ADAPTABILITY IN NATURAL MEASUREMENT, REPRESENTATION AND EFFECTOR SYSTEMS

Organized by Peter Kugler and George Kampis

Adaptability in Natural Systems: Syntactic, Semantic, Pragmatic?

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A central challenge for the so-called mind-body/symbol-matter problem concerns identification of the functional interface linking constraints residing in an n-dimensional symbolic space (such as, natural language, mathematical, scientific, musical, or other notation systems) with constraints residing in a physical 4-dimensional embedding space (such as 'world at large'). Two approaches to the design of mind-body/symbol-matter interface can be distinguished. The first approach views the problem as principally involving identification of transfer functions that constrain the mapping between states defined in a symbolic space and states defined in a 'world at large'. In this approach the constraints in symbolic space are either locally instantiated (Turing and Von Neumann architectures; symbolic manipulators) or globally distributed (PDP, connection machine, neural net architectures; subsymbolic manipulators). The transfer function acts as a mediational component that circularly map events between states defined in the world at large and states in a symbolic (or network) space through fixed input-output domains. These mappings are distinguished by their required logical depth or layers of analysis. This approach is either syntactically-bound by the isolation of the system's formal description and the world or semantically-bound by a time-invariant set of interface states linking the world at large to internal states. The focus of this approach is on the formulation of mapping algorithms linking inputs to outputs through constraints defined in logical depth or hidden layers. A second approach views the mind-body problem as a fabrication problem associated with the assembly and disassembly of new input-output domains. The input-output domains are identified with meter-effector linkages that dynamically change as a function of time and spatial location. The nonstationarity of input-output domains restricts the logical depth of internal analysis procedures. The focus of this approach is on the fabrication and adaptation principles that underlie the origin and evolution of interface linkages. The openness of the interface domain yields a pragmatic system that is open to new semantic and syntactic primitives. Whereas the former approach emphasizes analysis principles defined on fixed input-output primitives, the later approach emphasizes fabrication and adaptation principles defined on variable meter-effector primitives. The purpose of this talk is to compare and contrast the role of syntactic, semantic, and pragmatic constraints in the entailment of a natural measurement, representation and effector system.

Perception and Life Itself

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There could be no perception without percepts; qualities which are, or which can be, perceived. Much of science is concerned with characterizing a class of elementary or atomic percepts, out of which all others of concern can be built. Particularly, we seek to build general percepts out of atomic ones through syntactic processes of accretion, such as we build white light out of spectral colors. A bundle of percepts can be called a quality, roughly synonymous with what the old scholastic philosophers called an essence. The relation of a percept, or quality, or essence, to whatever manifests it is roughly analogous to the linguistic relation of adjectives to a noun. We will consider, or reconsider, the relation between arbitrary qualities, and those special or atomic ones we inherit from contemporary (especially quantum) physics, which take values only in computable numbers, and which they call quantities. From the perspective of Biology, we shall consider whether what goes on in organisms is compatible with the reductionistic hypothesis that every quality can be quantitated. We will argue that the two are not compatible, and explain some of the implications of this.

Self-Modifying Systems in Biology and Cognitive Science

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The usual method by which life and the mental phenomena are approached starts with the modeling of concrete functional aspects. In this lecture, another approach is presented, trying to give a general characterization of the class to which such systems must belong. A notion that plays a fundamental role here is that of a reading frame. A reading frame (or r-frame) is a mode of interactions that defines a process; for example, the reading frame of a tape recorder is that what specifies it to be a tape recorder, with the magnetic bits (and not, for example, the colors) as relevant information carriers. Analogously, in a formal system, an r-frame is constituted by the interpretation of the symbols. R-frames are closely related to the description frames (or d-frames) by which a process can be represented; through their equivalence, we get a link to models and logic.

What will be characterized as 'simple systems' involve a fixed definition of the internal r-frames and hence of the d-frames too. Their variables, machine parts, categories, etc., are invariant. Such systems can be correctly represented by computational models, that is, *single schemes* to which they conform. However, any model grasps but one facet of an implicate real structure (which is unspeakable) to which it is applied; hence, to every model there belongs a complexity excluded by it.

A truly complex system is one which can access this implicate, hidden complexity and can embody it recursively in a process. An example for such a system would be a tape recorder which within the course of tape processing develops access to new modes of information storage (e.g., bits represented by knots in the tape).

A theory of complex systems called component-systems has been suggested by the author (Kampis, G. (1991). *Self-modifying systems in biology and cognitive science: A new framework for dynamics, information, and complexity.* New York: Pergamon). Component-systems are those which produce their own components. Examples are chemical systems (where the components are molecules) or mental structures (where the components are mental models of parts thereof). Component-production as a process can imply shifts of the r-frames of a system. In other words, the idea is that the newly (i.e., de novo) produced components can interact with some previously unused or undefined properties of the old components, thereby expanding and changing the relevant property space and the system's identity. Such phenomena allow for the production of information and for causal processes beyond the Church-Turing Hypothesis. They lead to non-algorithmic self-modification and to an autonomous definition of a 'vocabulary' together with the meaning of the terms; we get *multiple, variable schemes*, operated upon internally. This framework suggests a solution to a line of old problems in evolution and cognition, which range from tautology (Wittgenstein, Searle) through the frame problem (McCarthy, Pylyshyn) to personal language (Kelly, Pask) and self-reference (Hofstadter, Varela); also implied is a methodology for constructive modeling.

Center of Mass Perception for the Visual Guidance of Grasping: A GSD Problem

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Precision grasps (Napier, 1980) involve opposing contact of thumb and finger tips with object surfaces. Such grasps are organized with respect to the center of mass (CM) in an object. In precision grips, an opposition axis (Iberall, Bingham & Arbib, 1986) extends between thumb and finger tips. Object orientation about this axis is stable when the opposition axis lies above the CM, unstable when below, and neutrally stable when the axis passes through the CM. Which is desired depends on the task. Can observers perceive CM location and if so, what is the information? CM is a dynamic property, but information must lie in geometric properties of objects that map into patterns in light. How might object geometry specify the dynamic property, CM? CM is a symmetry property, so we investigated geometric symmetries in planar objects assuming homogeneous density. The CM lies on any axis of reflective symmetry. Two axis determine CM location in planar objects. We varied the number of such axes in polygonal shapes. O's were asked to indicate where they should grip objects for neutral stability. O's gripped objects using prongs without lifting. Random errors decreased with an increasing number of symmetry axes up to 4 axes. We also varied object size. Size and symmetry interacted in affecting random error. Object orientation affected systematic error. Our objects varied in rotational symmetry in the plane of the object as well as in reflective symmetry. However, the amount of each type of symmetry was not always the same. Which type provided the effective information? We constructed two new sets of objects. One set possessed the same reflective and rotational symmetries as before. The other possessed only the rotational symmetries. Results for the two sets were similar, but not strictly identical.

Finally, what happens when symmetry is absent? We investigated the possibility that an approximation to symmetry is used by perturbing symmetry on a continuum along which distances from symmetry points could be determined. The effect of perturbations was clear. The reliability of results and the accuracy of judgments leaves no doubt that people are extremely skilled at perceiving the CM.