Can Cloud Computing be Used for Planning? An Initial Study

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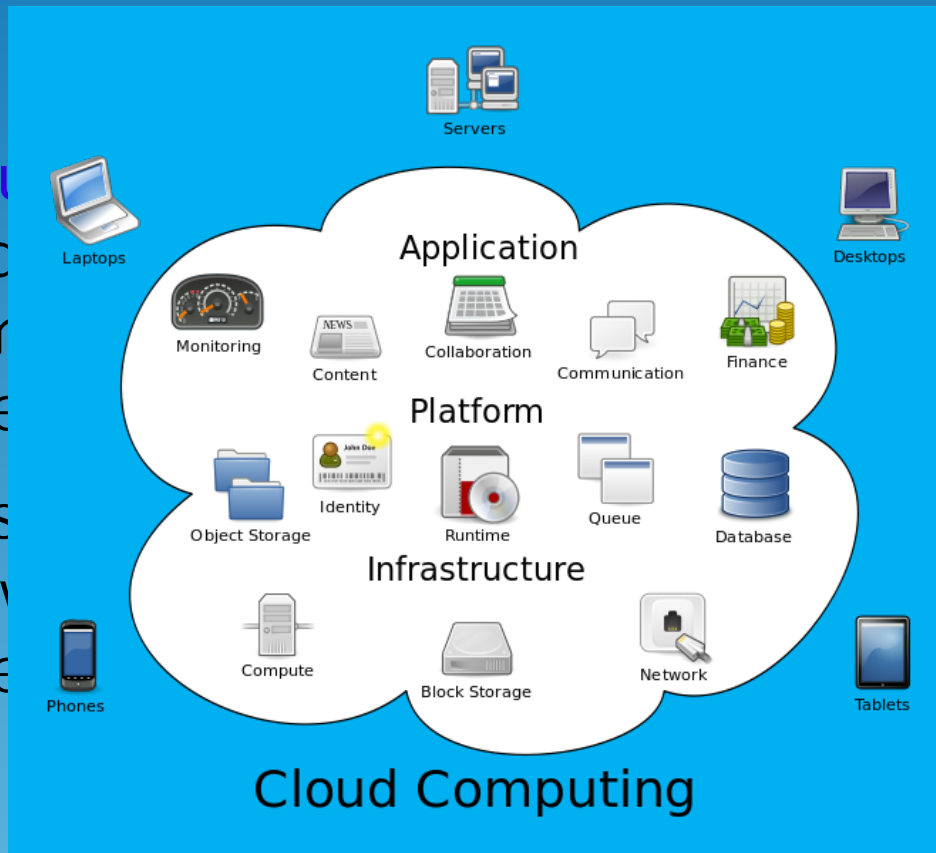Speaker: Lin Liu from Dept. of ECE, MTU

Outline

- Cloud Computing
- MRW
- PMRW
- Enhanced PMRW
- Implementation in Windows Azure
- Experimental Results
- Conclusions

What is Cloud Computing?

Cloud Computing

- Clou... ...rm used to c... ...rk based com... ...the Inte...

- It is... ...ted and netw... ...nd Inte... ...platform)

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Cloud Computing

- Advantages
  - Low cost
  - High availability, scalability, elasticity
  - Free of maintenance
- Disadvantages
  - High latency
  - Security

