



A BIT MORE RECURSION

COMPUTER NETWORKS

ANNOUNCEMENT

- Homework 2 has been posted
- Please contact TA Ross and William for questions
- Bonus Project 1 also posted, due March 1st
- Quiz 3: Thursday, 2/11, last 10 minutes in class. Topic: Recursion.

RECURSION

```
def recur_fact(x):
```

```
    if x == 1:
```

```
        return 1
```

```
    else:
```

```
        print x, "*", "recur_fact(", x-1, ")"
```

```
        return (x * recur_fact(x-1))
```

```
num=int(input("Enter a number: "))
```

```
if num >= 1:
```

```
    print("The factorial of", num, "is", recur_fact(num))
```

credit:

<http://www.programiz.com/python-programming/recursion>

```
recur_fact(4)      # 1st call with 4
4 * recur_fact(3)  # 2nd call with 3
4 * 3 * recur_fact(2) # 3rd call with 2
4 * 3 * 2 * recur_fact(1) # 4th call with 1
4 * 3 * 2 * 1      # retrun from 4th call as number=1
4 * 3 * 2          # return from 3rd call
4 * 6              # return from 2nd call
24                 # return from 1st call
```

Credit:
<http://www.programiz.com/python-programming/recursion>

Recursion with Python Turtle

<https://trinket.io/python>

More reading: <https://www.linuxvoice.com/issues/002/02drawing.pdf>

```
import turtle
```

```
myTurtle = turtle.Turtle()
```

```
myWin = turtle.Screen()
```

```
def drawSpiral(myTurtle, lineLen):
```

```
    if lineLen > 0:
```

```
        myTurtle.forward(lineLen)
```

```
        myTurtle.right(90)
```

```
        drawSpiral(myTurtle, lineLen-5)
```

```
drawSpiral(myTurtle, 100)
```

Credit:

[http://interactivepython.](http://interactivepython.org/runestone/static/pythonds/Recursion/pythondsintro-VisualizingRecursion.html)

[org/runestone/static/pythonds/Recursion/pythondsintro-VisualizingRecursion.html](http://interactivepython.org/runestone/static/pythonds/Recursion/pythondsintro-VisualizingRecursion.html)

```
import turtle
```

```
def tree(branchLen,t):  
    if branchLen > 5:  
        t.forward(branchLen)  
        t.right(20)  
        tree(branchLen-15,t)  
        t.left(40)  
        tree(branchLen-15,t)  
        t.right(20)  
        t.backward(branchLen)
```

Credit:

<http://interactivepython.org/runestone/static/pythonds/index.html>


```
def main():  
    t = turtle.Turtle()  
    myWin = turtle.Screen()  
    t.left(90)  
    t.up()  
    t.backward(100)  
    t.down()  
    t.color("green")  
    tree(75,t)  
    myWin.exitonclick()
```

```
main()
```

Credit:

<http://interactivepython.org/runestone/static/pythonds/index.html>

```
from turtle import *

def drawSnowFlake(length, depth):
    if depth > 0:
        for i in range(6):
            forward(length)
            drawSnowFlake(length // 3, depth - 1)
            backward(length)
            left(60)

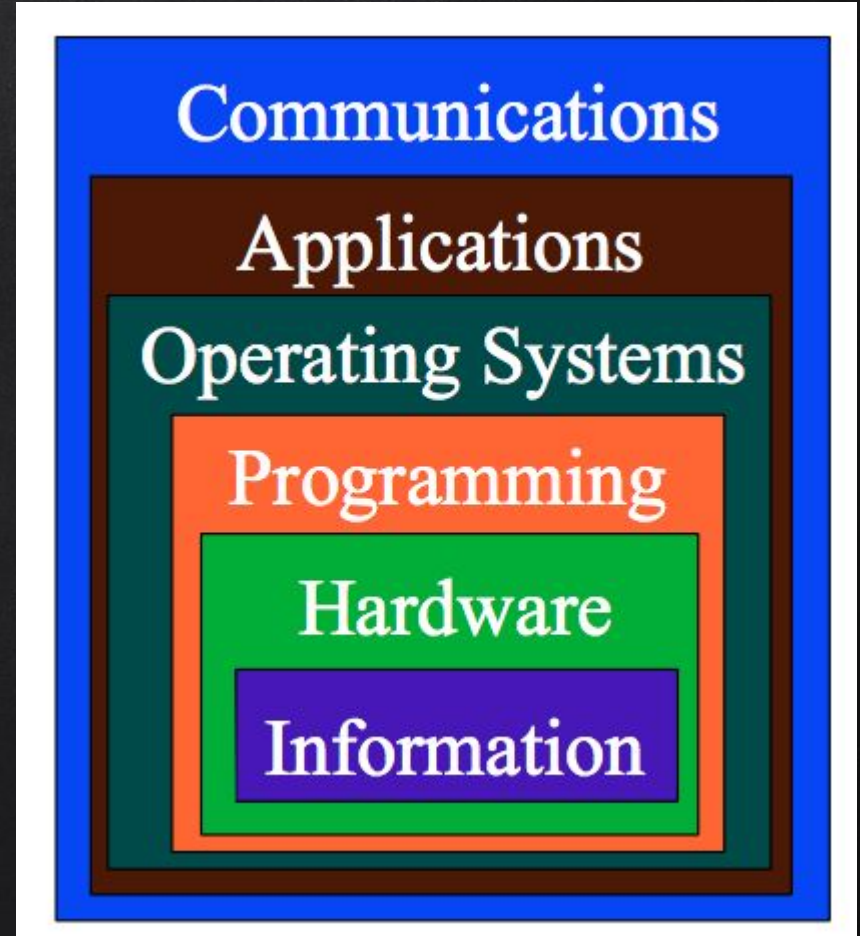
drawSnowFlake(60,2)
drawSnowFlake(60,3)
```

PLAY WITH PYTHON
LABS ON YOUR OWN!

COMPUTER NETWORKS

COMMUNICATION LAYER

- Computer networks form an infrastructure that allows data to travel from a source computer to a destination
- Networks are defined by the ability to communicate, not just physical connections

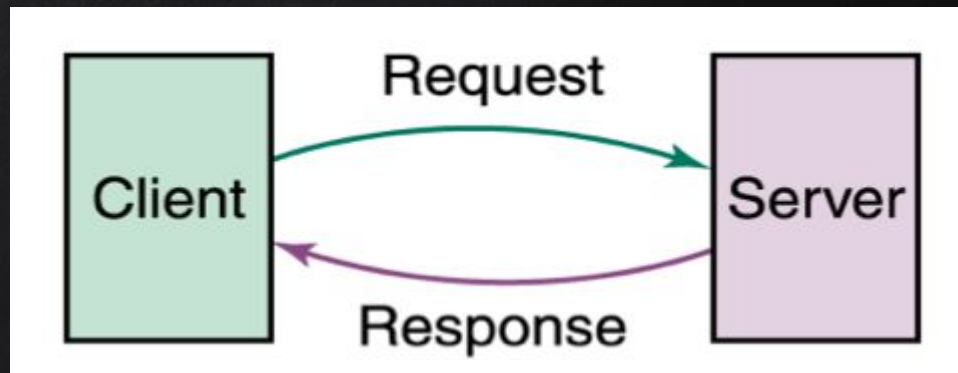


COMPUTER NETWORKS

- Host/**Node**: any device on a network
- Data transfer rate/**bandwidth**: the speed at which data is moved from one place on a network to another
 - We need to transfer more and larger data
- **Protocols**: a set of rules defining how data is formatted and processed on a network
 - Why is a common set of rules so important?

CLIENT-SERVER MODEL

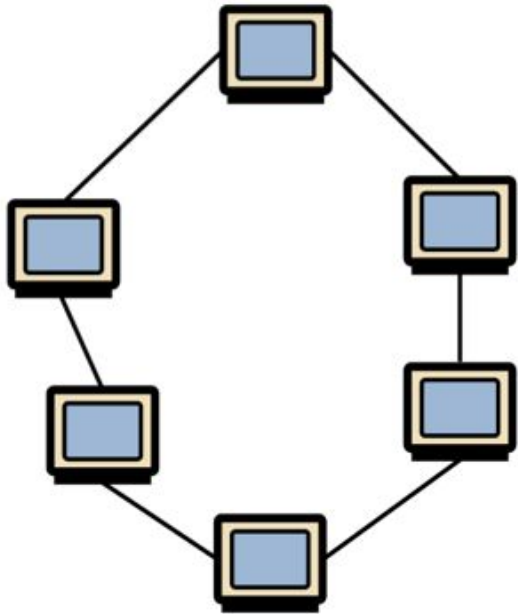
- Computing is not limited to the capabilities of one machine
 - Software systems can be distributed across a network
- A client sends a request to a server (for info or action) and the server responds
- Examples: file server, web server



