Lecture 04
text, pipes & redirects

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Lecture 04 outline

Previously: git

This time: text, pipes & redirects

let's learn how to

- work with text
- send info between commands
- send output to file
- create "pipelines"

Unix design philosophy

Designed for complex, modular workflows

1. ***Make each program do one thing well.*** To do a new job, build afresh rather than complicate old programs by adding new "features."
2. ***Expect the output of every program to become the input to another, as yet unknown, program.*** Don't clutter output with extraneous information. Avoid stringently columnar or binary input formats. Don't insist on interactive input.
3. ***Design and build software***, even operating systems, ***to be tried early***, ideally within weeks. Don't hesitate to throw away the clumsy parts and rebuild them.
4. ***Use tools in preference to unskilled help to lighten a programming task***, even if you have to detour to build the tools and expect to throw some of them out after you've finished using them.

McIlroy, Pinson, Tague (*Bell System Technical Journal* 1978)

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What format can potentially
be read and written by any program,
and read and written by any user?

(hint: this stuff)

Strings

A ***string*** is a sequence of ***standard text characters*** that can be interpreted (or read) by humans

Binary string
- 010010010101

Hexidecimal string
- bf2741f09ce03ede19231

Text string
- Hello, world!
- top_secret_password.txt

Text strings

Text strings can include any standard character (*e.g., letters, numbers, symbols, spaces, ...*)

A string is ***constructed*** as a sequence of characters that is ***delimited*** by a matching pair of single quotes or double quotes

```
# valid single-quote construction
'Hello, world!'
# valid double-quote construction
"Hello, world!"
# not valid, due to mismatched quotes
'Hello, world!"
```

Escaped characters

Certain characters have special meanings, such as the string delimiter tokens (‘ and “)

Special characters can be ***escaped*** when preceded by the backslash (\ )

When constructing a string, an escaped character will print its apparent (or ***literal***) value rather than apply its special meaning

Escaped strings

string construction	**string literal**
“my friend”	my friend
“my ‘friend’”	my ‘friend’
”my “friend””	syntax error
”my \\”friend\\””	my “friend”

For most programs/shells:

- single-quote strings escape all characters
- double-quote strings require manual escapes

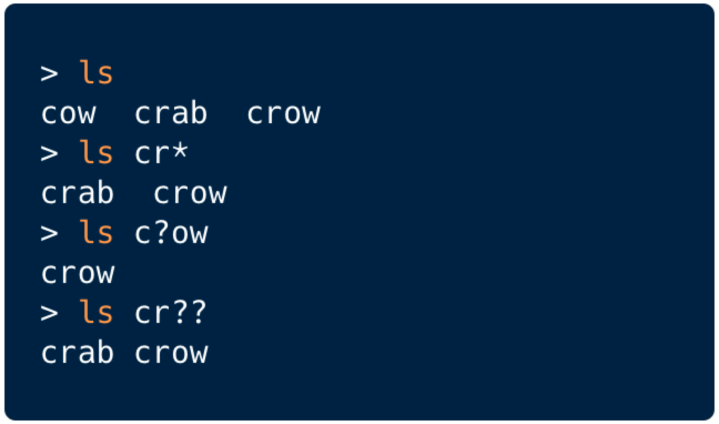
Common special characters

escaped character	**string literal**	**special meaning**
\”	“	string delimiter
\’	‘	string delimiter
\$	$	shell variable identifier
*	*	wildcard
\?	?	wildcard
\\\\	\\	escape character
\n	<newline>	enters newline
\t	<tab>	enters tab

Wildcards

Wildcards match general patterns across many strings (useful with filesystems)

Each wildcard character in a string can match
- any *single* character against the **?** wildcard
- any *string* of characters against the ***** wildcard



