Command-line parsing order.

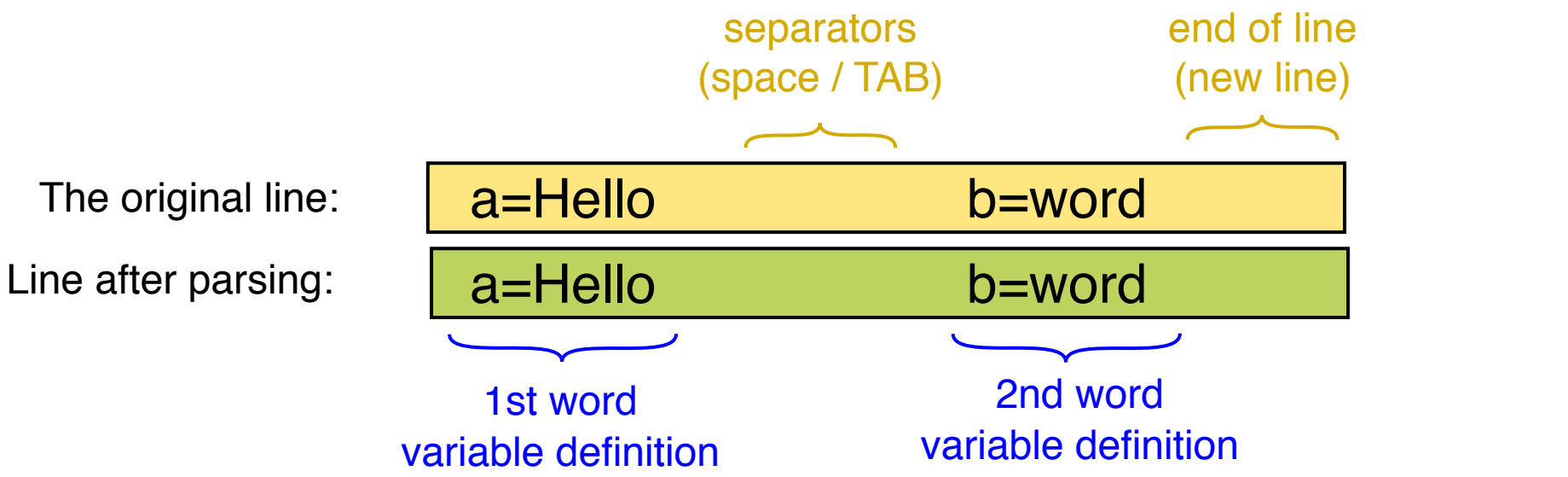
Special characters.

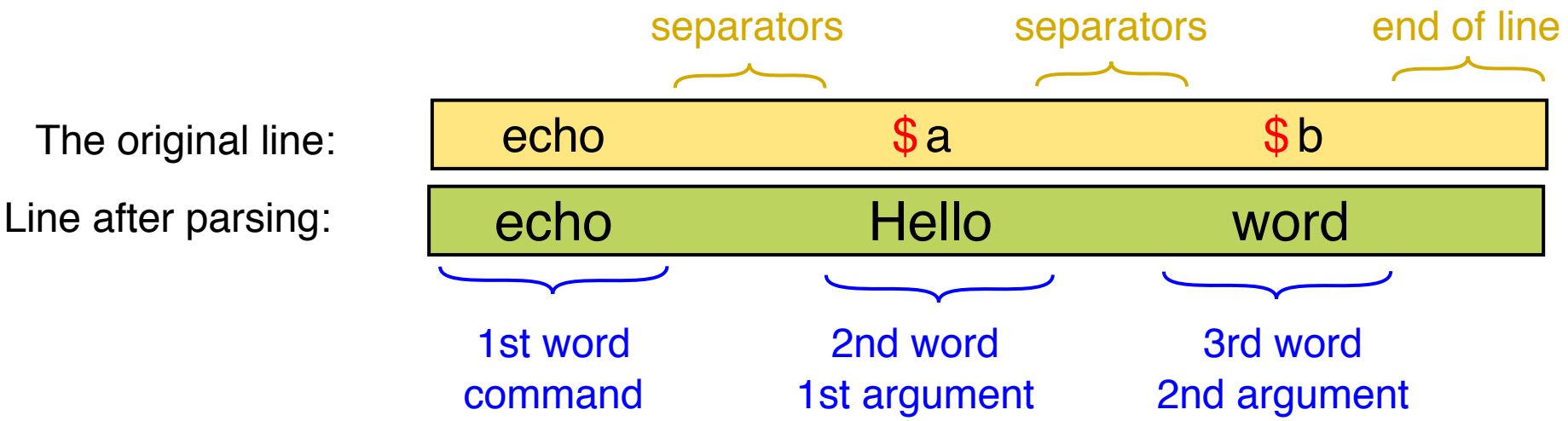
Command execution.

Shell variables.

