HPC-I Lab1 Automatic Vectorization

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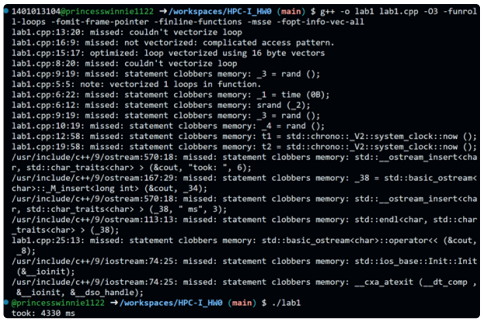
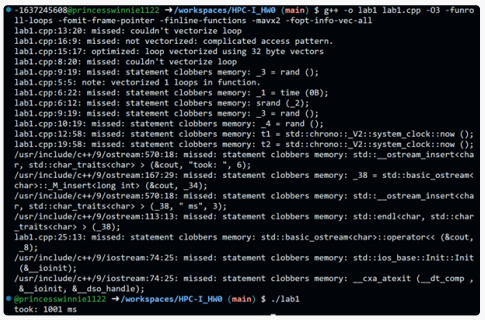
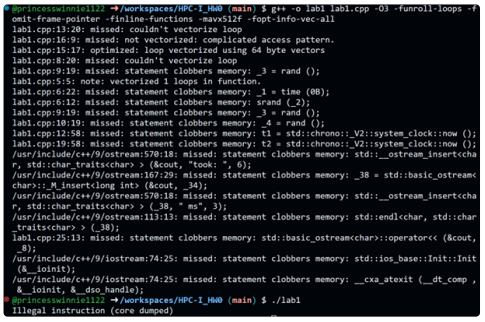
SIMD Instruction Set	Time	Screenshot (including compilation logs)
SSE	4330 ms	
AVX2	1001 ms	
AVX512 (if your computer supports AVX512)	Not supported	

Compare SSE, AVX2 and AVX512

1. **SSE Compilation**
    - Vectorized using **16-byte vectors**
    - Execution took **4330 ms**

    - Some loops could not be vectorized due to complex access patterns or functions like `rand()` that clobber memory.
2. **AVX2 Compilation**:
    - Vectorized using **32-byte vectors**
    - Execution took **1001 ms**
    - *Significantly faster than SSE* , likely due to more data being processed per vector operation.
3. **AVX-512 Compilation**:
    - Vectorized using **64-byte vectors**
    - Encountered *"Illegal instruction (core dumped)"* upon execution, indicating the CPU does not support AVX-512 instructions, or there was an issue with how these instructions were utilized.

Flags for optimization

- **`-O3`**: Enables all the optimizations that the compiler offers, excluding those that increase compilation time substantially.
- **`-funroll-loops`**
    - Tells the compiler to unroll loops where it deems beneficial for performance
    - Reduces the overhead of loop control but increases the size of the binary.
- **`-fomit-frame-pointer`**
    - Omits the frame pointer for a slight performance benefit in some cases.
    - Make debugging harder but can also free up a register for general use in certain architectures.
- **`-finline-functions`**: Encourages the compiler to inline functions, which can reduce the overhead of function calls but might increase the size of the binary.
- **`-fopt-info-vec-all`**: Provides detailed vectorization optimization reports from the compiler, showing which loops have been vectorized.