

Computing Basics for Bioinformatics on the Cloud

Session 2

Yaoyu Wang

Overview

- Introduction to cloud computing
- Get on to the cloud
- Get around on the cloud with linux
- Free bioinformatics resources on the cloud

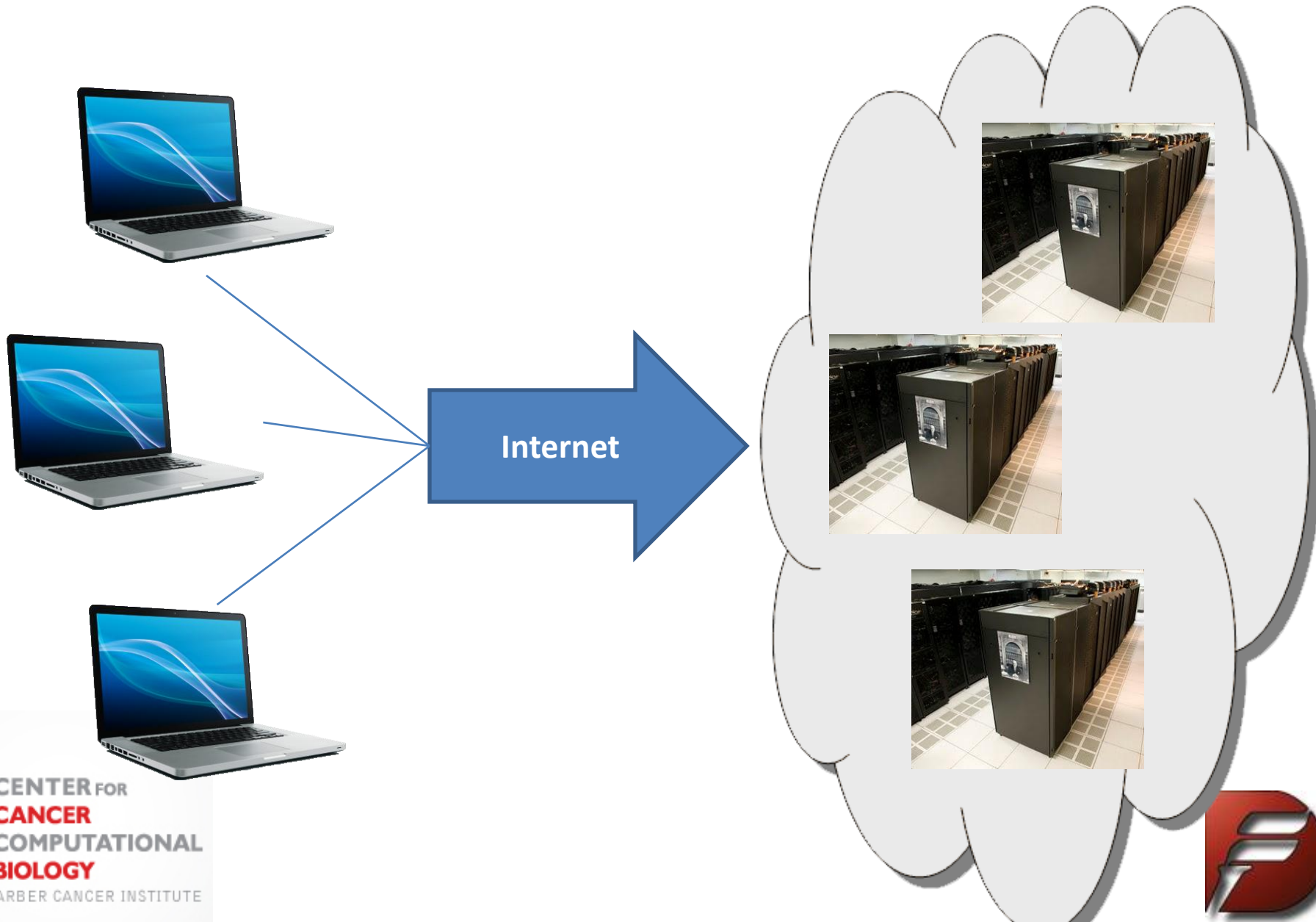
- Download slide at:

<http://tinyurl.com/cccbtrain>

What is Cloud Computing?

Cloud Computing is a general term used to describe a network based computing that takes place over the Internet

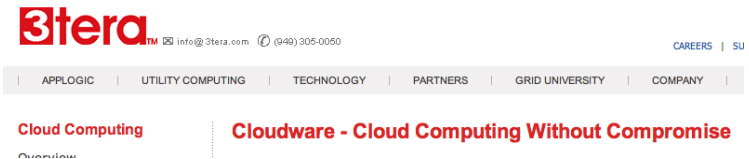
Overly Simplistic Cloud Computing Schema



Basic Cloud Characteristics

- The “**flexibility and elasticity**” allows these systems to scale up and down at will – utilising the resources of all kinds (CPU, storage, server capacity, load balancing, and databases).
- The “**pay as much as used and needed**” type of utility computing and the “**always on!, anywhere and any place**” type of network-based computing.
- The “**no-need-to-know**” in terms of the underlying details of infrastructure, applications interface with the infrastructure via the APIs.

