Linux Session, Standard Streams, Pipes & Filters in Linux

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Outline

- Linux Session
- Standard Input Output
- Redirection & Pipes
- Filters
- Q & A

Process Groups and Sessions

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- A process group (Job) is created each time a command or a pipeline of commands in a shell is executed.
- In its turn, each process group belongs to a session.
- Linux kernel provides a **two-level hierarchy** for all running processes.
- As such, a process group is a set of processes, and a session is a set of related process groups.
- Another important limitation is that a process group and its members can be members of a single session.

```
$ sleep 100                                  # a process group with 1 process
$ cat /var/log/nginx.log | grep string | head     # a process group with 3 processes
```

More on this in wait and signal topic….

A relationship between a session, its process groups and processes.

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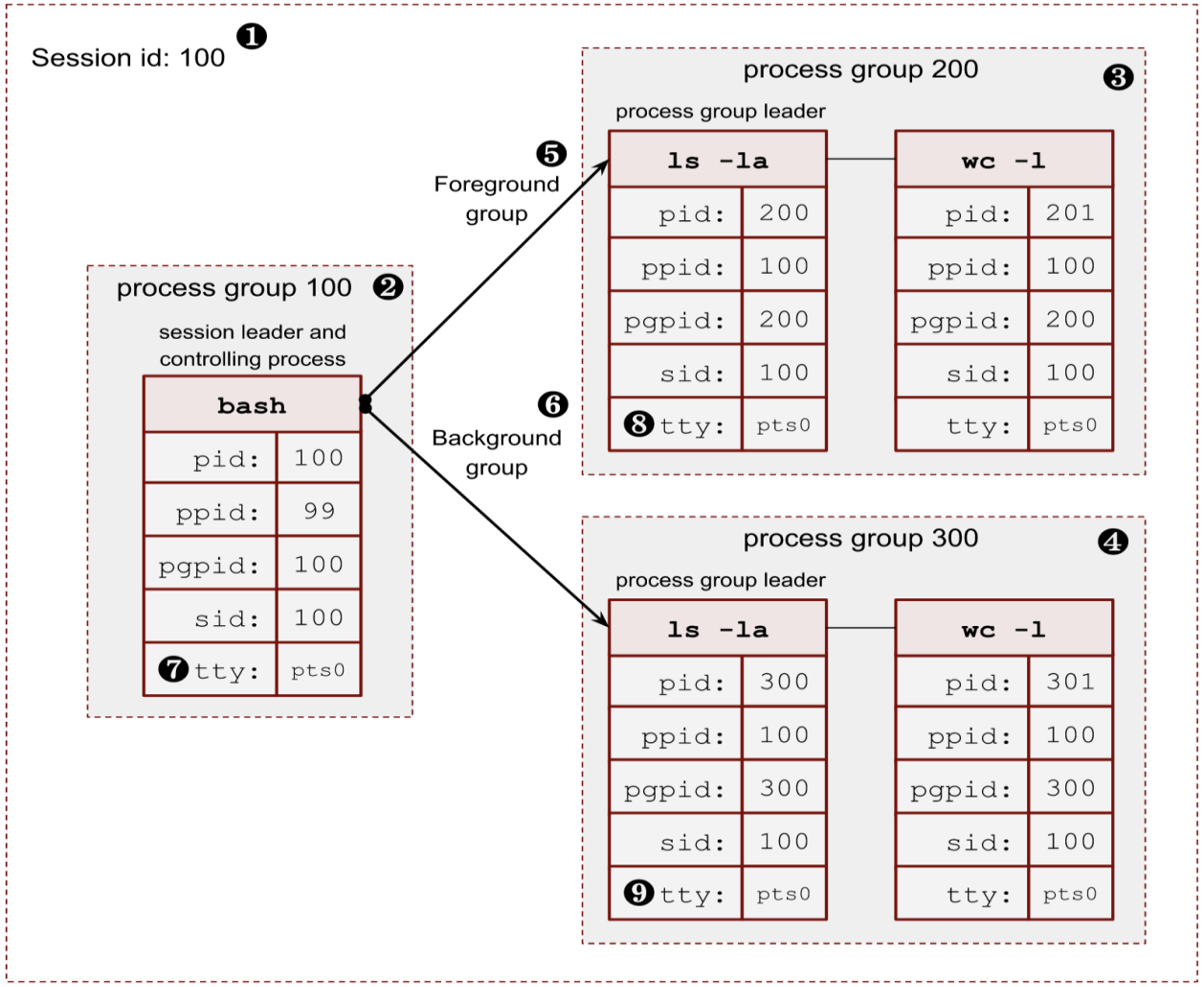
- ❶ SID is the same as the session leader process bash PID
- ❷ The session leader process (bash) has its own process group, where it's a leader, so PGID is the same as its PID.
- ❸, ❹ The session has 2 more process groups with PGIDs 200 and 300.
- ❺, ❻ Only one group can be a foreground for a terminal. All other process groups are background.
- ❼, ❽, ❾ All members of a session share a pseudo-terminal /dev/pts/0.



Linux Sessions

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- A session is a collection of process groups.
- All members of a session identify themselves by the identical SID (type: pid_t)
- As a process group, SID is also inherited from the session leader, which created the session.
- All processes in the session share a single controlling terminal
- A new process inherits its parent’s session ID.
- To start a new session a process should call setsid().

