TECHNIQUES TO MAPPING HOMOGENEOUS PROCESSES IN HETEROGENEOUS ENVIRONMENTS

INDEX

INTRODUCTION

- Until now, a lot of sofware has been developed for homogeneous systems.
- Now, heterogeneous systems.
- Two options
  - To rewrite sofware
  - Mapping routines in heterogeneous systems.
- Complex Problems ⇒ To Paralell
- To Paralell ⇒ To Estimate parameters ⇒ To Build mathematical modell execution time

INTRODUCTION

- Execution Time Estimation:

  $t_{exe} = f(n, SP, AP)$

  n = problem size

  SP = system parameters

  AP = algorithm parameters

Autooptimization → to estimate parameters

Autooptimization → studied in homogeneous

INTRODUCTION

- Heterogenous system algorithms
  - HoHe
    - * 1 process/processor
    - * processes with different load work
  - HeHo
    - * > 1 process/processor
    - * processes with equal load work

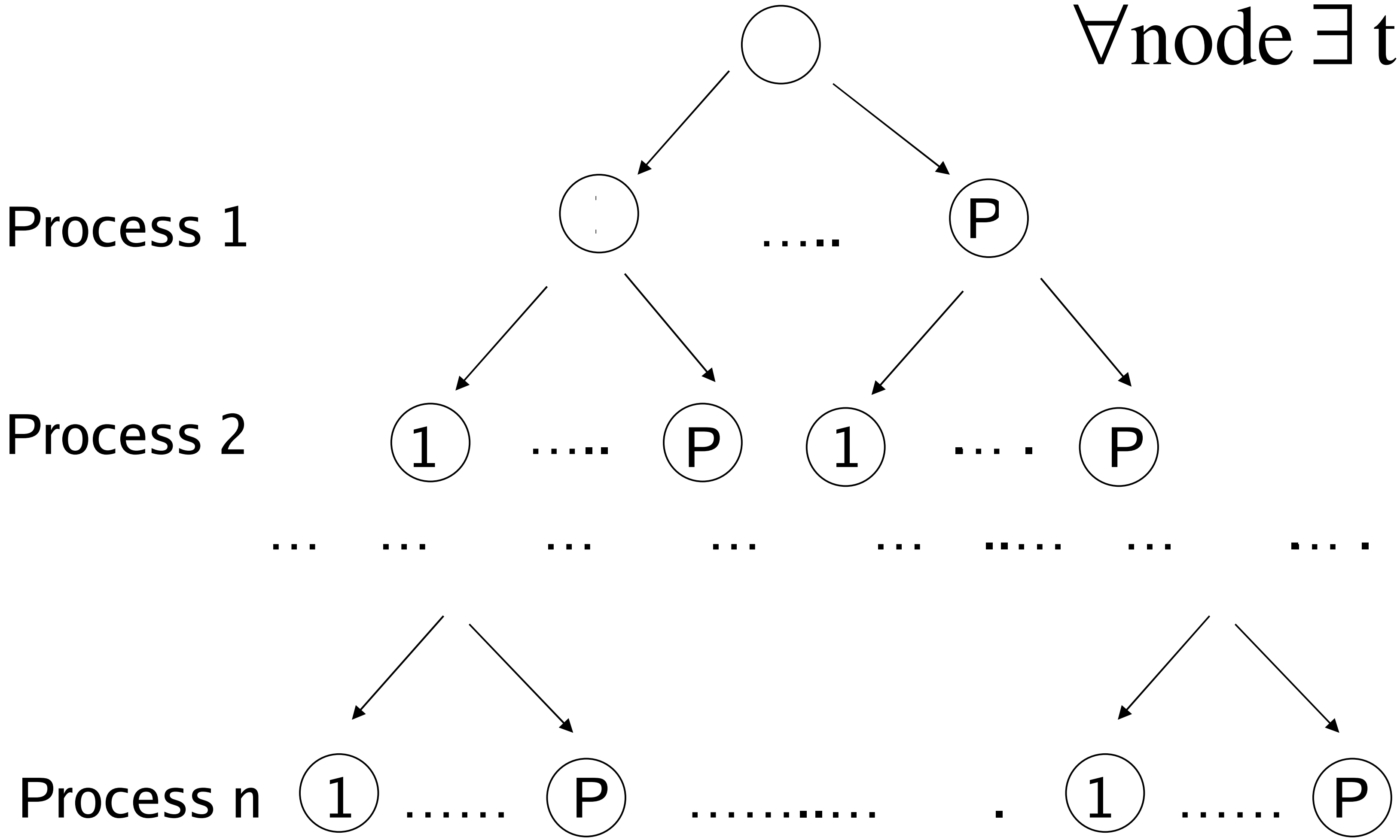
- HeHo better: no to rewrite routines

THE PROBLEM

- In parallel computing, assign processes to processors in order to obtain a mapping which reduces execution time.
- Efficient and optimal solutions for some particular problems.
- For other problems approximate solutions are obtained with heuristic methods.
- The assignation was studied for a parallel dynamic programming scheme and for dense linear algebra factorizations.
- The problem is solved by searching through an assignation tree.

THE PROBLEM

$$\forall node \; \exists \; t_{modell}$$



❖ Mapping processes (1..n) to processors (1..P).

THE PROBLEM

❖The search through the tree:

- ❖Backtracking
- ❖Backtracking by pruning nodes
- ❖Branch and Bound
- ❖Greedy methods
- ❖…..

