

Abstract Patterns in Stories: From the intellectual legacy of David G. Hays

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Abstract. Coleridge’s “Kubla Khan” exhibits nested structures suggesting an underlying computational process. Seeking to understand that process I joined the computational linguistics research group of David G. Hays in 1974, which was investigating a scheme whereby abstract concepts were defined over patterns in stories. Hays examined concepts of alienation; Mary White examined the beliefs of a millenarian community; and Brain Phillips implemented a system that analyzed short stories for the theme of tragedy. I examined Shakespeare’s sonnet 129, “The Expense of Spirit”, but was unable to apply the system to “Kubla Khan”. In 1976 Hays and I imagined a future system capable of ‘reading’ a Shakespeare play in some non-trivial manner. Such a system had not yet materialized, nor is it in the foreseeable future. Meanwhile, I have been identifying texts and films that exhibit ring-composition, which is similar to the nesting evident in “Kubla Khan”. Do any story generators produce such stories?

Keywords: narrative, abstraction, cognitive networks, ring composition.

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In scientific prognostication we have a condition analogous to a fact of archery—the farther back you draw your longbow, the farther ahead you can shoot.
— Buckminster Fuller

Since this a workshop in history and I'm in the no-man's zone between middle and old age, perhaps you won't mind if I take a somewhat personal and informal style in this paper. In the spirit of Wordsworth's "The child is father to the man" I start there, but then move quickly to the intellectual milieu of my undergraduate years in the middle and late 1960s. From there it's symmetry in "Kubla Khan" and off to Buffalo where I joined a computational linguistics research group convened by David Hays, in linguistics, while at the same time working on a Ph.D. in English literature. The work of that research group is the focus of my story. From there we go through the mid-1980s AI Winter and arrive at my current hobbyhorse, ring-composition. I conclude that the singularity is now.

1957: Sputnik, Frye, and Chomsky

I was almost ten years old when, in October of 1957, the Soviet Union launched the first artificial earth satellite. By that time watching Walt Disney on TV had primed me for space travel, not to mention science fiction films such as *Forbidden Planet*. The launching of Sputnik is thus the first world-historical event that was also personally important to me—that's where I wanted to go, up there, space.

1957 also saw the publication of Noam Chomsky's *Syntactic Structures*, and Northrup Frye's *Anatomy of Criticism*, while George Miller published his classic paper, "The Magical Number Seven, Plus or Minus Two" in the previous year, 1956, which also gave us The Dartmouth Summer Program on Artificial Intelligence. John von Neumann died early in 1957, but not before he all but finished his last work, *The Computer and the Brain*, which was published in 1958, which also saw Claude Lévi-Strauss publish *Anthropologie Structurale*.

I never made it into space, though I spent the summer of 1981 on NASA fellowship, but I read Chomsky, Frye, Lévi-Strauss, and Miller during my years at Johns Hopkins in the 1960s and 70s and, had, of course been influenced indirectly by von Neumann – haven't we all? – and by the work that came out of that Dartmouth summer program. During my freshman year at Hopkins (65-66) we all trooped to a certain dorm room where the door was adorned with a the image of a naked woman rendered in a pattern of alphanumeric characters – oh, the school was all-male at the time. It was a thing of wonder: *A computer did that? Won!* Surely it had been nothing more than a printout of a text file, but what did we know? It was a computer. A couple years later I took my one and only course in computer programming. We programmed in Dartmouth Basic using punch cards and paper tape for input. I remember three programs, one was a search of a hidden surface, one was a queuing problem, and one was tic-tac-toe. I got a B.

I majored in philosophy, but it was literature that captured my imagination. I took several courses and an independent study with Dr. Richard Macksey, a polymath who was also interested in film, spoke I don't know how many languages (12-18, something like that), and had a fabulous library that included first editions of *Tristram Shandy* and of the *Principia Mathematica*. Macksey was

associated with the newly formed Humanities Center, which had been funded by the Ford Foundation to undertake interdisciplinary work. The Center's first major project brought a bunch of French eminences to Hopkins in the fall of 1966 for the (in)famous structuralism conference, "The Language of Criticism and the Sciences of Man". That conference that put Jacques Derrida on the intellectual map.

I didn't attend the conference—wouldn't have done me any good, as I didn't speak French. But that was the milieu in which I got my undergraduate education, call it 'comparative literature in English translation as the focal point for the study of mind, language, and culture'. It culminated in a master's thesis on Coleridge's "Kubla Khan". And thereby hangs a tale.

Computing "Kubla Khan"

"Kubla Khan" is one of the best known and most frequently anthologized poems in the English language. It's not obvious how to apportion this prominence between the poem's intrinsic qualities and the aura of mystery Coleridge bestowed upon which his preface. He claimed the poem came to him as a vision in an opium-inspired reverie that was, alas, interrupted by a "person on business from Porlock".

One of the century's great romanticists, Meyer Abrams, started his career with a mid-1930s Harvard honor's thesis entitled, *The Milk of Paradise: The Effect of Opium Visions on the Works of DeQuincey, Crabbe, Francis Thompson, and Coleridge*. In 1953 Elisabeth Schneider published *Coleridge Opium and Kubla Khan*. Albert Hoffman first synthesized LSD in 1938 and discovered its psychedelic properties in 1943. A whole generation – or so it would seem – discovered those properties in the 1960s, leading Disney to market *Fantasia* as a psychedelic film in a 1969 theatrical re-release.

That's when I became interested in "Kubla Khan", the spring of my senior year at Hopkins. I went on to write a master's thesis about the poem. I started out intending to do a structuralist analysis of the poem, more or less on the model of Lévi-Strauss's work on myth. For whatever reason that didn't work out. Without going into the bloody details, which include, wouldn't you know it? an acid trip – I tell the story at some length [1] – I ended up discovering that the poem had a most remarkable structure.