Linux Sessions

- The process running this syscall begins a new session, becomes its leader, starts a new process group, and becomes its leader too.
- SID and PGID are set to the process' PID.
- That's why the process group leader can't start a new session: the process group could have members, and all these members must be in the same session.

- Basically, a new session is created in two cases:
  - When we need to log in a user with an interactive shell. A shell process becomes a session leader with a controlling terminal.
  - A daemon starts and wants to run in its own session to secure itself

I/O in Shell

A Linux shell, such as Bash, receives input and sends **output as sequences or *streams* of characters.**

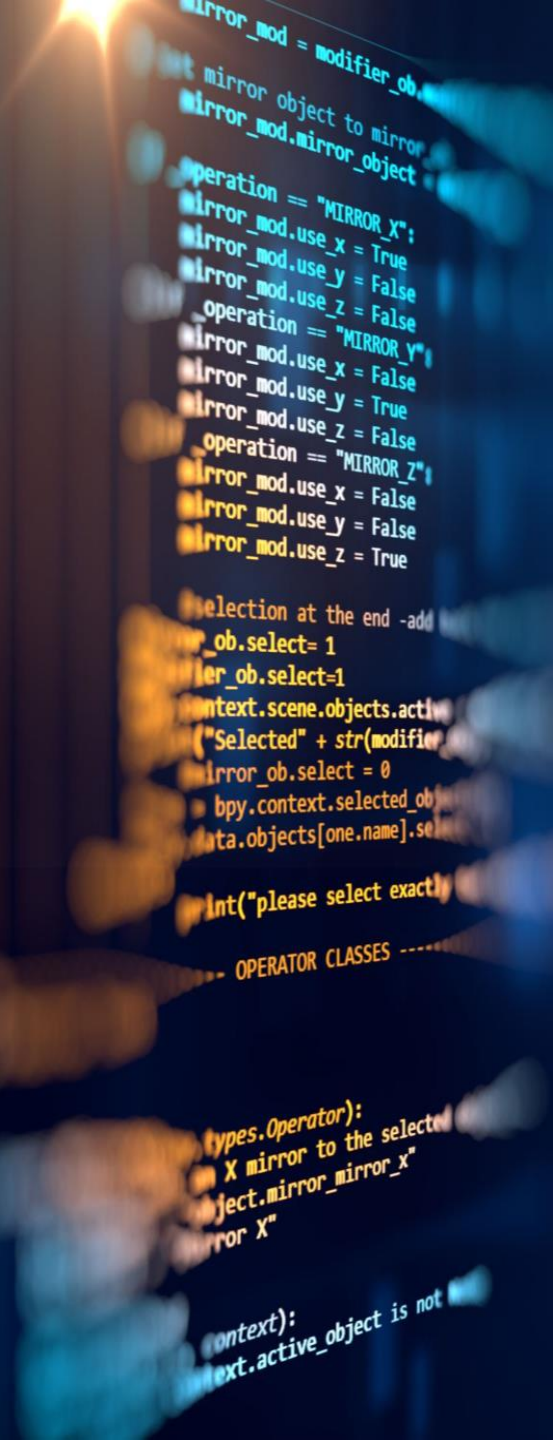
Each character is ***independent***.

The characters are ***not*** organized into structured records or fixed-size blocks.

Streams are accessed using file IO techniques, **whether the actual stream of characters comes from or goes to a file, a keyboard, a window on a display, or some other IO device.**

I/O Streams

- Linux shells use 3 standard I/O streams, each of which is associated with a file descriptor (fd):
  - ***stdout*** is the *standard output stream*, which displays output from commands. It has fd 1.
  - ***stderr*** is the *standard error stream*, which displays error output from commands. It has fd 2.
  - ***stdin*** is the *standard input stream*, which provides input to commands. It has fd 0.



Redirecting standard Output

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- Prepare input data in a file or save output or error information in a file.
- Redirecting output
  - There are two ways to redirect output to a file:
    - ***n*>**
    - ***n*>>**
  - Where n is a file descriptor

Redirect both standard output and standard error into a file

This is done for automated processes or background jobs so that you can review the output later.

Use ***&> or &>>*** to redirect both standard output and standard error to the same place

Another way of doing this is to redirect file descriptor *n* and then redirect file descriptor *m* to the same place using the construct ***m>&n or m>>&n***

The order in which outputs are redirected is important

Redirecting input

We redirect stdin from a file using the < operator

```
[vimal@baghel]$ cat text1
```

