

# SER 321 B Session

**SI Session**

**Sunday, April 13th 2025**

*7:00 pm - 8:00 pm MST*

# Agenda



Connections

Gradle Task Structure Review

Handling Multiple Clients

*Why* we thread our Server

*How* to thread our Server

Concurrency 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](http://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



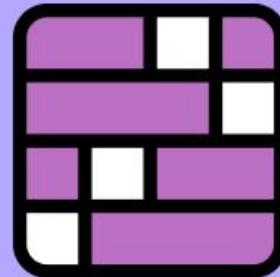
### **Zoom Chat**

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

**SER 321**  
**Connections**

Connections!

The New York Times **Games**



**Connections**

# SER 321

## Gradle Review

Which of the following will run the main method in `/java/taskone/Server.java` with `gradle runTask1` ?

```
▶ task runServer(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server.runTask1'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

A.

```
▶ task1 runServer(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

C.

```
▶ task runServer(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

B.

```
▶ task runTask1(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

D.

# SER 321

## Gradle Review

Which of the following will run the main method in `/java/taskone/Server.java` with `gradle runTask1` ?

```
▶ task runServer(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server.runTask1'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

A.

```
▶ task1 runServer(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

C.

```
▶ task runServer(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

B.

```
▶ task runTask1(type: JavaExec) {  
    group 'server'  
    description 'Creates Server socket waits for messages'  
  
    classpath = sourceSets.main.runtimeClasspath  
  
    main = 'taskone.Server'  
    standardInput = System.in  
  
    args 8000;  
    if (project.hasProperty('port')) {  
        | args(project.getProperty('port'));  
    }  
}
```

D.

# SER 321

## Gradle Review

Which of the following will run the main method in `/java/tasktwo/Server.java` with `gradle runTask2` ?

```
▶ task runTask2(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'taskone.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

A.

```
▶ task runTask2(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'tasktwo.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

B.

```
▶ task2 runServer(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'tasktwo.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

C.

```
▶ task runServer(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'tasktwo.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

D.

# SER 321

## Gradle Review

Which of the following will run the main method in `/java/tasktwo/Server.java` with `gradle runTask2` ?

```
▶ task runTask2(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'taskone.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

A.

```
▶ task runTask2(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'tasktwo.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

B.

```
▶ task2 runServer(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'tasktwo.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

C.

```
▶ task runServer(type: JavaExec) {
    group 'server'
    description 'Creates Server socket waits for messages'

    classpath = sourceSets.main.runtimeClasspath

    main = 'tasktwo.Server'
    standardInput = System.in

    args 8000;
    if (project.hasProperty('port')) {
        args(project.getProperty('port'));
    }
}
```

D.

# SER 321

## Gradle Review

Which of the following will run the main method in `/java/taskone/Client.java` with `gradle runClient` ?

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'))
    }
}
```

A.

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'))
    } else if (project.hasProperty("host")) {
        args(project.getProperty('host'), 8000)
    } else if (project.hasProperty("port")) {
        args("localhost", project.getProperty('port'))
    } else {
        args("localhost", 8000)
    }
}
```

C.

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    args("localhost", 8000)
    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'))
    }
}
```

B.

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'))
    } else if (project.hasProperty("host")) {
        args(project.getProperty('host'), 8000)
    } else if (project.hasProperty("port")) {
        args("localhost", project.getProperty('port'))
    }
}
```

D.

# SER 321

## Gradle Review

Which of the following will run the main method in `/java/taskone/Client.java` with `gradle runClient` ?

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'));
    }
}
```

A.

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'));
    } else if (project.hasProperty("host")) {
        args(project.getProperty('host'), 8000);
    } else if (project.hasProperty("port")) {
        args("localhost", project.getProperty('port'));
    } else {
        args("localhost", 8000);
    }
}
```

C.

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    args("localhost", 8000);
    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'));
    }
}
```

B.

```
▶ task runClient(type: JavaExec) {
    group 'client'
    description 'Creates client socket sends a message to the server'

    classpath = sourceSets.main.runtimeClasspath
    standardInput = System.in

    main = 'taskone.Client'
    standardInput = System.in

    if (project.hasProperty("host") & project.hasProperty('port')) {
        args(project.getProperty('host'), project.getProperty('port'));
    } else if (project.hasProperty("host")) {
        args(project.getProperty('host'), 8000);
    } else if (project.hasProperty("port")) {
        args("localhost", project.getProperty('port'));
    }
}
```

D.

# SER 321

## Single Threaded Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets
\JavaSimpleSock> gradle socketServer

> Task :SocketServer
Server ready for a connection
Server waiting for a connection
<=====--> 75% EXECUTING [20s]
> :SocketServer
```

Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets
\JavaSimpleSock> gradle socketServer

> Task :SocketServer
Server ready for a connection
Server waiting for a connection
<=====--> 75% EXECUTING [53s]
> :SocketServer
```

Server

## What will happen if there are two clients?

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets
\JavaSimpleSock> gradle socketClient

> Task :SocketClient
Please enter a String to send to the Server (enter
"exit" to quit):
<=====--> 75% EXECUTING [14s]
> :SocketClient
```

Client 1

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets
\JavaSimpleSock> gradle socketClient
```

Client 2

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets
\JavaSimpleSock> gradle socketClient

> Task :SocketClient
Please enter a String to send to the Server (enter
"exit" to quit):
<<<<=====--> 75% EXECUTING [47s]
> :SocketClient
Hello!
```

Client 1

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets
\JavaSimpleSock> gradle socketClient
Starting a Gradle Daemon, 2 busy and 4 stopped Daemons
could not be reused, use --status for details
<=====--> 75% EXECUTING [15s]
> :SocketClient
```

Client 2

# SER 321

## Single Threaded Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets
\JavaSimpleSock> gradle socketServer

> Task :SocketServer
Server ready for a connection
Server waiting for a connection
Received the String Hello!
Received the Integer 9
<=====--> 75% EXECUTING [1m 27s]
> :SocketServer
[]
```

Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketClient

> Task :SocketClient
Please enter a String to send to the Server (enter
"exit" to quit):
<<=====--> 75% EXECUTING [59s]      P
lease enter a Number to send to the Server (enter
0 to quit):
<<=====--> 75% EXECUTING [1m 18s]      9
and Hello! ... Got it!
Please enter a String to send to the Server (enter
"exit" to quit):
<<=====--> 75% EXECUTING [1m 21s]
> :SocketClient
[]
```

Client 1

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketClient
Starting a Gradle Daemon, 2 busy and 4 stopped Daemons
could not be reused, use --status for details
<=====--> 75% EXECUTING [49s]
> :SocketClient
[]
```

Client 2

# SER 321

## Single Threaded Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketServer  
  
> Task :SocketServer  
Server ready for a connection  
Server waiting for a connection  
Received the String Hello!  
Received the Integer 9  
<=====--> 75% EXECUTING [1m 55s]  
> :SocketServer  
[]
```

Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketClient  
  
> Task :SocketClient  
Please enter a String to send to the Server (enter  
"exit" to quit):  
<<=====> 75% EXECUTING [59s] P  
lease enter a Number to send to the Server (enter  
0 to quit):  
<<=====> 75% EXECUTING [1m 18s] 9  
and Hello! ... Got it!  
Please enter a String to send to the Server (enter  
"exit" to quit):  
<<=====> 75% EXECUTING [1m 49s]  
> :SocketClient  
exit
```

Client 1

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketClient  
Starting a Gradle Daemon, 2 busy and 4 stopped Daemons could not be reused, use --status for details  
<=====--> 75% EXECUTING [1m 18s]  
> :SocketClient  
[]
```

Client 2

What do we think will happen?

# SER 321

## Single Threaded Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets  
\JavaSimpleSock> gradle socketServer  
  
> Task :SocketServer  
Server ready for a connection  
Server waiting for a connection  
Received the String Hello!  
Received the Integer 9  
Received the String exit  
Received the Integer 0  
Server waiting for a connection  
<=====--> 75% EXECUTING [2m 15s]  
> :SocketServer  
[]
```

```
and Hello! ... Got it!  
Please enter a String to send to the Server (enter  
"exit" to quit):  
<=====--> 75% EXECUTING [2m 3s]      e  
xitingketClient  
  
Deprecated Gradle features were used in this build  
, making it incompatible with Gradle 8.0.  
  
You can use '--warning-mode all' to show the individual deprecation warnings and determine if they come from your own scripts or plugins.  
  
See https://docs.gradle.org/7.4.2/userguide/command\_line\_interface.html#sec:command\_line\_warnings  
  
BUILD SUCCESSFUL in 2m 5s  
2 actionable tasks: 1 executed, 1 up-to-date  
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock>
```

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketClient  
Starting a Gradle Daemon, 2 busy and 4 stopped Daemons could not be reused, use --status for details  
  
> Task :SocketClient  
Please enter a String to send to the Server (enter  
"exit" to quit):  
<=====--> 75% EXECUTING [1m 37s]  
> :SocketClient  
[]
```

Server

Client 1

Client 2

# SER 321

## Single Threaded Server

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets  
\JavaSimpleSock> gradle socketServer
```

```
> Task :SocketServer  
Server ready for a connection  
Server waiting for a connection  
Received the String Hello!  
Received the Integer 9  
Received the String exit  
Received the Integer 0  
Server waiting for a connection  
Received the String Hello!  
<=====> 75% EXECUTING [3m 7s]  
> :SocketServer  
[]
```

```
and Hello! ... Got it!  
Please enter a String to send to the Server (enter  
"exit" to quit):  
<=====> 75% EXECUTING [2m 3s] e  
xitingketClient
```

```
Deprecated Gradle features were used in this build  
, making it incompatible with Gradle 8.0.
```

```
You can use '--warning-mode all' to show the individual deprecation warnings and determine if they come from your own scripts or plugins.
```

```
See https://docs.gradle.org/7.4.2/userguide/command\_line\_interface.html#sec:command\_line\_warnings
```

```
BUILD SUCCESSFUL in 2m 5s  
2 actionable tasks: 1 executed, 1 up-to-date  
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> []
```

Server

Client 1

Client 2

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketClient  
Starting a Gradle Daemon, 2 busy and 4 stopped Daemons could not be reused, use --status for details
```

```
> Task :SocketClient  
Please enter a String to send to the Server (enter  
"exit" to quit):  
<=====> 75% EXECUTING [2m 24s] P  
lease enter a Number to send to the Server (enter  
0 to quit):  
<=====> 75% EXECUTING [2m 30s]  
> :SocketClient  
77[]
```

# SER 321

## Single Threaded Server

# Why?

Client 1

Client 2

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets  
\JavaSimpleSock> gradle socketServer  
  
> Task :SocketServer  
Server ready for a connection  
Server waiting for a connection  
Received the String Hello!  
Received the Integer 9  
Received the String exit  
Received the Integer 0  
Server waiting for a connection  
Received the String Hello!  
<===== 75% EXECUTING [3m 7s]  
> :SocketServer  
[]
```

1. Define Params

2. Create Socket

3-5. Mark Socket to Listen

6. Wait for Connection

7. Handle Client Connection

8. Close Client Connection

9.

```
PS C:\ASU\SER321\examples_repo\ser321examples\Sockets\JavaSimpleSock> gradle socketClient  
Starting a Gradle Daemon, 2 busy and 4 stopped Daemons could not be reused, use --status for details
```

```
> Task :SocketClient  
Please enter a String to send to the Server (enter  
"exit" to quit):  
<===== 75% EXECUTING [2m 24s] P  
lease enter a Number to send to the Server (enter  
0 to quit):  
<===== 75% EXECUTING [2m 30s]  
> :SocketClient  
77
```

Server

Client 1

Client 2

Given the standard server socket steps...

Ideas on how we could introduce threads?