Parallel Search Algorithms

- Search is a key technique for planning

- The reported parallel algorithms are not suitable for the cloud environment

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Portfolio Search

- A portfolio of algorithms is a collection of different algorithms and/or different copies of the same algorithm running in parallel on different processors or interleaved on one processor
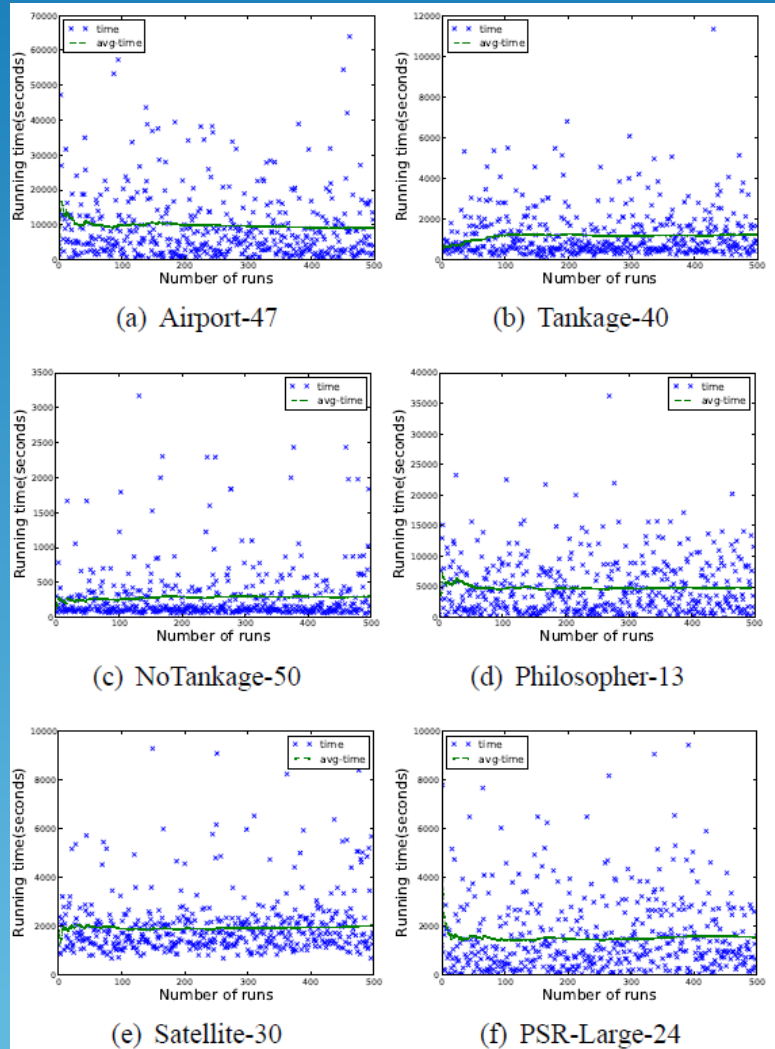
Monte-Carlo Random Walk (MRW)

Algorithm 1: MRW(Π)

Input: a classical planning problem Π
Output: a solution plan

1   $s \leftarrow s_I$;
2   $h_{min} \leftarrow h(s_I)$;
3   $counter \leftarrow 0$;
4   **while** s *does not satisfy* s_G **do**
5   **if** $counter > c^m$ **or** *dead-end*(s) **then**
6         $s \leftarrow s_I$;
7         $h_{min} \leftarrow h(s_I)$;
8         $counter \leftarrow 0$;
9      $s \leftarrow RandomWalk(s, \Pi)$;
10   **if** $h(s) < h_{min}$ **then**
11         $h_{min} \leftarrow h(s)$;
12         $counter \leftarrow 0$;
13   **else**
14         $counter \leftarrow counter + 1$;
15 **return** $plan$;

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MRW Runtime

(a) Airport-47

(b) Tankage-40

(c) NoTankage-50

(d) Philosopher-13

(e) Satellite-30

(f) PSR-Large-24

Two runs with different random seeds have significantly different running time

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Portfolio Search With MRW

- It is common to observe that a MRW run with a different random seed solves the same instance much faster than another one

- Such a large variability can benefit a portfolio scheme that makes multiple independent runs and terminates as soon as one run finds a solution

PMRW

Algorithm 2: PMRW(Π)

Input: a classical planning problem Π
Output: a solution plan

1 **for** *each processor* $P_i, 1 \leq i \leq N$ **do**
2   *plan* $\leftarrow$ MRW(Π);
3   **if** *plan is a solution* **then**
4   abort all other processors;

5 **return** *plan*;

As soon as a processor finds a solution, all other processors will be halted.
The solution time of PMRW is the minimum running time of the N independent runs.