Some Commercial Cloud Offerings





Amazon Web Services

- Elastic Compute Cloud (EC2)
 - Rent computing resources by the hour
 - Basic unit of accounting = instance-hour
 - Additional costs for bandwidth
- Elastic Block Storage (EBS)
 - Persistent storage
 - Charge by provision block
 - Additional costs for bandwidth

Cloud Computing

Quick-start an Amazon EC2 instance...

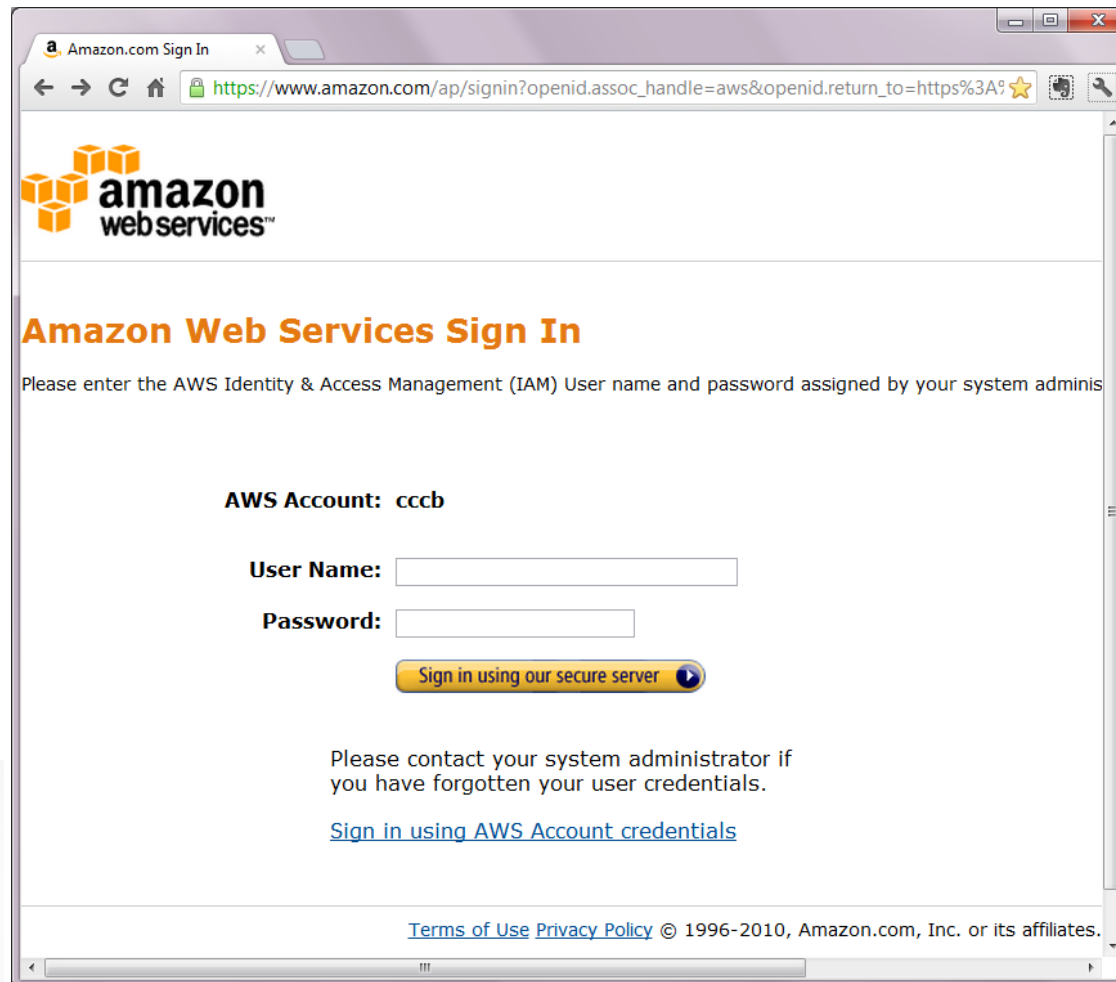
Cloud Computing

Running a server on Amazon Web Service (AWS) requires you to go through the following steps:

1. Create your account on Amazon (if you do not already have one) and setup your credentials
2. Install Amazon EC2 API Tools
3. Instantiate your image (i.e. your account)
4. Configure your instance (i.e. your virtual machine)

