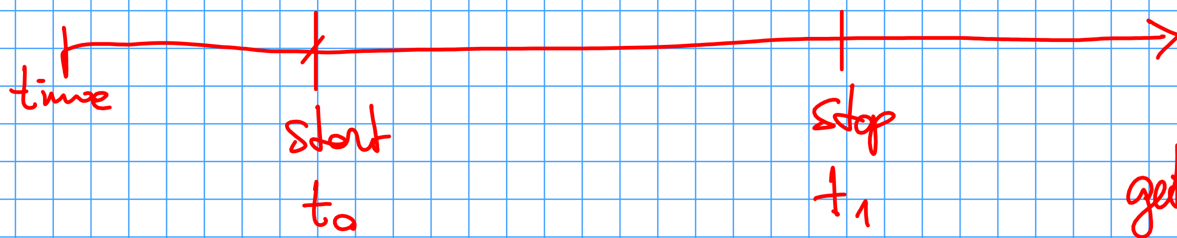
T completion time



gettimeofday

$t_0 = \ldots$

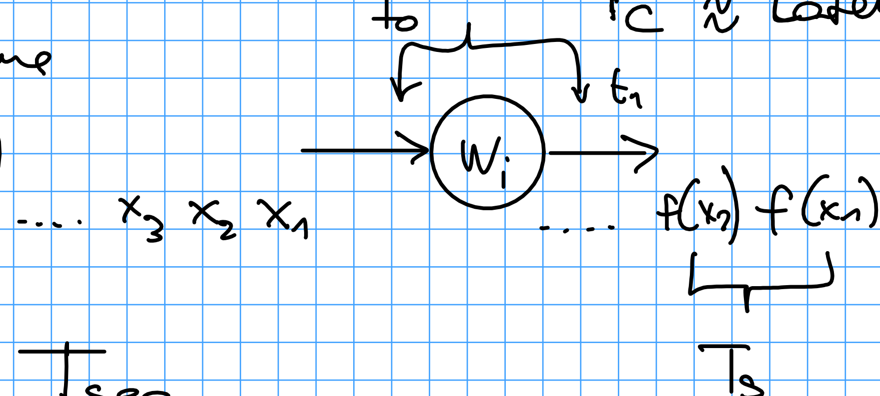
$t_1 = \ldots$

$T_C = (t_1 - t_0)$

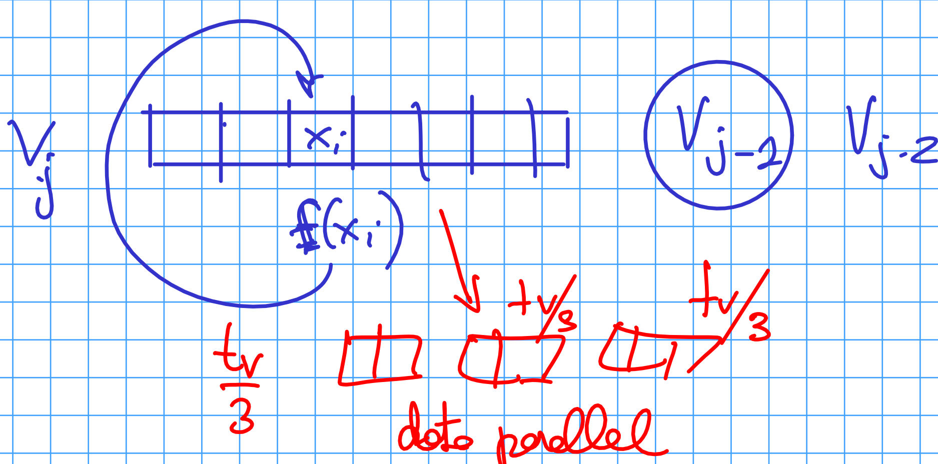
Wall clock time

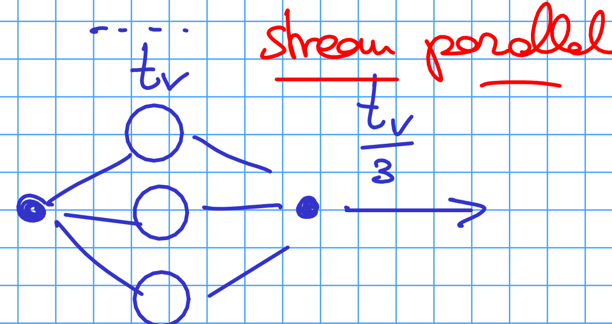
T_S Service time (throughput)

$T_C \approx$ Latency



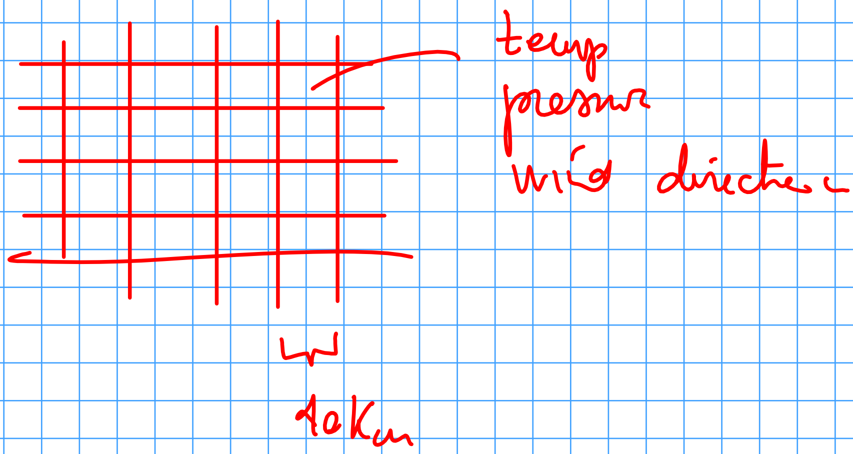
$$\text{Speedup}(n) = \frac{T_{seq}}{T(n)}$$

