Data 301 Data Analytics Command Line

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Why learn command line?

The *command line* is the text interface to the computer.

Understanding the command line allows you to interact with the computer in ways that you often cannot with the graphical user interface (GUI).

The command line is commonly used for scripting and automation of tasks and when accessing remote systems.

It will also be useful to run programs that make use of the command line (eg. github).

What is the Command Line?

The **command line** is the text interface to the computer that accepts commands that the computer will execute. These commands include:

- starting programs
- navigating directories and manipulating files
- searching, sorting, and editing text files
- system and environment configuration

Why use command line?

The command line is part of the *operating system (OS)*, which is software that manages your computer including all devices and programs.

- Common operating systems include Windows, Mac OS, and Linux/Unix.
- Some commands will be OS specif

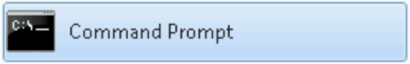
You might be wondering why we would ever prefer command line over using the graphical user interface (GUI).

- Certain tools may only be available to command line.
- Sometimes command line is faster.

Windows Command Line

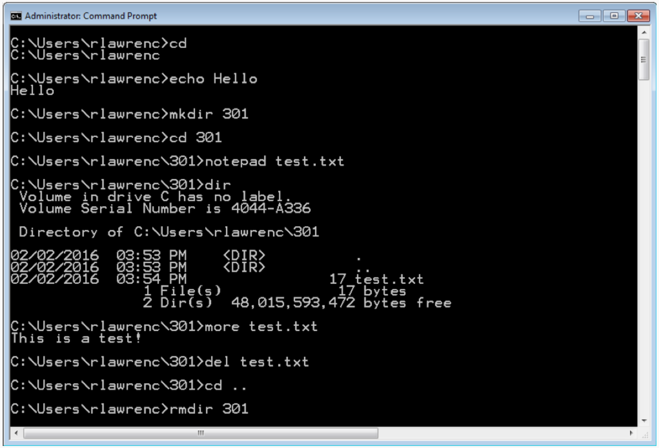
The command line on Windows dates back to the original Microsoft operating system called DOS (Disk Operating System) in 1981.

This command line interface is still part of all modern Windows operating systems and is accessible as the "Command Prompt".



To access this, navigate to the start menu with your mouse (or click the windows button on your keyboard) and type “cmd" then ENTER .

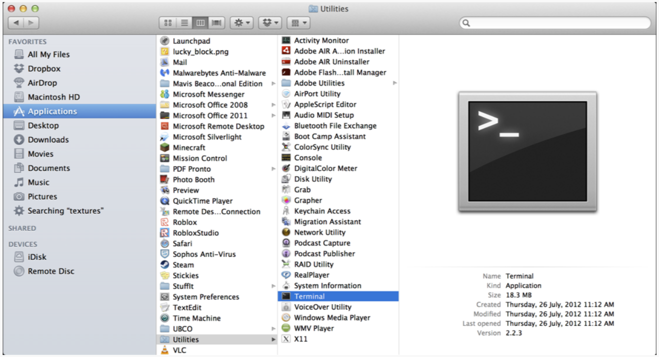
Command Line - Windows



```
C:\Users\rlawrenc>cd
C:\Users\rlawrenc

C:\Users\rlawrenc>echo Hello
Hello

C:\Users\rlawrenc>mkdir 301

C:\Users\rlawrenc>cd 301

C:\Users\rlawrenc\301>notepad test.txt

C:\Users\rlawrenc\301>dir
 Volume in drive C has no label.
 Volume Serial Number is 4044-A336

 Directory of C:\Users\rlawrenc\301

02/02/2016  03:53 PM    <DIR>          .
02/02/2016  03:53 PM    <DIR>          ..
02/02/2016  03:54 PM                17 test.txt
               1 File(s)             17 bytes
               2 Dir(s)  48,015,593,472 bytes free

C:\Users\rlawrenc\301>more test.txt
This is a test!

C:\Users\rlawrenc\301>del test.txt

C:\Users\rlawrenc\301>cd ..

C:\Users\rlawrenc>rmdir 301
```

Mac OS Command Line

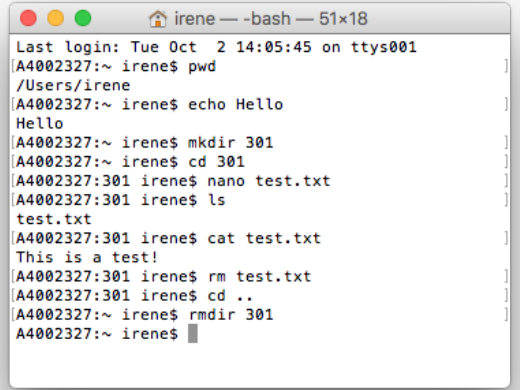
The command line for Mac OS uses the same commands as Linux. It can be opened using Finder then Utilities then Terminal.



