HPC Homework III

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Processor Information: I use the CIMS server to finish this homework. AMD Opteron(TM) Processor 6272 with Bulldozer micro-architecture (64 CPUs/cores). The cloud speed is 2.1GHz, and it has 8 flops per cycle. The total peak FLOP-rate is:

$$2.1 \times 10^9 \times 8 \times 64 \approx 1075 \text{ GFLOP/s}$$

Problem 1. I have changed the implementations for both functions of *sin4_intrin* and *sin4_vector* by adding more terms to the Taylor series expansion and improve the accuracy to 12-digits, as shown in the following results:

```
Reference time: 16.9144
Taylor time:    2.4301      Error: 6.928125e-12
Intrin time:    0.6853      Error: 6.928125e-12
Vector time:    0.6677      Error: 6.928125e-12
```

Extra Credit: My code and idea are partially inspired from MathExchange. To evaluate the sine function outside of $[-\pi/4, \pi/4]$, we could firstly move any x to $[-\pi/4, 7\pi/4]$ by $x = x - 2\pi \cdot \lfloor x + \pi/4 \rfloor$. Also, $\sin(x) = -\sin(x - \pi)$, so we could move $x \in [3\pi/4, 7\pi/4]$ to $[-\pi/4, 3\pi/4]$. From the previous, we have already calculated the $\sin(x)$ in $[-\pi/4, \pi/4]$, so only remaining a half part $[\pi/4, 3\pi/4]$: since $\sin(x) = \cos(x - \pi/2)$, we could then calculate the Taylor expansion for the cos function to x^{12} for $x \in [-\pi/4, \pi/4]$. The results are following:

```
Reference time: 16.9754
EC Reference time: 24.0671
Taylor time:    2.4926      Error: 6.928125e-12
EC Taylor time: 14.2977     Error: 6.928014e-12
Intrin time:    1.0036      Error: 6.928125e-12
Vector time:    0.9673      Error: 6.928125e-12
```

Problem 2. The results for different scan size and different threads are the following:

Scan Size	Thread 1	Thread 2	Thread 3	Thread 4
50000000	0.536100s	0.301920s	0.212112s	0.181933s
100000000	0.862035s	0.436828s	0.304313s	0.223344s

The information or architecture is introduced above.