Status of High Level Loop Optimizations in GCC

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Jul. 9th, 2012
Not so high-level loop optimizations

Work on innermost loops or at least do not consider a loop nest as whole.
Not so high-level loop optimizations

- loop header copying
- final value replacement
- complete loop peeling
- loop invariant motion and store sinking
- loop unswitching
- loop distribution and pattern detection
- loop if-conversion
- loop vectorization
- predictive commoning
- loop induction variable optimization
- loop array prefetching
- loop unrolling and peeling
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High level loop optimizations

Work on loop nests and change the shape or order of the loop tree.
Memory hierarchy optimization.
High level loop optimizations

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High level loop optimizations

- loop parallelization
- loop strip mining
- loop blocking
- loop interchange

- unroll and jam
- working interchange
- better heuristics for complete loop nest unrolling
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Preserving Loop Structure

- Alongside the regular
- Track individual loops throughout the entire compilation
- Attach information
  - Makes some CFG transforms hard
  - Destroy loop form
  - Inhibit CFG transform
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When to do (highlevel) loop transforms?
Cost model issues
- Too many tiny scalar optimization passes in random order
- Inflexible static pass pipeline
**Pass managing**

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GRAPHHITE.

Graphite.
GRAPHITE pros

- Almost all high level loop optimizations implemented in the GRAPHITE framework
- The polyhedral model is well researched and other compilers use it
- No phase-ordering issues(?)
- GRAPHITE has been updated to work with ISL instead of PPL and with a recent CLooG version
- Possibly using shared infrastructure between GCC and LLVM (Polly)
The GCC side of GRAPHITE is still considered unmaintained due to lack of ressources
Polyhedral optimizations are slow and memory-hungry
Discourages work on non-GRAPHITE high level loop optimizers?
Alternatives

- Re-surrect the old interchange code?
- Middle-end array expressions?
- Other suitable representation for high-level loop optimizations?
- Simply throw away GRAPHITE first?

- Volunteers?
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Discussion.