Cloud Computing: Start the Machine

<http://aws.amazon.com/>

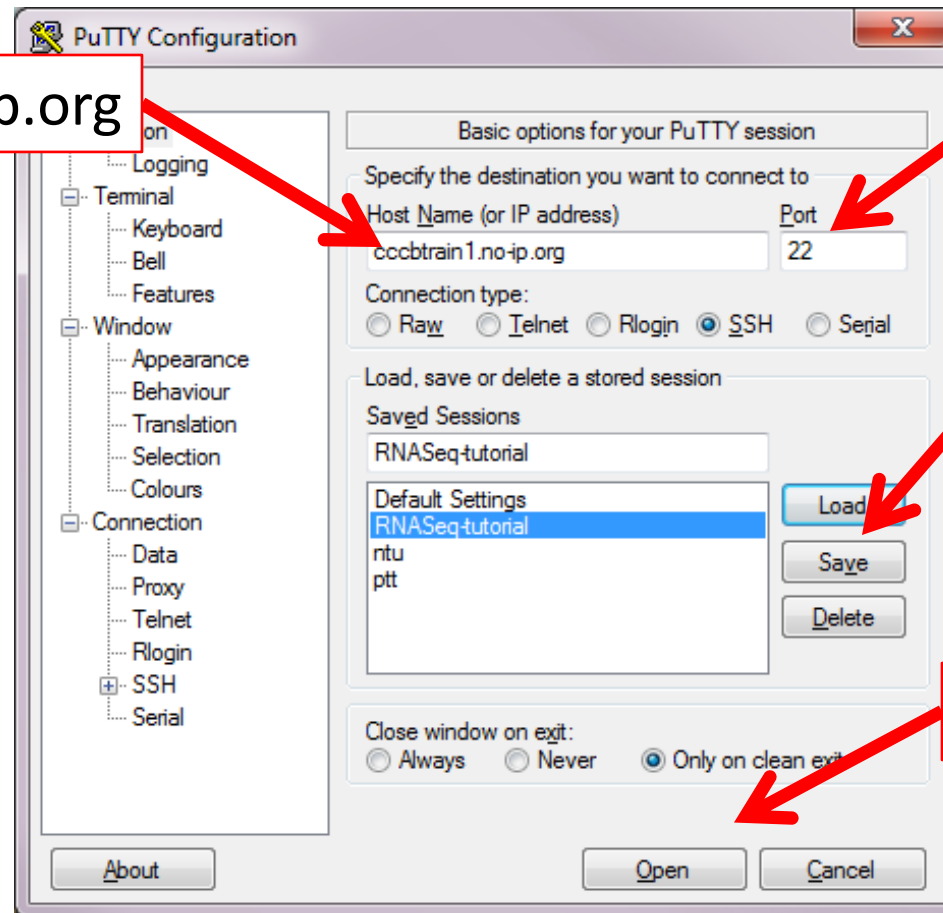


A screenshot of a web browser window showing the Amazon Web Services Sign In page. The browser's address bar displays the URL https://www.amazon.com/ap/signin?openid.assoc_handle=aws&openid.return_to=https%3A%3A.... The page features the Amazon Web Services logo at the top left. Below the logo, the heading "Amazon Web Services Sign In" is displayed in orange. A message states: "Please enter the AWS Identity & Access Management (IAM) User name and password assigned by your system administrator". The "AWS Account:" field is populated with "cccb". The "User Name:" and "Password:" fields are empty text boxes. A yellow button with a play icon and the text "Sign in using our secure server" is positioned below the password field. At the bottom of the form, a link reads "Please contact your system administrator if you have forgotten your user credentials." followed by a blue hyperlink "Sign in using AWS Account credentials". The footer contains links for "Terms of Use" and "Privacy Policy", and a copyright notice: "© 1996-2010, Amazon.com, Inc. or its affiliates."

