Papers on Instantaneously Trained and Related Neural Networks

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Introduction

This paper presents a bibliography of instantaneously trained neural networks (ITNN). The principal ITNN is the corner classification neural network (CCNN) that includes its variant FC neural network (FCNN). These networks are an attempt to model biological memory.

The corner classification (CC) network is based on the idea of phonological loop and the visio-spatial sketchpad. It was proposed by Kak in 1992 in three variations. These and its more advanced variants are also known as the class of Kak neural networks.

The concept of radius of generalization was introduced in CC3 and thus this neural network overcame the generalization problem that plagued the earlier CC2 network. The Hamming distance was used for classification between binary vectors, i.e. any test vector whose Hamming distance from a training vector is smaller than the radius of generalization of the network is classified in the same output class as that training vector. A unique neuron is associated with each training sample and each node in the network acts as a filter for the training sample. The filter is realized by making it act as a hyper plane to separate the corner of the n-dimensional cube represented by the training vector and hence the name corner-classification (CC) technique.

There are four versions of the CC technique, represented by CC1 through CC4. The CC4 is shown to be better than the other networks in the CC category. The number of input and output neurons is equal to the length of input and output patterns or vectors. The number of hidden neurons is equal to number of training samples the network requires. The last node of the input layer is set to one to act as a bias to the hidden layer. The binary step function is used as activation function for both the hidden and output neurons. The output of the function is 1 if summation is positive and zero otherwise.

Human decision making has the element of uncertainty in it, for example when we interpret temperature we can only express the degree of hotness or coldness, this is not like a truth statement which might be true or false. One might say it is hot, another might say its or very hot etc. The principle of fuzzy classification networks depend on the concept of “nearest neighbor”, it consists of three layers-an input layer, a hidden layer and an output layer. The FC acronym has been seen either to stand for fuzzy classification or fast classification.

Implementation of an algorithm speaks of its success in the commercial arena. The CC4 algorithm was implemented using reconfigurable computing and to design an optical neural network .The FC network was implemented on FPGA's.

Zhu and Sutton implemented Kak's FC network on FPGA's. The Celoxica RC2000 board with Xilinx XC2V6000 Virtex-II chip was used and JHDL hardware description language was used for design and simulation for hardware implementation. The hidden neuron circuit was based on Euclidian distance in Kak's FC network but such a implementation in a FPGA would require a computational complexity of O(mn) "square operations" where m is the number of neurons and n is the number of elements in the weight vector.

Zhu and Milne showed that Kak's CC4 is hardware implementable in reconfigurable computing using fine grained parallelism. Shortt, Keating, Moulinier, Pannell show that the Kak neural network is suitable for optical implementation using a bipolar matrix vector multiplier, suitable modifications to the structure and training algorithm were required to build an optical neural network implementing *N*-parity.

References

[1] S. Kak, On training feedforward neural networks. Pramana, vol. 40, pp. 35-42, 1993.

[2] S. Kak, New algorithms for training feedforward neural networks. Pattern Recognition Letters 15, 1994, pp.295-298.

[3] S. Kak, The three languages of the brain: quantum, reorganizational, and associative." In Learning as Self-Organization, Karl Pribram and Joseph King (editors). Lawrence Erlbaum Associates, Mahwah, NJ, 1996, pp. 185-219.

[4] S. Kak, A new training algorithm for feedforward neural networks. In Advances in Fuzzy Theory and Techniques, P.P. Wang (editor), Durham NC: Bookwright Press, 1993.

[5] S. Kak, Reflections in Clouded Mirrors: Selfhood in Animals and Machines." In Learning as Self-Organization, Karl Pribram and Joseph King (editors). Lawrence Erlbaum Associates, Mahwah, NJ, 1996, pp. 511-534.

[6] S. Kak, "On generalization by neural networks," Information Sciences 111, 1998, pp. 293-302.

[7] S. Kak, "Better web searches and faster prediction using instantaneously trained neural networks." IEEE Intelligent Systems, vol. 14(6), pp. 78-81, 1999.

[8] B. Shu and S. Kak "A neural network-based intelligent metasearch engine." Information Sciences, vol. 120, 1999, pp. 1-11.

[9] K. W. Tang and S. Kak, "A new corner classification approach to neural network training," Circuits, Systems Signal Processing 17, 1998, pp. 459-469.

[10] K. W. Tang and S. Kak, "Fast classification networks for signal processing," Circuits, Systems Signal Processing 21, 2002, pp.207- 224.

[11] J. Zhu and G. Milne, "Implementing Kak neural networks on a reconfigurable computing platform," In FPL 2000, LNCS 1896, R.W. Hartenstein and H. Gruenbacher (eds.), Springer-Verlag, 2000, pp. 260-269.

