

Homework 1

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Assumption for all questions:

- Fixed power budget
- Total power is proportional to square of frequency
- Performance is proportional to frequency
- 90% program can be perfectly parallelised, 10% of the program remains sequential

Part 1

Let P be the power, f_1 be the frequency for single core, f_2 be the frequency for dual core.
Performance of this program on a single core is $f_1 = 1$ solution/s

$$\begin{aligned}P &= cf_1^2 \\ \frac{P}{2} &= cf_2^2 \\ \frac{cf_2^2}{2} &= cf_1^2 \\ \frac{f_1^2}{\sqrt{2}} &= f_2^2\end{aligned}$$

$$\begin{aligned}\text{For 90\% parallel, and 10\% sequential, } &= 0.9(2 \times f_2) + 0.1(f_1) \\ &= 0.9(2 \times \frac{f_1^2}{\sqrt{2}}) + 0.1(f_1^2) \\ &= 0.9(\sqrt{2} \times f_1^2) + 0.1(f_1^2) \\ &= f_1^2(0.9\sqrt{2} + 0.1) \\ &= (0.9\sqrt{2} + 0.1)\end{aligned}$$

Part 2

$$\begin{aligned}P &= cf_1^2 \\ \frac{P}{4} &= cf_2^2 \\ \frac{cf_2^2}{4} &= cf_1^2 \\ \frac{f_1^2}{\sqrt{4}} &= f_2^2\end{aligned}$$

$$\begin{aligned}\text{For a quad core then, } &= 0.9(2 \times f_2) + 0.1(f_1) \\ &= 0.9(2 \times \frac{f_1^2}{\sqrt{4}}) + 0.1(f_1^2) \\ &= 0.9(f_1^2) + 0.1(f_1^2) \\ &= f_1^2(0.9 + 0.1) \\ &= f_1^2 \\ &= 1\end{aligned}$$