SER 334 A Session

SI Session

Sunday, February 4th 2024

7:00 pm - 8:00 pm MST

Agenda

- Critical Section & Solutions
  - Hardware Solutions
  - Peterson’s Solution
  - Mutexes
  - Semaphores
  - Monitors

SI Session Expectations

Thanks for coming to the **SER 334** SI session. We have a packed agenda and we are going to try to get through as many of our planned example problems as possible. This session will be recorded and shared with others.

- If after this you want to see additional examples, please visit the drop-in tutoring center.
- We will post the link in the chat now and at the end of the session.
  - tutoring.asu.edu
- Please keep in mind we are recording this session and it will be made available for you to review 24-48 hours after this session concludes.
- Finally, please be respectful to each other during the session.

Interact with us:

Zoom Features

Zoom Chat

- Use the chat feature to interact with the presenter and respond to presenter's questions.
- Annotations are encouraged

SER 334
Critical Section

Stepping on each other's toes

What is the Critical Section?

Area of code where thread execution can impact other threads

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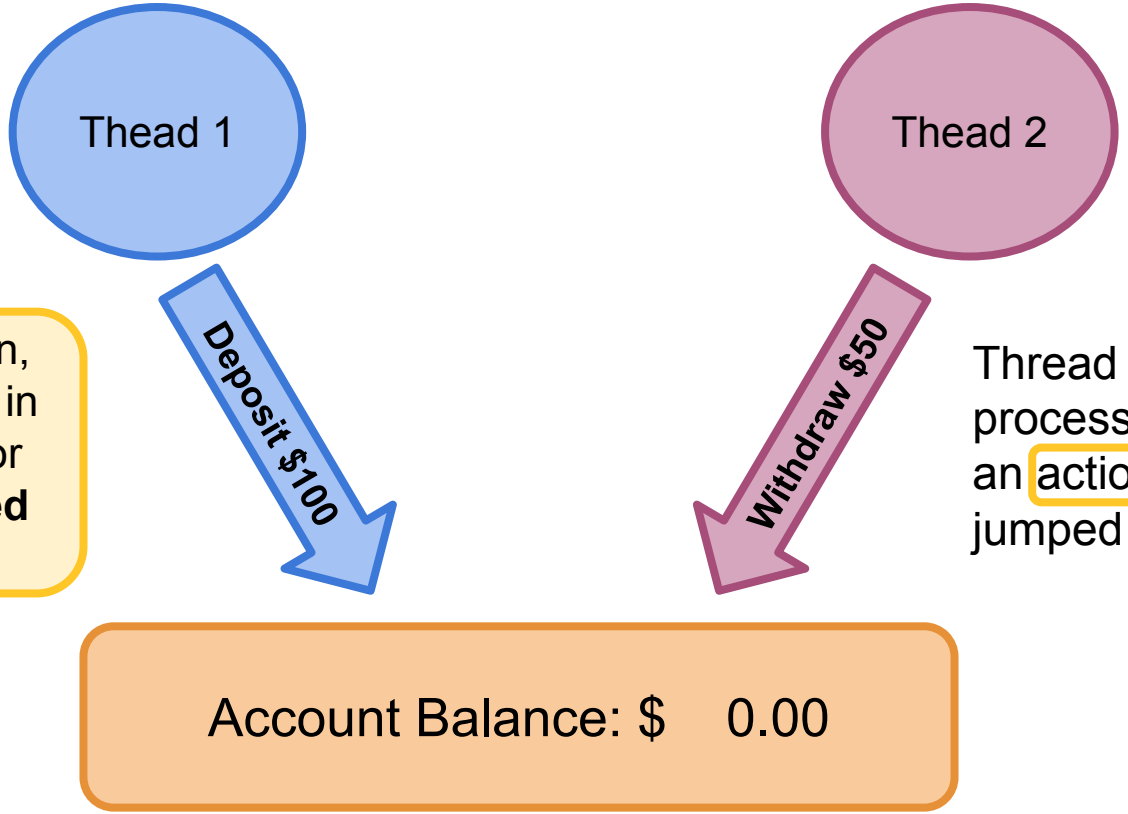
Critical Section



Not just any action, actions that result in a **state change** or manipulate **shared resources**.