Name Terminal
Kind Application
Size 18.3 MB
Created Thursday, 26 July, 2012 11:12 AM
Modified Thursday, 26 July, 2012 11:12 AM
Last opened Thursday, 26 July, 2012 11:12 AM
Version 2.2.3

Alternatively, we could type Cmnd + spacebar, then type "Terminal" and press ENTER

Command Line - Mac/Linux



```
Last login: Tue Oct  2 14:05:45 on ttys001
A4002327:~ irene$ pwd
/Users/irene
A4002327:~ irene$ echo Hello
Hello
A4002327:~ irene$ mkdir 301
A4002327:~ irene$ cd 301
A4002327:301 irene$ nano test.txt
A4002327:301 irene$ ls
test.txt
A4002327:301 irene$ cat test.txt
This is a test!
A4002327:301 irene$ rm test.txt
A4002327:301 irene$ cd ..
A4002327:~ irene$ rmdir 301
A4002327:~ irene$ 
```

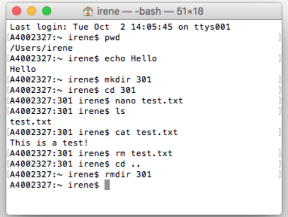
Entering a Command

Enter a *command* at a *prompt*.

The prompt may be a $>$ or a \$ or customized by the user.

Press ENTER to execute the command.

On Windows, commands are mostly case-insensitive while on Mac/Linux they are case-sensitive.



```
Last login: Tue Oct  2 14:05:45 on ttys001
A4002327:~ irene$ pwd
/Users/irene
A4002327:~ irene$ echo Hello
Hello
A4002327:~ irene$ mkdir 301
A4002327:~ irene$ cd 301
A4002327:301 irene$ nano test.txt
A4002327:301 irene$ ls
test.txt
A4002327:301 irene$ cat test.txt
This is a test!
A4002327:301 irene$ rm test.txt
A4002327:301 irene$ cd ..
A4002327:~ irene$ rmdir 301
A4002327:~ irene$ 
```

ls

For example, the `ls`/`dir` (Mac/Windows), lists all the contents (i.e files and folders) inside or your current directory.

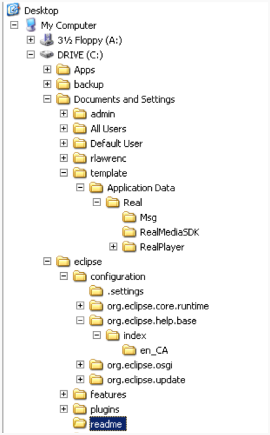
File System

The *file system* organizes data on a device as a hierarchy of directories and files (like a tree).

Each *folder (AKA directory)* has a name and can contain any number of files or subdirectories.

Each file has a name.

The user can change (navigate) directories in the hierarchy.



File System

The tree is rooted at, well, the **root**.

- There is only one root of a directory hierarchy.

Every item in the tree is either a *file* or a *directory* (AKA *folder*).

- You can think of a directory as a container that may contains files and/or other directories.
- Files on the other hand holds information (and cannot contain other files or directories) .

If `directoryC` is contained in `directoryP`, then `directoryC` is a **child** of `directoryP` and `directoryP` is said to be the **parent** to `directoryC`.

- A directory may have many children, but can only have one parent.

Absolute versus Relative Path

- The **root** of the file system is the directory "/"
  - There is only one root of a directory hierarchy.
- A path to a new location (from your current location) can be specified as an *absolute path* from the root (this will work no matter where we are in the file system):

  ```
  cd /Users/ivrbik/301/level1
  ```

  or a *relative path* from your current location (this will only work if we are in `/Users/ivrbik/`):

  ```
  cd 301/level1
  ```
- The directory separator is a forward slash '/' for Macs/Linux. In windows you may use forward or backward slashes '/' or '\'

Short forms

- '.' is the short-form for the current directory
- '..' signifies the **parent** directory (akin to pressing Cmnd + ↑ on a Mac)
- For example, to navigate (i.e. **c**hange **d**irectories) to the parent directory of the current directory, use the command:

  ```
  cd ..
  ```

  Note that this command is dependant on your **current directory** (i.e. the folder you are currently in).

pwd/cd

To print your current working directory type `pwd/cd` (Mac/Windows) then ENTER .

