The Royal Academy of Engineering

Research Fellowship

Adaptable Processor Architecture and Software for Energy-Efficient Computing

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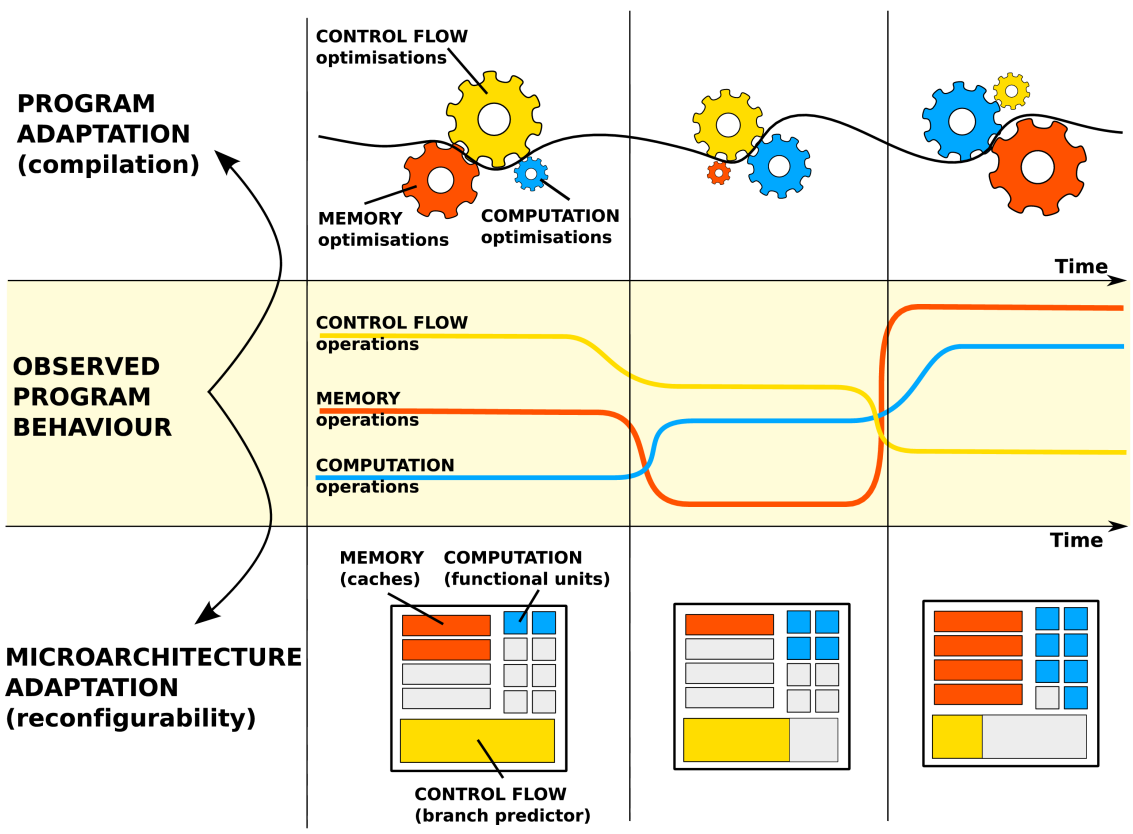
Need for Energy-Efficiency

Energy consumption is now a major concern for both **mobile devices** and **high-performance data centres**. Consumer electronics requires more powerful and versatile mobile devices with extended battery life, while businesses increasingly rely on data centres to run their services. Given this trend and the **rising cost of energy**, it will become increasingly unsustainable to run such centres. The challenge is to develop new techniques that span the entire range of computer systems and enable truly energy-efficient computing.

This research aims at investigating novel ways of **designing adaptable systems** where both the software and the hardware constantly reshape themselves in tandem to fit the dynamic behaviour of the application. This will result in higher levels of **energy efficiency**.

Dynamic Adaptation



1. Programs exhibit different **phase behaviour** during runtime. This can be exploited to tailor the software and hardware to the specific needs of these phases.

2. By observing the phase behaviour, both software and hardware are adapted in order to obtain the **best performance** while **limiting** the **energy consumed**.

3a. In the case of software, the system keeps **recompiling** the **application** with different optimisations, each aimed at increasing performance related to the program's workload.

3b. In the case of hardware, the main processor's **resources are switched on or off** to save energy depending on the requirements of the application.

Statistical Learning

Dynamically adapting the software and the hardware means that whenever the application enters a new phase, a decision must be taken about the optimal microarchitecture parameters and the software optimisations to apply. This research investigates how this process can be driven by considering **statistical techniques** coupled **with artificial intelligence**. This systematic approach promises to automate the design of such systems achieving high levels of energy-efficiency.

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