

TOWARD A STUDY OF STRING FIGURES AND KNOWLEDGE REPRESENTATION

H. T. GORANSON

Name: H T Goranson.

Address: Sirius-Beta, 1976 Munden Point Road, Virginia Beach Virginia 23457-1227, USA.

Email: tedg@sirius-beta.com

Fields of Interest: Deep Structure for Emerging Cognition; Symmetries in Indexing Schemes; Geometric Metaphors in Myth and Art; Collaborative Processes; Insight through Games.

Abstract: *Symmetry and cognition are linked through the simple mechanics of knotting and weaving. We speculate that knots and deep structure in language co-evolved, based on relatively secure data. A research agenda into string-related, geometric concept indexing is suggested. String figures ("cat's cradle") is a proposed focus; artificial conceptual systems the target; work in preparation of the ISIS-Symmetry intertaxonomy a foundation.*

1 THE MOTIVATION

In the past three decades we have seen quite a few approaches to studies which involve an understanding of human cognition. Some approaches, especially those associated with computer science, can in retrospect be termed fads. Several major controversies still rage, with no clear resolution in sight. At the same time, we have applications in current computer environments that demand some practical techniques in developing new languages and cognitive interfaces.

The notion for this study came from a workshop in a United States government laboratory. That lab was one of many that are creating artificial worlds that have very promising properties for general use. Some massive leaps in productivity or utility are foreseen if these worlds can be shaped in such a way to be intuitively negotiable by humans. A useful set of solutions would include a new family of devices for interacting with that world. Presumably, these devices would use some natural motions of hands.

The workshop reviewed possibilities from existing human experience, with an emphasis on those that seem universal, capable of extreme subtleness, and mappable to formal notations. Musical instruments were a focus of much study. In the end though, knots, weaving and string figures were determined the most attractive for a study.

2 A BACKGROUND OF KNOTS AND STRINGS

The evolution of the cognitive senses predated the evolution of modern man. At the first ISIS-S Congress, Nicholas Toth mapped this evolution as seen through symmetry characteristics in stone tools. Stone tools first appear about 2.5 million years ago. At probably a million and a half years ago, these tools show signs of deliberate symmetry. Between 100,000 and 35,000 years ago, the tools went through a shift in manufacturing technology, apparent through great diversity in symmetries. And at 35,000 years ago modern man appeared, displacing all predecessors. The date is controversial and tied to theories of the development of language.

Most probably, some tools from a million years ago used knot technology to affix to sticks, but this is merely induced. But with modern humans, we have representational art, which gives clear evidence for knots and weaving. Some of the oldest art clearly shows that weaving and knotting were part of everyday life. One theory of the evolution of language holds that it co-evolved with basic cognitive skills unique to humans: self-awareness and "explanation." A natural assumption is that such cognitive developments occurred as a result of manual manipulation in toolmaking, including weaving and knotting regardless of the period.

Knots and weaves would have been used for clothing, nets, containers, shelters, affixing tools and assembling boats. Knots would necessarily be learned from one person to another. It doesn't take much imagination to imagine scenarios where mnemonics associated with learning were tied (literally) to representational schemes and associated games.

Repetitive hand motions have been physically linked to higher level reasoning and memory, and since knotted strings produce a physical artifact, the association of cognitive deep structure with string manipulation seems logical. Our proposed study will assume such a linkage without absolute proof. We will then explore what advantages knotting might afford as interface to new artificial spaces, what specific techniques and manipulations might be tied to certain associations, and what the implications for "evolving" new languages may be.

In this, we propose to focus on string figures, often known as "cat's cradle" games. String figures use a continuous loop of string or hide, and a pair or two of hands to produce "figures" often of substantial complexity. String figures are apparently ancient,

with representations as old as art. They are found all over the planet, deeply embedded in many mystical traditions.

String figures are especially notable in Native Australian and American cultures. Similarity with African string diagrams, which use hand motions as mnemonics, is striking, indicating that the linkage with language is very old, and "natural." Incidentally, string figure manipulations can be seen in terms of symmetry operations.

3 ISIS-S TAXONOMY BACKGROUND

A related study has been discussed as a project of the Society (the International Society for the Interdisciplinary Study of Symmetry) since its beginning at the First Congress in Budapest. The aspirations of the project were always high. The immediate need was to provide some sort of indexing system for interdisciplinary contributions. But the scope quickly expanded to employ symmetry principles for a general purpose concept indexing scheme with several quite advanced qualities, many drawn from existing "grand challenges" in logic and cognitive science. One of these qualities was the ability for a researcher to maintain the superficial and ontological peculiarities of their local representations while "seeing" those of others in familiar form.

The notion was that the project itself was deeply rooted in intuitive (artistic) and mathematical understandings of symmetry, and required interdisciplinary skills. It was formally proposed as a project of the Society at the Second Congress in Hiroshima, 1992. Some preliminary work on geometric symmetries in this problem space was performed under US government sponsorship. It was determined that regular periodic concept lattices held great promise from the machine side. Indeed, some experimental applications were built, some patent action taken and a new startup firm (Fusecap, Inc.) eventually formed. But significant problems remained on the human side.

These problems were presented at the third ISIS-S Congress in Washington, D.C. An indepth workshop was conducted including some experts flown in for the event. Out of this began a series of workshops conducted by the US Advanced Research Projects Agency (ARPA). The first of these, held in Dallas, Texas in 1996 focused on topological logic and involved world experts - the president of ISIS-S, Denes Nagy, attended. This series continued for a few years. Some substantial funding was made available to the Society to be the host for the continuing effort. Difficulties with the Secretariat in Budapest prevented this from going forward.

Nonetheless, there was some work done external to the Society, and by the Fourth Congress in Haifa (1998) there were reported some results on notations and historical perspectives related to metaphoric cosmological indices. Since that time, the workshop noted above produced the recommendation to explore string figures. This presentation to the Fifth Congress outlines a possible new research project, for which we invite

participation from ISIS-S members. We will make a similar presentation to the International String Figure Association.

4 THE MATTER OF THE PROJECT

The successful conduct of the project will require experts in: cognitive anthropology, topological logic, human-machine interface, concept indexing, and group/graph/category theory. But it will only work if (image) art and dance performers/theorists are involved. We'll need experts in myth and memory, and of course in the figures themselves.

The goal might be to produce four items:

- A theory. A theory for a new class of notations that are three dimensional: to describe complex symmetry relationships, and that consist themselves of string figure-related symmetry manipulations.
- A technique. An instance of the theory bound to practical limitations of knowledge representation and analyses. Probably, this will relate to several possibly breakthrough projects in related fields. (Distributed, soft, multilayered agent systems is the likely target.)
- A device. A pair of feedback gloves that when manipulated display on a screen one or more of three modes: representations of the hands virtually performing the figures; similar motions "writing" the new three dimensional expressions; navigating and manipulating the ordered three dimensional space.
- A specific vocabulary. A coherent set of ordered metaphors to serve as mnemonics in learning the motions and using the environments. Presumably this would leverage common myths and (as is the case now) physical representations formed by the strings,

References

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