- 1 apple
- 2 pear
- 3 banana

```
[vimal@baghel]$ tr ' ' '\t'<text1
```

- 1	apple
- 2	pear
- 3	banana

Redirecting input

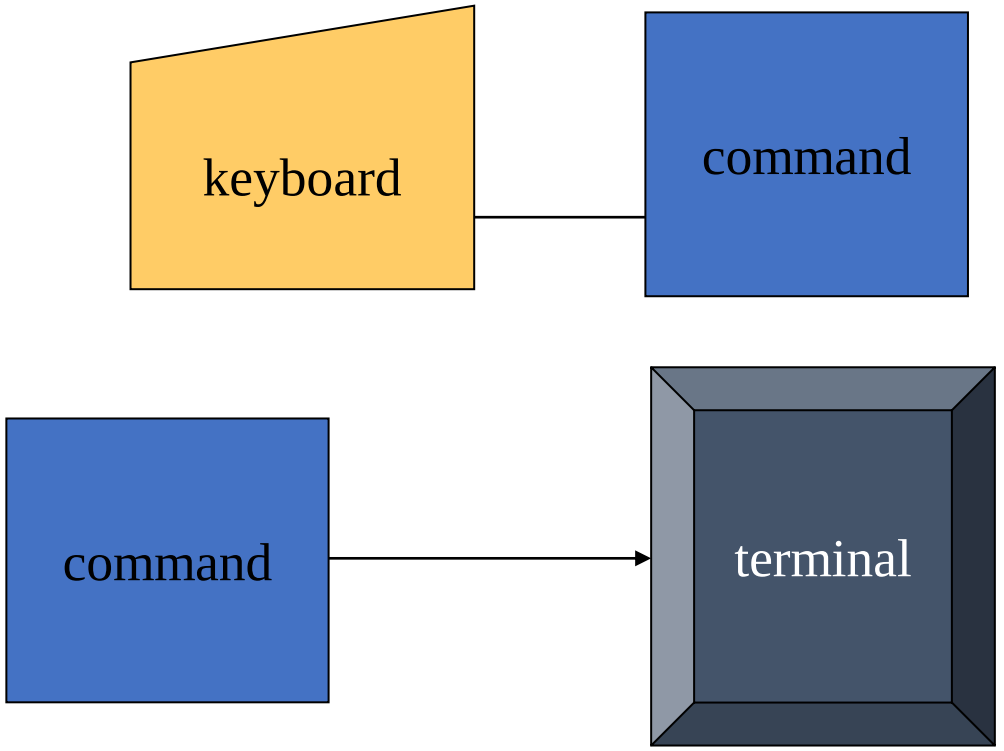
```
[vimal@baghel]$ sort -k2 <<END
```

- > 1 apple
- > 2 pear
- > 3 banana
- > END

Sorted output

- 1 apple
- 3 banana
- 2 pear

Standard Input and Output

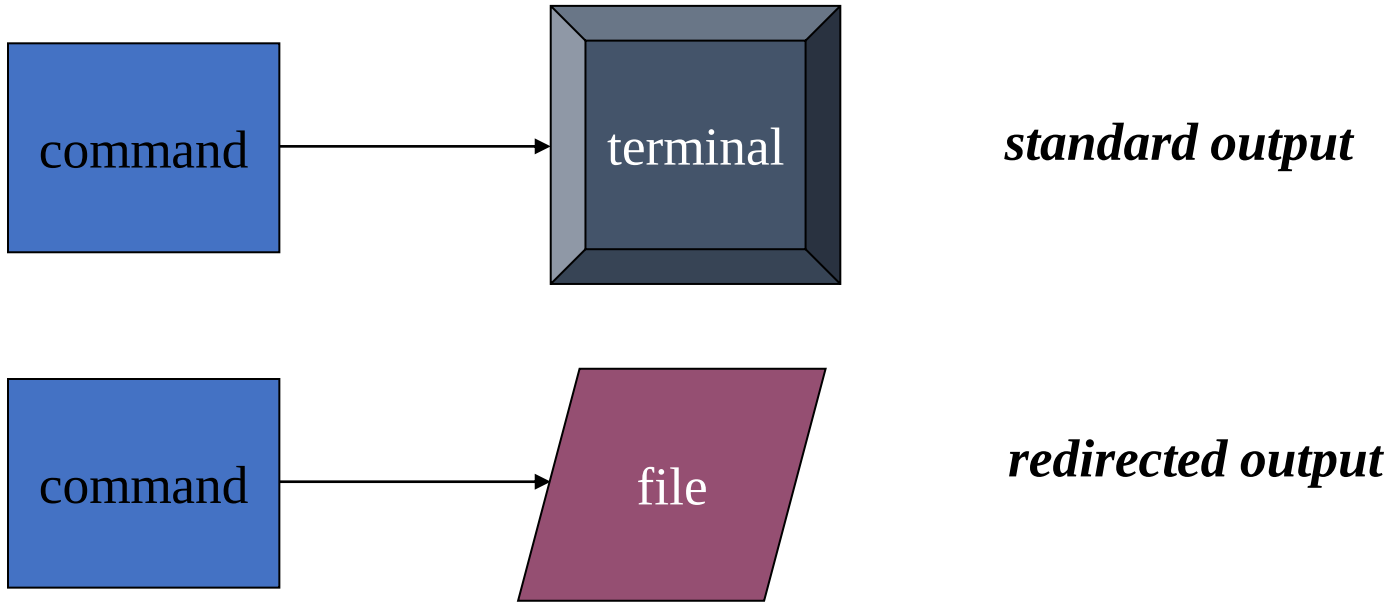


standard input

standard output

Redirection and Pipes

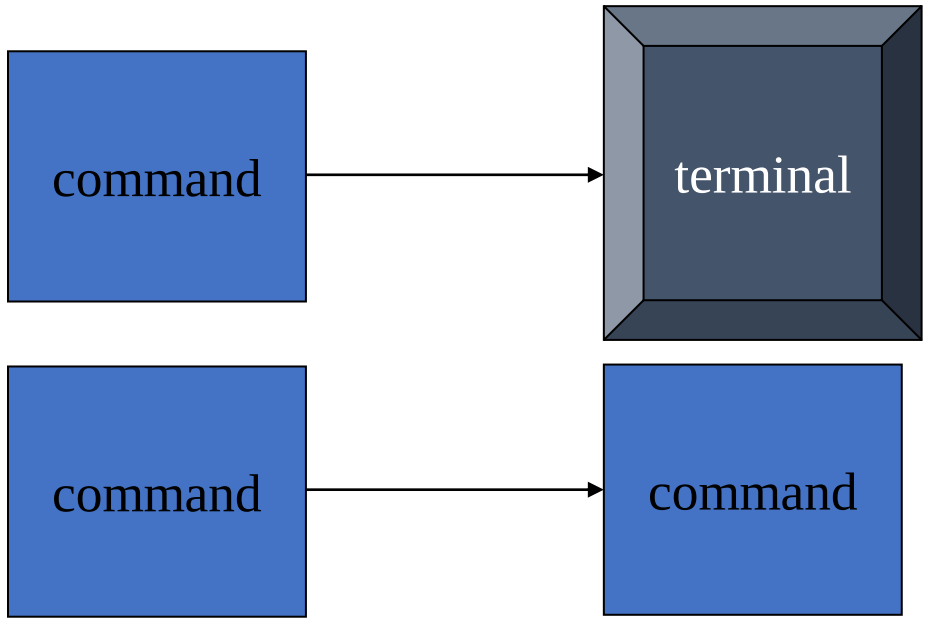
