

Assignment Solution 1- HPC

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Problem 1

Do you have a smartphone?

- a. **How many processors does it have? How many cores?**

Answer: The iPhone 11 has the **A13 Bionic chip** with **6 cores**.

- b. **How much main memory?**

Answer: The iPhone 11 has **4 GB of RAM**.

- c. **What kind of GPU does it have?**

Answer: The iPhone 11 has a **4-core GPU designed by Apple**.

- d. **What are the FLOPS for the smartphone?**

Answer: The A13 Bionic delivers approximately **1.8 TFLOPS**. Compared to the fastest machines of 2019, such as the Summit supercomputer (148.6 PFLOPS), the iPhone 11 is far behind.

Problem 2

Comparison of Computers A and B

- a. **Which computer is faster for this program?**

Steps:

Clock cycle of Computer A: $1 \text{ ns} = 10^{-9} \text{ seconds}$.

Clock cycle of Computer B: $600 \text{ ps} = 600 \times 10^{-12} \text{ seconds}$.

Instructions per cycle for A: 2, so execution time per instruction: $\frac{1 \text{ ns}}{2} = 0.5 \text{ ns}$.

Instructions per cycle for B: 1.25, so execution time per instruction: $\frac{600 \text{ ps}}{1.25} = 480 \text{ ps} = 0.48 \text{ ns}$.

Answer: Computer B is faster as its execution time per instruction (0.48 ns) is less than Computer A (0.5 ns).

- b. What if Computer B required 10% more instructions than Computer A?

Steps:

Adjusted instructions for Computer B: $1.1 \times N$, where N is the number of instructions for A.

Adjusted execution time for Computer B: $0.48 \text{ ns} \times 1.1 = 0.528 \text{ ns}$.

Answer: In this case, Computer A is faster as its execution time (0.5 ns) is less than Computer B (0.528 ns).

Problem 3

Peak Performance and Efficiency

- a. How many GFlops/s did the application attain?

Steps:

Total FLOPS computed: 15 TFLOPS = 15,000 GFLOPS.

Time taken: 1 hour = 3600 seconds.

$$\text{Attained GFlops/s: } \frac{15,000}{3600} = 4.17 \text{ GFLOPS/s.}$$

- b. Which efficiency did it achieve?

Steps:

$$\text{Efficiency: } \frac{\text{Attained GFlops/s}}{\text{Peak GFlops/s}} = \frac{4.17}{8} = 0.52125 = 52.13\%.$$

Answer: The application attained **4.17 GFLOPS/s** with an efficiency of **52.13%**.

