Lecture 3: Unix Shell, Pattern Matching, Regular Expressions

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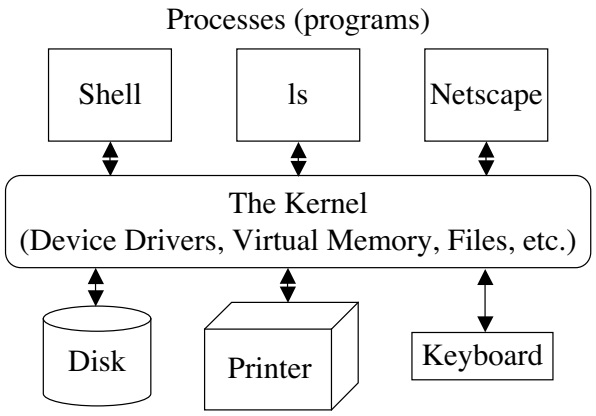
Today's Lecture

- Review Lab 0's info on the shell
- Discuss pattern matching
- Discuss regular expressions

Unix Architecture (simplified)



The Unix Shell

- A shell is a program that presents the user with an interpreted programming environment; there are many many shells!
- It provides
  - Variables and built-in commands
  - The ability to execute external commands (e.g. programs)
  - The ability to redirect input and output
  - Shortcuts such as aliases and wildcards
- In this class we are going to be using tcsh
  - Its an extended version of csh (The C Shell); the tcsh author added the "t" after adding features from the TENEX and TOP-10s operating systems to the vanilla C shell
- The purpose behind csh was to emulate the syntax and operators of the C programming language

Variables

% **set x = ken**

% **echo x**

x

% **echo $x**

ken

% **set y = (bananas apples kiwi)**

- This creates a 1-based array (first element indexed with a 1)
- An array is separated by spaces (which can cause problems) and surrounded by parentheses
- What happens if you leave the parentheses out?

- Certain constructs can take advantage of an array

%**echo $y[2]**

apples

%**foreach fruit ($y)**

foreach? **echo $fruit**

foreach? **end**

bananas

apples

kiwi

%**set y[2] = oranges**

%**echo $y**

bananas apples kiwi

More on Spaces

- Arrays are often used to iterate over the contents of directories in the file system
- Since the space character is used as a delimiter for arrays, you need to watch out for spaces that appear in file and directory names
  - See example next slide

Example Directory Structure

- Tenure Review/
  - Tenure Talk
  - Tenure Demo

```
%set z = (`find Tenure\ Review -type d -print`)
%echo $z
Tenure Review Tenure Review/Tenure Talk …
%echo $z[1]
Tenure
%echo $z[2]
Review
```

- This is not what we want!

How to fix?

- Use the shell “quoting” mechanism
- Already saw one example when I used the string “Tenure\ Review” in the find command
  - The backslash “escapes” the space and allows the two words to be treated as a single directory name
- You will learn more about the quoting mechanism in your labs; In addition, there is a lot of inforamtion about the quoting mechanism in your reference text book

Example Revisited

- Tenure Review/
  - Tenure Talk
  - Tenure Demo

```
%set z = (`"find Tenure\ Review -type d -print"`)
%echo $z
Tenure Review Tenure Review/Tenure Talk …
%echo $z[1]
Tenure Review
%echo $z[2]
Tenure Review/Tenure Talk
```

- Much better!

Math

- "set" treats the value as a string

% **set x = (2 + 3)**
% **echo $x**
  2 + 3
% **echo $x[2]**
  +
% Use "@" to do math;
  - Note: the space between the "@" and the variable is **REQUIRED**

% **@ x = (2 + 3)**
% echo $x
  5

- tcsh supports most of C's expression operators (such as plus, minus, multiply, divide, less than, greater than, equal, etc.)

  + - * / > < == >= <= && || ! ++ -- += -= *= /=

Input/Output Redirection

- tcsh can redirect input and output
  - it can also redirect error output (not shown)

% **date**
  Sun Aug 20 11:11:10 MDT 2000
% **date > today**
% **more today**
  Sun Aug 20 11:11:14 MDT 2000
% **rev < today**
  0002 TDM 41:11:11 02 guA nuS

Control Flow Constructs

- Conditional

```
if ($x > 3) then
    echo true
else
    echo false
endif
```

- Iteration

```
while !($done)
    …
end

foreach directory (bin build lib)
    mkdir $directory
end
```

Control Flow Constructs, cont.

