What Computers Can't Do

By Jon A. Schmidt, P.E., SECB

My title this month comes from a controversial 1972 book by Hubert L. Dreyfus, which he revised and updated in 1979 and again in 1992, at which point he retitled it *What Computers Still Can't Do*. The subtitle is *A Critique of Artificial Reason*, and the basic thesis is that disembodied machines are inherently incapable of reproducing the higher mental functions required for human-like intelligence and consciousness.

The original edition appeared at a time when optimism about cognitive simulation (CS) and artificial intelligence (AI) was largely unbridled. Dreyfus sought to bring the tools of philosophy to bear on the matter, and his findings ran completely counter to the dominant mindset of those working in the field. He identified and challenged what he saw as four key assumptions underlying their objectives and strategies:

1) *The Biological Assumption* – On some level, presumably that of the neurons, the brain processes information by means of discrete operations.
2) *The Psychological Assumption* – The mind can be viewed as a device operating on individual bits of information in accordance with formal rules.
3) *The Epistemological Assumption* – All knowledge can be formalized; i.e., whatever can be understood can be expressed in terms of logical relations.
4) *The Ontological Assumption* – Everything that exists can be represented as a set of facts, each of which is logically independent of all the others.

Taken together, these premises amount to characterizing intelligent humans as general-purpose symbol-manipulating devices – in other words, as digital computers. Dreyfus presented and defended his main objections to each of them in turn:

1) Empirical evidence strongly suggests that the brain operates more like an analog computer than a digital one – for example, there is no one-to-one correspondence between each synapse firing and some symbol in a processing sequence; rather, the *rate* of pulse transmissions appears to be a more important factor.
2) Information theory should not be confused with or illegitimately transformed into a theory of meaning; the ability to find rules that accurately *describe* a certain behavior does not mean that the behavior itself is actually *caused* by such rules.
3) The ability to find rules that accurately describe *some* behaviors does not mean that such rules can be found for *all* nonarbitrary behaviors, nor that such rules can be used by a computer to *reproduce* those behaviors.
4) There is no reason to suppose that the specific kind of data that a computer is capable of processing – discrete, explicit, and determinate – is truly available with respect to the human world; and even if it is, that such a large mass of data could ever be feasibly stored and accessed.

Dreyfus then offered three alternative accounts of intelligent human behavior using phenomenological descriptions:

- The role of *the body* in organizing and unifying our experience of objects.
- The role of *the situation* in providing a background against which behavior can be orderly without being rule-like.
- The role of *human purposes and needs* in organizing the situation so that objects are recognized as relevant and accessible.

I think that Dreyfus's case has interesting ramifications for structural engineering, especially his effective refutation of the last two assumptions. One of the major concerns in the profession today is establishing and maintaining appropriate parameters for the proper use of computers within the analysis and design process, so that practitioners are not relegated to serving merely as technicians, with the software doing most or all of the real work. Recognizing and calling attention to the (apparently) insurmountable limitations of CS and AI can help us resist this potentially dangerous trend.

It is worth noting that Dreyfus traces the roots of the epistemological and ontological assumptions all the way back to Plato – that is, throughout the entire history of Western philosophy. As Steven L. Goldman has written (see my InFocus column, "The Principle of Insufficient Reason," in the May 2008 issue of STRUCTURE®), this history has largely favored the formulation of abstract theories that lead to universal and necessary truths. The misguided notion that intelligence involves merely the application of explicit rules to isolated facts is consistent with this entrenched tradition.

By contrast, as Goldman (and I) also pointed out, engineering largely involves the implementation of concrete practices that lead to particular and contingent solutions. It cannot be reduced to a programmable list of rules and facts, no matter how large and comprehensive such a compilation might become. As a result, engineering is – and probably always will be – something that computers can't do.■

Your Turn

Do you believe that the development of artificial intelligence is possible? Could computers ever take over the practice of structural engineering from humans? Why or why not? Please submit your responses and see what others have had to say by clicking on the "Your Turn" button at **www.STRUCTUREmag.org**.

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