GPU computing: semantics and analysis

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1 Context

The postdoc position will be associated with the Computer Science Laboratory at École Polytechnique (LIX[1]) and will be supervised by Dominique Rossin, Éric Goubault, Samuel Mimram and Emmanuel Haucourt. The lab is composed of about a hundred researchers, and is associated with CNRS and INRIA through joint research projects. École Polytechnique is one of the most famous engineering schools in France, with a great tradition and excellence in science and technology. Students are highly selected, begin their studies at the end of undergraduate level, and can carry over until a Ph.D.

The postdoc position will also be linked to a collaborative research project involving some industrial partners in the security and IT domain, as well as the applied mathematics department (CMAP) of École Polytechnique. Mathematically, CMAP is involved in the definition of numerical filtering methods. LIX is involved in the parallelization of the code on GPUs, in particular on an NVIDIA K20 graphical card running under CUDA.

2 Work

The postdoc will be involved equally in theoretical studies and in practical work.

On the theoretical side, the postdoc candidate will study and formalize the semantics of GPU computing such as the ones implemented by CUDA and OpenCL, focusing on the most recent features of these parallel platforms (including dynamic parallelism, complex synchronization primitives such as compare&swap, streams, asynchronous memory copies, etc.), with both host and device primitives. The semantics should account for the underlying weak memory model, and should be tested against actual hardware implementations as well as against the current specification.

The aim of the definition of this semantics will be the verification (see for instance [8]) and the automatic parallelization of code, and will be coupled with other classical formal methods such abstract interpretation based methods [2]. A question that we wish to answer is whether we can use the recent tools from true concurrency [5] and in particular from geometric semantics [3, 4, 1], to study a realistic fragment of CUDA/OpenCL.

[1] `http://www.lix.polytechnique.fr/`

This semantics should be compared with existing litterature, such as [7] and [6] (even though we are more interested in high-level semantics of CUDA/OpenCL than the lower level of PTX assembly).

3 Miscellaneous

The salary may depend on the experience of the candidate, but should be around 2400 euros per month (net salary).
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References

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