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Information Science and Technology Seminar Series

Pentti Kanerva, Visiting Scholar
UC Berkeley, Redwood Center for Theoretical Neuroscience

"Hyperdimensional Computing as a Model of the Brain's Computing"

Wednesday, May 9, 2012
3:00 - 4:00 PM
TA-3, Bldg. 1690, Room 102 (CNLS Conference Room)

Abstract: It is very likely that a computer for producing brainlike behavior must have brainlike architecture, but what in the architecture accounts for the brain's cognitive powers? One possible answer, suggested by the very size of the brain's circuits, is high-dimensional representation: computing with, say, 10,000-bit words rather than with 16-to-64-bit words. What would computing with such wide words be like? Neural-net associative memories (e.g., Willshaw, Hopfield, and my Sparse Distributed Memory) provide early examples. They are content-addressable and can work with incomplete and noisy data.

High-dimensional vectors' tolerance for noise is well know in signal processing. Less well known is the possibility of combining several such vectors into a single vector of the same dimensionality and then computing with it while retaining the identity of the original vectors: they can be recovered from the result. This allows sequences and data structures to be represented in a single vector, thereby extending neural-net computing into the symbolic domain (the term Vector-Symbolic Architecture or VSA is sometimes used). The required operations form the core of a new kind of computing that is most naturally realized in nanotechnology. The best-known model of the kind, and perhaps the first, is Plate's Holographic Reduced Representation in the early 1990s. Research in the area is ongoing, but the field remains largely unexplored.

Reference: Kanerva, P. Hyperdimensional Computing: An Introduction to Computing in Distributed Representation with High-Dimensional Random Vectors. COGNITIVE COMPUTATION 1(2):139-159, 2009. http://www.springerlink.com/content/966151841g415165/ http://redwood.berkeley.edu/wiki/Publications

Biography: Pentti Kanerva grew up in rural Finland, he has Master's in Forestry from University of Helsinki, PhD in Philosophy from Stanford, and a 20-year career in computing in between. Kanerva's thesis on Sparse Distributed Memory was published by MIT Press in 1988, and the ensuing research has focused on computing in high-dimensional distributed representation, first as a postdoc at Stanford's Center for the Study of Language and Information (1984-85), then as a principal investigator at NASA Ames Research Center (1985-92) and the Swedish Institute of Computer Science (1993-2002), followed by a year as a senior fellow at the Redwood Neuroscience Institute in Menlo Park, California, and now as a semiretired visiting scholar at UC Berkeley's Redwood Center for Theoretical Neuroscience. Kanerva's research has been aimed at understanding the principles of computing that underlie the extraordinary powers of the ordinary brain.

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