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Homework 1

Assumption for all questions:

- Fixed power budget
- Total power is proportional to square of frequency
- Performance is proportional to frequency

Question:

Assume the 90% program can be perfectly parallelized, 10% of the program remains sequantial. If the performance of this program on a single core is 1 solution/s

- What is the performance of this program on a dual-core chip with the same power budget?

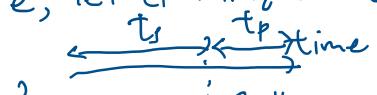
  (Hint: use frequency as the bridge to estimate power and performance)
- What is the performance of this program on a quad-core chip with the same power budget?

You should submit a report with the calculation process.

I interpret '90% of program can be perfectly parallelized' as meaning that when core CPU runs at a frequency of f, the throughput of the parallelizable portion $\propto 0.9f$.

On a single core, let CPU freq be $f_1 \propto 1$ sol'n/s, and $P = cf_1^2$

On dual core,



When core 1 performs seq. operation (during t_s), 100% of power budget allocated to core 1, so core 1 CPU freq $= f_1$

When both cores perform // operation (during t_p), power budget is evenly split betw both cores.

$\frac{P}{2} = cf_2^2$

$\therefore f_2 = \frac{1}{\sqrt{2}} f_1$, each core runs at a lower CPU freq than before.

However, as both cores combined, the total throughput performance (proportional to frequency) increases.

Total perf $\propto 0.1 f_1 + 0.9 \times 2 f_2$

$= 0.1(1) + 0.9 \times 2 \left(\frac{1}{\sqrt{2}}\right)(1)$

$= 1.373$ sol'n/s //

On four cores, during t_s, CPU freq $= f_1$.

during t_p,

$\frac{P}{4} = cf_3^2$

$\therefore f_3 = \frac{1}{2} f_1$

Total perf $\propto 0.1 f_1 + 0.9 \times 4 f_3$

$= 0.1(1) + 0.9 \times 4 \times \frac{1}{2}(1)$

$= 1.9$ sol'n/s //