SURREALISTIC IMAGERY & THE CALCULATION OF BEHAVIOR

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We present a model for human cognitive processing which assumes that a major component of the rules for calculating behavior are resident outside the individual, in the inherited, collective phenomena that anthropologists call 'culture.' Our model contains rules of behavior encoded in propositional structures such a frames or scripts, plus a method for calculating behavior by analogy. The propositional rules are transformed into situational state descriptions that are related by transformation operators which are also valid for transforming situations analogically. This kind of operator has been named, 'Appositional Transformation Operator,' or ATO (Klein 1977). The term refers to a theory which posits that the division of labor between propositional and appositional modes of reasoning is culturally determined (TenHouten & Kaplan 1973; Paredes & Hepburn 1976, 1977). The ATO's described by Klein (1977) are derived from the 2-valued, strong equivalence operator of mathematical logic, and from a 3-valued variant. ATO's, mechanically derived from propositional frame descriptions, can be used to calculate behavior by analogy, and in a way that evades many combinatorial problems associated with computation using propositional forms. Tasks of goal related planning can be handled in particularly efficient ways.

The model represents a radical interpretation and extension of ideas of Claude Lèvi-Strauss (1962, 1964-71). We suggest that many of the ATO's in a given society are encoded in the material and symbolic artifacts of its culture. It is not necessary to assume that human processors compute behavior in significantly better ways than contemporary computer models. Rather, it is the collective, inherited cultural environment that supplies the information and constraints that make calculation of behavior a relatively simple task. We suggest that surrealistic imagery present in myth structures encodes ATO's that control social behavior. Surrealistic dream imagery encodes both collective and individual ATO's. The archetypes of Jung, supposedly resident in a collective unconscious, can be interpreted in this model as ATO's in the form of surrealistic, iconic imagery. This imagery emerges independently and in parallel among members of similar social groups as a consequence of their social interactions. ATO imagery is both culturally inherited and spontaneously emergent: it aids in learning the rules of social structure, and emerges as epiphenomena in the minds of individuals as a consequence of the structure and repetition in their everyday interactions. The imagery may shift with social change and the replacement of generations. This reinterpretation of Jung limits similar archetypes to similar sociocultural groups, and makes unnecessary any genetic or metaphysical basis for the concept of 'collective unconscious.'

To explore the ATO thesis, we have constructed a computer simulation model of an artificial society, culture and universe- a world derived from Edwin Abbott's 19th-century fantasy, FLATLAND: A Romance of Many Dimensions (1884). The model is embedded in a new version of the Meta-symbolic Simulation System (Klein et al. 1976, 1977, 1979; Appelbaum 1976) now interpreted in PASCAL for the Terak and Apple microcomputers, and named, ' ||||| ,' (pronounced 'BAR BAR,' for short). We have built a frame-driven model that generates an opera, complete with textual, visual and musical output, all derived from the same semantic source. The rules are somewhat similar in form to those of Propp (1928) and are related to the type in Klein et al. (1976, 1977), plus an improvement: we have now implemented Propp's concept of multi-move tales (i.e. the satisfaction of goals through the calculation of events in parallel). Our output is an opera entitled, REVOLT IN FLATLAND: An Opera in Two Dimensions, produced in the form of a videotape (Klein et al. 1981). At each time increment during the generation of the opera, the complete state of the universe is recorded in a two or three dimensional, binary feature array. This encoding is a consequence of the implementation of the data structures in ||||| (BAR BAR). We may calculate an ATO to relate any two such states. If we save the entire series of ATO's that relate the sequential states of the opera, we have the basis for generating a surrealistic version. To accomplish this we interpret the ATO's, not as operators, but as state descriptions of the universe (they are in exactly the same format as the state descriptions they relate). They may then be used, in original sequence, to generate text, visual imagery and music. It is our thesis that this multi-medium encoding is a significant component of the material and symbolic artifacts of a culture. We suggest that what anthropologists call 'culture' serves as a repository for the analogical operators (ATO's) that make computation of behavior (rules of social structure) a feasible task for human automata. It is also possible to compute ATO's that relate ATO's. These, also, may be interpreted as state descriptions and used to generate a kind of surrealistic imagery in the form of text, visual images and music. At the highest levels, such ATO's can relate patterns behind the patterns that relate patterns of behavior; these ultimately relate all the domains of behavior possible in a society. Such ATO's may be encoded as myth systems, deities or as other forms of iconic imagery. Such a model provides a new level of mechanism for ideas of Lèvi-Strauss (Klein et al. 1980).

We are currently working on a videotape performance of a surrealistic version of our opera, REVOLT IN FLATLAND, to accompany the original. The calculation of plots by propositional reasoning is quite time consuming. The ATO's derived from a simulation generation can also be used to generate a new opera by analogy. All that is required is to specify a new set of initial conditions and the quantification of classes referenced by the ATO's. The derivation of a new opera that is an analogue of the old can take place with calculations no more complex than operations between feature arrays, carried out in chained sequence.