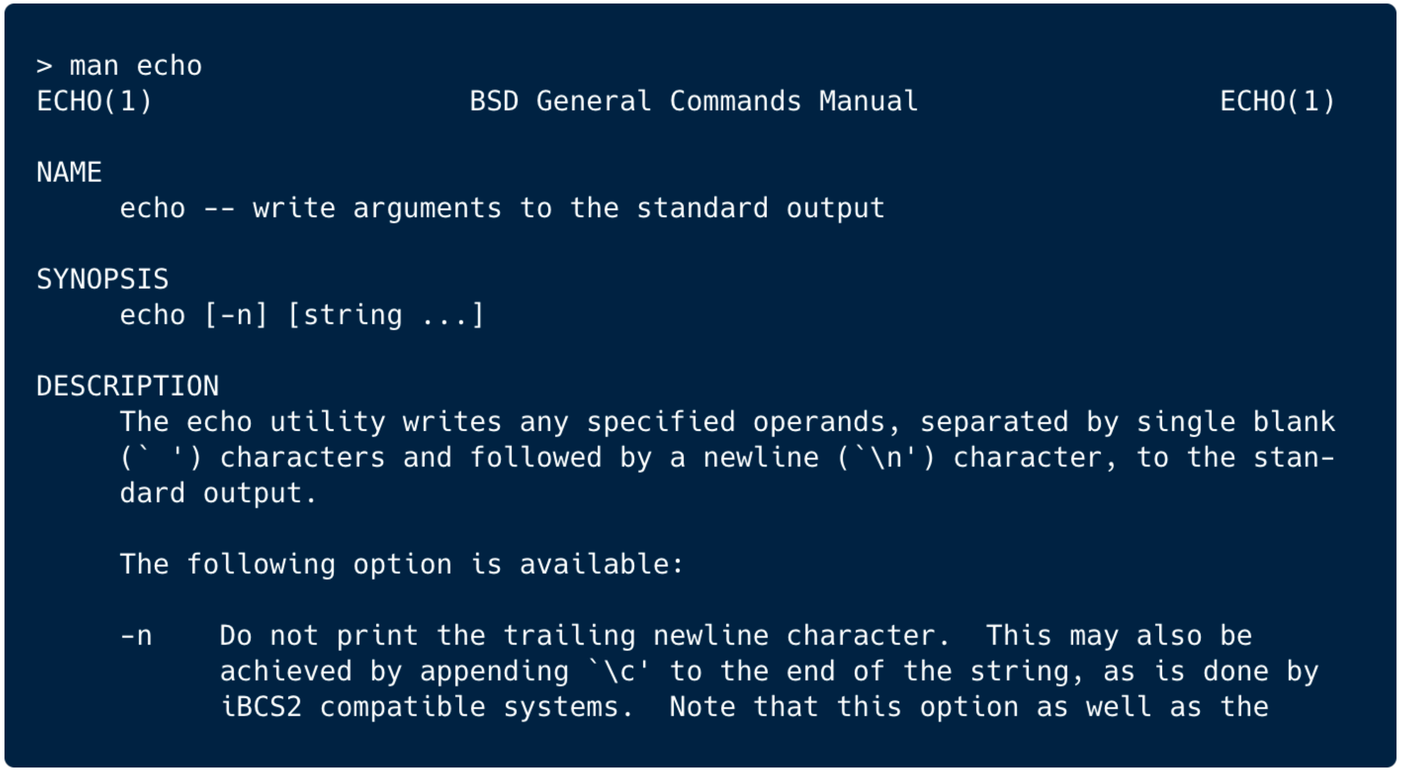
```
> ls
cow   crab   crow
> ls cr*
crab   crow
> ls c?ow
crow
> ls cr??
crab crow
```