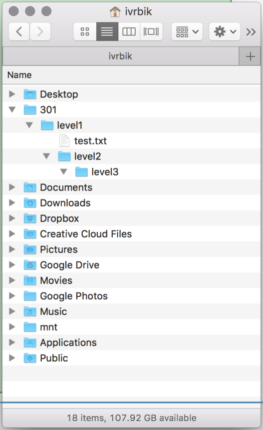
Absolute versus Relative Path Question

Example

Given this directory hierarchy and that the user is currently in the directory level2 and level1 directory contains a file test.txt. How many of the following statements are TRUE?

1. A relative path to change to directory 301 is ..
2. Absolute path to test.txt is /Users/ivrbik/301/level1/test.txt
3. Relative path to test.txt is ../test.txt
4. Relative path to test.txt is different if user was currently in level3 directory.
5. There is only one root of the directory hierarchy.

A) 0 B) 1 C) 2 D) 3 E) 4



```
▶ Desktop
▼ 301
    ▼ level1
        test.txt
        ▼ level2
            ▼ level3
▶ Documents
▶ Downloads
▶ Dropbox
▶ Creative Cloud Files
▶ Pictures
▶ Google Drive
▶ Movies
▶ Google Photos
▶ Music
▶ mnt
▶ Applications
▶ Public
```

18 items, 107.92 GB available

makdir

Download this filesystem as a zip file on Canvas.

- To create a new folder in the current directory we use `mkdir`.
- To complete this task we need to specify the directory name as an *argument*.
- For example, the following creates a folder called `NewFolder` in the current directory:

```
mkdir NewFolder
```

Exercise: `mkdir`

Navigate to the 301 folder and create a new folder called `Demo`.

touch

- We can create files using the `touch` command.
- Like `mkdir` we need to specify a argument.
- Rather than a folder name, we provide a filename as the argument.
- For example, the following command creates a new file named `empty.txt` inside the current working directory.

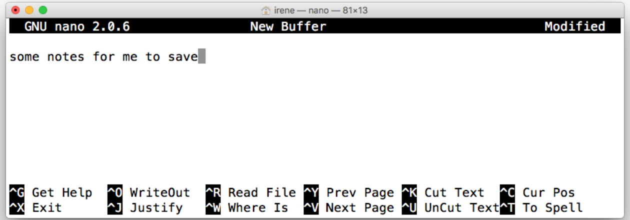
```
touch empty.txt
```

touch

Navigate to the `Demo` folder and type `touch abc.txt`

notepad/nano

- To create a file with actually text, we can use the `notepad/nano` command (Windows/Mac).
- Typing `nano` will open a blank file for editing.
- We can then type the desired text and save using the shortcuts given on the bottom of the window. More shortcuts here.
- N.B. the standard shortcuts we might be used to wont work in this command line (eg. Ctrl /Cmnd + C for copy);

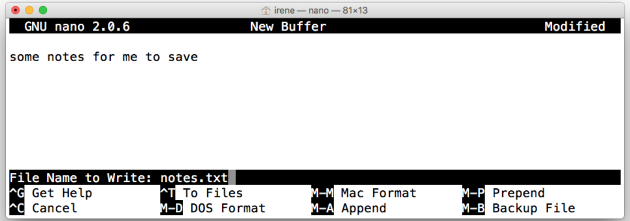


```
irene — nano — 81×13
  GNU nano 2.0.6                 New Buffer                          Modified

some notes for me to save





^G Get Help  ^O WriteOut  ^R Read File ^Y Prev Page ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is  ^V Next Page ^U UnCut Text^T To Spell
```

notepad/nano

- Upon saving (ie WriteOut *via* Ctrl + O) you will be prompted to provide a filename to save the document under.
- We could have supplied this information as an argument in our nano command as follows:

```
nano notes.txt
```



```
  GNU nano 2.0.6                  New Buffer                          Modified

some notes for me to save









File Name to Write: notes.txt
^G Get Help          ^T To Files          M-M Mac Format        M-P Prepend
^C Cancel            M-D DOS Format       M-A Append            M-B Backup File
```

- N.B. We will still be asked to verify the name upon exiting, but we won't have to type it again.