The formal properties of ATO's permit calculation of successor and atecedant states. Accordingly, it is possible to plan by analogy. This kind of planning is not limited to goal states that are realistically attainable in the modelled universe. Because ATO's are analogic, one can calculate the hypothetical requirements to realize an unobtainable goal, via analogy with goal attainment sequences that are possible. The textual, visual and musical realization of our operas may also take a surrealistic or fantasy form if the starting conditions and hypothetical goal states that are specified are made very deviant from what is implied by the rules of primary simulation model. We are also working on the generation of analogical variants of the opera in which initial, intermediate and terminal states are specified that could not be

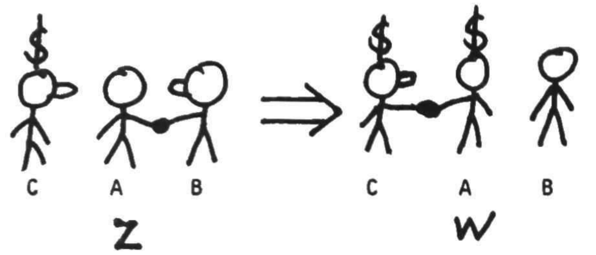
Z		W
A loves no one, has no $, is married to B. B loves A, has no $, is unmarried to A. C loves A, has $, is unmarried.	⇒	A loves no one, has $, is married to C. B loves no one, has no $, and is unmarried. C loves A, has $ and is married to A.

	La	Lb	Lc	$	Ma	Mb	Mc
A	.	0	0	0	.	1	0
B	1	.	0	0	1	.	0
C	1	0	.	1	0	0	.

	La	Lb	Lc	$	Ma	Mb	Mc
A	.	0	0	1	.	0	1
B	0	.	0	0	0	.	0
C	1	0	.	1	1	0	.

*ZW

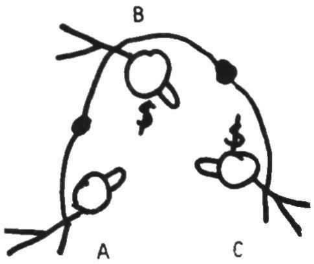
.	1	1	0	.	0	0
0	.	1	1	0	.	1
1	1	.	1	0	1	.



*(*XY)(*ZW)

.	1	1	0	.	1	0
0	.	1	1	1	.	1
1	1	.	1	0	1	.

=



"surrealistic" interpretation

A loves B & C, has no $, is married to B. B loves C, has $, and is married to A & C. C loves A & B, has $, and is married to B.

If we then postulate a situation P,

	La	Lb	Lc	$	Ma	Mb	Mc
A	.	1	1	0	.	0	0
B	1	.	0	0	0	.	0
C	1	0	.	1	0	0	.

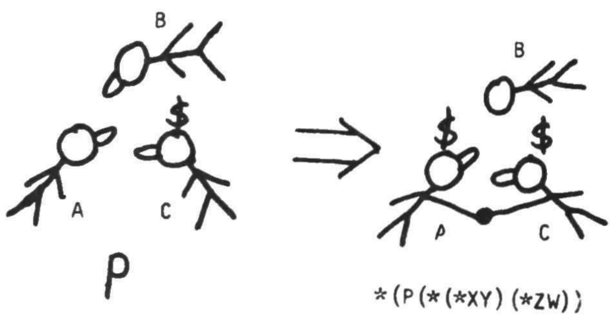
= A loves B & C, has no $, and is unmarried. B loves A, has no $ and is unmarried. C loves A, has $ and is unmarried.

we can compute its successor state by analogy with the combined results of X⇒Y & Z⇒W by solving ((X :: Y) :: (Z :: W)) :: (P :: ?), where ? =

P((*XY)(*ZW))

	La	Lb	Lc	$	Ma	Mb	Mc
A	.	1	1	1	.	0	1
B	0	.	0	0	0	.	0
C	1	0	.	1	1	0	.

= A loves B & C, has $, and is married to C. B loves no one, has no $, and is unmarried. C loves A, has $ and is married to A.



(P((*XY)(*ZW))

Planning and Deviant Behavior

If a sequence of events, A, B, C, D, occur, then

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   *AC *BD = patterns behind patterns behind events
     /\  /\
 *AB *BC *CD = ATO patterns behind events
  /\/ \/ \
A   B   C   D = event sequence
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If we wish to obtain a state E instead of D, without changing any of the ATO's, we derive, by analogy, a sequence leading to E by replacing A, B, C, respectively, with *A(*DE), *B(*DE), *C(*DE). If we wish to make a plan that specifies more than one goal state in the event sequence, we must alter some ATO's.

We suggest that the meaning of 'culturally defined behavior' is that members of a society plan in a way that minimizes the level and number of ATO's affected. It follows that deviant behavior may be interpreted as behavior that violates acceptable levels and numbers of ATO's. ATO patterns are part of the knowledge acquired by children. We posit that ATO patterns are encoded in multiple mediums of expression, both material and symbolic, and that they are the source of metaphor. It is this encoding that gives form to a culture, and it is this distributed presence in the environment that makes calculation of social behavior computationally feasible for the human mind.

