Code Modernization: Application Specific Code Tuning on Intel Architecture

A case study from "Reasonable" up to "Closing the Ninja Gap"

Intel High Performance and Throughput Computing (EMEA)
Hans Pabst, July 9th 2015

Motivation

"Improving Performance by Specializing Code."

- Generating* specialized code where "everything is hard/hand-coded"
- Emit specialized code (optimized, Intrinsics, or assembly code)

* For example, via scripting such as Python (printed code is covering important cases), or at runtime (JIT).

Intel MKL

DIRECT CALL

Intel Math Kernel Library (Intel MKL)

DIRECT CALL feature: Intel MKL allows inlining code for very small problem sizes as well as calling the low-level library implementation directly for small problem sizes. This feature may improve performance because of skipping error checks and calls to intermediate library layers.

- Works for Intel and non-Intel compilers
- Works for C/C++ and Fortran
- Compile-time decision

Improved performance for small problem sizes.

Intel MKL 11.2: DIRECT CALL

Tradeoffs and Limitations

BLAS-conformant error checking vs. low overhead

- No error checking or 'xerbla' callback

Code dispatch vs. compile-time decision

- AVX, AVX2, no MIC code path

Subset of functions LAPACK/BLAS3

- xGEMM

Make informed tradeoffs and gain performance.

Intel MKL

VERBOSE MODE

Intel MKL 11.2: VERBOSE Mode

Quickly check if an application performs small matrix multiplications, and estimate the performance impact.

1. Set the environment variable MKL_VERBOSE=1
2. Select a representative workload
3. Run with redirected standard output

Example: evaluate occurrences of DGEMM for M, N, and K

```
$ env MKL_VERBOSE=1 ./myapplication > verbose.txt
$ grep -a "MKL_VERBOSE DGEMM" verbose.txt | cut -d, -f3-5
```

LIBXSMM

LIBXSMM

Interface (C API)

Simplified interface for matrix-matrix multiplications

- $c_{m \times n} = c_{m \times n} + a_{m \times k} * b_{k \times n}$ (no full xGEMM)

Dispatched and non-dispatched code paths

- Specialized/generated, or inlined C code
- LAPACK/BLAS (fallback code path)
- Amortized dispatch (“zero” overhead)

License

- Open Source Software (BSD 3-clause license)*

* https://github.com/hfp/libxsmm

Compiler Hints

Compiler Hints: Pragmas and Directives

Unknown pragmas (C/C++) or unknown directives (FORTRAN) are ignored if unknown to the specific compiler. However…

Preprocessor can unify similar directives across different compilers

BIG ISSUE: C/C++ preprocessor does not allow pragmas as part of macros

- C++: vendor specific compiler intrinsic (__pragma, etc.)
- C99: _Pragma intrinsic

What's worth to be covered / beneficial?

- PRAGMA_SIMD, PRAGMA_SIMD_COLLAPSE, PRAGMA_SIMD_REDUCTION
- PRAGMA_LOOP_COUNT, PRAGMA_UNROLL_N, PRAGMA_UNROLL
- ALIGNED, ASSUME_ALIGNED, ASSUME

Downloading a starting point…

https://github.com/hfp/libxsmm/blob/master/include/libxsmm_macros.h

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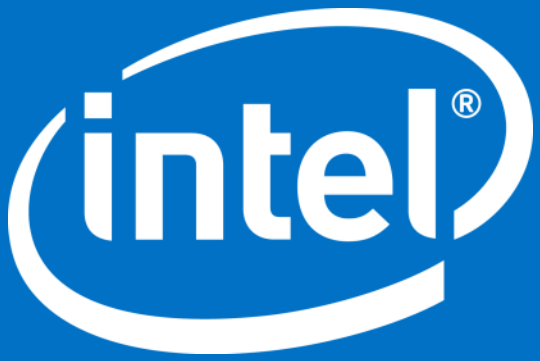
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