The Model-Based Mind

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Abstract

"The mind" can be defined as a range of functions created from sensory experience that are paired with our representation systems reflected through our behavior. These representation systems (visual, auditory and kinesthetic modalities) are foundations for how effective choices and belief systems are generated through sensory derived processes; how decision-making and learning strategies are constructed; how memory is accessed, stored, retrieved or recalled, and how behavior and knowledge is actualized at both the conscious and unconscious levels. It is these same representational systems that provide us with the capability to model and replicate cognitive processing of the human mind. This paper provides an explanation for modeling the inner workings of the 'cognitive blackbox,' better known as 'the mind.'

Index Terms: mind, representation systems, conscious, unconscious, strategies, cognitive, model, decision-making, behavior, knowledge, reality.

1 Introduction

Research into the behavior of brains indicates that processes of mind are self-referential, serve a function, and are context dependent [1-5]. This is disturbing in conventional science because descriptions of processes that are driven by function, context dependency, or Aristotelian Final Causality, are typically dismissed as unscientific [6]. Nevertheless, these processes can be subjectively modeled, duplicated and taught to others repeatably, consistently, and with considerable accuracy. To gain a deeper understanding of how these processes are modeled, we recognize, via unconscious behaviors revealed at a neuro-physiological level, how representation systems (RS) are paired with sensory input. This is done empirically [7]. However, what is needed is a mathematical description or meta-model that has congruency with the physiological and psychological processes through which awareness is constructed. Such a model would be *impredicative* logically tractable, but incomputable [8]. An impredicative property, P(x), of an object $x \in X$, is the property such that X is the set of objects possessing property P(x). In other words, a predicative object participates in its own definition. Mathematicians do not deny the existence of impredicativities, but regard them as a necessary evil [9]. Impredicative processes, closed loops of causality and bizarre systems are equivalent concepts.

Representation systems are functional components in mental processes. A functional component is context dependent [8]. It has inputs, both from the larger system of which it is a component, and the environment of the larger system. It also has outputs, both to the larger system, and the environment. If the environment, A, changes, then the function of the component, B, changes. A can typically be described by a family of mathematical mappings, that carries a set (the range X, where $x \in X$) to another set (the domain Y, where $y \in Y$), such that, y = a(x), or more formally, $A: X \rightarrow Y$. B can typically be described by another family of mathematical mappings that carries a set (the range U, where $u \in U$) to another set (the domain V, where $v \in V$), such that, v = b(u), or more formally, $B: U \rightarrow V$.

The functionality, F, of the functional component can be described as a mapping that maps a domain set of mappings (A, where mapping $a \in A$) to a range set of mappings, (B, where mapping $b \in B$), such that b = f(a), or $F: A \rightarrow B$. The concept of a mapping that maps one set of maps to another set of maps is not unfamiliar to engineers. This is precisely what happens with a symbolic Laplace Transform.

A functional component differs from the idealized particle of Newtonian physics. The particle's identity (defined in terms of parameters such as mass) is unaffected by context. A particle does not acquire new properties by being associated with other particles. A functional component's context dependency requires that its identity be tied to its function in a larger system. Although it is a thing in itself, it acquires new properties as a consequence of association with other functional components.

The methodological foundation by which we observe these mental processes in terms of representation systems is known as Neuro-Linguistic Programming (NLP). To be effective, representation systems must be impredicative. Predicative processes are too rigid for all but the most superficial communication [10]. This leads one to imagine that NLP can provide a capability in mental processes that, while much more complex than conventional engineering is similar in its functionality to system identification in linear control theory. In system identification, we estimate a transfer function given a set of inputs and outputs. NLP provides a method to estimate a subject's mental strategies (structures of representation systems by which the subject effects learning, motivation, creativity, decision making, remembering, the construction of belief systems, and perhaps other functions) by observing a subject's neuro-physiologically driven responses to given situations.

The conventional applications of NLP are in psychotherapy, learning, salesmanship, and other human-to-human interaction processes in which it is desirable to be able to predict human behavior. We are seeking a radically different application. We seek to use NLP to provide guidance as to how to construct impredicative models on a man-made substrate. These models could be manipulated to draw inferences and abstract meaning from data. The process would be non-algorithmic, unlike any computer program ever yet developed. Today's artificial intelligence systems (AI) are "smart systems" reflecting the programmer's learning and decision-making strategies; these typically include adherence to the Church-Turing thesis, and its limitation to strictly predicative processes. In escaping this limitation by constructing impredicative models guided by the insights afforded by representation systems, we can evolve intelligent systems that become increasingly flexible in the natural adaptation of cognitive processes. In other words, we believe this to be the strategy to develop genuine artificial intelligence systems. The foundation for this approach to artificial intelligence is the understanding of the causal linkages in representation systems and construction of models whose inferential linkages are congruent with them.