❖A large amount of time is consumed (Backtracking)

❖Solution obtained far from the optimum (greedy method, backtracking by pruning nodes, …)

THE PROBLEM

- ❖We consider parallel iterative schemes.
- ❖A large variety of problems: dynamic programming, graph algorithms, genetic algorithms…
- ❖ Additionally, the method can be applied to other problems and schemes, as for example linear algebra factorizations.
- ❖The theoretical model requires a precise knowledge of system parameters like basic arithmetic operations time, or sending and start-up times of a communication.

THE PROBLEM

- Modelled execution time

$$t(s,D) = \underbrace{t_c * t_{comp}(s,D)}_{\text{computation}} + \underbrace{t_{comm}(s,D)}_{\text{communication}}$$

s: problem size

D: number of processes used in the solution

t_c: cost of a basic arithmetic operation

t_{comp}: number of basic arithmetic operations

t_{comm}: communication cost

- It is easy to represent computation part.

- It is frequently difficult to represent communication part: some adjust by least square.

POSSIBLE SOLUTIONS

- ❖To use traditional techniques in trees to achieve a good solution, but this consumes a large amount of time.
  - ❖Even with strategies to prune nodes in the tree.

- ❖To use heuristic techniques sucessfully applied to solve other hard optimization problems, like **Scatter Search**.
- ❖**Scatter Search**: heuristic technique by which different generations of a initial population is possible to achieve a good solution of a problem.

HEURISTIC APPROACHES

- Basic Scatter Search Scheme:

1. generate initial population
2. while convergence is not reached
3. element selection to be combined
4. combining of selected elements
5. inclusion of the most promising elements in the population
6. inclusion in the population of the most scattered elements with respect to the most promising elements
7. endwhile

HEURISTIC APPROACHES

- A large number of different schemes of scatter search in order to apply our problem.

HEURISTIC APPROACHES

- A large number of different schemes of scatter search in order to apply our problem.

A.- Initial population

Initial assignation of processes to processors randomly: **AA**

Initial assignation of processes to processors considering number of processors: **AC**

HEURISTIC APPROACHES

❖A large number of different schemes of scatter search in order to apply our problem.

A.- Initial population

- Initial assignation of processes to processors randomly: **AA**
- Initial assignation of processes to processors considering number of processors: **AC**

B.- To select elements to combine

- All elements of population vs all elements: **TT**
- Best elements of population vs worst elements: **MP**

HEURISTIC APPROACHES

C.- To include the most scattered respect to the most promising

- To include elements with longest distance to most promising elements: **MF**
- To include elements which are more “different” with respect to promising elements: **MD**

HEURISTIC APPROACHES

C.- To include the most scattered respect to the most promising

- To include elements with longest distance to most promising elements: **MF**
- To include elements which are more “different” with respect to promising elements: **MD**

D.- Convergence reached?

- The best of the new solutions are not better than the best of the older ones: **MM**
- The average of new solutions is not better than old ones: **MA**

RESULTS

- Best scheme with options of initial reference set: **AC** and convergence reached: **MA.**

DIFFERENT OPTIONS OF SCATTER SEARCH SCHEME VERSUS BACKTRACKING WITH PRUNING

B.- Combine / C.- Include	TT	MP
MF	90%	85%
MD	91%	86%

- Best scheme with optiones: **TT-MD**

RESULTS

❖REAL TIMES IN KIPLING

SIZE	COMPLEXITY	ANOTHER TECHNIQUES	SCATTER SEARCH
SMALL [1..100.000	SMALL	82%	18%
	BIG	80%	20%
MEDIUM [100.000..500.000]	SMALL	63%	37%
	BIG	59%	41%
BIG [500.000…1.000.000]	SMALL	52%	48%
	BIG	47%	53%

TABLE WITH COMPARISONS AMONG TRADITIONAL TECHNIQUES AND SCATTER SEARCH TO ESTIMATE THE BEST MAPPING OF PROCESSES TO PROCESSORS

RESULTS

❖SIMULATIONS TIMES

SIZE	COMPLEXITY	ANOTHER TECHNIQUES	SCATTER SEARCH
SMALL [1..100.000	SMALL	91%	9%
	BIG	73%	27%
MEDIUM [100.000..500.000]	SMALL	42%	58%
	BIG	40%	60%
BIG [500.000…1.000.000]	SMALL	22%	78%
	BIG	5%	95%

TABLE WITH COMPARISONS AMONG TRADITIONAL TECHNIQUES AND SCATTER SEARCH TO ESTIMATE THE BEST MAPPING OF PROCESSES TO PROCESSORS

FUTURE WORKS

- ❖SCATTER SEARCH IS A PROMISING TECHNIQUE TO MAPPING IN HETEROGENEOUS SYSTEMS.
- ❖TO APPLY ANOTHER HEURISTIC TECHNIQUES, LIKE TABU SEARCH, GENETIC ALGORITHMS. AND TO STUDIE APPLICATIONS TO ANOTHER PARALELL ALGORITHMS SCHEMES
- ❖OUR FINAL GOAL IS THE SOFTWARE MUST DECIDE HOW TO MAPPING AN HOMOGENEOUS ALGORITHM IN AN HETEROGENEOUS SYSTEMS, DEPENDIND ON DIFFERENT ALGORITHMS AND SYSTEM PARAMETERS.