Lecture 22: Actors (continued)

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Worksheet #21: Interaction between finish and actors

What output will be printed if the end-finish operation from slide 15 is moved from line 13 to line 11 as shown below?

1. `finish() -> {`
2. `int threads = 4;`
3. `int numberOfHops = 10;`
4. `ThreadRingActor[] ring = new ThreadRingActor[threads];`
5. `for(int i=threads-1;i>=0; i--) {`
6. `ring[i] = new ThreadRingActor(i);`
7. `ring[i].start(); // like an async`
8. `if (i < threads - 1) {`
9. `ring[i].nextActor(ring[i + 1]);`
10. `}
11. }); // finish`
12. `ring[threads-1].nextActor(ring[0]);`
13. `ring[0].send(numberOfHops);`
14. `}

Deadlock (no output): the end-finish operation in line 11 waits for all the actors started in line 7 to terminate, but the actors are waiting for the message sequence initiated in line 13 before they call `exit()`.
Announcements

• Checkpoint #2 for Homework 3 is now due Thursday, March 12th at 11:59pm (24-hour extension).
• The entire written + programming homework (Checkpoint #3) is due by Friday, March 27th.
• Quiz for Unit 5 will be in class on Wednesday, March 11th
• The registrar has announced the schedule for the COMP 322 final exam:
  — 6-MAY-2020 (Wednesday)
  — 9:00AM - 12:00PM
  — Location TBD
• Scope of final exam (Exam 2) will be limited to Lectures 19 - 38
Recap of Actors

- Rely on asynchronous messaging
- Message are sent to an actor using its `send()` method
- Messages queue up in the mailbox
- Messages are processed by an actor after it is started
- Messages are processed asynchronously
  — one at a time
  — using the body of `process()`
Simple Pipeline using Actors

A Simple pipeline with 3 stages

Stage-1 Filter even length strings
Stage-2 Filter lowercase strings
Stage-3 Print results
Sieve of Eratosthenes using Actors
Limitations of Actor Model

- Deadlocks possible
  - Occurs when all started (but non-terminated) actors have empty mailboxes
- Data races possible when messages include shared objects
- Simulating synchronous replies requires some effort
  - e.g., does not support addAndGet()
- Implementing truly concurrent data structures is hard
  - No parallel reads, no reductions/accumulators
- Difficult to achieve global consensus
  - Finish and barriers not supported as first-class primitive
Implementing an Unbounded Buffer using Actors

Diagram showing the interaction between producers and consumers through a master node in an unbounded buffer environment.
Unbounded Buffer Actor Interaction Diagram

1. Determine new item required

2. Request Data from an idle producer

3. Produce Data

4. Send newly produced data

5. Store data item in buffer
Unbounded Buffer Actor Interaction Diagram (cont.)

Master

1. Retrieve data item from buffer

2. Send Data to an idle consumer

3. Notify master of becoming idle

4. Store idle consumer locally for future use

Consumer-C

3. Consume Data
Exercise: Is Main Actor needed for Producer-Consumer model?

Under which of the following scenarios is a main actor needed to model producer-consumer relationship with an unbounded buffer? Assume Producer(s) have access to Consumer list.

- 1 producer, 1 consumer
- 1 producer, many consumers
- Many producers, 1 consumer
- Many producers, many consumers

Under which of those scenarios is having a main actor more efficient?
Pipeline and Actors

Pipelined Parallelism:
- Each stage can be represented as an actor
- Stages need to ensure ordering of messages while processing them
- Slowest stage is a throughput bottleneck
Motivation for Parallelizing Actors

Pipelined Parallelism:
- Reduce effects of slowest stage by introducing task parallelism.
- Increases the throughput.