What Makes Something "Ad Hoc"

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Only one of the questions posed before this session really inspires me to take pen in hand. "How general are various formalisms? Are they really ad hoc solutions to relatively narrow domains?"

That is not exactly my favorite question. I find the thought of having to address it palatable only if I can delude myself into believing that this is the last time I shall have to deal with it. So, proceeding on the basis of that delusional belief, I shall begin.

Ad Hocness, I have come to believe, is a disease that all new theories in the three fields in which I consider myself well-versed, namely linguistics, psychology and Artificial Intelligence, contract at conception, sort of like original sin. This would not be so bad if it were a disease for which there were a cure, but alas there is none.

We are all familiar with the phrase "beauty is in the eye of the beholder." In this case we have an instance of "the disease is in the eye of the beholder" which of course explains why the cure is so elusive. The beholder rarely wants to do anything about it. To discuss this more subjectively, let's take a neutral case. Before doing so, we shall have to point out what a case can be expected to look like. A case of "ad hocness" usually fits the form (or should I say the "ad hoc" form)

Theory X is called "ad hoc" by group with rival theory Y

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To get to our neutral case, we shall start our discussion where X is Conceptual Dependency and Y is Transformational Generative Grammar. Before I begin, I should note that there are conditions on X and Y relative to each other, namely that X must be a theory that has been conceived at a date later than Y was conceived. Furthermore Y should have been dominating some academic field which X is seeking to invade.

What makes a theory X assailable by Y as ad hoc? There are a number of criteria:

1 - X must explain a phenomenon that Y chose to ignore and that Y would rather go on ignoring since Y could not possibly explain it.

2 - X must be fundamentally at variance with Y, so that if X were right Y would be necessarily wrong.

3 - X must use different criteria of judgment of how a phenomena should be explained than Y does.

The following rules are used for the strategy to be followed in labelling an X as ad hoc:

1 - Since X will undoubtedly show how its theory explains a given particular phenomenon, accuse X's theory of only working in that case. This will put the burden of proof for generality on X rather than Y and also has the desirable effect of putting X in the position of not being able to prove anything with out proving everything.

2 - Choose a phenomenon to explain in which it is virtually impossible to explain everything, thus giving game and set to Y.

Consider our hypothetical case where Conceptual Dependency is X and Tranformational Grammar is Y. An examination of the literature will show that criteria 1 through 3 as well as the two available strategies have been used by the Transformationalists. In various articles and public performances charges of "ad hocness" have

been raised against Conceptual Dependency. We are told that our structures only work for the examples we discuss; that we have "no principled way of going from a sentence to a conceptualization" (Dresher and Hornstein (1976)) or that "Schank provides no demonstration that his scheme is more than a collection of heuristics that happen to work on a specific class of examples" (Weizenbaum (1976)). (If the reader is wondering how Weizenbaum got to be a transformationalist in my view, he need only read Weizenbaum's further remarks extolling Chomsky as having met the criteria that he claims I have not met.)

To what extent are these charges valid? To not knowing if one can extract a conceptualization from any sentence (and its corroborating charge of not proving that there exists a right CD diagram for any sentence) I plead guilty. But of course, I would be less than completely honest if I did not also note that there does not exist any theory or theorist who would not also have to plead guilty. Have the transformationalists shown us that they have some principled way of extracting conceptualizations from sentences or determining the correct representation for any sentence? Unless they are keeping their solution as a secret plan not to be revealed until after the election, I would have to imagine that the answer to this is that they do not have a solution to the problem. So clearly, they are no more or less ad hoc than we are. (Of course I might note here that we do have programs that suggest that we can do a large class of examples and show that our parsers are at least the beginning of some set of principles that work, but I won't).

What about Weizenbaum's attack? Perhaps it is all heuristics. To this charge I plead no contest. It might be that, in the end, we will have built a working program that solves the entire natural language problem and it will be easily labelled as a grand set of heuristics. Won't that be terrible! To quote Dresher and Hornstein again, "Not only has work in AI not yet made any contribution to a scientific theory of language, there is no reason to believe that (AI)...will ever lead to such theories".