2 Representation Systems

Results from nearly thirty years research and practical experience have shown that decision-making and learning strategies, behavior outcomes, belief systems and so forth, can be described in terms to the three representation systems: *visual, auditory and kinesthetic*. The genesis of our physical capabilities, the driver(s) of our responses to stimuli, and the information abstraction systems into which experience can be coded is based on the functionality provided by these RS.

RS are the "*atoms* of cognition" whose function is to construct mental models of reality and every individual has a preferred or primary RS (PRS). Consequently, we find that some individuals access and abstract information visually first, some auditorily and others kinesthetically (through feel and touch). This in turn establishes our information abstracting patterns and the strategies of our experiential language representation. The manner in which these RS are structured forms a strategy, or a series of strategies, or synesthesias - all of which lead to the development of belief systems that lead to behavior and ultimately to identity. As an elementary example, when an individual mentally images a goal, he may look up and to the right, an indirect physical response driven neurologically by the visual representation system.

Figure 1. Imaging a goal.

Incidental physical responses continue, usually unnoticed by the subject as he ponders the idea. As he determines how this image would feel and sound, he gazes directly ahead and then slightly to his right as he generates a feeling of the image that includes sounds. Here, the feelings, sounds and image all combine to form the basis of a response from the individual. Experiencing a sensation in terms of other senses is called synesthesia, and is illustrated in Figure 2.

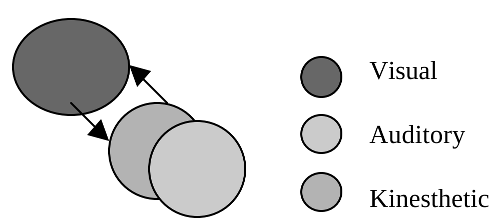

Figure 2. Synesthesia of an internal process

Combining the RS in one location is known as a *cluster* or *molecule* (Figure 3). Clusters are easily identified through the observation of neuro-physiologically driven cues, such as the NLP Eye Accessing Cues as shown in Figure 5.

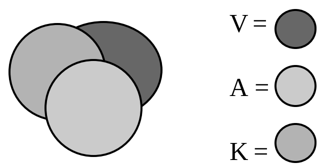

Figure 3. A cluster of an internal process.

In separating a cluster, as with as synesthesia, we are conducting a transderivational search of the deeper meaning of the experience that is expressed digitally through language. (Note: In this context, digital and analog do not have the meaning that computer engineers usually associate with the terms. Digital communications means the communications by a string of discrete symbols, such as the words of a spoken language. Analog communications means the communications through continuous body movements driven by physiology, such as mood-signs. [11])

Language, combining syntax (structure) and semantics (meaning) is our feedback mechanism via which RS are expressed. As long as there are linguistic distinctions that can describe actions, feelings or thoughts, the process can be parsed to a micro dynamic level of understanding, and re-constructed utilizing the RS model through application of the Meta-Model (as described below). As indicated by the simple example in Figure 4, the decision to throw a switch depends on whether it *feels* right, despite the fact that in this case the process begins with how it *looks.*

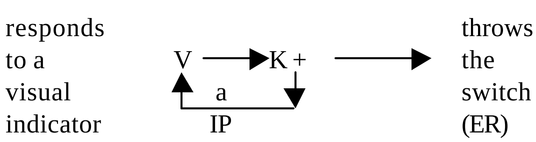

Figure 4. Internal Process of a Decision

Where,

V = the visual image
K = the feeling associated with the image
a = the feedback loop checking K against the image
IP = internal feedback loop of the process to throw .
ER = the external response or behavior

This response (and most others) can be externally observed and modeled at the physiological level. based on the eye accessing cue patterns of the RS as indicated below.

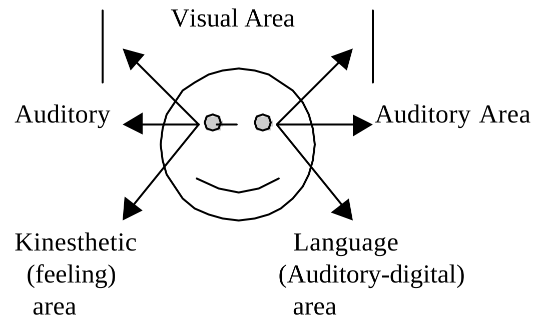

Figure 5. Physiological Cues

Figure 5 represents the standard model of eye accessing cues indicating where people pair internal representations of what they see, hear and feel reflecting their on-going experiences. Each of the visual and auditory modalities is further identified as to memory and abstraction of mental constructs.

