SER 321 B Session

SI Session

Thursday, April 11th 2024

7:00 pm - 8:00 pm MST

Agenda

- Concurrency Constructs
- Deadlock Examples and Solutions
- Distributed Structures

SI Session Expectations

Thanks for coming to the **SER 321** 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 321

Concurrency Structures

Can we name some concurrency structures?

Atomic Operations & Variables

Locks

Semaphores

Monitors

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Concurrency Structures

Atomic Operations & Variables

Recall *registers*…

Ensures updates are immediately visible for the local copy in *each thread*

```c
int main() {

    int w = 5;

    int x = 3 + 9;

    int y = w + 7;

    int z = x + y;

    printf("Calculated: %d\n", z);

    return 0;
}
```

```
main:
    pushq   %rbp
    movq    %rsp, %rbp
    subq    $48, %rsp
    call    __main
    movl    $5, -4(%rbp)
    movl    $12, -8(%rbp)
    movl    -4(%rbp), %eax
    addl    $7, %eax
    movl    %eax, -12(%rbp)
    movl    -8(%rbp), %edx
    movl    -12(%rbp), %eax
    addl    %edx, %eax
    movl    %eax, -16(%rbp)
    movl    -16(%rbp), %eax
    movl    %eax, %edx
    leaq    .LC0(%rip), %rax
    movq    %rax, %rcx
    call    printf
    movl    $0, %eax
    addq    $48, %rsp
    popq    %rbp
    ret
```

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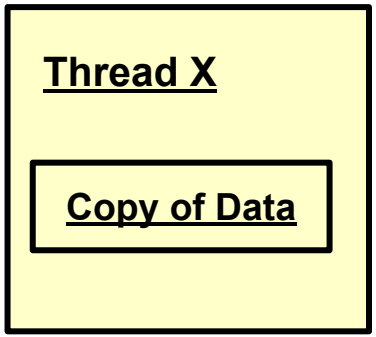
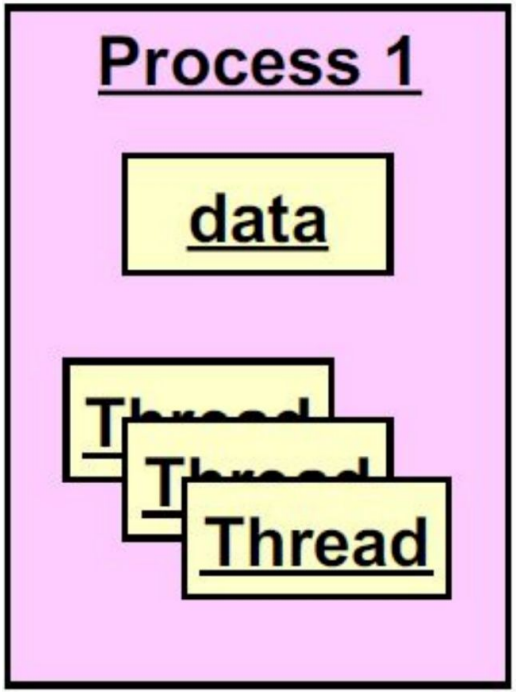
Concurrency Structures

Atomic Operations & Variables

Recall *registers*…

Ensures updates are immediately visible for the local copy in *each thread*





The *shared* data variable is only updated if needed

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Concurrency Structures

Pros and Cons?

Locks

Acquire the Lock → Open & Enter

Close & Lock

Release the Lock → Unlock & Exit

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Concurrency Structures

How am I different from a lock?

Semaphores

More than one stall!

Acquire Lock ⇨ Open & Enter, Close & Lock

Release Lock ⇨ Unlock & Exit

Semaphores support ***more than one*** acquirer

When would that be beneficial?

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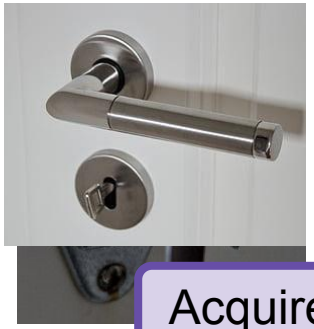
Concurrency Structures

Pros and Cons?

