THE LOCUS OF METAPHOR IN FRAME-DRIVEN TEXT GRAMMARS

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ABSTRACT

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The most important task of human and computer discourse systems is the use of context to resolve ambiguity. In a frame-driven text grammar model, this task is the identification of relevant frames in combination with accurate determination of the logical quantification of frame variables.

'Metaphor' phenomena are associated with insertion of items from the quantification domain of one frame into the quantification domain of another, and with the recognition of isomorphisms in propositional structure between frames. This process is also essential to frame merger and generalization in learning models. Frames are normally represented as propositional structures plus rules of quantification for their propositional variables. This form makes comparison of the internal structures of the propositional parts a computationally unwieldy problem for large scale models with heterogeneous subject matter. The ability to transform propositional logic formulations into the same appositional notation that can encode the quantification rules makes it possible to use efficient associative logic techniques to identify and manipulate frames and their quantification states.

Applying appositional transformations to frame descriptions of culture rules can also convert the data into a binary opposition notation that is suitable for the structural analysis techniques of Lévi-Strauss. These techniques make it possible to derive high-level symbolic relations among frame descriptions through a process that includes the analytic operations used in metaphor generation and recognition. The view of Lévi-Strauss that cultural forms in a primitive society are metaphorically related may be one that can be tested by computer. To the extent that his model is valid for modern societies, it suggests the design of large-scale discourse analysis systems that are computationally feasible in a way that current frame-driven systems are not.

* While frame models are used in several contemporary fields to represent world knowledge, V. Propp must receive credit for the first, 1st-order predicate calculus model of a frame-driven text grammar: Morfologija skazki (Leningrad 1928).

THE LOCUS OF METAPHOR IN FRAME-DRIVEN TEXT GRAMMARS

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The most important task of human and computer discourse systems is the use of context to resolve ambiguity. From an information processing point of view, no contemporary linguistic theory or artificial intelligence model is able to account for the human ability to resolve ambiguity on the basis of context at the speed at which human language processing takes place. It is typical of computer models, including models embodying particular linguistic theories, that as the size of the data base increases, the ability of such systems to provide unique resolutions of ambiguity on the basis of context decreases. At the same time, the processing time required to resolve or attempt to resolve such ambiguity increases exponentially, or worse, with increases in the size of the data base. The problem has plagued natural language processing work since the early days of machine translation. The classic statement of the problem as formulated by Bar-Hillel (1960) remains unchanged. Current research has accepted Bar-Hillel's challenge to incorporate world knowledge as part of the data base, but the problems of ambiguity recur as the size and heterogeneity of that data base approaches the encyclopedic content demanded.

Linguistic theories do not necessarily fall because of their pragmatic implications for computer models, and artificial intelligence research has not been affected because the theory and pragmaticsof that field are merged in the construction of small, automated models which, because of their limited size, function with subjectively interesting, if non-extendable results.[2]

The text grammarian movement has arisen among European linguists in reaction the failure of sentence grammar theories. As its name implies, its theoreticians incorporate macro context to handle linguistic problems, and they emphasize the importance of world knowledge as part of the data base for linguistic and computational linguistic models.[3]

The term 'frame' in artificial intelligence research is attributed to Minsky (1975). It can be applied to a set of propositional rules that describe an organized segment of world knowledge. The term is approximately equivalent to the notion of 'scripts' as used by Schank and Abelson (1977). While frame models are used in several contemporary fields[4] to represent world knowledge, V. Propp must receive credit for the first, 1st-order predicate calculus model of a frame-driven text grammar (1928).

In a frame-driven text grammar, the resolution of ambiguity is associated with the identification of relevant frames in combination with accurate determination of frame variables. The organization of such a grammar presupposes that every lexical item is linked to every concept it might represent, and that every concept is linked to every frame that might reference it. As the size of the lexicon increases, and as the number of frames and concepts increases, the resolution of ambiguity of reference in text analysis becomes increasingly difficult. The practical experience of text grammar construction has been associated with limited subject matter. The most elaborate automated text grammars have been use in text generation (Klein et al, 1973, 1974, 1976),[5] which is a simpler task than recognition in terms of ambiguity resolution, although the problems of accurate quantification of frame variables is not avoided.

