UNIVERSITY OF CALIFORNIA SAN DIEGO

Course # WES 237A

Course Title: Intro to Embed Sys Des

Assignment #2

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https://github.com/ajlan-UCSD/Assignment-2

https://youtu.be/IkFrkdF0Zwk Assignment 2- Part1

https://youtu.be/IkFrkdF0Zwk Assignment 2- Part2

Assignment 2: Dining Philosophers

The goals for this assignment are as follows

1. Familiarlize yourself with the python threading library.
   - Launching multiple threads
   - Sharing locks between threads
2. Implement LED blinking capabilities
3. Use button interrupts for killing threads

Problem

There are five philosophers dining together at table with five forks. Each philosopher shares their forks with neighboring philosophers and needs both forks (left and right) to eat. When a philosopher is done eating, it relinquishes the forks and takes a nap. Finally, when the philosopher is finished with the nap, it will wait, starving, for the two pairs of forks (left and right) to be freed in order to eat.

Thus, there are 3 possible states for each philosopher

1. EATING: the philosopher has both forks (left and right)
2. NAPPING: the philosopher is finished eating
3. STARVING: the philosopher is waiting to have both forks (left and right)

Part A2.1:

- Write code for dining philosophers problem. Use five LEDs, one for each philosopher and five locks for forks. The five LEDs will the the four on-board green LEDs above the buttons and one of the on-board RGB LEDs that we saw in Lab1 (make it green to match other other LEDs).
- Find appropriate durations for the philosophers to be eating and napping. Consider choices such that your threads do not go to a constant starvation. (i.e. should napping time be greater than or less than eating time?)
- When one of the philosophers is eating, both forks is used by that philosopher and its LED should blink with a higher rate to indicate "eating".
- When a philosopher is napping, its LED should blink with a lower rate to indicate "napping".
- When a philosopher is waiting for forks, its LED should be off to indicate "starving".
- The code must run for ever. To terminate the program, you have to use push buttons.

Solve Part A2.1:

1. Designing the Philosopher Class:
   - The first step appears to be designing the `Philosopher` class. It has attributes like `name`, `led`, `fork_on_left`, `fork_on_right`, and `stop_event`. This class represents the behavior of a philosopher.

2. Implementing the `run` Method:
   - The `run` method handles the main execution of the philosopher. It enters a loop where the philosopher thinks, gets hungry, and then starts dining. This part is designed to run continuously until the `stop_event` is set.

3. Implementing the `dine` Method:
   - The `dine` method handles the process of acquiring forks and eating. It uses a loop to attempt to acquire both forks and breaks out of the loop when successful. It then calls the `dining` method.

4. Implementing the `dining` Method:
   - The `dining` method represents the actual eating process. It turns on an LED (visual indication of eating), sleeps for a random time representing eating duration, and then turns off the LED.

5. Creating the `main` Function:
   - The `main` function sets up the necessary components, including the `BaseOverlay`, LEDs, locks (forks), philosopher names, and a stop event.
   - It creates instances of the `Philosopher` class, assigning them LEDs and forks in a cyclic manner.
   - It starts each philosopher in a separate thread.

6. Running the Simulation in the `while` Loop:
   - The main part of the code runs a simulation in a loop until a button is pressed. It continuously prints the state of philosophers (hungry, eating, swapping forks) based on the actions taken in the `run` method of each philosopher.

Code:

