Parallel Programming Exercise 4 – 8

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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.)

這個程式計算< 1,000,000 的數中有幾組相鄰奇數同為質數。

我修改課本的 Sieve of Eratosthenes，改成只 mark 奇數，並且每個 processor 多檢查下一個奇數，尋找相鄰奇質數就只需要在同個 process 內尋找。

最後用 `MPI_Reduce` 加總個數得到答案。

2 Theoretical Analysis Model

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

p: processor 數量

χ: mark 數字所需的時間

λ: processor 間傳訊息所需時間

$$\frac{\chi \cdot N \ln \ln N}{2p} + \frac{\lambda \sqrt{N} \log N}{\ln \sqrt{N}}$$

跟 sieve 一樣，不過 mark 數字的數量變成一半

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	0.00289	0.00169	0.00121	0.00093	0.00076	0.00074	0.00067	0.00063
Estimate execution time	0.00300	0.00174	0.00138	0.00123	0.00116	0.00112	0.00111	0.00110
Speedup	x	1.71691	2.39170	3.10474	3.79858	3.93391	4.30506	4.59498
Karp-flatt metrics	x	0.1649	0.1272	0.0961	0.0791	0.1050	0.1043	0.1059

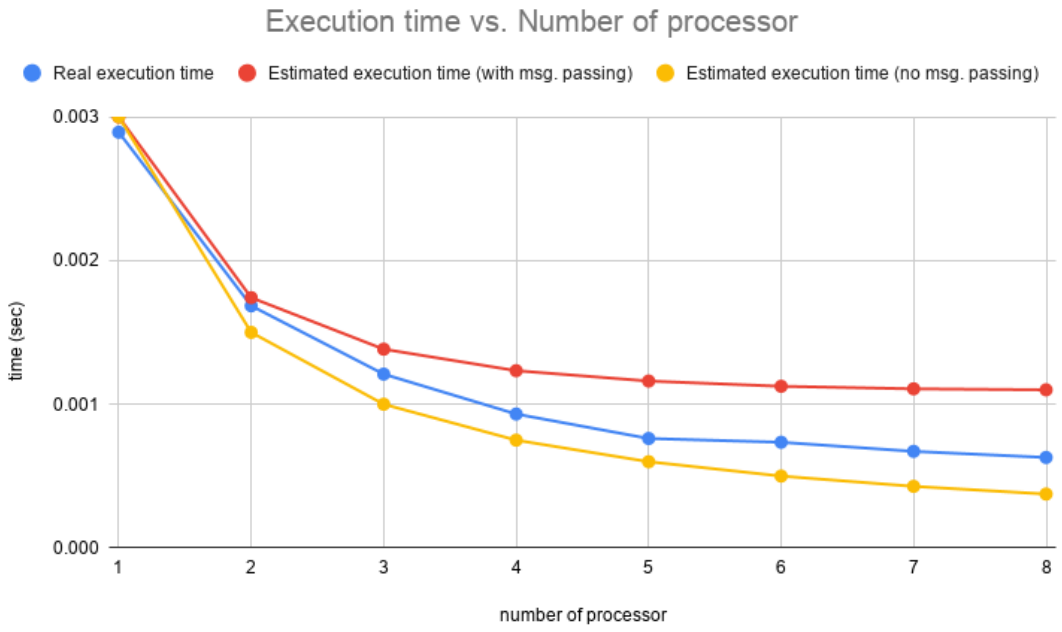

Figure 1. The performance diagram

另外用 1~32 個 processor 跑了 15 次取平均，得到以下結果

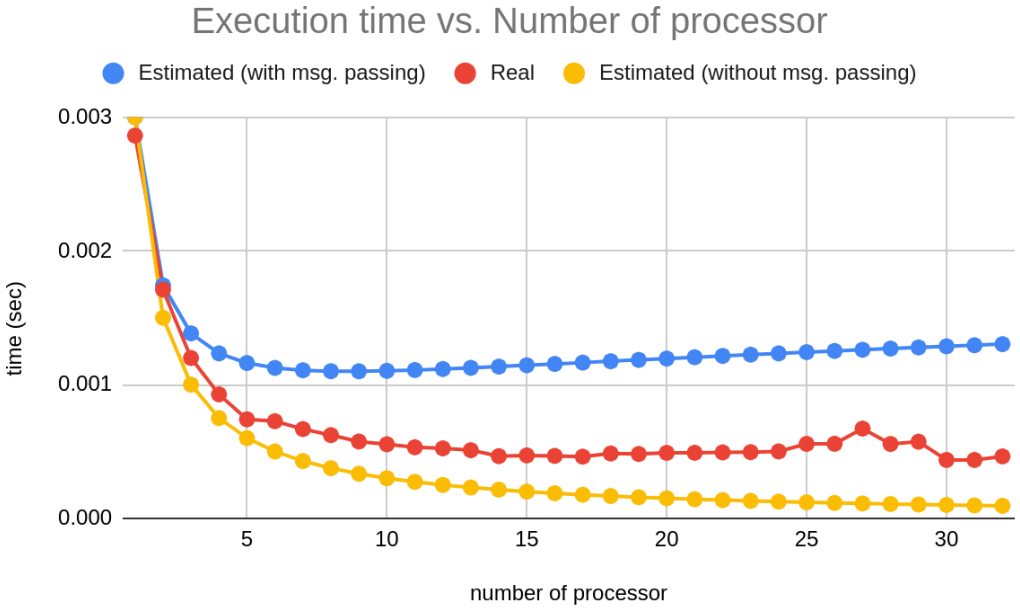

Figure 2. The performance diagram

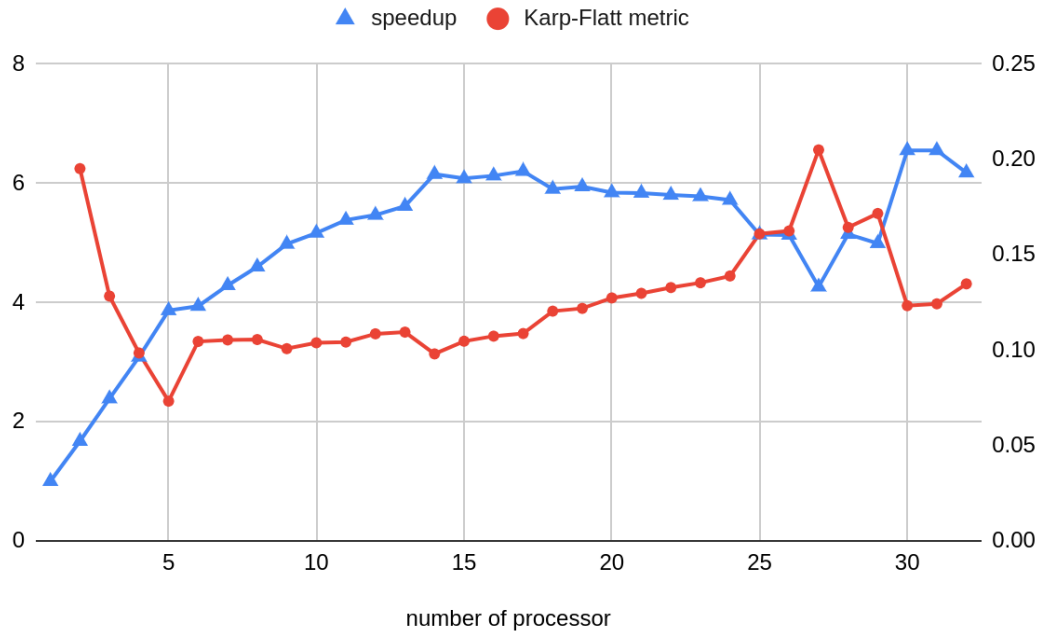

Figure 3. The performance diagram

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?

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1. speedup 最多在 6.5 倍左右，而且不一定越來越高
2. 可以用 sieve 的 improve 方式，例如讓每個 process 算 sqrt(N) 以下的所有質數，就不需要 broadcast。或是用 pipeline 的方式， process n 傳給 process n+1，每次只需要 n-1 次 send，不需要 broadcast。
3. Communication 的存在 (Broadcast) 讓 p 增大時執行時間不一定下降
4. Karp-Flatt metrics 的增加代表了 parallel overhead 導致 speedup 無法持續增加，可能是 broadcast 花的時間太長。

Appendix(optional):

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