پاسخ تمرینات فصل اول - مقدمات و Performance

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Algorithm	Instruction count, possibly CPI	The algorithm determines the number of source program instructions executed and hence the number of processor instructions executed. The algorithm may also affect the CPI, by favoring slower or faster instructions. For example, if the algorithm uses more floating-point operations, it will tend to have a higher CPI.
Programming language	Instruction count, CPI	The programming language certainly affects the instruction count, since statements in the language are translated to processor instructions, which determine instruction count. The language may also affect the CPI because of its features; for example, a language with heavy support for data abstraction (e.g., Java) will require indirect calls, which will use higher CPI instructions.
Compiler	Instruction count, CPI	The efficiency of the compiler affects both the instruction count and average cycles per instruction, since the compiler determines the translation of the source language instructions into computer instructions. The compiler's role can be very complex and affect the CPI in complex ways.
Instruction set architecture	Instruction count, clock rate, CPI	The instruction set architecture affects all three aspects of CPU performance, since it affects the instructions needed for a function, the cost in cycles of each instruction, and the overall clock rate of the processor.

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Instr/sec = f/CPI

- $P1 = \frac{3}{1.5} \times 10^9 = 2 \times 10^9$
- $P2 = \frac{2.5}{1.0} \times 10^9 = 2.5 \times 10^9$
- $P3 = \frac{4}{2.2} \times 10^9 = 1.8 \times 10^9$

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Formulas:

- No. cycles = time $\times$ clock rate
- time = (No. Instr $\times$ CPI)/clock rate
- No. instructions = No. cycles/CPI

Answers:

- P1

  cycles $= 10 \times 3 \times 10^9 = 30 \times 10^9$ s

  No. instructions $= \frac{30}{1.5} \times 10^9 = 20 \times 10^9$

- P2

  cycles $= 10 \times 2.5 \times 10^9 = 25 \times 10^9$ s

  No. instructions $= \frac{25}{1.0} \times 10^9 = 25 \times 10^9$

- P3

  cycles $= 10 \times 4 \times 10^9 = 40 \times 10^9$ s

  No. instructions $= \frac{40}{2.2} \times 10^9 = 18.18 \times 10^9$

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$\text{time}_{\text{new}} = \text{time}_{\text{old}} \times 0.7 = 7$ s
$\text{CPI}_{\text{new}} = \text{CPI}_{\text{old}} \times 1.2 \Rightarrow \text{CPI(P1)} = 1.8, \text{CPI(P2)} = 1.2, \text{CPI(P3)} = 2.6$
f = No. Instr $\times$ CPI/time

- P1 $\rightarrow 20 \times 10^9 \times \frac{1.8}{7} = 5.14$ GHz
- P2 $\rightarrow 25 \times 10^9 \times \frac{1.2}{7} = 4.28$ GHz
- P3 $\rightarrow 18.18 \times 10^9 \times \frac{2.6}{7} = 6.75$ GHz

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Class A: 10^6 instr.
Class B: 2×10^6 instr.
Class C: 5×10^6 instr.
Class D: 2×10^6 instr.
Time = No. instr × CPI/clock rate

- P1

  $$\frac{(10^6) + (2 \times 10^6 \times 2) + (5 \times 10^6 \times 3) + (2 \times 10^6 \times 3)}{2.5 \times 10^9} = 10.4 \times 10^{-3} \text{ s}$$

- P2

  $$\frac{(10^6 \times 2) + (2 \times 10^6 \times 2) + (5 \times 10^6 \times 2) + (2 \times 10^6 \times 2)}{3 \times 10^9} = 6.66 \times 10^{-3} \text{ s}$$

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CPI = time × clock rate/No. instr

- $\text{P1} = 10.4 \times 10^{-3} \times \frac{2.5 \times 10^9}{10^6} = 26$
- $\text{P2} = 6.66 \times 10^{-3} \times \frac{3 \times 10^9}{10^6} = 20$

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- $\text{P1} = (10^6 \times 1) + (2 \times 10^6 \times 2) + (5 \times 10^6 \times 3) + (2 \times 10^6 \times 3) = 26 \times 10^6$
- $\text{P2} = (10^6 \times 2) + (2 \times 10^6 \times 2) + (5 \times 10^6 \times 2) + (2 \times 10^6 \times 2) = 20 \times 10^6$

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No. Instr = CPU time × Clock rate / CPI

- $\text{A} \rightarrow 820 \times 0.9 \times 4 \times \frac{10^9}{0.96} = 3075 \times 10^9$
- $\text{B} \rightarrow 580 \times 0.9 \times 4 \times \frac{10^9}{2.94} = 710 \times 10^9$

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Clock rate = No. Instr × CPI/CPU time

Clock rate_{new} = No. Instr × $\frac{\text{CPI}}{0.9}$ × CPU time ⇒ $\frac{1}{0.9}$ × Clock rate_{old} = 3.33 GHz

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Clock rate = No. Instr *times* CPI/CPU time

Clock rate_{new} = No. Instr×0.85×$\frac{\text{CPI}}{0.80}$×CPU time ⇒ $\frac{0.85}{0.80}$×Clock rate_{old} = 3.18 GHz

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CPI = clock rate × CPU time/instr count

- $\text{CPI(bzip2)} = 3 \times 10^9 \times \frac{750}{2389 \times 10^9} = 0.94$
- $\text{CPI(go)} = 3 \times 10^9 \times \frac{700}{1658 \times 10^9} = 1.26$

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CPU time = No. instr × CPI/clock rate

If CPI and clock rate do not change, the CPU time increase is equal to the increase in the of number of instructions, that is, 10%.

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CPU time(before) = No. instr × CPI/clock rate

CPU time(after) = 1.1 × No. instr × 1.05 × CPI/clock rate

CPU times(after)/CPU time(before) = 1.1 × 1.05 = 1.155 Thus, CPU time is increased by 15.5%.