More shell comands

man	display manual page
wc	line, word, character counts
head	display first lines of file
tail	display last lines of file
diff	compare files line-by-line
grep	file pattern searcher

man

display manual page



```
> man echo
ECHO(1)                   BSD General Commands Manual                  ECHO(1)

NAME
     echo -- write arguments to the standard output

SYNOPSIS
     echo [-n] [string ...]

DESCRIPTION
     The echo utility writes any specified operands, separated by single blank
     (` ') characters and followed by a newline (`\n') character, to the stan-
     dard output.

     The following option is available:

     -n    Do not print the trailing newline character.  This may also be
           achieved by appending `\c' to the end of the string, as is done by
           iBCS2 compatible systems.  Note that this option as well as the
```

arrow keys to navigate; ‘q’ to exit

wc

count lines, words, characters for file

```
# print file contents
> cat lyrics.txt
I am the very model of a modern Major-General,
I've information vegetable, animal, and mineral,
I know the kings of England, and I quote the fights historical
From Marathon to Waterloo, in order categorical;
I'm very well acquainted, too, with matters mathematical,
I understand equations, both the simple and quadratical,
About binomial theorem I'm teeming with a lot o' news,
With many cheerful facts about the square of the hypotenuse.
I'm very good at integral and differential calculus;
I know the scientific names of beings animalculous:
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.

# count lines, words, and characters
> wc lyrics.txt
      12     108     669 lyrics.txt
```

line count

word count

char. count

target file

head

display first lines of file

print first
10 lines
(default)

```
# print first ten lines (default)
> head lyrics.txt
I am the very model of a modern Major-General,
I've information vegetable, animal, and mineral,
I know the kings of England, and I quote the fights historical
From Marathon to Waterloo, in order categorical;
I'm very well acquainted, too, with matters mathematical,
I understand equations, both the simple and quadratical,
About binomial theorem I'm teeming with a lot o' news,
With many cheerful facts about the square of the hypotenuse.
I'm very good at integral and differential calculus.
I know the scientific names of beings animalculous:

# print first two lines
> head -n2 lyrics.txt
I am the very model of a modern Major-General,
I've information vegetable, animal, and mineral,
```

print only
first 2 lines
(-n2)

tail

display last lines of file

print last
10 lines
(default)

```
# print last ten lines (default)
> tail lyrics.txt
I know the kings of England, and I quote the fights historical
From Marathon to Waterloo, in order categorical; a
I'm very well acquainted, too, with matters mathematical,
I understand equations, both the simple and quadratical,
About binomial theorem I'm teeming with a lot o' news,
With many cheerful facts about the square of the hypotenuse.
I'm very good at integral and differential calculus;
I know the scientific names of beings animalculous:
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.

# print last two lines
> tail -n2 lyrics.txt
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.
```

print only
last 2 lines
(-n2)

diff

compare files line-by-line

```
# view end of first file
> tail -n2 lyrics.txt
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.

# view end of second file
> tail -n2 or_were_these_the_lyrics.txt
In short, in matters vegetable, animal, and mineral,
I am the HAIRY model of a modern Major-General.

# show differences in files
> diff lyric.txt or_were_these_the_lyrics.txt
12c12
< I am the very model of a modern Major-General.
---
> I am the HAIRY model of a modern Major-General.
```

difference on line 12

grep

file pattern searcher

print lines
that contain
pattern “animal”

```
# print lines containing "animal"
> grep animal lyrics.txt
I've information vegetable, animal, and mineral,
I know the scientific names of beings animalculous:
In short, in matters vegetable, animal, and mineral,

# print lines that do _not_ contain "animal"
> grep -v animal lyrics.txt
I am the very model of a modern Major-General,
I know the kings of England, and I quote the fights historical
From Marathon to Waterloo, in order categorical;
I'm very well acquainted, too, with matters mathematical,
I understand equations, both the simple and quadratical,
About binomial theorem I'm teeming with a lot o' news,
With many cheerful facts about the square of the hypotenuse.
I'm very good at integral and differential calculus;
I am the very model of a modern Major-General.
```

print lines
that *do not* contain
pattern “animal”
(-v for in**v**erted grep)

We’ll learn more about this powerful tool
when we learn about regular expressions

echo -e, again

Different shells (bash, zsh, dash, *etc.*) have different versions of *echo* and process strings differently

