

## CS465 Homework 1

Question 1: ①

$$CPI(bzip2) = \frac{CPU \text{ Time}}{IC \times \text{cycle Time}} = \frac{750}{2400 \times 10^9 \times 0.333 \times 10^{-9}}$$
$$= 0.94$$

$$CPI(go) = \frac{CPU \text{ Time}}{IC \times \text{cycle Time}} = \frac{700}{1600 \times 10^9 \times 0.333 \times 10^{-9}}$$
$$= 1.31$$

②  $SPEC(bzip2) = \frac{\text{ref. time}}{\text{execution time}} = 9650 / 750$

$$= 12.87$$

$$SPEC(go) = \frac{\text{ref. time}}{\text{execution time}} = 10490 / 700$$
$$= 14.99$$

③ The final geometric mean

$$\sqrt{12.87 \times 14.99} = 13.89$$

③ CPU time (before) =  $IC \times CPI / \text{clock rate}$

$$CPU \text{ time (after)} = 1.1 \times IC \times 1.05 \times CPI / \text{clock rate}$$

$$CPU \text{ time (after)} / CPU \text{ time (before)} = 1.1 \times 1.05 = 1.155$$

So. CPU time of bzip2 increased by 15.5%

$$\textcircled{a} \text{ CPU time} = \text{IC} \times \text{CPI} / \text{clock rate}$$

So If IC is increased by 1% and CPI doesn't change.  
then CPU time is increased by 1%.

Question 2: a.

$$\# \text{ cycles} = 650 \times 1 + 200 \times 5 + 600 \times 5 + 150 \times 2 = 4950$$

$$\begin{aligned} \text{CPU time} &= \# \text{ cycles} / \text{cycles rates} = 4950 / 3.0 \text{ GHz} \\ &= 1650 \text{ ns} \end{aligned}$$

$$\begin{aligned} \text{b. CPI} &= \# \text{ cycles} / \# \text{ Instructions} = 4950 / (650 + 200 + 600 + 150) \\ &= 3.09 \end{aligned}$$

$$\begin{aligned} \text{c. New \# cycles} &= 650 \times 1 + 200 \times \frac{1}{2} \times 5 + 600 \times \frac{2}{3} \times 5 + 150 \times 2 \\ &= 2450 \end{aligned}$$

$$\begin{aligned} \text{New \# Instruction} &= 650 + 200 \times \frac{1}{2} + 600 \times \frac{1}{3} + 150 \times 1 \\ &= 1250 / 300 \end{aligned}$$

$$\begin{aligned} \text{New CPI} &= \text{New \# cycles} / \text{New \# instruction} \\ &= 2450 / 1250 = 1.96 \approx 2.65 \end{aligned}$$

$$\text{Speedup} = \text{old CPU Time} / \text{new CPU time}$$

$$\begin{aligned} &= \text{Old cycles} / \text{New cycles} = 4950 / 2450 \\ &= 2.02 \approx 1.43 \end{aligned}$$



a:

Question 3:  $\text{CPU time } (P_1) = \text{CPI}_1 \times \text{IC}_1 / \text{Clock Rate}_1 =$

$$= 0.9 \times 6 \times 10^6 / 4 \times 10^9 = 1.35 \times 10^{-3} \text{ s}$$

$$\text{CPU time } (P_2) = \text{CPI}_2 \times \text{IC}_2 / \text{Clock Rate}_2 =$$
$$= 0.5 \times 2 \times 10^6 / 3 \times 10^9 = 0.33 \times 10^{-3} \text{ s}.$$

$$\text{Performance } (P_1) < \text{Performance } (P_2)$$

b.  $\text{MIPS} = \text{Clock Rate} / \text{CPI} \times 10^6$

$$\text{MIPS } (P_1) = 4 \times 10^9 / 0.9 \times 10^6 = 4.44 \times 10^3$$

$$\text{MIPS } (P_2) = 3 \times 10^9 / 0.5 \times 10^6 = 6 \times 10^3$$

$$\text{MIPS } (P_1) < \text{MIPS } (P_2)$$

$$\text{Performance } (P_1) < \text{Performance } (P_2)$$