1. Define Params

2. Create Socket

3-5. Mark Socket to Listen

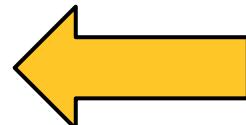
6. Wait for Connection

7. Handle Client Connection

8. Close Client Connection

9. Continue Listening

Why do we send the *client socket* to the thread?



7. Send Client Socket to thread

# SER 321

## Threads

1. Define Params

2. Create Socket

3-5. Mark Socket to Listen

6. Wait for Connection

7. Send Client **Socket** to Thread

8. Close Client Connection

9. Continue Listening



1

2 & 3-5

9

6

7

8

```
public static void main(String args[]) throws IOException {
    Socket sock = null;
    int id = 0;
    try {
        if (args.length != 1) {
            System.out.println
                ("Usage: gradle ThreadedSockServer --args=<port num>");
            System.exit( code: 0);
        }
        int portNo = Integer.parseInt(args[0]);
        if (portNo <= 1024)
            portNo = 8888;
        ServerSocket serv = new ServerSocket(portNo);

        while (true) {
            System.out.println
                ("Threaded server waiting for connects on port " + portNo);
            sock = serv.accept();
            System.out.println
                ("Threaded server connected to client-" + id);
            // create thread
            ThreadedSockServer myServerThread =
                new ThreadedSockServer(sock, id++);
            // run thread and don't care about managing it
            myServerThread.start();
        }
    } catch (Exception e) {
        e.printStackTrace();
    } finally {
        if (sock != null) sock.close();
    }
}
```

## JavaThreadSock

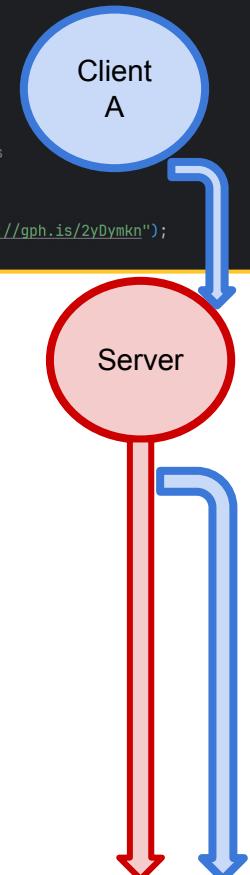
# SER 321 Threads

```
public void run() {
    try {
        // setup read/write channels for connection
        ObjectInputStream in = new ObjectInputStream(conn.getInputStream());
        ObjectOutputStream out = new ObjectOutputStream(conn.getOutputStream());

        // read the digit being send
        String s = (String) in.readObject();
        int index;
        // while client hasn't ended
        while (!s.equals("end")) {
            Boolean validInput = true;

            // checks if input only contains digits
            if (!s.matches("^[\\d]+$")) {
                validInput = false;
                out.writeObject("Not a number: https://gph.is/2yDymkn");
            }

            // if it contains only numbers
            if (validInput) {
                // convert to an integer
                index = Integer.valueOf(s);
                System.out.println("From client " + id + " get string " + index);
                if (index > -1 & index < buf.length) {
                    // if valid, pull the line from the buffer array above and write it to socket
                    out.writeObject(buf[index]);
                } else if (index == 5) {
                    // fun surprise for mostly correct
                    out.writeObject("Close but out of range: https://youtu.be/dQw4w9WgXcQ");
                } else {
                    // really wrong
                    out.writeObject("index out of range");
                }
            }
            // wait for next token from the user
            s = (String) in.readObject();
        }
        // on close, clean up
        System.out.println("Client " + id + " closed connection.");
        in.close();
        out.close();
        conn.close();
    } catch (Exception e) {
        e.printStackTrace();
    }
}
```



```
public static void main(String args[]) throws IOException {
    Socket sock = null;
    int id = 0;
    try {
        if (args.length != 1) {
            System.out.println
                ("Usage: gradle ThreadedSockServer --args=<port num>");
            System.exit( code: 0);
        }
        int portNo = Integer.parseInt(args[0]);
        if (portNo <= 1024)
            portNo = 8888;
        ServerSocket serv = new ServerSocket(portNo);

        while (true) {
            System.out.println
                ("Threaded server waiting for connects on port " + portNo);
            sock = serv.accept();
            System.out.println
                ("Threaded server connected to client-" + id);
            // create thread
            ThreadedSockServer myServerThread =
                new ThreadedSockServer(sock, id++);
            // run thread and don't care about managing it
            myServerThread.start();
        }
    } catch (Exception e) {
        e.printStackTrace();
    } finally {
        if (sock != null) sock.close();
    }
}
```