And what will they say after success has been achieved and the ultimate natural language system has been designed? The same thing of course. Chomsky himself (personal communication) has claimed that such an achievement would be no more interesting than the achievement of the 16th century clockmakers.

I mention all this in the hope of pointing out that it is not just me and my theories that are damned by criticisms of ad hocness. We are all damned by them. Our ultimate success would not be even recognized much less applauded by those who criticize our solutions as ad hoc. Suppose every domain we worked on required yet another ad hoc solution. This might well be the case after all. What would we lose if this happened? Nothing at all. That's what artificial intelligence is all about. AI is the designing and testing of theories about human understanding capabilities. There is, at the moment, no reason to believe that people solve puzzles the way they read newspapers or that they play chess the way they answer questions. Of course, we all hope that there exist some general mechanisms that solve all these problems in some neat way. We hope this in large part because we are lazy. We would not like to have to work on each problem individually. We also hope this because we believe our intuitions when they tell us how reading a newspaper is a lot like watching a soap opera. A word of caution is necessary here. Beware of your intuitions. As a child you learned how to do each of these things separately and were pained to deal with each one of them. Of course, we do expect there to be some general principles that apply across domains. But if these principles are affix - hopping or trace - deletion we are all in trouble.

Part II

Having said all this, now let me tell you what I actually believe. I do not believe that any of our theories are ad hoc. Just because CD needed to be modified by causal chaining rules, and those by scripts and those by plans and goals and themes, and those by triangles, does not mean that what we are doing is ad hoc. We are no more ad hoc in hypothesizing our primitive elements than chemists were in hypothesizing theirs. I do not know what the ultimate result will be. How many elements make up the correct number, or what other kinds of formalisms will need to be added to those listed above is still unknown.

I do know how AI does its research however. We build a program to do a small class of examples and when we are finished we rip it apart and build a bigger and better program to do larger examples. In so doing, ad hoc entities (oftimes called kludges) cannot survive. If a formalism does not keep handling more data it is either abandoned or moved down to a special purpose role within a larger program.

Well, in ten years of research by my research group what has survived? After ten years and probably a hundred different kinds of programs, Conceptual Dependency is still with us. It still works for us. I challenge any other theory that has been programmed to say the same! Is it ad hoc? I leave that as an exercise for the reader.

PART III

Just to give the reader a feel for the nature of ad hoc thinking in AI that I believe to be worth espousing, I will now consider a problem that I have recently been working on. We have had a problem in representing certain kinds of political concepts in our old representation. Since we have been very concerned with the problem of newspaper story understanding it is very important that we be able to handle such concepts in a clean representation that will facilitate computer understanding.

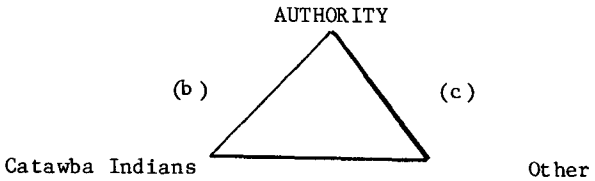
The problem we are attempting to solve can be illustrated by looking at a recent New York Times headline: "Catawba Indians land claim supported." The problem here is to be able to represent what "land claim" and "supported" mean. We know that a land claim is more than what we might use to

represent it in Conceptual Dependency.

Something like "Indians MTRANS land be possessed by Indians" is possibly true, but it misses the point. A "land claim" is in a sense a petition to a higher authority to resolve a dispute between two parties. That is, the Indians are saying to the U.S. Government, "this land is ours". It may not be possible to infer the particulars of this land claim. Indians have been known to take the land by force, to file documents in government offices, to complain to newsmen and so on. The important point here is that we really need not know, and in most cases a reader would not bother to worry about, exactly which method has been selected. Rather, a reader feels that he understands such a sentence when he has been able to identify the relationships and aims of the parties involved.