Thread 1 was in the process of performing an action, and Thread 2 jumped in the middle!

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Critical Section

Race Condition

Starvation

Deadlock

The solution needs to ensure…

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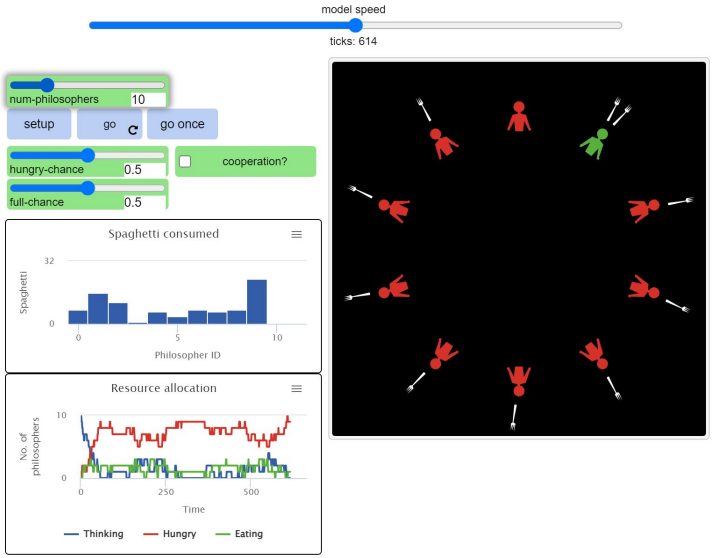
SER 334
Critical Section

Dining Philosophers

Race Condition

Deadlock

Starvation



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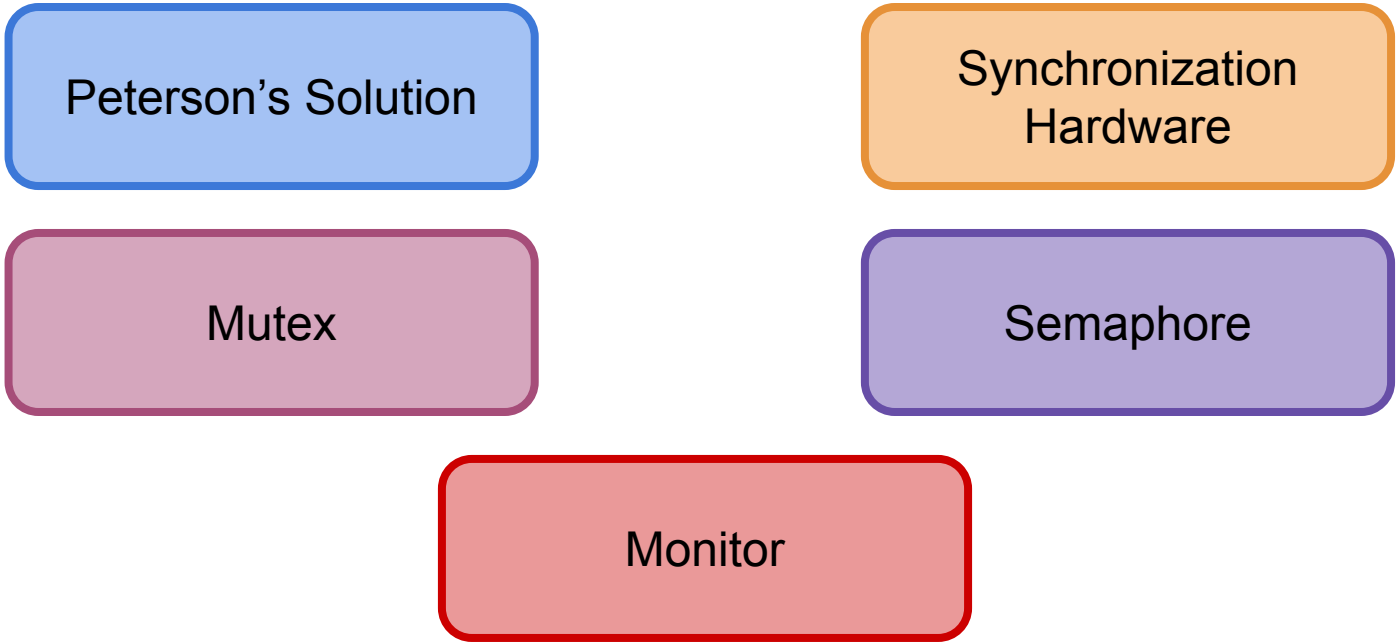
Critical Section Solutions