Cloud Computing: Logging in

For Windows

Download PuTTY at: <http://tinyurl.com/putty-d>



cccbtrain1.no-ip.org

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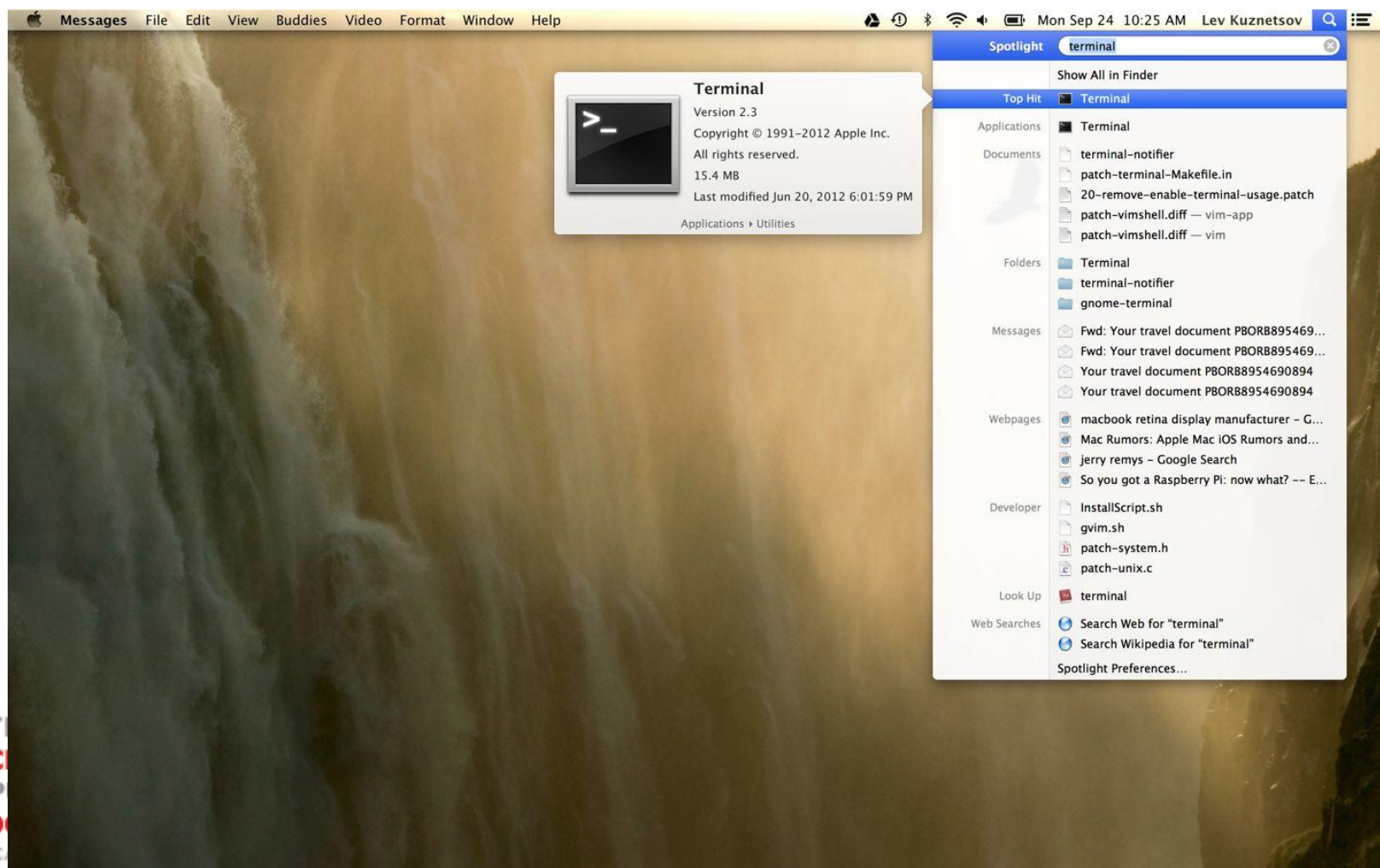
Save Session

Launch!

