COMP 322: Fundamentals of Parallel Programming

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

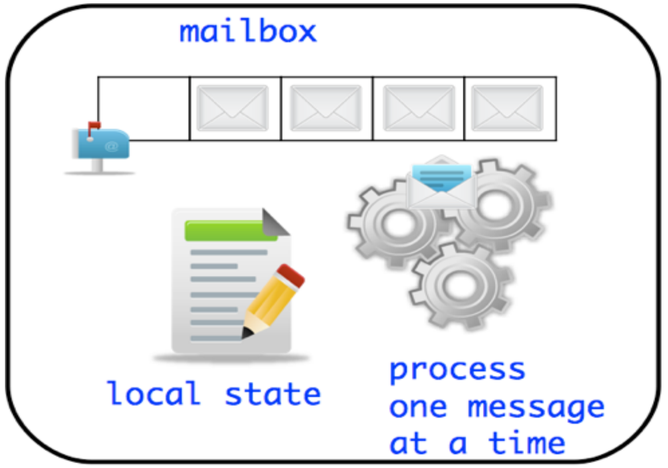
- Checkpoint #2 for Homework 3 is now due Thursday, March 12th at 11:59pm (24-hour extension).
- The entire written + programming homework (Checkpoint #3) is due by Friday, March 27th.
- Quiz for Unit 5 will be in class on Wednesday, March 11th
- The registrar has announced the schedule for the COMP 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

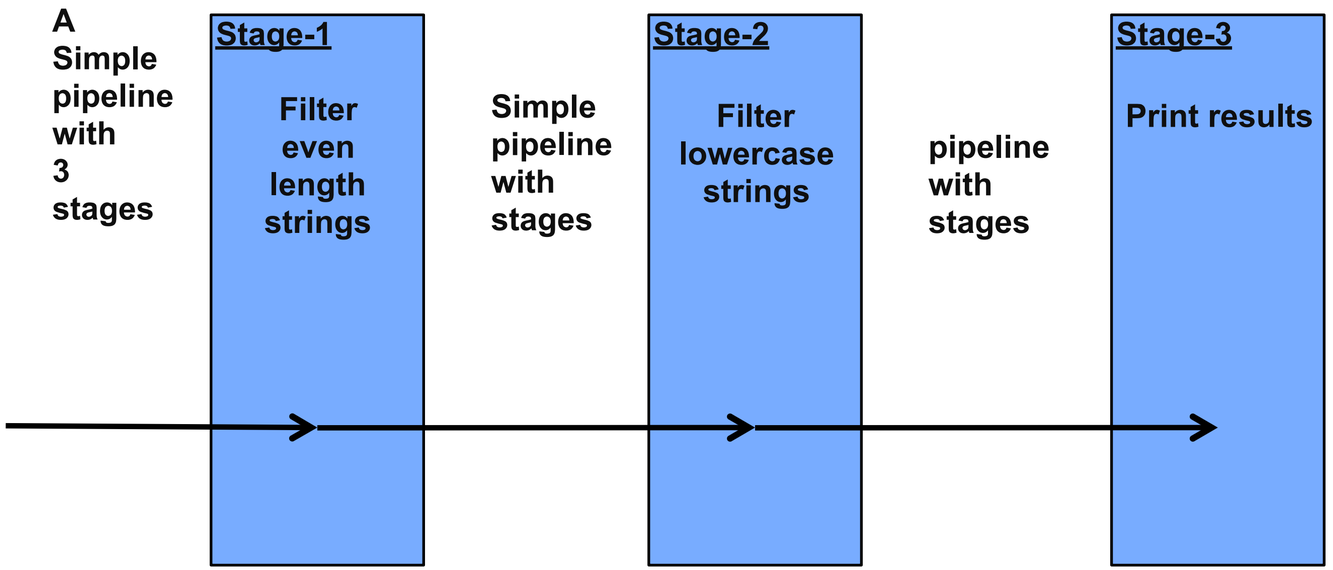
- Rely on asynchronous messaging
- Message are sent to an actor using its `send()` method
- Messages queue up in the mailbox
- Messages are processed by an actor after it is started
- Messages are processed asynchronously