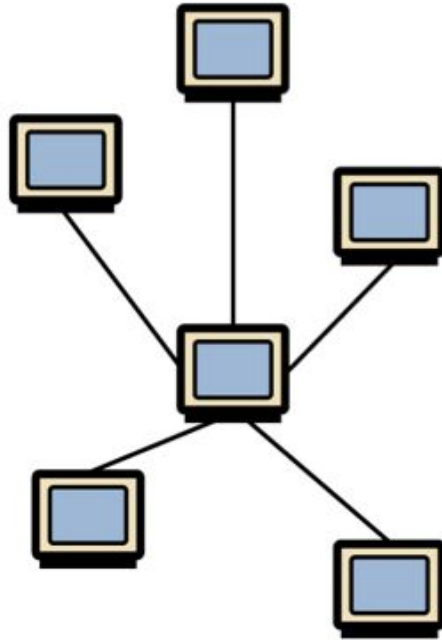
LOCAL-AREA NETWORK

- A **LAN** connects a relatively small # of machines in a relatively close geographical area.
- Usually confined to a room or a building
- How might devices be configured in a LAN?
- **Ethernet**: the industry standard bus technology for LAN

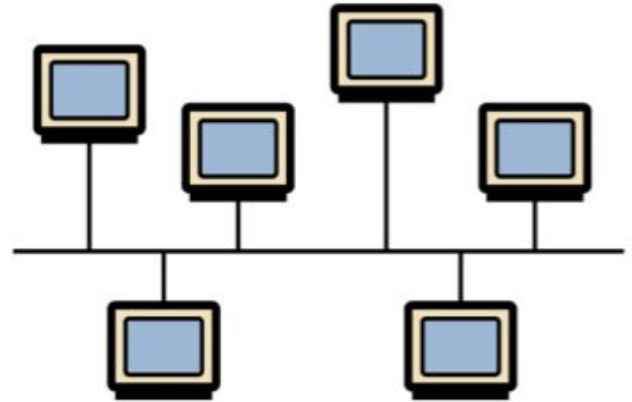
LAN TOPOLOGIES



Ring topology



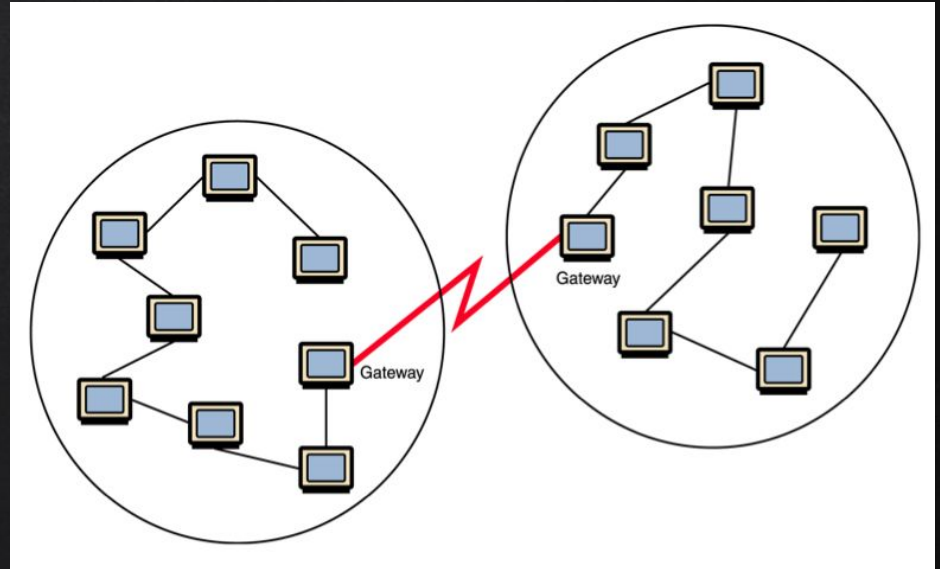
Star topology



Bus topology

WIDE-AREA NETWORKS

- A WAN connects 2 or more LANs over a potentially large geographic distance
- The Internet is essentially the ultimate WAN



