CS131: Programming Languages

Fall 2015
Week #7

Today

- HW 5 Roundup

- Python & Project Intro

- Midterm

HW 5 Finer Details

- Commutativity of lambda args & let bindings

```
(lambda (x y) (+ x y)) ; (lambda (y x) (+ y x))

(let ((a 1) (b 2)) (+ a b)) ;

    (let ((b 2) (a 1)) (+ a b))
```

- Do we say they're the same and compare bodies? Or different?
  - A: Different

```
(if TCP (let ((a 1) (b 2)) (+ a b))

    (let ((b 2) (a 1)) (+ a b)))
```

HW 5 Finer Details

- If every element of the list is different, do we do comparison element-wise or on the whole list?

```
(compare-expr '(cons 1 2) '(+ 3 4))
```

- A: Don't need to be smart here:

```
((if TCP cons +) (if TCP 1 3) (if TCP 2 4))
```

HW 5 Finer Details

- `#!r6rs` stuff
- Implement one-armed if (and we might test it)
  - But! the test cases you submit don't have to demonstrate that it works.
- You can test your file and submit without all the `#!r6rs` stuff

CS 131 Discussion 8

Winter 2015

Announcements

- **Project**
  - Thursday, March 05, 23:55

Midterm

- Please see CCLE announcement for details
- I graded: questions 1, 3, 4
- Prof. Eggert graded: questions 2, 5

Variables & Printing

Variables do not have to be declared before assignment, and can be rebound

```
>>> x = 1 + 2
>>> x
3
>>> x = "foo"
>>> x
'foo'
```

Strings can be enclosed in single, double, or triple (""") quotes (which can span across multiple lines)

```
>>> print "Mary's car"
Mary's car

>>> print("""Mary's "beautiful" car
was worth %s dollars""" % (x))
Mary's "beautiful" car
was worth 3 dollars
```

Dictionaries, List, Tuple

Dictionary   elements can be added easily

```
>>> w = {"Mary" : 1, "George" : 2,
"Martin" : 3}

>>> w
{'Martin': 3, 'Mary': 1, 'George': 2}

>>> w.get("Martin")
3

>>> w["Betty"] = 4
>>> w.get("Betty")
4
```

You can use anything as key/value, as long as the key is hashable (eg. a list is not)

```
>>> y = {x : 1, "bar" : [1, 2, "baz"], 42 : (1,1)}
>>> y
{42: (1, 1), 3: 1, 'bar': [1, 2, 'baz']}
>>> z = y.get(42)
>>> z.count(1)
2
```

Both list and tuple can have any elements inside

```
>>> y.get("bar")[1:3]
[2, 'baz']

>>> y.get("bar")[2]
'baz'
```

Control Flow Statements

Empty lists & tuples, or null objects are false
```
>>> if ([] or () or None):
        print "() or [] or None is true"
else:
        print "() and [] and None are false"


() and [] and None are false
```

```
>>> if 3 != 4:
        x = "foo"
else:
        x = "bar"

>>> x
'foo'
```

```
>>> z = [1,2,3]
>>> for i in z:
        print i
1
2
3
>>> i
3
```

```
>>> for j in y.iteritems():
        print j

(42, (1, 1))
('foo', 1)
('bar', [1, 2, 'baz'])
```

Note: Indenting is crucial! All statements in the same level **must** have the same indentation

Functions

You can return different values, or no value

```
>>> def inverse(x):
     if x == 0:
          print "Oops!"
          return
     if x == 1:
          return "It's the same!"
     print "the answer is:"
     return 1./x

>>> inverse(0)
Oops!
>>> inverse(1)
"It's the same!"
>>> inverse(2)
the answer is:
0.5
```

Nameless functions are also possible, if the function body is to return a single expression

```
>>> (lambda x:x*x)(3)
9

>>> def applyTwice(f, x):
     return f(f(x))

>>> applyTwice((lambda x: x*x), 2)
16

>>> f = lambda x:x*x

>>> applyTwice(f, 2)
16
```