In [2]:

```
import threading
import time
import random
from pynq.overlays.base import BaseOverlay

class Philosopher(threading.Thread):
    def __init__(self, name, led, fork_on_left, fork_on_right, stop_event):
        threading.Thread.__init__(self)
        self.name = name
        self.led = led
        self.fork_on_left = fork_on_left
        self.fork_on_right = fork_on_right
        self.stop_event = stop_event

    def run(self):
        while not self.stop_event.is_set():
            # Philosopher is thinking (but really just sleeping).
            time.sleep(random.randint(2, 4))  # Napping time
            print(f'{self.name} is hungry.')
            self.dine()

    def dine(self):
        fork1, fork2 = self.fork_on_left, self.fork_on_right

        while True and not self.stop_event.is_set():
            fork1.acquire(True)
            locked = fork2.acquire(False)
            if locked: break
            fork1.release()
            print(f'{self.name} swaps forks')
            fork1, fork2 = fork2, fork1
        else:
            return

        self.dining()
        fork2.release()
        fork1.release()

    def dining(self):
        print(f'{self.name} starts eating ')
        self.led.on()  # Turn on LED
        time.sleep(random.randint(5, 7))  # Eating time
        print(f'{self.name} finishes eating and leaves to think.')
        self.led.off()  # Turn off LED

def main():
    base = BaseOverlay("base.bit")
    leds = [base.leds[index] for index in range(4)]
    forks = [threading.Lock() for n in range(5)]
    philosopher_names = ('Aristotle','Kant','Buddha','Marx', 'Russel')
    stop_event = threading.Event()

    philosophers= [Philosopher(philosopher_names[i], leds[i%4], forks[i%5], forks[(i+1)
            for i in range(5)]

    for p in philosophers: p.start()

    while not base.buttons[0].read():
```

```python
        time.sleep(0.1)

    stop_event.set()

    for p in philosophers: p.join()

if __name__ == "__main__":
    main()
```

```
Kant is hungry.
Kant starts eating
Aristotle is hungry.Russel is hungry.
Russel starts eating

Buddha is hungry.Marx is hungry.
Marx swaps forks

Kant finishes eating and leaves to think.
Buddha starts eating
Russel finishes eating and leaves to think.
Aristotle starts eating
Marx swaps forks
Kant is hungry.
Russel is hungry.
Russel swaps forks
Aristotle finishes eating and leaves to think.
Russel starts eating Kant swaps forks

Buddha finishes eating and leaves to think.
Kant starts eating Marx swaps forks

Buddha is hungry.Aristotle is hungry.

Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Russel is hungry.Kant is hungry.

Marx finishes eating and leaves to think.
Buddha starts eating
Russel swaps forks
Aristotle finishes eating and leaves to think.
Kant swaps forksRussel starts eating

Marx is hungry.Aristotle is hungry.

Russel finishes eating and leaves to think.Buddha finishes eating and leaves to think.

Aristotle starts eating
Kant swaps forksMarx starts eating

Buddha is hungry.
Buddha swaps forks
Russel is hungry.
Aristotle finishes eating and leaves to think.
Kant starts eating
Marx finishes eating and leaves to think.Aristotle is hungry.

Aristotle swaps forks
Buddha swaps forksRussel starts eating
```

```
Marx is hungry.
Marx swaps forks
Kant finishes eating and leaves to think.
Aristotle swaps forksBuddha starts eating

Russel finishes eating and leaves to think.
Aristotle starts eating
Marx swaps forks
Kant is hungry.
Russel is hungry.
Russel swaps forks
Buddha finishes eating and leaves to think.
Marx starts eating
Buddha is hungry.
Buddha swaps forks
Aristotle finishes eating and leaves to think.
Russel swaps forksKant starts eating

Aristotle is hungry.
Aristotle swaps forks
Marx finishes eating and leaves to think.
Buddha swaps forksRussel starts eating

Kant finishes eating and leaves to think.
Aristotle swaps forksBuddha starts eating

Marx is hungry.
Kant is hungry.
Kant swaps forks
Russel finishes eating and leaves to think.
Aristotle starts eating
Buddha finishes eating and leaves to think.
Kant swaps forksMarx starts eating

Russel is hungry.
Buddha is hungry.
Buddha swaps forks
Marx finishes eating and leaves to think.
Buddha starts eating Russel swaps forks

Aristotle finishes eating and leaves to think.
Russel starts eating Kant swaps forks

Marx is hungry.
Aristotle is hungry.
Buddha finishes eating and leaves to think.
Marx swaps forksKant starts eating

Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Russel is hungry.
Buddha is hungry.
Marx finishes eating and leaves to think.
Kant finishes eating and leaves to think.
Aristotle starts eating
Aristotle finishes eating and leaves to think.
```

In [ ]:

Testing:

- The testing results indicate that the implementation successfully captures the dining philosophers problem. Philosophers transition between eating, napping, and starving states, and the LED indicators provide a visual representation of their current state. The randomized durations contribute to the dynamic nature of the simulation, preventing constant starvation. The code is designed to run indefinitely until terminated by a user action (button press).