"Kubla Khan", like any natural language text, is a string. And strings consist of substrings, which may themselves consist of substrings, and so forth. Ultimately you get to individual alphanumeric characters. "Kubla Khan" is 54 lines long and consists of two movements, let's call them; the first is 36 lines long and the second is 18 lines long. Figure 1 analyses the first movement into component strings, where each terminal node consists of two or three lines. Notice that the movement as a whole breaks into three components, the middle of those in turn breaks into three, and the middle of that, three substrings again. One might think of those nested Russian dolls. Or one might think of some kind of nested computational structure. Since the poem is not carved out of wood, the latter is a more plausible bet. It turns out that the second movement is pretty much the same kind of structure. With half as many lines, it's not so fully developed, but that three in three in three nesting is there.

Now things get really interesting. The first movement ends with this line: "A sunny pleasure-dome with caves of ice" (l. 36). Guess what appears in the middle (of the middle (of the middle)) of the second movement? You guessed it: "That sunny dome! Those caves of ice!" (l. 47). It's as though the value of some expression is calculated to be "A sunny pleasure-dome with caves of ice" in the first movement and that value is inserted into the center (of the center (of the center)) of the second movement at line 47. That's what I thought then, in the early 1970s, and it's what I think now. Just how that calculation works, that I do not know. But I've put the question on the table.

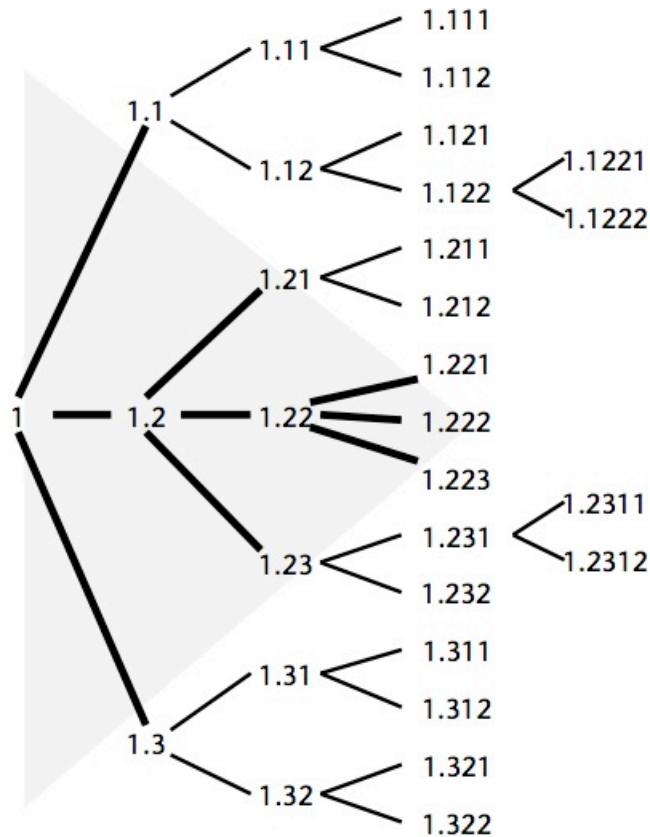


Figure 1. Structure of “Kuba Khan”, lines 1-36.

There’s much more to the poem’s structure than just that, which I set out in some detail [2, 3], but that’s enough to show why I decided that I needed to know more about computation. Do I think the mind IS a digital computer? No. I don’t think that now, didn’t think it then. But surely the mind has a computational aspect and there is a digital aspect to those computations, no?

That’s what I wanted to investigate for my Ph.D. I set off for the Department of English at the State University of New York at Buffalo in the fall of 1973. At the time there was a strong relationship between literary studies at Hopkins and literary studies at Buffalo. For example, the novelist John Barth had just left Buffalo to join the faculty at Hopkins (where he’d done his undergraduate work) and Eugenio Donato, who’d been one of the co-organizers of the structuralism conference at Hopkins, had just gone to Buffalo. There was a two-way pipeline in place.

Moreover, Buffalo English had what was arguably the finest experimental Ph. D. program in the nation [4]. Where almost all humanities doctoral programs required competence in two, if not three foreign languages (one of them classical), Buffalo would waive that in favor of a master’s level of competence in a cognate discipline. The department itself offered programs in psychology (mostly psychoanalysis), society (mostly Marxism), and philosophy (generally Continental). But students were free to take courses in other departments, which is what I did.

Abstract concepts as patterns over stories

I studied psycholinguistics under David G. Hays in the Department of Linguistics. Hays had gotten his degree in Social Relations at Harvard, spent a year at the Center for Advanced Studies in the Behavioral Sciences at Stanford and took a job at the RAND Corporation where he headed their

program in machine translation in the 1950s and into the 1960s. He championed Lucien Tesnière's dependency grammar, as opposed to Chomsky's immediate-constituent approach, published the first textbook in computational linguistics, *Introduction to Computational Linguistics* (American Elsevier 1967), helped found both the Association for Computational Linguistics and the International Committee on Computational Linguistics, and was the first editor of *Computational Linguistics* (then called the *American Journal of Computational Linguistics*). He left RAND in 1968 and joined the faculty of SUNY Buffalo in 1969, where he was founding chair of the new linguistics department and also held appointments in Computer Science and in Information and Library Studies.

I didn't know Hays was at Buffalo when I applied there in English, nor would that knowledge have meant much to me if I had known. *Computational linguistics?* To be honest, I didn't know what I was going to do at Buffalo. My work on "Kubla Khan" was unlike anything I, or anyone I know, was familiar with. I was just hoping things would somehow work out.

I didn't find my way to Hays until the spring of 1974. I was sitting in the English Department's student lounge talking with Ralph Henry Reese, who showed me some cognitive network diagrams he'd done with this guy in linguistics, David Hays. That got my attention. Before I'd left Hopkins I'd found Sydney Lamb's work in stratificational grammar which, as you may know, is based on a network notation [5]. It was centered on morphology and syntax and rather thin on semantics, which is what I was after, but I liked the diagrams. I'd also found Ross Quillian's early work [6] and Don Norman's work [7]; both used diagrams as well. If this David Hays could teach me to draw cognitive diagrams, then I'd better check him out.