What does it mean to incorporate world knowledge in a text grammar? Is it possible to describe the world in a finite number of frames in a consistent, non-trivial manner? Ultimately, the task is one of formalizing a person's knowledge of his world in a set of logical constructs that are also part of a generative and recognition grammar. For practical purposes, the universe must be treated as non-finite, but for computational purposes, the rules of the data base must be finite in number. To insure global coverage of subject matter, many of the rules must be formulated at high levels of generality, with propositions using variables that require logical quantification for particular applications to world phenomena. The process of quantification consists of determining which particular facets of the world are to be assigned to the variables in the frame arguments, and maintaining the binding of those assignments during relevant segments of data processing. The problems of logical quantification are the same for generation and recognition; the testing of automated versions of Propp's model for Russian fairytales demonstrated the difficulties that Propp had (Klein et al, 1974, 1976).[6]

At this point, a simple example will be useful. Consider processing of the text:

> THE COACH DISPUTED THE UMPIRE'S CALL, BUT THE UMPIRE REFUSED TO LISTEN.

For our frame-driven text grammar, we shall assume a simple model in a notation related to, but simpler than the notation of the Metasymbolic Simulation System (MESSY).[7] We assume the existence of semantic objects, relations and classes. Objects and relations are linked to lexical expressants. Every frame is simultaneously an object or a relation, and a class. Classes may contain objects, relations and classes, and may function as variables. Every class is also an object. The syntax of MESSY defines the appropriate interpretations of these multiply functioning units. The propositions in frames are formulated in terms of semantic triples (including 2-tuples) which consist of ordered sequences of objects and relations, or class variables. Class memberships may be modified during processing, and units may be recursively defined and expanded, or their interpretation may be limited to their first level significance. All of these units have index links to each of the frames in the data base that reference them.

For the processing of this example, we will reference eight simple and incomplete frames: DISPUTE, REFUSE, LISTEN, IGNORE UMPIRE, CALL, COACH and BASEBALL-GAME. Classes include:

CLASS ALPHA: judgement, proposal...
CLASS PERSON: person1, person2...
CLASS PLAYER: player1, player2...
CLASS TEAM: team1, team2
CLASS BATTER:
CLASS ALPHA:

<u>DISPUTE FRAME</u>

D1: person1-dispute-alpha
D2: alpha-of-person2
D3: D4 or D5
D4: person2-reply-person1
D5: person2-ignore-person1

<u>REFUSE FRAME</u>

R1: person-refuse-give
R2: give-attention

<u>LISTEN FRAME</u>

L1: listen-be-give
L2: give-attention

<u>IGNORE FRAME</u>

I1: ignore-be-refuse
I2: refuse-to-notice

<u>UMPIRE FRAME</u>

U1; umpire-be-official
U2: official-in-sport
U3: official-rule
U4: rule-on-play
U5: umpire-supervise-game
U6: umpire-responsible
U7: responsible-for-conduct
U8: conduct-accordingto-rule

<u>CALL FRAME</u>

C1: call-be-judgement
C2: judgement-of-umpire

<u>COACH FRAME</u>

CH1: coach-be-person
CH2: person-train-player
CH3: coach-assist-manager
CH4: assist-in-strategy
~~CH5: strategy-of-game~~

<u>BASEBALL-GAME FRAME</u>

B1: hometeam-take-position
B2: position-in-field
B3: umpire-call-B4
B4: play-ball
B5: batter-stand
B6: stand-in-batterbox
B7: pitcher-throw-ball
B8: B9 or B10
B9: umpire-call-strike
B10: umpire-call-ball
B11: if B12-then-B13
B12: strike-be-three
B13: batter-be-out
B14: if not B15-then-B16
B15: out-be-three
B16: next (player)-cometo-bat
B17: if B15-then-B18 and B19
B18: team-retire
B19: next (team)-at-bat
.
.
.

For the purpose of the example, suppose that the baseball frame has been activated and "driving" the interpretation of the text. A frame is activated when it is referenced in the flow of processing. When there is ambiguity of reference, frames which are alternatives to a hypothesized frame must be kept on a list and tested later should the first choice be rejected. Frame activation is important to the disambiguation process. For example, if the BASEBALL-GAME frame is active, an occurence of the lexical item 'call' will activate the CALL frame about the judgement of the umpire in preference to any other possibility. This call frame is termed a 'local' frame.

