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PyPS a programmable pass manager

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► **To cite this version:**

Serge Guelton, Mehdi Amini, Ronan Keryell, Béatrice Creusillet. PyPS a programmable pass manager. The 24th International Workshop on Languages and Compilers for Parallel Computing, Sep 2011, Fort Collins, United States. hal-01087303

HAL Id: hal-01087303

<https://hal-mines-paristech.archives-ouvertes.fr/hal-01087303>

Submitted on 25 Nov 2014

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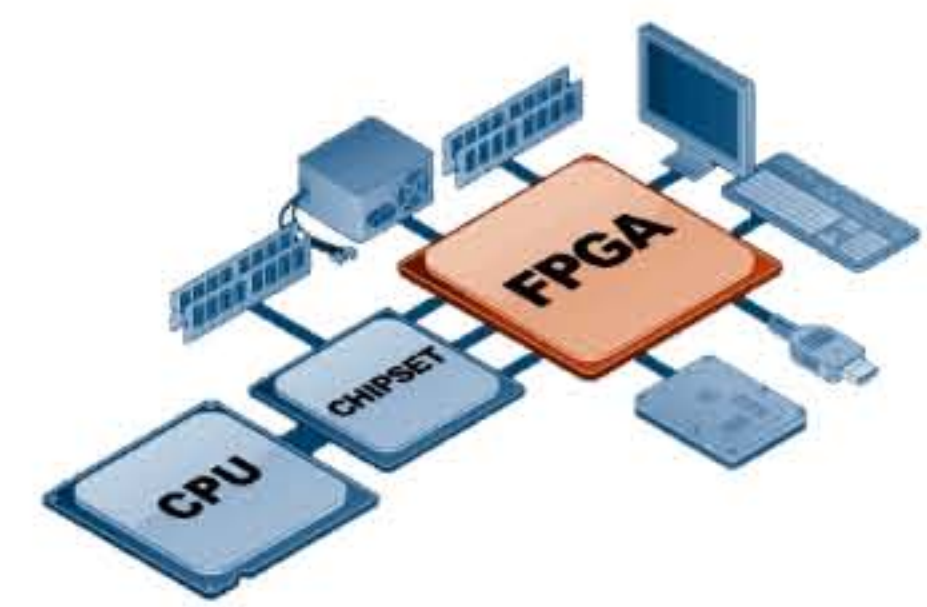
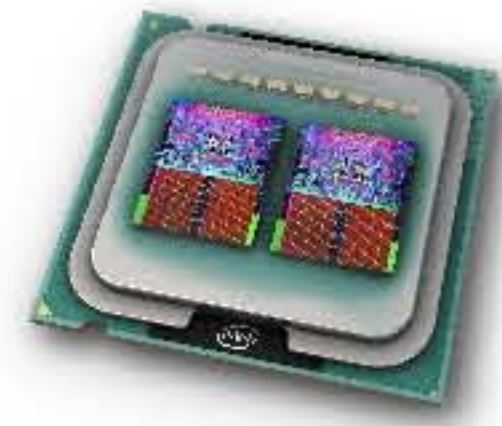
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1 - Complex Environment



Parallel and heterogenous hardware
Compilers must be multi-target,
collaborate, and be specialized.



7 - Targets

OpenMP ; classic scheme but still illustrating basic functionalities.
TERAPIX is a fpga based accelerator for image processing from thales.
SAC vectorizer targets AVX, SSE, or NEON.
An Iterative Compiler ; try different compilation schemes or transformation flavors.
Par4All makes use of other compilers to provide automatic parallelization of applications to multiple hybrid architectures.

2 - Source-to-Source

Many source-to-source successful compilers.
Flexible transformation systems for heterogeneous computing :
→ parallelism detection algorithm,
→ variable privatization,
→ communication generation,
→ etc.