A program must recognize that a "land claim" is a type of petition to a higher authority to resolve a dispute about land ownership. We do not know who presently owns the land, but we know enough about ownership of property to infer that there is probably a counter petition of some sort. We also know about petitions to authority. They usually get resolved by the authority. In this case then, "supported" refers to the decision of the authority in the case.

This information can be represented graphically by a kind of triangle (example 1):



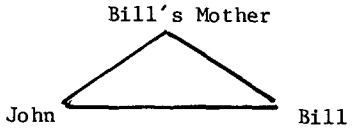
(a)

In this triangle (a) represents the dispute between the Indians and the owners of the land, (b) represents the appeal to authority to resolve the dispute made by the Indians, and (c) represents the authority's decision.

Triangles of this sort have use in representing any type of dispute. For example, in (2) and (3) such triangles can also be constructed:

(2) Burma appeals to UN to settle border dispute with Thailand.

(3) John complained to Bill's mother that Bill hit him.



Of course, these triangles just suggest the basic relationships involved. In order to add substance to the bare bones of the triangles we shall have to deal with some representational issues that are being glossed over here. The important point at this juncture is that there is an essential similarity across (1), (2) and (3), that the similarity must be represented in some way, and that that similarity can be exploited for use in an understanding system.

The first representational problem we encounter in trying to make explicit much of what is implicit in the triangle representation is that we will need to design a new set of ACTs to take care of the various relationships.

In the primitive ACTs of Conceptual Dependency we have a system that represents physical actions by using a small set of basic actions that can combine in various ways to describe detailed or complex actions that underlie seemingly simple verbs and nouns. The primitive ACTs do not account for intentionality and goals underlying physical action. To account for such things we devised a complex apparatus discussed in Schank and Abelson (1977). If we wish to account for social events, we will need a system of basic social ACTs to represent the social actions that comprise the events. I term these "basic social ACTs" rather than primitive ACTs because in the end most social ACTs have some physical manifestation. Often their physical manifestation is uninteresting however. For example a government decision may be MTRANS-ed in a variety of ways. The manner of the MTRANS (written, announced in a speech, etc) is often not significant with respect to the overall social effect of the action. Furthermore the MTRANS itself is only slightly interesting. The standard inferences from MTRANS apply, but there are some highly significant inferences that need to be made that are not obviously available.

For example, the most significant inference to be made from an authority's decision is that simply by virtue of that decision something has actually happened. That is, a government authorization is a truly performative ACT. Thus, if the government says some property is mine, or that a man is a criminal, then it is so by virtue of their saying it. Similarly other authority figures have the same power. A professor can say a thesis is finished and a student has a Ph.D. and these things are the case by virtue of his saying it.

Not all authority's decisions are like this to be sure. Sometimes an authority gives an order and that order must be carried out for the decision to have effect. Frequently these orders come about as a result of a governmental decision or authorization. If the government says the land belongs to the Catawba Indians, then it does, but they may have to send in the National Guard to get the original owner off the property.

What I am proposing then is two basic social ACTs - AUTHORIZE (abbreviated AUTH) and ORDER. AUTH is something only an authority can do. (This is a bit circular actually since if you actually can AUTH then that defines you as an authority.)

In a sense then, an authority is one who when he acts like he is doing an AUTH (that is he does the physical ACTs that ordinarily correspond to an AUTH) in fact causes some things to happen as a result of the AUTH that were supposed to be the results of the AUTH. In other words, you cannot really tell if an AUTH has taken place until it becomes clear that the person doing the AUTH can back up his AUTH in some way.) The object of the AUTH is the authorization or new state of the world. AUTH takes a recipient, namely the relevant parties in the dispute.

