Algorithm Engineering Lab Assignment 7

Brian Zahoransky (brian.zahoransky@uni-jena.de)

February 22, 2021

1. Explain three vectorization clauses of your choice that can be used with #pragma omp simd.

#pragma omp simd aligned(var1, ..., varN: LENGTH)
Above is shown the complete OpenMP SIMD aligned pragma. It gives the compiler a hint that the allocated memory on which the pointers var1, ..., varN point are aligned. Instead of LENGTH the programmer has to insert the right width of alignment. The most common is an alignment of 64 bytes since a cache line is 64 byte. In this case, the user would invoke the aligned-clause with 64 instead of LENGTH.

#pragma omp simd safelen(LENGTH)
Through the safelen-clause, the programmer can provide additional information for the compiler to ensure the correctness of a program. To give an example, consider the following case. An algorithm uses in a for-loop elements that have been updated nine iterations before. It may be that an AVX-512 supporting machine compiles the code using vectors containing 16 floating-point numbers. The result will be incorrect. To avoid such behaviour, the developer can replace LENGTH by 8.

#pragma omp simd reduction(OPERATION: var1, ..., varN)
The simd-reduction-clause works similar to the OpenMP-reduction-clause for multiple threads. The user can choose between +, -, *, &, |, ^ , &&, and || to replace OPERATION. At the end of the OpenMP section, each variable of the list var1, ..., varN will be reduced on its own with respect to the given operation.

2. Give reasons that speak for and against vectorization with intrinsics compared to guided vectorization with OpenMP.

Advantages of vector intrinsics over guided vectorization with OpenMP:

+ Assuming that the required compiler flags are set, the produced program is similar to one written in assembly.

+ Therefore, the program is performance portable. That means it does not matter which compiler is used; the program has the same performance.

+ Thus, the developer has full control over what happens, executing the program.

Disadvantages of vector intrinsics compared to guided vectorization with OpenMP:

- The written code may be not system portable. If the program is written with procedures of AVX-512 instruction set, it cannot be executed on a processor with AVX2 only support.

- It seems also to be harder to learn.

3. What are the advantages of vector intrinsics over assembly code?

+ still easier to implement if one has knowledge in C/C++

+ more compatible

4. What are the corresponding vectors of the three intrinsic data types: _ _m256, _ _m256d and _ _m256i.

_ _**m256** is used for vectors containing eight single-precision floating-point values

_ _**m256d** is used for vectors containing four double-precision floating-point values

_ _**m256i** is used for vectors containing all kinds of integer values (unsigned, signed, short, long Integer, etc). The used procedures give the compiler information about the specific type and how to deal with it.