



Collaborative Compiler Vectorization

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Motivation

- ▶ Compilers are only partially successful at automatic vectorization
- ▶ Only 62 out of 151 inner loops automatically vectorized by GCC, 109 by at least one of the compilers
- ▶ Many vectorization obstacles can be handled by at least one of the compilers

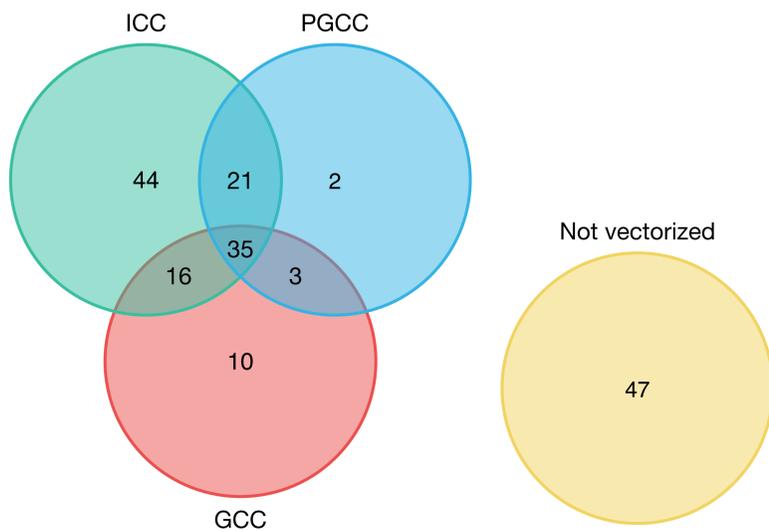


Figure: Inner loops optimized by three compilers on the Extended Test Suite for Vectorizing Compilers

- ▶ We argue that many compiler limitations can be overcome if the compilers collaborated!

Tool

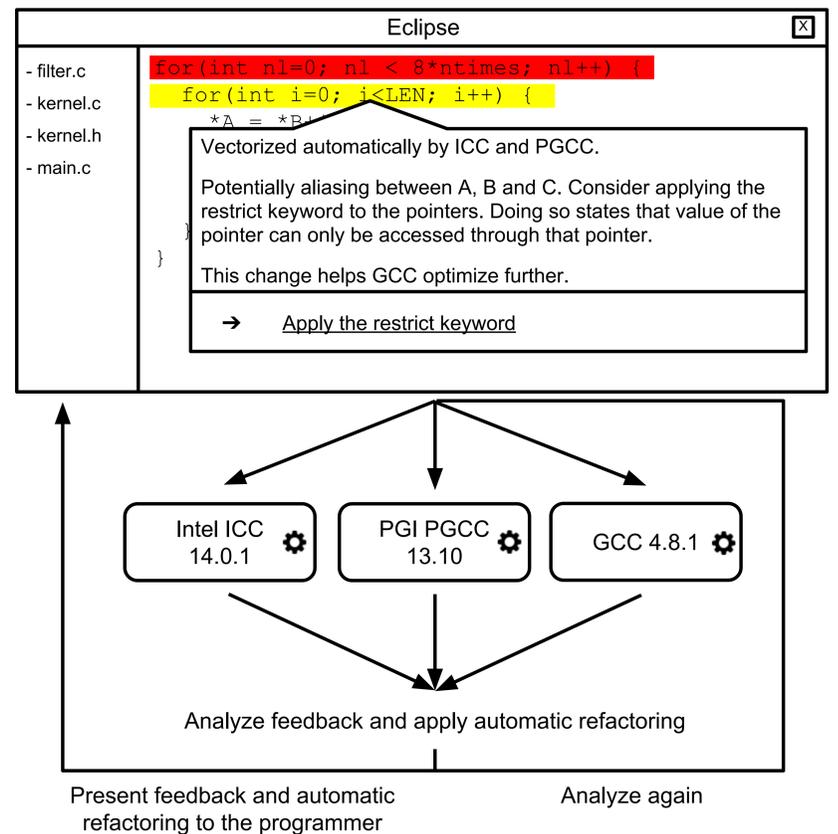


Figure: Illustration of the compiler driven feedback system

Basic Idea

- ▶ Combine compiler feedback from many compilers
- ▶ Use feedback to make all compilers optimize further
- ▶ Apply automatic refactorings and validate effect
- ▶ Only advice on automatic refactoring if it has any effect
- ▶ Suggest automatic refactoring to the programmer and let the programmer determine whether the transformation is safe

