Cost-Time Performance of Scaling Applications on the Cloud

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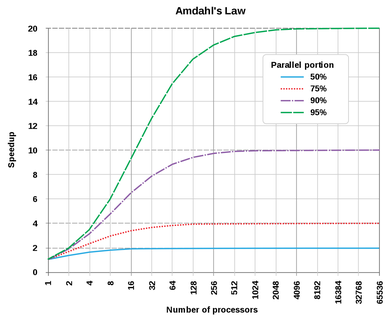
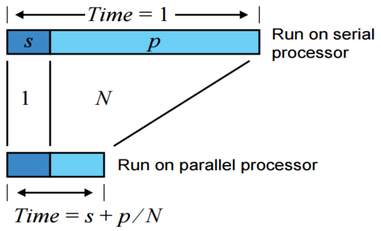
1 Motivation

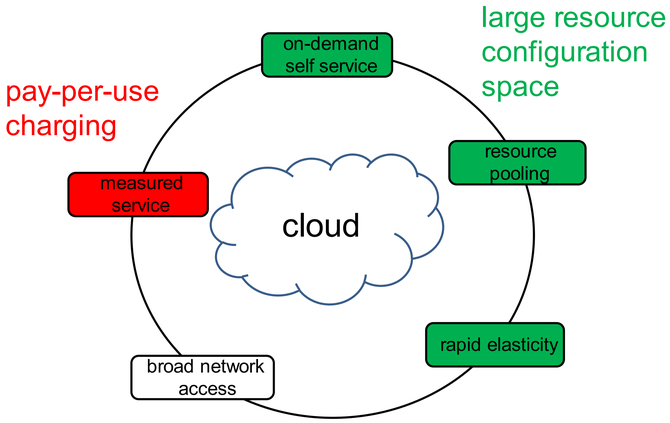
scaling in parallel computing

- fixed-workload (Amdahl's law) — limited by **resources**
- fixed-time (Gustafson's law)

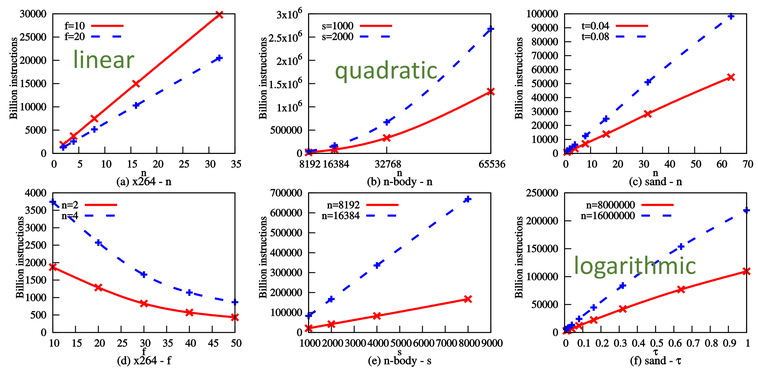




J. L. Gustafson, Reevaluating Amdahl's Law, Communications of the ACM, 31(5):532–533, 1988.

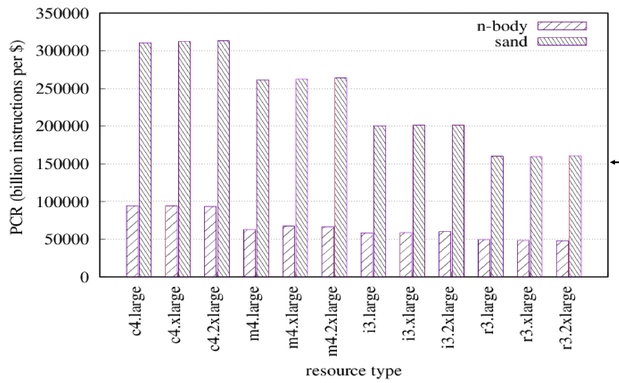


application resource demand scale differently



S. Rathnayake, D. Loghin, Y. M. Teo, CELIA: Cost-time Performance of Elastic Applications on Cloud, Proc. of 46th International Conference on Parallel Processing, pages 342–351, 2017.

