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Dialog Column Are Natural Languages Symbolic in the Brain? by Juyang Weng

Meaning-bearers in Computers, Brains, and Natural or Artificial Minds

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Cognition includes symbol-use, both externally and internally, to express meaning or information (not in Shannon's sense). How that is possible is an old problem with several old unsatisfactory answers, such as: meaning is based on experience of things referred to, meaning depends on causal connections between symbol and referent, meanings are possible only because of social/cultural conventions, and expressing meaning requires a human language.

Reference cannot require causal connection, since we can refer to non-existent objects, e.g. "The elephant on the moon". There was a largest mammal in Africa 500 years ago, but our ability to refer to it does not require us to be causally linked to it: meaning, or reference, can use, but does not require, causal links. That's why we can ask questions without knowing the answers, select goals that we may not achieve, and have false beliefs. If meaning depended on causal links most human thinking would be impossible. Reference to genes, quarks and transfinite ordinals cannot depend on experience of referents. Percepts, intentions, learnt associations, and thoughts in pre-verbal children and non-human animals cannot depend on human conventions or language.

Symbols, i.e. discrete meaningful tokens, such as words, are not the only meaning-bearers. Spoken languages also use continuous variation, e.g. of pitch, or intensity; and human sign languages use continuous gestures. Maps, chemical formulae, equations, and semaphore signals, are among the external meaning-bearers we use. Internal meaning-bearers also exist but cannot be found in brains using physical sensing devices, any more than physical sensors can detect spelling correction, or a threatening chess move, in a multi-processing computer. Such events occur in virtual, not physical, machinery. But they exist, since they have causal consequences.

Most interesting contents of computers exist in .running. virtual machines (running VMs), which are implemented in physical machinery, using complex technology based on a tangled causal web of hardware, firmware and software, that alters virtual-physical mappings dynamically. Many tasks, including checking spelling, formatting documents, fetching web pages, and eliminating malware, require VMs. When a computer manipulates numbers the physical machine uses groups of switches implementing bit-patterns that, depending on context, represent numbers, instructions, pointers to complex structures, or other things. Whether a bit-pattern represents a number or something else depends on what procedures are active and what they are doing. When a chess program creates a threat, that is not a physical state. Likewise when I doubt whether someone is talking sense, the doubt is not a physical brain state. "Threat" and "doubt" cannot be defined in the language of physics nor instances detected by physical sensors -- though in simple cases physical footprints may be detectable under special conditions.

Over decades, human engineers found that complex control mechanisms need to operate on entities in virtual machinery that, unlike physical machinery, allows rapid construction and modification of complex structures, and rapid garbage collection after use.

Conjecture: long before that, evolution "discovered" the need for representation and control functions distinct from, but implemented in, physical mechanisms: so mental meaning-bearers exist in those biological VMs running on brains.

Since perceptual and other contents must change faster than physical parts of brains can be rearranged (e.g. walking with eyes open in a busy city), biological minds need VMs. That can include symbols, for example if you solve equations in your head, rehearse a Shakesperian sonnet, or wonder how brains work. Brain-based VMs can also construct and manipulate diagrams, e.g. visualising the Chinese proof of Pythagoras' theorem, or designing a new information-processing architecture, or imagining the operation of a threaded bolt rotating as it goes into a nut. Virtual machinery includes, but is not restricted to, discrete, discontinuous, structures and processes. Interacting VMs on computers and attached devices run concurrently . their state being preserved in memory while CPUs switch tasks, relying on decades of complex design by hardware and software engineers, solving many different problems . including self-monitoring and control. Very few grasp the big picture combining their efforts.

Biological evolution did something similar, though far more complex and difficult to understand. Support for VMs used in human language, in construction of percepts, in formation of motives, in specifying actions, in generating, evaluating and executing plans, and learning, probably took thousands of intermediate design steps, not yet known to us. Clues exist in the competences of other animals and in pre-verbal children (Karmiloff-Smith, 1992). Exactly what the VMs are, how they evolved, how they are implemented in brains and what their functions are, are still unanswered questions. We cannot find answers simply by studying a narrow subset of products of evolution (e.g. humans) nor a narrow class of robots that mimic some tiny (often arbitrary) subset of animal competence.

Much thinking about language, mind and philosophy of science by roboticists, ignores most of what has already been written over hundreds of years, including work on semantics last century by philosophers of science. Previously, scholars could be familiar with all the important prior published work when investigating a problem, such as the problem of how meaning is possible. But that is no longer possible. I call this the Singularity of Cognitive Catchup (SOCC), see (Sloman, 2010a).

Does SOCC mean that on many important topics we are now doomed to arguing in circles, producing only minor variations on previous failed theories? Perhaps not, if we can find a new high level synthesis to reorganise our thinking. That may be possible if we replace pointless debates (e.g. about embodiment) with deep investigations of the evolutionary discontinuities in information processing requirements and mechanisms, not just in humans but in a wide range of organisms, including microbes, insects and other animals. That will help us focus on the real design issues and help us understand some of the solutions, as suggested in (Sloman, 2010b).

References:

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