# Lecture 5

CprE 308

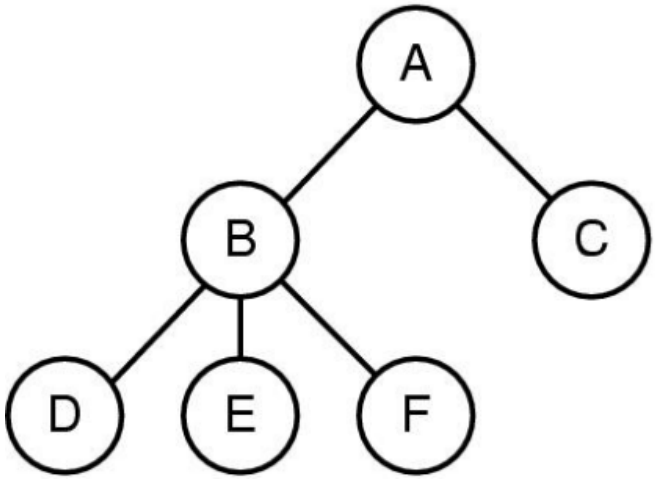
January 21, 2015

# Review from Last Week

# Processes

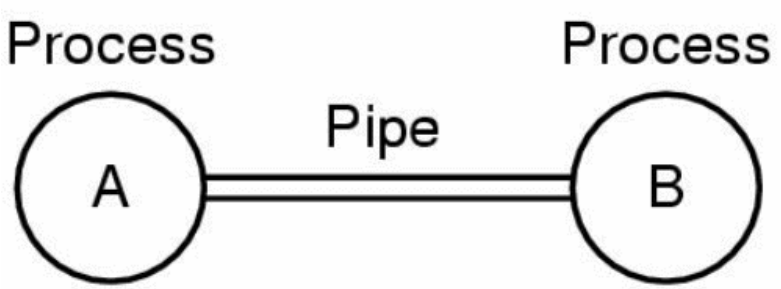
- Process = program in execution
  - Address space: Program (text), data, stack
  - Registers: Program counter, stack pointer, etc.
- Process can be created, suspended, restarted, killed (!)
- Process scheduler decides which process to run next among all the current processes