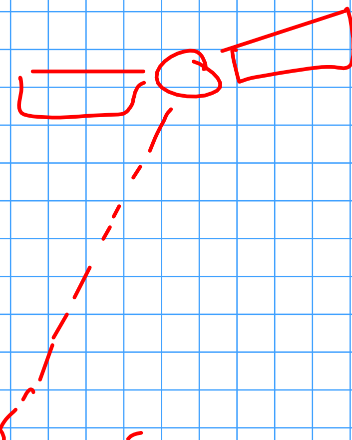




T_C stream of m items L

↳ seq $\approx L \cdot m$ par (farm) $\approx \frac{L \cdot m}{n_w}$





geo-referencing

clean

store

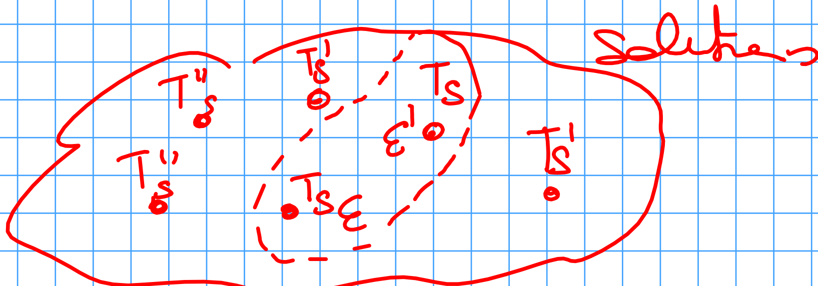
stream parallelism to shorten T_s

$$\text{Efficiency}(n) = \frac{T_{seq}}{T(n) \cdot n} = \frac{T_{seq}}{T(n)} \cdot \frac{1}{n} = \frac{\text{speedup}(n)}{n}$$