  —one at a time

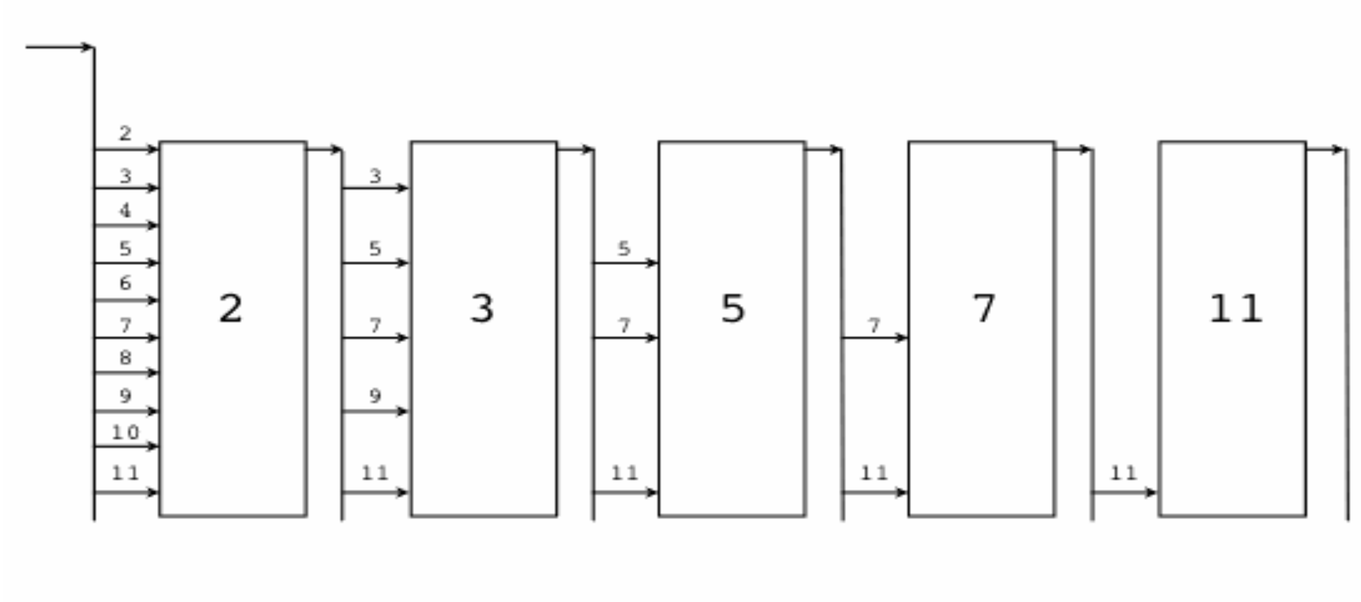
  —using the body of `process()`



Simple Pipeline using Actors



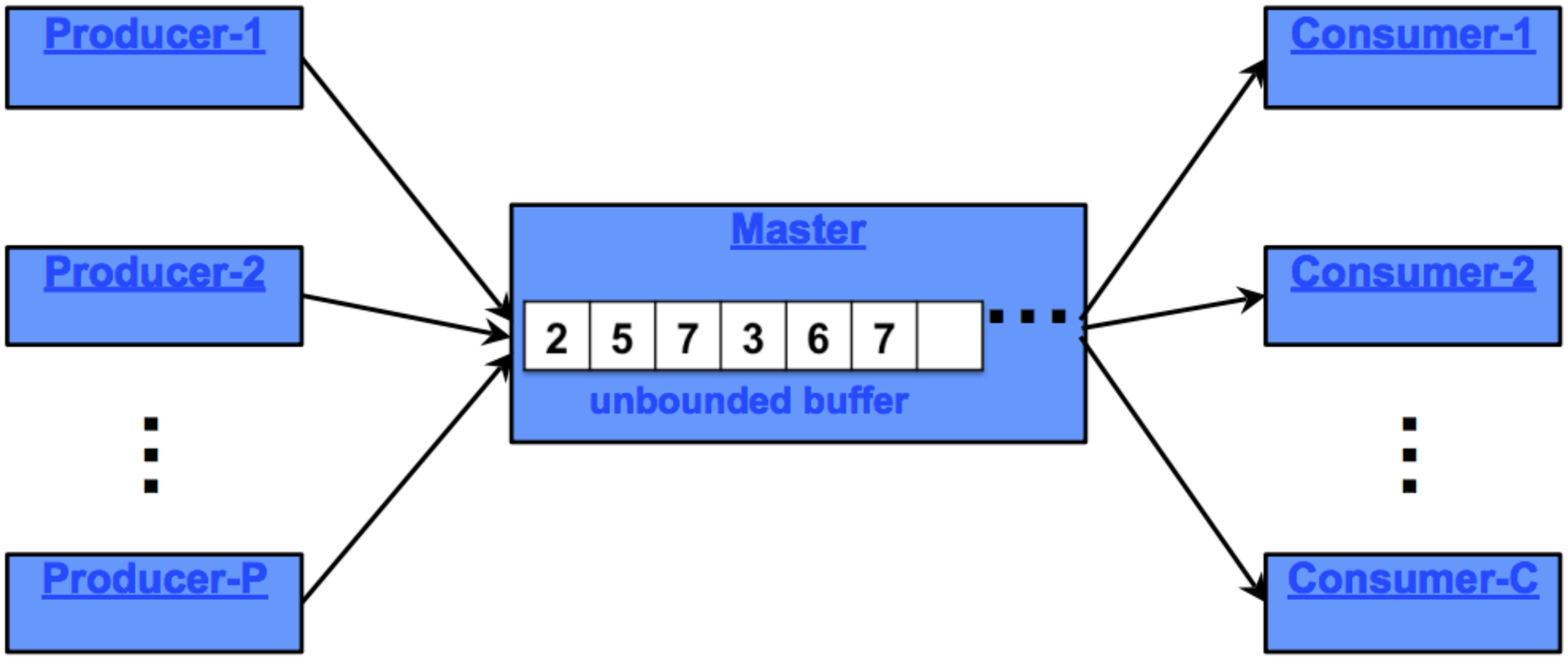
Sieve of Eratosthenes using Actors