Monitors

You lock the main door instead!



Acquire Lock → Open & Enter
Acquire Lock → Close & Lock

Release Lock → Unlock & Exit

Covers the ***entire object***

NetworkDeadlock

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Threading Pitfalls

As the project name implies, we encounter a ***deadlock***.

But what happened?

Client

```
class SockClient {
    public static void main (String args[]) throws Exception {
        Socket      sock = new Socket( host: "localhost", port: 8888);    //Any IP name

        ObjectInputStream in = new ObjectInputStream(sock.getInputStream());
        ObjectOutputStream out = new ObjectOutputStream(sock.getOutputStream());

        String s = (String) in.readObject();
        out.writeObject("Back at you");

        in.close();
        out.close();
        sock.close();
    }
}
```

Server

```
class SockServer {
    public static void main (String args[]) throws Exception {

        int count = 0;
        ServerSocket    serv = new ServerSocket( port: 8888);

        Socket sock = serv.accept();

        ObjectInputStream in = new ObjectInputStream(sock.getInputStream());
        ObjectOutputStream out = new ObjectOutputStream(sock.getOutputStream());

        String s = (String) in.readObject();
        System.out.println("Received " + s);
        out.writeObject("Back at you");
        System.out.println("Received " + s);

        in.close();
        out.close();
        sock.close();
    }
}
```

```
PS C:\ASU\SER321\examples_repo\ser321examples\Threads\NetworkDeadlock> gradle
server
<=========----> 75% EXECUTING [1m 33s]
> :server
```

```
PS C:\ASU\SER321\examples_repo\ser321examples\Threads\NetworkDeadlock> gradle
client
Starting a Gradle Daemon, 1 busy and 1 stopped Daemons could not be reused, us
e --status for details
<=========----> 75% EXECUTING [53s]
> :client
```

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Concurrency Structures

How can we fix this?

What happened??

```
PS C:\ASU\SER321\examples_repo\ser321examples\Threads\Deadlock> gradle run
Starting a Gradle Daemon (subsequent builds will be faster)

> Task :run
Alphonse: Gaston  has bowed to me!
Gaston: waiting to bow back
Gaston: Alphonse  has bowed to me!
Alphonse: waiting to bow back
<==========----> 75% EXECUTING [18s]
> :run
```

```
public class Deadlock {
    6 usages
    static class Friend {
        5 usages
        private final String name;
        2 usages
        public Friend(String name) { this.name = name; }
        public String getName() { return this.name; }
        /* See the README.md for a reference on 'synchronized' methods */
        2 usages
        public synchronized void bow(Friend bower) {
            System.out.format("%s: %s"
                    + "  has bowed to me!%n",
                    this.name, bower.getName());
            System.out.format("%s: waiting to bow back%n", bower.getName());
            bower.bowBack( bower: this);
        }
        1 usage
        public synchronized void bowBack(Friend bower) {
            System.out.format("%s: waiting", this.name);
            System.out.format("%s: %s"
                    + " has bowed back to me!%n",
                    this.name, bower.getName());
        }
    }

    public static void main(String[] args) {
        final Friend alphonse =
                new Friend( name: "Alphonse");
        final Friend gaston =
                new Friend( name: "Gaston");
        /* start two threads - both operating on the same objects */
        new Thread(new Runnable() {
            public void run() { alphonse.bow(gaston); }
        }).start();
        new Thread(new Runnable() {
            public void run() { gaston.bow(alphonse); }
        }).start();
    }
}
```

How can we fix this?