## JavaThreadSock

# SER 321

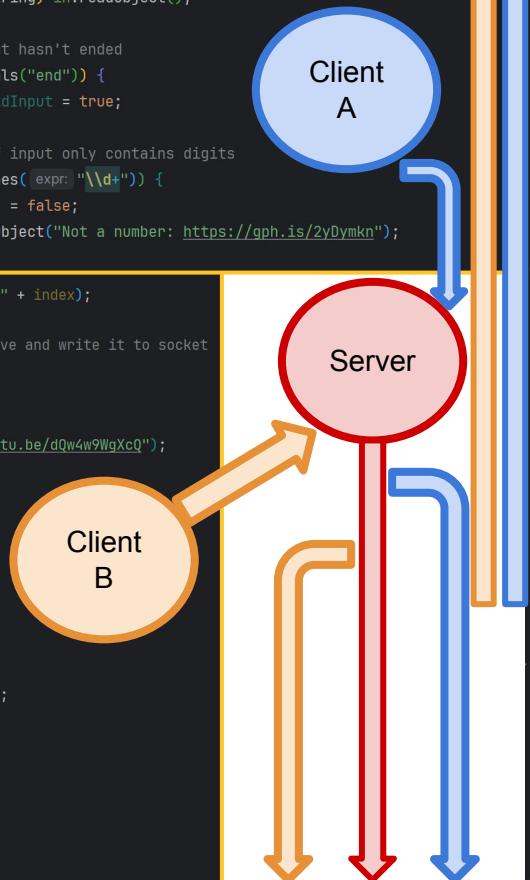
## Threads

```
public void run() {
    try {
        // setup read/write channels for connection
        ObjectInputStream in = new ObjectInputStream(conn.getInputStream());
        ObjectOutputStream out = new ObjectOutputStream(conn.getOutputStream());

        // read the digit being send
        String s = (String) in.readObject();
        int index;
        // while client hasn't ended
        while (!s.equals("end")) {
            Boolean validInput = true;

            // checks if input only contains digits
            if (!s.matches("^[\\d]+$")) {
                validInput = false;
                out.writeObject("Not a number: https://gph.is/2yDymkn");
            }

            // if it contains only numbers
            if (validInput) {
                // convert to an integer
                index = Integer.valueOf(s);
                System.out.println("From client " + id + " get string " + index);
                if (index > -1 & index < buf.length) {
                    // if valid, pull the line from the buffer array above and write it to socket
                    out.writeObject(buf[index]);
                } else if (index == 5) {
                    // fun surprise for mostly correct
                    out.writeObject("Close but out of range: https://youtu.be/dQw4w9WgXcQ");
                } else {
                    // really wrong
                    out.writeObject("index out of range");
                }
            }
            // wait for next token from the user
            s = (String) in.readObject();
        }
        // on close, clean up
        System.out.println("Client " + id + " closed connection.");
        in.close();
        out.close();
        conn.close();
    } catch (Exception e) {
        e.printStackTrace();
    }
}
```



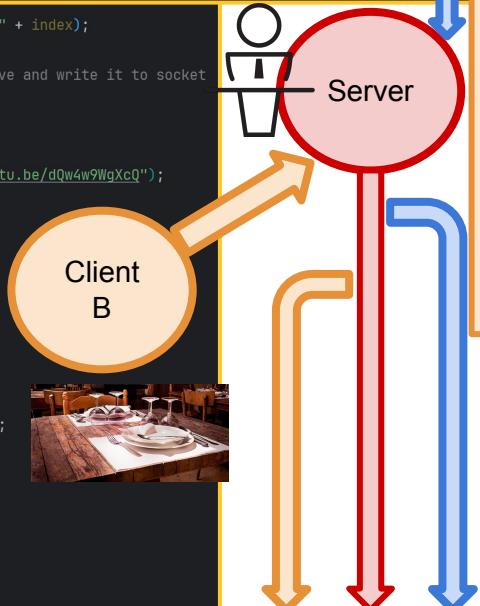
```
public static void main(String args[]) throws IOException {
    Socket sock = null;
    int id = 0;
    try {
        if (args.length != 1) {
            System.out.println(
                "Usage: gradle ThreadedSockServer --args=<port num>");
            System.exit( code: 0);
        }
        int portNo = Integer.parseInt(args[0]);
        if (portNo <= 1024)
            portNo = 8888;
        ServerSocket serv = new ServerSocket(portNo);

        while (true) {
            System.out.println
                ("Threaded server waiting for connects on port " + portNo);
            sock = serv.accept();
            System.out.println
                ("Threaded server connected to client-" + id);
            // create thread
            ThreadedSockServer myServerThread =
                new ThreadedSockServer(sock, id++);
            // run thread and don't care about managing it
            myServerThread.start();
        }
    } catch (Exception e) {
        e.printStackTrace();
    } finally {
        if (sock != null) sock.close();
    }
}
```

# JavaThreadSock

## SER 321 Threads

```
// if it contains only numbers
if (validInput) {
    // convert to an integer
    index = Integer.valueOf(s);
    System.out.println("From client " + id + " get string " + index);
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        // if valid, pull the line from the buffer array above and write it to socket
        out.writeObject(buf[index]);
    } else if (index == 5) {
        // fun surprise for mostly correct
        out.writeObject("Close but out of range: https://youtu.be/dQw4w9WgXcQ");
    } else {
        // really wrong
        out.writeObject("index out of range");
    }
    // wait for next token from the user
    s = (String) in.readObject();
}
// on close, clean up
System.out.println("Client " + id + " closed connection.");
in.close();
out.close();
conn.close();
} catch (Exception e) {
    e.printStackTrace();
}
```