So I made an appointment to meet with him – perhaps Reese gave me an introduction, I don't remember – and we met and talked. I gave him a copy of my "Kubla Khan" thesis. He read it and liked it, but didn't have much to say. We hit it off and I became his student. In the fall of 1975 I enrolled in a seminar with him, one of those open-ended "topics in X" courses where you can make it up as you go along. Hays was big on "language as a focus of intellectual integration" – that may even have been the name of the course. There were only a half-dozen or so students enrolled and we each got to put books on the table. As I recall, we read, among others, Talcott Parsons, *The Social System* (Hays had studied under Parsons at Harvard), William Powers, *Behavior: The Control of Perception* (which loomed large in our subsequent work), Gregory Bateson, *Steps to an Ecology of Mind*, Northrup Frye, *Anatomy of Criticism*, and Claude Lévi-Strauss, *The Raw and the Cooked*. At the same time I had weekly tutorial sessions in Hays's cognitive system. Later on I attended weekly meetings of his research group which he held at his home on the shore of Lake Erie.

In 1973 Hays had proposed that abstract concepts got their meaning from stories [8]. Charity was the standard example. What is *charity*? *Charity* is when *someone does something nice for someone else without thought of reward*. Consider the following diagram:

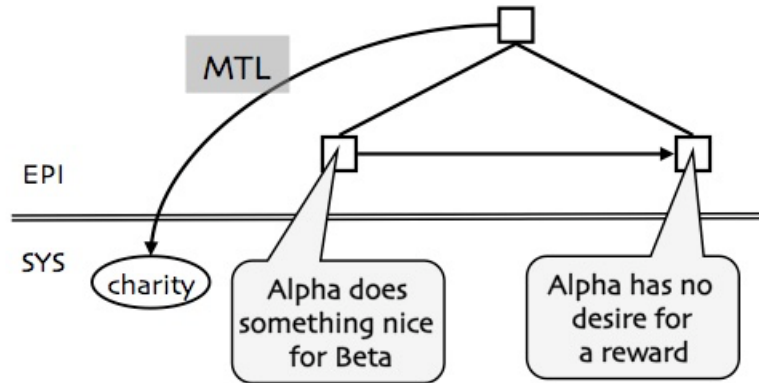


Fig 2. Metalingual definition for *charity*.

Note, first of all, that the network is divided into a systemic network (SYS) at the bottom and an episodic network (EPI) at the top. That was a fairly standard distinction at the time, where the systemic network is roughly like dictionary while the episodic network is roughly like an encyclopedia. Those square episodic nodes are called modalities and they anchor things and events in space and time. The two speech balloons, of course, are just a quick and dirty stand-ins to represent networks of systemic concepts. In this case, someone (Alpha) does something nice for someone else (Beta) and subsequently has no desire for a reward. It is these two things conjoined together – the modality at the top – that constitute the charitable act.

Notice that the episodic pattern is linked back to a node, labeled *charity*, in the systemic network. The edge that does that is said to be a metalingual edge (MTL), named after the metalingual function of language as defined by Roman Jakobson [9]. We called this mechanism metalingual definition. Thus defined, charity is a function of the entire story, not of any one element in the story. One recognizes acts by charity by identifying stories that have the appropriate elements in the appropriate arrangement. A systemic concept that is thus metalingually defined could, in turn, play a role in a story that defines some other systemic concept, yielding a recursive nesting of abstract concepts within abstract concepts.

At the time I joined his research group Hays had just completed a paper in which he used the concept of metalingual definition to analyze various concepts of alienation used in the social sciences [10], including those by Karl Marx (“a condition of certain societies at certain periods”), Melvin Seeman (“the content of certain beliefs”), and Walter Gerson (“a mode of operation of the human personality”). One graduate student, Mary White, was finishing a dissertation where she investigated the belief system of a contemporary millenarian community and used the model to analyze and describe those beliefs [12] – CDC (Control Data Corporation) no longer exists.

Phillips was interested in the difference between stories that were merely narratives and stories that had thematic content. He chose tragedy as his theme. What is tragedy? Tragedy is when “someone does a good act that results in his death” [13]. Figure 3 shows how Phillips represented it (redrawn from 13, Figure 6):

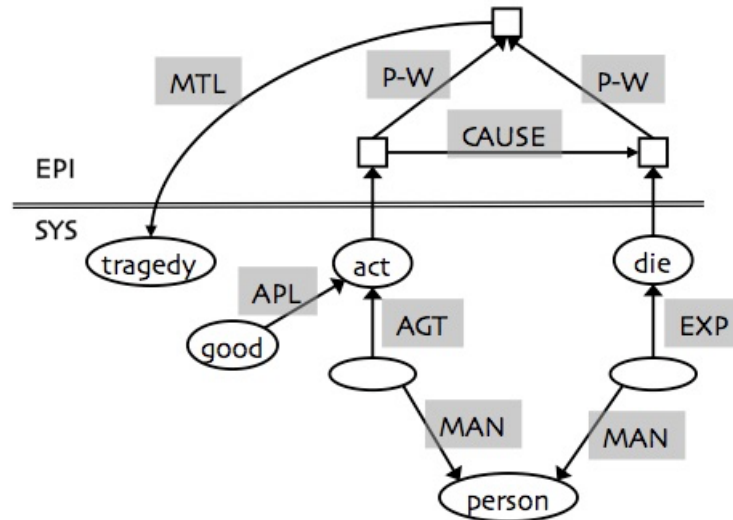


Fig. 3. Metalingual definition for *tragedy*.

The first clause (just left of center) indicates that some person does a good thing and the second clause (to the right) indicates that they subsequently died. It is the conjunction of these two events that constitutes the abstract notion of tragedy. For those who are interested in such details, the meanings of the edge labels are: P-W: part-whole; CAUSE: event at the tail end causes the one at the head; APL: apply, node at tail modifies node at head; AGT: agent, tail node is agent in the act; EXP: experiencer, tail node experiences the act.