Cloud Computing: Logging in

For Mac

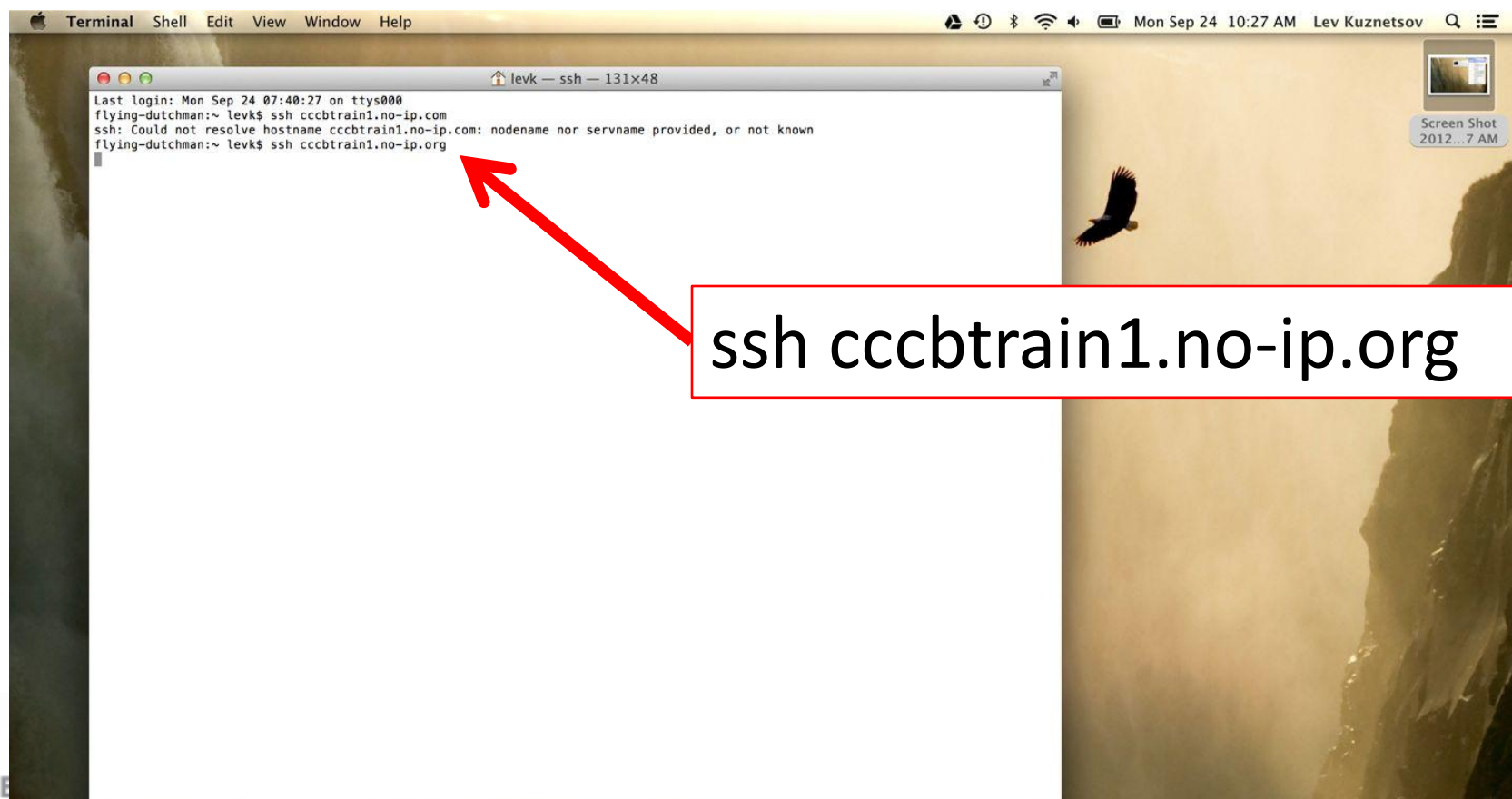
You already have the necessary program pre-installed



Cloud Computing: Logging in

For Mac

You already have the necessary program pre-installed



The screenshot shows a Mac desktop with a Terminal window open. The window title is "levk — ssh — 131x48". The terminal output shows a successful login for "levk" on "Mon Sep 24 07:40:27 on ttys000". The user "flying-dutchman" enters the command "ssh cccbtrain1.no-ip.com". The terminal then displays the error message: "ssh: Could not resolve hostname cccbtrain1.no-ip.com: nodename nor servname provided, or not known". The user then enters "ssh cccbtrain1.no-ip.org". A red arrow points from a text box containing the command "ssh cccbtrain1.no-ip.org" to the terminal window. The desktop background is a scenic image of a mountain peak with a bird in flight. A "Screen Shot 2012...7 AM" icon is visible in the top right corner of the desktop.