- multi-branch

```
switch ($char)
    case a:
        echo character is “a”
        breaksw
    default:
        echo character is not
          “a”
        breaksw
    endsw
```

- tcsh does not have a for loop construct…e.g.,

```
for (x = 0; x < 5; x++)
        …
end
```

- …use a while loop instead

```
@ x = 0
while ($x < 5)
        …
        @ x++
end
```


File Inquiry operations

- tcsh has file inquiry operators. They can be used in expressions.

```
% set filename = ~/.cshrc
% echo $filename
    /home/ken/.cshrc
% if (-e $filename) echo true
    true
% @ x = (5 + -e $filename)
% echo x = $x
    x = 6
```


Job control

- When you invoke a program, you are executing a “job”
- You can find out what jobs are running with the “jobs” command
- Typically, a job “suspends” the shell until it has finished running, e.g. when you invoke the “ls” program, the shell waits until ls generates its output
  - You can run a job in the background with an ampersand “&”, e.g. “% emacs &”
- You can suspend a running job using C-z (control-z)
- You can interrupt a running job using C-c
- A job can be brought into the foreground with “fg” and placed into the background with “bg”

Wildcards

- The shell, and some other UNIX programs (such as find) make use of wildcard characters. The name wildcard comes from card games where a “wild” card can stand for any other card. We will also call wildcard characters, *metacharacters*.

```
% ls
    graph.c graph.h main.c stack.c stack.h
%ls *.c
    graph.c main.c stack.c
```

- Note: ls does not do the wildcard search, the shell does. If you do not want the shell to perform a wildcard search, then you need to quote all metacharacters

```
%ls “*.c”
  ls: *.c: No such file or directory
```

Wildcards and their meanings

- * - match 0 or more instances of any character
- ? - match a single instance of any character
- [123ab] - match a single instance of any character within the brackets
- [0-9] - Shorthand for [0123456789]
  - The range is based on the ASCII character set. So, [a-Z] does not capture lowercase and uppercase letters. Use [a-zA-Z] instead
- [^0-9] - Match a single instance of any character except those specified in the brackets
- {pattern1,pattern2, …} - Match one of the listed patterns

Wildcard Examples

- Consider a directory with the following files: aa aba a123aa baa Abbb a3ab

% **ls a***
aa aba a123aa a3ab

% **ls a?**
aa

% **ls [ab][123][ab][ab]**
a3ab

% **ls *b[a-z]**
aba Abbb

% **ls {a?,*b}**
Abbb a3ab aa

Pattern Matching

- Wildcards are one form of pattern matching. Another form of pattern matching is based on a formalism known as “regular expressions.”
- We need to make this distinction since some programs, such as **grep** and **awk**, use regular expression pattern matching rather than wildcard pattern matching.
- Unfortunately, the syntax for each uses the same characters but in different ways!
  - Actually, the situation is worse (especially for newcomers). Some metacharacters remain the same, but some are different in rather significant ways!

Regular Expression Syntax

- . - match a single instance of any character except newline
- [123ab] - Match a single instance of any character within the brackets
- [0-9] - Shorthand for [0123456789]
- [^0-9] - Match a single instance of any character except those specified in the brackets
- pattern1 | pattern2 | … Match one of the listed patterns

- Question: if [a-z] means match a single instance of “a, b, c, d, …, z”, how do I match a “-” in a range expression?

Regular Expression Syntax, cont.

- ^ - Match the beginning of the line
- $ - Match the end of the line
- * - Match zero or more repetitions of the previous regular expression
- + - Match one or more repetitions of the previous regular expression (requires egrep)
- ? - Match zero or one repetitions of the previous regular expression (requires egrep)
- \ - Remove the special meaning of the next character

Wildcard and RE Differences

- In regular expressions "*" means something very different than it does in wildcards
- In wildcards a* matches a, aa, abc, a52b, …
- In regular expressions a* matches only a, aa, aaa, aaaa, …
- This also applies to "+" and "?". They do not stand for any characters themselves, but rather modify the previous regular expression.
  - So, how do you search for an "*"?
    - a* matches only "a*"

Regular Expression Strategies

- When using a regular expression to find a desired search string, be aware of the following three quantities
- Hits
  - Lines you wanted to match
- Omissions
  - Lines you didn't match but wanted to match
- False Alarms
  - Lines you matched but didn't want to match

Looking for the word "book"

%cat example
This file tests for book in various places, such as
book at the beginning of a line or
at the end of a line book
as well as the plural books and
handbooks
%grep " book " example - matches only line 1
%grep "book" example - matches all lines

How would we match lines 1, 2, and 3?