PROFIT1)) HUMAN HUMAN)
   )
(WANT
     (S WANT1 HUMAN)
     (T NEED1 HUMAN HUMAN)
     (T (X MAIN WANT1 OBJ (ONE1 MAIN TRANS1 OBJ Y OBJR X ONE1)) HUMAN PHYSOBJ)
   )
(WALK
     (IO (X MAIN GO1 OBJI FOOT1) HUMAN)
     (T (X (AND Y) MAIN GO1 OBJI FOOT1) HUMAN ANIMAL)
   )
(WAIT
     (I WAIT1 HUMAN)
   )
(WAIT-FOR
     (T (X MAIN WAIT1 AND (X MAIN EXPECT1 OBJ (Y MAIN GO1 OBJD PLACE1 (QUALPR X))
     (T (X MAIN EXPECT1 OBJ (ONE1 MAIN TRANS1 OBJ Y OBJR X ONE1)) HUMAN PHYSOBJ)
```

```
        )
    (WATCH
        (T (X MAIN INTEND1 OBJ (X MAIN SEE1 OBJ Y)) HUMAN ANY)
        )
    (WISH
        (S HOPE1 HUMAN)
        )
    (WORK
        (I WORK1 HUMAN)
        )
    (WORK-AT
        (T (ONE1 MAIN EMPLOY1 OBJ X OBJI Y) HUMAN ANY)
        (T (Y MAIN EMPLOY1 OBJ X) HUMAN HUMINST)
        )
    (WORK-FOR
        (T (Y MAIN EMPLOY1 OBJ X) HUMAN HUMINST)
        )
    (WORRY
        (S FEAR1 HUMAN)
        (T ZPA CON HUMAN)
        )
```

```
(ADVISE1 S HUMAN)
(AGREE1 S HUMAN)
(ANSWER1 C HUMAN CON CON HUMAN)
(ANSWER2 P HUMAN PHYSOBJ BODYPART)
(ARRIVE1 R HUMAN (VEHICLE CON) LOC)
(ASK1 C HUMAN CON CON HUMAN)
(ATTACK1 P HUMAN ANY (WEAPON CON ARMY1))
(ATTEND1 D HUMAN VEHICLE HUMINST)
(BE1 I PHYSOBJ)
(BEAT1 P HUMAN ANIMAL WEAPON)
(BEAT-UP1 P HUMAN HUMAN WEAPON)
(BELIEVE1 S HUMAN)
(BITE1 P ANIMAL (FOOD ANIMAL) TEETH1)
(BREAK1 I PHYSOBJ)
(BUY1 T HUMAN PHYSOBJ MONEY1 HUMAN (HUMAN HUMINST))
(CALL1 C HUMAN NAME SPEECH HUMAN HUMAN)
(CARE-FOR1 P HUMAN (CHILD ANIMAL PLANT) CON)
(CHANGE1 I PHYSOBJ)
(CLOSE1 I PHYSOBJ)
(COME1 I HUMAN)
(COMMUNICATE1 C HUMAN CON SPEECH HUMAN)
(CREATE1 P HUMAN PHYSOBJ (HANDS1 MACHINE))
(CRY1 I HUMAN)
(CUT1 P HUMAN PHYSOBJ KNIFE1)
(DECIDE1 S HUMAN)
(DEMONSTRATE1 S HUMAN)
(DESCRIBE1 C HUMAN ANY (SPEECH PICTURE1) HUMAN)
(DIE1 I ANIMAL)
(DIVORCE1 P HUMAN HUMAN (STATE1 MAIN DECREE1))
(DREAM1 S HUMAN)
(DRINK1 P HUMAN BEVERAGE MOUTH1)
(DRINK2 P HUMAN LIQUOR1 MOUTH1)
(EARN1 S HUMAN)
(EMPLOY1 S (HUMINST HUMAN))
(END1 I ANY)
(ENJOY1 I HUMAN)
(EAT1 P ANIMAL FOOD MOUTH1)
(EXPECT1 S HUMAN)
(FEAR1 S HUMAN)
(FEEL1 P HUMAN PHYSOBJ BODYPART)
(FIGHT1 P ANIMAL ANIMAL WEAPON)
(FIGHT2 P HUMAN HUMINST CON)
(FIND1 S (ANIMAL HUMINST))
(FLY1 R (BIRD PLANE INSECT) WING1)
(FORGIVE1 S HUMAN)
(GO1 R ANIMAL VEHICLE)
(GROW1 I (ANIMAL PLANT))
(GUESS1 S HUMAN)
(HATE1 E HUMAN PHYSOBJ)
(HATE2 S HUMAN)
(HELP1 S HUMAN)
```

