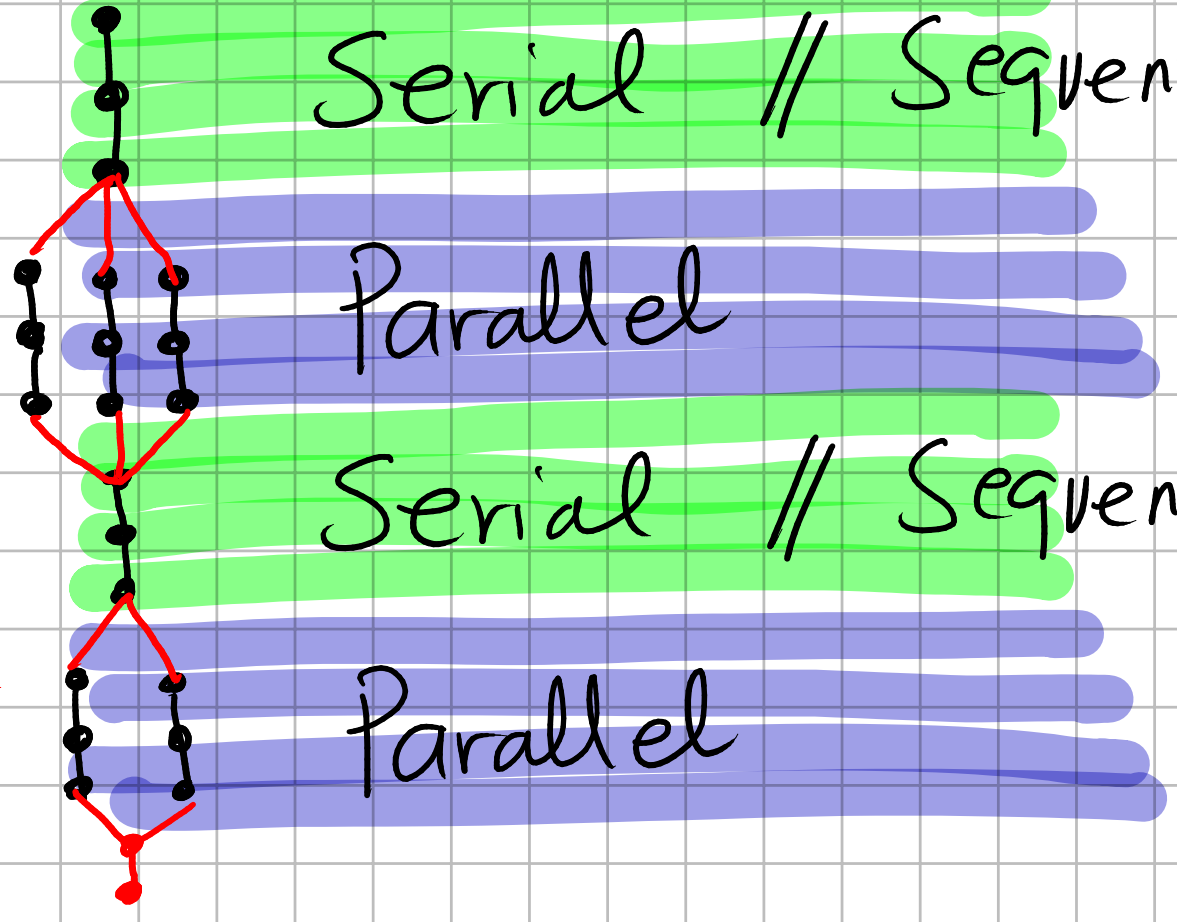
fork + join times
↳ overhead.

Main ( )
{



fork time [

join time [

f.t {

j.t {
}

$O(n)$ $O(n^2)$ $O(\log(n))$

$\longrightarrow$ # of Instructions

$S(n,p) = 1$.

$\rightarrow \sigma(n)$ — Percent.

$\rightarrow \phi(n)$

$\rightarrow$ larger time

$\rightarrow$ smaller time ≥ 1

$$\sigma(n) = \frac{\sigma(n)}{\sigma(n) + \phi(n)}$$

$$\phi(n) = \frac{\phi(n)}{\sigma(n) + \phi(n)}$$

(1) time $\longrightarrow$ $T(n,1)$ {

$T(n,p)$ {

$T(n,p) \leq T(n,1)$

$\downarrow$ $\qquad$ $\downarrow$

$\sigma(n) + \frac{\phi(n)}{p}$ $\qquad$ $\sigma(n) + \phi(n)$

metrics

observations & Laws

(2) Speed up

(3) Efficiency.