Classes

```
>>> class BaseClass(object):
        def __init__(self, argx):
            self.x = argx

>>> foo = BaseClass(3)
>>> foo.x
3
```

Class members are always accessible
```
>>> foo.x = 5
```

You can also add members to an instance
```
>>> foo.y = 6
>>> bar = BaseClass(8)
>>> bar.y #This results in a error!
```

```
>>> class ChildClass(BaseClass):
        def __init__(self, argx, argy):
            super(ChildClass,self).__init__(argx)
            self.y = argy
        def getX(self):
            return self.x
        def getY(self):
            return self.y


>>> baz = ChildClass(1,2)
>>> baz.__dict__
{'y': 2, 'x': 1}
>>> baz.getX()
1
```

Twisted

Event-Driven Architecture
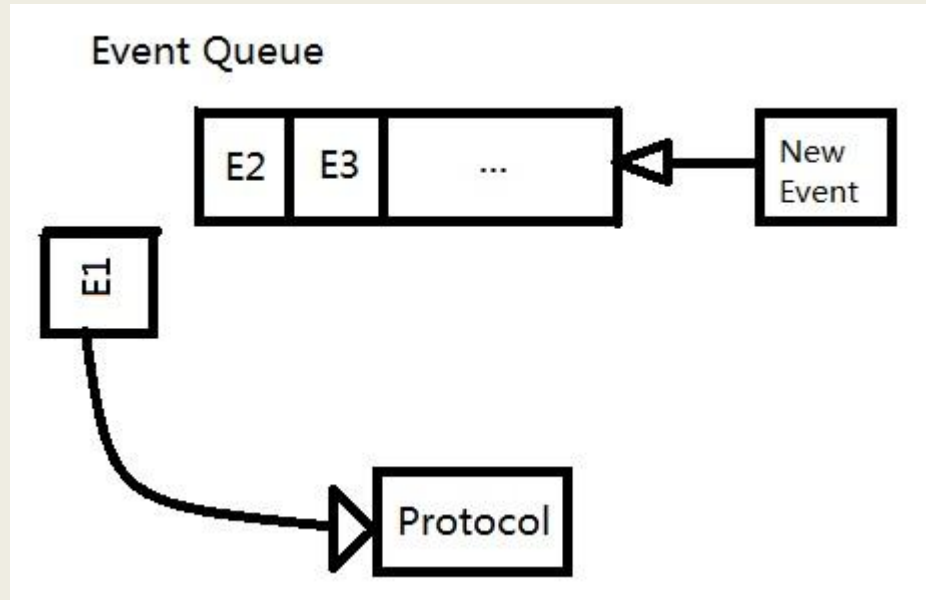
Event Queue

- Events can enter the event queue

- The event in the front of the queue is pass to a protocol, which processes the event

Reactor, Protocol, Factory, Transport

Reactor event loop
- Waits on and dispatches events to event handlers

Protocol
- Must handle these events:
  makeConnection, connectionMade, dataReceived, connectionLost

Protocol Factory
- Builds new instances of protocols (for each new connection)
- Saves persistent information

Transport
- Represents the connection between two endpoints
- Has following methods, which can be called by a protocol:
  write, writeSequence, loseConnection, getPeer, getHost

Example: chatserver.py

```python
from twisted.internet.protocol import Factory
from twisted.protocols.basic import LineReceiver
from twisted.internet import reactor

class ChatProtocol(LineReceiver):
    def __init__(self, factory):
        self.factory = factory
        self.name = None
        self.state = "REGISTER"

    def connectionMade(self):
        self.sendLine("What's your name?")

    def connectionLost(self, reason):
        if self.name in self.factory.users:
            del self.factory.users[self.name]
            self.broadcastMessage("%s has left the channel." % (self.name,))

    def lineReceived(self, line):
        if self.state == "REGISTER":
            self.handle_REGISTER(line)
        else:
            self.handle_CHAT(line)

    def handle_REGISTER(self, name):
        if name in self.factory.users:
            self.sendLine("Name taken, please choose another.")
            return
        self.sendLine("Welcome, %s!" % (name,))
        self.broadcastMessage("%s has joined the channel." % (name,))
        self.name = name
        self.factory.users[name] = self
        self.state = "CHAT"

    def handle_CHAT(self, message):
        message = "<%s> %s" % (self.name, message)
        self.broadcastMessage(message)

    def broadcastMessage(self, message):
        for name, protocol in self.factory.users.iteritems():
            if protocol != self:
                protocol.sendLine(message)

class ChatFactory(Factory):
    def __init__(self):
        self.users = {}

    def buildProtocol(self, addr):
        return ChatProtocol(self)

reactor.listenTCP(8000, ChatFactory())
reactor.run()
```