Commonly Used File Navigation Commands

	Windows	Mac OS & Linux
List contents of directory	dir	ls
Change directory	cd 301	cd 301
Print working directory	cd	pwd
Make a directory	mkdir 301	mkdir 301
Remove a directory	rmdir 301	rmdir 301
Rename a file	ren old.txt new.txt	mv old.txt new.txt
Remove a file	del file.txt	rm file.txt
Copy a file	copy src.txt dest.txt	cp src.txt dest.txt
Move a file	move <source> <dest>	mv <source> <dest>

Click here for see some more Windows and Unix equivalents.

Commonly Used Text Related Commands

	Windows	**Mac OS & Linux**
Open a text editor	notepad	nano
Echo output	echo Hello	echo Hello
Output contents of a file	more file.txt	cat file.txt
Search text files	find	grep
Sort text files	sort	sort

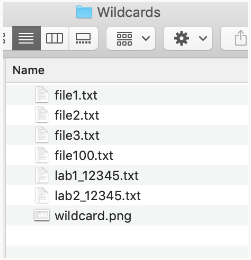
Wildcards

A **wildcard** character allows for matching file names with more flexibility.

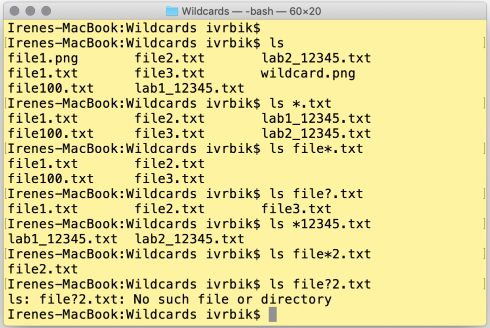
The **?** represents any *one* character in a file name. Example: `file?.txt` would match `file1.txt`.

The ***** (asterisk) matches any number of characters (including no characters). Example: `*.txt` would match anything ending with `.txt` (i.e. all .txt files).

Wildcards



```
file1.txt
file2.txt
file3.txt
file100.txt
lab1_12345.txt
lab2_12345.txt
wildcard.png
```



```
Irenes-MacBook:Wildcards ivrbik$
Irenes-MacBook:Wildcards ivrbik$ ls
file1.png       file2.txt       lab2_12345.txt
file1.txt       file3.txt       wildcard.png
file100.txt     lab1_12345.txt
Irenes-MacBook:Wildcards ivrbik$ ls *.txt
file1.txt       file2.txt       lab1_12345.txt
file100.txt     file3.txt       lab2_12345.txt
Irenes-MacBook:Wildcards ivrbik$ ls file*.txt
file1.txt       file2.txt
file100.txt     file3.txt
Irenes-MacBook:Wildcards ivrbik$ ls file?.txt
file1.txt       file2.txt       file3.txt
Irenes-MacBook:Wildcards ivrbik$ ls *12345.txt
lab1_12345.txt  lab2_12345.txt
Irenes-MacBook:Wildcards ivrbik$ ls file*2.txt
file2.txt
Irenes-MacBook:Wildcards ivrbik$ ls file?2.txt
ls: file?2.txt: No such file or directory
Irenes-MacBook:Wildcards ivrbik$ 
```

Replace `ls` with `dir` if you are using Windows.

Navigating the Command Line

	Windows	**Mac OS & Linux**
Previous command in history	Up	Up
Next command in history	Down	Down
First command in history	PageUp	
Last command in history	PageDown	
Move to start of line	Home	Ctrl+A
Move to end of line	End	Ctrl+E
Auto-compete file name	Tab	Tab

Pausing or Cancelling Commands

To **pause** a command:

Windows: Press Ctrl + S or the Pause To resume, press any key.

Mac: Ctrl + Esc or Cmnd + .

To **cancel** a command, press Ctrl + C .

- The command is canceled, and the command prompt returns.
- However, any actions performed before the cancel are not undone.

Example

How many of the following statements are TRUE?

1. To cancel a command, press Ctrl + X .
2. To go to the most recent command, press Up arrow.
3. This wildcard expression `te*a?.txt` matches `tea12.txt`.
4. The command to change a directory is `pwd`.

