Parallel Programming ch.7

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7.1

$\psi(n,p) = \dfrac{T(n,1)}{\sigma(n) + \frac{\varphi(n)}{p} + \kappa(n,p)}$

$\Rightarrow \frac{\varphi(n)}{p} + C\log p > \frac{\varphi(n)}{p_0} + C\log p_0$

when $\varphi(n) = n$, $\kappa(n,p) = n\log p$, $p=4$, $p_0=2$

$\Rightarrow \frac{n}{4} + 2n > \frac{n}{2} + n$

$\Rightarrow \frac{9}{4}n > \frac{3}{2}n$ ※ ($\kappa(n,p)$ dominate)

7.2

$\varepsilon(n,p) \le \dfrac{T(n,1)}{p[\sigma(n) + \frac{\varphi(n)}{p} + \kappa(n,p)]}$

$\varepsilon(n,p') \le \varepsilon(n,p)$

$\Rightarrow p'(\sigma(n) + \frac{\varphi(n)}{p'} + \kappa(n,p')) \ge p(\sigma(n) + \frac{\varphi(n)}{p} + \kappa(n,p))$

$\Rightarrow p'\sigma(n) + \cancel{\varphi(n)} + p'\kappa(n,p') \ge p\sigma(n) + \cancel{\varphi(n)} + p\kappa(n,p)$

$\Rightarrow p'\sigma(n) + p'\kappa(n,p') \ge p\sigma(n) + p\kappa(n,p)$

$\Rightarrow \because p' > p \quad \therefore \begin{cases} p'\sigma(n) > p\sigma(n) \\ \kappa(n,p') > \kappa(n,p) \end{cases}$ ※

when $\sigma(n) = 0$, $\kappa(n,p) = 0$

等號成立 ※

7.3

$(\lceil \frac{n}{p} \rceil - 1)\chi + \lceil \log p \rceil (\lambda + \chi)$

$\psi(n,p) = \dfrac{(n-1)\chi}{(\lceil \frac{n}{p} \rceil - 1)\chi + \lceil \log p \rceil (\lambda + \chi)}$

$\psi(n,1) = 1$, $\psi(n,2) = \dots$ $\psi(n,16) = \dots$

7.4

From Amdahl's Law:

$f = \dfrac{\sigma(n)}{\sigma(n) + \varphi(n)} = 5\%$

$\psi \le \dfrac{1}{f + (1-f)/p} = \dfrac{1}{5\% + \frac{95\%}{10}} = 6.89$ ※

7.5

From Gustafson's Law:

$s = \dfrac{\sigma(n)}{\sigma(n) + \frac{\varphi(n)}{p}} = 6\%$

$\Rightarrow$ set 94% can be parallelization

$\psi \le p + (1-p)s$

$10 - 0.06 \le 0.94p$

$10.57 \le p$

$p = 11$ ※

7.6

set $\kappa(n,p) = 0$

$\psi(n,p) = \dfrac{\sigma(n) + \varphi(n)}{\sigma(n) + \varphi(n)/p} \ge 50$

$\psi(n,p) = \dfrac{1}{f + (1-f)/p}$, $p \to \infty$

$\frac{1}{f} \ge 50$, $f \le 0.02$ ※

7.7

$f + (1-f)/10 = \frac{1}{9}$

$9f = \frac{1}{9}$

$f = \frac{1}{81} = 1.23\%$ ※

7.8

$\dfrac{9 + 233 \times 16}{242} = 15.44$ ※

or $s = \dfrac{9}{242}$

$\psi \le p + (1-p)s = 15.44$ ※

7.9

$s = 0.01$

$\psi \le 40 - 39 \times 0.01 = 39.61$ ※

7.10

$e = \dfrac{\frac{1}{\psi} - \frac{1}{p}}{1 - \frac{1}{p}}$ e：不可平行化佔比

I: 0.197, 0.2, 0.2 $\Rightarrow$ e constant B

II: 0.058, 0.077 … 0.12 $\Rightarrow$ e↑ C

III: 0.058, 0.059, 0.06 $\Rightarrow$ e constant A

IV: 0.02, 0.03, 0.04 $\Rightarrow$ e↑ C

V: 0.15, 0.153, 0.157 $\Rightarrow$ e constant B

VI: 0.03, 0.031, 0.032 $\Rightarrow$ e constant A

$e_8 \cdot \frac{7}{8} + \frac{1}{8} = \frac{1}{\psi_8}$, $e_{16} \cdot \frac{15}{16} + \frac{1}{16} = \frac{1}{\psi_{16}}$

$\dfrac{8}{7e_8 + 1} \times 1.4 \le \dfrac{16}{15e_{16} + 1}$

$10.5e_{16} + 0.7 \le 7e_8 + 1$

$10.5e_{16} - 7e_8 \le 0.3$

if $e_{16} = e_8$: $e \le 0.0857$

7.11

Amdahl's Law: treat problem size as constant $\Rightarrow$ bounded

Gustafson Law: treat problem size as an increasing func of p

2.12

No, as problem size increase $\sigma(n)$ and overhead will require more time to solve the problem

$\Rightarrow$ efficiency will decrease as $p \uparrow$

2.13

a. $\frac{(Cp)^2}{p} = C^2 p$

b. $\frac{C^2 p \log p^2}{p} = C^2 \log p^2$

c. $\frac{C^2 p}{p} = C^2$

d. $\frac{C^2 p^2 \log p^2}{p} = C^2 p \log p^2$

e. $\frac{Cp}{p} = C$

f. $\frac{p^2}{p} \sim \frac{p}{p} \Rightarrow p \sim 1$

g. $\frac{p^2}{p} \Rightarrow$ over p

$\Rightarrow e > c > f > b > a > d > g$