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Peterson's Solution

Peterson's Solution

```
//shared memory
int turn = 0;
bool flag[2] = { false, false };


//for some process i
do {
    flag[i] = true;
    turn = j;
    while (flag[j] && turn == j);
    //critical section
    flag[i] = false;
    //remainder section
} while (true);
```

I *want* to go

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Peterson's Solution

```
//shared memory
int turn = 0;
bool flag[2] = { false, false };
```

```
//for some process i
do {
    flag[i] = true;
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```

I *want* to go

But you can go first…

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Peterson's Solution

```
//shared memory
int turn = 0;
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//for some process i
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```

I *want* to go

But you can go first…

Wait for my turn

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Peterson's Solution

```
//shared memory
int turn = 0;
bool flag[2] = { false, false };


//for some process i
do {
    flag[i] = true;
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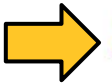

I *want* to go

But you can go first…

Wait for my turn

Danger Zone

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Peterson's Solution

```
//shared memory
int turn = 0;
bool flag[2] = { false, false };


//for some process i
do {
    flag[i] = true;
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    while (flag[j] && turn == j);
    //critical section
    flag[i] = false;
    //remainder section
} while (true);
```

I *want* to go

But you can go first…

Wait for my turn

Danger Zone

You can go now

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Synchronization Hardware

Synchronization Hardware

Hardware that has special ***atomic*** actions

```
//shared data
boolean lock = false;

do {
    while (test_and_set(&lock));
    // critical section
    lock = false;
    // remainder section
} while (true);
```

T → T : ⟳

F → T : ⤸

```
//shared data
int lock = 0;

do {
    while (compare_and_swap(&lock, 0, 1)
           != 0);
    // critical section
    lock = 0;
    // remainder section
} while (true);
```

Expected

New Value

If lock is currently zero, set lock to 1

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Mutex

A Mutex is sort of like a lock on a door

Lock the door behind you

```
//thread safe!
void add_front(int data) {
    struct data_node* node = (struct data_node*)malloc(sizeof(struct data_node));

    node->data = data;

    pthread_mutex_lock(&list_lock);
        node->next = list_head;
        list_head = node;
    pthread_mutex_unlock(&list_lock);
}
```

Already Locked? → In use!

Unlock door as you leave

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Semaphores

What is the difference between a mutex and a *semaphore*?

Many stalls…

```
//shared data
semaphore lock = 1;

do {
    wait(&lock);
    // critical section
    sign(&lock);
    // remainder section
} while (true);
```

Wait in line for open stall

Unlock when leaving

Semaphores support ***more than one*** resource

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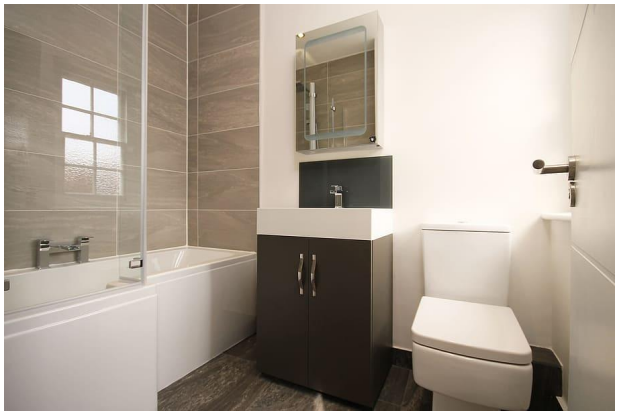
Monitors

Monitor expands the concept to cover a ***class as a whole***.

Only one process can execute within the class at one time



```
monitor class Account {
    int balance;

