# Homework 1

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1. a. $5 = IC \cdot CPI \cdot P$

   $P = \frac{5}{IC \cdot CPI}$

   $newTime = 0.8IC \cdot 1.3CPI \cdot P$

   $newTime = 0.8IC \cdot 1.3CPI \cdot \frac{5}{IC \cdot CPI}$

   $newTime = 0.8 \cdot 1.3 \cdot 5 = 5.2$

   $speedUp = \frac{6}{5.2} = 1.15$

   So gcc with the changes is only 1.55 times faster than glang which makes sense since one of the optimzations was an unoptimization and it was larger than the other actual optimization.

   b. $6 = IC \cdot CPI \cdot P$

   Performance of optimized gcc is 5.2 so set that equal to our optimized clang settings

   $5.2 = xIC \cdot 1.7CPI \cdot P$

   Substitution P from the original clang equation

   $5.2 = x \cdot 1.7 \cdot 6$ so

   $x = \frac{5.2}{6 \cdot 1.7} \approx .509 \approx .51$ So we would need about half the dynamic instruction count to match the performance of gcc.

   c. The speedup is the same because the period still cancels out of the equation as long as we are not comparing across two different processors.

2. $CPI = 0.35 \cdot 2 + 0.45 \cdot 3 + 0.2 \cdot 1 = 2.25$

   $CPI_{improved} = 0.35 \cdot 2 + 0.45 \cdot 0.75 \cdot 3 + 0.2 \cdot 1 = 1.9125$

3. $\frac{1}{\frac{.2}{4} + \frac{.3}{2} + \frac{x}{10} + \frac{.5-x}{2.3}} = 3 \quad \rightarrow_{\text{wolframalpha}} \quad x = 0.251 = 25.1\%$

4. Normalized Table with respect to Computer A

| Benchmarks | Computer A | Computer B | Computer C |
|---|---|---|---|
| perl | 1 | 0.76933 | 0.71413 |
| bzip2 | 1 | 0.58819 | 3.9853 |
| gcc | 1 | 0.71471 | 0.62521 |
| mcf | 1 | 0.66650 | 2.98891 |
| Arith | 1 | 0.68468 | 1.57839 |
| Geom | 1 | 0.86222 | 1.15174 |

   Fair Salesman: Geometric mean (1, 0.86222, 1.15174) so computer C is clearly a better by because it is overall faster than yours.

   Unfair Salesman: gcc row (1, 0.71471, 0.62521) Notice how much faster computer B is much faster at compiling code than computer C. Still slower than computer A mind you but if it can compile code faster IMAGINE how much faster it must run that code.

5. a. $CPI = 0.4 \cdot 7 + 0.6 \cdot 3 = 4.6$

   $Time = \frac{13bil \cdot 4.6}{\pi Ghz} = \frac{13 \cdot 4.6}{\pi} \approx 19.035$

   b. $CPI_{new} = 0.4 \cdot 2.33 + 0.6 \cdot 1.5 = 1.832$

   $Time = \frac{13bil \cdot 1.832}{\pi Ghz} = \frac{13 \cdot 1.832}{\pi} \approx 7.581$

   c. $Speedup = CPI / CPI_{new} \approx 2.55$