$\mathcal{E}(n)$ 99% 0.99 "good" > 85%

$$\mathcal{E}(1) = \frac{T_{seq}}{T(1) \cdot 1} = \frac{T_{seq}}{T(1)} \approx 1$$

could be



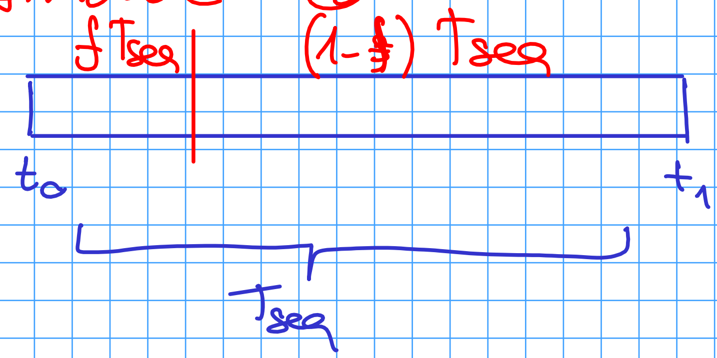
min T_s

goal !!

$\max\{\varepsilon, \varepsilon'\}$

$T_s < T_s' < T_s''$

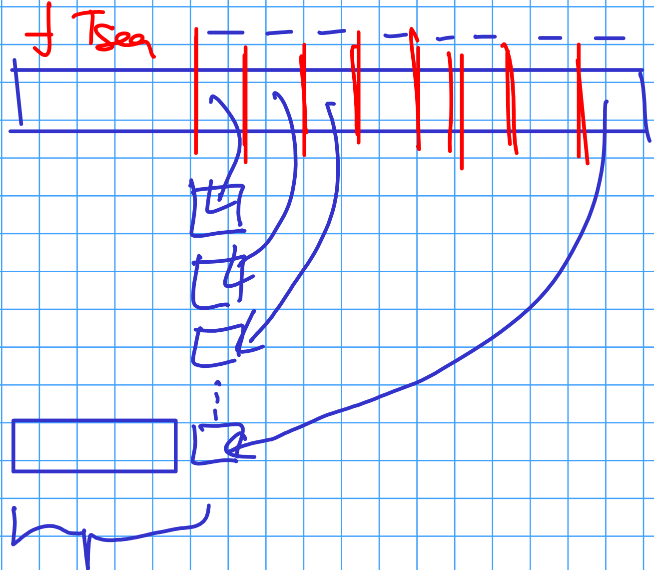
Amdahl Law



= percentage p (fraction) can be parallelized

(1-p) cannot be parallelized

→ f (serial fraction)