- Redirecting Standard Output to a File with: ‘>’, ‘>>’



- ls –al > mylist (creates or overwrites file)
- ls –al >> mylist (appends or creates file)

Redirection and Pipes

- Redirecting Standard Output to a Command with: '|'



standard output

redirected output

- ls –al | more (passes output to command)

Redirection and Pipes

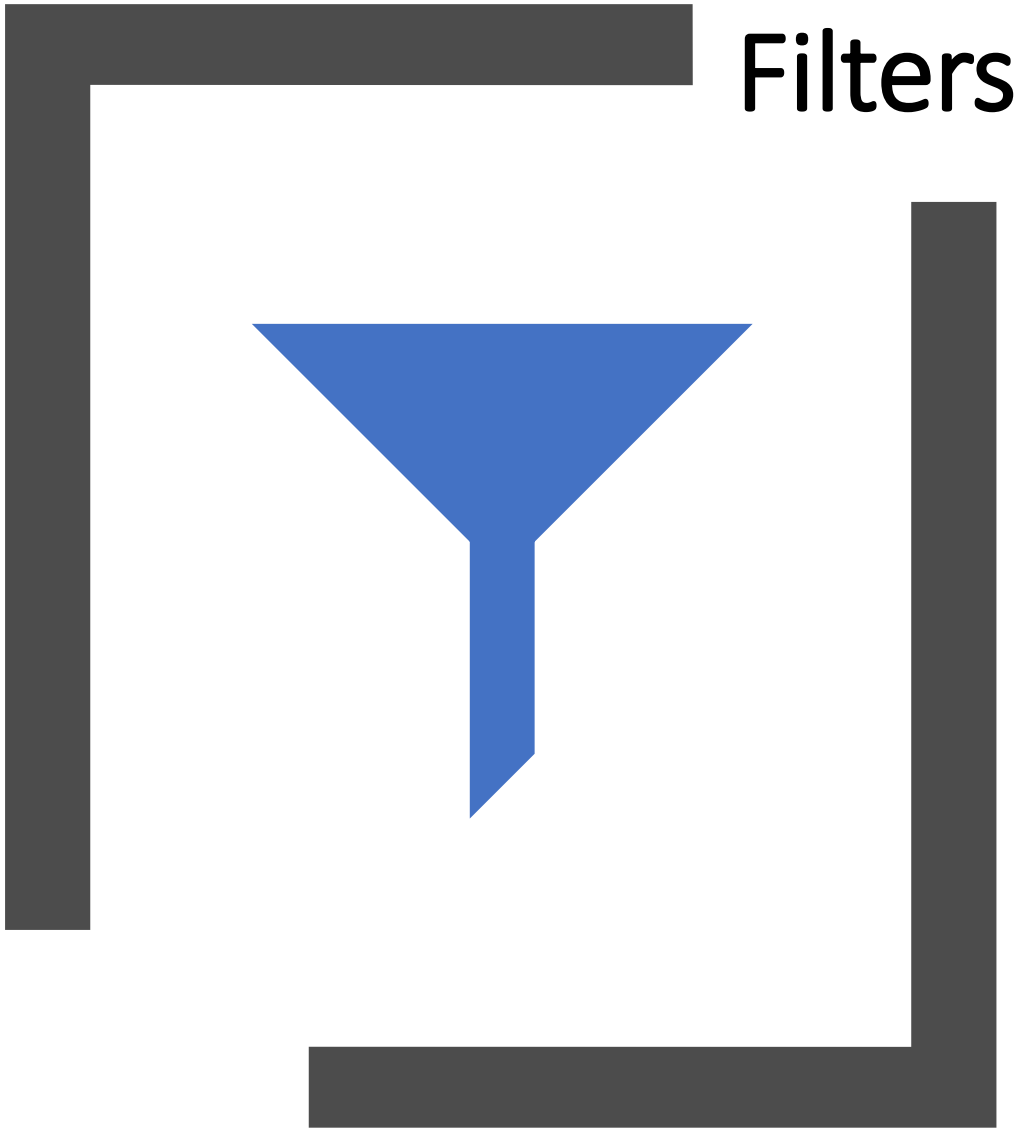
- Redirecting Standard Input from a File with: ‘<’

standard input

redirected input

- cat < file (passes file to command)