Assume a parser has obtained the following triples from our text (THE COACH DISPUTED THE UMPIRE'S CALL, BUT THE UMPIRE REFUSED TO LISTEN.):

1. coach-dispute-call
2. call-of-umpire
3. umpire-refuse-listen

Processing begins with triple 1. The general DISPUTE frame is activated because the BASEBALL-GAME frame does not contain a local instance of a dispute frame. A match is attempted between D1: 'person-dispute-alpha' and triple 1: 'coach-dispute-call'. 'coach' is not a direct match with 'person1', but 'person1' is a 'person', and 'person' is a superset of 'coach', a condition which is necessary for potential matching. A match results in 'coach' being bound to the variable 'person1' in the DISPUTE frame. The remainder of the match of triple 1 to D1 is analogous, and 'call' is bound to the class variable 'alpha'. The matching of triple 2 to D2 is also straightforward with the result that 'umpire' is bound to 'person1' D3 is a control triple and it is interpreted to mean that D4 or D5 must be matched for the DISPUTE frame to remain active. Because a 'refuse' triple is part of the IGNORE frame, a partial match is obtained with D5. The failure to find matches for 'refuse' and 'listen' results in the expansion of 'refuse' as the frame REFUSE, in order to determine if 'listen' can be interpreted as a relational object of 'refuse'. It can be so interpreted and, because 'coach' is already bound to 'person1', it is the 'coach' who is interpreted as being ignored.

A metaphorical version of the preceeding text might read:

THE COACH DISPUTED THE UMPIRE'S CALL, BUT THE UMPIRE
SAID THAT THE COURT WAS ADJOURNED.

Before analyzing it, we might review traditional views of metaphor.

Theories of metaphor can be sorted into one of two classes: theories of metaphorical structure and theories of metaphorical processing. The first class of theories raises the question, what makes a particular statement metaphorical? The second, what cognitive operations must a speaker perform in understanding a metaphor? The two major theories propounded in the literature, the traditional "comparison" view[8] and Black's "interactive" theory,[9] though generally held to be competing <u>accounts</u> of metaphor, reflect a structural and processing approach, respectively.

Although the term "comparison" may signify a specific process or effect of interpreting a metaphor, the comparison view was originally conceived to describe the structure of metaphorical statements, not the psychological processes involved in their comprehension. The origins of the comparison view derive not from Aristotle's Rhetoric, where he analyzes the rhetorical impact of artistically active metaphors,[10] but from the Poetics, where he identifies metaphor structurally as a specific type of noun, and then adduces four grammatical forms that a metaphorical statement may assume: genus-species, species-genus, species-species, and analogy.[11] Rhetoricians subsequent to Aristotle referred to the genus-species, species-genus comparisons as synecdoches.[12] This left the species-species (e.g."man is a wolf")and analogical (e.g."old age is to life as evening is to day") comparisons as the two accepted structural forms of metaphor.

Besides its historical basis, there is a substantive reason for not associating the comparison view with a theory of metaphorical processing--the comparison view, in its standard interpretation, represents a substantially flawed processing theory. Consider the claims implied by the traditional comparison view regarding the processing of the metaphor, "man is a wolf." When interpreted as a processing theory, the comparison view implies that an understander makes a comparison between "man" and "wolf" and that the outcome of this comparison process determines the metaphorical meaning. Taken by itself, this implication is reasonable (however vague). Nonetheless, this is the only implication of metaphorical processing the traditional comparison view offers. There are many other processing factors for which a comparison view does not account. For example, the comparison view has has nothing to say about whether the metaphor under analysis is frozen or active, and it is indifferent to the various personal and situational exigencies that might prompt its utterance.

Notice that the comparison view leaves unspecified the very factors that do not require specification within a theory of metaphorical structure. For a structural theory of metaphor, it matters little whether one studies active or frozen metaphors or the context of metaphorical utterance. The structure of a metaphor does not change even as the metaphorical novelty and context do, with one and the same structure possibly eliciting different processing strategies under varying conditions. Given this observation, it is hardly surprising that Black and his associates who advocate an interactive view of metaphor have seen fit to criticize the comparison view for ignoring the very data that would be crucial to a theory of metaphorical processing. They have criticized comparison theorists for their preponderant focus on frozen metaphors. They have criticized comparison theorists for focusing only on examples (e.g."he is a lion in battle")that express an explicit comparison in the surface structure, and ignoring examples in which no explicit comparison is evident (e.g. the personified phrase "the spiteful sun" where the explicit terms 'spiteful' and 'sun' are surely not being used as the basis of a metaphorical comparsion, but rather the terms 'sun' and 'human being').[13] Moreover, they have criticized comparison theorists for failing to consider sentences that exhibit no internal metaphorical structure, but which are made metaphorical by context. For example, the sentence, "that net catches a lot of fish" is most likely literal when spoken between two fishermen wading in a stream, but metaphorical when spoken by a professor to comment on a student's vague definition.[14]

