The CONSCIOUS Virtual Machine Model : Transparently Exploiting Probability Processors

Jonathan Appavoo (BU), Dan Schatzberg (BU Student), Mark Reynolds (BU Student), and Amos Waterland (Harvard Student)

As typified by the recent announcement of the Lyric GP5[1] Probability Processor, very efficient scalable hardware for pattern recognition and prediction are on the horizon. One class of such devices, called neuromorphic[2], was pioneered by Carver Mead in the 80's to provide a path for breaking the power, scaling, and reliability barriers associated with standard digital VLSI technology. Recent neuromorphic research examples include work at Stanford[3], MIT[4], and the DARPA Sponsored SyNAPSE Project[5]. These devices operate transistors as un-clocked analog devices organized to implement pattern recognition and prediction several orders of magnitude more efficiently than functionally equivalent digital counterparts. Abstractly, the devices implement modern machine learning or statistical inference. When exposed to data as a time-varying signal, the devices learn and store patterns in the data at multiple time scales and constantly provide predictions about what the signal will do in the future. This kind of function can be seen as a form of predictive associative memory.

While this new class of analog device is poised to revolutionize machine learning and search applications, it is not obvious how to accelerate general purpose systems with them. In this poster we present the CONSCIOUS Virtual Machine Model that exploits probability processors as co-processors to transparently accelerate general purpose computation. Our model introduces a virtual machine monitor that uses both standard processors and probability co-processors to implement and optimize virtual machine instances. The instances provide a commodity machine level interface using the standard processors but their performance is transparently optimized by the virtual machine monitor's use of the probability co-processors.

The goal of the poster is to introduce our model and research agenda to the community. We will illustrate the CONSCIOUS Virtual Machine Model, our basic conjectures, and experimental method. A fundamental observation of our work is that the operation of a standard virtual machine instance can be converted into a signal that is amenable to probability processing. We will demo our initial experimental infrastructure system that generates a signal for a standard x86 PC VM instance.

References

[1] Lyric Semiconductor, *Probability Processor: GP5 (General Purpose Programmable Probability Processing Platform*, http://www.lyricsemiconductor.com/technology-processor.htm.

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