Filters



- *A FILTER is any program that reads from Standard Input and writes to Standard Output.*
  - grep
  - uniq
  - look
  - spell
  - sort
  - wc

Filters: grep

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The grep command searches for the pattern specified and writes these lines to Standard Output.

- **grep [-cilnvw]** *pattern [file…]*

> grep ‘Easy’ assignments.txt

Filters: uniq

The uniq command examines data, looking for **consecutive**, duplicate lines.

- **uniq [-cdu]** *[infile [outfile]]*

uniq –d , retains one copy of all lines that are duplicated

uniq –u, retains only those lines that are not duplicated.

uniq –c, counts how many times each line is found.

> uniq document.txt

Filters: look

The look command searches data in alphabetical order and will **find lines that begin with a specified pattern** (alphabetical characters only).

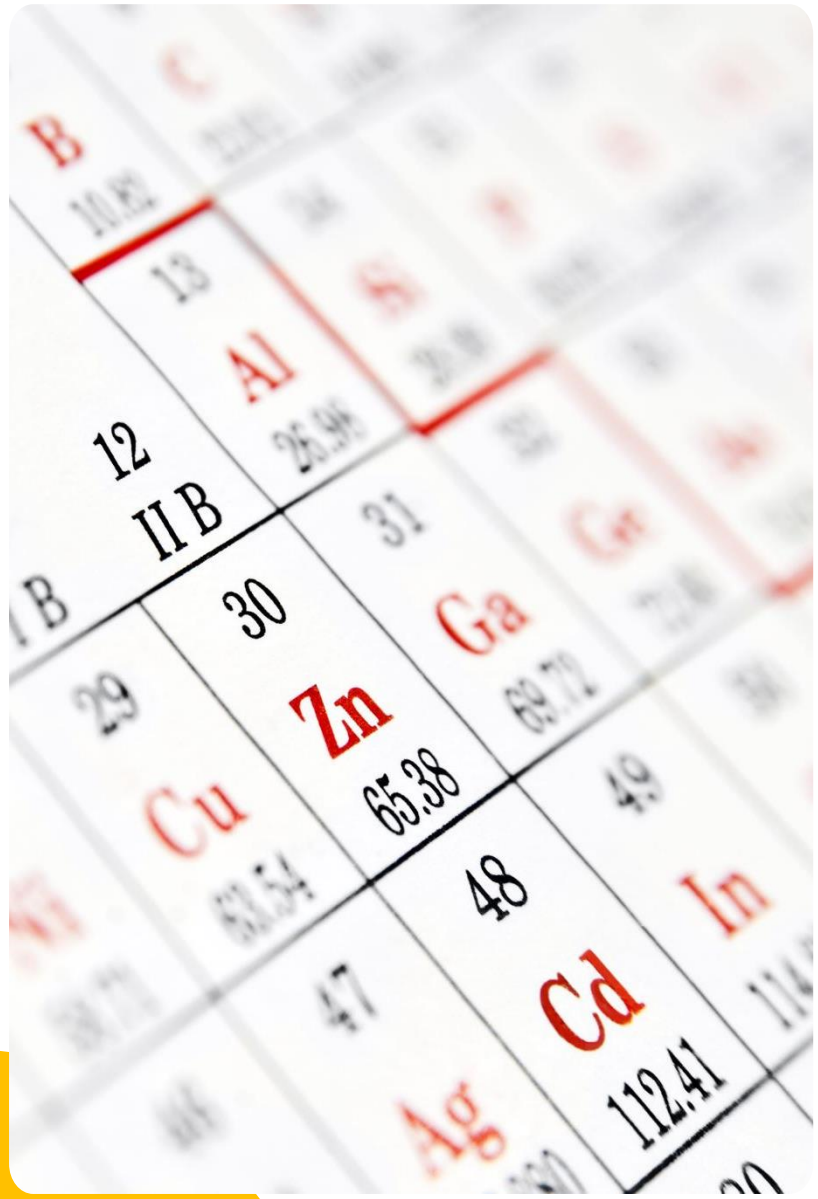
look [-df] *pattern [file…]*

>look Amer

* Access the dictionary of correctly spelled words.

- Look is not really a filter and cannot be used within a pipeline.
- *File* must be pre-sort file with –dfu options. I.e dictionary, fold, unique.

Filters: look



Filters: spell

- ✓The spell command will read data and generate a list of all words that look as if they are misspelled.
- ✓***This is a very primitive spell checker.***

spell *[file…]*

>spell document.txt

Filters: sort

- The sort command sorts data (using ASCII format).