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Concurrency Structures

Remove the synchronized methods

```
public void bow
```

```
public void bowBack
```

Synchronize the bowBack call

```
synchronized(bower.bowBack(this));
```

Synchronize the bowBack call with a synchronized statement

```
synchronized (this) { bower.bowBack( bower: this); }
```

Synchronize the run method calls

```
public synchronized void run() { alphonse.bow(gaston); }
```

```
public synchronized void run() { gaston.bow(alphonse); }
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SER 321

Concurrency Structures

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Synchronize the bowBack call

RACE

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Synchronize the bowBack call with a synchronized statement

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Synchronize the run method calls

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```

```
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```

```
> Task :run
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Alphonse: waiting to bow back
Alphonse: waiting
Alphonse: Gaston has bowed back to me!
Gaston: waiting
Gaston: Alphonse has bowed back to me!
```

```
                + " has bowed back to me!%n",
```

```
> Task :run
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Gaston: waiting
Gaston: Alphonse has bowed back to me!
Gaston: Alphonse  has bowed to me!
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Alphonse: waiting
Alphonse: Gaston has bowed back to me!
```

```
}
```

How can we fix this?

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Concurrency Structures

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Synchronize the bowBack call

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        1 usage
        public synchronized void bowBack(Friend bower) {
            System.out.format("%s: waiting", this.name);
            System.out.format("%s: %s"
                    + " has bowed back to me!%n",
```

```
Required type:    Object
Provided:         void

© Deadlock.Friend

public void bowBack(
    @NotNull ↗ Deadlock.Friend bower
)

Deadlock.main
```

```
e same objects */
); }
); }
}).start();
}
}
```

Deadlock

How can we fix this?

SER 321
Concurrency Structures

Remove the synchronized methods

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public void bow
public void bowBack
```

Synchronize the bowBack call

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synchronized(bower.bowBack(this));
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Synchronize the bowBack call with a synchronized statement

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        /* See the README.md for a reference on 'synchronized' methods */
        2 usages
        p
        }
        1
        p
        }
    }
    publi
        f
        f
        /
        n
        }
        n
        }
    }
}
```

```
> Task :run
Alphonse: Gaston  has bowed to me!
Gaston: waiting to bow back
Gaston: waiting
Gaston: Alphonse has bowed back to me!
Gaston: Alphonse  has bowed to me!
Alphonse: waiting to bow back
Alphonse: waiting
Alphonse: Gaston has bowed back to me!