On Cloud, application scalability is limited only by the cost budget!



cloud resources have different **cost** and **performance** e.g. Amazon EC2

Given an **application, time deadline** and a **cost budget**

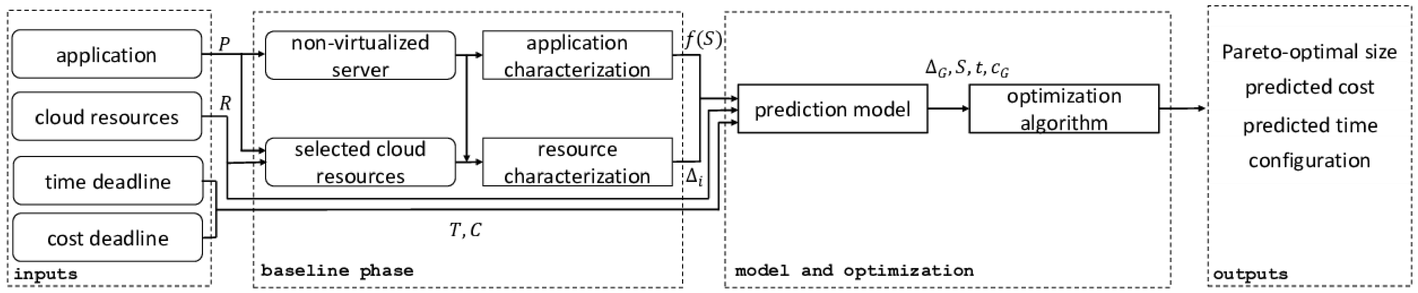
- **largest size** of the application executable?
- execution **cost** and **time**?
- cloud **configuration**?

2 Approach

measurement-driven analytical modeling approach

$$PCR = \frac{instruction\ execution\ rate}{cost\ per\ unit\ time}$$

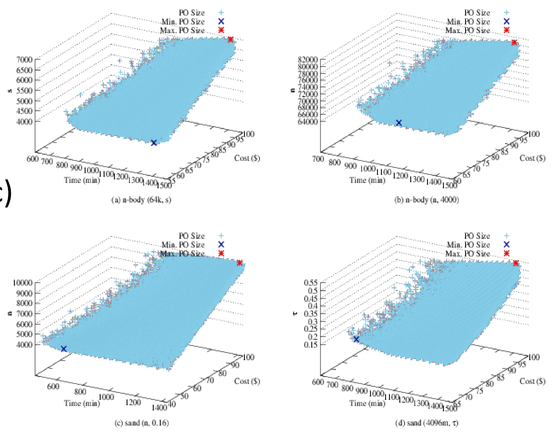
application demand-> number of instructions
resource capacity -> instruction execution rate



3 Evaluation

- Applications
  - n-body (linear, quadratic)
  - sand (linear, logarithmic)
- Cloud Resources
  - Amazon EC2 cloud
  - 9 resource types

Pareto Optimal Problem Size

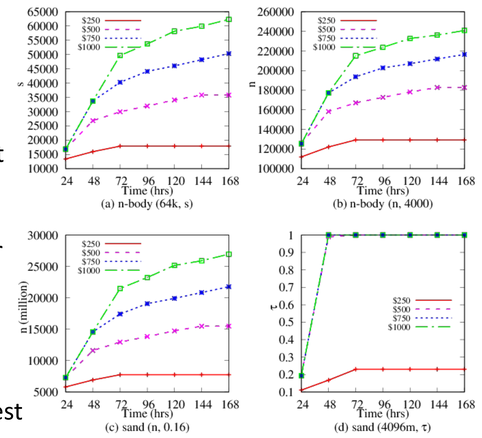


Observation 1:
Multiple Pareto-optimal problem sizes.

Observation 2:
Increasing the cost budget and relaxing the time deadline does not always result in obtaining a larger problem size.

Observation 3:
Resource demand is allocated in order of highest PCR.

Impact of Time Deadline on Largest Pareto-optimal Problem Size



Observation 4:
Among Pareto-optimal problem sizes, tightening the time deadline results in relatively smaller reduction of problem size.

Observation 5:
Among Pareto-optimal problem sizes, increasing cost results in relatively smaller increase of problem size because PCR is non-linear across resource types.

Impact of Cost Budget on Largest Pareto-optimal Problem Size