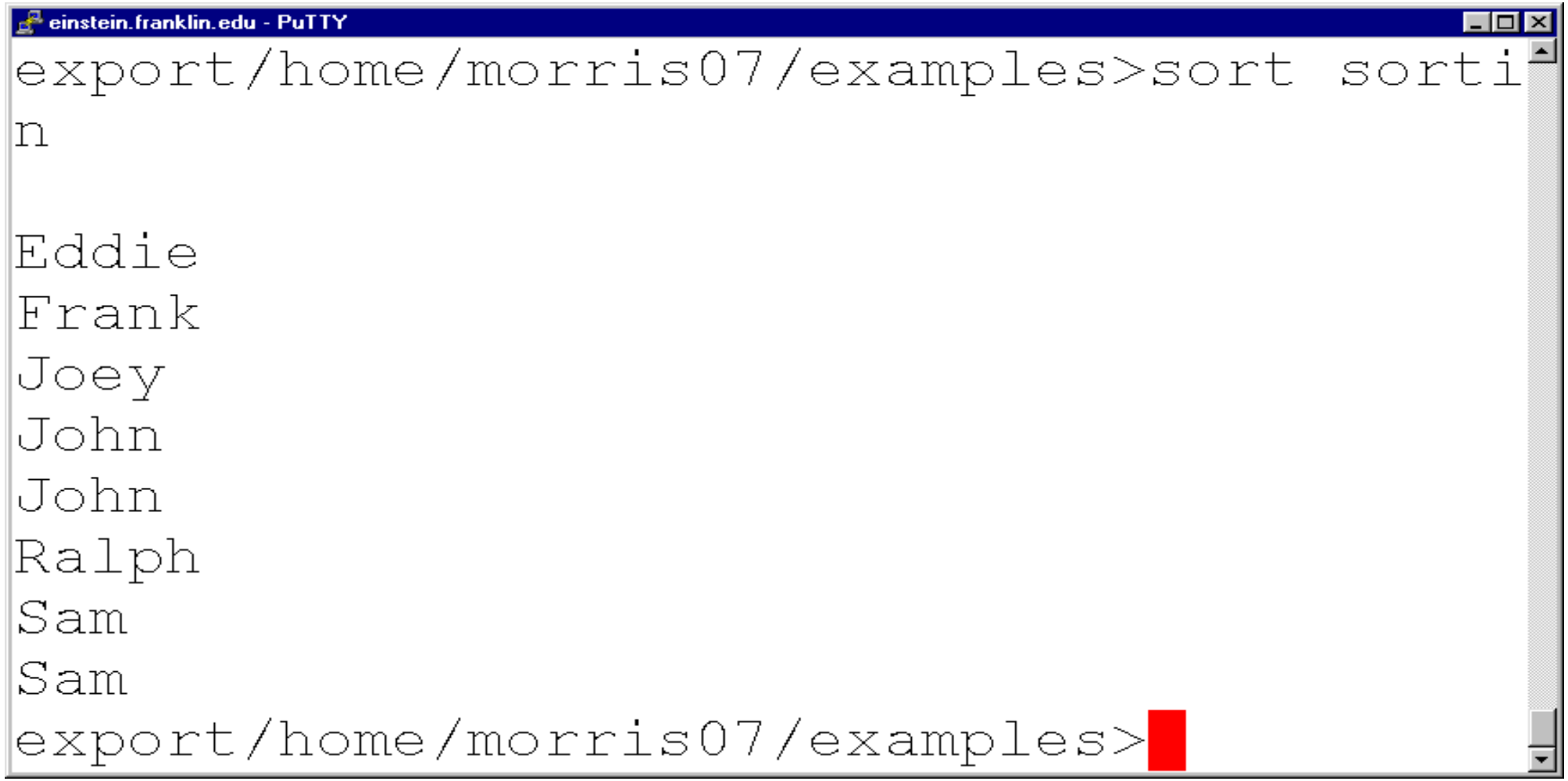
sort [-dfnru] [infile…] [**-o** outfile]