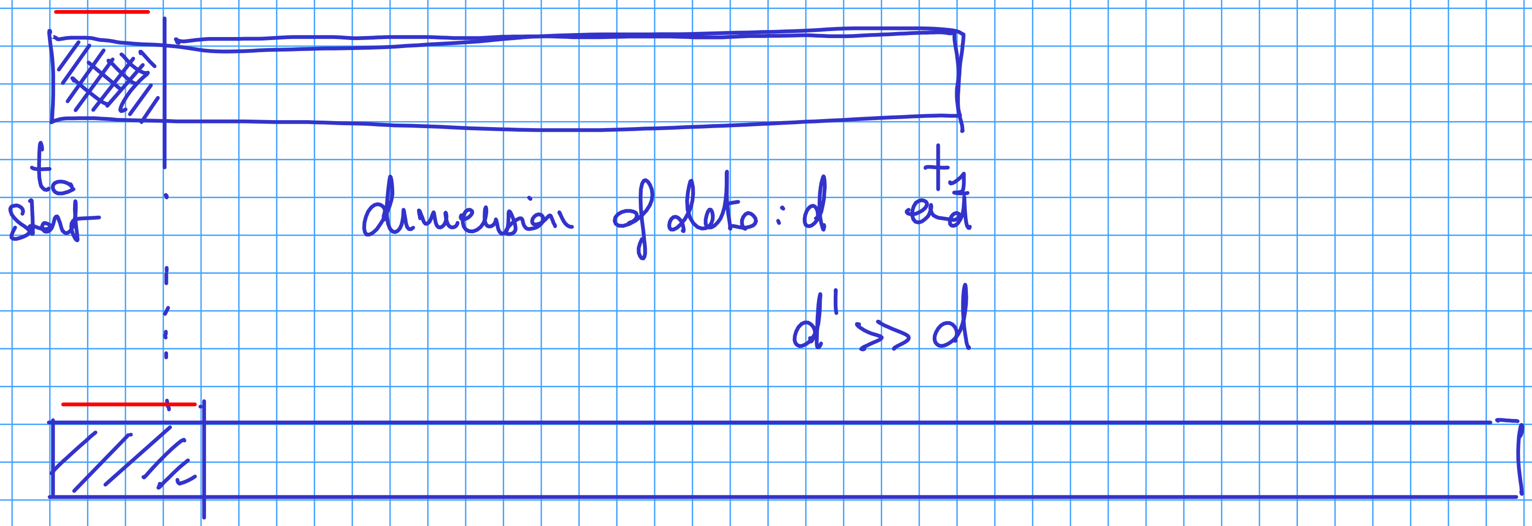
$$f \cdot T_{seq} + \frac{(1-f)\,T_{seq}}{nw} = T_{par}(nw)$$

$$T(nw) = T_{seq}\left(f + \frac{(1-f)}{nw}\right)$$

$$Speedup(nw) = \frac{T_{seq}}{T_{seq}\left(f + \frac{(1-f)}{nw}\right)} = \frac{1}{f + \frac{(1-f)}{nw}}$$

$\frac{(1-f)}{nw} \to 0$

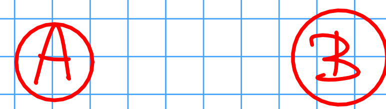
$$\lim_{nw \to \infty} Speedup(nw) = \frac{1}{f}$$



t0
start
dimension of data : d
t1
end
d' >> d

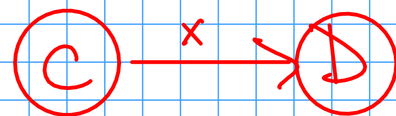
STRUCTURED PARALLEL PROGRAMMING APPROACH

