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hw02

1.6

From the problem description, we know class A executes $10^6 \times 10\% = 10^5$ instructions, class B executes $10^6 \times 20\% = 2 \times 10^5$ instructions, class C executes $10^6 \times 50\% = 5 \times 10^5$ instructions, and class D executes $10^6 \times 20\% = 2 \times 10^5$ instructions.

We have the following formula: CPU Clock Cycles $= \sum_{i=1}^{n}(CPI_i) \times C_i$. Then we can compute the correspoinding the following CPU Clock Cycles.

$P_{1\text{CPU Clock Cycles}} = (10^5) + (2 \times 2 \times 10^5) + (3 \times 5 \times 10^5) + (3 \times 2 \times 10^5) = 2.6 \times 10^6$.

$P_{2\text{CPU Clock Cycles}} = (2 \times 10^5) + (2 \times 2 \times 10^5) + (2 \times 5 \times 10^5) + (2 \times 2 \times 10^5) = 2 \times 10^6$.

Then the corresponding cpi equals to $\dfrac{\text{CPU Clock Cycles}}{\text{number of total instructions}}$.

Thus $CPI_{P_1} = \dfrac{2.6 \times 10^6}{10^6} = 2.6$

$CPI_{P_2} = \dfrac{2 \times 10^6}{10^6} = 2$

(a). $CPI_{P_1} = 2.6$, $CPI_{P_2} = 2$.

(b). $P_{1\text{CPU Clock Cycles}} = 2.6 \times 10^6$, $P_{2\text{CPU Clock Cycles}} = 2 \times 10^6$

1.9

1.9.1

1 processor: Clock Cycle $= (2.56 \times 10^9) \times 1 + (1.28 \times 10^9) \times 12 + (2.56 \times 10^8) \times 5 = 1.92 \times 10^{10}$.

Thus execution time $= \dfrac{1.92 \times 10^{10}}{2 \times 10^9} = 9.6$.

For p processors, we have clock cycles$_p$ $= \dfrac{2.56 \times 10^9}{0.7p} \times 1 + \dfrac{1.28 \times 10^9}{0.7p} \times 12 + 256 \times 10^6 \times 5 = \dfrac{2.56 \times 10^{10}}{p} + 1.28 \times 10^9$.

Therefore execution time for p processors is $\dfrac{\text{clock cycles}_p}{\text{clock rate}} = \dfrac{12.8}{p} + 0.64$.

Core	execution time	speed up
1	9.60	1.00
2	7.04	1.36
4	3.84	2.50
8	2.24	4.29

1.9.2

clock cycles $= (2.56 \times 10^9) \times 2 + (1.28 \times 10^9) \times 12 + (2.56 \times 10^8) \times 5 = 2.176 \times 10^{10}$

Expected time for 1 cpu: $\dfrac{2.176 \times 10^{10}}{2 \times 10^9} = 10.88$.

Let p be the number of processors. Then we have clock cycles $= \dfrac{2.56 \times 10^9}{0.7p} \times 2 + \dfrac{1.28 \times 10^9}{0.7p} \times 12 + 256 \times 10^6 \times 5 = \dfrac{2.93 \times 10^{10}}{p} + 1.28 \times 10^9$.

Then execution time $= \dfrac{\dfrac{2.93 \times 10^{10}}{p} + 1.28 \times 10^9}{2 \times 10^9} = \dfrac{14.65}{p} + 0.64.$

Thus we have:

Core	execution time	speed up
1	10.88	1.13
2	7.97	1.13
4	4.30	1.12
8	2.47	1.11

1.9.3:

3 times. Execution time $= 3.84s$

We have Execution time $= \dfrac{clockcycles}{clockrate}$. Then: $\dfrac{\text{clock cycles}}{2Ghz} = 3.84s$

Clock cycles $= 7.68 \times 10^9 = 2.56 \times 10^9 + 1.28 \times 10^9 \times CPI + (2.57 \times 10^8) \times 5$ Thus $CPI = \dfrac{7.68 \times 10^9 - 3.84 \times 10^9}{1.28 \times 10^9} = 3.$

1.12:

1.12.1:

CPU time $= \dfrac{\text{number of instuctions} \times CPI}{clockrate}$

$CPU_1 = \dfrac{5 \times 10^9 \times 0.9}{4GHz} = 1.125s$

$CPU_1 = \dfrac{1 \times 10^9 \times 0.75}{3GHz} = 0.25s$

P_2 is faster

1.12.2:

CPU time $= \dfrac{10^9 \times 0.9}{4GHz} = 0.225s$

$\dfrac{instructionsP_2 \times 0.75}{3GHz} = 0.225s$

number of instructions $= \dfrac{0.225 \times 3 \times 10^9}{0.75} = 9 \times 10^8$

1.14:

1.14.1 execution time $= \dfrac{\text{number of instructions} \times CPI}{Clockrate}$ There are in total $50 \times 106 = 5300$ FP instructions, $110 \times 106 = 11660$ INT instructions, and $80 \times 106 = 8480$ LS instructions, and $16 \times 106 = 1696$ instructions.

Execution time $= \dfrac{5300 + 11600 + 8480 \times 4 + 1696 \times 2}{2GHz} = 27\mu s.$

To cut that in half, we need cpi equal to:

$$13.5\mu a = \frac{5300 \times CPI + 11600 + 8480 \times 4 + 1696 \times 2}{2 \times 10^9}$$

Thus CPI = -4.13. Which is impossible

1.14.2:

$$13.5\mu a = \frac{5300 + 11600 + 8480 \times CPI + 1696 \times 2}{2 \times 10^9}$$

Thus CPI = 0.79. We need to reduce it from 4 to 0.79.

1.14.3: execution time $= \dfrac{5300 \times 0.6 + 11600 \times 0.6 + 8480 \times 2.8 + 1696 \times 1.4}{2GHz} = 18\mu s$

$\dfrac{18}{27} = 0.66$. Then spped up 33.3%.