Deprecated Gradle features were used in

You can use '--warning-mode all' to sho

See https://docs.gradle.org/7.4.2/userg

BUILD SUCCESSFUL in 1s
2 actionable tasks: 2 executed
```

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Concurrency Structures

RECAP

Atomic Operations & Variables

YOU control the locks directly

Locks

YOU control the locks directly

Semaphores

YOU control the locks directly

Monitors

Locks managed for you

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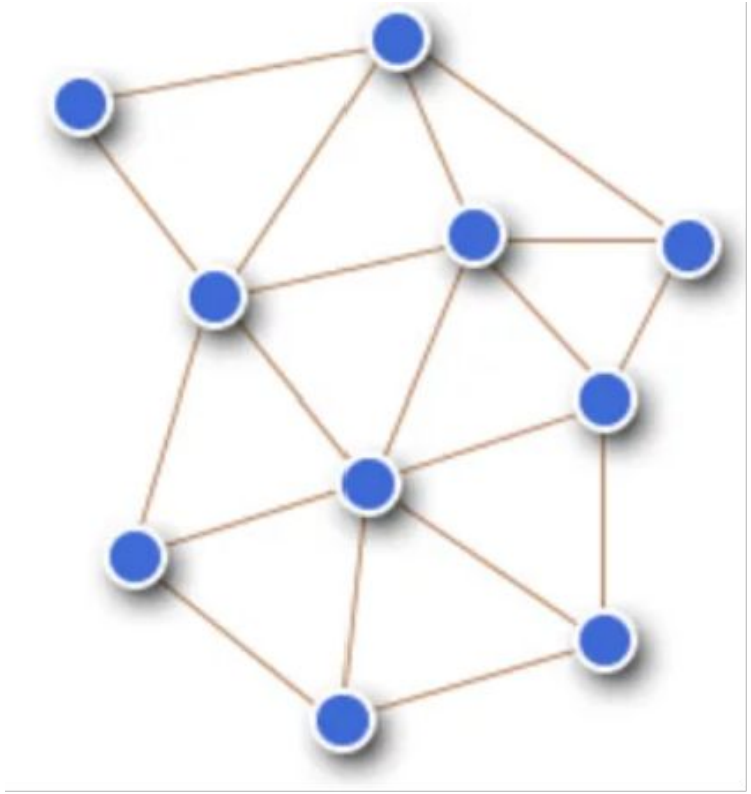
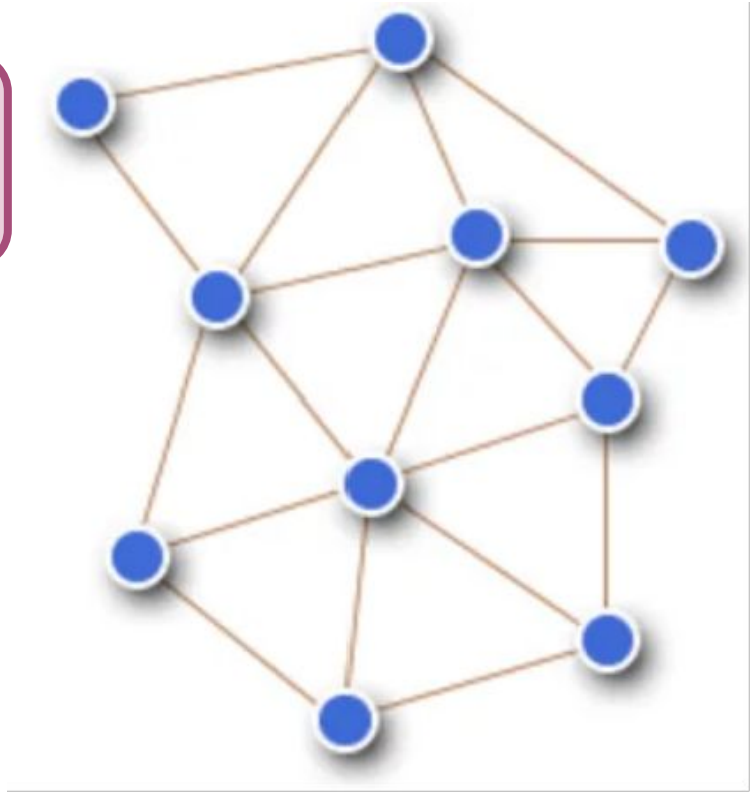
Distributed Systems

What do we mean by
"Distributed Systems"
or
"Distributed Algorithms"?



SER 321
Distributed Systems

Remember that we are operating in ***reality***



- Nodes *will* fail
- Web of nodes *will constantly* change
