Duane A. Bailey — Research Interests (2019)

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Below, topics of interest.
Students with similar inclinations are also interesting.

My work with students typically focuses on the hardware/software boundary. I develop

(1) software artifacts that improve the effective use of hardware and

(2) hardware features that improve performance of software.

We have come to the end of the performance scaling associated with Moore's Law. We're now in the Age of Dark Silicon: while we continue to fit an increasing number of transistors on each chip, a decreasing percentage of these transistors can be powered on at any time. In the immediate future, the competition will not be in making processors run faster, but the focus will be on reducing the amount of power consumed.

Evolutionary Hardware

One thread of my research focuses on the development of processors that can *evolve*. Here, we've looked at ways to assemble computation from a pool of processor parts that are selectively activated to support power-efficient computation. Imagine: a processor evaluates its own performance, keeping track of the effectiveness of different processing units (for example: how often are floating-point calculations performed) and, occasionally, reconfigures itself to shed underutilized components in favor of software emulation and incorporates tailored accelerators that reduce the total power needs of the most common calculations. A phone that is heavily used as a camera exchanges some of its data cache for an enhanced streaming image processing unit.

A Shape-Shifting Soft-Core Processor

Over the next year we will be migrating the open source RISC-V "Rocket" soft-core from Berkeley to a shape-shifting field programmable gate array (FPGA) from Xilinx (see, for example, pynq.io). Our hope is to develop a series of processor modifications that allow real-time reconfiguration of hardware that helps to reduce total power.

Hardware/Software boundary, in the Wild

I am also interested in efficient and effective computation "in the wild". Biological systems often depend on computation to make decisions about life in a (possibly) resilient or robust manner. For example, a plant leaf must establish a consensus decision about whether to exchange gases with the outside world. It is believed that this decision occurs as a result of exchange of information/gas with neighbors. I am interested in pushing our understanding of how relatively unorganized systems are able to establish platforms for resilient computation and robust decision making.

Sound interesting? Let's talk.