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CSE308 Operating Systems

Dining-Philosophers Problem

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SASTRA

- Consider **five philosophers** who spend their lives **thinking and eating.**
- The philosophers share a **circular table** surrounded by five chairs, each belonging to one philosopher.
- In the center of the table is a **bowl of rice**, and the table is laid with **five single chopsticks.**
- When a philosopher **thinks**, she does not interact with her colleagues.

- From time to time, a philosopher gets hungry and **tries to pick up the two chopsticks** that are closest to him (the two adjacent chopsticks).
- A philosopher may pick up only one chopstick at a time followed by the second chopstick
- When a hungry philosopher **has both chopsticks** at the same time, he eats without releasing the chopsticks.
- When he is finished eating, he **puts down both chopsticks** and starts thinking again

- It is an example of a large class of concurrency-control problems.
- It is a simple representation of the need to allocate several resources among several processes in a **deadlock-free and starvation-free manner.**
- **Two potential problems:**
  - Two philosopher try to take the same chopstick
  - Each philosopher take one chopstick and wait for the other
- One simple solution is to **represent each chopstick with a semaphore.**
- A philosopher tries to **grab a chopstick by executing a wait()** operation on that semaphore.
- He **releases chopsticks by executing the signal()** operation on the appropriate semaphores

- Thus, the shared data are

```
semaphore chopstick[5];
do {
   wait(chopstick[i]);
   wait(chopstick[(i+1) % 5]);
   /* eat for awhile */

   ...
   signal(chopstick[i]); signal(chopstick[(i+1) % 5]);
   ...
   /* think for awhile */ ...
} while (true);
```

- All the elements of chopstick are initialized to 1.
- Although this solution **guarantees that no two neighbors are eating simultaneously**, it nevertheless must be rejected because it **could create a deadlock.**
- Suppose that all five philosophers become hungry at the same time and each grabs her left chopstick. All the elements of chopstick will now be equal to 0.
- When each philosopher tries to grab her right chopstick, she **will be delayed forever**

- Several possible remedies to the deadlock problem are replaced by:
  - Allow **at most four philosophers** to be sitting simultaneously at the table.
  - Allow a philosopher to pick up his chopsticks **only if both chopsticks are available** (to do this, he must pick them up in a critical section).
  - Use an asymmetric solution—that is, an odd-numbered philosopher picks up first his left chopstick and then right chopstick, whereas an even numbered philosopher picks up his right chopstick and then her left chopstick