- Network is not *always* reliable
- Latency is *always present*
- The path traversed *changes*
- Some resources *must be shared*
- *You* need to prevent the pitfalls!
  - No deadlocks
  - No starvation
  - No error states

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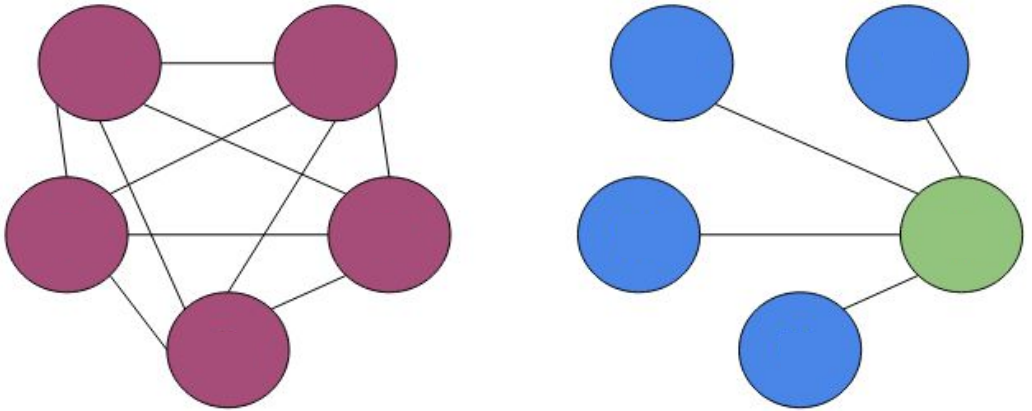
Distributed Systems

Main and Worker

Peer to Peer

Which is which?



SER 321
Distributed Systems

Main and Worker

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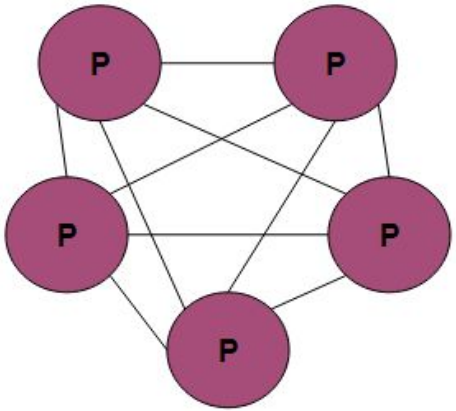
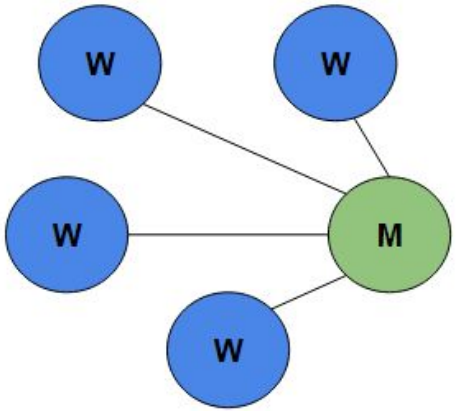
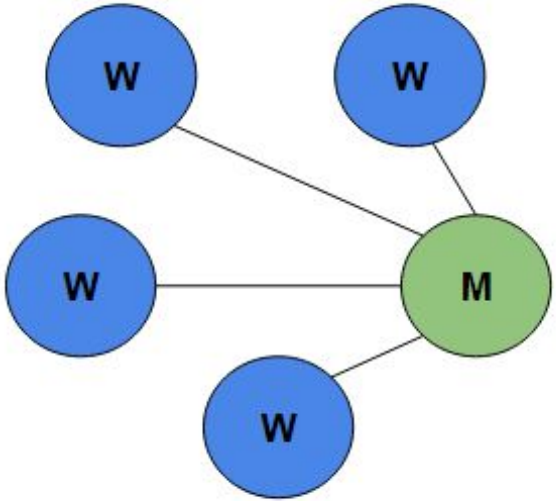
Peer to Peer





Main and Worker

Pros and Cons



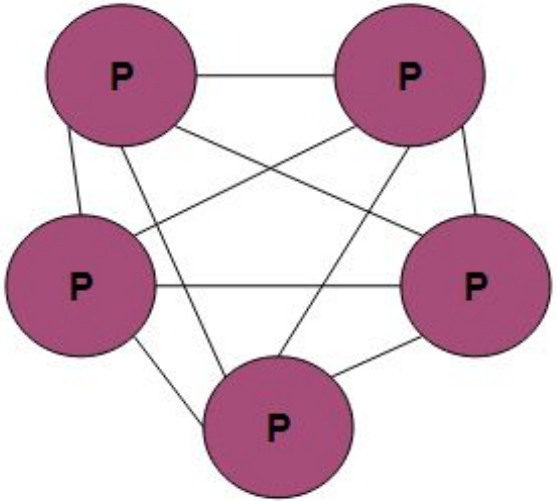
Pros:

- Straightforward setup
- Logic is centralized
- Communication is linear

Cons:

- Single point of failure