1) designing/recognizing CONCURRENT ACTIVITY GRAPH



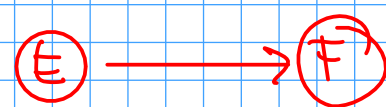
independent Conc. Activities

DATA DEPENDENCY



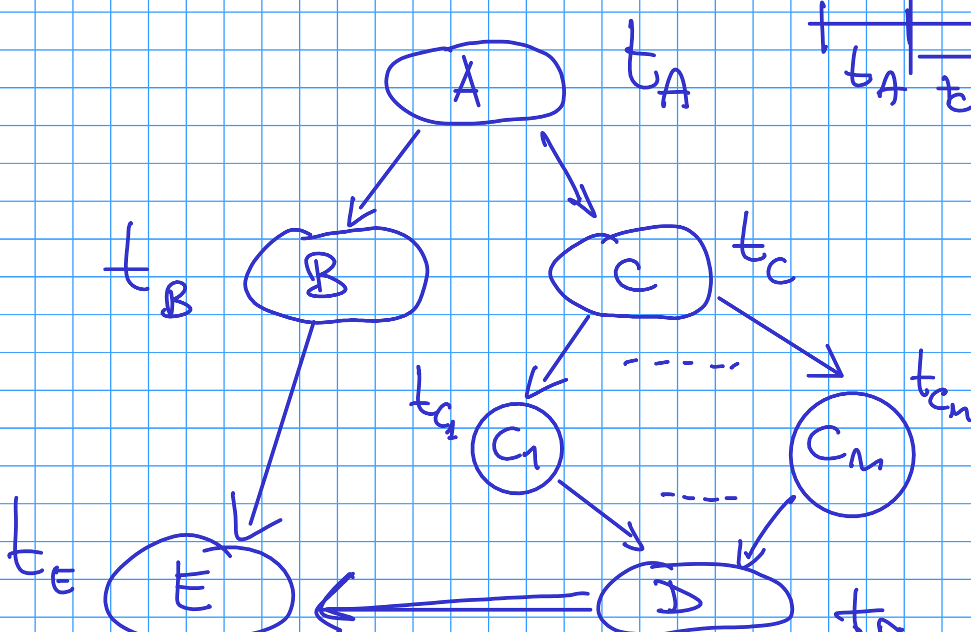
C produces input data needed by D

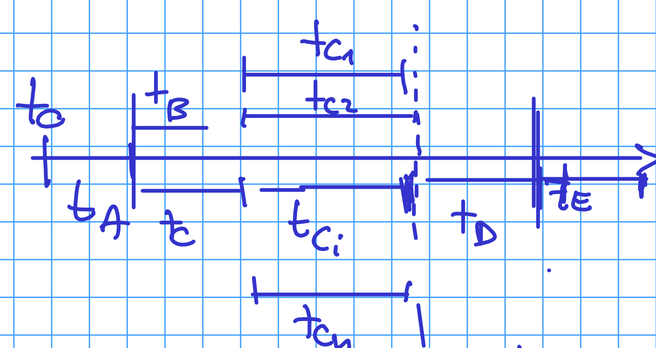
CONTROL DEPENDENCY



F should wait for the completion of E

Sample graph

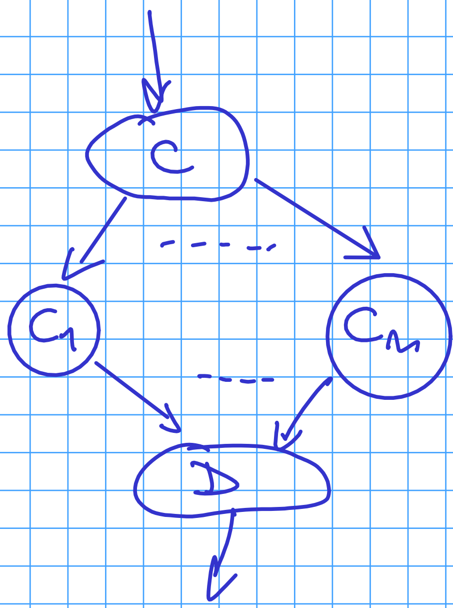




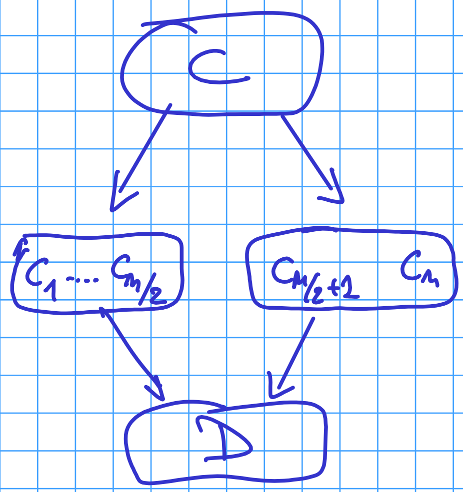
$$T_{par} = t_A + \max\{t_B, t_C + t_{C_i} + t_D\} + t_E$$

$$t_{C_i} \approx t_{C_j}$$

$$T_{SEQ} = t_A + t_B + t_C + t_{C_1} + \ldots + t_{C_n} + t_D + t_E$$



C
C_1
C_n
D



C
$C_1 \ldots C_{n/2}$
$C_{n/2+1}$ C_n
D