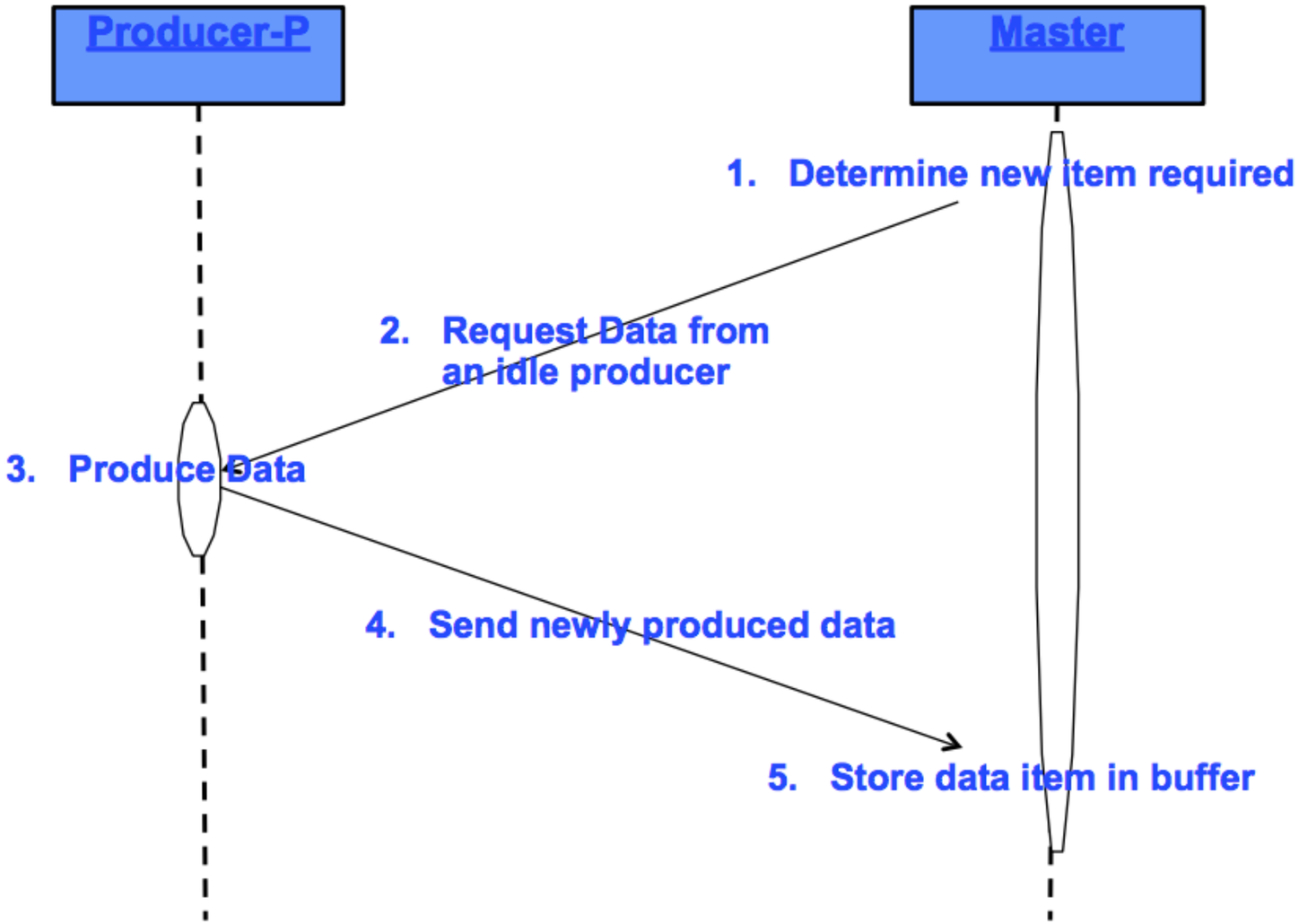
Limitations of Actor Model

- 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

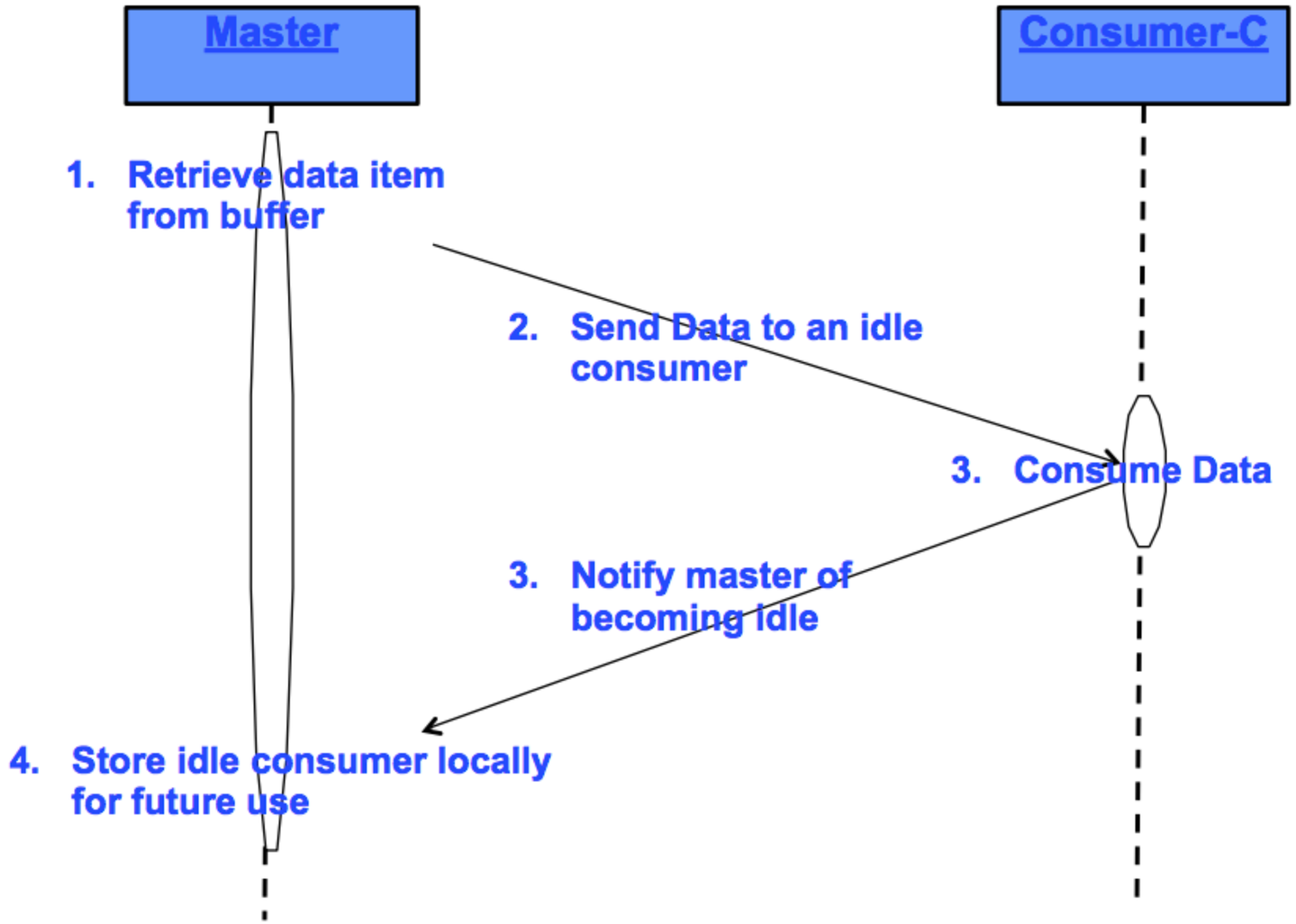