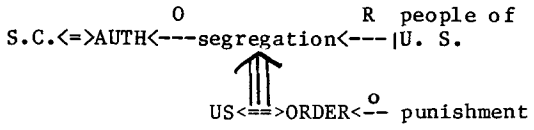
ORDER is a frequent inference of AUTH. The government can AUTH the army to fight a war, but that doesn't, simply by virtue of the statement, imply that they are fighting it. A subsequent ORDER is required that carries with it the implicit punishments that are relevant in carrying out an order.

Why can't we do these things with CD primitives we now have? What is the advantage of these new ACTs? To answer these questions, we need to look at the purpose of a primitive ACT. It is possible to represent ORDER in CD for example. The verb 'order' means to MTRANS to someone that they must do a particular action or face some (usually implicit) consequence. Thus, implicit in the verb 'order', but explicit in the CD representation for 'order', is the idea that if the required ACT is not performed, then someone will possibly do something to harm the recipient of the order in some way. This implied punishment is a part of the concept 'order' but is it necessary that we think of it each time that we understand an 'order' to have taken place?

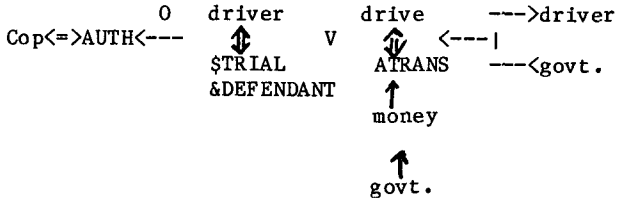
The same question can be asked with respect to 'authorize'. We understand what authorization or governmental decision is, but we need not access all that information each time we understand the word. Consider the problem of explaining the meaning of these words to a child for example. It is very difficult to explain them precisely because they are so complicated at the level of physical primitive ACTs. Yet these ideas are really not complicated at all at a social level of ACTs. Such simple concepts such as ORDER and AUTHORIZE form the basis of the organization of societies. What is complex at one level is simple at another. This idea of nested levels of complexity, each with their own set of primitives, is a very important one for the representation of information in artificial intelligence. By choosing a good set of primitives we can effectively organize what we need to know. Thus, ORDER and AUTHORIZE have inferences that come from them just as the physical primitive ACTs do. The main difference is that these basic social ACTs are not primitive in the same sense. They can be broken down, but we would rarely choose to do so.

The use of these new basic ACTs is much like the use of the original primitive ACTs. We can predict what will fill slots reasonably in a conceptualization and make inferences about slot fillers and consequent inferences as we would any conceptualization. Thus we represent sentences such as the following using AUTH:

(4) The Supreme Court decided segregation is illegal.



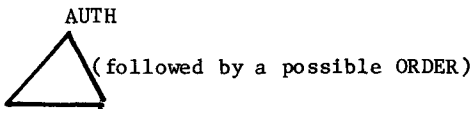
(5) The cop gave the speeder a ticket.



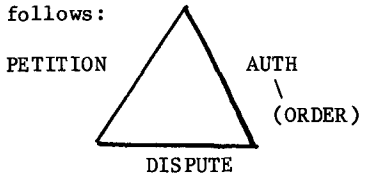
In (4) we have chosen to ignore representing 'segregation' for the moment, since it is obviously complex. Supreme Court decisions are AUTHs. They also carry with them (as do most AUTHs) an implicit ORDER for 'punishment' if certain circumstances are not met. The straightforward inference from (4) then is that someone practicing segregation can expect to be punished.

Policemen are authorities also. In (5) the ticket is a written manifestation of an AUTH that either puts the driver in a DEFENDANT role in a $TRIAL script or forces him to pay a fine. The instrument of the AUTH is the actual PTRANS of the ticket (left out here). The important point here is that we could represent (5) using PTRANS only. However, what we would be describing is the physical ACT itself when it is the social ACT that is significant here. (When I was young there was much talk of bad kids getting "JD cards". I never understood what was so horrible about that. Couldn't they just throw them away?) The social significance of an ACT must be represented if it is understood.