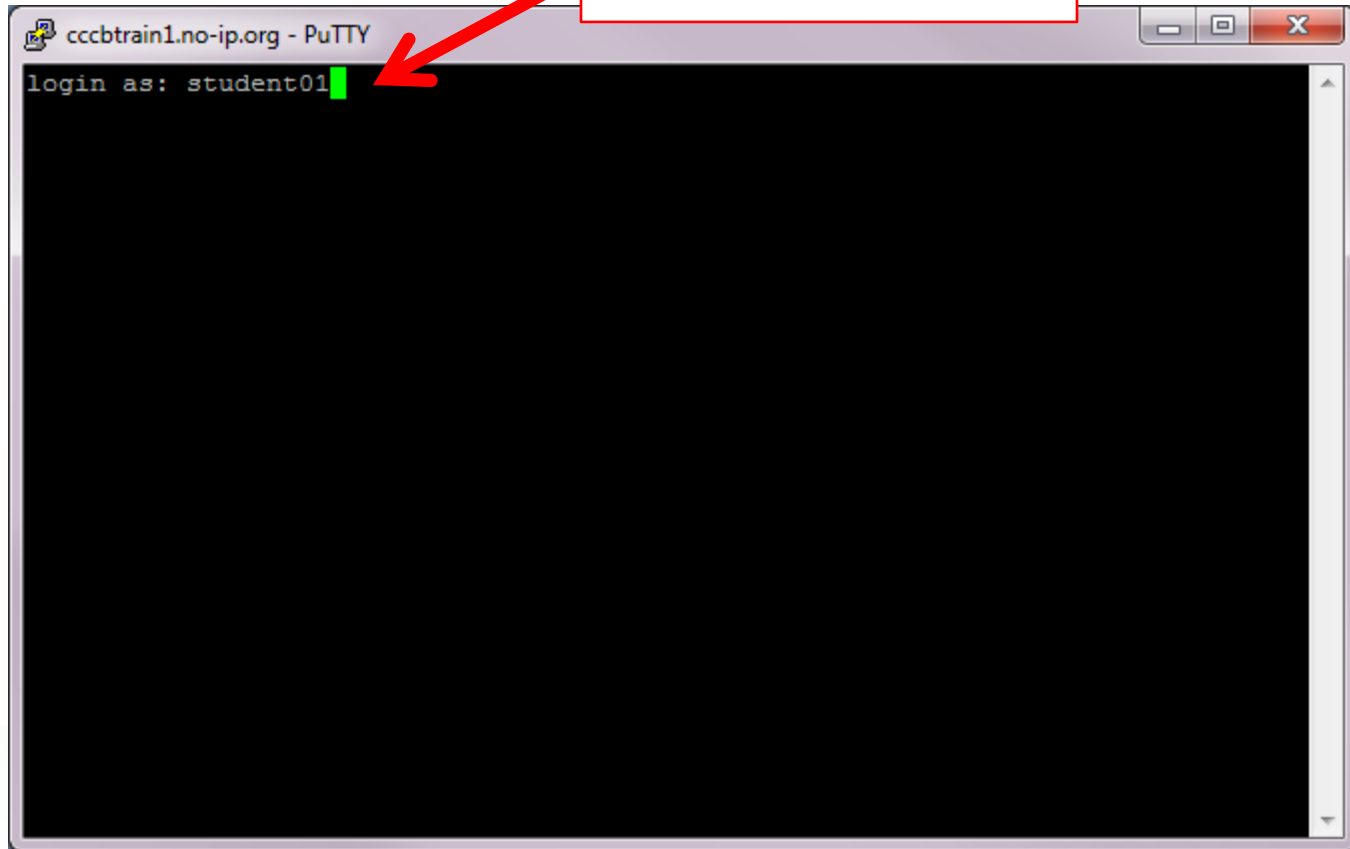
```
levk — ssh — 131x48
Last login: Mon Sep 24 07:40:27 on ttys000
flying-dutchman:~ levk$ ssh cccbtrain1.no-ip.com
ssh: Could not resolve hostname cccbtrain1.no-ip.com: nodename nor servname provided, or not known
flying-dutchman:~ levk$ ssh cccbtrain1.no-ip.org
```

ssh cccbtrain1.no-ip.org

Cloud Computing: Logging in

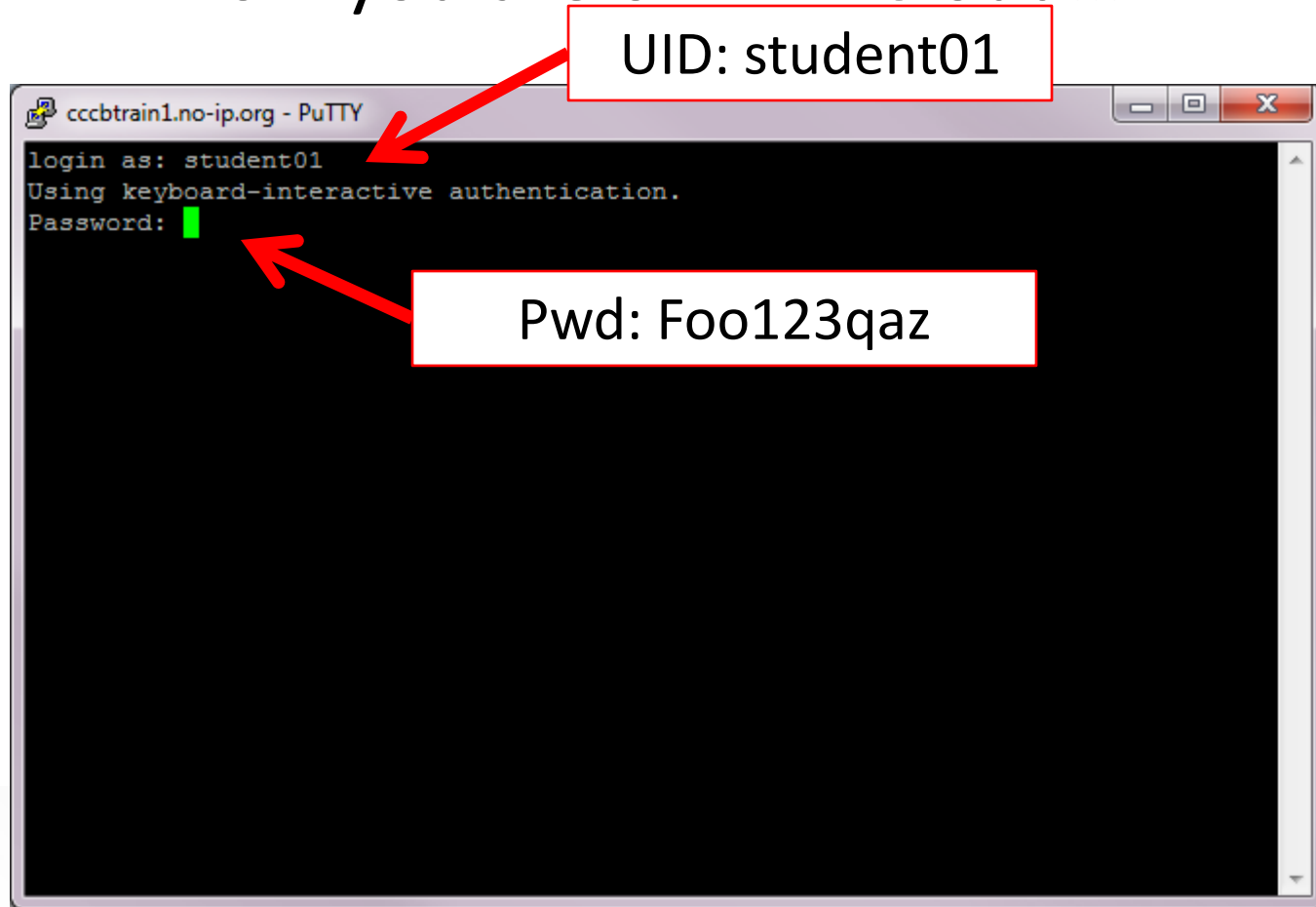
Now you are on THE Cloud...