MAN, for *manifestation*, was one of Phillips's contributions to the model. A manifestation of some entity is, if you will, a time-slice of that entity, that entity at a particular time and in a particular place. Properties attached to a manifestation are limited to that manifestation. If you attach the property *sick* directly to *John*, that implies that John is inherently and perpetually sick. If you attach it to a manifestation of John, then it is only that particular manifestation that is sick. In our little definition of tragedy the manifestation that does the good deed is different from the one that dies (and, of course, the death of a manifestation entails the death of the person).

Phillips tested the system by analyzing a number of stories. Most had been elicited from students taking linguistics and English classes, but he found at least one in *The New York Times*. The system had no parser, only semantics; input was thus expressed in a cognitive formalism rather than using raw text.

Consider the following two examples:

(Story 4) A body was found early yesterday at the foot of the Mango River, near Clubsport. The body is believed to be that of Jose Gepasto. It seems as if Mr. Gepasto's car made a wrong turn on the highway and plunged into the water.

(Story 22) DF, 43 years old, of Queens, drowned today in MB reservoir after rescuing his son D, who had fallen into the water while on a fishing trip at TF, near here, the police said.

Story 22 – the story from *The New York Times*, with names redacted – exhibits the pattern of tragedy, a man died subsequent to rescuing his son. Story 4 does not.

Notice that in reading Story 4 we assume that Mr. Gepasto must have been inside his car and the, because the car fell into the water, he must have fallen too. The story doesn't explicitly say

that, nor does it say that he drowned. We infer such things because it is, well, you know, common sense. *Everyone knows that*. But not the computer; such knowledge must be hand-coded into the system's knowledge base. We'll return to this idea a bit later.

Reading Shakespeare

I came to Hays with a very specific problem: I wanted to understand what was going on in “Kubla Khan”. When I started working with him I assumed that “Kubla Khan” would be the central example in my dissertation. For whatever reason, things did not work out that way. Instead, I used a Shakespeare sonnet. But we're getting ahead of the story.

Reworking the model

Forget about abstract concepts for a moment. How do simple concrete things get their definitions in such a system? There's nothing abstract about sticks, stones, or apples, but how do such things get defined? That was a major topic of discussion in Hays's research group in 1975 and was central to the book that Hays wrote at that time, *Cognitive Structures* [14]. The answer we arrived at, and that Hays worked out in some detail, was hardly novel in general outline. Such things were defined by sensorimotor schemas of some kind. Hays turned to William Powers for a scheme on which to model the sensorimotor system. Powers explained that scheme in *Behavior: The Control of Perception*, which we had read in that 1975 seminar. The scheme was based on classic negative feedback control systems dating back to the work of Harold Black in the 1920s. Now we had a sensorimotor system that was analog in character riding 'beneath' our systemic and episodic networks, which were digital in character.

Thus we have:

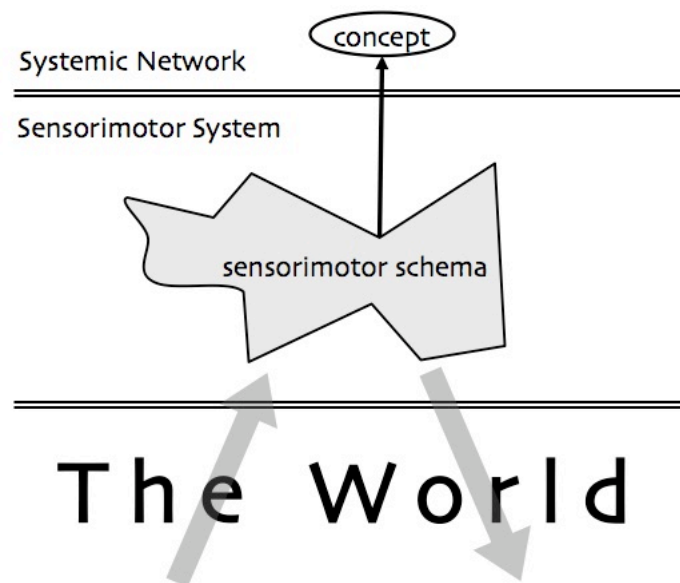


Fig. 4. Sensorimotor definition of systemic node.

If the systemic concept is that of *apple*, then it is defined by the sensorimotor schema for apple. If it is the concept of *rabbit*, then it is defined by the sensorimotor schema for rabbit. If we're dealing with *hit*, as in *the car hit the boy* or *the batter hit the ball*, then it is defined by the sensorimotor schema for hit. Though Hays had some (nontrivial) things to say about how such things might work in

Cognitive Structures, those remarks were not sufficient for a computer implementation. But, as I'll get to in a moment, that's beside the point. It seemed to us then, and seems to me now, that the sensorimotor world, the world of perceptions and motor actions, operates on somewhat different principles from the symbolic world, and that we have to make provision for that difference in our thinking, even if it requires us to postulate the existence of processes whose mechanisms elude us.

There's an important methodological issue at stake here. In those days there was a bit of tension between computational linguistics and artificial intelligence. Many workers in CL, and psychology for that matter, thought that work in AI was too focused on hacking a system together without regard for theoretical motivation. A working computer system is a good thing; if your objective is a practical one, it is also a necessary thing. A working system may also be useful in simulating psychological and neural processes. But we can't always create such models and we may not wish to confine our investigations to areas where such models are possible. Indeed, to do so would be foolish, for it would confine our inquiry to the current state of the art. How can we extend our capabilities if we cannot first imagine what we cannot actually accomplish? That's where Hays was when he began incorporating Powers's analogy feedback loops into the model. Understanding requires that we postulate their existence, even if we don't have the means to model them.