Pros and Cons



Pros:

- Peers can join or leave as needed
- Robust - no single point of failure

Cons:

- Communication is *complex*
- Setup is not as straightforward
- Client connections are handled *differently*

SER 321

Scratch Space

Questions?

Survey:

http://bit.ly/ASN2324

25

Upcoming Events

SI Sessions:

- Sunday, April 14th at 7:00 pm MST
- Monday, April 15th at 7:00 pm MST
- Thursday, April 18th at 7:00 pm MST

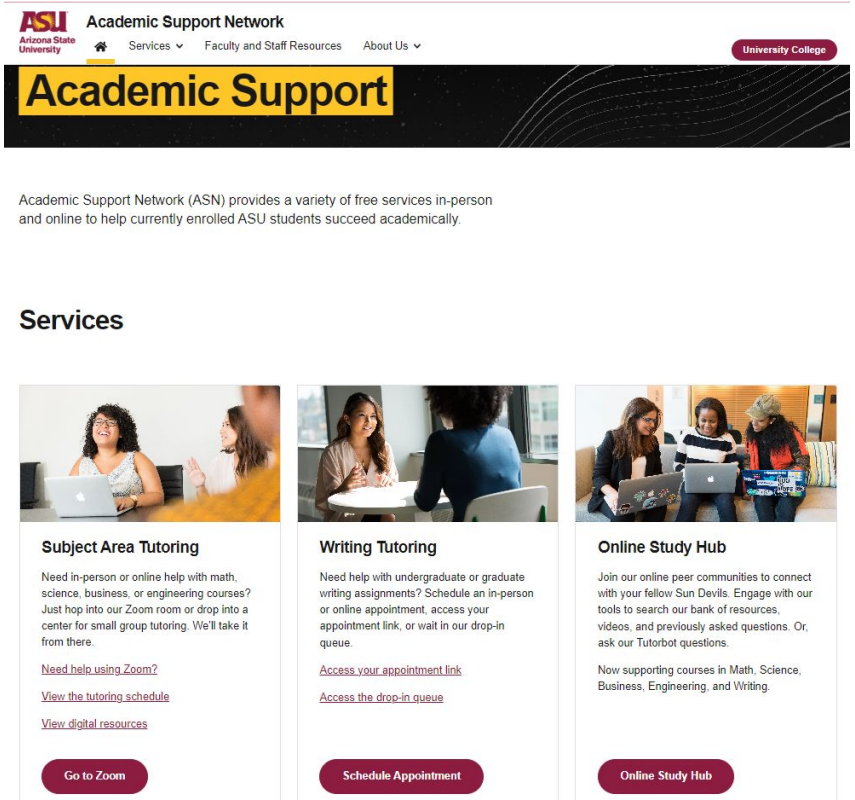
Review Sessions:

- Sunday, April 21st at 7:00 pm MST
- **Thursday, April 25th Session is *cancelled***

More Questions?

Check out our other resources!

tutoring.asu.edu

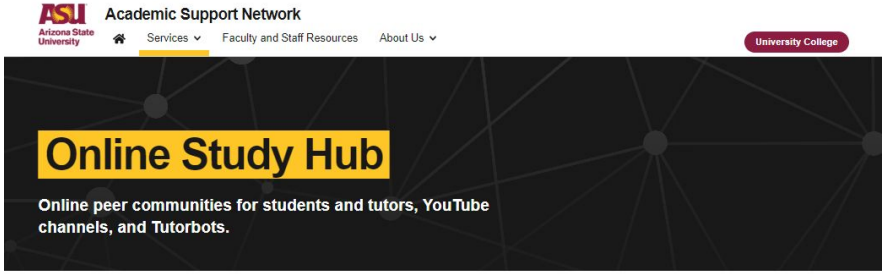


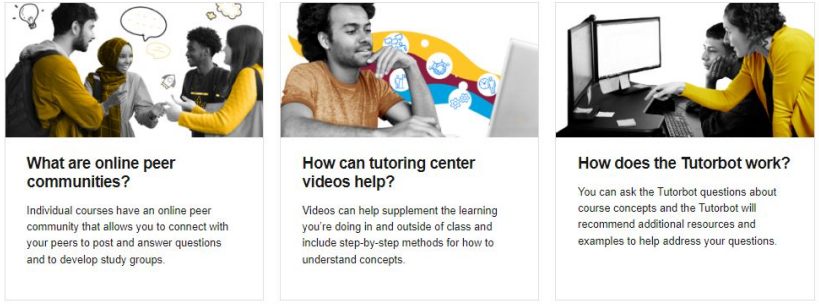
1. **Click on ‘Go to Zoom’ to log onto our Online Tutoring Center.**