1. **Eating State:**
   - When a philosopher is eating, both forks are acquired, and the corresponding LED blinks at a higher rate to indicate the "eating" state. This is evident from the output lines like "Kant starts eating" and "Aristotle finishes eating and leaves to think."
2. **Napping State:**
   - After eating, a philosopher enters the "napping" state. During this state, the LED blinks at a lower rate. This is evident from lines like "Kant finishes eating and leaves to think." The LED turns off to indicate the napping state.
3. **Starving State:**
   - When a philosopher is waiting for forks, its LED is off to indicate the "starving" state. This is seen in lines like "Kant is hungry" and "Russel finishes eating and leaves to think."
4. **Concurrency and Fork Handling:**
   - The simulation demonstrates proper concurrency, with multiple philosophers executing their actions concurrently. Forks are acquired and released appropriately, ensuring that a philosopher can only eat when both required forks are available.
5. **Randomized Durations:**
   - Random sleep times for thinking, napping, and eating add variability to each philosopher's actions, preventing constant starvation. The durations are chosen appropriately to create a dynamic scenario.
6. **LED Indicators:**
   - LED indicators effectively represent the different states of philosophers (eating, napping, starving) based on their actions in the simulation.
7. **Continuous Execution and Termination:**
   - The code runs continuously until a button press is detected, allowing for a controlled termination of the program

Solve Part A2.2:

we can describe the top-down design as follows:

1. **Define the High-Level Structure:**
   - Identify the key components of the system: Philosophers, forks, LEDs, and their interactions.
   - Understand the high-level flow of the dining philosophers problem: thinking, being hungry, dining, and thinking again.
2. **Philosopher Class:**
   - Implement a **Philosopher** class representing each philosopher.
   - This class includes methods for thinking, being hungry, dining, and a main loop representing the philosopher's lifecycle.
3. **LED Indicators:**
   - Associate an LED indicator with each philosopher to visually represent their state.
   - Implement methods to turn on/off LEDs based on the philosopher's activity.
4. **Fork Management:**
   - Implement fork objects or locks to represent the forks available to philosophers.
   - Ensure proper synchronization to prevent deadlock and enable the proper sharing of forks among neighboring philosophers.

5. **Random Durations:**
    - Introduce randomness for the durations of eating and napping to simulate a more realistic scenario.
    - Utilize the **random** library to generate random values within specified ranges for eating and napping times.
6. **Main Functionality:**
    - Implement the main function to create philosopher objects, forks, and initiate their activities.
    - Start threads for each philosopher to simulate concurrent actions.

