Announcements

- PS4 will be released on October 26th, 2020 and due on November 4th, 2020
- P2 is due on October 28th, 2020.
Dining Philosophers
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- Actions: Thinking and Eating
- Each P needs a pair of forks
- When a P is done eating, he is back to thinking and puts back his forks
Dining Philosophers

Step 1: think until the left chopstick is available; when it is, pick up;
Dining Philosophers

Step 1: think until the left chopstick is available; when it is, pick up;

Step 2: think until the right chopstick is available; when it is, pick up;
Dining Philosophers

Step 1: think until the left chopstick is available; when it is, pick up;

Step 2: think until the right chopstick is available; when it is, pick up;

Step 3: when both chopsticks are held, eat for a xed amount of time;
Dining Philosophers

Step 1: think until the left chopstick is available; when it is, pick up;
Step 2: think until the right chopstick is available; when it is, pick up;
Step 3: when both chopsticks are held, eat for a fixed amount of time;
Step 4: then, put the right chopstick down;
Dining Philosophers

Step 1: think until the left chopstick is available; when it is, pick up;
Step 2: think until the right chopstick is available; when it is, pick up;
Step 3: when both chopsticks are held, eat for a fixed amount of time;
Step 4: then, put the right chopstick down;
Step 5: then, put the left chopstick down;
Dining Philosophers

Step 1: think until the left chopstick is available; when it is, pick up;

Step 2: think until the right chopstick is available; when it is, pick up;

Step 3: when both chopsticks are held, eat for a fixed amount of time;

Step 4: then, put the right chopstick down;

Step 5: then, put the left chopstick down;

Step 6: repeat from the beginning.
Dining Philosophers

A concurrent system with a need for synchronization, should ensure

Correctness    Efficiency    Fairness
Dining Philosophers

A concurrent system with a need for synchronization, should ensure

Correctness       Efficiency       Fairness

No two philosophers should be using the same chopsticks at the same time.
Dining Philosophers

A concurrent system with a need for synchronization, should ensure

Correctness

No two philosophers should be using the same chopsticks at the same time.

Efficiency

Philosophers do not wait too long to pick-up chopsticks when they want to eat.

Fairness
Dining Philosophers

A concurrent system with a need for synchronization, should ensure

**Correctness**
No two philosophers should be using the same chopsticks at the same time.

**Efficiency**
Philosophers do not wait too long to pick-up chopsticks when they want to eat.

**Fairness**
No philosopher should be unable to pick up chopsticks forever and starve
Pseudocode

while(true) {
    // Initially, thinking about life, universe, and everything
    think();
    // Take a break from thinking, hungry now
    pick_up_left_fork();
pick_up_right_fork();
    eat();
    put_down_right_fork();
    put_down_left_fork();

    // Not hungry anymore. Back to thinking!
}


What’s wrong with the previous code?
Lock on Objects!
Still problematic!
Detecting Deadlocks using the Terminal

java -classpath . DiningPhilosophers (in ubuntu)

Jps -l -m (lists the running)

Jstack <process_number>
Circular Wait
Philosopher 1 180505382632200: Thinking
Philosopher 5 180505383334600: Thinking
Philosopher 4 180505383106400: Thinking
Philosopher 2 180505382688400: Thinking
Philosopher 3 180505382872500: Thinking
Philosopher 2 180505389078900: Picked up left fork
Philosopher 3 180505403615600: Picked up left fork
Philosopher 4 180505408710400: Picked up left fork
Philosopher 1 180505419627800: Picked up left fork
Philosopher 5 180505462908100: Picked up left fork
Dining Philosophers

A concurrent system with a need for synchronization, should ensure:

Correctness: No two philosophers should be using the same chopsticks at the same time.

Efficiency: Philosophers do not wait too long to pick-up chopsticks when they want to eat.

Fairness: No philosopher should be unable to pick up chopsticks forever and starve.
How can we break the cycle?
Only 4 philosophers at a time...

Assume we now have an additional waiter who allows only 4 philosophers at the table at any given time. The waiter will only allow another philosopher to join once there are <4 philosophers at the table. Is there a desirable property of concurrent systems that is still violated? If so, give an example of when it is violated.