

Parallel Programming Exercise 9-10

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(If you and your team member contribute equally, you can use (co-first author), after each name.)

1 Problem and Proposed Approach

(Brief your problem, and give your idea or concept of how you design your program.)

題目是找到前 8 個 perfect number

因為已知的 perfect number 都是偶數，而且偶數的 perfect number 都是 $(2^p - 1) * 2^{(p-1)}$ 的形式，所以我用 cyclic allocation，將不同的 p 分給所有 process，檢查 $2^p - 1$ 是不是質數，如果是質數就代表 $(2^p - 1) * 2^{(p-1)}$ 是 perfect number。

檢查質數的方法是看 $2 \sim \sqrt{2^p - 1}$ ，如果遇到因數就代表 $2^p - 1$ 不是質數。

2 Theoretical Analysis Model

(Try to give the time complexity of the algorithm, and analyze your program with iso-efficiency metrics)

總共有 n 個 p 要算，每個 p 要檢查 $\sqrt{2^p - 1}$ 個數字

Sequential execution time:
$$\sum_{p=0}^n \sqrt{2^p - 1} < \sum_{p=0}^n \sqrt{2^n - 1} = O(n\sqrt{2^n})$$

Parallel execution time:
$$O\left(\frac{n}{p}\sqrt{2^n}\right)$$

因為沒有 communication 所以不能算 isoefficiency

3 Performance Benchmark

(Give your idea or concept of how you design your program.)

Table 1. The execution time

Processors	1	2	3	4	5	6	7	8
Real execution time	2.62E-4	2.63E-4	2.00E-4	2.11E-4	2.39E-4	2.01E-4	1.98E-4	2.07E-4
Estimate execution time	2.62E-4	1.54E-4	1.19E-4	1.02E-4	9.33E-5	8.78E-5	8.43E-5	8.20E-5
Speedup	x	0.999	1.313	1.243	1.098	1.303	1.326	1.269
Karp-flatt metrics	x	1.002	0.643	0.739	0.889	0.721	0.713	0.758

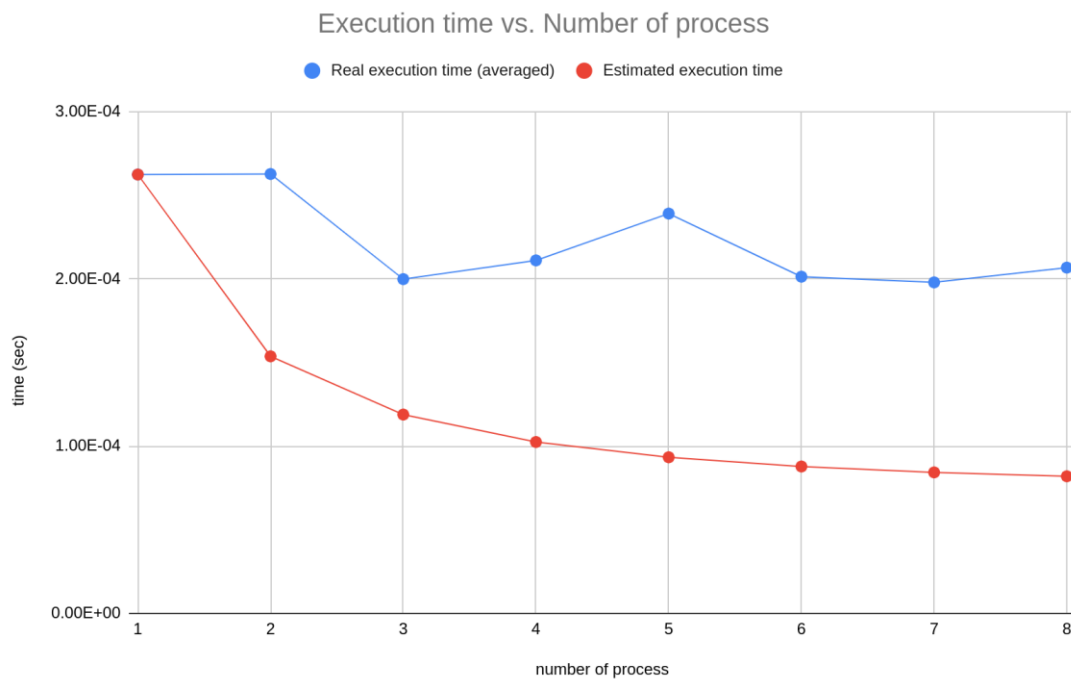


Figure 1. The performance diagram

4 Conclusion and Discussion

(Discuss the following issues of your program

1. What is the speedup respect to the number of processors used?
2. How can you improve your program further more
3. How does the communication and cache affect the performance of your program?
4. How does the Karp-Flatt metrics and Iso-efficiency metrics reveal?

)

1. Speedup 浮動很大，沒有提昇很多。這是因為檢查質數的 $O(\sqrt{2^p - 1})$ 是 upperbound，實際上可能檢查到兩三個因數就能確定不是質數，所以只有在檢查實際上是質數的 process 工作量比較大，load 沒有平均分配在 process 間，所以 speedup 沒有想像中好。
2. 如果能把檢查質數的工作平均分配會更好
3. 因為沒有 communication 所以影響不大
4. Karp-Flatt metrics 大致上維持定值，代表 sequential part 佔了很大一部份，實際上也是如此。

Appendix(optional):

(If something else you want to append in this file, like picture of life game)

程式執行結果：

```
[u1167044@clogin1 9-10]$ mpicc -o perfect ./Perfect\ Number\ \((Cyclic\).c -O3 -Wall
[u1167044@clogin1 9-10]$ mpiexec -n 1 ./perfect
6 28 496 8128 33550336 8589869056 137438691328 2305843008139952128 Time elapsed: 0.000351, Number of process: 1
```