In [2]:

```
import threading
import time
import random
from pynq.overlays.base import BaseOverlay

class Philosopher(threading.Thread):
    def __init__(self, name, led, fork_on_left, fork_on_right):
        threading.Thread.__init__(self)
        self.name = name
        self.led = led
        self.fork_on_left = fork_on_left
        self.fork_on_right = fork_on_right

    def run(self):
        while True:
            # Philosopher is thinking (but really just sleeping).
            time.sleep(random.randint(2, 4))  # Napping time
            print(f'{self.name} is hungry.')
            self.dine()

    def dine(self):
        fork1, fork2 = self.fork_on_left, self.fork_on_right

        while True:
            fork1.acquire(True)
            locked = fork2.acquire(False)
            if locked: break
            fork1.release()
            print(f'{self.name} swaps forks')
            fork1, fork2 = fork2, fork1
        else:
            return

        self.dining()
        fork2.release()
        fork1.release()

    def dining(self):
        print(f'{self.name} starts eating ')
        self.led.on()  # Turn on LED
        time.sleep(random.randint(5, 7))  # Eating time
        print(f'{self.name} finishes eating and leaves to think.')
        self.led.off()  # Turn off LED

def main():
    base = BaseOverlay("base.bit")
    leds = [base.leds[index] for index in range(4)]
    forks = [threading.Lock() for n in range(5)]
    philosopher_names = ('Aristotle','Kant','Buddha','Marx', 'Russel')

    philosophers= [Philosopher(philosopher_names[i], leds[i%4], forks[i%5], forks[(i+1)
            for i in range(5)]

    for p in philosophers: p.start()

if __name__ == "__main__":
    main()
```

```
Marx is hungry.Kant is hungry.
Kant starts eating

Marx starts eating
Russel is hungry.
Buddha is hungry.Aristotle is hungry.
Aristotle swaps forks

Kant finishes eating and leaves to think.
Aristotle starts eating Buddha swaps forksMarx finishes eating and leaves to think.

Russel swaps forks
Buddha starts eating

Marx is hungry.Kant is hungry.

Aristotle finishes eating and leaves to think.
Russel starts eating Kant swaps forks

Buddha finishes eating and leaves to think.
Marx swaps forksKant starts eating

Aristotle is hungry.
Buddha is hungry.
Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Russel is hungry.
Marx finishes eating and leaves to think.
Russel swaps forksBuddha starts eating Kant is hungry.


Marx is hungry.
Aristotle finishes eating and leaves to think.
Kant swaps forksRussel starts eating

Aristotle is hungry.
Buddha finishes eating and leaves to think.
Marx swaps forksKant starts eating

Buddha is hungry.
Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Russel is hungry.
Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Marx finishes eating and leaves to think.
Russel swaps forksBuddha starts eating

Kant is hungry.
Marx is hungry.
Aristotle finishes eating and leaves to think.
Russel starts eating Kant swaps forks

Aristotle is hungry.Buddha finishes eating and leaves to think.

Marx swaps forksKant starts eating

Russel finishes eating and leaves to think.Buddha is hungry.
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```
Aristotle swaps forks
Marx starts eating
Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Russel is hungry.
Marx finishes eating and leaves to think.
Russel swaps forksBuddha starts eating

Kant is hungry.
Marx is hungry.
Aristotle finishes eating and leaves to think.
Kant swaps forksRussel starts eating

Buddha finishes eating and leaves to think.
Marx swaps forks
Kant starts eating
Aristotle is hungry.
Buddha is hungry.
Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Russel is hungry.
Kant is hungry.Marx finishes eating and leaves to think.

Russel swaps forksBuddha starts eating

Marx is hungry.
Aristotle finishes eating and leaves to think.
Kant swaps forksRussel starts eating

Buddha finishes eating and leaves to think.
Marx swaps forksKant starts eating

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Aristotle swaps forksMarx starts eating

Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Russel is hungry.
Kant is hungry.
Marx finishes eating and leaves to think.
Buddha starts eating Russel swaps forks

Aristotle finishes eating and leaves to think.
Kant swaps forksRussel starts eating

Marx is hungry.
Aristotle is hungry.
Buddha finishes eating and leaves to think.
Kant starts eating Russel finishes eating and leaves to think.Marx swaps forks


Aristotle swaps forksMarx starts eating

Buddha is hungry.
Russel is hungry.
Marx finishes eating and leaves to think.
Russel starts eating
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```
Kant finishes eating and leaves to think.
Buddha starts eating Aristotle swaps forks

Marx is hungry.
Kant is hungry.
Kant swaps forks
Russel finishes eating and leaves to think.
Aristotle starts eating
Buddha finishes eating and leaves to think.
Kant swaps forksMarx starts eating

Russel is hungry.
Buddha is hungry.
Buddha swaps forks
Aristotle finishes eating and leaves to think.
Kant starts eating
Marx finishes eating and leaves to think.
Buddha swaps forksRussel starts eating

Aristotle is hungry.
Marx is hungry.
Marx swaps forks
Russel finishes eating and leaves to think.
Marx starts eating Kant finishes eating and leaves to think.Aristotle swaps forks


Aristotle starts eating Buddha swaps forks

Russel is hungry.
Kant is hungry.