port #

Project

Your task

- Investigate Twisted

- Build prototype of an event-driven application with an "application server herd" architecture. Five servers and non-predetermined number of clients

- Make comment on Twisted's usefulness and compare to Node.js (Javascript, also event-driven)

Application Server Herd

Example with 3 servers and 3 clients:
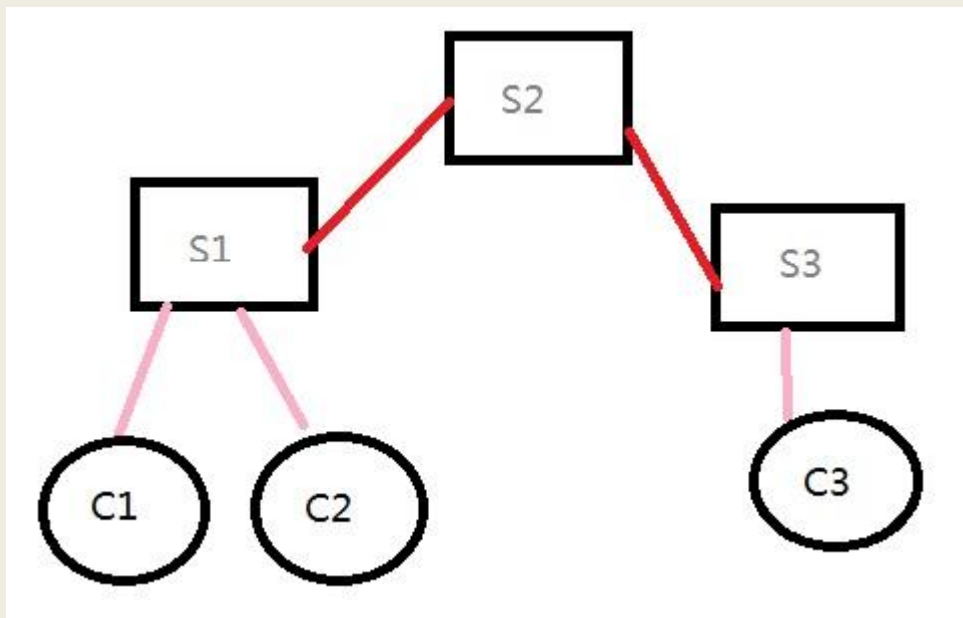
Your Prototype

- 5 servers: 'Alford', 'Bolden', 'Hamilton', 'Parker', 'Powell'
    - Alford talks with Parker and Powell
    - Bolden talks with Parker and Powell
    - Hamilton talks with Parker

- Each server should accept TCP connections from clients (eg. via telnet)

Client

- A client can send its location to the server:

  ```
  IAMAT kiwi.cs.ucla.edu +34.068930-118.445127 1400794645.392014450
  ```

- Or it can query for places near a client's location:

  ```
  WHATSAT kiwi.cs.ucla.edu 10 5
  ```

Server

- Upon receiving an IAMAT from client C, the server sends C, and the server's neighbours:

  ```
  AT Alford +0.563873386 kiwi.cs.ucla.edu +34.068930-118.445127 1400794699.108893381
  ```

- Upon receiving an WHATSAT from client C, the server queries Google Places and returns the location of the queried client (via AT), followed by the JSON returned by Google Places