2. **Click on ‘View the tutoring schedule’ to see when tutors are available for specific courses.**

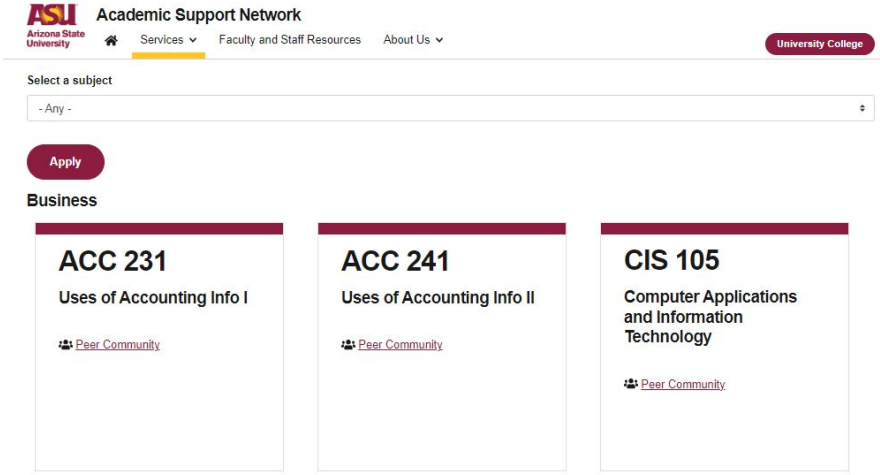
More Questions?

Check out our other resources!

tutoring.asu.edu/online-study-hub



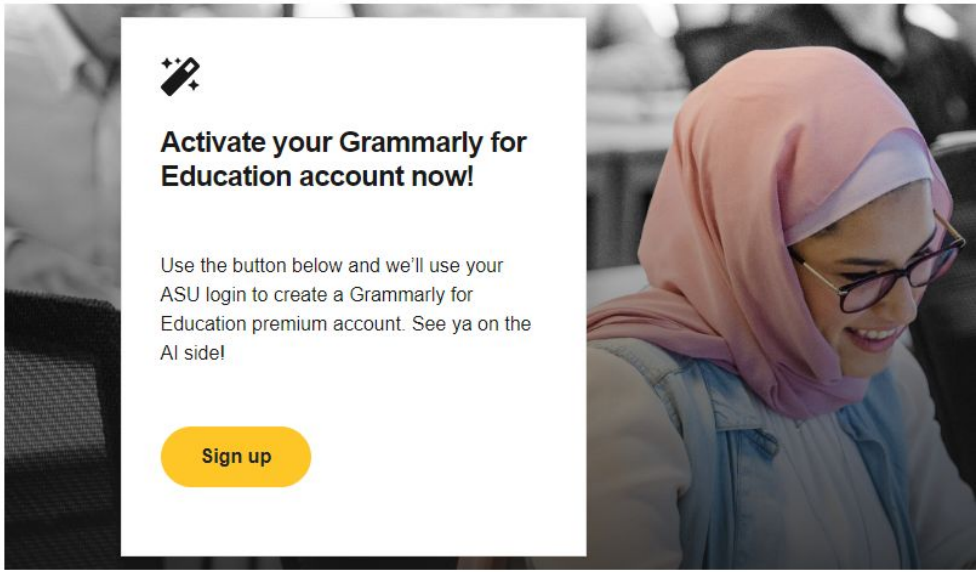




Don't forget to check out the Online Study Hub for additional resources!

Expanded Writing Support Available

Including Grammarly for Education, at no cost!



tutoring.asu.edu/expanded-writing-support

*Available slots for this pilot are limited

Additional Resources

- Course Repo
- Gradle Documentation
- GitHub SSH Help
- Linux Man Pages
- OSI Interactive
- MDN HTTP Docs
  - Requests
  - Responses
- JSON Guide
- org.json Docs
- javax.swing package API
- Swing Tutorials
- Dining Philosophers Interactive
- Austin G Walters Traffic Comparison