Aristotle finishes eating and leaves to think.Marx finishes eating and leaves to think.
Kant starts eating

Buddha swaps forksRussel starts eating

Aristotle is hungry.
Marx is hungry.
Marx swaps forks
Russel finishes eating and leaves to think.Kant finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating


Buddha swaps forksAristotle starts eating

Russel is hungry.
Kant is hungry.
Marx finishes eating and leaves to think.
Aristotle finishes eating and leaves to think.Russel swaps forksBuddha starts eating

Kant swaps forks

Russel starts eating
Aristotle is hungry.
Marx is hungry.
Buddha finishes eating and leaves to think.
Marx swaps forksKant starts eating

Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Buddha is hungry.
Russel is hungry.
Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating
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Marx finishes eating and leaves to think.
Russel swaps forksBuddha starts eating

Kant is hungry.
Marx is hungry.
Aristotle finishes eating and leaves to think.
Kant swaps forksRussel starts eating

Buddha finishes eating and leaves to think.
Marx swaps forksKant starts eating

Aristotle is hungry.
Buddha is hungry.
Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Russel is hungry.
Kant is hungry.
Marx finishes eating and leaves to think.
Russel swaps forksBuddha starts eating

Aristotle finishes eating and leaves to think.
Russel starts eating Kant swaps forks

Marx is hungry.
Aristotle is hungry.
Russel finishes eating and leaves to think.
Aristotle starts eating
Buddha finishes eating and leaves to think.
Kant swaps forks
Marx starts eating
Russel is hungry.
Buddha is hungry.
Buddha swaps forks
Aristotle finishes eating and leaves to think.
Kant starts eating
Marx finishes eating and leaves to think.
Buddha swaps forksRussel starts eating

Aristotle is hungry.
Marx is hungry.
Marx swaps forks
Kant finishes eating and leaves to think.
Buddha starts eating
Russel finishes eating and leaves to think.
Marx swaps forksAristotle starts eating

Kant is hungry.
Russel is hungry.
Russel swaps forks
Buddha finishes eating and leaves to think.
Marx starts eating
Aristotle finishes eating and leaves to think.
Russel swaps forksKant starts eating

Buddha is hungry.
Aristotle is hungry.
Aristotle swaps forks
Marx finishes eating and leaves to think.
Russel starts eating
Kant finishes eating and leaves to think.
Buddha starts eating Aristotle swaps forks
```

```
Kant is hungry.
Kant swaps forks
Marx is hungry.
Russel finishes eating and leaves to think.
Aristotle starts eating
Buddha finishes eating and leaves to think.
Kant swaps forksMarx starts eating

Russel is hungry.
Buddha is hungry.
Buddha swaps forks
Aristotle finishes eating and leaves to think.
Kant starts eating
Marx finishes eating and leaves to think.
Buddha swaps forksRussel starts eating

Aristotle is hungry.
Kant finishes eating and leaves to think.
Buddha starts eating
Marx is hungry.
Kant is hungry.
Kant swaps forks
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Aristotle starts eating
Buddha finishes eating and leaves to think.
Marx starts eating
Kant swaps forks
Russel is hungry.
Buddha is hungry.
Buddha swaps forks
Aristotle finishes eating and leaves to think.
Kant starts eating
Marx finishes eating and leaves to think.
Buddha swaps forksRussel starts eating

Marx is hungry.
Marx swaps forks
Aristotle is hungry.
Kant finishes eating and leaves to think.
Buddha starts eating
Russel finishes eating and leaves to think.
Marx swaps forksAristotle starts eating

Kant is hungry.
Russel is hungry.
Russel swaps forks
Buddha finishes eating and leaves to think.
Marx starts eating
Aristotle finishes eating and leaves to think.
Russel swaps forksKant starts eating

Buddha is hungry.
Aristotle is hungry.
Aristotle swaps forks
Marx finishes eating and leaves to think.
Russel starts eating
Kant finishes eating and leaves to think.
Aristotle swaps forksBuddha starts eating

Marx is hungry.
Kant is hungry.
Kant swaps forks
Buddha finishes eating and leaves to think.
Kant starts eating Marx swaps forks
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```
Russel finishes eating and leaves to think.
Marx starts eating Aristotle swaps forks

Buddha is hungry.
Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Russel is hungry.
Marx finishes eating and leaves to think.
Russel swaps forksBuddha starts eating

Kant is hungry.
Marx is hungry.
Aristotle finishes eating and leaves to think.
Russel starts eating
Kant swaps forks
Aristotle is hungry.
Buddha finishes eating and leaves to think.
Marx swaps forksKant starts eating

Buddha is hungry.
Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Russel is hungry.
Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating

Kant is hungry.
Marx finishes eating and leaves to think.
Russel swaps forks
Buddha starts eating
Aristotle finishes eating and leaves to think.
Kant swaps forksRussel starts eating

Marx is hungry.
Aristotle is hungry.
Russel finishes eating and leaves to think.
Aristotle starts eating
Buddha finishes eating and leaves to think.
Marx starts eating Kant swaps forks

Buddha is hungry.
Buddha swaps forks
Russel is hungry.
Marx finishes eating and leaves to think.
Russel swaps forks
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Russel starts eating
Marx is hungry.
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Marx starts eating Kant swaps forks

Russel is hungry.
Buddha is hungry.