    Account(int opening) {
        balance = opening;
    }

    void deposit(int amount) {
        balance = balance + amount;
    }

    void withdraw(int amount) {
        balance = balance - amount;
    }
};
```

Deposit $100

Withdraw $50

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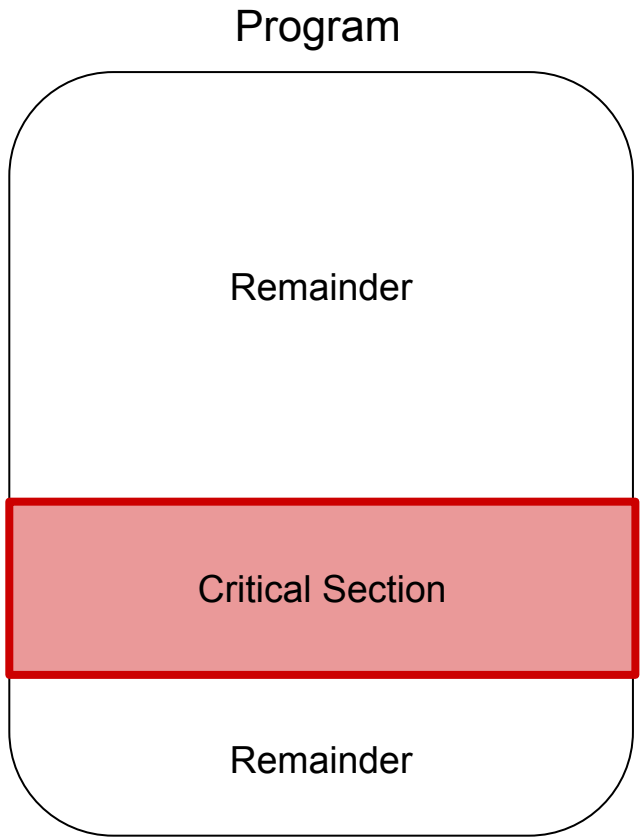
Samples

4. [Acuña] Explain how it would be possible to have a situation where programs are making progress but do not have bounded waiting time.



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Scratch Space

Upcoming Events

SI Sessions:

- Monday, February 5th at 7:00 pm MST

- ~~Sunday, February 11th at 7:00 pm MST~~ **Cancelled - Good luck on Exam 2!**
- Monday, February 12th at 7:00 pm MST

Review Sessions:

- Exam 2 Review: Thursday, February 8th 7:00 pm - 9:00 pm MST
- Exam 3 Review: TBD