Enhanced PMRW (PMRWᵐˢ)

- PMRWᵐˢ is a strategy that takes in a candidate configuration set $C = \{c_0, c_1, \ldots, c_n\}$

- Each processor p_i performs search independently and simultaneously using the setting c_i
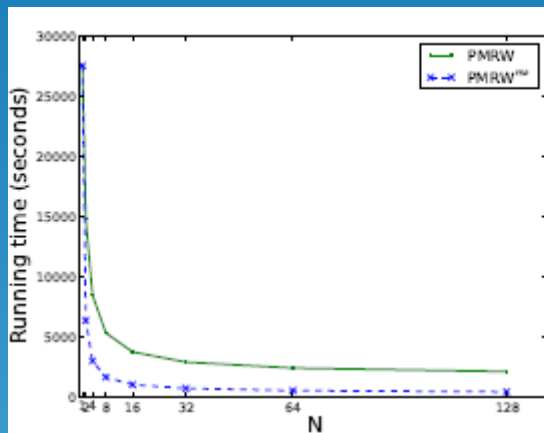
- Details are neglected due to time limitation.
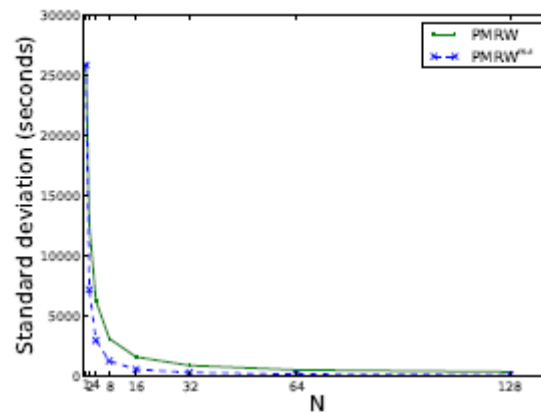
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Implementation In Windows Azure
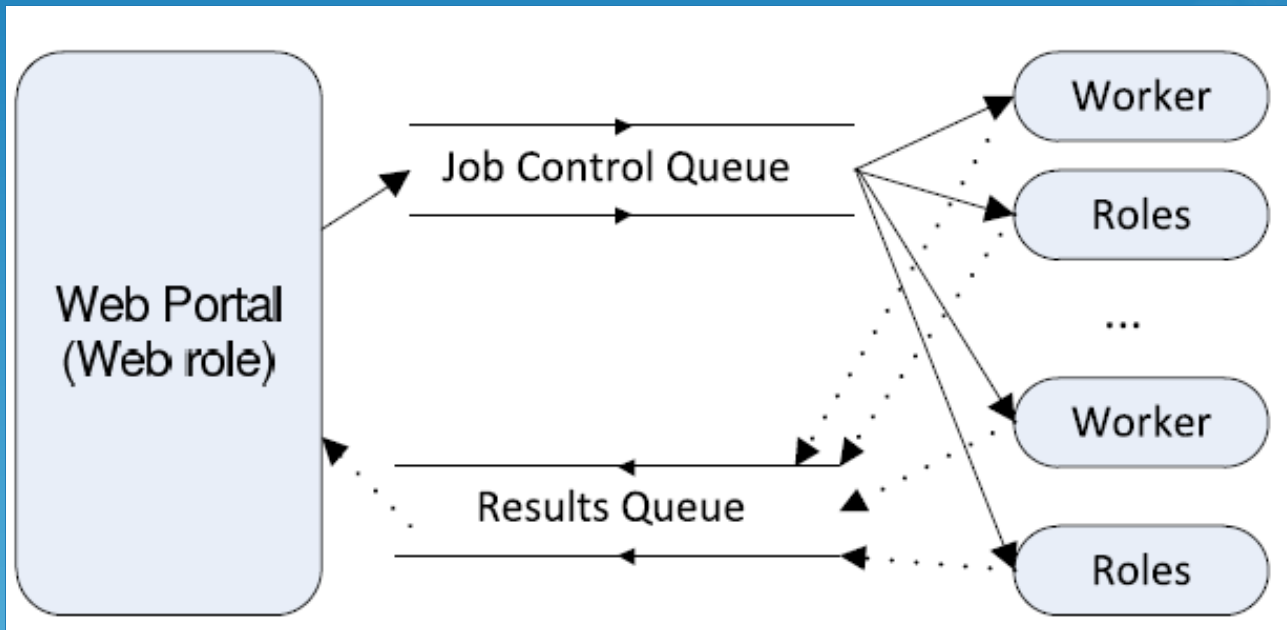
Experimental Results

