ADDRESS REGISTER
1,000 bits

WORD-IN REGISTER
1,000 bits

x [1 0 0 · · · 1 0 1]

w [0 1 0 · · · 1 1 0]

N

d

y

U

0 1 0	1 0 1
1 0 1	0 0 1
0 1 0	0 1 1
0 0 0	1 0 1
1 1 1	0 0 1
0 0 0	1 1 0

1,000,000 hard locations

A
ADDRESS MATRIX
M hard addresses

1 1 1   0 0 0
1 0 0   1 0 0
1 0 0   0 1 0
0 1 1   0 1 1

M

d column:
501
444
550
447
493
531
·
·
·
480
446
512
498

y column:
0
1
0
1
0
0
·
·
·
0
1
0
0

Contents matrix C:
0 2 −2   4 0 0
−1 −1 −1   1 3 −1
1 1 −3   −1 1 1
−2 4 2   0 2 0
−1 1 1   −3 −1 −1
2 0 −4   0 2 0

C
CONTENTS MATRIX
M × *U* counters

1 3 −1   3 −3 5
−1 1 −1   1 1 −1
2 0 −4   0 6 −4
0 0 0   0 0 0

Hamming distances

Activations (*H* = 447)

Sums

S [−445 379 −201 · · · 77 611 −517]

z [0 1 0 · · · 1 1 0]

WORD-OUT REGISTER
1,000 bits

Sparse Distributed Memory

Research Institute for Advanced Computer Science (U.S.)

Sparse Distributed Memory:

    <u>Sparse Distributed Memory</u> Pentti Kanerva,1988 Motivated by the remarkable fluidity of memory the way in which items are pulled spontaneously and effortlessly from our memory by vague similarities to what is currently occupying our attention Sparse Distributed Memory presents a mathematically elegant theory of human long term memory The book which is self contained begins with background material from mathematics computers and neurophysiology this is followed by a step by step development of the memory model The concluding chapter describes an autonomous system that builds from experience an internal model of the world and bases its operation on that internal model Close attention is paid to the engineering of the memory including comparisons to ordinary computer memories Sparse Distributed Memory provides an overall perspective on neural systems The model it describes can aid in understanding human memory and learning and a system based on it sheds light on outstanding problems in philosophy and artificial intelligence Applications of the memory are expected to be found in the creation of adaptive systems for signal processing speech vision motor control and in general robots Perhaps the most exciting aspect of the memory in its implications for research in neural networks is that its realization with neuronlike components resembles the cortex of the cerebellum Pentti Kanerva is a scientist at the Research Institute for Advanced Computer Science at the NASA Ames Research Center and a visiting scholar at the Stanford Center for the Study of Language and Information A Bradford Book   **Kanerva's Sparse Distributed Memory** National Aeronautics and Space Adm Nasa,2019 The advent of the Connection Machine profoundly changes the world of supercomputers The highly nontraditional architecture makes possible the exploration of algorithms that were impractical for standard Von Neumann architectures Sparse distributed memory SDM is an example of such an algorithm Sparse distributed memory is a particularly simple and elegant formulation for an associative memory The foundations for sparse distributed memory are described and some simple examples of using the memory are presented The relationship of sparse distributed memory to three important computational systems is shown random access memory neural networks and the cerebellum of the brain Finally the implementation of the algorithm for sparse distributed memory on the Connection Machine is discussed Rogers David NASA CR 185417 NAS 1 26 185417 RIACS TR 88 32 NCC2 408 NCC2 387   <u>A View of Kanerva's Sparse Distributed Memory</u> ,1986   **Sparse Distributed Memory and Related Models** National Aeronautics and Space Administration (NASA),2018-07-16 Described here is sparse distributed memory SDM as a neural net associative memory It is characterized by two weight matrices and by a large internal dimension the number of hidden units is much larger than the number of input or output units The first matrix A is fixed and possibly random and the second matrix C is modifiable The SDM is compared and contrasted to 1 computer memory 2 correlation matrix memory 3 feet forward artificial neural network 4 cortex of the cerebellum 5 Marr and Albus models of the cerebellum and 6 Albus cerebellar model arithmetic computer CMAC Several variations of the basic SDM design are discussed the selected coordinate and hyperplane designs of Jaeckel