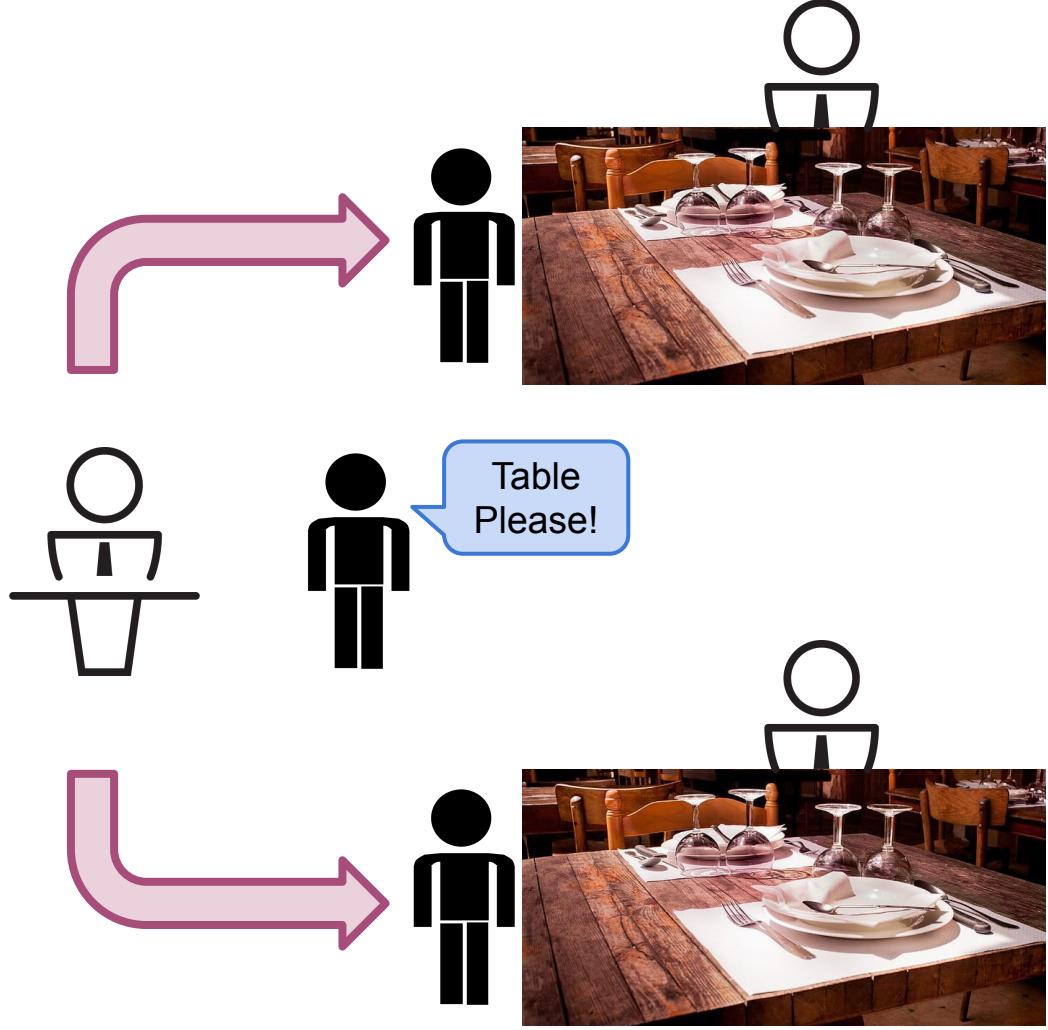
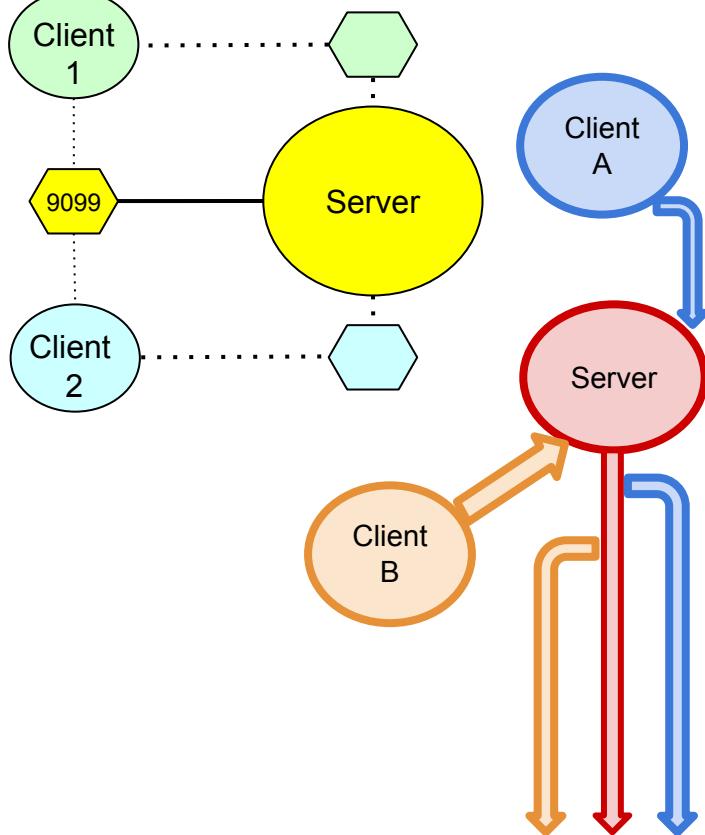


```
public static void main(String args[]) throws IOException {
    Socket sock = null;
    int id = 0;
    try {
        if (args.length != 1) {
            System.out.println(
                "Usage: gradle ThreadedSockServer --args=<port num>");
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            myServerThread.start();
        }
    } catch (Exception e) {
        e.printStackTrace();
    } finally {
        if (sock != null) sock.close();
    }
}
```