The Expense of Spirit

And that's certainly where I was with my interest in poetry. When I began working on Shakespeare's famous sonnet 129, "The Expense of Spirit" I had no intention of modeling the *whole thing*, much less implementing a computer simulation of such a model. I just wanted to do something that *felt useful* – a vague criterion if ever there was one, but nonetheless real – that afforded some kind of insight.

Here's the sonnet, with modernized spelling:

- 1 The expense of spirit in a waste of shame
- 2 Is lust in action, and till action, lust
- 3 Is perjured, murderous, bloody, full of blame,
- 4 Savage, extreme, rude, cruel, not to trust;
- 5 Enjoyed no sooner but despised straight,
- 6 Past reason hunted, and no sooner had,
- 7 Past reason hated as a swallowed bait
- 8 On purpose laid to make the taker mad:
- 9 Mad in pursuit and in possession so,
- 10 Had, having, and in quest to have, extreme;
- 11 A bliss in proof, and proved, a very woe,
- 12 Before, a joy proposed, behind, a dream.
- 13 All this the world well knows; yet none knows well
- 14 To shun the heaven that leads men to this hell.

Let's begin at the beginning. The first line and a half is generally taken as a play words. In one sense, *expense* means ejaculation and *spirit* means semen, making *lust in action* an act of sexual intercourse. You can't get more sensorimotor than that.

But the lines can also be mapped into Elizabethan faculty psychology, in which *spirit* was introduced as a *tertium quid* between the material body and the immaterial soul(s). The rational soul exerted control over the body through the intellectual spirit or spirits; the sensitive soul worked

through the animal spirit; and the vegetative soul worked through the vital spirit. Madness could be rationalized as the loss of intellectual spirit causing a situation in which the rational soul can no longer control the body. The body is consequently under control by man's lower nature, the sensitive and vegetative souls. That too is lust in action. But the conception is abstract. It is this abstract lust in action that allows uncontrolled pursuit of the physical pleasures (and disappointments) of sex.

The uncontrolled and unfulfilling pursuit of sex can be expressed as a narrative that is at the core of the sonnet. The first 12 lines direct our attention back and forth over the following sequence of actions and mental states:

Desire: Protagonist becomes consumed with sexual desire and pursues the object of that desire using whatever means are necessary: "perjur'd, murderous, bloody . . . not to trust" (ll. 3-4).

Have Sex: Protagonist gets his way, having "a bliss in proof" (l. 11)

Shame: Desire satisfied, the protagonist is consumed with guilt: "despised straight" (l. 5), "no sooner had/ Past reason hated" (ll. 6-7).

We might diagram that narrative like this:

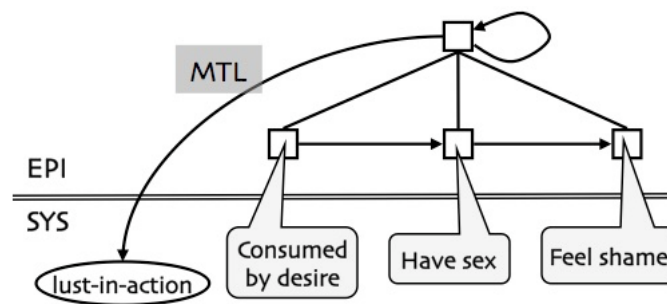


Fig. 5. Metalingual definition for lust-in-action.

Line 4 looks at Desire ("not to trust"), then line 5 evokes Have Sex followed by Shame. Line 6 begins in Desire then moves to Have Sex, followed by Shame at the beginning of line 7, whose second half begins a simile derived from hunting. Line 10 begins by pointing to Shame, then to Have Sex, then to Desire, thus moving through the sequence in reverse order. It concludes by characterizing the whole sordid business as "extreme." I leave it as an exercise for the reader to trace the sequence in lines 11 and 12.

Now, consider that simile in lines 7 and 8, in which a person possessed by lust is likened to an animal enraged by poison, poison deliberately laid to achieve that effect. Here's a diagram:

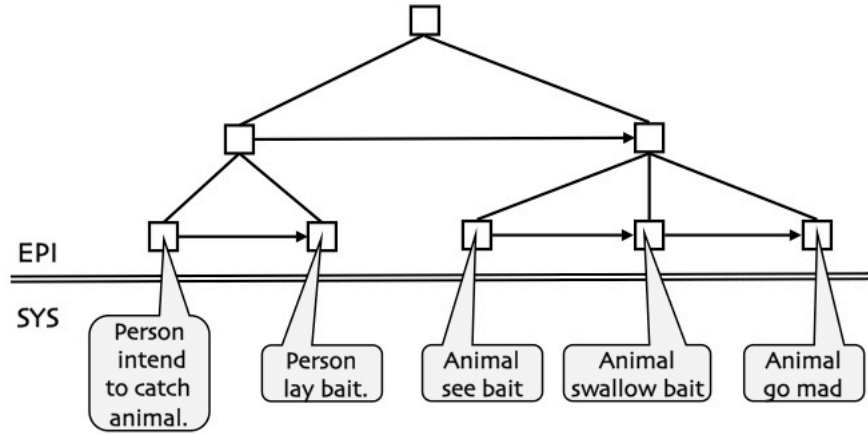


Fig. 6. A swallowed bait.

The three episodes at the right conform to the same pattern as the lust sequence in Figure 5. “Animal see bait” is parallel to “consumed by desire”; “animal swallow bait” is parallel to “have sex”; and “animal go mad” is parallel to “feel shame”. But what about that pair of episodes to the left, where the person lays the bait to capture the animal? There’s nothing like that in the lust sequence. But then, the poem doesn’t end with the lust sequence.

The concluding couplet leaves that entire sordid business behind, rises above it, and treats it as an object of contemplation:

All this the world well knows; yet none knows well
To shun the heaven that leads men to this hell.

It is that whole sordid business that the world well knows. While that knowledge does not exempt us from that sordid business, perhaps there is some solace in realizing that we’re all in this together.