Department of Computer Systems FIT, Czech Technical University in Prague

Example: simple commands





Motivation

Variables

```
A=Hello
A="Number of logged-in users:    `finger | tail +2 | wc –l` "
```

Commands

```
ls   –la   /
echo   $A
finger   |   tail +2   |   wc –l

:(){ [ $1 -gt $2 ] && echo $1 || echo $2; }; : 1 3; : 2 1
```

Meta-characters

- Characters that represent something other than its literal self (depending on the context).

  #, " ",´ ´, ` `, \, $, |, {}, (), [], …

Command Line Parse Order

1. Turning off the special meaning of characters

\	(backslash/escape) turns off the special meaning of the following character.
´ … ´	(apostrophes) turn off the special meaning of all characters between them (except apostrophe)
" … "	(double quotes) turn off the special meaning of characters except: \ turns off the special meaning of the following character ` cmd` command substitution $ $NAME - variable substitution $((expr)) - arithmetic expansion (except sh) $(cmd) - command substitution (except sh)

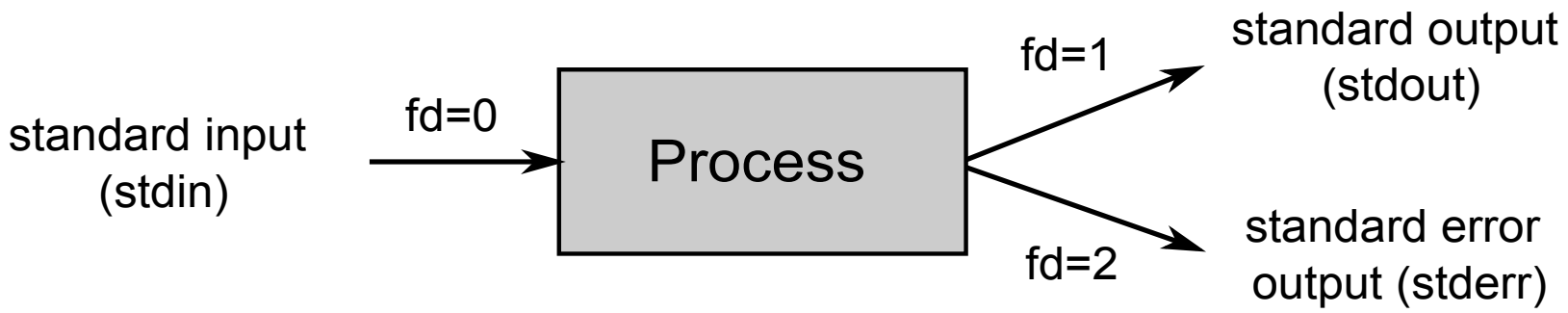
- Shell removes these characters during command line parsing.

Command Line Parse Order

2. **Comment removing** # (hash)
3. **Command line splitting into simple commands and definition of I/Os**
   - **Simple command**
     - Sequence of optional variable assignment followed by blank-separated words.
     - Command name followed by options and arguments.
   - **Pipeline**
     - Sequence of one or more commands separated by the character ' | '.
   - **List**
     - Sequence of one or more pipelines separated by one of the operators ; & && or ||, and optionally terminated by one of ; & <newline>.
   - **Compound command**
     (list) { list ; } ((expression)) [[expression]] for while until if case.

Command Line Parse Order

- **Input/output Redirection**



- **File descriptor** is an abstract indicator for accessing a file (0,1,2,…).

- Every process has 3 standard POSIX file descriptors by default:
  0 – standard command input (stdin)
  1 – standard command output (stdout)
  2 – standard command error output (stderr)

- New process inherits file descriptors from his parent process by default.
- User can redefine/redirect every file descriptor by special characters.

Command Line Parse Order

cmd < file	(less than) executes cmd, using file as the source of the standard input
cmd > file	(greater then) executes cmd, placing the standard output in file
cmd >> file	executes cmd, appends the standard output to the end of the file
cmd << string	here-document, shell reads lines until the line begining with the given string, then all lines are sent to standard input

Command Line Parse Order

cmd 2> file	executes cmd, placing the standard error output in file
cmd >&*n*	executes cmd, placing the standard output in file defined by file descriptor *n*
cmd *m*>&*n*	executes cmd, placing the output defined by file descriptor *m* in file defined by file descriptor *n*
cmd > file 2>&1	executes cmd, placing the standard output and standard error output in

- IO redirection is evaluated from left to right.

Command Line Parse Order

- **Exit status/return code** is a small number passed from a child process to a parent process when it has finished executing.
  (0 = succes, 1,2,3,…, 255 = error)

cmd &	(ampersand) The shell executes the command in the background in a subshell. The shell does not wait for the command to finish.
cmd1 ; cmd2	(semicolon) Commands are executed sequentially; the shell waits for each command to terminate in turn.
(cmd1 ; cmd2)	(brackets) Commands are executed sequentially by the subshell.
{ cmd1 ; cmd2 ; }	(brackets) Commands are executed sequentially by current shell.