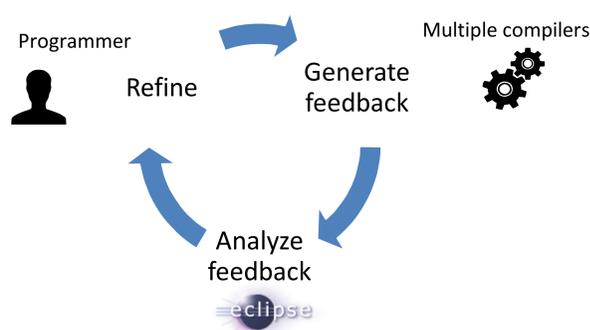


Figure: Tool feedback loop including the programmer in the optimization process

Evaluation

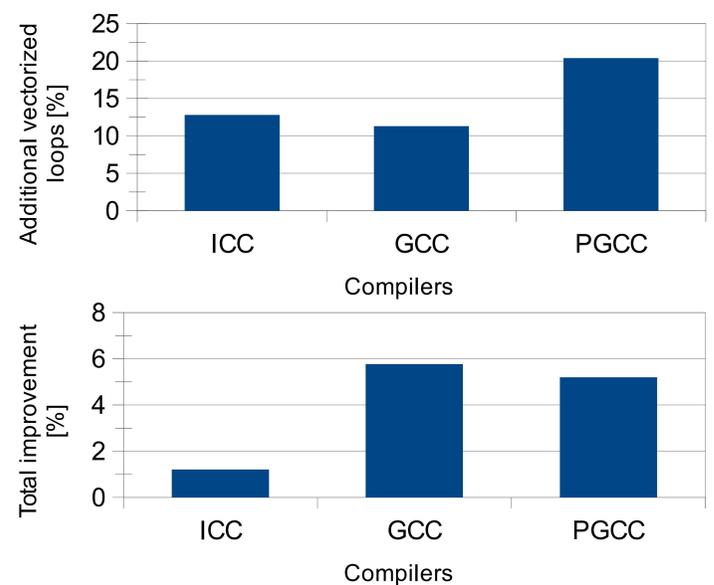


Figure: Evaluation on the Extended Test Suite for Vectorizing Compilers where obstacles preventing optimization have been solved using the automatic refactorings. Platform: Intel Core i7-3517U with AVX @ 1.90GHz

- ▶ Combined 30 additional loops vectorized
- ▶ Speedups of up to 17x achieved on one loop using GCC

Contributions

- ▶ Focuses the programmers attention by only showing the most promising feedback
- ▶ Can provide feedback on:
 - ▶ Aliasing by suggesting static and global arrays or automatic refactoring for restrict keyword
 - ▶ Data alignment by suggesting adding alignment attribute
 - ▶ Data dependency by compiler specific pragmas making the compilers assume no loop carried data dependency
 - ▶ Profitability by suggesting pragmas for forcing vectorization
 - ▶ Suggesting linking against a math library with vector implementations
 - ▶ Suggesting permuting loop order

Future Work

- ▶ Take input from more compilers: XLC, Clang/llvm and Oracle Solaris Studio
- ▶ Include advice and optimization reports for automatic parallelization
- ▶ Provide feedback on more obstacles
- ▶ Use advice on other platforms, e.g. for automatic parallelization on GPUs

Conclusion

- ▶ We can make multiple compilers collaborate using optimization reports and automatic refactorings
- ▶ Cost effective total speedup of up to 5.8% on entire benchmark suite