CS525 Parallel Computing

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Information

- No slides, no textbook.

Contents

1 Application properties of parallelism

- Simulations. e.g., weather forecasting, molecular dynamics, etc.
- Learning & Data Analysis. e.g., machine learning, data mining, etc.

2 Parallel Programming Platforms

There is no slides but I found a past course slide for reference. here.

2.1 Processors

Jobs of a processor: 1. fetch instructions. 2. decode instructions. 3. execute instructions. 4. store results.

Most of the time, the instructions are of few types: e.g. MOVE, ADD, LD, FSD

2.1.1 Pipeline Parallelism

Basic idea: an instruction can be executed while the next one is being decoded and the next one is being fetched.

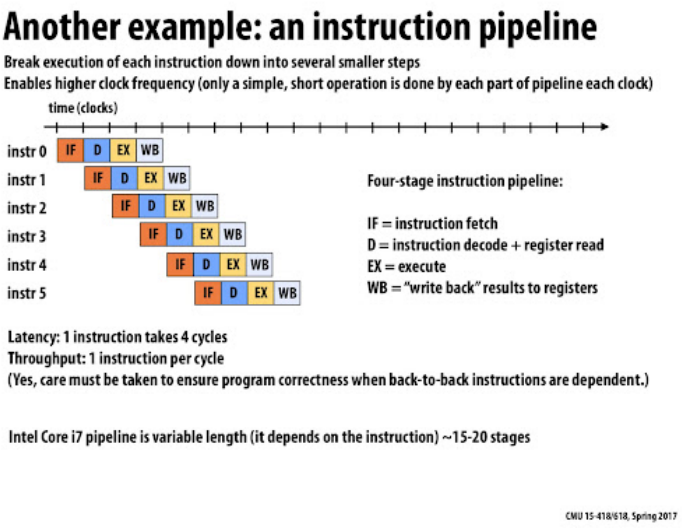

Figure 1: Pipeline Parallelism

Limitations:

- Bottleneck: the slowest stage determines the speed of the pipeline. We solve by 1. **decpmosing** the slowest stage into multiple stages. 2. Use multiple pipelines (**Superscalar Excution**).
- Conditional jumps: the pipeline must be flushed when a branch is encountered. We solve by **branch prediction**.

Superscalar Execution

How to schedule instructions to multiple pipelines? We consider:

- Data Dependencies: the result of one operation is an input to the next.

- Read Dependencies: the result of one operation is read by the next.
- Control Dependencies: the next operation depends on the result of a conditional branch.
- Resource Dependencies: the next operation requires the same resource as the current one.

We also **unroll the loops** to expose more parallelism.