The positive role played by the interactive account has been to point out data that would be "anomalous" within the restrictive processing implication of the traditional comparison view. However, the interactive account posits no structure over which the "interaction" of the terms in the metaphor takes place. Because a process can be formally understood as well-defined operations on a structure, this omission marks a serious flaw in the interactive view. Indeed, the interactive view should be understood as a reaction against the limited processing implications of the comparison view as much as a constructive theory in its own right. In contrast to the the traditional comparison view which isolates structure from process, and the interactive view which isolates process from structure, an adequate theory of metaphor must chart precisely the interaction between the two in the form of a structural-processing theory.

In terms of frame-driven text grammars, metaphor phenomena are associated with insertion of items from the quantification domain of one frame into the quantification domain of another, and with the recogntion of isomorphisms in propositional structure between frames. Our metaphorical text example: THE COACH DISPUTED THE UMPIRE'S CALL, BUT THE UMPIRE SAID THAT THE COURT WAS ADJOURNED might yield the semantic triples:

1: coach-dispute-call	3: umpire-say-4
2. call-of-umpire	4: court adjourn

To perform an analysis we must first add three frames: JUDGE, JUDGE-ADJOURN-COURT and TRIAL:

JUDGE FRAME

J1: judge-be-official
J2: official-be-public
J3: judge-be-authority
J4: judge-administer-justice
J5: judge-decide-question
J6: question-brought
J7: brought-before-court
J8: judge-supervise-trial
J9: judge-assure-conduct
J10: conduct-be-proper
J11: conduct-of-trial

JUDGE-ADJOURN-COURT FRAME

JAC1: judge-say-JAC2
JAC2: court-adjourn

TRIAL FRAME

T1: judge-convene-court
T2: counsel-select-jury
T3: judge-read-charge
T4: defendant-enter-plea
T5: prosecutor-make-openingstatement
T6: prosecutor-offer-evidence
T7: defender-crossexamine-witness
T8: witness-for-prosecution
T9: if T10-then-T12,T13 & T14
T10: defender-believe-T11
T11: evidence-be-improper
T12: defender-make-objection
T13: judge-decide-amissibility
T14: amissibility-of-evidence
T15: if T16 & T17-then-T18
T16: prosecutor-offer-evidence
T17: evidence-be-all
T18: prosecution-rest-case
T19: defender-make-motion
T20: motion-be-22
T21: judge-dismiss-charge
T22: if T23-then-T35
T23: judge-grant-motion
T24: if T25-then-T26
T25: judge-deny-motion
T26: defender-offer-evidence
T27: prosecution-give-evidence
T28: evidence-in-rebuttal
T29: counsel-make-closingstatement
T30: judge-submit-case
T31: submit-to-jury
T32: jury-deliberate-case
T33: jury-deliver-verdict
T34: judge-enter-judgement
T35: judge-adjourn-court
T36: if(T23 or T34) & T35-then T37
T37: trial-be-over

The processing of triples 1, 2 and 3 proceeds as for their counterparts in the literal example. Triple 4, however, yields a figurative interpretation: neither 'court' nor 'adjourn' is present in the frames on the active frame stack (BASEBALL-GAME and DISPUTE). A search is made for non-active frames containing the best match with triple 4, 'court-adjourn'. In this data base, the JUDGE-ADJOURN-COURT frame is retrieved, as well as the TRIAL frame, which contains an embedded triple of the same name (T35), and the JUDGE frame, which explicates the function of 'judge' in the other frames. There are numerous parallels, and both 'umpire' and 'judge' are determined to share membership in at least one superset. Other mappings can be inferred from other frame parallels, including an erroneous mapping (in this case) between 'trial' and 'game' rather than between 'trial' and the dispute taking place in the context of the game. Inclusion of more detail in the frames might help to resolve the problem. However, even with the sketchy data base provided in this example, the linkage of 'trial' to 'game' might be rejected if and when additional text indicates that the umpire's statement, "COURT IS ADJOURNED", does not mean the end of the ball game.