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derived from the propositional rules, but which could be obtained by hypothetical analogy.

ATO's - Appositional Transformation Operators

ATO's relate situational descriptions in the form of feature arrays. A 2-valued version, essentially, is the strong equivalence operator of mathematical logic. If the interpretation of 1 and 0 are reversed, the operator is equivalent to non-carry, binary addition. The ATO is actually an array of bit operators defined as follows:

* a b	= c
0 0	1
0 1	0
1 0	0
1 1	1
. .	.

where '.' means 'does not apply,' making this specification 2-valued, with some augmentation.

The operator has the following properties:

*ab = "ATO"

*ab = *ba

*a (*ab) = b

*b (*ab) = a

	a		b
e.g.	110	⟺	011
	011		100
	1.1		0.0

*ab
010
000 = "ATO"
0.1

A 3-valued variant is useful for state transitions where events emerge that were not present in the initial state. One can represent this with the 2-valued ATO, but the 3-valued variant is also useful. Again, a reversal of the interpretation of 1 & 0 yields an implementation as non-carry addition.

*	0	1	.	.0
0	1	0	.0	.
1	0	1	.	.0
.	.0	.	1	0
.0	.	.0	0	.

Examples of ATO's in Analogical Inference

Consider, first, some simple verbal analogies. A feature array referencing 'male,' 'female,' 'young,' 'adult,' 'love,' 'hate,' 'light,' 'dark,' is sufficient to formulate the following analogy:

X = Boy loves light / Y = Woman hates light :: Z = Girl hates dark / ?

M F Y A L H Lt Dk

where M = male, F = female, Y = young, A = adult, L = love, H = hate, Lt = light, Dk = dark

X = 10101010 / Y = 01010110 :: Z = 01100101 / ?   *XY = 00000011

? = *Z(*XY) = 10011001 = Man loves dark

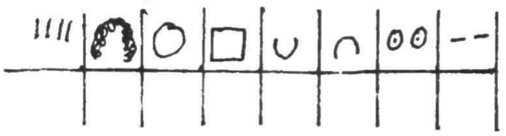
another example:

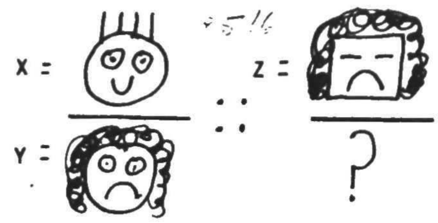
X = Man hates dark / Y = Woman loves light :: Z = Boy hates light / ?

X = 10010101 / Y = 01011010 :: Z = 10100110 / ?   *XY = 00110000

? = *Z(*XY) = 01101001 = Girl loves dark

The same method can be applied to visual analogies. For example, if the following set of visual features is used to create a pictorial analogy, the answer can be calculated using ATO's:



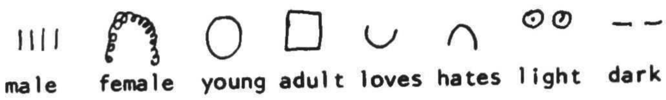


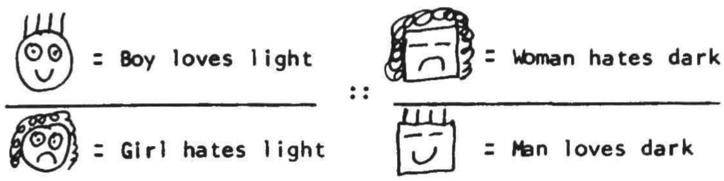
X = 10101010 / Y = 01100110 :: Z = 01010101 / ?   *XY = 00110011

? = *Z(*XY) = 10011001 = 

A visual interpretation of *XY might yield 

If we give natural language interpretations to these visual features, such as,





ATO = *XY =  = sexless being, both old and young; indifferent to light and dark.

Complex analogies may also be computed, e.g.,

If ((X :: Y) :: (Z :: W)) :: (P :: ?) then

? = *P(*(*XY)(*ZW)). Consider a complex example:

X		Y
A loves B, has no $, and is not married. B loves A, has no $, and is not married. C loves no one, has $ and is unmarried.	⇒	A loves B, has no $, is married to B. B loves A, has no $, is married to A. C loves no one, has $ and is unmarried.

Where La = 'loves A,' etc., $ = 'has money,' and Ma = 'married to A,' etc., the X Y states may be represented as follows:

X:

	La	Lb	Lc	$	Ma	Mb	Mc
A	.	1	0	0	.	0	0
B	1	.	0	0	0	.	0
C	0	0	.	1	0	0	.

⇒

Y:

	La	Lb	Lc	$	Ma	Mb	Mc
A	.	1	0	0	.	1	0
B	1	.	0	0	1	.	0
C	0	0	.	1	0	0	.

*XY

.	1	1	1	.	0	1
1	.	1	1	0	.	1
1	1	.	1	1	1	.

If we depict 'loves' as a nose pointing at the beloved (in between, if two loves), and if a noseless state means 'loves no one,' and if holding hands depicts 'married to,' and if a '$' indicates, 'has money,':