Figure 7 depicts the cognitive structure of the final couplet at the left and the lust sequence on the right:

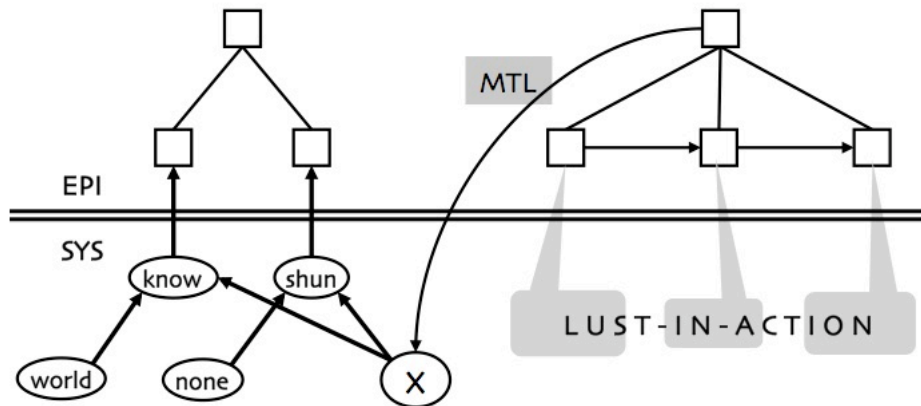


Fig. 7. This the world well knows.

Notice that node labeled with an X. Its meaning is given metalingually by the lust sequence, all of it. The world (i.e. everyone in the world) knows something. What? The story of lust. No one is able to shun *something*. What? The story of lust, that’s what.

The whole diagram is now rather like that in Figure 6, the story of poisoned bait. “Rather like” is not, of course, “exactly like”. But then, this is poetry, not chess, or mathematics. And rather like is good enough. What I’m suggesting is that the simile in lines 7 and 8 – at the end of the second quatrain, by the way, a strategic position in a sonnet – sets the reader up for something in addition to the three-part-lust sequence, something that has a similar relationship to that sequence that the hunter’s action has to consequent madness of the animal that swallowed the bait. That concluding couplet satisfies that expectation. To the extent that one’s knowledge of the lust sequence is unable to prevent that sequence, we can say that that knowledge plays a causal role in that sequence.

It’s not the kind of argument I’d want a propulsion engineer to use. But this isn’t rocket science. It’s poetry. It’s myth. It’s magic, and it’s just fine. It was good enough for publication in the special Centennial Issue of *MLN*, one of the oldest and most prestigious literary journals in the country [15].

Prospero or bust

At about the same time Hays had been invited to review the computational linguistics literature for a journal that was then called *Computers and the Humanities*. By that time I had been working as bibliographer for the *American Journal of Computational Linguistics* for about a year and, in that capacity, had been reading widely in the current literature. So Hays asked me to draft the review [16]. By that time humanities computing, as it was then called, had been around for two decades or so, but it was rather distant from computational linguistics. Hays and I explained briefly what the discipline was about, reviewed work in parsing, speech recognition, speech understanding, and cognitive networks – giving attention to both CL and AI without, I hope, prejudice – and then reviewed my work on Sonnet 129.

Beyond that we sketched out a thought experiment we called Prospero. Prospero was a computational model of Shakespeare’s mind, or at least enough of a mind that it could ‘read’ Shakespeare plays in some ‘interesting’ way, whatever that might mean. The idea is that, while we can’t get inside a person’s head while they’re reading a text, or attending the theater, we can examine what steps a computer takes as it works its way through, say, *Hamlet*. We didn’t specify a delivery date for Prospero. Hays didn’t believe in such things.

You’ll recall that he had been a first generation researcher in machine translation. You may also know that most of that work was funded by the Department of Defense and that by the early 1960s their Congressional handlers were getting a bit anxious about ever seeing any useful technology in return for their research dollars. The National Academy of Sciences appointed a committee to look into it, the Automatic Language Processing Advisory Committee [17]. ALPAC, as it came to be known, as chaired by John R. Pierce of Bell Labs and Hays was one of the members. The report concluded that no practical technology was forthcoming, but that a research program with a more scientific focus held promise. The first conclusion was attended to, but the second was not, with the result that funding dried up, which in the view of one of Hays’s colleagues, Martin Kay [18] is something Hays had anticipated.

The deeper point, though, is that one simply cannot predict these things, not when you are undertaking research in a fundamentally new arena, which machine translation/computational linguistics was at the time. Hays told me this and, yes, I believed him, but still, I wanted to guess at the future. Though Hays would not have been willing to speculate on a delivery date for Prospero – I doubt that I even suggested one to him, though if I had, I’m sure he would have vetoed it – I did so in my mind. I figured that in 20 years or so I’d be working with Prospero.

Well, 20 years from the mid-1970s would have been the mid-1990s. Was I working with Prospero, or something like it, at the time? No. Not even close. In another two decades, actually a bit less (2011), IBM's Watson would beat humans at Jeopardy. But Watson didn't have anything remotely like the capabilities required for Prospero. Nor is a Prospero-like system on the current horizon. It just doesn't compute.

What happened? A decade before my imagined delivery date for a working Prospero system the bottom fell out of symbolic computing. I am, of course, talking about the so-called AI Winter of the mid-1980s. The systems were computationally expensive, were to be too brittle, and the common sense problem was proving to be intractable. The common sense problem? Remember Brian Phillips's Story 4, the one asserting that a man's car went into the water? Common sense tells us that he must have been inside the car – it was his, after all – and so must have gone into the water when it did. That's what the common sense problem is about, all those little things we know because we've been living in the world 24/7/365 for however many years. If we want computers to make useful inferences about every day events, those systems have to be endowed with common sense. Programming all those itty bitty chunks of trivial information proved to be exhausting.