# SER 321

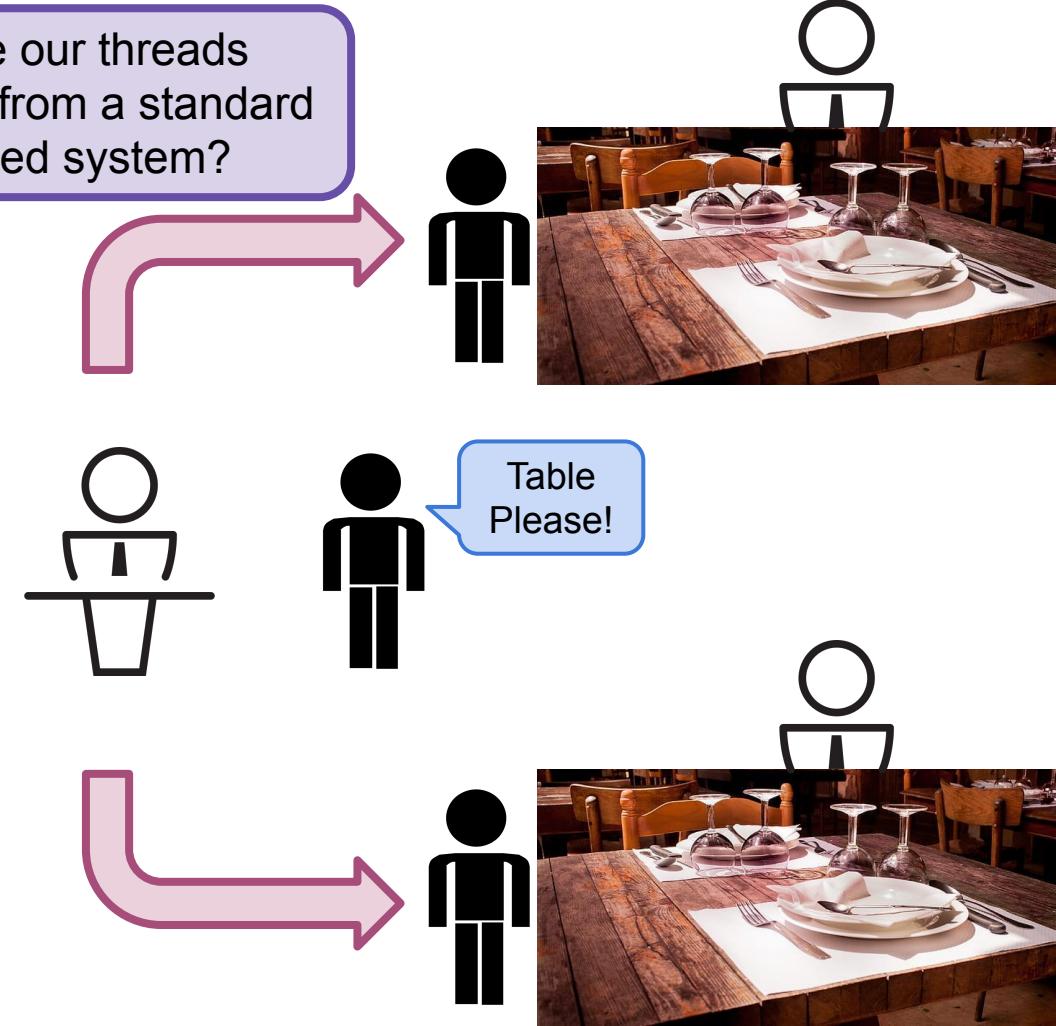
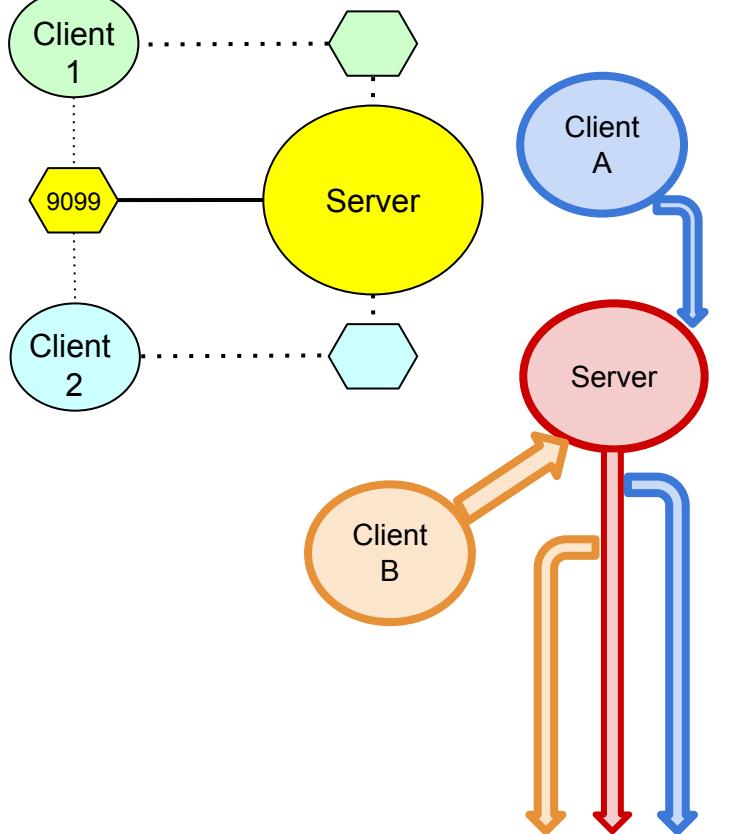
## Port Examination



# SER 321

## Port Examination

What are our threads simulating from a standard distributed system?