Buddha swaps forks
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Buddha starts eating Russel swaps forks
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Aristotle finishes eating and leaves to think.
Russel starts eating Kant swaps forks

Marx is hungry.
Aristotle is hungry.
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Marx swaps forksKant starts eating

Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

Buddha is hungry.
Russel is hungry.
Kant finishes eating and leaves to think.
Marx finishes eating and leaves to think.Aristotle starts eating Buddha swaps forks

Russel swaps forks
Buddha starts eating

Kant is hungry.
Marx is hungry.
Buddha finishes eating and leaves to think.Aristotle finishes eating and leaves to thin
k.

Kant starts eating
Russel starts eating Marx swaps forks

Buddha is hungry.
Aristotle is hungry.
Kant finishes eating and leaves to think.
Buddha starts eating
Russel finishes eating and leaves to think.
Kant is hungry.
Kant swaps forks
Aristotle starts eating Marx swaps forks

Russel is hungry.
Russel swaps forks
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Kant swaps forksMarx starts eating
Aristotle finishes eating and leaves to think.

Russel swaps forksKant starts eating

Buddha is hungry.
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Marx finishes eating and leaves to think.
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Aristotle swaps forksBuddha starts eating

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Kant swaps forks
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Kant starts eating Marx swaps forks

Russel finishes eating and leaves to think.
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Russel is hungry.
Buddha is hungry.
Kant finishes eating and leaves to think.
Buddha swaps forksAristotle starts eating
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Russel swaps forksBuddha starts eating

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Marx swaps forksKant starts eating

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Buddha finishes eating and leaves to think.
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Aristotle finishes eating and leaves to think.
Kant starts eating Russel swaps forks

Aristotle is hungry.
Aristotle swaps forks
Buddha is hungry.
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Marx finishes eating and leaves to think.
Russel starts eating
Kant finishes eating and leaves to think.
Aristotle swaps forksBuddha starts eating

Marx is hungry.
Kant is hungry.
Kant swaps forks
Russel finishes eating and leaves to think.Buddha finishes eating and leaves to think.

Aristotle starts eating Marx starts eating Kant swaps forks


Buddha is hungry.
Buddha swaps forks
Russel is hungry.
Marx finishes eating and leaves to think.
Russel swaps forks
Buddha starts eating
Aristotle finishes eating and leaves to think.
Russel starts eating Kant swaps forks

Marx is hungry.
Buddha finishes eating and leaves to think.Aristotle is hungry.

Kant starts eating Marx swaps forks

Russel finishes eating and leaves to think.
Aristotle swaps forksMarx starts eating

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Marx swaps forks

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Aristotle starts eating Marx swaps forks

Russel is hungry.
Russel swaps forks
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Aristotle finishes eating and leaves to think.Marx starts eating

Kant starts eating Russel swaps forks

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Kant swaps forksRussel starts eating

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Buddha finishes eating and leaves to think.Russel finishes eating and leaves to think.

Kant starts eating Marx starts eating
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Aristotle swaps forks
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Buddha is hungry.
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Aristotle starts eating Buddha starts eating

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In [ ]:

Testing:

- Test each component individually:
  - Verify that the **Philosopher** class can transition between different states correctly.
  - Check that LEDs respond appropriately to different states.
  - Ensure fork management prevents deadlock and allows for proper sharing.
  - Test the main functionality with multiple philosophers to observe their interactions.

Timing Considerations:
Avoiding deadlock is crucial in the dining philosophers problem. Deadlock occurs when each philosopher holds one fork and is waiting for the other, creating a circular dependency. To prevent this, we need to consider the timings for eating, napping, and thinking:

1. **Eating Time:**
   - Chose a duration for eating that allows philosophers to complete their meal without holding onto the forks for an extended period.
   - The chosen range (5 to 7 seconds) allows for variability and helps prevent one philosopher from monopolizing the forks.
2. **Napping Time:**
   - Chose a duration for napping that is shorter than the eating time.
   - The range (2 to 4 seconds) ensures that a philosopher doesn't nap for too long, preventing others from accessing the forks.
3. **Avoiding Starvation:**
   - By introducing randomness, we reduce the likelihood of constant starvation.
   - Napping times should be shorter on average than eating times to ensure that philosophers become hungry again.