>sort names -o sorted_names

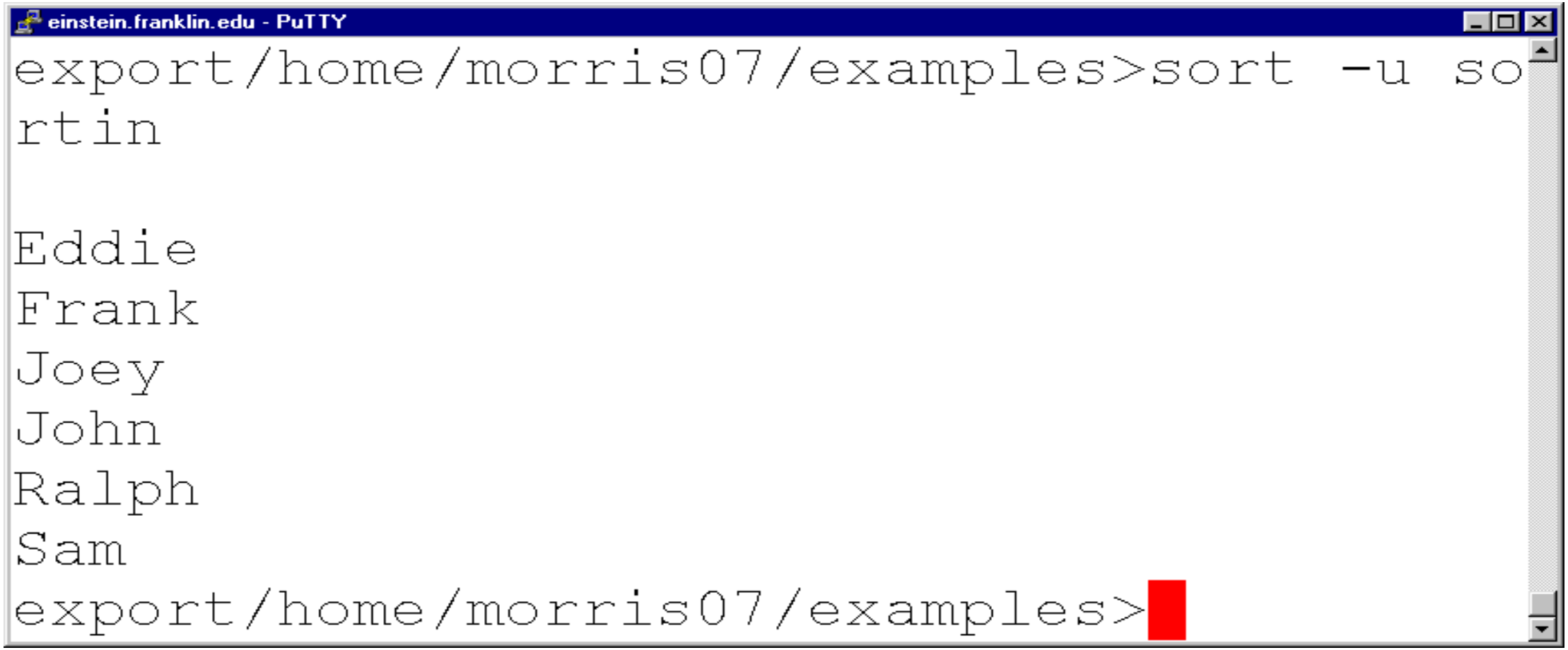
or

>sort names > sorted_names

Filters: sort



Filters: sort



Filters: wc

The wc command counts **l**ines, **w**ords, and **c**haracters.

- **wc [-lwc]** *[file...]*

```
> wc -l
document.txt
```

wc options

-c Count bytes.

-m Count characters.

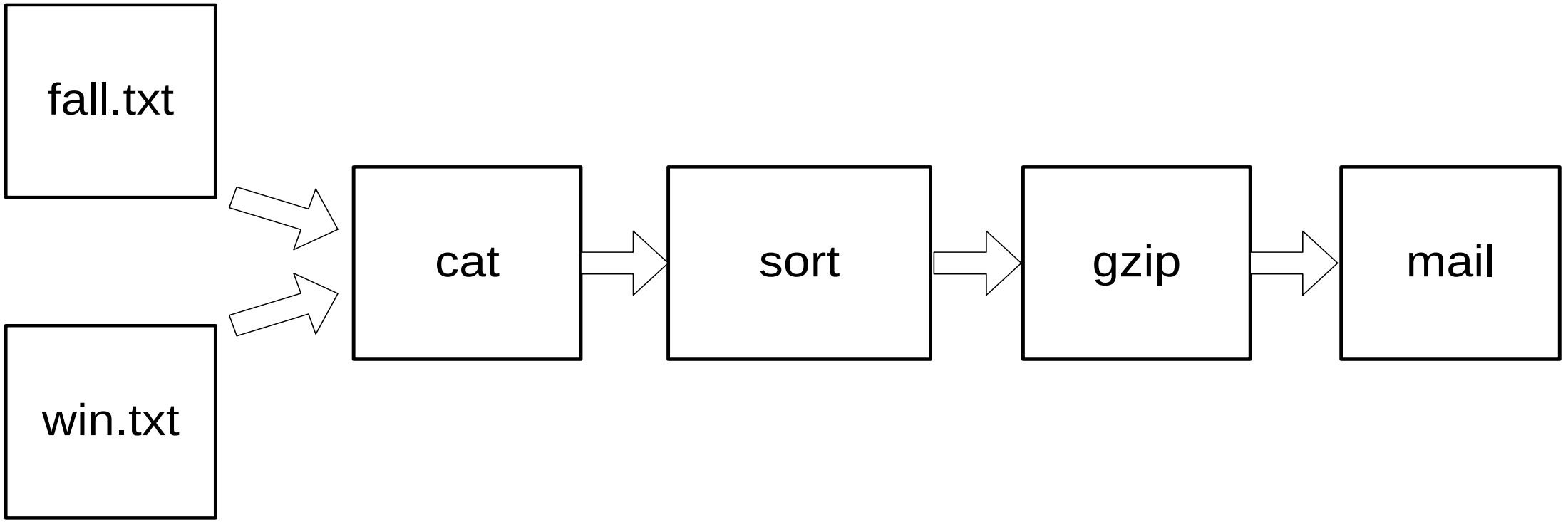
-C Same as -m.

-l Count lines.

