Operating System

Dining Philosopher Problem

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Content

- Introduction
- DeadLocks
- Problem
- Solution

Introduction

- The **dining philosophers problem** is an example problem often used in concurrent algorithm design to illustrate synchronization issues and techniques for resolving them.

- It was originally formulated in 1965 by Edsger Dijkstra as a student exam exercise, presented in terms of computers competing for access to tape drive peripherals. Soon after, Tony Hoare gave the problem its present formulation.

What is Concurrent ?

- **concurrency** is the decomposability property of a program, algorithm, or problem into order-independent or partially ordered components or units

- This means that even if the concurrent units of the program, algorithm, or problem are executed out-of-order or in partial order, the final outcome will remain the same.

- This allows for parallel execution of the concurrent units, which can significantly improve overall speed of the execution in multi-processor and multi-core systems

What is Synchronization ?

- **synchronization** refers to one of two distinct but related concepts:
    1. synchronization of processes
    2. synchronization of data.
- *Process synchronization:*
    - *Process synchronization* refers to the idea that multiple processes are to join up or handshake at a certain point, in order to reach an agreement or commit to a certain sequence of action.
- *Data synchronization :*
    - *Data synchronization* refers to the idea of keeping multiple copies of a dataset in coherence with one another, or to maintain data integrity.

What is DeadLock ?

- **Deadlock** is a state in which each member of a group of actions, is waiting for some other member to release a lock.

- Deadlock is a common problem
in multiprocessing systems, parallel computing, and distributed systems, where software and hardware locks are used to handle shared resources and implement process synchronization.

Problem Statement

- Five silent philosophers sit at a round table with bowls of spaghetti. Forks are placed between each pair of adjacent philosophers

- Each philosopher must alternately think and eat. However, a philosopher can only eat spaghetti when they have both left and right forks.

- Each fork can be held by only one philosopher and so a philosopher can use the fork only if it is not being used by another philosopher.

Conti……

- After an individual philosopher finishes eating, they need to put down both forks so that the forks become available to others.

- A philosopher can take the fork on their right or the one on their left as they become available, but cannot start eating before getting both forks.

- Eating is not limited by the remaining amounts of spaghetti or stomach space; an infinite supply and an infinite demand are assumed.

Conti….

- The problem is how to design a discipline of behavior such that no philosopher will starve

- i.e.
  - each can forever continue to alternate between eating and thinking, assuming that no philosopher can know when others may want to eat or think

Problem

- The problem was designed to illustrate the challenges of avoiding deadlock, a system state in which no progress is possible.
- To see that a proper solution to this problem is not obvious, consider a proposal in which each philosopher is instructed to behave as follows:
  - think until the left fork is available; when it is, pick it up;
  - think until the right fork is available; when it is, pick it up;
  - when both forks are held, eat for a fixed amount of time;
  - then, put the right fork down;
  - then, put the left fork down;
  - repeat from the beginning.

Conti…..

- This attempted solution fails because it allows the system to reach a deadlock state, in which no progress is possible.

- This is a state in which each philosopher has picked up the fork to the left, and is waiting for the fork to the right to become available, vice versa.

- With the given instructions, this state can be reached, and when it is reached, the philosophers will eternally wait for each other to release a fork.

Thank You