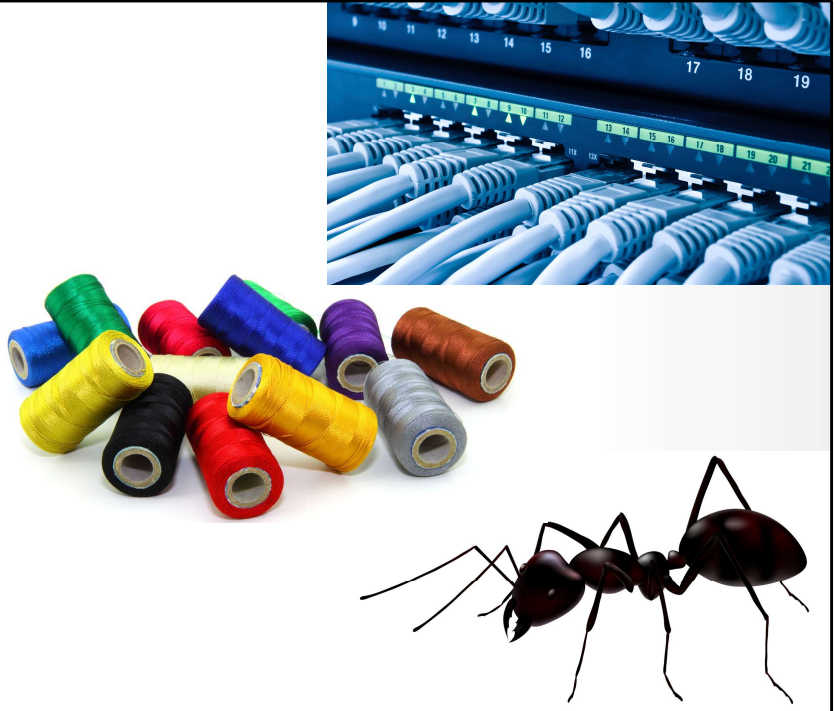


CS221 C and Systems Programming



Today we're gonna review some recent difficult topics

Debugging Review

Debugging tools

`printf()`

CLion and breakpoint debugging

gdb

valgrind and memory debugging

corefile debugging

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Let's try our parallel mergesorts. add printf's. Run in Eclipse. Run in valgrind. Enable cores. Anyone got a core?

Try our primecheckers?

Multithreading Review

Multithreading

How to make new threads?

How to pass input values to a thread?

How to get a return value from a thread?

How to wait until a thread exits?

Communication between threads

Either master thread waits for child threads to finish, or...
...need safe communication between threads

Thread-safe queues

- With "critical code" protected by mutexes
- `sem_init();`
- `sem_wait();`
- `sem_post();`

Avoid **deadlock**

Networking Review

Computer Networks

(Almost) every computer has an IP address (or >1)

Client/server model

- One end listens, one end connects (or multiple connections)

`read()` and `write()`

- Both ends can both read and write on the same socket

How to make a Server socket?

```
socket()  
bind()  
listen()  
accept()
```

How to make a Client socket?

```
socket()  
connect()
```

Program Workflow

```
while (1) {  
    read(fd, data, len);  
    handleData(data);  
}  
  
while (1) {  
    if (anythingToAccept(listenFd)) {  
        readFd = accept(listenFd);  
        handleNewFd(readFd);  
    }  
    for (thisFd : allReadFds) {  
        if (anythingToRead(thisFd)) {  
            read(thisFd, data, len);  
            handleData(data);  
        }  
    }  
    doOtherWork();  
    or sleep();  
}
```

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sleep() rather than thrash the computer if nothing to read or accept

Responsive program: make a loop, nonblocking read from server. Use backspace code "\b" and sleep(1) to print a counter, as in clientdemo.c. When read from server, print message

Non-blocking `read()`

My program calls `read()`, nothing to be read yet. What happens?

- It depends...
- BLOCKING mode
- NON-BLOCKING mode
- `fcntl()`

Same issue with `accept()`

End-of-file and `read()`

Errors...

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Non-blocking read: check IF there is something to read, handle it if so, if not, continue immediately

EXAMPLE: `clientdemo.c`