A) 0 B) 1 C) 2 D) 3 E) 4

Try It: Navigating Directories with Commands

Example

Using a terminal window, perform the following actions:

1. Create a directory called 301.
2. Change into the directory 301.
3. Echo I am awesome!
4. Show your current directory (print working directory).
5. Create a text file called message.txt with a message in it.
6. List the contents of your directory.
7. Rename the file message.txt to test.txt. Verify the name change.
8. Delete the test.txt file.
9. Change directory to directory above 301.
10. Delete directory 301.

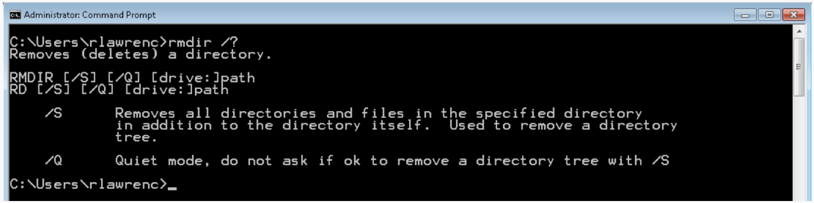
Command Arguments - Windows

A command can take *arguments* that changes its behaviour.

- Example: Path was an argument for the cd command. `cd` 301

On Windows, commands also can be modified by a *switch* (or extension) which is usually a slash then a letter (e.g. `/S`).

- To find out what is available, run the command with: `/?`

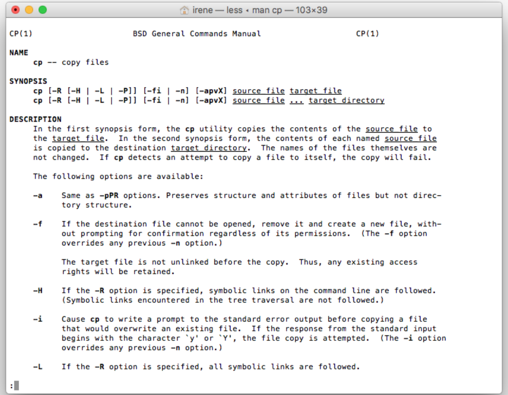


```
C:\Users\rlawrenc>rmdir /?
Removes (deletes) a directory.

RMDIR [/S] [/Q] [drive:]path
RD [/S] [/Q] [drive:]path

    /S      Removes all directories and files in the specified directory
            in addition to the directory itself.  Used to remove a directory
            tree.

    /Q      Quiet mode, do not ask if ok to remove a directory tree with /S

C:\Users\rlawrenc>_
```

Command Arguments - Mac/Linux

On Mac/Linux arguments are separated by spaces and begin with '-'

An explanation of arguments can be found by using man then the command name. Example: `man cp` (to *quit* press q)



```
CP(1)                        BSD General Commands Manual                       CP(1)

NAME
     cp -- copy files

SYNOPSIS
     cp [-R [-H | -L | -P]] [-fi | -n] [-apvX] source_file target_file
     cp [-R [-H | -L | -P]] [-fi | -n] [-apvX] source_file ... target_directory

DESCRIPTION
     In the first synopsis form, the cp utility copies the contents of the source_file to
     the target_file.  In the second synopsis form, the contents of each named source_file
     is copied to the destination target_directory.  The names of the files themselves are
     not changed.  If cp detects an attempt to copy a file to itself, the copy will fail.

     The following options are available:

     -a    Same as -pPR options. Preserves structure and attributes of files but not direc-
           tory structure.

     -f    If the destination file cannot be opened, remove it and create a new file, with-
           out prompting for confirmation regardless of its permissions.  (The -f option
           overrides any previous -n option.)

           The target file is not unlinked before the copy.  Thus, any existing access
           rights will be retained.

     -H    If the -R option is specified, symbolic links on the command line are followed.
           (Symbolic links encountered in the tree traversal are not followed.)

     -i    Cause cp to write a prompt to the standard error output before copying a file
           that would overwrite an existing file.  If the response from the standard input
           begins with the character `y' or `Y', the file copy is attempted.  (The -i option
           overrides any previous -n option.)

     -L    If the -R option is specified, all symbolic links are followed.

:
```

Standard Input, Output, and Error

Standard input (`stdin`) is the default input device (usually a keyboard) into the terminal.