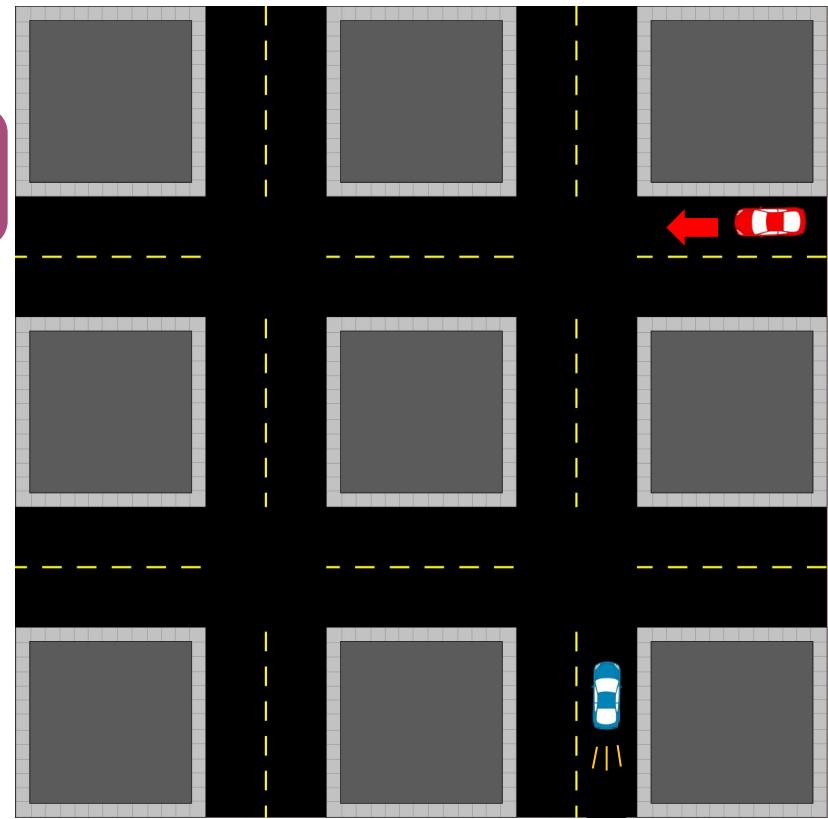
# SER 321

## Threading Pitfalls

Race Condition

Crash

More than one thread accesses a single resource at once



# SER 321

## Threading Pitfalls

Race Condition

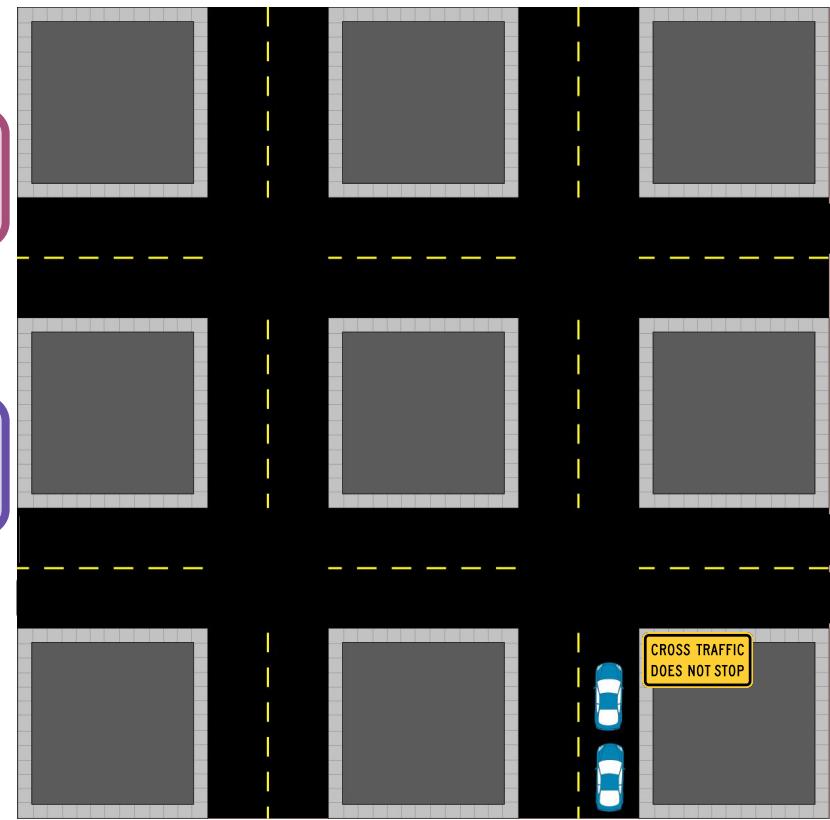
Crash

More than one thread accesses a single resource at once

Starvation

Cross Traffic

A thread never gains access to the resource it needs



# SER 321

## Threading Pitfalls

Race Condition

Crash

More than one thread accesses a single resource at once

Starvation

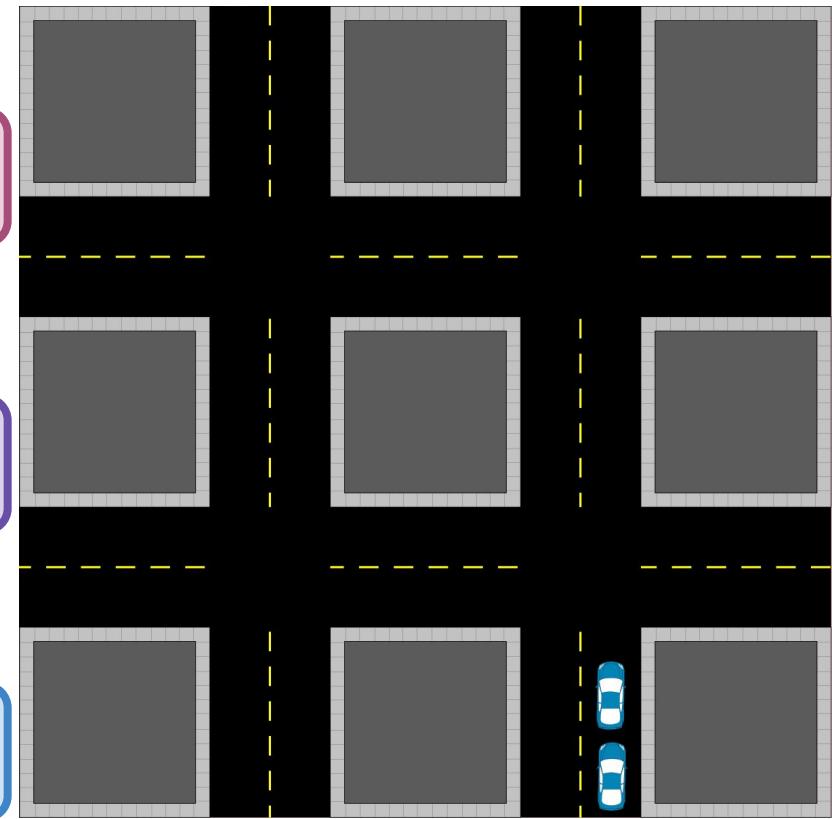
Cross Traffic

A thread never gains access to the resource it needs

Deadlock

Gridlock

A thread is only able to acquire some of the needed resources



**SER 321**

## **Concurrency Structures**

Can we name some concurrency structures?

Atomic Operations &  
Variables

Locks

Semaphores

Monitors

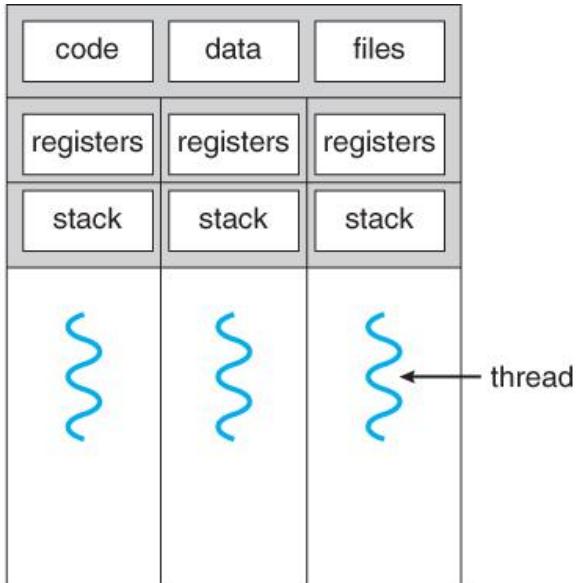
# SER 321

## Concurrency Structures

### Atomic Operations & Variables

Recall *registers*...