- Upon receiving an AT from another server S, this server must check the timestamp of the AT, before storing the new location information and relaying the message to its neighbours

Painfully-Detailed Step by Step Tutorial to Run the Example in the Spec

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p: Permission denied
bash-4.1$ export PATH=/usr/local/cs/bin:$PAT
H
bash-4.1$ sed 's/1025/12000/' /u/cs/fac/egge
rt/src/Twisted-14.0.0/doc/_downloads/chatser
ver.py >chatserver.py
bash-4.1$ vi chatserver.py
bash-4.1$ ~
```

```
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* For assistance please contact help@seas.uc
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[yunl@lnxsrv02 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellsetu
p: Permission denied
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ver.py >chatserver.py
bash-4.1$ vi chatserver.py
bash-4.1$ vi chatserver.py
bash-4.1$ twistd -n -y chatserver.py
2015-02-25 00:27:46-0800 [-] Log opened.
2015-02-25 00:27:48-0800 [-] twistd 14.0.0 (/
usr/local/cs/Python-2.7.6/bin/python 2.7.6) s
tarting up.
2015-02-25 00:27:48-0800 [-] reactor class: t
wisted.internet.epollreactor.EPollReactor.
2015-02-25 00:27:48-0800 [-] ServerFactory st
arting on 12000
2015-02-25 00:27:48-0800 [-] Starting factory
 <twisted.internet.protocol.ServerFactory ins
tance at 0x1133128>
```

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* Priority is given both on the servers and
* students doing coursework. Computing suppo
* each department.
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* For assistance please contact help@seas.uc
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[yun1@lnxsrv02 ~]$ bash
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p: Permission denied
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bash-4.1$ sed 's/1025/12000/' /u/cs/fac/egge
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2015-02-25 00:27:48-0800 [-] Starting factory
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tance at 0x1133128>
2015-02-25 00:29:49-0800 [twisted.internet.pr
otocol.ServerFactory] Got new client!
```

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        * Please use "lnxsrv.seas.ucla.edu" t
        * User processes older than 36 hours
        * You can run graphical applications
        !! Please see http://www.seasnet.ucla

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* each department.
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* For assistance please contact help@seas
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[yun1@lnxsrv04 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellset
up: Permission denied
bash-4.1$ telnet lnxsrv.seas.ucla.edu 12000
Trying 164.67.100.234...
telnet: connect to address 164.67.100.234:
Connection refused
Trying 164.67.100.231...
telnet: connect to address 164.67.100.231:
Connection refused
Trying 164.67.100.232...
Connected to lnxsrv.seas.ucla.edu.
Escape character is '^]'.
```

```
l@lnxsrv.seas.ucla.edu's password:
t login: Wed Feb 25 00:14:09 2015 from
****************************************
            lnxsrv01.seas.ucla.edu RF
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    * Please use "lnxsrv.seas.ucla.edu" t
    * User processes older than 36 hours w
    * You can run graphical applications f
    !! Please see http://www.seasnet.ucla.

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n1@lnxsrv01 ~]$ 
```

Left window:
```
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students doing coursework. Computing suppo
each department.
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For assistance please contact help@seas.uc
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yun1@lnxsrv02 ~]$ bash
ash: /u/cs/class/cs111/cbin/share/shellsetu
: Permission denied
ash-4.1$ export PATH=/usr/local/cs/bin:$PAT

ash-4.1$ sed 's/1025/12000/' /u/cs/fac/egge
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ash-4.1$ vi chatserver.py
ash-4.1$ vi chatserver.py
ash-4.1$ twistd -n -y chatserver.py
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015-02-25 00:27:48-0800 [-] ServerFactory st
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015-02-25 00:27:48-0800 [-] Starting factory
<twisted.internet.protocol.ServerFactory ins
ance at 0x1133128>
015-02-25 00:29:49-0800 [twisted.internet.pr
tocol.ServerFactory] Got new client!
015-02-25 00:30:30-0800 [MyChat,0,164.67.100
234] received 'Hello World!'
```

Middle window:
```
        * Please use "lnxsrv.seas.ucla.edu" t
        * User processes older than 36 hours
        * You can run graphical applications
        !! Please see http://www.seasnet.ucla