And so classical symbolic processing, both in AI and CL, bit the dust. New technology emerged, technology based on distributional analysis, machine learning, and neural nets and requiring more computing horsepower than we had in those ancient times. While this work was emerging Hays and I published a series of papers on cultural evolution. Hays was attending the ballet and reviewing the anthropological literature on cultural complexity. I coauthored a coffee table book on computer graphics (*Visualization: The Second Computer Revolution*) and wrote a book on music. And that book on music will take us back where we began, the symmetrical structure of "Kubla Khan".

In search of ring-form texts

In 1976 I noticed an article with an intriguing title, "Measure and Symmetry in Literature" [19]; it was by one R. G. Peterson and appeared in *PMLA* – Publications of the Modern Language Association – the flagship journal of the MLA (Modern Language Association). Given my work on "Kubla Khan" you can see why such a title would capture my attention, for that poem exhibited measure and symmetry in spades. Peterson reviewed a wide variety of work on the topic with the attitude: What are we to make of this? He didn't dismiss the work outright, but he didn't know what to make of it either. It was just, you know, there.

By that time the avant-garde cohort of academic literary critics began rushing headlong into deconstruction and postmodernism; consequently no one paid much attention to Peterson's article. A critical milieu that prided itself on revolutionary subversion, eruption, and disruption was not about to consider the possibility that literary texts might in fact be rigorously and even symmetrically ordered. Having already burned my way through deconstruction on the way to "Kubla Khan" I couldn't afford to be so dismissive.

One of Peterson's topics seemed particularly interesting, ring-composition, texts of the form

$$A, B, C...X...C', B', A'$$

where the first element in the text was answered by the last, the second by the next to last, and so forth, with there being some one central element. Almost all of the work on ring-form texts involved narratives, mostly Biblical and classical, so it didn't seem directly applicable to "Kubla

Khan”, which was not a narrative poem. Still, the formal resemblance between the symmetry in those ring-form narratives and the symmetry in the two movements stuck in my mind.

And it remained there until it was called forth early in the new millennium. In 2001 I had published a book on music, *Beethoven’s Anvil: Music in Mind and Culture*. Mary Douglas, the distinguished anthropologist, had been kind enough to blurb the book and my editor put me in touch with her after the book had been published. It turns out she had become interested in ring composition and would eventually deliver the Terry Lectures at Yale on the subject [20]. Once she’d brought the subject to life for me I went looking for ring-form texts. I spotted something interesting in Osamu Tezuka’s *Metropolis*, a manga he’d drawn and written shortly after the end of World War II. There was a temporal anomaly near the middle, a point where the narrative unexpectedly jumped back in time.

I decided to take a closer look. I created a table in MSWord where each row represented a single scene or self-contained sequence (see Table 1). I put an identifying number in the first column, inclusive page numbers in the second, and notes about the scene in the third. As the manga had no chapter divisions it was up to me to figure out how the narrative broke down. That wasn’t obvious, but it wasn’t rocket science either. When I was done I found that, yes, *Metropolis* was a ring-composition [21].

Table 1. Part of an analytic table for Tezuka’s *Metropolis*.

	Pages	Events
1	8	Frontispiece
2	9–13	Evolution from dinosaurs to the present (19XX)
3	14–18	Enter, the Red Party and Duke Red, infiltrating an international scientific meeting. Duke Red has a big nose. Lawton talks about his synthetic cells.
4	19	Full page zoom (Dr. Piccolo), announcing a most serious matter.
5	20–21	Two page spread on chatter during the meeting.
6	22–23	The end of the world. Black spots on the sun. To the roof.
7	24–25	Scientific deliberations.
8	26–29	Lawton’s proteins are alive. Duke Red commissions an artificial super being. It is to look like a statue from the museum.
9	30–33	Lawton brings it to life and destroys the building, taking the being with him and deceiving Duke Red.
10	34–35	Lawton and the being reappear.
11	36–37	The being goes outside and rescues a girl selling flowers.
12	38–39	A boy, Kenichi, recognizes that the being is modeled after a statue in the Dharma museum.

Over the past few years I’ve spent a fair amount of time looking for and documenting other ring-form texts. For example, Figure 8 depicts paragraph lengths in Joseph Conrad’s *Heart of Darkness*. The paragraphs are listed in order from left to right and the length of each bar is proportional to the number of words in the paragraph:

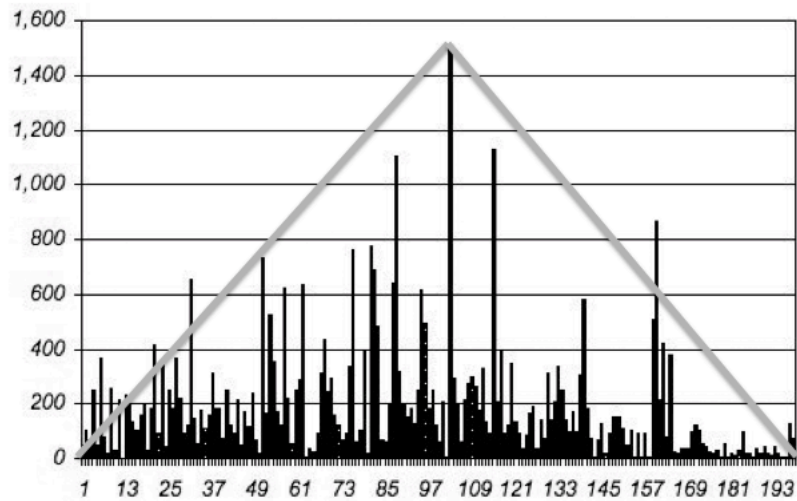


Fig. 8. Paragraph length in *Heart of Darkness*.

That longest paragraph – and at just over 1500 words it is VERY long – surely seems to be in the center. But is that a mere matter of word count (which actually puts it a bit after the center), or is there something deeper going on?