Implementing an Unbounded Buffer using Actors



Unbounded Buffer Actor Interaction Diagram



Unbounded Buffer Actor Interaction Diagram (cont.)



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.

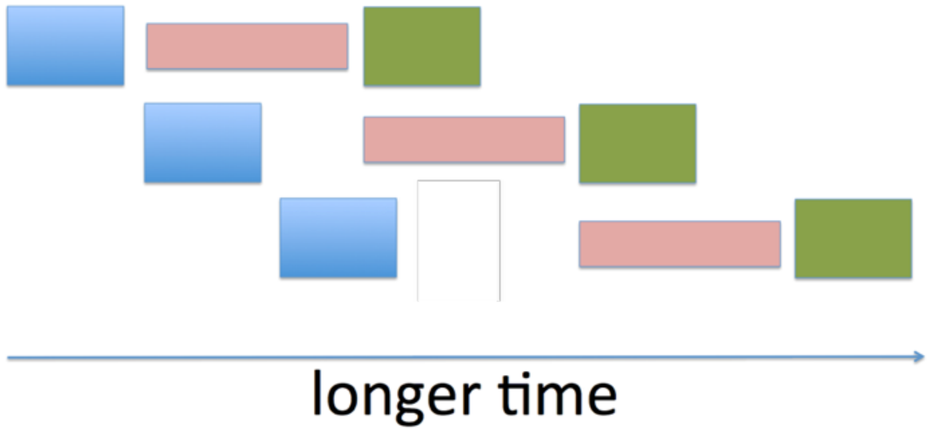
- 1 producer, 1 consumer
- 1 producer, many consumers
- Many producers, 1 consumer
- Many producers, many consumers

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.