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* students doing coursework. Computing su
* each department.
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* For assistance please contact help@seas
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[yun1@lnxsrv04 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellset
up: Permission denied
bash-4.1$ telnet lnxsrv.seas.ucla.edu 12000
Trying 164.67.100.234...
telnet: connect to address 164.67.100.234:
Connection refused
Trying 164.67.100.231...
telnet: connect to address 164.67.100.231:
Connection refused
Trying 164.67.100.232...
Connected to lnxsrv.seas.ucla.edu.
Escape character is '^]'.
Hello World!
Hello World!
```

Right window:
```
t login: Wed Feb 25 00:14:09 2015 from s
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n1@lnxsrv01 ~]$
```

```
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* For assistance please contact help@seas.uc   * User processes older than 36 hours    ********************************
*********************************             * You can run graphical applications            lnxsrv01.seas.ucla.edu
[yunl@lnxsrv02 ~]$ bash                       !! Please see http://www.seasnet.ucla   ********************************
bash: /u/cs/class/cs111/cbin/share/shellsetu
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2015-02-25 00:30:30-0800 [MyChat,0,164.67.100 Escape character is '^]'.                  Trying 164.67.100.232...
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2015-02-25 00:31:37-0800 [twisted.internet.pr Hello World!                             Escape character is '^]'.
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[yunl@lnxsrv02 ~]$ bash                          * You can run graphical applications              lnxsrv01.seas.ucla.edu R
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bash-4.1$ sed 's/1025/12000/' /u/cs/fac/egge    ************************                 * You can run graphical applications
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bash-4.1$ twistd -n -y chatserver.py            * each department.                           * SEASnet Computing Access
2015-02-25 00:27:46-0800 [-] Log opened.        ************************                 *
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2015-02-25 00:27:48-0800 [-] reactor class: t   bash: /u/cs/class/cs111/cbin/share/shellse   ************************
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2015-02-25 00:29:49-0800 [twisted.internet.pr   telnet: connect to address 164.67.100.231:   Trying 164.67.100.231...
otocol.ServerFactory] Got new client!           Connection refused                           telnet: connect to address 164.67.100.231
2015-02-25 00:30:30-0800 [MyChat,0,164.67.100   Trying 164.67.100.232...                      nection refused
.234] received 'Hello World!'                   Connected to lnxsrv.seas.ucla.edu.           Trying 164.67.100.232...
2015-02-25 00:31:37-0800 [twisted.internet.pr   Escape character is '^]'.                    Connected to lnxsrv.seas.ucla.edu.
otocol.ServerFactory] Got new client!           Hello World!                                 Escape character is '^]'.
                                                Hello World!                                 Hello Ever
```

Column 1 (left):

```
[yun1@lnxsrv02 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellsetu
p: Permission denied
bash-4.1$ export PATH=/usr/local/cs/bin:$PAT
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bash-4.1$ sed 's/1025/12000/' /u/cs/fac/egge
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otocol.ServerFactory] Got new client!
2015-02-25 00:32:31-0800 [MyChat,1,164.67.100
.231] received 'Hello Everyone!'
```

Column 2 (middle):

```
              * User processes older than 36 hours
              * You can run graphical applications
              !! Please see http://www.seasnet.ucla

*************************************************
*************************************************
* SEASnet Computing Access
*
* Priority is given both on the servers a
* students doing coursework. Computing su
* each department.
*************************************************
* For assistance please contact help@seas
*************************************************
[yun1@lnxsrv04 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellse
up: Permission denied
bash-4.1$ telnet lnxsrv.seas.ucla.edu 1200
Trying 164.67.100.234...
telnet: connect to address 164.67.100.234:
Connection refused
Trying 164.67.100.231...
telnet: connect to address 164.67.100.231:
Connection refused
Trying 164.67.100.232...
Connected to lnxsrv.seas.ucla.edu.
Escape character is '^]'.
Hello World!
Hello World!
Hello Everyone!
```

Column 3 (right):

