Operating System (OS)
CS232

Concurrency Control

Dr. Muhammad Mobeen Movania
Dr. Muhammad Saeed

Outlines

- What is Concurrency?
- Why Concurrency is required?
- Levels of Concurrency
  - Computer Hardware
  - Operating System
  - Software/Algorithm
- How to Achieve Concurrency
  - Multi-Programming
  - Multithreading
  - Multiprocessing
- Issues with concurrency
  - Data Inconsistency/Coherency
  - Solutions
    - Mutual Exclusion
    - Synchronization
- Deadlock and Solutions
- Summary

What is Concurrency?

- Oxford :
  - The fact of two or more events or circumstances happening or existing at the same time.
  - Computing : The ability to execute more than one program or task simultaneously.

Why Concurrency is required?

- The real world contains **actors** that execute independently of, but **communicate** with, each other.
- In modeling the world, many **parallel executions** have to be **composed and coordinated**, and that's where the study of concurrency comes in

- Examples:
  - Software Engineering (Gantt Chart)
  - Expression Parsing ((x+y) * (a-b))^2
  - Client/Server Computing

Levels of Concurrency

- Hardware Level
  - Processors/Cores
  - Computers
- Operating System Level
  - Processes
  - Threads
- Software Level
  - Client/Server

Concurrency - (Computer Hardware)

- Flynn’s Taxonomy
  - SISD
  - SIMD
    - Vector, Array Processors , GPU
  - MIMD
    - Shared Memory (Symmetric Multiprocessing)
    - Distributed Memory (Cluster and Grid Computing)

Concurrency - (Operating System)

- Single-User vs Multi-User
- Single-tasking vs Multi-tasking
- Multi-tasking vs Multi-threading
- Multi-threading vs Multi-Processing
- API
  - fork() vs pthread_create()

Concurrency - (Software/Algorithms)

- Types of Applications
  - Client/Server
  - Peer-to-Peer
- Types of Algorithms
  - Sequential
  - Parallel (GPU, Multiprocessing etc)
  - Distributed (Cluster/Grid)

Summary

- Now you know what is concurrency and how it can be achieve at different levels
- Concurrent hardware can use multi-processor, multi-core , GPU or even multiple computers connected via a network.
- Multi-programming, multi-threading and multiprocessing are used at operating system level to achieve concurrency.
- Different modeling approaches can be used to design concurrent applications.