INTERNET

- A vast collection of smaller networks that have agreed to communicate using the same protocols and pass messages along to their final destinations
- **Internet backbone**: a set of high-speed data routes that carry Internet traffic
 - At&T, Verizon, academic, government
 - No central network
- **Internet service provider**: a company that connects directly or indirectly to the Internet backbone

INTERNET CONNECTIONS

- ❑ Phone modem: convert data into an analog audio signal
- ❑ DSL (Digital subscriber line): uses phone line to transfer digital data (however digital signal degrades, must be close to ISP)
- ❑ Cable modem: transfer digital data using cable lines
- ❑ Typically download and upload speeds differ
- ❑ Fiber > Cable > DSL

PACKET SWITCHING

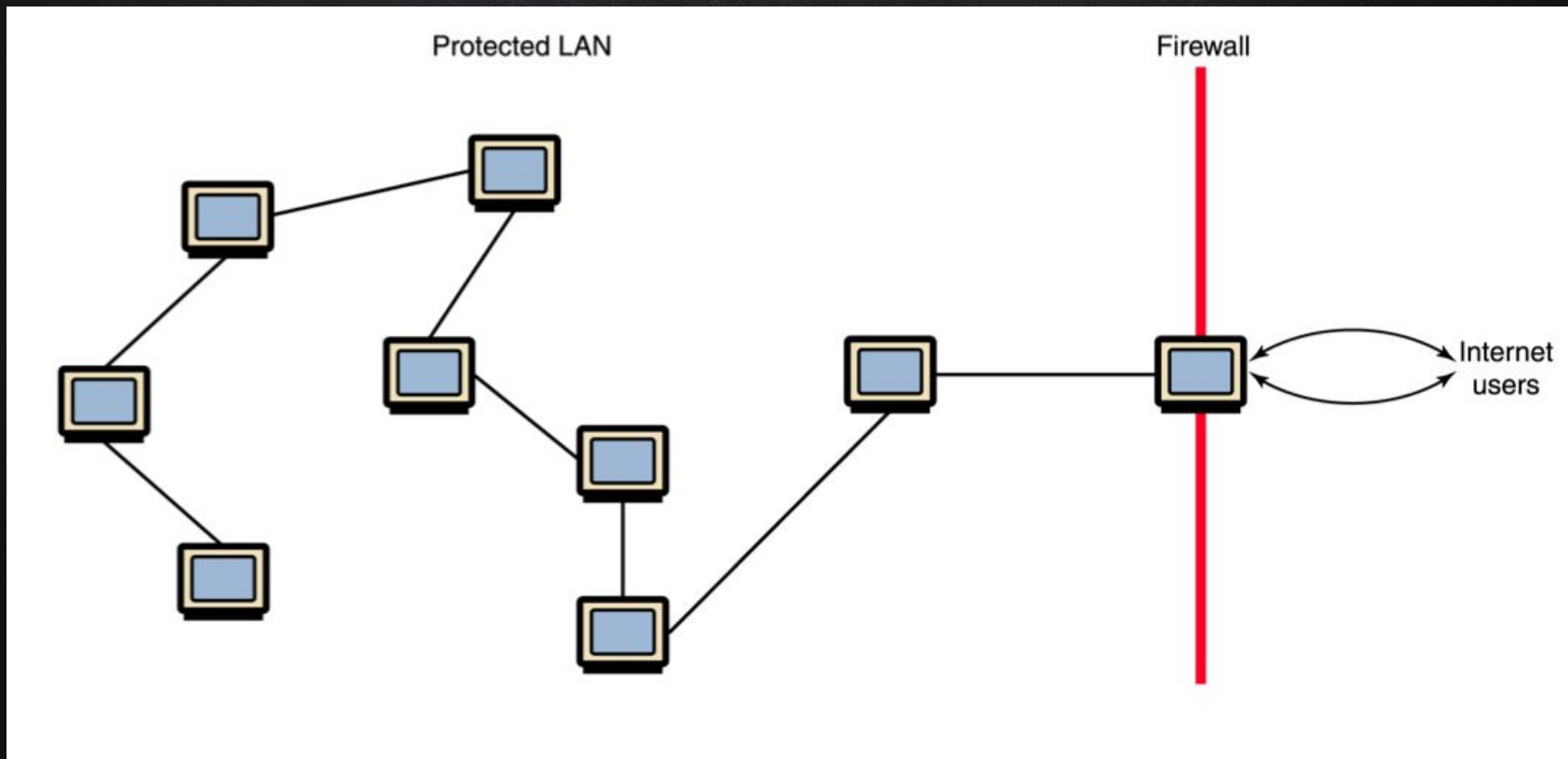
- Messages are divided into fixed-size, numbered packets
- Each packet is sent over the network individually
 - Packets may take different routes to the destination
 - At the destination, packets must be reassembled
- Router: a device that directs packets as they move between networks
 - Each router simply directs the packet to the next router to get it closer to its destination
 - Due to down machines and heavy traffic, routers can send a packet along an alternate route