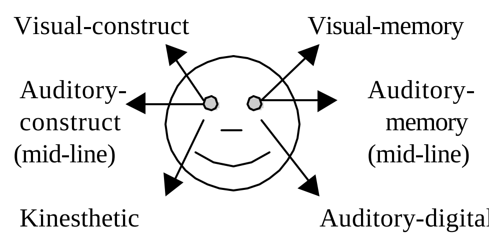

Figure 6. Typical Eye Accessing Cue for A Normally Oriented Right-Handed Person

These patterns may differ if the person is normally oriented (e.g., not standing on his head) and left-handed or ambidextrous. The top two locations may switch places, or the bottom two may switch. What is consistent is the location of the primary modalities. Visual modality remains above mid-line of the eyes, auditory modality at mid-line, and the kinesthetic modality below the mid-line. Only the states: memory and construct may change location. These mental states are significant in knowing where an individual stores memories for review and recall, and where unfamiliar images, sounds and feelings are generated.

The physiological responses to mental states provide a map of the thought process of a decision. Knowing this, it is clear that the “cognitive blackbox’” posited by behaviorism is an excessively oversimplified representation of mental processes. It matters what is in the box, and the contents of the box can be estimated from the physiologically generated cues. As with the engineering task of system identification, behavior can be observed externally and modeled at the micro dynamic level. We can actually model the functional aspects of human behavior as the thought process incidentally constructs a physiological response. In NLP, this process of determining what is in the "cognitive blackbox" is known as unpacking.

3 Applying the Representational Analysis

By making the representational form of test and operate procedures explicit, RS can make the analysis and transfer of any behavior much more accessible and systematic. In identifying the representational type and the function of each step, we can unpack essentially any behavioral structure so that it may be easily modeled. Thus, RS allow insight into such complex behavioral structures as "belief systems," that have a tremendous impact on decision-making and learning strategies, training, system development, programming and inherent system design and operational errors and more.

For example, an auditory oriented person would choose to hear an arrangement of musical notes repeatedly, as he or she mimicked the sound on an instrument. Whereas, the visually oriented person would want to see and practice the notes a segment at a time. This preference is often generalized to many different types of tasks even when inappropriate for the task. Every decision leads to a behavior and every decision and behavior can be reduced to the three RS. We can utilize the RS to model both success and failure, and show that all behavior is propagated by a *feeling* (or intuition). Brown-VanHoozer and VanHoozer have found through several years of research involving subjects ranging from 4 to 60 years old that all decisions are promulgated by feelings whether at the conscious or unconscious level of awareness. Consequently, process words used to describe feelings can be modeled employing the RS. Examples of process words are *love, friendship, communication, anger* and so forth. We can observe how an individual constructs the process for friendship and map the sequence of the RS that the individual is accessing to form sounds, images and/or feelings for 'friendship.'

An individual may recall a voice (auditory-memory); associate an image (visual-memory) to the tempo and tones of the voice; then compare the image and sounds to a feeling. Stepping through the process requires that we incorporate the Meta-Model in search of defining the *meaning* of the representation. The Meta Model is an impredicative tool which makes explicit those semantic and syntactic constructs in which the communication or language structure, e.g., sentence, phrase, etc. is unclear by replacing or repairing insufficient information with more explicit, accurate descriptions. It is a modeling tool that supports the search for definitions of *meaning* of experiences via language feedback. This (paired with the RS) is then used in modeling the experience.

How finely we calibrate our own neural and physiological systems to accept the information from a particular representational system, as we go through the steps of an individual's strategy or strategies, or synesthesia, will determine the reliability of our model. This model can then be used to identify the structure of linkages for true artificial intelligent systems.

4 The Role of Final Cause in Cognition

The idea that cognition cannot be algorithmic is not a particularly new idea. Bateson described that consciousness has function, or serves as a final cause of the behavior of the conscious organism, in some detail decades ago [12]. Consciousness is context dependent; the environment both changes, and is changed by the conscious entity. Cognition is impredicatively self-referential. The organization of mind is inseparable from its material substrate [13]. The structure of causal linkages in such processes forms a closed loop [14].