UID: student01



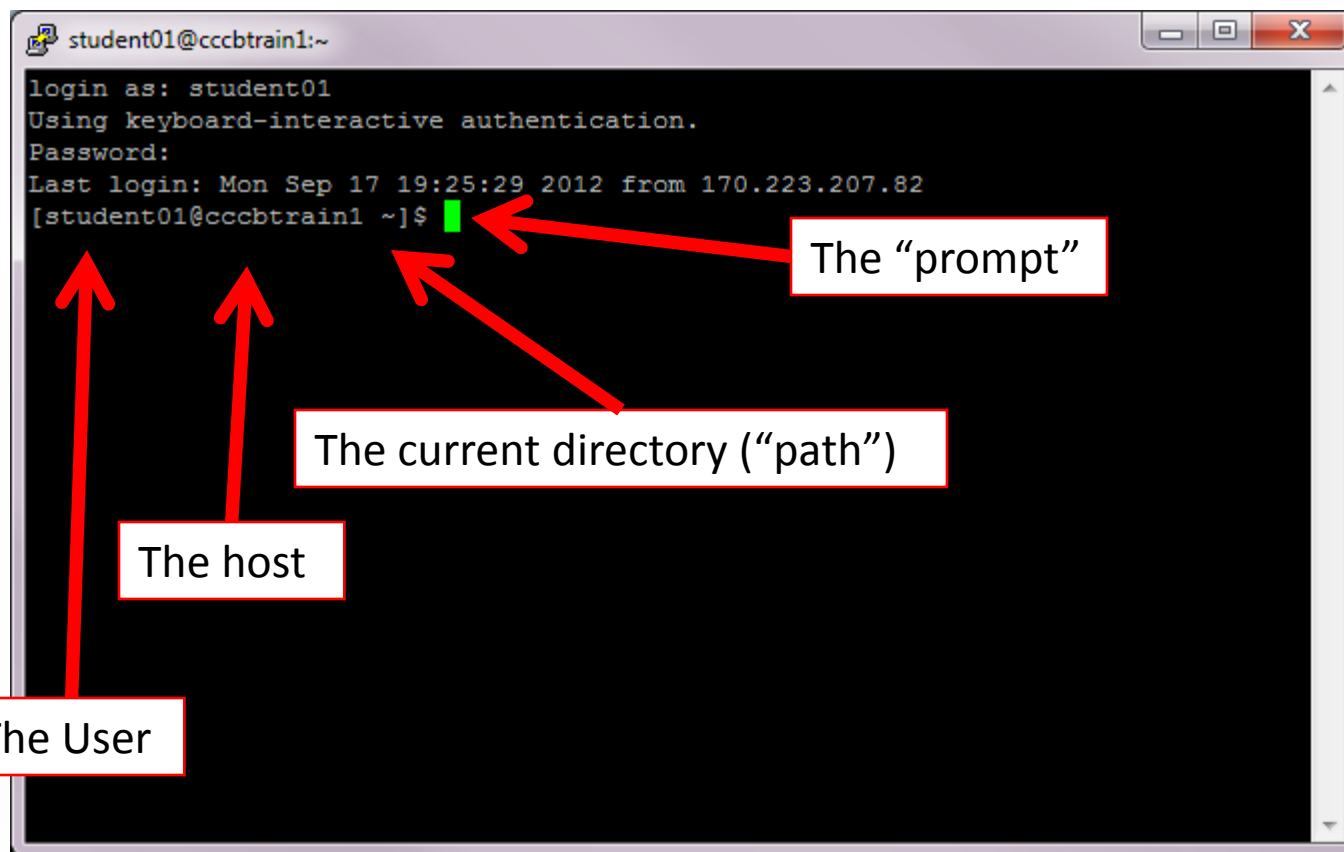
Cloud Computing: Logging in

Now you are on THE Cloud...



