Parallel Programming Exercise 4 – 9

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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.)
這個程式計算小於 1000000 相鄰質數的最大間距。

我修改課本的 Sieve of Eratosthenes，改成只 mark 奇數，並且每個 processor 除了在自己分到的範圍內算質數間距，還用 `MPI_Send`, `MPI_Recv` 拿到下一個 processor 的第一個質數來算間距。

最後用 `MPI_Reduce` 取最大值得到答案。

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

$$\frac{\chi \cdot N \ln \ln N}{2p} + \frac{\lambda \sqrt{N} \log N}{\ln \sqrt{N}} + 2\lambda(p-1)$$

跟 Sieve 一樣，不過 mark 的數量變成一半，以及加上邊界上的質數傳輸所需的 p-1 次 Send/Recv（mark 完後 O(N)找質數的部份比第一項小）。

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	1.51E-3	9.41E-4	7.11E-4	5.98E-4	5.49E-4	4.66E-4	4.52E-4	4.37E-4

Estimate execution time	1.51E-3	1.00E-3	8.94E-4	8.72E-4	8.77E-4	8.94E-4	9.15E-4	9.38E-4
Speedup	x	1.609	2.127	2.532	2.756	3.250	3.345	3.460
Karp-flatt metrics	x	0.243	0.205	0.193	0.204	0.169	0.182	0.187

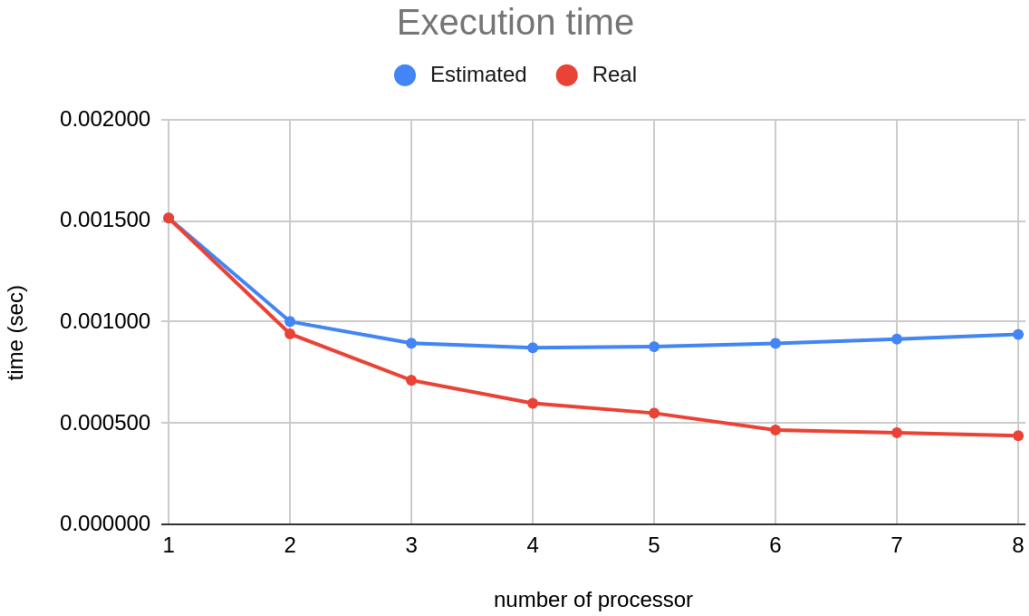

Figure 1. The performance diagram

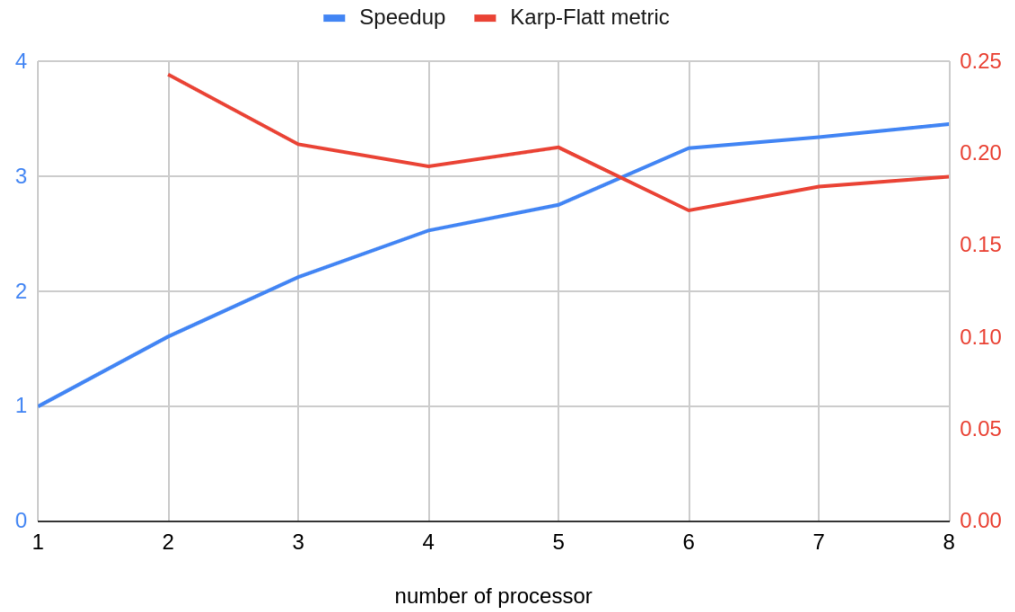

Figure 2. The performance diagram

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 有越來越多的趨勢，不過增加越來越少，最後大概在 3.x
2. 速度主要是找質數的部份決定，所以要改進的地方應該是在 sieve 的部份，跟 4-8 一樣可以用課本上的改進方法。
3. 在 p 越多的情況下，communication overhead 會有比較大的影響，導致 speedup 上不去
4. Karp-Flatt metric 沒有越來越小的趨勢，代表平行 overhead 影響不大。

Appendix(optional):

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