Deadlock

Daniel Zappala

CS 360 Internet Programming
Brigham Young University

Deadlock Definition and Conditions

- *permanent blocking of a set of processes or threads that either compete for system resources or communicate with each other*
- conditions
  1. mutual exclusion: only one thread may use a resource at a time
  2. hold-and-wait: a thread keeps one resource while waiting for another
  3. no preemption: a thread can't be forced to release a resource
  4. circular wait: a cycle of threads waiting for each other
- if first three conditions hold, then deadlock is possible if circular wait occurs
- depends on execution order!

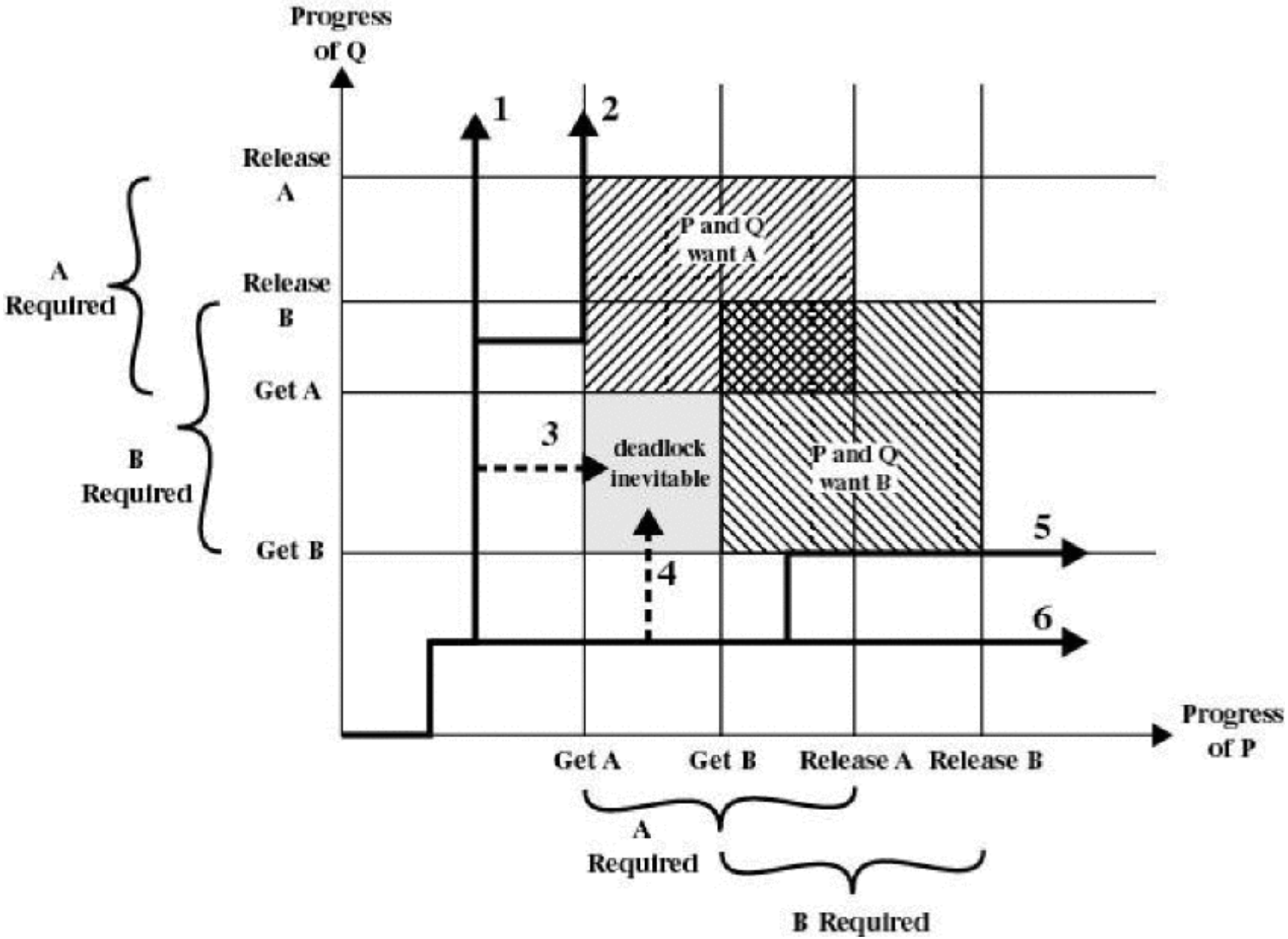
Example

```
1  Thread P
2  ...
3  Get A
4  ...
5  Get B
6  ...
7  Release A
8  ...
9  Release B
```

```
1  Thread Q
2  ...
3  Get B
4  ...
5  Get A
6  ...
7  Release B
8  ...
9  Release A
```