- Evaluation in a local cloud
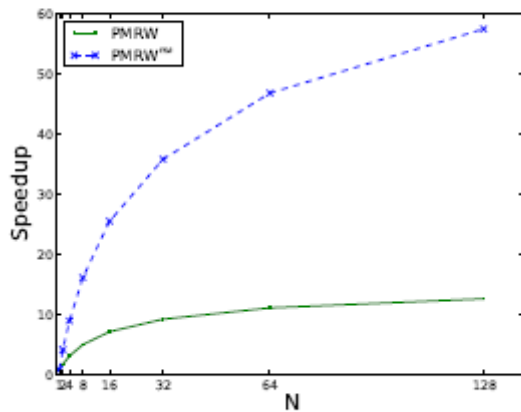- Evaluation in Windows Azure
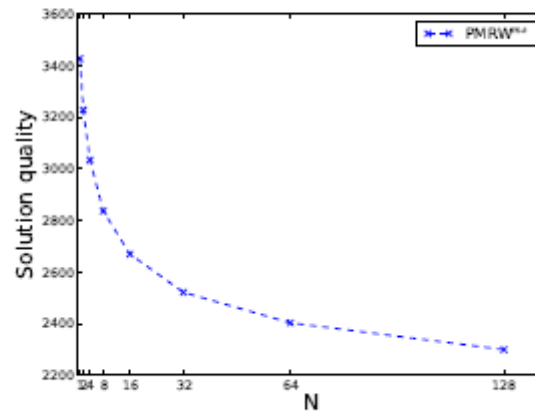
Evaluation In A Local Cloud
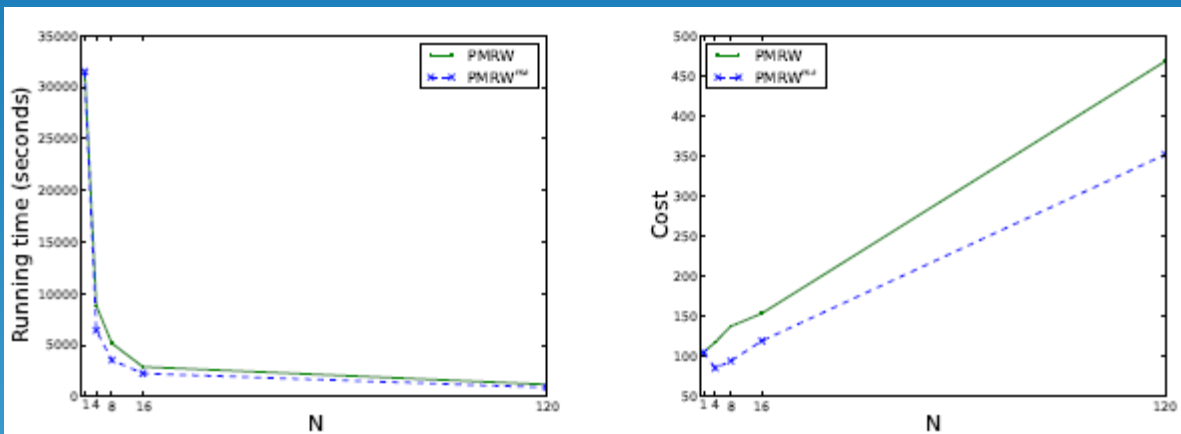

(a) Running time

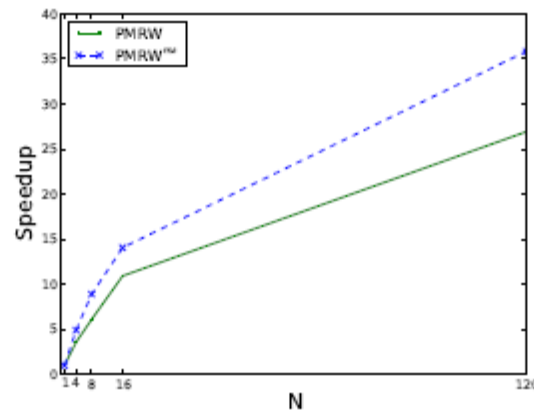(b) Standard deviation

(c) Speedup

(d) Solution quality

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Evaluation In Windows Azure

(a) Running time

(b) Financial cost

(c) Speedup

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Conclusions

- A portfolio search algorithm which is suitable for cloud computing is proposed

- The portfolio of MRW algorithm is implemented in a local cloud and the Windows Azure platform

- The proposed algorithm is economically sensible in clouds and robust under processor failures

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Thanks!

Q & A