The potential for ambiguity would increase tremendously if the data base contained a set of frames for the game of tennis. Some tennis matches have both judges and umpires. However, the fact that the BASEBALL-GAME frame is active, and not a tennis frame, is of importance. Also, the triple, 'court-adjourn', is presumably not applicable to any tennis frame. Accordingly, the set of frames concerned with the legal domain might be retrieved for figurative explication rather than frames for tennis.

Of course the judge in a tennis match might make a figurative statement in a dispute that might parallel the baseball case. The computational task would be to determine that the judge in the tennis frames is not the same kind of judge as in the legal frames, and that a figurative linkage between the two is implied.

The computation of figurative association can involve direct chains of linkage through intermediate frames, or through indirect associational aspects of frames. Perrine's (1971) classification of four types of metaphorical statements provides some illustrations. He observes that while metaphors often contain both a literal and a figurative term in their explicit structure (e.g. "John is a rock"), some metaphors contain only an explicit literal term and an implied figurative term. For example, in the statement "their love flickered," the term "love" is not explicitly compared with "flicker" but, rather, implicitly compared with a flame or candle. Nonetheless, the word "flicker" cognitively triggers these implicit figurative terms (e.g. flame, candle, etc.) and thus brings the implied comparative asymmetry[15] ("love is a flame") into focus. A third class of metaphors, according to Perrine, contains only an explicit figurative term and an implied literal term. Such metaphors usually comprise whole sentences or discourses rather than parts of sentences. For example, the sentence "that net catches a lot of fish" can be literal, but it may also function to trigger a figurative connection between it and some literal term not explicitly mentioned in the sentence, such as a definition. Perrine also isolates a fourth form of metaphor in which both the literal and figurative terms are implicit, and which are rare, occuring primarily in literary and poetic contexts. Perrine's classification can be re-stated in a frame model on the basis of direct and indirect linkage between frames and on the basis of direct or associational linkage of terms within frames. Frozen metaphors are easier to process in that they can be handled with reference only to a single frame. However, frozen metaphors can become active. For example, the prototypically frozen phrase, "the foot of the mountain," can become active in a context such as "the explorers climbed to the foot of the mountain before attempting its knee."[16]

The analysis of metaphor in a frame model is rather straightforward if one is able to write the frames with advance knowledge of the kinds of metaphors to be processed. A general model must overcome two major problems:

1. The writing and encoding of enough frames to encompass the physical and social universe of a speech community. Who will write the frames? What will be the methodology? ... the level of abstraction? What guarantees are there that the frame writing process will approach some limit in its attempt to cover the world knowledge of a speech community?

2. Retrieval. If one has succeeded in encoding an encyclopaedic inventory of frames, how does one retrieve the relevant frames for

resolution of a metaphor? As the number of frames in the data base increases, the ability to find unique metaphoric referents must decrease. The process of analysis may require detailed logical study of the internal structures of frames to determine the number and adequacy of the isomorphisms. Moreover, there can be no guarantee that frames relevant to the resolution of a metaphor will be identifiable even if they are in the data base. The isomorphisms that might be set up between two frames might not be computable because of variation in the styles of encoding of the propositional structures. Even attempts at normalization of style might fail. A canonical form to permit matching of frames A and B might not be the ideal canonical form for recognition of isomorphisms between frames B and C.

The problems just formulated are essentially ones of ambiguity, and are applicable to general aspects of frame-driven text processing systems. Where existing systems work, they do so because of circularity in the construction of the data base and task domain. (It is not part of the methodology of artificial intelligence research to design experiments that preclude circularity.[17])

How do humans do it and how may machines replicate the feat? Models of the types proposed by Schank and Abelson (1977) and Jackendoff (1976) are inadequate because they would reduce human experience to configurations with a fixed number of semantic units so small as to guarantee unresolvable ambiguity for large data bases of varied subject matter. An answer is to be found. It has two components, both of which stem from Lèvi-Strauss (1962), and one of which receives support from current split-brain research:

1. The conversion of frames as propositional structures into frames as appositional structures.

2. The exploitation of Lèvi-Strauss' observation that cultural forms are metaphorically related (at least in primitive societies).