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



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
```

# SER 321

## Concurrency Structures

Pros and Cons?

Locks

Acquire the Lock

Open & Enter

Close & Lock

Release the Lock

Unlock & Exit



# SER 321

## Concurrency Structures



### 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?

How am I  
different from a  
lock?

### Pros and Cons?

#### Monitors



You lock  
the main  
door  
instead!



Acquire Lock



Open & Enter

Close & Lock

Covers the  
*entire object*

Release Lock



Unlock & Exit

# SER 321

## 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

# SER 321

## Concurrency Structures

### Monitors

Both `bow()` and `bowBack()` are synchronized → are we good?

```
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 [17s]
> :run
```

Deadlock!

```
public class Deadlock {
    static class Friend { 6 usages
        private final String name; 5 usages
        public Friend(String name) { this.name = name; }
        public String getName() { return this.name; }
        /* See the README.md for a reference on 'synchronized' methods */
        public synchronized void bow(Friend bower) { 2 usages
            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);
        }
        public synchronized void bowBack(Friend bower) { 1 usage
            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();
    }
}
```

# SER 321

## Concurrency Structures

Monitors  
manage locks  
for us by  
***locking the  
entire object***

```
> 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 [17s]
> :run
```

This program demonstrate how a deadlock can be created with synchronized methods:

- <https://docs.oracle.com/javase/tutorial/essential/concurrency/syncmeth.html>
- <https://docs.oracle.com/javase/tutorial/essential/concurrency/locksSync.html>

The key to why it locks can be found in this bullet point from the Tutorial:

- "When a thread invokes a synchronized method, it automatically acquires the intrinsic lock for that method's object and releases it when the method returns. The lock release occurs even if the return was caused by an uncaught exception."

Since both the `bow()` and `bowback()` method are synchronized methods, they cannot both be called on the same object at the same time, whichever is called first must complete prior to the other executing.

The key to solving this is to use a synchronized statement rather than a synchronized method. With this approach a separate lock object can be shared and keep a deadlock from occurring by not allowing the second bower to start before the first has finished.

A more sophisticated locking scheme can be accomplished with explicit Lock objects and is described here:

- <https://docs.oracle.com/javase/tutorial/essential/concurrency/newLocks.html>

**SER 321**

**Scratch Space**

## Upcoming Events

### SI Sessions:

- Tuesday, April 15th at 10:00 am MST
- Thursday, April 17th at 7:00 pm MST
- Sunday, April 20th at 7:00 pm MST

### Review Sessions:

- Sunday, April 27th at **6:00 pm** MST - **2 hour Exam Review Session**
- Tuesday, April 29th, at 10:00 am MST - **Q&A Session**

# Questions?

## Survey:

<https://asuasn.info/ASNSurvey>



# More Questions?

## Check out our other resources!

tutoring.asu.edu

The screenshot shows the ASU Academic Support Network homepage. At the top, there's a yellow header with the ASU logo and the text "Academic Support Network". Below the header, there's a navigation bar with links for "Services", "Faculty and Staff Resources", and "About Us". A red button labeled "University College" is visible. The main section features a large yellow banner with the text "Academic Support". Below the banner, there's a brief description of the service: "Academic Support Network (ASN) provides a variety of free services in-person and online to help currently enrolled ASU students succeed academically." There are also sections for "Services" and "Online Study Hub" with images and descriptions.

Academic Support Network (ASN) provides a variety of free services in-person and online to help currently enrolled ASU students succeed academically.

## Services



### Subject Area Tutoring

Need in-person or online help with math, science, business, or engineering courses? Just hop into our Zoom room or drop into a center for small group tutoring. We'll take it from there.

[Need help using Zoom?](#)

[View the tutoring schedule](#)

[View digital resources](#)



### Writing Tutoring

Need help with undergraduate or graduate writing assignments? Schedule an in-person or online appointment, access your appointment link, or wait in our drop-in queue.

[Access your appointment link](#)

[Access the drop-in queue](#)

[View digital resources](#)



### Online Study Hub

Join our online peer communities to connect with your fellow Sun Devils. Engage with our tools to search our bank of resources, videos, and previously asked questions. Or, ask our Tutorbot questions.

Now supporting courses in Math, Science, Business, Engineering, and Writing.

[Online Study Hub](#)

1 -

**Go to Zoom**

[Need help using Zoom?](#)

[View the tutoring schedule](#)

[View digital resources](#)

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](https://tutoring.asu.edu/online-study-hub)

Online Study Hub

Online peer communities for students and tutors, YouTube channels, and Tutorbots.



## What are online peer communities?

Individual courses have an online peer community that allows you to connect with your peers to post and answer questions and to develop study groups.



## How can tutoring center videos help?

Videos can help supplement the learning you're doing in and outside of class and include step-by-step methods for how to understand concepts.



## How does the Tutorbot work?

You can ask the Tutorbot questions about course concepts and the Tutorbot will recommend additional resources and examples to help address your questions.

ASU Academic Support Network

Arizona State University Services Faculty and Staff Resources About Us

University College

Select a subject

- Any -

Apply

Business

## ACC 231

Uses of Accounting Info I

Peer Community

## ACC 241

Uses of Accounting Info II

Peer Community

## CIS 105

Computer Applications and Information Technology

Peer Community

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

Select a subject

- Any -

Apply

# Expanded Writing Support Available

Including Grammarly for Education, at no cost!



 Activate your Grammarly for Education account now!

Use the button below and we'll use your ASU login to create a Grammarly for Education premium account. See ya on the AI side!

[Sign up](#)

\*Available slots for this pilot are limited



[tutoring.asu.edu/expanded-writing-support](https://tutoring.asu.edu/expanded-writing-support)

# 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](#)
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