Scheduling for MW applications

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Contents

¬ Statement of the problem.
¬ Simulation framework.
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Objective

• To develop and evaluate efficient scheduling policies for parallel applications with the following MW model:

\[
\text{for } i = 1 \text{ to } M \\
\quad \text{for } j = 1 \text{ to } N\text{Tasks} \\
\quad \quad \text{do } F(j) \\
\quad \text{end} \\
\quad \text{[computation]} \\
\text{end}
\]

In an opportunistic environment
Objective

- How many workers?
- How to assign tasks to workers?

→ Efficiency without forgetting performance.
→ How sensitive is efficiency with respect to variance changes.
Example

Without preoccupation

Efficiency = \frac{6 + 12}{12 + 12} = \frac{3}{4}

LPTF Policy

Efficiency = \frac{9 + 9}{9 + 9} = 1
Platforms

- Dedicated homogeneous machines.
- Non-dedicated (such as Condor) homogeneous machines.
- Non-dedicated (such as Condor) heterogeneous machines.
Policies Simulated

- LPTF: Largest processing time first
- LPTF on Average
- Random
- Random and Average
<table>
<thead>
<tr>
<th>Policy</th>
<th>Next task to be assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPTF</td>
<td>The biggest task</td>
</tr>
<tr>
<td>LPTF on Average</td>
<td>The biggest task considering execution times without variation</td>
</tr>
<tr>
<td>Random</td>
<td>A random task</td>
</tr>
<tr>
<td>Random &amp; Average</td>
<td>$1^{st}$ iteration: A rand task &lt;br&gt;Next iterations: The biggest task based on execution times of previous iterations</td>
</tr>
</tbody>
</table>
Simulation

• Response Variables:
  – Efficiency
  – Execution Time
Simulation. Factors. Variation

20% deviation

40
24
8
7
6

35
28
9
6
6
Simulation. Factors. Workload

WorkPercentage: 70% 0-0 TASKS=10

WorkPercentage: 70% 1-1 TASKS=10
Simulation. Factors

- Processor Number ➔ 31, 100, 300
- Standard Deviation ➔ 0, 10, 30, 60, 100
- External Loop ➔ 10, 35, 50, 100
- Workload
  - 20%load: 30, 40, 50, 60, 70, 80, 90
  - 20%dist: equal, decreasing
  - 80%dist: equal, decreasing
Simulation Results

Dedicated homogeneous machines

EFFICIENCY. 30% 1-1 D=0 T=31 L=35

EFFICIENCY. 30% 1-1 D=100 T=31 L=35

EFFICIENCY. 90% 1-1 D=0 T=31 L=35

EFFICIENCY. 90% 1-1 D=100 T=31 L=35
Simulation Results

Dedicated homogeneous machines

RANDOM. W: 30% 1-1 T=31 L=35

1 Worker 5 Workers 10 Workers 15 Workers 20 Workers 31 Workers

RAND & AVG. W: 30% 1-1 T=31 L=35

1 Worker 5 Workers 10 Workers 15 Workers 20 Workers 31 Workers

RANDOM. W: 90% 1-1 T=31 L=35

1 Worker 5 Workers 10 Workers 15 Workers 20 Workers 31 Workers

RAND & AVG. W: 90% 1-1 T=31 L=35

1 Worker 5 Workers 10 Workers 15 Workers 20 Workers 31 Workers
Simulation Results

Dedicated homogeneous machines

EXEC TIME. 30% 1-1 D=0 T=31 L=35

EXEC TIME. 90% 1-1 D=0 T=31 L=35

EXEC TIME. 30% 1-1 D=100 T=31 L=35

EXEC TIME. 90% 1-1 D=100 T=31 L=35

LPTF Random LPTF on Avg Rand & Avg
Simulation Results

Dedicated homogeneous machines

EFF. 30% 1-1 D=0 T=100 L=35

EFF. 30% 1-1 D=100 T=100 L=35

EFF. 90% 1-1 D=0 T=100 L=35

EFF. 90% 1-1 D=100 T=100 L=35
Simulation Results

Dedicated homogeneous machines

RAND & AVERAGE. 30% 1-1 T=100 L=35

RAND & AVERAGE. 90% 1-1 T=100 L=35

RANDOM. 30% 1-1 T=100 L=35

RANDOM. 90% 1-1 T=100 L=35
Simulation Conclusions

Dedicated homogeneous machines

Rough analysis:

- Variance does not seem to make efficiency significantly worse.
- External loop does not affect efficiency.
- To achieve an efficiency > 80% and an execution time < 1.1 respect to LPTF execution time, the number of workers should range between 15% of the tasks number (90% load) and 40% (30% load).
Simulation

Non-dedicated homogeneous machines

• Factors:
  – Processor Number ✓
  – Standard Deviation ✓
  – External Loop ➔ Only 35
  – Workload ✓
  – Probability of loosing and getting machines
  – Checkpoint ➔ Always
    ➔ Never
    ➔ Only for “big” tasks that have been “a long time” in execution
Simulation Results

Non-dedicated homogeneous machines

EFF ck=NO 30% 1-1 D=0 T=31 L=35

EFF ck=YES 30% 1-1 D=0 T=31 L=35

EFF ck=NO 90% 1-1 D=0 T=31 L=35

EFF ck=YES 90% 1-1 D=0 T=31 L=35
Simulation Results

Non-dedicated homogeneous machines

EFF ck=NO 30% 1-1 D=100 T=31 L=35

EFF ck=YES 30% 1-1 D=100 T=31 L=35

EFF ck=NO 90% 1-1 D=100 T=31 L=35

EFF ck=YES 90% 1-1 D=100 T=31 L=35
Implementation on MW

- Support to the desired Program Model.
- Computation of the Efficiency.
- Scheduling policies ➞ Random
  ➞ Random & Average
Implementation on MW

Policy: Rand || Rand & Avg

S Statistics to get Eff.

iteration 1
iteration 2
iteration M
Future

• Non-dedicated homogeneous machines:
  – Complete the simulations.
  – Duplication of large tasks. (?)

• Non-dedicated heterogeneous machines:
  – Use dynamic load information (provided by Condor) to rank machines.

• Implementation on MW:
  – Test the MW scheduling policies with large applications.