- *is deadlock possible?*

Deadlock Possibilities



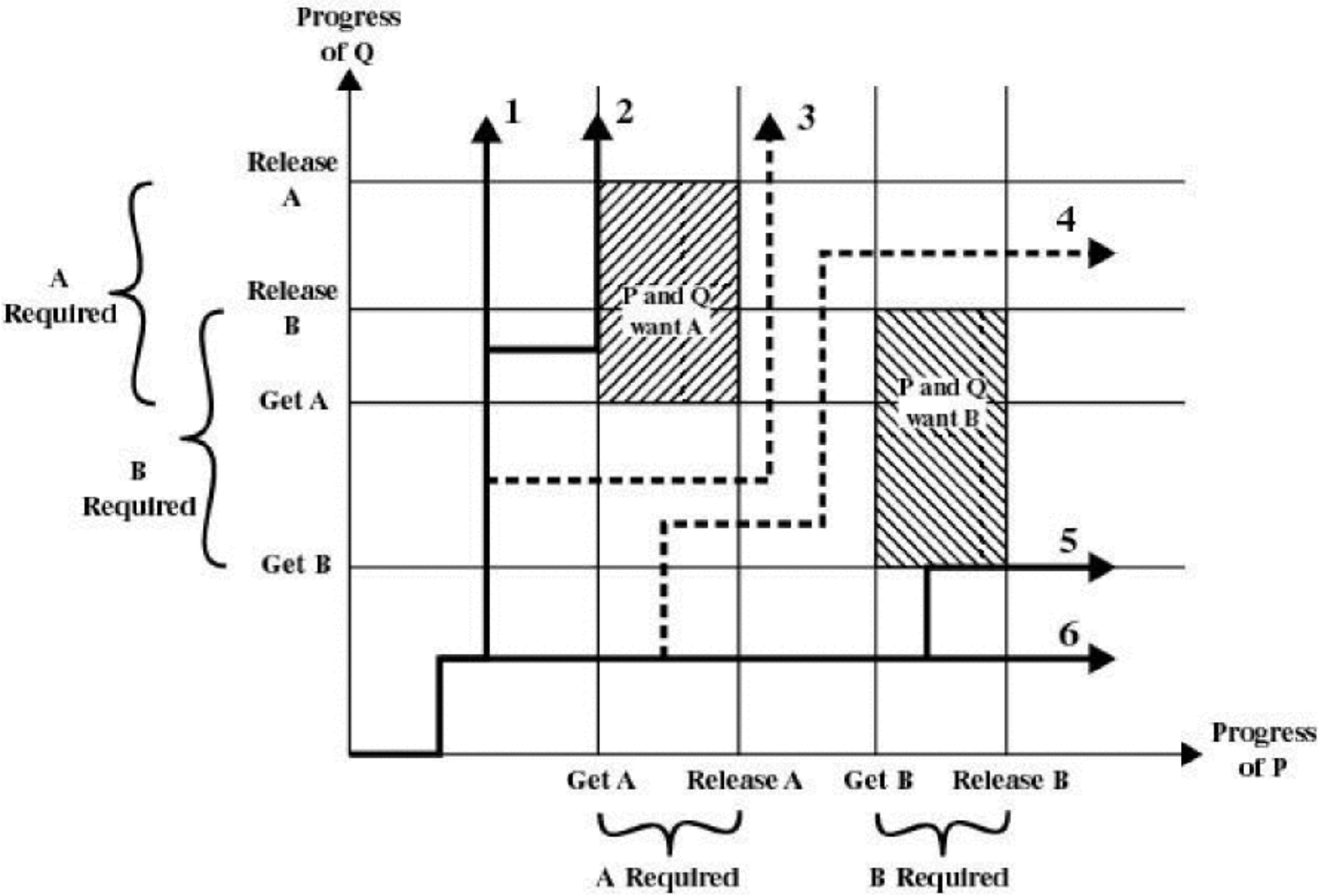
Revised Sample Code

```
1  Thread P
2  ...
3  Get A
4  ...
5  Release A
6  ...
7  Get B
8  ...
9  Release B
```

```
1  Thread Q
2  ...
3  Get B
4  ...
5  Get A
6  ...
7  Release B
8  ...
9  Release A
```

- *is deadlock possible?*

Deadlock Avoided



Deadlock Avoidance and Detection

- avoidance
  - monitor system and avoid granting a request to a lock (even if no other thread has the lock) if it might lead to deadlock
  - requires tracking allocation of all locks and determining safe vs unsafe states
- detection
  - allow deadlock to occur, but detect and resolve
  - requires tracking allocation of all locks and determining when deadlock has occurred
  - requires pre-empting a thread that owns a lock

Simple Deadlock Prevention

- prevent one of the conditions from happening
- simplest to prevent is hold-and-wait: hold only one resource at a time
- can also prevent circular wait: impose ordering on resources