Recent split-brain research has engendered several controversial theories among anthropologists regarding language and culture.[18] They include the view that the distribution of task analysis between propositional and appositional cognitive brain functions is culturally determined (Paredes & Hepburn, 1976) and the view that the Sapir-Whorf hypothesis can be reformulated in terms of language structures that provide propositional and appositional representations of the world in varying degrees. (TenHouten & Kaplan, 1973: 89-108).

Conversion of propositional frames to appositional format results in structures that are the verbal equivalent of pictorial icons. The formal devices mentioned in the frame examples earlier in this paper (i.e. the treatment of objects and relations as classes, the treatment of classes as objects or relations, and the treatment of frames as classes and objects or relations simultaneously, plus the features of recursion and self-embedding) facilitate the conversion of propositional frame structures to appositional representations in the form of matrices of binary oppositions of semantic features. The process is facilitated through exploitation of the fact that class memberships may be mechanically converted to distinctive features, and the fact that the creation of supersets through merger and generalization of frames automatically creates the possibility of binary oppositions. (i.e. the subsets of a superset are candidates for status as features in opposition.)

Analysis of text and retrieval of frames using appositional representations in the form of matrices of distinctive features can yield a much more efficient frame retrieval system than methods requiring analysis of logical propositions within frames. Such a notational model is particularly compatible with Lévi-Strauss' view that most of human thinking takes place through the medium of a calculus of binary oppositions. It lends itself to inter-frame inferences through analogical reasoning techniques, and provides a computationally plausible answer to the question, "how do humans do it?", especially if appositional and propositional modes of analysis are exploited in the same system.[18]

A reformulation of some of the ideas of Lévi-Strauss is appropriate at this point, and the following discussion supplies mechanisms for some concepts that he has not expanded:[19]

1. The most typical form of human thinking from an historical and cross-cultural point of view is appositional and in the form of a calculus of binary oppositions.

2. At least for primitive societies, socio-cultural forms are metaphorically and transformationally related. It is the view of Lévi-Strauss that these transformational-metaphorical relations exist as a device to simplify cognition of the world. Exploitation of such relationships can also simplify computer manipulation of data about the world. If early experiences contribute to the structuring of later experiences, it is the culturally defined interpretation of the early experiences that is the dominating factor. Children learn institutions in the context of a society formed of metaphorically related structures through a process of frame inference and generalization. The first frames learned might represent single or very few instances of a very limited number of events. Those events are compared with successive events and reformulated as more general frames, with classes or features that generalize the finite training inputs, and which define binary oppositions to be used in calculating context sensitive applications of the frames. The child's attempt to impose metaphor upon the world is <u>inherent</u> in the learning mechanisms that generalize finite experiences, and it is facilitated by the fact that the culture he inherits is already structured in metaphorical patterns because of the cyclic repitition of this process across generations. Modern societies do not yield the homogeneity demonstrated in <u>La Pensée sauvage</u> (1962), but metaphori-

cally related sub-groups of institutions may be found, even if their global integration is missing.

The process of frame generalization can be exceedingly difficult in large scale data base systems if the frames are compared in propositional form. If they are stated in appositional form, in a notation of arrays of distinctive features, then any matching of binary feature patterns implies a metaphorical relationship between the frames, and any matching of binary feature patterns through application of a regular system of transformations also implies a metaphorical relation between the frames. The existence of such abstract structural patterning is sufficient to compute mappings between the quantification variables in one frame and the quantification variables in the other. The mappings can be made without direct reference to the internal propositional structure of the frames in question.[20]

It is hardly surprising that the major work of Lèvi-Strauss has been concerned with the logic of myth (1964-71), the highest form of metaphor to be found in a culture. There is heirarchy in the metaphorical and transformational relations of the institutions of a society, and the higher level units of relationship may be encoded in symbolic form. The mythological system symbolically encodes the binary feature patterns that relate whole systems of institutions for a particular society. From this point of view, it is not the content of a myth or a system of myths that is of computational importance, but rather the binary opposition patterns they encode, and the sets of transformations that exist between them. It is these patterns and their relating transformational system that encode the key patterns of the socio-cultural forms in a society, and which provide the ultimate basis for metaphorical relationships.

