Review of topics in concurrency

What is the smallest value of `counter`, among those listed, after the threads terminate?

```
int counter = 0;
```

thread `t`

```
int cnt;
for (int i = 0; i < 5; i++) {
  cnt = counter;
  counter = cnt + 1;
}
```

thread `u`

```
int cnt;
for (int i = 0; i < 5; i++) {
  cnt = counter;
  counter = cnt + 1;
}
```

1. 1
2. 5
3. 6
4. 10

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2. 5
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The final value of `counter` is `5` when both threads read `counter == 0`, one thread proceeds and increments it to `5`, and the other thread overwrites the same values up to `5`.

But there are schedules where there is an even more destructive interference between the two threads, so that the final value of `counter` can be as low as 2!

#	t'S LOCAL	u'S LOCAL	SHARED
1	$pc_t: 2$ $cnt_t: \bot$	$pc_u: 6$ $cnt_u: \bot$	counter: 0
2	$pc_t: 2$ $cnt_t: \bot$	$pc_u: 7$ $cnt_u: 0$	counter: 0
3	$pc_t: 3$ $cnt_t: 0$	$pc_u: 7$ $cnt_u: 0$	counter: 0
4	$pc_t: 3$ $cnt_t: 0$	$pc_u: 6$ $cnt_u: 0$	counter: 1
5	$pc_t: 3$ $cnt_t: 0$	$pc_u: 7$ $cnt_u: 1$	counter: 1
6	$pc_t: 3$ $cnt_t: 0$	$pc_u: 6$ $cnt_u: 1$	counter: 2
7	$pc_t: 3$ $cnt_t: 0$	$pc_u: 7$ $cnt_u: 2$	counter: 2
8	$pc_t: 3$ $cnt_t: 0$	$pc_u: 6$ $cnt_u: 2$	counter: 3
9	$pc_t: 3$ $cnt_t: 0$	$pc_u: 7$ $cnt_u: 3$	counter: 3
10	$pc_t: 3$ $cnt_t: 0$	$pc_u: 6$ $cnt_u: 3$	counter: 4
11	$pc_t: 2$ $cnt_t: 0$	$pc_u: 6$ $cnt_u: 3$	counter: 1
12	$pc_t: 2$ $cnt_t: 0$	$pc_u: 7$ $cnt_u: 1$	counter: 1
13	$pc_t: 3$ $cnt_t: 1$	$pc_u: 7$ $cnt_u: 1$	counter: 1
14	$pc_t: 2$ $cnt_t: 1$	$pc_u: 7$ $cnt_u: 1$	counter: 2
15	$pc_t: 3$ $cnt_t: 2$	$pc_u: 7$ $cnt_u: 1$	counter: 2
16	$pc_t: 2$ $cnt_t: 2$	$pc_u: 7$ $cnt_u: 1$	counter: 3
17	$pc_t: 3$ $cnt_t: 3$	$pc_u: 7$ $cnt_u: 1$	counter: 3
18	$pc_t: 2$ $cnt_t: 3$	$pc_u: 7$ $cnt_u: 1$	counter: 4
19	$pc_t: 3$ $cnt_t: 4$	$pc_u: 7$ $cnt_u: 1$	counter: 4
20	done	$pc_u: 7$ $cnt_u: 1$	counter: 5
21	done	done	counter: 2

What is the value of `n` after 8 concurrent threads terminate?

```
int n = 0; Semaphore s = new Semaphore(1); // capacity 1
```

thread t_k

```
int x;
1  s.down();
2  x = n;
3  n = x + 1;
4  s.up();
```

1. Between 1 and 8
2. Between 4 and 8
3. Always 4
4. Always 8

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What is the value of `n` after 8 concurrent threads terminate?

```
int n = 0; Semaphore s = new Semaphore(2); // capacity 2
```

thread t_k

```
int x;
1  s.down();
2  x = n;
3  n = x + 1;
4  s.up();
```

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2. Between 4 and 8
3. Always 4
4. Always 8

What is the value of `n` after 8 concurrent threads terminate?

```
int n = 0; Semaphore s = new Semaphore(2); // capacity 2
```

thread t_k

```
int x;
1 s.down();
2 x = n;
3 n = x + 1;
4 s.up();
```

1. Between 1 and 8
2. Between 4 and 8
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The value 1 occurs if one thread *t* reads 0 initially, and then waits inside its critical section, while the other threads go through their critical section in mutual exclusion. Then, *t* finishes by writing 1, thus overwriting the increments of all other threads.

What do threads continuously calling `x()` and `y()` print?

```
monitor class CountPrint {
  private Condition isX = new Condition();
  private Condition isY = new Condition();
  public void x()
  { isX.wait(); System.out.print("X"); isY.signal(); }
  public void y()
  { isY.wait(); System.out.print("Y"); isX.signal(); }
}
```

1. A sequence of alternating `X` and `Y`.
2. The first answer, if the monitor uses “signal and wait”.
3. The first answer, if the monitor uses “signal and continue”.
4. The program deadlocks.

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```

1. A sequence with at least one `X` between every pair of `Y`.
2. The first answer, if the monitor uses “signal and wait”.
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1. A sequence with at least one `X` between every pair of `Y`.
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3. The first answer, if the monitor uses “signal and continue”.
4. The program deadlocks.

Under “signal and continue”, it is possible that two unblocked calls to `y()` get in the entry queue and then execute one after another.