the pseudorandom associative neural memory of Hassoun and SDM with real valued input variables by Prager and Fallside SDM research conducted mainly at the Research Institute for Advanced Computer Science RIACS in 1986 1991 is highlighted Kanerva Pentti Unspecified Center **Sparse Distributed Memory: Principles and Operation** Research Institute for Advanced Computer Science (U.S.),Stanford University. Computer Systems Laboratory,M. J. Flynn,P. Kanerva,N. Bhadkamkar,1989 **Sparse Distributed Memory and Related Models** Pentti Kanerva,Research Institute for Advanced Computer Science (U.S.),1992 Abstract This paper describes sparse distributed memory SDM as a neural net associative memory It is characterized by two weight matrices and by a large internal dimension the number of hidden units is much larger than the number of input or output units The first matrix A is fixed and possibly random and the second matrix C is modifiable The paper compares and contrasts SDM to 1 computer memory 2 correlation matrix memory 3 feed forward artificial neural network 4 cortex of the cerebellum 5 Marr and Albus models of the cerebellum and 6 Albus cerebellar model arithmetic computer CMAC Several variations of the basic SDM design are discussed the selected coordinate and hyperplane designs of Jaeckel the pseudorandom associative neural memory of Hassoun and SDM with real valued input variables by Prager and Fallside SDM research conducted mainly at RIACS in 1986 1991 is highlighted **Sparse Distributed Memory** National Aeronautics and Space Administration (NASA),2018-07-16 Sparse distributed memory is a generalized random access memory RAM for long 1000 bit binary words Such words can be written into and read from the memory and they can also be used to address the memory The main attribute of the memory is sensitivity to similarity meaning that a word can be read back not only by giving the original write address but also by giving one close to it as measured by the Hamming distance between addresses Large memories of this kind are expected to have wide use in speech recognition and scene analysis in signal detection and verification and in adaptive control of automated equipment in general in dealing with real world information in real time The memory can be realized as a simple massively parallel computer Digital technology has reached a point where building large memories is becoming practical Major design issues were resolved which were faced in building the memories The design is described of a prototype memory with 256 bit addresses and from 8 to 128 K locations for 256 bit words A key aspect of the design is extensive use of dynamic RAM and other standard components Flynn M J and Kanerva P and Bhadkamkar N Unspecified Center *An Alternative Design for a Sparse Distributed Memory* Research Institute for Advanced Computer Science (U.S.),1989 *The Sparse Distributed Memory* Timothy Hely,University of Edinburgh. Department of Artificial Intelligence,1994 **Statistical Prediction with Kanerva's Sparse Distributed Memory** National Aeronautics and Space Adm Nasa,2019-01-04 A new viewpoint of the processing performed by Kanerva s sparse distributed memory SDM is presented In conditions of near or over capacity where the associative memory behavior of the model breaks down the processing performed by the model can be interpreted as that of a statistical predictor Mathematical results are presented which serve as the framework for a new statistical viewpoint of sparse distributed

memory and for which the standard formulation of SDM is a special case This viewpoint suggests possible enhancements to the SDM model including a procedure for improving the predictiveness of the system based on Holland s work with genetic algorithms and a method for improving the capacity of SDM even when used as an associative memory Rogers David NASA CR 187314 NAS 1 26 187314 RIACS TR 89 02 NCC2 378 NCC2 408 *Kanerva's Sparse Distributed Memory: an Associative Memory Algorithm Well-suited to the Connection Machine* Research Institute for Advanced Computer Science (U.S.),D. Rogers,1988 *Kanerva's Sparse Distributed Memory with Multiple Hamming Thresholds* National Aeronautics and Space Adm Nasa,2018-12-28 If the stored input patterns of Kanerva s Sparse Distributed Memory SDM are highly correlated utilization of the storage capacity is very low compared to the case of uniformly distributed random input patterns We consider a variation of SDM that has a better storage capacity utilization for correlated input patterns This approach uses a separate selection threshold for each physical storage address or hard location The selection of the hard locations for reading or writing can be done in parallel of which SDM implementations can benefit Pohja Seppo and Kaski Kimmo NASA CR 190552 NAS 1 26 190552 RIACS TR 92 06 *Sparse Distributed Memory* Research Institute for Advanced Computer Science (U.S.),P. J. Denning,1989 **Some Comments on the Information Stored in Sparse Distributed Memory** Jan Kristoferson,1995 **Kanerva's Sparse Distributed Memory with Multiple Hamming Thresholds** Seppo Pohja,Research Institute for Advanced Computer Science (U.S.),Kimmo Kaski,1992 Abstract If the stored input patterns of Kanerva s Sparse Distributed Memory SDM are highly correlated utilization of the storage capacity is very low compared to the case of uniformly distributed random input patterns Here we consider a variation of SDM that has a better storage capacity utilization for correlated input patterns This approach uses a separate selection threshold for each physical storage address or hard location The selection of the hard locations for reading or writing can be done in parallel of which SDM implementations can benefit **A Class of Designs for a Sparse Distributed Memory** National Aeronautics and Space Administration (NASA),2018-06-27 A general class of designs for a space distributed memory SDM is described The author shows that Kanerva s original design and the selected coordinate design are related and that there is a series of possible intermediate designs between those two designs In each such design the set of addresses that activate a memory location is a sphere in the address space We can also have hybrid designs in which the memory locations may be a mixture of those found in the other designs In some applications the bits of the read and write addresses that will actually be used might be mostly zeros that is the addresses might lie on or near z hyperplane in the address space The author describes a hyperplane design which is adapted to this situation and compares it to an adaptation of Kanerva s design To study the performance of these designs he computes the expected number of memory locations activated by both of two addresses Jaeckel Louis A Unspecified Center NCC2 387 NCC2 408 **Recognition of Simple Visual Images Using a Sparse Distributed Memory: Some Implementations and Experiments** Research Institute for Advanced Computer Science (U.S.),1990 **A**

Class of Designs for a Sparse Distributed Memory Research Institute for Advanced Computer Science (U.S.),1989   *A Study of Sparse Distributed Memory* Sidney D'Mello,2000   A Study of Sparse Distributed Memory Shambulingappa V. Chinvar,1994

Reviewing **Sparse Distributed Memory**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is truly astonishing. Within the pages of "**Sparse Distributed Memory**," an enthralling opus penned by a very acclaimed wordsmith, readers attempt an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve into the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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