In conclusion, we note that while we have assumed an implicit metaphorical relationship between computers and the human brain, it is in a theory about the human mind that we find a solution to problems of computation.

Notes

1 We are grateful to Richard K. Greicar, Susan R. Kimura, Margaret R. de Marinis and Stephen J. Scalpone for their assistance with computer programs related to this research.

2 For a review of the literature in computer comprehension systems, see Y. Wilks, "Natural Language Understanding Systems Within the A.I. Paradigm: A Survey and Some Comparisons," in Zampolli (1977:341-398).

3 Recently published works of this movement include van Dijk (1977a, 1977b), van Dijk & Petöfi (1975, 1977), Dressler (1977) and Petöfi & Rieser (1973).

4 Other artificial intelligence researchers who have considered the subject include Bobrow & Norman (1975) and Winograd (1977). The social psychologist, Erving Goffman's concept of frame analysis (1974) is related to the A.I. concept but differs in that the concept of frame is more closely identified with frame as context rather than with frames as abstract scenarios. Labov and Fanshel (1977) have applied Goffman's model in a contribution to sociolinguistics, psycholinguistics and psychiatry.

5 "Automated Novel Writing: A Status Report," (Klein et al, 1973) describes a program that generated 2100 word murder mystery stories in less than 18 seconds, on a UNIVAC 1108/1110 computer, from a first order-predicate calculus text grammar model written in MESSY (meta-symbolic simulation system). The paper also appears in Burghardt & Hölker (1979). "Modelling Propp and Lévi-Strauss in a Meta-symbolic Simulation System," (Klein et al, 1974) describes an automated version of Propp's folktale model, and it contains some 50 fairytales generated by the program. It also appears in Jason & Segal (1977). A revised French version of the paper, with a revised Propp model (and expanded Lévi-Strauss model), and a different set of 50 fairytales, is to be found in Klein et al (1976).

6 The Russian fairytales generated by the computer program follow Propp's model in detail, yet the stories are bad Russian fairytales because of violations of high-level, culturally determined symbolic constraints. In this sense, the results confirm the criticism Lévi-Strauss has made of Propp's work (1960), a paper which is available also in his Anthropologie structurale deux, (1973) (English translation, 1976).

7 A simulation language with a semantic component. Text grammars may be formulated within it as simulation rules, and used generatively in a simulation. Plots are actually executed as computer simulations (with controlled degrees of randomness). The events are recorded in a semantic network, and as the simulation progresses, the altered portions of the semantic network are sent to a linguistic production component that maps semantic network sections onto syntactic rules in a phrase-structure/transformational model. Appelbaum has written a user-manual for the system (1976) with a forward by S. Klein describing its history.

8 This view can be traced back to Aristotle. However, it was not given airing as a systemic thesis until Black (1962:25-47).

9 Ibid.

10 The Rhetoric, 1045a

11 The Poetics, 1457b. See Black, p. 36 for discussion of the relevance of this Poetics section to the traditional comparison view.

12 See J. David Sapir, "The Anatomy of Metaphors," in Sapir and Crocker (1977).

13 These criticisms have been levelled by, among others, I. Loewenberg (1973:30-45) and R. Haynes (1975:272-277).

14 Ibid.

15 Ortony (1978) has discussed (though he has not attempted to explain) the asymmetry of metaphorical statements.

16 The original freshness of a frozen metaphor can always be "figured out" with some elaboration. Perelman remarks (Perelman & Olbrechts-Tyteca, 1966:405) that "the most usual way of awakening a metaphor is to develop a fresh analogy, with the metaphor as a starting point."

17 See note 2.

18 S. Klein, "Whorf Transforms and a Computer Model for Propositional/Appositional Reasoning," presented at the Applied Mathematics Colloquium, University of Bielefeld, Federal Republic of Germany, December 1977, and at the Computer Science Colloquium, University of Paris-Orsay, December 1977. S. Klein, "Lévi-Strauss Computes," presented at a Joint Colloquium of the Anthropology Dept. & the Computer Science Dept., University of California, Irvine, March 1978.

19 Brenda E.F. Beck's excellent review article, "The Metaphor as a Mediator Between Semantic and Analogic Modes of Thought," (1978) also exemplifies the fact that theoretical discussions in anthropological literature usually leave the mechanisms behind concepts unexplored.

20 See note 18.

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