Command Line Parse Order

cmd1 | cmd2	(pipe/pipeline) The standard output of cmd1 is connected via a pipe to the standard input of cmd2. Commands are executed in parallel. The return status of a pipeline is the exit status of the last command.
cmd1 && cmd2	cmd2 is executed if, and only if, cmd1 returns an exit status of zero.
cmd1 || cmd2	cmd2 is executed if and only if cmdd1 returns a non-zero exit status.

Command Line Parse Order

4. Replacement of

- Directory name abbreviation ~ (tilde)

~	Home directory of the current user (except of sh)
~username	Home directory of the given user (except of sh)

- Command substitutions

` cmd `	Shell performs the expansion by executing cmd and replacing the command substitution with the standard output of the cmd.
$(cmd)	Different syntax. (except of sh)

- Arithmetic expressions $((expr))
- Variables ($1, $HOME,…)

Command Line Parse Order

5. Word splitting

newline space TAB	Default word separators (it can be change by shell variables IFS)

Command Line Parse Order

6. File Name Substitution

*	(asterisk) matches zero or more characters, except the leading . (period) of a hidden file.
?	(question mark) matches exactly one character except the leading . (period) of a hidden file.
[abc] [a-z]	(square brackets) matches one character in the set or in the range
[!abc] [!a-z] [^ijk] [^m-z]	matches one character not in the set or in the range ([^…] except of sh)

Command Line Parse Order

7. **Options and arguments setting**
8. **Variable setting or command execution**

- **Command** eval string
  - The command line is scanned twice by the shell.
  - First, the shell interprets the command line when it passes to the eval command.
  - Then shell interprets it a second time as a result of executing the eval command

- **Example:**

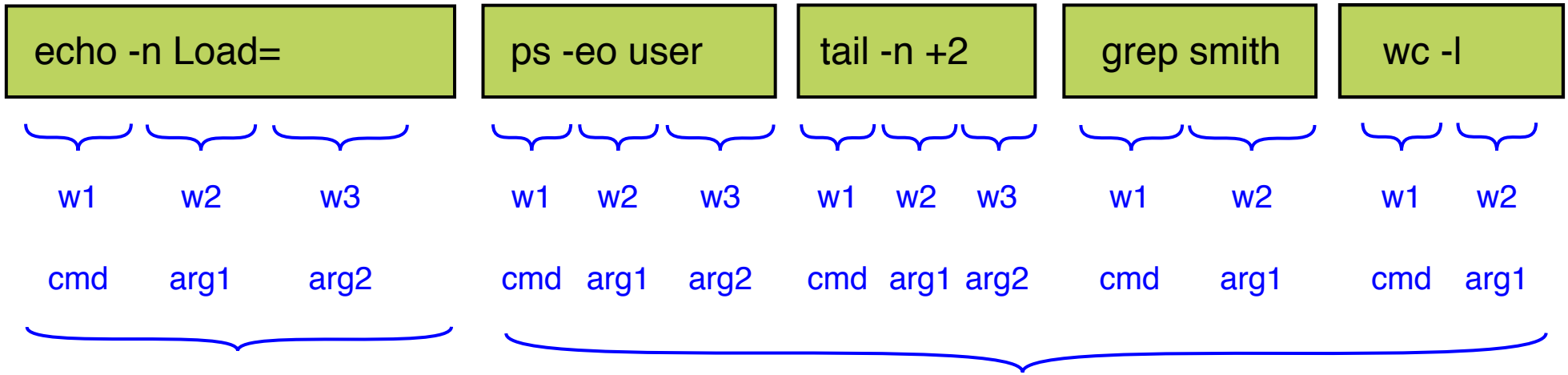
```
unset B  ;  A='$B'  ;  B=date  ;  echo $A

unset B ;  A='$B'  ;  B=date  ;  eval echo $A
```

Example: Command Line Parse Order

The original line:

```
echo -n " Load= " > l.txt ; ps -eo user | tail -n +2 | grep $USER | wc -l >>l.txt
```

Line after parsing:



This command is executed first.
The input is from keybord and
the output is written to file.

This goup of commands are executed in parallel after
the termination of the first command.
The output of every command is redirected like input of the next one.
Only the output of the last command is added to the end of file.

Command Execution

- **Which program will be executed?**
  - **Absolute/relative path to command**
  - **Shell function**
  - **Shell built-in command**
  - **Only program name**
    - Shell variable PATH contains list of directories.
    - The shell searches through each of these directories, one by one, until it finds a directory where the executable program exists.

Shell Variables

variable=value	Creation of local variable
export variable[=value]	Creation of environment/global variable
$variable	Display the content of variable
set	List all variables
env	List only the environment/global variables

- **Some built-in shell variables**

  HOME home directory

  PWD current working directory

  PS1 defines prompt

  PATH list of directories for command searching

Shell Variables

- **Some built-in shell variables**

0	program name
1,…,9	command line arguments
#	number of command line arguments
$	process ID of current shell
?	exit status of the last executed command

- **Some other environment variables**

PAGER	defines program for displaying of man. Pages
MANPATH	list of directories for manual pages searching