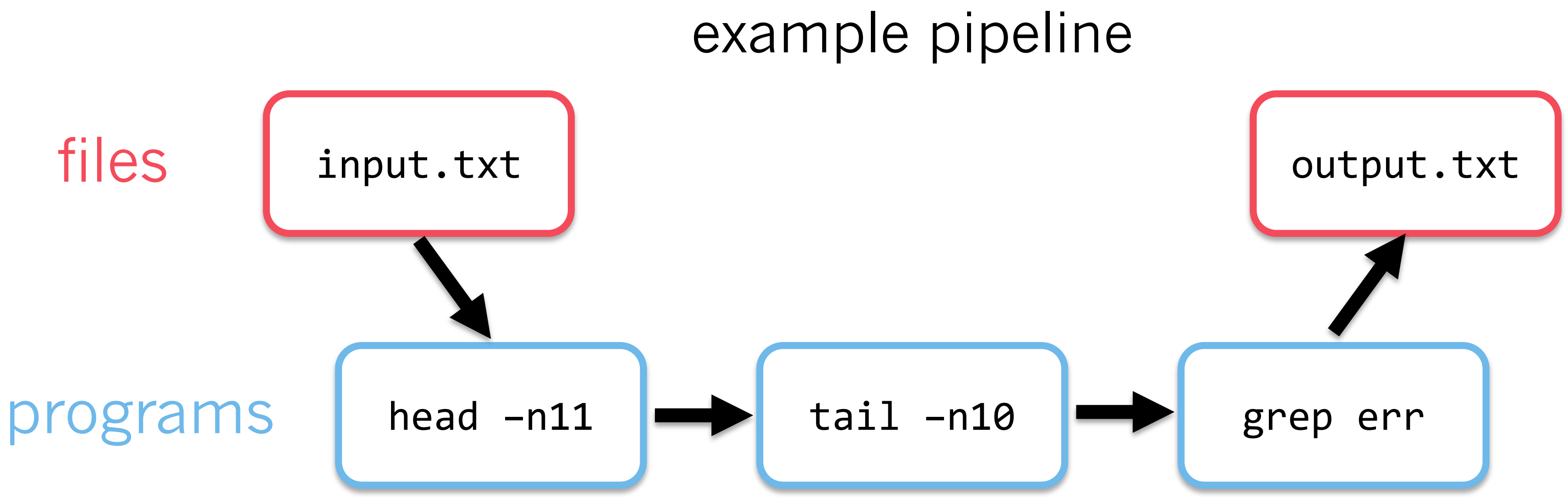
```
# string contains \n
$ echo -e "This should print '\n', right?"
This should print '
', right?

# shell converts \\ to \, so echo processes \n
$ echo -e "This should print '\\n', right?"
This should print '
', right?

# shell converts \\ to \, echo converts remaining \\ to \
$ echo -e "This should print '\\\n', right?"
This should print '\n', right?
```

set -x

Prints debug information to show how command is processed

```
# enable debugging
$ set -x

# shell converts \\ to \, so echo processes \n
$ echo -e "This should print '\\n', right?"
+ echo -e 'This should print '\''\n'\'', right?'
This should print '
', right?

# shell converts \\ to \, echo converts remaining \\ to \
$ echo -e "This should print '\\\n', right?"
+ echo -e 'This should print '\''\\n'\'', right?'
This should print '\n', right?

# string concatenation
$ echo -e 'Strings get con'"cat"'en'"ated"'\n\t\\n'
+ echo -e 'Strings get concatenated\n\t\\n'
Strings get concatenated
         \n

# disable debugging
$ set +x
```

Redirects and pipes



Redirects transmit info between files and programs

Pipes transmit info directly between programs

Use > to ***redirect*** program <u>output</u> into a file

```
$ echo "Hello, world!"
Hello, world!
# redirect echo output into file.txt
$ echo "Hello, world!" > file.txt
$ ls
file.txt
$ cat file.txt
Hello, world!
```

Use >> to ***append*** program <u>output</u> into a file

```
# append echo output into file.txt
$ echo "...um, hello?" >> file.txt
$ cat file.txt
Hello, world!
...um, hello?
```