```
(HOPE1 S HUMAN)
(HIT1 P HUMAN HUMAN WEAPON)
(HIT2 P ANIMAL ANIMAL (BODYPART VEHICHLE))
(HIT3 T HUMAN PHYSOBJ (BODYPART WEAPON) PHYSOBJ)
(HURT1 I ANIMAL)
(HOPE1 S HUMAN)
(IMAGINE1 S HUMAN)
(INGEST1 P HUMAN (FOOD MEDICATION DRINK) ANY)
(INTEND1 S HUMAN)
(INTEREST-IN1 S HUMAN)
(INTEREST-IN2 E HUMAN HUMAN)
(KISS1 P HUMAN PHYSOBJ LIPS1)
(KNOW1 S HUMAN)
(KNOW2 E HUMAN HUMAN)
(LAUGH1 I HUMAN)
(LICK1 P ANIMAL (FOOD BODYPART) TONGUE1)
(LIE-DOWN1 I HUMAN)
(LIKE1 E HUMAN HUMAN)
(LIKE2 S HUMAN)
(LOVE1 E HUMAN HUMAN)
(LOVE2 S HUMAN)
(MARRY1 E HUMAN HUMAN)
(NEED1 S HUMAN)
(MOVE1 D PHYSOBJ)
(OFFER1 S HUMAN)
(OPEN1 I PHYSOBJ)
(PAINS1 E BODYPART ANIMAL)
(PERCEIVE1 C HUMAN (SOUND SIGHT) BODYPART HUMAN)
(PERMIT1 S HUMAN)
(PLAN1 S HUMAN)
(REGRET1 S HUMAN)
(REMEMBER1 S HUMAN)
(SAY1 C HUMAN CON (SOUNDAIDER MOUTH1) HUMAN)
(SCREW1 E HUMAN HUMAN)
(SHOOT-AT1 T HUMAN IMPL-DES ARMS HUMAN ARMS)
(SHOW-TO1 T HUMAN PHYSOBJ ANY HUMAN)
(SIT1 I ANIMAL)
(STAND1 I ANIMAL)
(STUDY1 C HUMAN (PHYSOBJ ACADSUBJ) EYES1 (BOOK1 CON) HUMAN)
(SYMPATHIZE-WITH1 E HUMAN HUMAN)
(TRY1 S HUMAN)
(UNDERSTAND1 S HUMAN)
(UNDERSTAND2 E HUMAN HUMAN)
(UNDERSTAND3 F HUMAN (PHYSOBJ ACADSUBJ))
(WAIT1 I HUMAN)
(WORK1 I HUMAN)
```

APPENDIX II - Output of Spinoza I

A sample of the output of Spinoza I is listed here. We were always just testing this version of the parser so we operated with a very small vocabulary. The form of the output is in two parts. The first part is a list of dependencies úsing the notation shown in Appendix I. The second part consists of nested ACTOR-ACTION-OBJECT lists that are intended to look more like the conceptual networks.

SENTENCE:
*HE HAS EATEN A FLY.

NETWORK:

```
(Ø G0094 (WD3 EAT1 :ACT VT (TEN . PT:PAR)) OBJ (WD5 FLY2 :PP CN) Ø)
(Ø G0092 (WD1 HE1 :PP PRON) MAIN (WD3 EAT1 :ACT VT (TEN . PT:PAR)) Ø
(TEN : :F))
ACTOR: HE1
ACTION: EAT1
OBJ: FLY2
ASPECTS: :F
```

$HE \overset{t_F}{\Longleftrightarrow} EAT \leftarrow FLY$

SENTENCE:
*I HIT THE GIRL IN THE PARK.

NETWORK:

```
(Ø G0107 (WD4 GIRL1 :PP CN) QUALPR (WD7 PARK1 :PP PPLOC) Ø (CONT . IN
))
(Ø G0104 (WD2 HIT1 :ACT VT) OBJ (WD4 GIRL1 :PP CN) Ø)
(Ø G0101 (WD1 I1 :PP PRON) MAIN (WD2 HIT1 :ACT VT) Ø)
ACTOR: I1
ACTION: HIT1
OBJ: GIRL1 ((CONT . IN) PARK1)
ASPECTS:
```

I ⟺ HIT ← GIRL
⇑ IN
PARK

SENTENCE:
*WE LIKE TO WRITE.

NETWORK:

```
(Ø G0113 (WD1 WE1 :PP PRON) MAIN (WD4 WRITE1 :ACT VT) Ø)
(Ø G0114 (WD2 LIKE1 :ACT VS) OBJCON (G0113 CZN1 :PP N) Ø)
(Ø G0111 (WD1 WE1 :PP PRON) MAIN (WD2 LIKE1 :ACT VS) Ø)
ACTOR: WE1
ACTION: LIKE:
OBJCON: ACTOR: HE1
        ATTRIBUTE: WRITE1
        ASPECTS:

ASPECTS:
```

WE ⟺ LIKE
↑
WE ⟺ WRITE

SENTENCE:
*THE FRUIT MAY BE EATEN IN THE PARK.

NETWORK:

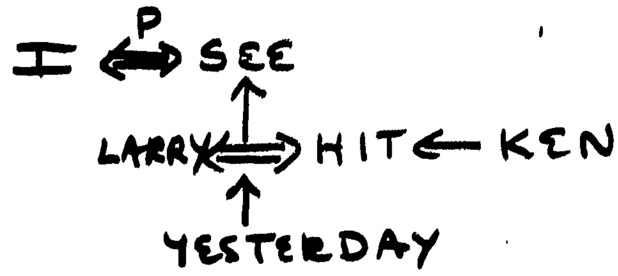
```
(Ø G0132 (G0126 CZN1 :PP N) QUALPR (WD8 PARK1 :PP PPLOC) Ø (CONT . IN
))
(Ø G0127 (WD5 EAT1 :ACT VT (TEN . PT:PAR)) OBJ (WD2 FRUIT1 :PP CN) Ø)

(Ø G0126 (G0125 ONE1 :PP PRON) MAIN (WD5 EAT1 :ACT VT (TEN . PT:PAR))
 Ø (PASV . T) (TEN . C))
ACTOR: ONE1
ACTION: EAT1
OBJ: FRUIT1
ASPECTS: C
(CONT . IN): PARK1
```

$ONE \overset{c}{\Longleftrightarrow} EAT \leftarrow FRUIT$
⇑ IN
PARK

SENTENCE:
*I SAW LARRY HITTING KEN YESTERDAY.

NETWORK:

(Ø G0154 (G0146 CZN1 :PP N) QUAL (WD6 YESTERDAY1 :PP TIME) Ø)
(Ø G0150 (WD4 HIT1 :ACT VT (TEN . PR:PAR)) OBJ (WD5 KEN1 :PP PN) Ø)
(Ø G0146 (G0148 :DELTA1 :PP PN) MAIN (WD4 HIT1 :ACT VT (TEN . PR:PAR)
) Ø)
(Ø G0147 (WD3 LARRY1 :PP PN) QUAL (G0146 CZN1 :PP N) Ø)
(Ø G0144 (WD2 SEE1 :ACT VS (TEN . PT)) OBJC (WD3 LARRY1 :PP PN) Ø)
(Ø G0142 (WD1 I1 :PP PRON) MAIN (WD2 SEE1 :ACT VS (TEN . PT)) Ø (TEN
. PT))
ACTOR: I1
ACTION: SEE1
OBJC: LARRY1 ACTOR: :DELTA1
ATTRIBUTE: HIT1
OBJ: KEN1
ASPECTS:
TIME: YESTERDAY1



ASPECTS: PAST

SENTENCE:
*LOVE IS BEAUTIFUL.

NEW WORD: BEAUTIFUL

NETWORK:

(Ø G0157 (G0158 CZN1 :PP) MAIN (WD3 BEAUTIFUL1 :PA ADJ) Ø (TEN . :K))

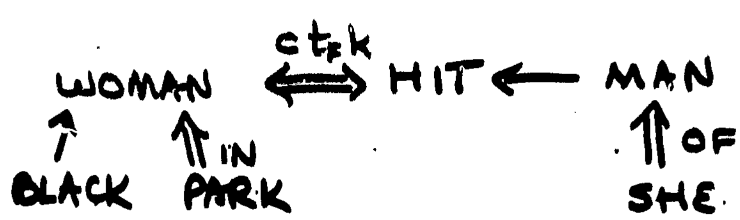
(Ø G0156 (G0159 ONE1 :PP PRON) MAIN (G0160 LOVE1 :ACT VT) NIL)
ACTOR: ACTOR: ONE1
ACTION: LOVE1
ASPECTS:

ATTRIBUTE: BEAUTIFUL1
ASPECTS: :K

SENTENCE:
*THE BLACK WOMAN IN THE PARK MAY HAVE BEEN HITTING HER MAN.
*
NETWORK:

(Ø G0181 (WD10 HIT1 :ACT VT (TEN . PR:PAR)) OBJ (WD12 MAN1 :PP CN) Ø)

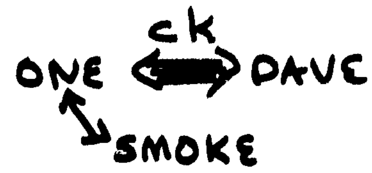
(Ø G0180 (WD12 MAN1 :PP CN) QUALPR (WD11 SHE1 :PP PRON (VAR . POSS))
Ø (POSS . OF))
(Ø G0170 (WD3 WOMAN1 :PP CN) MAIN (WD10 HIT1 :ACT VT (TEN . PR:PAR))
Ø (TEN . C:F:K))
(Ø G0167 (WD3 WOMAN1 :PP CN) QUALPR (WD6 PARK1 :PP PPLOC) Ø (CONT . I
N))
(Ø G0162 (WD3 WOMAN1 :PP CN) QUAL (WD2 BLACK1 :PA ADJ) Ø)
ACTOR: WOMAN1 (BLACK1) ((CONT . IN) PARK1)
ACTION: HIT1
OBJ: MAN1 ((POSS . OF) SHE1)
ASPECTS: C:F:K



SENTENCE:
*THE SMOKER MIGHT BE DAVE.

NETWORK:

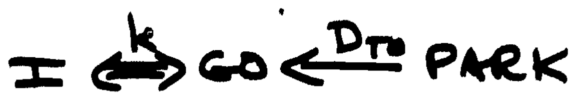
```
(Ø G0190 (G0192 ONE1 :PP PRON) MAIN (WD5 DAVE1 :PP PN) Ø (TEN . C:K))