The story, as you may know, has two central characters, Capt. Marlow, the narrator, and Mr. Kurtz, a trader who'd gone incommunicado. Marlow's mission was to find Marlow and retrieve the ivory he'd amassed. Until we get to that paragraph we know little more about Kurtz than the fact that he's station chief of a post up the Congo River and that he's been silent for several months. In that paragraph we get a précis of Kurtz's entire history. That's the sort of thing that led me to think that this paragraph is indeed structurally central. There's more to the analysis than that, of course [22].

And then we have Francis Ford Coppola's *Apocalypse Now*, a film loosely based on *Heart of Darkness*. Does it share a similar structure? I've made an argument [23], though of course it needs to be validated by others. Several years ago David Bordwell, the film scholar, suggested to me in private correspondence that *King Kong* (1933) might exhibit ring composition. I've checked, and it does [24] as does the 1954 Japanese *Gojira* [25] – which started the longest running franchise in film history. President Obama's eulogy for Clementa Pinckney is a completely different kind of text. Guess what? Ring form [26]. And if you examine the televised footage you see that he gets the strongest audience response at the structural center and the very end.

I have no idea how pervasive ring composition is, what percentage of narratives exhibit it – 1%, 17%, 22 %, 48%, I wouldn't want to guess. I'm just looking for them because, well, they're there and I'm sure we've got something to learn by examining them closely. Just what we'll learn, how would I know? I'm just a butterfly collector looking for interesting specimens. Let someone else figure out how they work.

It's in that spirit that I ask you: are there any story generators that produce ring-form texts? If so, how do they do it? If not, what would it take to create such a story-generator? Without cheating. What do I mean by that, without cheating?

What I have in mind is how humans(might) create such structures. Mary Douglas has asserted that she believes ring composition to be conscious and deliberate [20 p. 32]. I can understand why she would believe that. How could a long text be structured in such a way on the basis of intuition alone? I find the question compelling, but Douglas provides no evidence for her

belief beyond her entirely reasonable feeling that such things don't just happen by themselves. She doesn't, for example, produce a passage from ancient rhetorical handbook that argues for ring form, nor does she – or anyone else that I'm aware of – produce a statement by an author saying that they set out to create a ring composition. On the whole I'm inclined to think that ring composition just happens, that it arises from an author's intuitive efforts to make the story “feel right”. Just as Douglas has no explicit evidence for her position, I have none for mine. It's just an educated guess.

Given that, how might ring composition emerge as a byproduct of some computational process? Imagine a very simple and utterly uninteresting story about leaving your home, walking a couple of blocks to the corner store to buy a quart of milk, and then returning home by the same route. Thus:

I put my jacket on and left the house. (1) I turned left and walked past the old Miller place (2), then turned right at the firehouse (3) and headed up Jefferson. I walked a block and a half and arrived at Aunt Maude's Corner Store and went in through the door (4). I got a quart of Farmer Joe's Dairy Fresh Milk and took it to the counter (CENTER) where I paid for it. I turned around and left through the front door (4') and walked along Jefferson to the firehouse (3'), where I turned and walked past the old Miller place (2') and then on back to my house (1). I took my jacket off and tossed it on the hook.

That's a ring composition and it's the byproduct of a simple procedure: Describe your walk. The walk took that form because it had a certain task to be achieved in a certain setting. It's the execution of the task in that particular setting that produced the ring. I might, for example, have taken a different route on my return home; perhaps I wanted to chat with a friend for a few minutes. In that case, no ring.

I have yet to find an example that works like that, though two cases come interestingly close. Both *King Kong* and *Heart of Darkness* involve journeys that depart from one place, go somewhere, and return back to the starting point [27]. Of course, what makes the stories compelling is not just the route, but what happened in the process. That's where the action is.

That, however, is a different kind of discussion. I just wanted to give an idea about how one could get a ring-form text without consciously setting out to do so. There must be other ways of doing it. Or perhaps one can tell a tale where the journey is more abstractly characterized and so is not transparently mapped onto physical space.

The singularity is now

Let's go back to the beginning. As a child my imagination was shaped by Walt Disney, among others. Disney, as you know, was an optimist who believed in technology and in progress. He had one TV program about the wonders of atomic power, where, alas, things haven't quite worked out the way Uncle Walt hoped. But he also evangelized for space travel. That captured my imagination and is no doubt, in part, why I became a fan of NASA. I also watched *The Jetsons*, a half-hour cartoon show set in a future where everyone was flying around with personal jetpacks. And then there's Stanley Kubrick's *2001: A Space Odyssey*, which came out in 1969, which depicted manned flight to near-earth orbit as routine. In the reality of 2017 that's not the case, nor do we have a computer with the powers of Kubrick's HAL. On the other hand, we have the Internet and social media; neither Disney, nor the creators of *The Jetsons*, nor Stanley Kubrick anticipated that.

The point is that I grew up anticipating a future filled with wondrous technology. By mid-1950s standards, yes, we do have wondrous technology. Just not the wondrous technology that was

imagined back then. One bit of wondrous future technology has been looming large for several decades, the super-intelligent computer. I suppose we can think of HAL as one instance of that. There are certainly others, such as the computer in the *Star Trek* franchise, not to mention Commander Data. For the last three decades Ray Kurzweil has been promising such a marvel under the rubric of “The Singularity”. He’s not alone in that belief.

Color me skeptical.

But here’s how John von Neumann used the term: “The accelerating progress of technology and changes in the mode of human life, give the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue” [28]. Are we not there? Major historical movements are not caused by point events. They are the cumulative effect of interacting streams of intellectual, cultural, social, political, and natural processes. Think of global warming, of international politics, but also of technology, space exploration – *Voyager 1 has left the solar system!* – and the many ways we can tell stories that didn’t exist 150 years ago. Have we not reached a point of no return?

The future is now. Oh, I’m sure there are computing marvels still to come. Sooner or later we’re going to figure out how to couple Old School symbolic computing with the current suite of machine learning and neural net technologies and trip the lights fantastic in ways we cannot imagine. That day will arrive more quickly if we concentrate on the marvels we have at hand rather than trying to second guess the future. We are living in the singularity.

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