Questions?

Survey:

http://bit.ly/ASN2324

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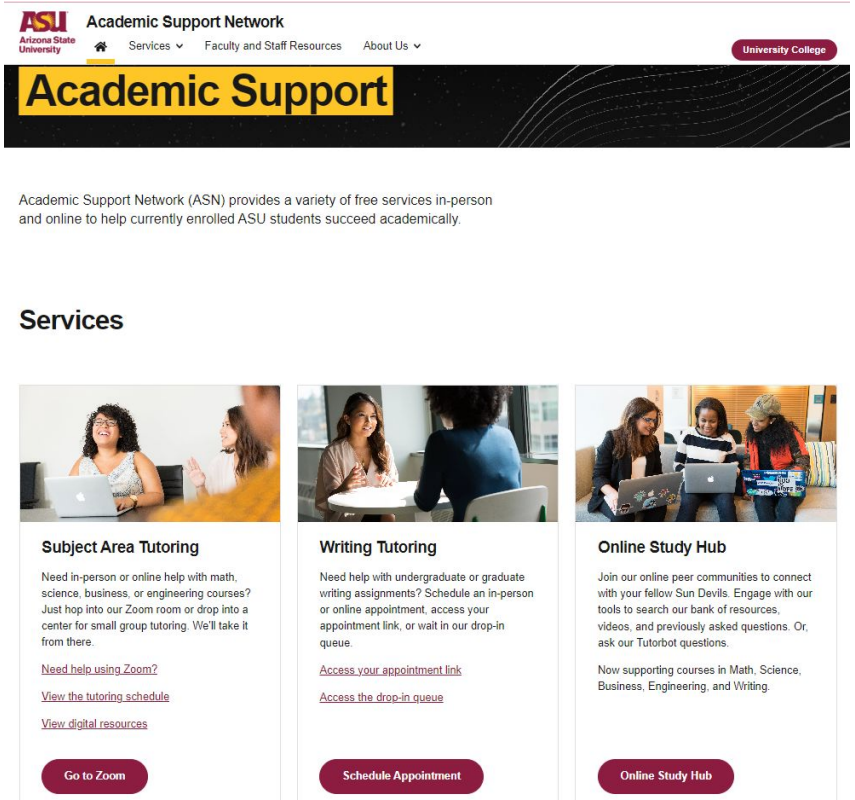
More Questions?

Check out our other resources!

tutoring.asu.edu

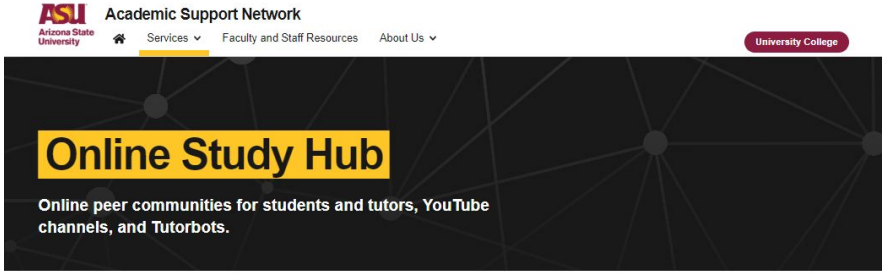


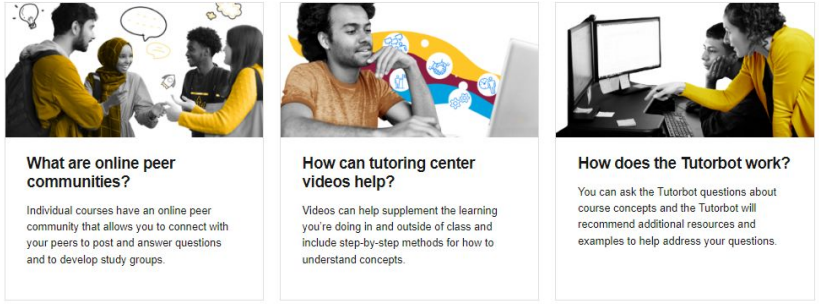
1. **Click on ‘Go to Zoom’ to log onto our Online Tutoring Center.**
2. **Click on ‘View the tutoring schedule’ to see when tutors are available for specific courses.**

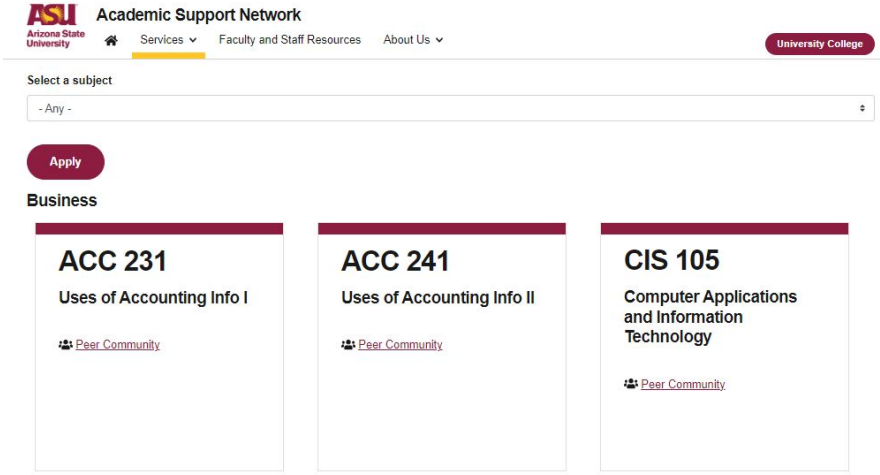
More Questions?

Check out our other resources!

tutoring.asu.edu/online-study-hub







Don't forget to check out the Online Study Hub for additional resources!

Additional Resources

- Course Repo
- Course Discord
- BMP File Format (Wiki)
- Linux Kernel API
- Bootlin - Linux Cross Referencer
- Dining Philosophers Interactive
- Producer/Consumer Visual