```
              lnxsrv01.seas.ucla.edu RI
*************************************************
* Please use "lnxsrv.seas.ucla.edu" to
* User processes older than 36 hours v
* You can run graphical applications
!! Please see http://www.seasnet.ucla

*************************************************
*************************************************
* SEASnet Computing Access
*
* Priority is given both on the servers a
* students doing coursework. Computing su
* each department.
*************************************************
* For assistance please contact help@seas
*************************************************
[yun1@lnxsrv01 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellse
 Permission denied
bash-4.1$ telnet lnxsrv.seas.ucla.edu 1200
Trying 164.67.100.231...
telnet: connect to address 164.67.100.231
nection refused
Trying 164.67.100.232...
Connected to lnxsrv.seas.ucla.edu.
Escape character is '^]'.
Hello Everyone!
Hello Everyone!
```

```
bash-4.1$ export PATH=/usr/local/cs/bin:$PAT
H
bash-4.1$ sed 's/1025/12000/' /u/cs/fac/egge
rt/src/Twisted-14.0.0/doc/_downloads/chatser
ver.py >chatserver.py
bash-4.1$ vi chatserver.py
bash-4.1$ vi chatserver.py
bash-4.1$ twistd -n -y chatserver.py
2015-02-25 00:27:46-0800 [-] Log opened.
2015-02-25 00:27:48-0800 [-] twistd 14.0.0 (/
usr/local/cs/Python-2.7.6/bin/python 2.7.6) s
tarting up.
2015-02-25 00:27:48-0800 [-] reactor class: t
wisted.internet.epollreactor.EPollReactor.
2015-02-25 00:27:48-0800 [-] ServerFactory st
arting on 12000
2015-02-25 00:27:48-0800 [-] Starting factory
<twisted.internet.protocol.ServerFactory ins
tance at 0x1133128>
2015-02-25 00:29:49-0800 [twisted.internet.pr
otocol.ServerFactory] Got new client!
2015-02-25 00:30:30-0800 [MyChat,0,164.67.100
.234] received 'Hello World!'
2015-02-25 00:31:37-0800 [twisted.internet.pr
otocol.ServerFactory] Got new client!
2015-02-25 00:32:31-0800 [MyChat,1,164.67.100
.231] received 'Hello Everyone!'
2015-02-25 00:33:41-0800 [MyChat,1,164.67.100
.231] received 'Say goodbye by typing ctrl-]'
2015-02-25 00:34:03-0800 [MyChat,1,164.67.100
.231] Lost a client!
```

```
       * User processes older than 36 hours
       * You can run graphical applications
       !! Please see http://www.seasnet.ucla

*********************************************
*********************************************
* SEASnet Computing Access
*
* Priority is given both on the servers a
* students doing coursework. Computing su
* each department.
*********************************************
* For assistance please contact help@seas
*********************************************
[yunl@lnxsrv04 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellse
up: Permission denied
bash-4.1$ telnet lnxsrv.seas.ucla.edu 1200
Trying 164.67.100.234...
telnet: connect to address 164.67.100.234:
Connection refused
Trying 164.67.100.231...
telnet: connect to address 164.67.100.231:
Connection refused
Trying 164.67.100.232...
Connected to lnxsrv.seas.ucla.edu.
Escape character is '^]'.
Hello World!
Hello World!
Hello Everyone!
Say goodbye by typing ctrl-]
```

```
       * User processes older than 36 hours w
       * You can run graphical applications f
       !! Please see http://www.seasnet.ucla.