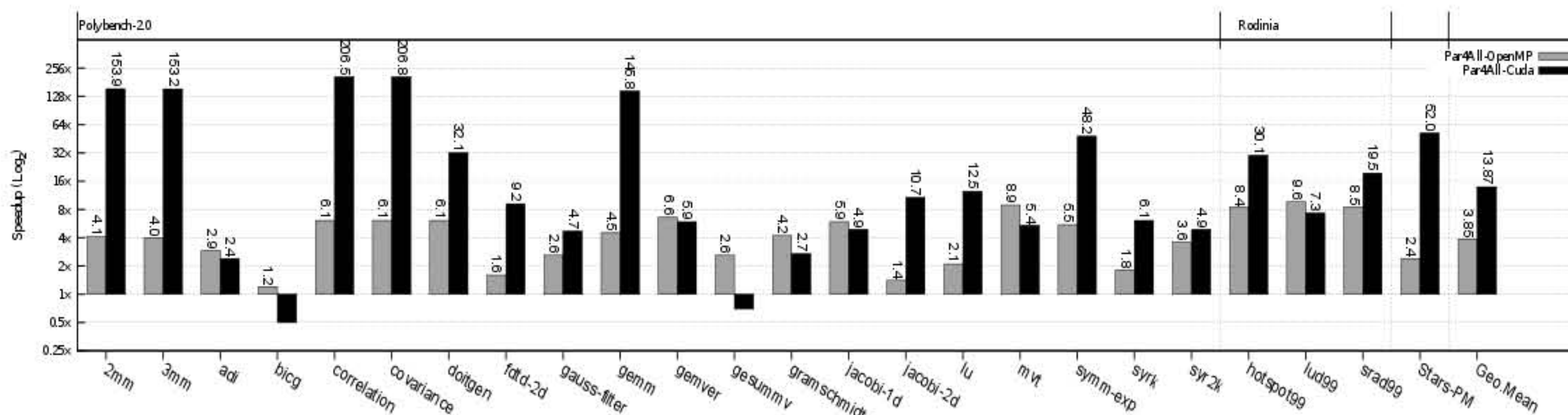


PyPS

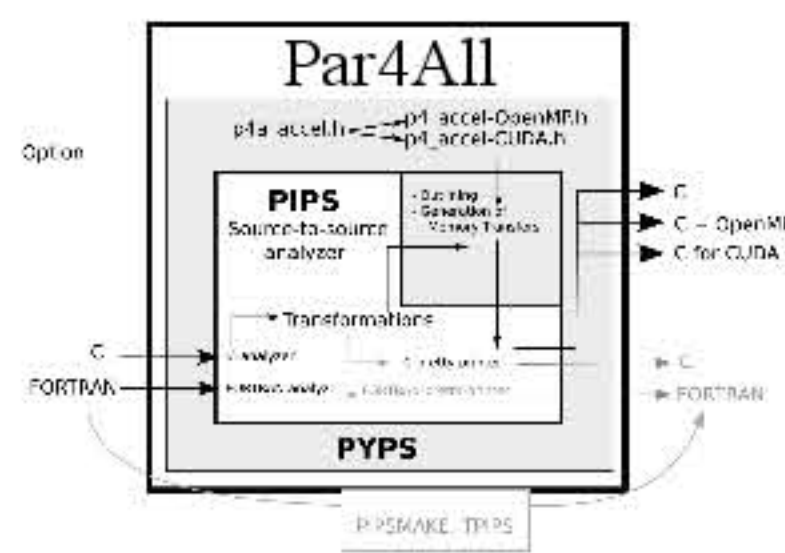
a programmable pass manager

6 - Control Structures

Conditionals: manage switches, choose different compilation schemes.
For loops: iterate over the callgraph, loop nests.
Exceptions: recover from compilation failure, impossible transformations, etc.
While loops: look for fixed point for sequence of passes.



A code transformation is an application $P \rightarrow P$ that preserves the semantics of the program, that is to say:
 $\forall p \in \mathcal{P}, \forall v_{in} \in \mathcal{V}_{in}(p), P(p, v_{in}) = P(t(p), v_{in})$



3 - Model for Code Transformations

Sequencing of code transformations is the compiler core.
Formal point of view for interactions between passes : several transformation composition rules.


A failsafe operator :
 $\forall t \in \mathcal{T}, \forall p \in \mathcal{P}, \tilde{t}(p) = \begin{cases} t(p) & \text{if } t(p) \neq \text{error} \\ p & \text{otherwise} \end{cases}$

A failsafe composition:
 $\forall t_0, t_1 \in \mathcal{T} \times \mathcal{T}, t_1 \circ t_0 = \tilde{t}_1 \circ \tilde{t}_0$

A conditional composition:
 $\forall t_0, t_1, t_2 \in \mathcal{T} \times \mathcal{T}, \forall p \in \mathcal{P} \quad ((t_1, t_2) \circ t_0)(p) = \begin{cases} (t_1 \circ t_0)(p) & \text{if } t_0(p) \neq \text{error} \\ t_2(p) & \text{otherwise} \end{cases}$

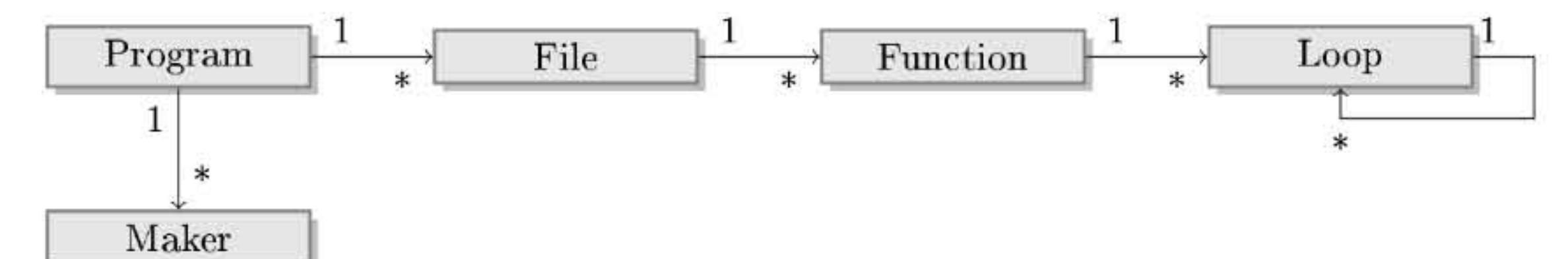
An error propagation operator :
 $\forall t_0, t_1 \in \mathcal{T} \times \mathcal{T}, t_1 \circ t_0 = (t_1, id_{\mathcal{T}}) \circ t_0$

4 - Based on a Scripting Language

on the shoulders of giants  python powered
`print "Hello, world!"`

No DSL, does not reinvent the wheel, build over a high level language with a rich ecosystem which widens the set of possibilities.

5 - Abstractions



Classes: high level program representation
high level compilation scheme
Methods: compose transformations into more complex ones
Inheritance: compose scheme for heterogeneous targets

Related Work

Automated Programmable Control and Parameterization of Compiler Optimizations. Yi. CGO 2011.
Finding effective optimization phase sequences. Kulkarni et al. LCTES 2003.
MILEPOST GCC: machine learning based research compiler. Fursin et al. GCC Developers' Summit, 2008.