Standard output (`stdout`) is the location where output is sent after a command is run. The default is the terminal window.

Standard error (`stderr`) is the location where error messages are displayed (typically the terminal window).

Redirecting Input

By default, a command gets its input from standard input and outputs results to standard output.

A command can get its input from the output of another command by using the **pipe** (|) symbol. Example:

```
cat test.txt | wc
```

Note the example commands are Mac OS/Linux only: `wc` (word count) is not on Windows.

Also can use redirect input (<) to send input to a command. Ex:

```
cat < test.txt
```

same as

```
sort cat test.txt
```

Redirecting Output

Redirect output using > which will overwrite the file:

```
sort test.txt > sorted.txt
```

Use» to append to the existing file:

sort test.txt » sorted.txt

Redirection Summary

	Symbol
Redirect input	<
Redirect output	>
Redirect output (append)	>>
Pipe output to input of next command	|

Escape Symbol

An *escape symbol* is used when a command requires input that contains a character with a special meaning. The escape symbol indicates this character is data not part of the command.

Windows the caret (^) indicates that whatever character that follows it is data rather than part of the command.

- Example: `cp test.txt a^&b.txt`

Linux use the backslash (\\).

This is especially common when dealing with spaces in a file name. The other way to handle file names with spaces is to enclose them in double quotes:

```
cp test.txt "c:\program files\file spaces.txt"
```

Environment Variable

Environment variables allow for customization and control of the command and system environment.

Current variables are seen using the `set` or `env` command.

Important variables:

`$PATH`	list of directories where commands/applications will be found
`$HOME`	user home directory

Finding Text in Files

The grep command allows for searching for text in files that match a pattern (Mac/Linux only, find on Windows).

- grep stands for "global regular expression print"
- Search is case-sensitive (use -i for case-insensitive) and can contain regular expressions.
  - grep -i will be case-insensitive

Example:

```
grep er *.txt
```

searches for er in any file that ends in .txt

Batch Files

A **batch program** (also commonly called a *batch file* or *command file*) is a text file that contains a sequence of commands to be executed.

You define the sequence of commands, name the sequence, and then execute the commands by entering the name at a command prompt. Any action you can take by typing a command at a command prompt can be encapsulated in a batch program.

In Windows files typically end in `.bat` or `.cmd` and on Mac/Linux with `.sh`

Batch files can take arguments like other commands.

Connecting to Another Computer using SSH

Secure shell or *SSH* is a protocol allowing remote login to other machines to execute commands.

- The network communication is encrypted for security.
- An open-source program on campus is Putty.

Using SSH allows you to connect and execute commands on another machine even when you do not have physical access to that machine.

SSH may be used to send or retrieve data from other computers for analysis.

Try it: Using Batch Files

Before creating the batch file, create a file called **numbers.txt** that has the numbers `one`, `two`, `three`, `...` , `ten`.

Example

Using a terminal window, create a batch file called **myscript.bat** (or **.sh**), to perform the following:

1. sort **numbers.txt** and output as **sorted.txt**.
2. output the word count on **numbers.txt** to **count.txt**.
3. take **numbers.txt** and append its data three times into the file **output.txt**.
4. search for `"e"` in **output.txt** and write results as file **search.txt** (use `grep`).
5. Output the contents of **sorted.txt**, **output.txt**, and **search.txt** .
6. Run your batch file.

Conclusion

The *command line* is the text interface to the computer that accepts commands that the computer will execute including running programs, manipulating files, and running scripts.

The command line allows for automation and more control than may be available in the user interface. It may also be the only way to interact with the machine if connecting via SSH.

The command environment allows for redirecting the standard input and output using input/output redirection and pipes.

Objectives

- Define command line and list some of its uses
- Explain the purpose of an operating system
- Know how to open the command line window on Mac OS and Windows
- Be able to enter commands and stop them
- Define: file system, folder, file
- Explain the difference between an absolute and relative path
- Use command line shortcuts to save time
- Be able to match wildcards involving ? and *
- Be able to cancel a command

Objectives cont'd

- Explain standard input, standard output, and standard error
- Be able to use input and output redirection and pipes (?, >, < , »)
- Explain the reason for an escape symbol
- Define and explain the purpose of environment variables.
- Be able to use grep to search text files.
- Explain the purpose of a batch program.
- Be able to connect to another machine using SSH.

Questions