Use < to ***redirect*** a file as input into a program

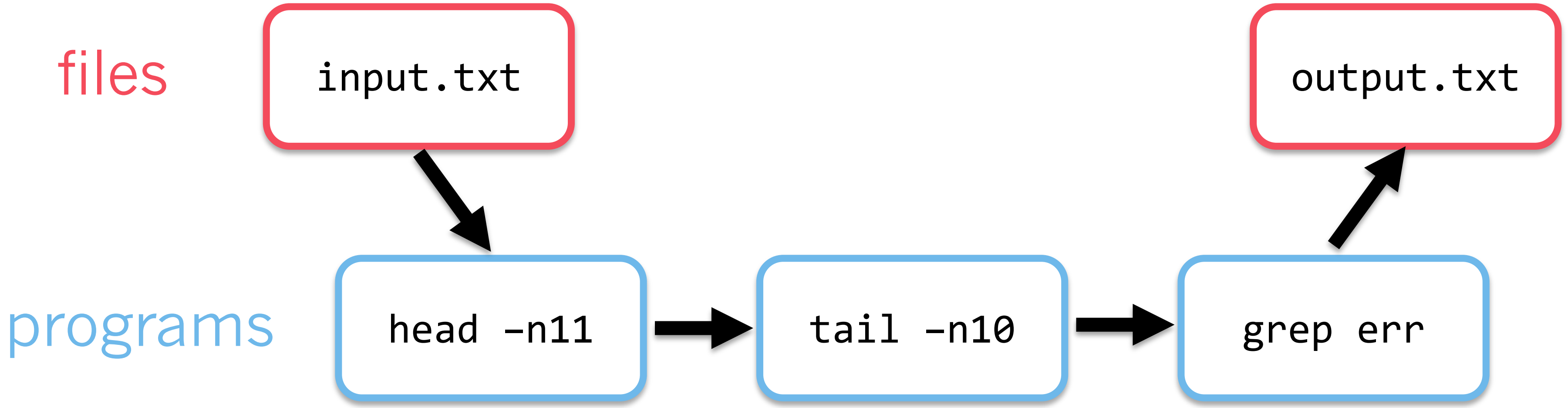
```
# redirect file.txt as input into cat
$ tail -n2 < lyrics.txt
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.
```

Use | to transmit (or ***pipe***) the output of one program as the input of a second program

```
# pipe the output of the ls command
# as input for the wc command
$ ls
eenie.txt  meenie.txt minie.txt  mo.txt
$ ls | wc
       4       4      38
$ ls *eenie.txt | wc
2 2 21
```

Redirects and pipes

example pipeline



example command

```
$ head -n11 < input.txt | tail -n10 | grep err > output.txt
```

more pipeline examples

```
# create a new file with text
$ echo "I made a file for you" > new_file.txt
$ cat new_file.txt
I made a file for you
```

```
# count how many lines contain "animal";
# print that count to the file "num_animal.txt"
$ grep animal lyrics.txt | wc -l > num_animal.txt
$ cat num_animal.txt
3
```

```
# quickly scan man page for option to number lines
$ man cat | grep "  -" | grep Number
     -b      Number the non-blank output lines, starting at 1.
     -n      Number the output lines, starting at 1.
```

```
# redirect file.txt as input into tail;
# then redirect out from cat into lyrics_tail.txt
$ tail -n2 < lyrics.txt > lyrics_tail.txt
$ cat lyrics_tail.txt
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.
```

```
# Suppose you fit a model to the same dataset twice;
# this is often done to ensure that the inference
# method succeeded to find the best estimate. Find
# instances where the two output files contain
# _different_ values for parameter x2, but at least
# one model-fitting method claims success.
$ cat output1.txt
10.321,x1,failure
36.331,x2,success
91.585,x3,success
$ cat output2.txt
10.321,x1,failure
35.268,x2,failure
96.521,x3,success
# find differences in x2 where an entry claims success
$ diff output1.txt output2.txt | grep x2 | grep success
< 36.331,x2,success
```

Overview for Lab 04