Problem 4

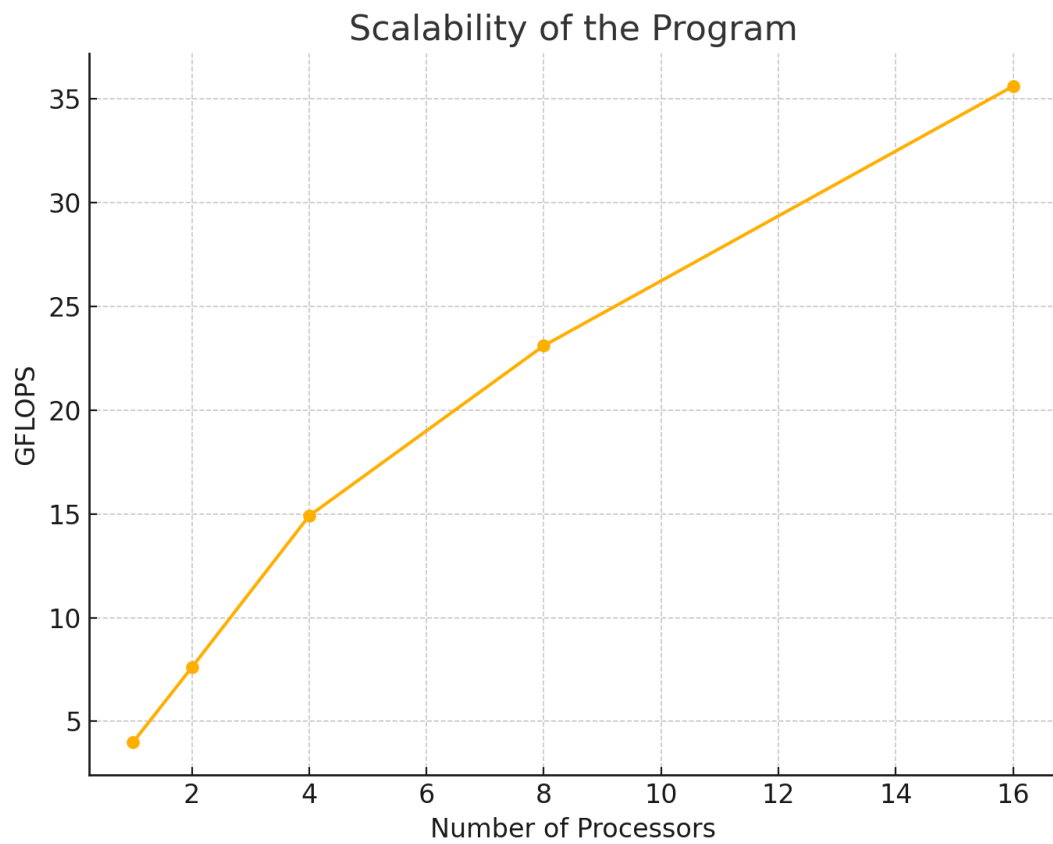
Scalability and Parallel Efficiency

- a. Scalability of the program (speedup vs. number of processors)

Steps:

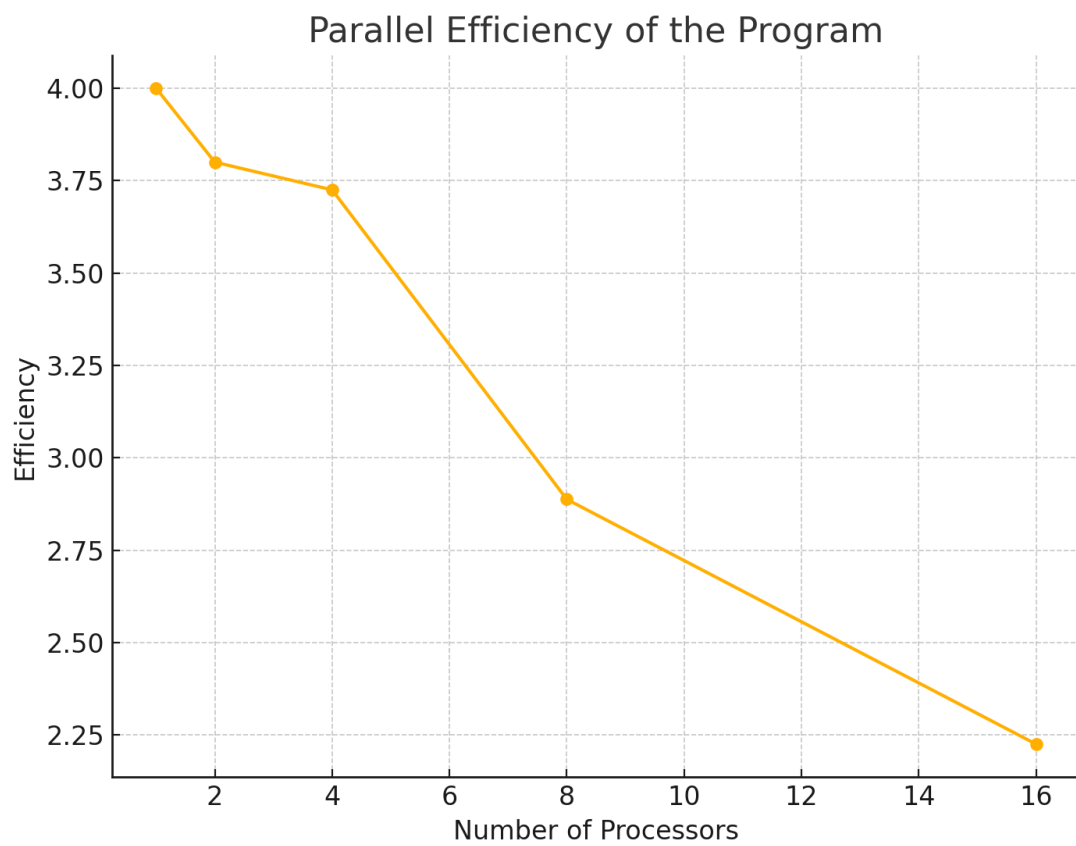
Processors: {1, 2, 4, 8, 16},

GFLOPS: {4.0, 7.6, 14.9, 23.1, 35.6}.



- b. **Parallel efficiency attained (parallel efficiency vs. number of processors)**
Steps:

$$\text{Efficiency: } \frac{\text{GFLOPS}}{\text{Processors}} = \{4.0, 3.8, 3.725, 2.8875, 2.225\}.$$



Please refer to the definition of parallel efficiency at [this link](#).