An impredicative loop or self-referential chain of causal links cannot be represented as an algorithm that halts after a finite number of steps. An algorithm is separable from its hardware, cognition is not. An algorithm is purely syntactic; any semantic meaning attributed to the symbols flipped by the production rules in an algorithmic computer is abstracted by the mind of the user. Mind is incomputable. [8] It is a profound error to think of the brain as a computer, and the mind as the software running on it.

Because of the closed-loop causality of functional components, information can cause the material configuration of the substrate to change. From this theoretical perspective, Rosen argues that functional components cannot be separated into a distinct software part and a distinct hardware part [15]. Several observers of mental processes embedded in wetware are led by empirical observation to a similar conclusion. Based on his observations of human behaviors and brains, Damasio concludes that the mind is an inseparable entity composed of both matter and organization [16]. Similarly, based on his observations of salamander behaviors and brains, Freeman concludes that the intentionality of lower animals forms a closed causal loop, and is inseparably composed of both matter and organization [17].

5 AI Systems of Thought

Today's artificial intelligence (AI) systems are algorithmic, and can neither hear nor feel whether a process is functioning properly, and no non-human system has yet been developed that can accomplish these tasks. Nevertheless, there is no fundamental reason that this cannot be done. Indeed, it is expected that cognitive instrumentation systems will be one of the major engineering breakthroughs in sensing and control within the next 10 to 20 years [8]. Consider this impact (for good and ill) on the world community.

We know that the mind, based on models generated by the context dependent functionality of RS, can perform valid reasoning about problems that cannot be described by a list of numbers. Process words such as "self," "life," and "mind," can be characterized by a set of strategies that can modeled as a system of impredicative expressions based on a context dependent structure of functional RS [18,19].

This much can be done today, despite the fact that the mathematics (probably based in category theory) for drawing inferences on these expressions is in its infancy. Nothing motivates the development of mathematical technique like the necessity driven by an unsolved problem. Knowledge includes the compilation of these impredicative expressions representing strategies. These are the specific and effective structures of the RS that an individual uses on the unconscious level to abstract percepts from a sensory stream, and at a conscious level to abstract meaningful concepts from a stream of percepts. It is from these meanings that representations of reality are formed and can be identified to determine the strategies used by individuals in the external world. By identifying the structure of inferential linkages within these strategies, and modeling them on an artificial substrate that has congruent causal linkages, we envision a new approach to computing. The development of a non-algorithmic system that will process information similar to that used in our minds, inseparably connected to *feelings*.

6 Conclusions

As humans, we use digital communications or language to represent our experiences; however, language is too discrete to express the total depth of experience, or to assure clarity in communication. Thus, analog communications, the neurally driven physiological responses, such as body language and eye movements are essential aspects of human interaction.

Since analog communication occurs at a more primitive level than digital, it reveals more about the internal mental state of the subject. We display the seemingly minimal cues (eye movements, breathing, hand gestures, muscle tonus, etc.) produced by analog communication approximately 88% of the time during any conversation. It is at this level of observation, that we begin to determine how the models of understanding, beliefs and knowledge are constructed. By replacing missing information given by an individual with its most specific possible form, the optimum in reliable knowledge can be extracted from users. This provides a foundation from which language and non-verbal behavioral indicators can be observed and allows us to model the individual's externally observable behaviors taking place at the unconscious level.

Research of the NLP method has shown that there is the potential for the results to cause major changes in multiple disciplines (e.g., learning, psychology, physiology, philosophy, etc.,) regarding human behavior, belief systems and thought processes. The step in introducing these findings is a key aspect to the changes. Therefore, even in the simplest of applications, the way we design systems, develop code, write procedures, manuals or papers is oriented toward the PRS we choose for abstracting information. In other words, the models of NLP can enhance our thinking processes even without using a computer, or its non-algorithmic successor.

In addition, NLP modeling can provide us with the insight to create the non-algorithmic successor to the computer. If we are aware of how we process information, and hence, how this information can be modeled to the point of mathematical interpretation, we are lead to the fact that a man-made artifact grown from a quantum seed might run impredicative models constructed from RS - the basis for true artificial intelligence. Such a system would construct its own virtual world (its model of reality and itself….(and) use the resulting percepts to update its model of reality.

The key is that the system would know that they have an understanding of the deeper structure of process words, e.g., love, friend, anger, hate, etc., when they recognize within themselves "the *feeling* of knowing." Thus, the system must evolve to the point where internal process is based on *feelings* paired with sight and sound toward a linguistic representation in natural language.

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