# Process Creation



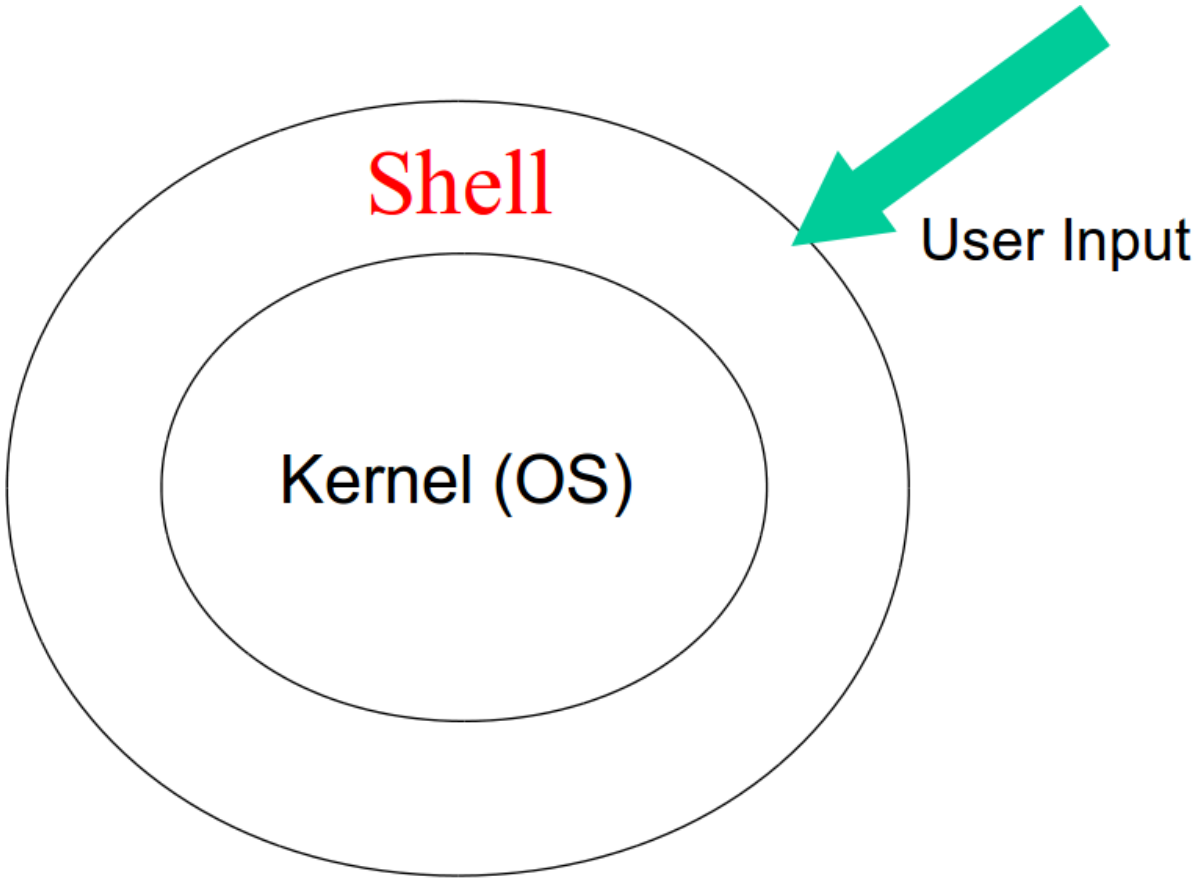

- In UNIX, there is a way for one process to "spawn" more processes
- A process tree
  - Process A created two child processes, B and C
  - Process B created three child processes, D, E, and F

# Inter process communication (UNIX)




- A *pipe* is like a pseudo file
- Processes set up a pipe in advance
- Processes read from or write to a pipe

# Structure of UNIX



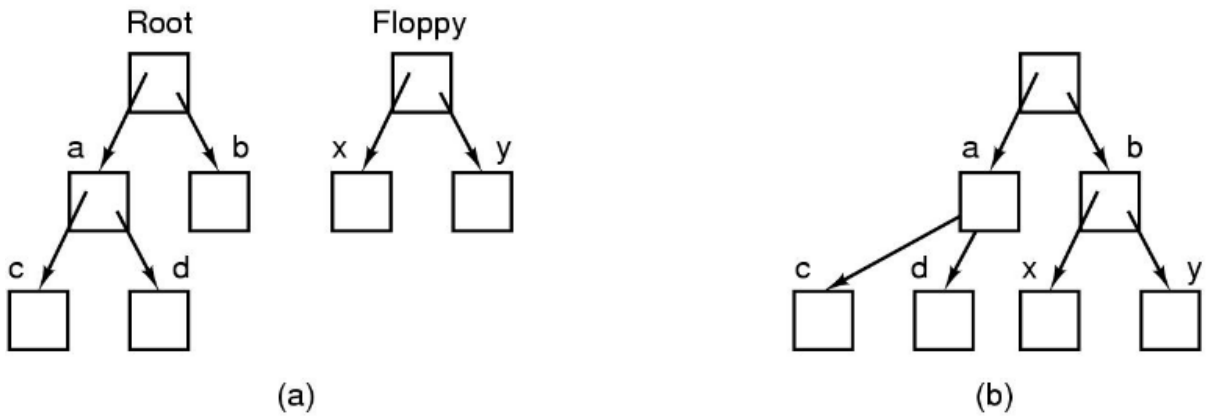
# System Calls

- Interface between the user and the operating system (kernel)
- Handle processes, files, directories, time, input/output
- Switch processor from user to kernel mode
  - In *User mode*, some instructions are forbidden
  - In *Kernel mode*, all instructions are allowed

# Example

- Read from file
  n = read(fd, buffer, nbytes);
- Change directory
  s = chdir(dirname);
- Get time
  s = time(&seconds);

# Mounting Files (UNIX)




- Before mounting,
  - files on floppy are inaccessible
- After mounting floppy on b,
  - files on floppy are part of file hierarchy

# Today's Topics

- Memory Basics - Stack and Heap
- Process Address Space

# Memory Basics

# Two Types of Memory

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## Stack:

- Automatically allocated and deallocated
- Local variables, parameters
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## Heap:

- Manually allocated and deallocated (sometimes not!)
- Dynamic sized data structures
- Used for data structures whose size is hard to predict

# Example C Program

```
int main() {
    int a;
    a = f();
}

int f() {
    int a,b;
    a = 10; b=10;
    return (a*b);
}
```

# Example C Program (2)

```
int main() {
    int a;
    a = f();
}

int f() {
    int a,
    a = 10;
    return (a*g());
}

int g() {
    int a;
    a=100;
    return (a);
}
```

# Fibonacci Numbers

```
int fib(int n) {
    if (n < 0) return 0;
    if (n ==0) return 1;
    if (n==1) return 1;
    return (fib(n-1)+fib(n-2));
}
```

# Using the Heap

```
int main() {
    int i;
    int *c = (int*) malloc(10*sizeof(int));
    for(i=0;i<10;i++)
        c[i] = i*i;
    free(c);
}
```

# Linked Lists

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- Computer Game
  - Maintain list of all moves made by the player
- Memory requirement unknown
  - Use dynamic memory, or the "heap"

# Where would the following go?

- Parameters, Return values

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- Parameters, Return values
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- User Input

# Garbage Collection

- No need to explicitly deallocate memory
  - i.e. no need for free() or equivalent
- No memory leaks
- Automatic Garbage Collection
- A key feature of Java is its garbage-collected heap