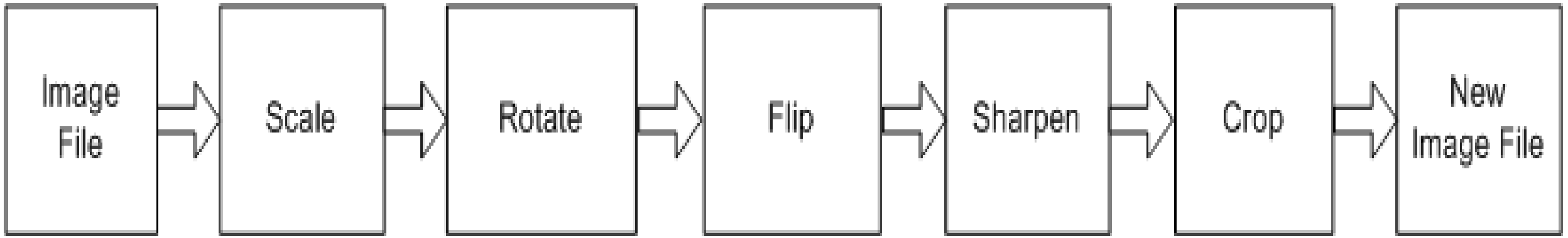
-w Count words delimited by white space characters or new line characters.

Known Uses: UNIX Command Pipelines

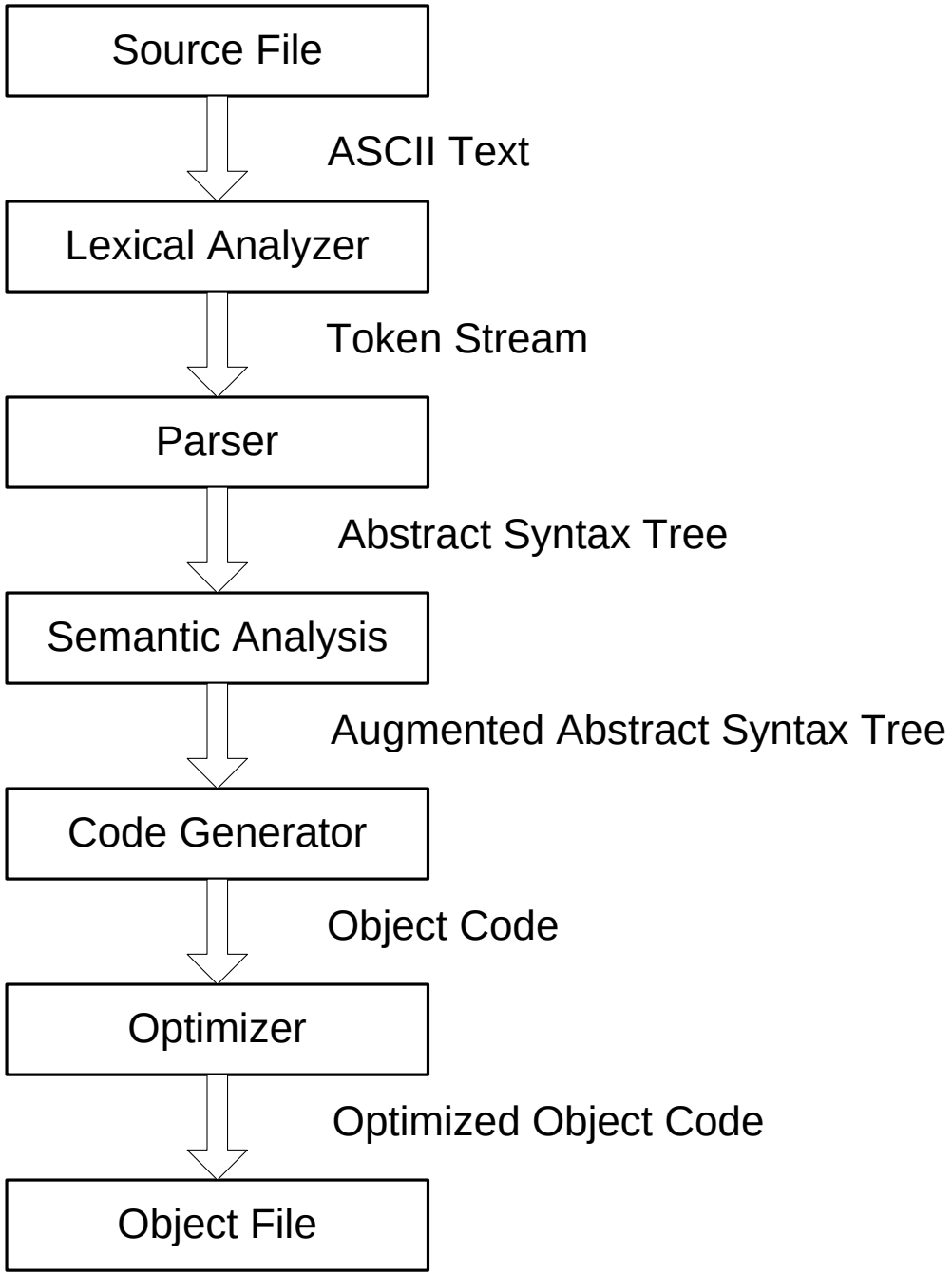
```
$ cat fall.txt win.txt | sort | gzip | mail fred@byu.edu
```



Known Uses: Image Processing



Known Uses: Compilers



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Thanks

Q & A