TEMPUS: Activity 2
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Parallel Algorithms

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Lecture notes

TEMPUS: Activity 2

Parallel Algorithms
Introduction

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Overview

1 Why do we need parallel computing?
Cost-performance comparison of serial computers

2 What is parallel computing?

3 Applications where parallel computing is needed

4 Main purposes for parallel computing

5 Metrics for performance evaluation of parallel algorithms

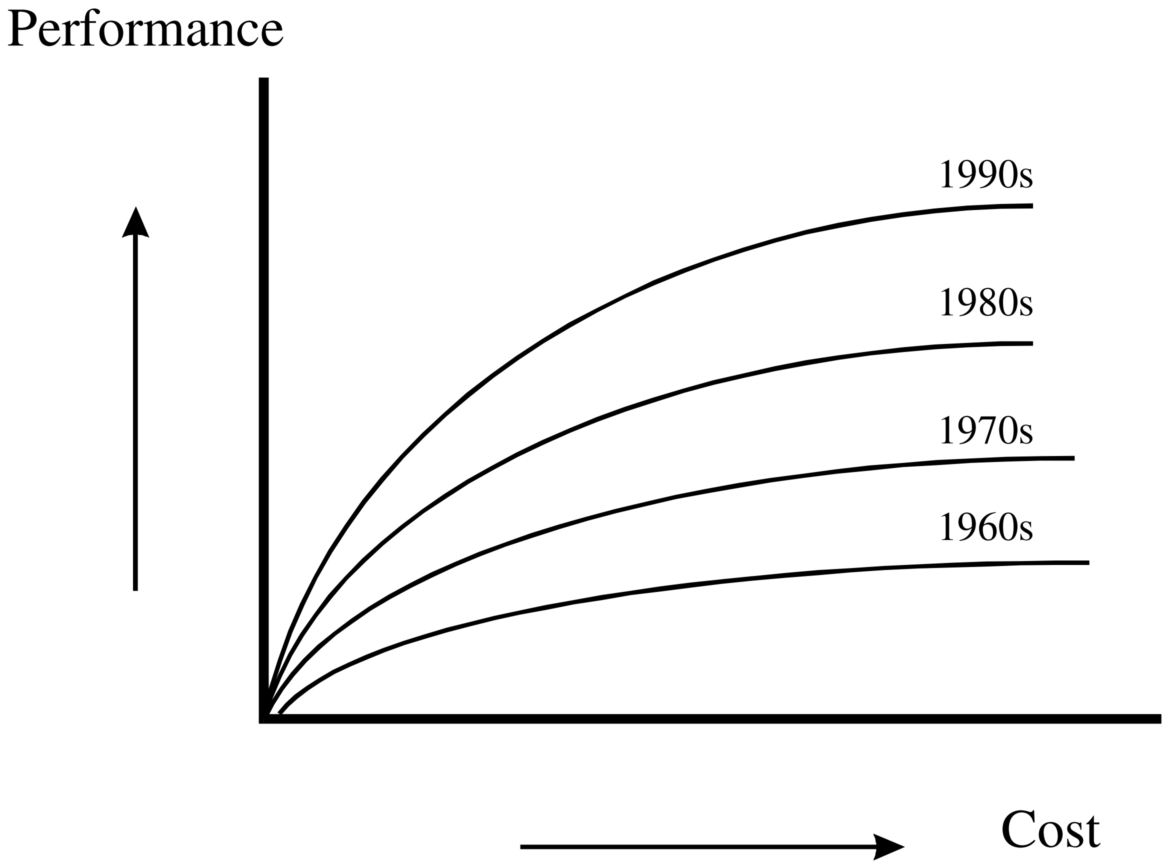
Introduction
1 Why Parallel Computing?

Speed of computers is steadily increasing
New applications require even higher speed

Performance of serial computers is beginning to saturate
Natural way to solve the problem is the usage of an ensemble of processors

Cost-performance comparison of serial computers: *at lower end performance increases faster than linearly, then the curve saturates and small gains in performance come at tremendous increase in cost.*

Cost-performance comparison of serial computers



Cost-performance curve of serial computers and its change over the decades

Introduction
2 What is Parallel Computing?

The architecture of parallel computers is parallel: ensemble of processors, and storage units, connected with each other via powerful communication network

Parallel computers are operated via parallel programming environment

The construction and execution of the program is designed via developing parallel algorithms for their execution

Effective program execution needs optimal matching of the architecture and algorithm

Not optimal algorithms may result in very ineffective program execution

Introduction
3 Applications where Parallel Computing is needed

Acquisition and processing of large amounts of data (weather forecasting, pollution measurements, image processing, etc.)

A lot of computationally intensive problems exist with extensive state space search (VLSI design, planning, logistics, control, protocol validation)

Modeling of materials, ocean modeling, study of chemical phenomena, computer tomography, database query processing

Computer Aided Design systems

Grand challenge problems: natural language understanding, neural networks learning, speech recognition, artificial intelligence, automated discovery of concepts.

Introduction
4 Main purposes for Parallel Computing

Performing faster computation
Faster solutions
Solution of large size problems

A Parallel computer is simply a collection of processors, interconnected in a certain fashion to allow the *coordination of their activities* and the *exchange of data*

Parallel computers can be classified according to a variety of *architectural features* and *modes of operation*

Parallel algorithms are algorithms suitable for implementation on parallel computers

Introduction
5 Metrics to evaluate the performance of Parallel Algorithms

Speedup:

$S_p(n)=T^*(n)/T_p(n)$

where:

$T^*(n)$ is the running time of the best possible sequential algorithm

$T_p(n)$ is the running time on a parallel computer with p processors

n is the input size of the task

Efficiency:

$E_p(n)=T_1(n)/pT_p(n)$

where:

$T_1(n)$ is the execution time on a single processor computer