## **An Energy-Efficient Stochastic Computational Deep Belief Network** UNIVERSITY OF ALBERTA Yidong Liu, Yanzhi Wang, Fabrizio Lombardi and Jie Han, University of Alberta, Edmonton, AB, Canada

Abstract	Stochastic computing	A-SCAU design
<ul> <li>In this paper, a deep belief network is proposed based on stochastic computational methods.</li> <li>An approximate SC activation unit (A-SCAU) is proposed to implement different types of activation functions such as the sigmoid, the rectifier linear and the pure line functions.</li> <li>The design achieves a smaller area, lower power and energy consumption with a similar accuracy and speed compared to conventional binary implementations.</li> </ul>	<ul> <li>In SC, values are encoded by stochastic bit streams.</li> <li>Some fundamental computational elements can be implemented by simple circuits [2].</li> <li>S1: 111001110111</li></ul>	□ A-SCAU consists of an APC, a linear approximation unit (LAU), an RNG and a comparator. Comparator $K_1$ $K_2$ $K_3$ $K_5$ $K_6$ $K_6$ $K_6$ $K_6$ $K_6$ $K_6$ $K_6$ $K_6$ $K_6$ $K_6$ $K_7$ $K_6$ $K_7$
Introduction	Sel: 001101001110	□ The LAU is the core of the A-SCAU, based on binary

algorithms, implementing multiple activation functions.

A DBN consists of one input layer, multiple hidden



sigmoid

S3: 101110101010

S1: 111110111011 —



parallel counter (APC) and an up/down counter.



linear feedback shift register (LFSR).

designs.



[1] G. E. Hinton, S. Osindero, and Y.-W. The, "A fast learning

## **Energy efficiency comparison**

	SC-DBN	Fixed (8 bits)	Floating (32 bits)
area (um <sup>2</sup> )	23062.61	86875.05	437767.22
power (mW)	1.12	4.01	24.86
latency (us)	1.90	1.77	2.58
energy (nJ)	2.12	7.10	64.14

significantly reduce the area and energy consumption of the RNGs.

SC-DBN achieves high RNG sharing rate, thus

□ The proposed design takes 5.27%, 4.49% and 3.31% of the area, power and energy consumption of the 32-bit floating-point design; 26.55%, 27.82% and 29.89% of the 8-bit fixed-point design, with similar accuracy and computation speed.

Acknowledgements



□ The



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