Performance projection on x86 CPUs

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With the advent of heterogeneous systems that combine CPUs and GPUs, designing a supercomputer becomes more and more complex. The hardware characteristics of GPUs significantly impact the performance. Choosing the CPU that will maximize performance for a limited budget is tedious because it requires predicting the performance on a non-existing hardware platform. In a recent paper, we proposed a new methodology for predicting the performance of kernels running on GPUs. This method analyzes the behavior of an application running on an existing platform, and projects its performance on another GPU based on the target hardware characteristics. The performance projection relies on a hierarchical roofline model as well as on a comparison of the kernel's assembly instructions of both GPUs to estimate the operational intensity of the target GPU.

Another similar paper focused on performance projection on ARM CPUs. This work uses DynamoRIO to instrument an application binary in order to collect performance metrics on a source CPU. The performance metric is then projected to a target CPU to predict the application performance on a future machine. Unfortunately, this tool is quite complex to run, and it only works for ARM CPUs.

Objective

The goal of this research project is design a similar performance projection tool for x86 CPUs. This tool may rely on dynamic binary instrumentation tools such as DynamoRIO or PIN, or it may use other instrumentation techniques (eg. LD_PRELOAD) to collect performance metrics. Another approach could be to simplify the performance projection model in order to require fewer performance metrics. The student could compare the performance projection accuracy depending on the intrusiveness of the instrumentation technique.

What you will learn

- CPU architecture performance details
- performance analysis on HPC applications
- dynamic binary instrumentation

Contact

Elisabeth Brunet <elisabeth.brunet@telecom-sudparis.eu>
François Trahay <francois.trahay@telecom-sudparis.eu>