NETWORK PROTOCOLS

- TCP/IP
 - Internet Protocol: routing of packets
 - Transmission Control Protocol: breaking messages into packets and assembling packets back into messages
- Simple Mail Transfer Protocol (SMTP)
- File Transfer Protocol (FTP)
- Telnet: log into a computer from a remote computer
- Hypertext Transfer Protocol (HTTP)

FIREWALLS

Filters the network traffic coming in and/or going out



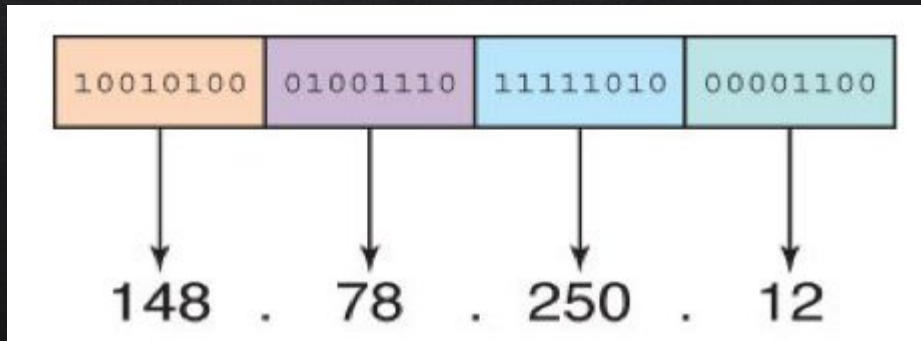
THE GREAT FIREWALL OF CHINA

- 1993: Golden Shield Project, a massive surveillance and censoring system, Cisco
- 2007: operate only sporadically at best, proxy servers
- 2008: Operation Tomorrow, crack down on youth usage of internet cafés to play online games and view content declared illegal
- Chilled speech and self-censorship: more effective at blocking internet content than the great firewall
- Filtered searches with Google
- 2013, Google's search share has declined to 1.7% from its August 2009 level of 36.2%.
- 2014, blocking Google
- Google is on its way back

Credit: wikipedia

NETWORK ADDRESSES

- Ultimately communicating with one particular computer out of all computers in the work
- Hostname: a unique identification that specifies a particular computer on the Internet
- How to find your computer's IP address? (Take-Home)
 - An IP address requires 32 bits, or 4 bytes, for storage



DOMAIN NAME SYSTEM

- lab1-1.eng.utah.edu
- Contains a machine name and a domain name
- The top-level domain (TLD) name (edu) indicates a particular type of organization, some carefully controlled
- .pizza
- Domain names in unrestricted TLDs were quickly taken
- Domain name system (DNS): used to translate hostnames to IP addresses
 - Distributed database with no central organization

CARD TRICK

What does this have to do with computer networks?

Need a student volunteer.

http://www.cs.utah.edu/~germain/out_of_body.html

PARITY BITS

- ❑ Error can occur during the transmission of data over a network
- ❑ Imagine losing a bit, how does that change a value?
- ❑ One parity bit is attached to each byte and set to make the number of 1s odd
 - ❑ If the byte is 1100 1100, the parity bit is set to 1
 - ❑ If the byte is 1111 0010, the parity bit is set to 0
- ❑ Upon receiving a byte the parity is checked
- ❑ Odd # of 1s – no error
- ❑ Even # of 1s – error
- ❑ Only limited power in checking errors



THANKS!

Any questions?

You can find me at
beiwang@sci.utah.edu

<http://www.sci.utah.edu/~beiwang/teaching/cs1060.html>

CREDITS

Special thanks to all the people who made and released these awesome resources for free:

- Presentation template by [SlidesCarnival](#)
- Photographs by [Unsplash](#)