(Ø G0191 (G0192 ONE1 :PP PRON) THAT (G0193 SMOKE1 :ACT VT) WIL)
ACTOR: ONE1 THAT: SMOKE1
        ASPECTS:

ATTRIBUTE: DAVE1
ASPECTS: C:N
```



SENTENCE:
*I AM GOING TO THE PARK.

NETWORK:

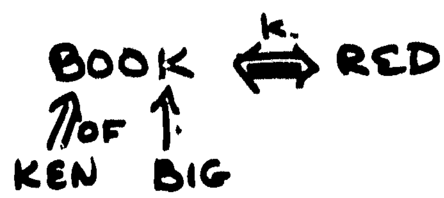
```
(Ø G0199 (WD3 GO1 :ACT VI (TEN . PR:PAR)) OBJPR (WD6 PARK1 :PP PPLOC)
 Ø (DIRN . TO))
(Ø G0196 (WD1 I1 :PP PRON) MAIN (WD3 GO1 :ACT VI (TEN . PR:PAR)) Ø (T
EV . :K))
ACTOR: I1
ACTION: GO1
(DIRN . TO): PARK1
ASPECTS: :K
```



SENTENCE:
*KEN'S BIG BOOK IS RED.

NETWORK:

```
(Ø G0211 (WD4 BOOK1 :PP CN) MAIN (WD6 RED1 :PA ADJ) Ø (TEN . :K))
(Ø G0210 (WD4 BOOK1 :PP CN) QUALPR (WD1 KEN1 :PP PN) Ø (POSS . OF))
(Ø G0209 (WD4 BOOK1 :PP CN) QUAL (WD3 BIG1 :PA ADJ) Ø)
ACTOR: BOOK1 (BIG1) ((POSS . OF) KEN1)
ATTRIBUTE: RED1
ASPECTS: :K
```



SENTENCE:
*SIGNOFF!

NETWORK:

```
(Ø G0217 (G0216 YOU1 :PP PRON) MAIN (WD1 SIGNOFF1 :ACT VI) Ø)
ACTOR: YOU1
ACTION: SIGNOFF1
ASPECTS:
```

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