Now that we have presented these two ACTs let's return to our triangle:



We have named one side of the triangle. The other sides represent ACTs as well. The complete triangle is as follows:

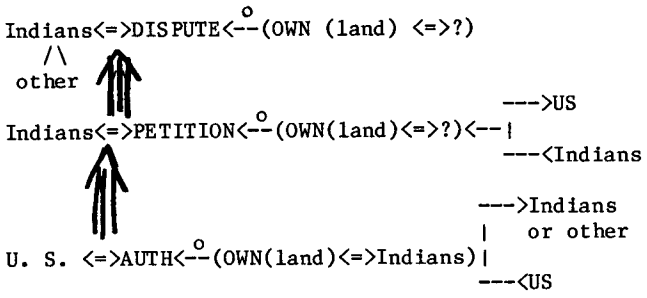


The ACT PETITION represents an individual or group's act of requesting AUTH's from an authority. Thus a "civil suit" is a PETITION to the courts using some legal scripts. A protest demonstration is a PETITION to unstated

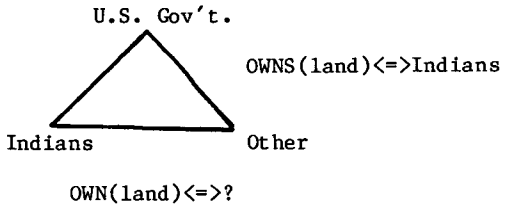
authorities using some demonstration script. The point here is that we cannot do away with the scripts that describe the actual physical manifestations of these events. However, the scripts are instruments of the social ACT involved - PETITION. The most important inference from PETITION is, of course, that an AUTH is expected that will resolve the issue that is the object of the PETITION.

The issue that is the object of the PETITION is the DISPUTE itself. DISPUTE takes two actors (one of whom may be quite passive). The object of the DISPUTE is the issue involved. DISPUTE takes no recipient as it is not an inherently directed ACT. It is the ACT of PETITION that directs it to a particular authority who can AUTH something that will resolve it.

We are now ready to deal with sentence (1) (Catawba Indians Land Claim Supported). The representation using the new social ACTs is:



Since this representation is not as easy to write as the triangular one, we shall continue to use triangles in the remainder of the paper. Thus (1) is:



We will leave out the arrows and the ACTS for diagrammatic purposes, but the above triangle should be understood as containing all the information given in the CD diagram for (1). (Actually the triangles contain more information.)

Triangles provide us with a method for representing the social significance of actions. As with any other representation scheme, the advantage of the symbols we create can only be in the new symbols or actions that they spawn. That is, it is the inferences that come from the triangles that are of key importance. When we created the original primitive ACTs we said that PROPEL was no more than the set of inferences that it fired off. The same is true here, so we must ask what these inferences are.

The first thing we can recognize about potential inferences here is that they will come in two varieties. The first are the inferences that are fired off from the new social ACTs that we have created. The second kind are those that come from the triangles themselves. That is, there should be patterns of triangles that are recognizable for the triangles they spawn as well as a set of inferences that come from the fact that certain triangles exist.

As examples of this let us consider again sentence (2):

(2) Burma appeals to UN to settle border dispute with Thailand.

Since the representation of (2) involves a PETITION we can employ the inference rules that are fired by PETITION. Some of these are:

a. For every PETITION we can expect a corresponding AUTH.

b. For every PETITION there was probably a DISPUTE that gave rise to it.

These rules lead us to the inferences available from AUTH and DISPUTE. Of course, inferences from inferences have a lower probability of truth, so for (2) the inferences below would be somewhat less certain.

c. An AUTH can cause a DISPUTE to end.

d. An AUTH can cause a PETITION to a higher authority from the party unfavorably affected by the AUTH.

e. An unfavorable AUTH can cause a rebellion, or lack of acceptance of the validity of the AUTH. This can give rise to ORDERs to effect the AUTH in the case of individuals versus governments or wars in the case of governmental conflicts.

f. An AUTH causes a new state of the world to exist, often ending an old state in conflict with the new state.

g. A DISPUTE can cause one party to PETITION.

h. A DISPUTE can cause a PROPEL to cause damage to occur for individuals, or a WAR triangle to be initiated for countries.