(4) throughput (FLOPS) $\qquad$ $\frac{\#\text{ of operations}}{\text{second}}$

f = percentage of serial region

$$f = \frac{\sigma(n)}{\sigma(n)+\phi(n)} \Rightarrow f[\sigma(n)+\phi(n)] = \sigma(n)$$

$$\sigma(n)+\phi(n) = \frac{\sigma(n)}{f}$$

$$\Rightarrow \phi(n) = \frac{\sigma(n)}{f} - \sigma(n)$$

$$S(n,p) = \frac{T(n,1)}{T(n,p)} = \frac{\sigma(n)+\phi(n)}{\sigma(n)+k(n,p)+\frac{\phi(n)}{p}}$$

$$\Rightarrow \phi(n) = \sigma(n)\left[\frac{1}{f} - 1\right]$$

$$S(n,p) = \frac{\sigma+\phi}{\sigma+\frac{\phi}{p}} = \frac{\sigma+\sigma\left[\frac{1}{f}-1\right]}{\sigma+\frac{\sigma}{p}\left[\frac{1}{f}-1\right]}$$

$$S(n,p) = \frac{1}{f + \frac{1}{p} - \frac{f}{p}}$$

$$S(n,p) = \frac{1}{f + \frac{[1-f]}{p}}$$

→ Amdahl's Law

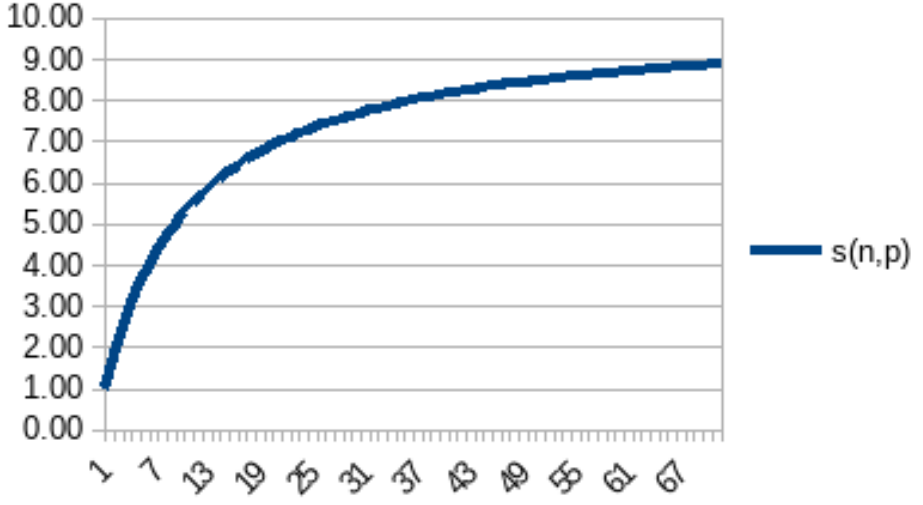
f = percentage of Sequential time.

p = # of processors.

$1-f$ = percentage of parallel time

$$s(n,p) = \frac{1}{f + \frac{[1-f]}{p}}$$

f	0.1
1-f	0.9
p	s(n,p)
1	1.00
2	1.82
3	2.50
4	3.08
5	3.57
6	4.00
7	4.38
8	4.71
9	5.00
10	5.26
11	5.50
12	5.71



$$S(n,p) = \frac{\sigma + \phi}{\sigma + \frac{\phi}{p}} = \frac{\sigma + \sigma\left[\frac{1}{f} - 1\right]}{\sigma + \frac{\sigma}{p}\left[\frac{1}{f} - 1\right]}$$

$$= \frac{\cancel{\phi} + \frac{\sigma}{f} - \cancel{\phi}}{\sigma + \frac{\sigma}{pf} - \frac{\sigma}{p}} = \frac{\frac{\sigma}{f}}{\sigma\left[1 + \frac{1}{pf} - \frac{1}{p}\right]}$$

$$= \frac{\cancel{\sigma}}{f} \cdot \frac{1}{\cancel{\sigma}\left[1 + \frac{1}{pf} - \frac{1}{p}\right]}$$