Understanding parallelism

SpeedUp vs Efficiency

SpeedUp (S_p): relative reduction of execution time whn using P processors with respect sequential.

Efficiency (Eff_p): it is a measure of the fraction of time for which processing element is usefull.

Escalability

> - Strong: resources x2 -> scalability x2
> - Weaak: resources x2 w. proportional work

Amdahl's law

Par_Fraction

> $\varphi = T_{seq\_time\_of\_par\_part} / T_{seq\_exec}$

$$S_p = \frac{T_1}{T_p} = \frac{T_1}{(1-\varphi) \times T_1 + (\varphi \times T_1 / P)}$$

$$S_p = \frac{1}{((1-\varphi) + \varphi/P)}$$

Note: If P approach to infinit, φ/P approach to 0, then S_p = 1/(1-φ).

Ex:

> ```
>     seq - 25s
>     par - 50s
>     seq - 25s
>           100s
> ```
>
> φ = 100/50 = 0,5 SpeedUp $_{par}$ = 50/10 = 5
>
> SpeedUp = 100/60 = 1.67

Sources of overhead

> - tark creation
> - barrier sync
> - tark sync
> - exclusive access to data
> - data sharing
> - Idleness
> - Computation (extra work to obtain a palallel algorithm)
> - Memory (extra memory to obtain a palallel algorithm)
> - Contention (competition for the access to shared resources)

$$T_p = (1 - \varphi) \times T_1 + \varphi \times T_1/p + overhead$$

How to model data sharing overload?

Example:

Jacobi solver

> $T_{calc} = (N^2/P)*t_{boddy}$
>
> $T_p = T_{calc} + T_{comm}$
>
> Tcomm = $2(t_s+t_w*N)$

Data sharing modeling

Example 4

```
void compute(int n, double *u, double *utmp) {
    int i, j;
    double tmp;
    for (i = 1; i < n-1; i++) {
        for (j = 1; j < n-1; j++) {
            tmp = u[n*(i+1) + j] + u[n*(i-1) + j] + // elements u[i+1][j]
and u[i-1][j]
            u[n*i + (j+1)] + u[n*i + (j-1)] - // elements u[i][j+1] and
u[i][j-1]
            4 * u[n*i + j]; // element u[i][j]
            u[n*i + j] = tmp/4; // element u[i][j]
        }
    }
}
```

Each cpu with n^2/P elements. Tasks compute segments of n/c rows by c columns.

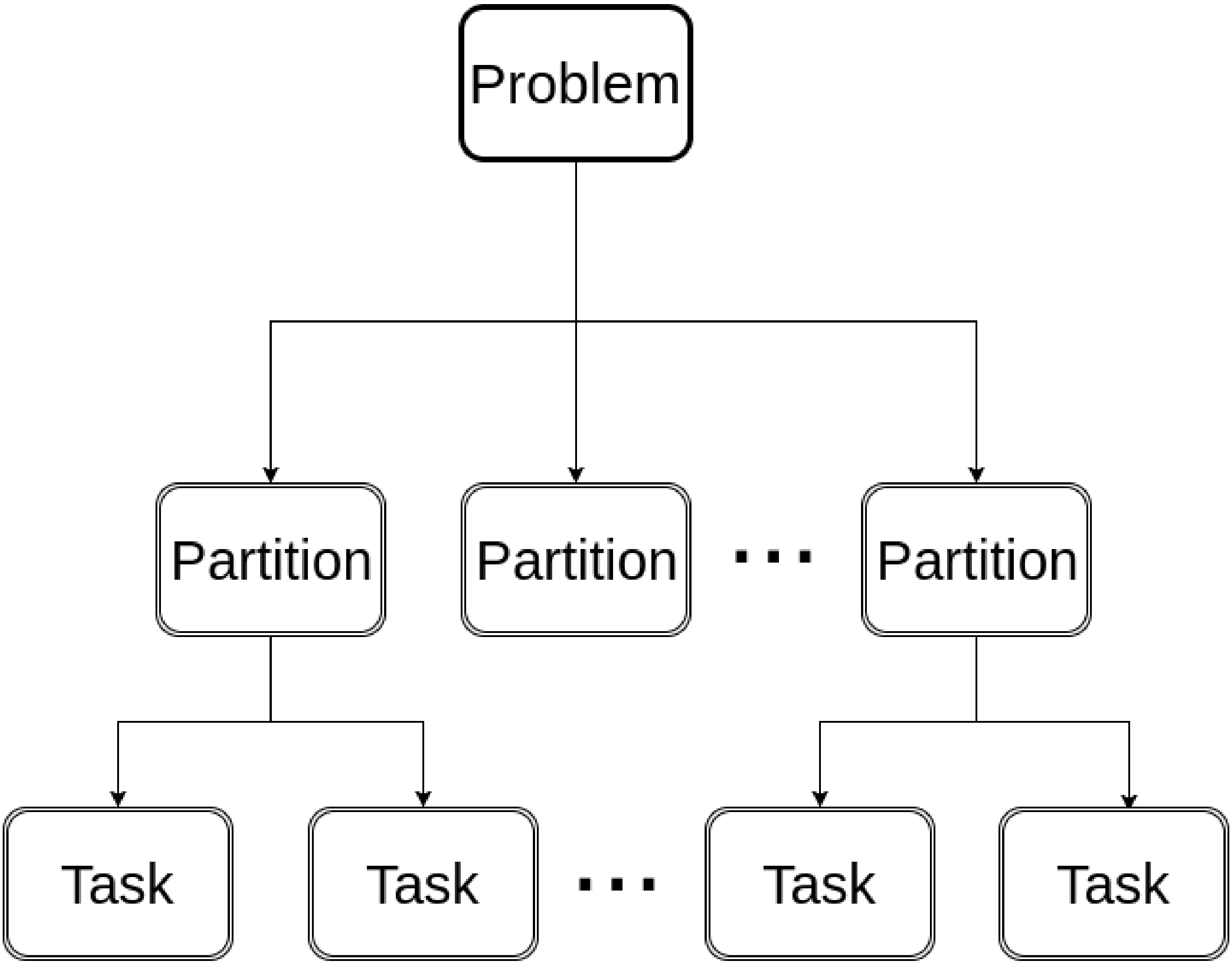
Then, time acquire the following form:

$$T_P = (\frac{n}{c} + P - 1) \times (\frac{n}{P} \times c) \times t_{body} \quad +$$

$$(t_s + n \times t_w) + ((\frac{n}{c} + P - 2) \times (t_s + c \times t_w))$$

$$S_P = \frac{T_1}{T_P} = \frac{n^2 \times t_{body}}{T_P}$$

Task decomposition



Types:

- Lineal Task decomposition

> Code block or procedure

- Iterative task decomposition

> Iterative constructs

- Recursive task decomposition

> Recursive procedures

Decomposition Strategies

Leaf strategy

Create one task squetentally for each leaf of task tree.

> Less tasks
>
> Less overhead

Tree strategy

Creater one task for each invocation.

> More Tasks
>
> More Overhead

Cut-off control

If tree strategy is in use, whan a certain number of task are created or the granulation si too small or in a certain number of recursive calls; you can change the strategy to Leaf in order to reduce overhead.