[12] Z. Jihan, P. Sutton “An FPGA implementation of Kak’s instantaneously-trained, fast-classification neural networks” Proceedings of the 2003 IEEE International Conference on Field-Programmable Technology (FPT), December 2003.
[13] S. Kak, “Artificial and biological intelligence.” ACM Ubiquity, vol. 6, number 42, 2005, pp. 1-20; arXiv: cs.AI/0601052.
[14] S. Kak, “The information complexity of quantum gates.” Int. J. of Theoretical Physics, 45, 2006; arXiv: quant-ph/0506013.
[15] S. Kak, Quantum information and entropy. Arxiv: quant-ph/0605096
[16] A. Shortt , J. G. Keating, L. Moulinier, C. N. Pannell , “Optical implementation of the Kak neural network” Information Sciences 171, 2005, pp.273-287.
[17] A Ponnath, “Instantaneously trained neural networks.” Arxiv preprint cs.NE/0601129
[18] E. Chen, S. Wang, Z. Zhang, X. Wang, “Document classification using CC4 network.” Department of Computer Science, Hefei, China.
[19] A. Hirose (ed.). Complex-valued Neural Networks: Theories and Applications, World ScientificPublishing, Singapore, 2003.
[20] K. Penumarthi and S. Kak, Augmented watermarking. Cryptologia, vol. 30, pp. 173-180,2006.
[21] N. Mandhani and S. Kak, Watermarking using decimal sequences." Cryptologia, vol. 29, pp. 50-58, 2005.
[22] S. Kak, A class of instantaneously trained neural networks. Information Sciences, vol. 148, pp. 97-102, 2002.
[23] D. Ventura and S.C. Kak, Introduction to Quantum Computing and Neural Information Processing, Information Sciences, vol. 128, pp. 147-148, 2000.
[24] S. Kak, Active agents, intelligence, and quantum computing. Information Sciences, vol. 128, pp. 1-17, 2000.
[25] S. Tejomurtula and S. Kak, Inverse kinematics in robotics using neural networks, Information Sciences, vol. 116, pp. 147-164, 1999.
[26] S. Kak, Can we define levels of artificial intelligence? Journal of Intelligent Systems, vol. 6, pp. 133-144, 1996.
[27] S. Kak, On the science of consciousness, Indian Journal of History of Science, vol. 32, pp. 105-120, 1997.
[28] S. Kak, Feedback neural networks: new characteristics and a generalization, Circuits, Systems, and Signal Processing, vol. 12, pp. 263-278, 1993.
[29] S. Kak, State generators and complex neural memories, Pramana, vol. 38, pp. 271-278, 1992.
[30] S. Kak, Self-indexing of neural memories, Physics Letters A, vol. 143, pp. 293-296, 1990.
[31] S. Kak, The Nature of Physical Reality. Peter Lang, New York, 1986.
[32] C.H. Youn and S. Kak, Continuous unlearning in neural networks, Electronics Letters, vol. 25, pp. 202-203, 1989.
[33] S. Kak and M.C. Stinson, A bicameral neural network where information can be indexed, Electronics Letters, vol. 25, pp. 203-205, 1989.
[34] D.L. Prados and S. Kak, Neural network capacity using the delta rule, Electronics Letters, vol. 25, pp. 197-199, 1989.

[35] S. Kak, A two-layered mesh array for matrix multiplication, Parallel Computing, vol. 6, pp. 383-385, 1988.
[36] S. Kak, Multilayered array computing, Information Sciences, vol. 45, pp. 347-365, 1988.
[37] M.C. Stinson and S. Kak, A bicameral neural network that improves convergence, Neural Networks, vol. 1, p. 136, 1988.
[38] S. Kak, The Paninian approach to natural language processing," International Journal of Approximate Reasoning, vol. 1, pp. 117-130, 1987.
[39] D.L. Prados and S. Kak, Shift Invariant Associative Memory, with D. Prados in VLSI for Artificial Intelligence, Edited by J. Delgado-Frias and W. Moore. Boston MA: Kluwer, 1989.
[40] A. Rishiyur, Neural networks with complex and quarternion inputs. Arxiv: cs.NE/0607090
[41] P. Rajagopal, The basic Kak network with complex inputs. Arxiv: cs.NE/0603015
[42] S. Kak, Are quantum computing models realistic? Arxiv: quant-ph/0110040
[43] S. Kak, The Gods Within. Munshiram Manoharlal, New Delhi, 2002.
[44] Z. Zhang, S. Zhang, E. Chen, X. Wang, H. Cheng. TextCC: New Feed Forward Neural Network for Classifying Documents Instantly. Advances in Neural Networks – ISNN 2005, volume 3497, Springer Verlag, 2005.
[45] Z. Zhang, S. Zhang, E. Chen, X. Wang, H. Cheng. Principle for outputs in hidden neurons in CC4 networks. Advances in Neural Networks – ISNN 2005, volume 3497, Springer Verlag, 2005.