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Parallel & Distributing  
Assign #6

## Amdahl's Law:

Amdahl's law is a formula which gives the theoretical speedup in latency of the execution of a task at fixed workload that can be expected of a system whose resources are improved.

It is often used in parallel computing to predict the theoretical speedup when using multiple processors.

$$\Rightarrow \text{Speedup} = P_e / P_w$$

OR

$$\text{speedup} = E_w / E_e$$

Formula: -

$$\text{Overall speedup} = \frac{\text{old execution time}}{\text{New execution time}}$$

$$= \frac{1}{\left(1 - \text{Fraction}_{\text{enhanced}}\right) + \left(\frac{\text{Fraction}_{\text{enhanced}}}{\text{Speedup}_{\text{enhanced}}}\right)}$$

Now

Let's prove the equation.



Proof:-

$S$  is speedup, old execution time  $T$ , new execution  $T'$

$A$  (that will be enhanced) is  $t$ ,

$A$  (after enhancing) is  $t'$ , fraction enhanced  $f'$ .

speedup enhanced is  $S'$ .

$$S = \frac{T}{T'}$$

$$T = t_n + t$$

$$T' = t_n + t'$$

$$f' = \frac{t}{T}$$

$$= \frac{t}{t_n + t}$$

$$1 - f' = 1 - \frac{t}{t_n + t}$$

$$= \frac{t_n}{t_n + t}$$

$$S' = \frac{t}{t'}$$

$$t' = \frac{t}{S'}$$

$$= \frac{T \times f'}{S'}$$

$$= \frac{(t_n + t) \times f'}{S'} = \frac{t'}{t_n + t} = \frac{f'}{S'}$$

$$= \frac{t_n + t}{t_n + t'}$$

$$S = \frac{1}{1 - f' + \frac{f'}{S'}}$$



Overall speedup =

$$1 - \text{fraction enhanced} + \left( \frac{\text{fraction enhanced}}{\text{speedup enhancement}} \right)$$

(Example)

calculate speedup gain: 67% parallel

(a) two processing cores (b) four processing cores

$$N = 2$$

$$P = 67\% = 0.67(1-S)$$

$$S = 33\% = 0.33$$

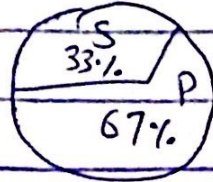
$$\text{speedup} \leq \frac{1}{S + (1-S)N}$$

$$= \frac{1}{0.33 + 0.67 \cdot 2}$$

$$= \frac{1}{0.33 + 0.335}$$

$$= \frac{1}{0.665}$$

$$\text{speedup} \leq 1.5 \text{ times}$$



$$N = 4$$

$$P = 67\% (1-S)$$

$$S = 0.33$$

$$\text{speedup} \leq \frac{1}{S + (1-S)N}$$

$$= \frac{1}{0.33 + 0.67 \cdot 4}$$

$$= \frac{1}{0.33 + 0.1675}$$

$$= \frac{1}{0.4975}$$

$$\text{speedup} \leq 2.01 \text{ times}$$

Amdahl's law. by mean adding processor number of cores. to the improvement of the speed. If you have parallel operations greated them serics operations of computer system, adding number of cores will definitely have an impact on the improvement of the series.