There are, of course, a great many more of these kinds of inferences than we are listing here. The above list is mostly intended to give the flavor of basic social ACT inferences. It is important to note that the social ACTs give rise to inferences at both of the other levels of representation besides those at the same level of representation. That is, given a social ACT we may be able to infer another social ACT, a new primitive ACT, or a new triangular representation.

Thus, for (2) we have two representations to start with: one is at the standard CD level and uses MTRANS; the other is at the social level and uses PETITION. Both of these representations would be available as output from the parser.

The MTRANS representation would fire off inferences about the methods of communication possibly used - that the UN now knows about the problem and so on.

The PETITION representation would fire off inferences about the expected AUTH from the UN. Since we know how the UN does its AUTHs, this would fire off a UN script of some kind that dealt with voting and debate. PETITION would also cause DISPUTE to be inferred which would cause inferences about the kind of methods possibly employed by the quarreling countries, both in creating the DISPUTE and escalating it.

The existence of the PETITION-AUTH-DISPUTE triangle would fire off an inference that the country kind of triangle existed. Thus, a new triangle that was lopsided showing possible aggression from Thailand towards Burma would be created. This triangle would in turn fire off inferences about attempts to RESOLVE the DISPUTE (one of which was (3) itself) and would predict an escalation towards the WAR triangle with its normal inferences if a RESOLVE did not take place.

Although the above is rather sketchy, the point should be clear. We need additional representational mechanisms to handle the many levels at which statements can be interpreted. Triangles provide us with a new set of inference rules providing more power to the understanding system. Are they ad hoc? Of course they are. My point is simply that such ad hoc mechanisms will either solve the problem or help us create a more general solution that will solve the problem. The program that we are writing that uses triangles is also ad hoc. Is is a kludge? No. If it were it wouldn't be worth a thing. But, here again, if the program we write can handle many examples as we rewrite it because of what we have learned from it, then it will have been worthwhile.

The program below reads newspaper headlines in English and generates, by use of triangles and the inferences available from triangles, a paraphrase of the input. This English paraphrase is generated by the program.

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TRIANGLE analyzer loaded.

INPUT SENTENCE:
(CATAWBA INDIAN LAND CLAIMS SUPPORTED)

 (PARSE I1) : CON4

 Expanding token: CON4 =
((CON ((ACTOR (*PP* CLASS (#GROUP)
 CFEATURE (*AMERINDIAN*) TYPE
(*ETHNIC*) NAME (CATAWBA) TOK NP1)
<=> (*PETITION*) OBJECT ((ACTOR
(*PP* CLASS (#REGION) TOK NP2 REL CON1)
IS (*OWN* VAL NP1)) TOK CON1)
FROM NP1 TO (*PP* CLASS (#INSTITUTION)
MEM *COURT* TOK NP3)) TOK CON2)
IR ((ACTOR NP3 <=> (*AUTH*) OBJECT CON1
RECIP1 NP1 RECIP2 GAP1 FROM
GAP2) TOK CON3)) TOK CON4)

The Catawba Indians asked a Federal
Court to rule that they own the land.

The Catawba Indians requested a Federal
Court to rule that the land is owned by
them.

The Catawba Indians appealed to a Federal
Court.

The Catawba Indians asked a Federal Court
to rule that they own the land and it
decreeed that the land is owned by them.


[ Generating inferences from CON4 ]

>(TELL-STORY)

The Catawba Indians and the other parties
disagreed over the ownership of the land.

The Catawba Indians requested a Federal
Court to rule that they own the land.

A Federal Court decided that the land is
owned by the Catawba Indians.

The other parties will probably appeal the
decision.

The other parties might use force against
the Catawba Indians to assert that they
own the land.

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This program was written by Jaime Carbonell and Stephen Slade.

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