**********************************************
**********************************************
* SEASnet Computing Access
*
* Priority is given both on the servers an
* students doing coursework. Computing sup
* each department.
**********************************************
* For assistance please contact help@seas.
**********************************************
[yunl@lnxsrv01 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellse
 Permission denied
bash-4.1$ telnet lnxsrv.seas.ucla.edu 1200
Trying 164.67.100.231...
telnet: connect to address 164.67.100.231:
nection refused
Trying 164.67.100.232...
Connected to lnxsrv.seas.ucla.edu.
Escape character is '^]'.
Hello Everyone!
Hello Everyone!
Say goodbye by typing ctrl-]
Say goodbye by typing ctrl-]
^]
telnet> quit
Connection closed.
bash-4.1$
```

Left panel:
```
wisted.internet.epollreactor.EPollReactor.
2015-02-25 00:27:48-0800 [-] ServerFactory st
arting on 12000
2015-02-25 00:27:48-0800 [-] Starting factory
 <twisted.internet.protocol.ServerFactory ins
tance at 0x1133128>
2015-02-25 00:29:49-0800 [twisted.internet.pr
otocol.ServerFactory] Got new client!
2015-02-25 00:30:30-0800 [MyChat,0,164.67.100
.234] received 'Hello World!'
2015-02-25 00:31:37-0800 [twisted.internet.pr
otocol.ServerFactory] Got new client!
2015-02-25 00:32:31-0800 [MyChat,1,164.67.100
.231] received 'Hello Everyone!'
2015-02-25 00:33:41-0800 [MyChat,1,164.67.100
.231] received 'Say goodbye by typing ctrl-]'
2015-02-25 00:34:03-0800 [MyChat,1,164.67.100
.231] Lost a client!
^C2015-02-25 00:34:36-0800 [-] Received SIGIN
T, shutting down.
2015-02-25 00:34:36-0800 [-] (TCP Port 12000
Closed)
2015-02-25 00:34:36-0800 [-] Stopping factory
 <twisted.internet.protocol.ServerFactory ins
tance at 0x1133128>
2015-02-25 00:34:36-0800 [MyChat,0,164.67.100
.234] Lost a client!
2015-02-25 00:34:36-0800 [-] Main loop termin
ated.
2015-02-25 00:34:36-0800 [-] Server Shut Down
.
bash-4.1$ ...Type ctrl-C to terminate server
```

Middle panel:
```
* User processes older than 36 hours
* You can run graphical applications
!! Please see http://www.seasnet.ucla

************************************
************************************
SEASnet Computing Access

Priority is given both on the servers a
students doing coursework. Computing su
each department.
************************************
For assistance please contact help@seas
************************************
unl@lnxsrv04 ~]$ bash
sh: /u/cs/class/cs111/cbin/share/shellse
: Permission denied
sh-4.1$ telnet lnxsrv.seas.ucla.edu 1200
ying 164.67.100.234...
lnet: connect to address 164.67.100.234:
nnection refused
ying 164.67.100.231...
lnet: connect to address 164.67.100.231:
nnection refused
ying 164.67.100.232...
nnected to lnxsrv.seas.ucla.edu.
cape character is '^]'.
llo World!
llo World!
llo Everyone!
y goodbye by typing ctrl-]
nnection closed by foreign host.
sh-4.1$
```

Right panel:
```
* Please use "lnxsrv.seas.ucla.edu" to
* User processes older than 36 hours wi
* You can run graphical applications fr
!! Please see http://www.seasnet.ucla.e

************************************
************************************
* SEASnet Computing Access
*
* Priority is given both on the servers and
* students doing coursework. Computing supp
* each department.
************************************
* For assistance please contact help@seas
************************************
[yunl@lnxsrv01 ~]$ bash
bash: /u/cs/class/cs111/cbin/share/shellset
 Permission denied
bash-4.1$ telnet lnxsrv.seas.ucla.edu 12000
Trying 164.67.100.231...
telnet: connect to address 164.67.100.231:
nection refused
Trying 164.67.100.232...
Connected to lnxsrv.seas.ucla.edu.
Escape character is '^]'.
Hello Everyone!
Hello Everyone!
Say goodbye by typing ctrl-]
Say goodbye by typing ctrl-]
^]
telnet> quit
Connection closed.
bash-4.1$
```