COMP 8551 Advanced Games Programming Techniqu

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Heterogenous computing

Overview

- Motivation

- Parallel software

  - Data-par

  - Task-par

- Heterogenous computing

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Motivation

- Programming computers composed of a combination of CPUs, GPUs, and other processors

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- Write single p   on wide range of systems
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  - Cell phones   Add WeChat edu_assist_pro
  - Laptops
  - Nodes in massive supercomputers

- High portability by *exposing* hardware

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Motivation

- Raw performance used to drive innovation
- Focus now performance delivered per watt expended
- Many cores at lower frequencies more power-efficient
- Will continue to   onto single die
- But now will co   instead of raw performance
- Microprocessors built from multi   wer cores

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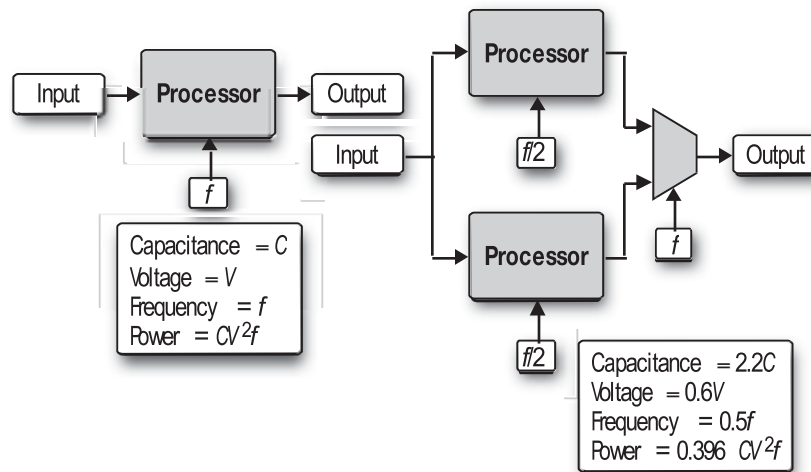
Concurrency/parallel software

- Parallelism = concurrency enabled by hardware

- Challenge for programmers:

  - find concurrency in problem
    - can be as simple as executing independent stream of operations for each pixel in i
    - can be incred   streams of operations that share information and must tig   their execution

  - express concurrency in software
    - streams of operations that will execute concurrently must be defined
    - data they operate on associated with them
    - dependencies between them managed so that correct answer is produced when they run concurrently

  - run resulting program so that concurrency delivers desired performance

Parallel programming

- This is the crux of the parallel programming problem

- Key to parallel programming: high-level abstraction or model to make   blem more manageable

- Task parallelism
  - E.g., problems organized around updates over points on grid

- Data parallelism
  - E.g., problems expressed as traversals over graphs

Data-parallel programming

- Programmers think of their problems in terms of collections of data elements that can be updated concurrently

- Parallelism expressed by concurrently applying the same stream of instruc   element

- Parallelism is in

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Task-parallel programming

- Directly define and manipulate concurrent tasks

- Problems decomposed into tasks that can run concurrently, w   o processing elements (PEs)   execution

- Easiest when tasks completely i   but is also used with tasks that share data

- Tasks vary widely in computational demands, so distributing them so that they all finish at about the same time can be difficult: **load balancing**

Task-parallel programming

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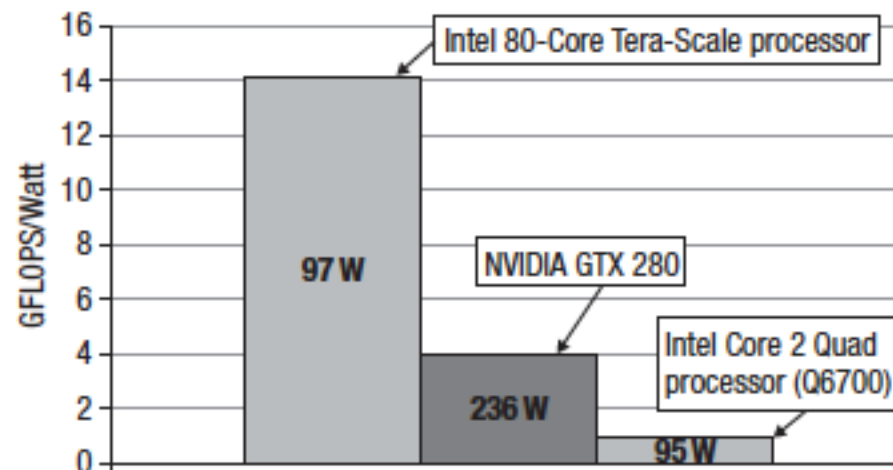
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Heterogenous computing

- General-purpose processor:
  - wide range of functional units to respond to any computational demand
- Processors specialized to a specific function:
  - fewer wasted tr
  - include only tho ~~~~~~~~~~~~~ by their special function

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Heterogenous computing

- Regardless of programming model, next step = map program onto real hardware

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- Here, heterog   esent unique problems   https://eduassistpro.github.io/

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- Computational elements in   :
  - have different instruction sets
  - have different memory architectures
  - run at different speeds

Heterogenous computing

- Traditionally:
  - think of software as set of modules implementing distinct portions of problem
  - modules explicitly tied to components in heterogeneous platform
  - E.g., graphics sof   are runs on CPU
  - General-purpos   g broke this model
  - Algorithms outside of graphics w   to fit onto GPU
- Hardware heterogeneity compli
- Programmers depend on high-level abstractions that hide complexity of hardware
- Heterogeneous programming language exposes heterogeneity and is counter to the trend toward increasing abstraction

Heterogenous computing

Application for heterogeneous platform must:

1. Discover components that make up heterogeneous system

2. Probe characte software can adapt to specif elements

3. Create blocks of instructions at will run on platform

4. Set up manipulate memory objects involved in computation

5. Execute kernels in correct order and on correct components of system

6. Collect final results

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Review

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  - Task-parallel

- Heterogenous computing

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