CSE 333
Lecture 21 -- server sockets

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Administrivia

HW4 out either Friday or Monday
- planning on letting you write more of the code

Bonus questions in HW2, HW3, HW4
- your grade will be completely unaffected if you don’t do any of the bonus questions
HW3 q1

How long did it take you?

- 10-12: 1
- 12-14: 1
- 14-16: 3
- 16-20: 3
- 20-25: 7
- 25-35: 4
- 35+: 3
HW3 q2

Confidence in your work

- low [tons ‘o bugs]: 1
- medium [a few bugs]: 6
- high [code pretty much correct]: 17
- supreme [ > Gribble’s]: 0
HW3 q3

Worthwhile

- True; even better than hw1/hw2:  8
- True; just as good as hw1/hw2: 14
- True; < hw1/hw2:  1
- False:  1
HW3 q4

We provided [...] code:

- Too little: 1
- Just right: 18
- Too much: 4
- Waaay too much, next time don’t provide any: 1
HW3 q5

I spent my time:

- on stupid C++ compiler errors: 1
- on memory-related bugs/errors: 3
- bugs in my on-file index format: 17
- learning STL: 0
- other: 3
HW3 q6

I like that you give us optional parts:

- True: 17
- False: 7
Q7

Other feedback?

- make the bonus due after the assignment  [agreed]
  ‣ I like the range of difficulty
- thanks for providing libhw1 and libhw2
  ‣ but fix your unit tests for HW1 and HW2!  [agreed!!!]
- liked the free format for filesearchshell
- I’d like to learn how to write C++ unit tests
- wish our test suite worked, but great project for learning C++
Q7

Other feedback?

- found that the homeworks are equivalent to giving an artist color-by-numbers. Very little thinking.
  - great potential, but please leave more to the student.
- filling out the table readers was repetitive, but it was a nice balance to the free-form QueryProcessor
- part D was *much* easier in C++ than in C  [yay!]
- consider giving us better tools for debugging index file errors
- for next assignment, give us *less* (specs, few statements)?
Q8:

Favorite game

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Answer</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bubble bobble</td>
<td>3</td>
<td>12.50%</td>
</tr>
<tr>
<td>2</td>
<td>Contra</td>
<td>2</td>
<td>8.33%</td>
</tr>
<tr>
<td>3</td>
<td>Donkey Kong</td>
<td>1</td>
<td>4.17%</td>
</tr>
<tr>
<td>4</td>
<td>Dr. Mario</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>5</td>
<td>Golf</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>6</td>
<td>The Legend of Zelda</td>
<td>5</td>
<td>20.83%</td>
</tr>
<tr>
<td>7</td>
<td>Lemmings</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>8</td>
<td>Lifeforce</td>
<td>1</td>
<td>4.17%</td>
</tr>
<tr>
<td>9</td>
<td>Mario Bros.</td>
<td>1</td>
<td>4.17%</td>
</tr>
<tr>
<td>10</td>
<td>Mega Man</td>
<td>1</td>
<td>4.17%</td>
</tr>
<tr>
<td>11</td>
<td>Pac-Man</td>
<td>1</td>
<td>4.17%</td>
</tr>
<tr>
<td>12</td>
<td>Super Mario Bros.</td>
<td>3</td>
<td>12.50%</td>
</tr>
<tr>
<td>13</td>
<td>Tennis</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>14</td>
<td>Tetris</td>
<td>4</td>
<td>16.67%</td>
</tr>
<tr>
<td>15</td>
<td>Tetris 2</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>16</td>
<td>Zelda II -- The Adventure of Link</td>
<td>2</td>
<td>8.33%</td>
</tr>
</tbody>
</table>
Today

Network programming

- server-side programming
Servers

Pretty similar to clients, but with additional steps

- there are seven steps:

  1. figure out the address and port on which to listen
  2. create a socket
  3. **bind** the socket to the address and port on which to listen
  4. indicate that the socket is a **listening** socket
  5. **accept** a connection from a client
  6. **read** and **write** to that connection
  7. **close** the connection
Accepting a connection from a client

Step 1. Figure out the address and port on which to listen.

Step 2. Create a socket.

Step 3. **Bind** the socket to the address and port on which to listen.

Step 4. Indicate that the socket is a **listening** socket.
Servers can have multiple IP addresses

- “multihomed”
- usually have at least one externally visible IP address, as well as a local-only address (127.0.0.1)

When you bind a socket for listening, you can:

- specify that it should listen on all addresses
  ‣ by specifying the address “INADDR_ANY” -- 0.0.0.0
- specify that it should listen on a particular address
bind()

The “bind()” system call associates with a socket:

- an address family
  - AF_INET: IPv4
  - AF_INET6: IPv6
- a local IP address
  - the special IP address INADDR_ANY (“0.0.0.0”) means “all local IP addresses of this host”
- a local port number
listen( )

The “listen( )” system call tells the OS that the socket is a listening socket to which clients can connect

- you also tell the OS how many pending connections it should queue before it starts to refuse new connections
  - you pick up a pending connection with “accept( )”

- when listen returns, remote clients can start connecting to your listening socket
  - you need to “accept( )” those connections to start using them
Server socket, bind, listen

see server_bind_listen.cc
Accepting a connection from a client

Step 5. Accept a connection from a client.

Step 6. read( ) and write( ) to the client.

Step 7. close( ) the connection.
accept( )

The “accept( )” system call waits for an incoming connection, or pulls one off the pending queue

- it returns an active, ready-to-use socket file descriptor connected to a client
- it returns address information about the peer
  ‣ use inet_ntop( ) to get the client’s printable IP address
  ‣ use getnameinfo( ) to do a reverse DNS lookup on the client
Server accept, read/write, close

see server_accept_rw_close.cc
Something to note...

Our server code is not concurrent

- single thread of execution
- the thread blocks waiting for the next connection
- the thread blocks waiting for the next message from the connection

A crowd of clients is, by nature, concurrent

- while our server is handling the next client, all other clients are stuck waiting for it
Exercise 1

Write a program that:

- creates a listening socket, accepts connections from clients
  - reads a line of text from the client
  - parses the line of text as a DNS name
  - does a DNS lookup on the name
  - writes back to the client the list of IP addresses associated with the DNS name
  - closes the connection to the client
Exercise 2

Write a program that:

- creates a listening socket, accepts connections from clients
  - reads a line of text from the client
  - parses the line of text as a DNS name
  - connects to that DNS name on port 80
  - writes a valid HTTP request for “/”
    • see next slide for what to write
  - reads the reply, returns the reply to the client
Exercise 2 continued

Here’s a valid HTTP request to server www.foo.com

- note that lines end with ‘\r\n’, not just ‘\n’

```
GET / HTTP/1.0\r\nHost: www.foo.com\r\nConnection: close\r\n\r\n```
See you on Friday!