Cloud Computing: Logging in

Now you are on THE Cloud...



A terminal window titled 'student01@cccbtrain1:~' showing the login process. The text inside the terminal is as follows:

```
login as: student01
Using keyboard-interactive authentication.
Password:
Last login: Mon Sep 17 19:25:29 2012 from 170.223.207.82
[student01@cccbtrain1 ~]$
```

Four red arrows point from text boxes to specific parts of the terminal output:

- 'The User' points to 'student01' in the title bar.
- 'The host' points to 'cccbtrain1' in the title bar.
- 'The current directory ("path")' points to '~' in the prompt.
- 'The "prompt"' points to '\$' in the prompt.

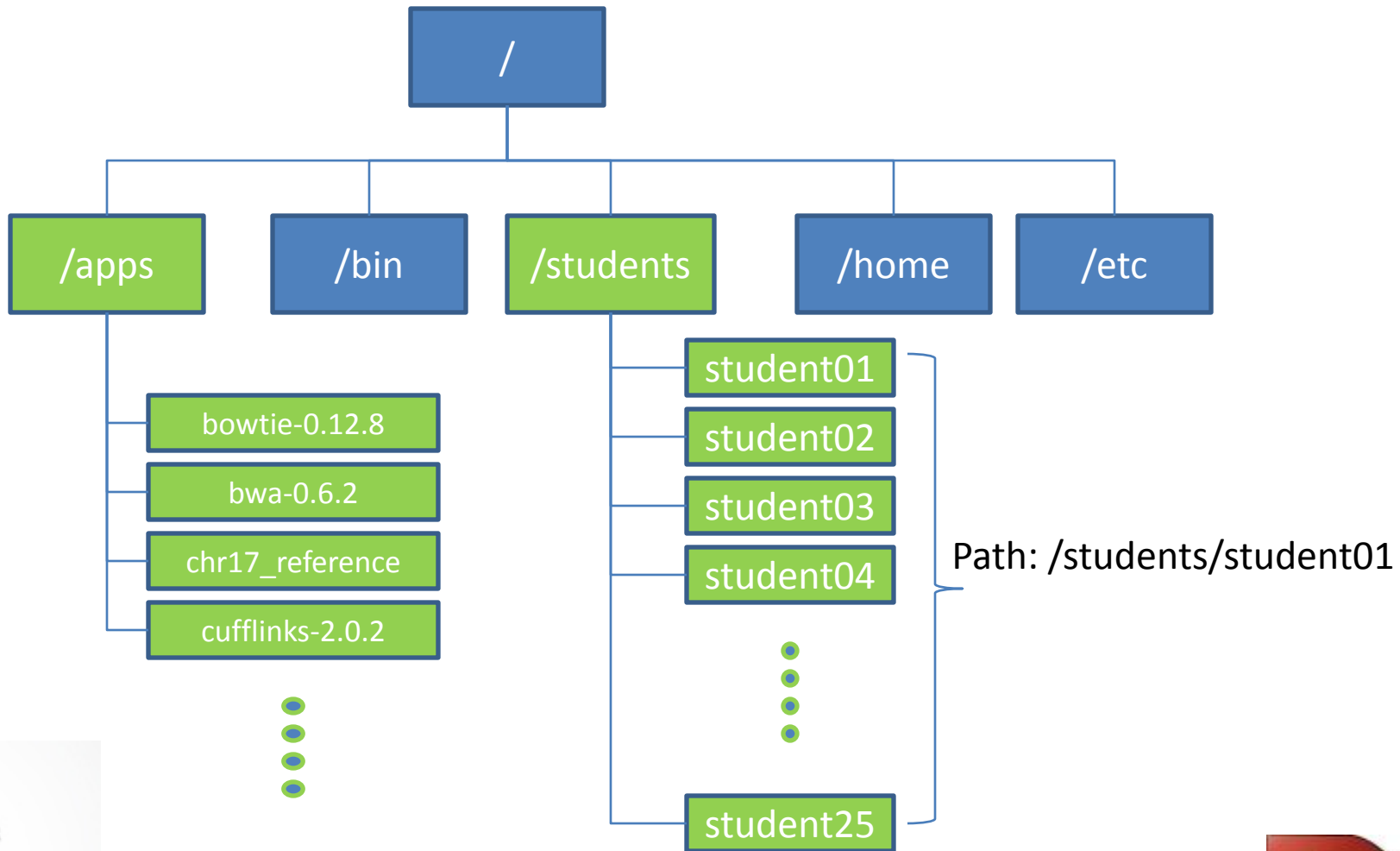
Cloud Computing

How to navigate around the Cloud?
(a.k.a Linux Basics)

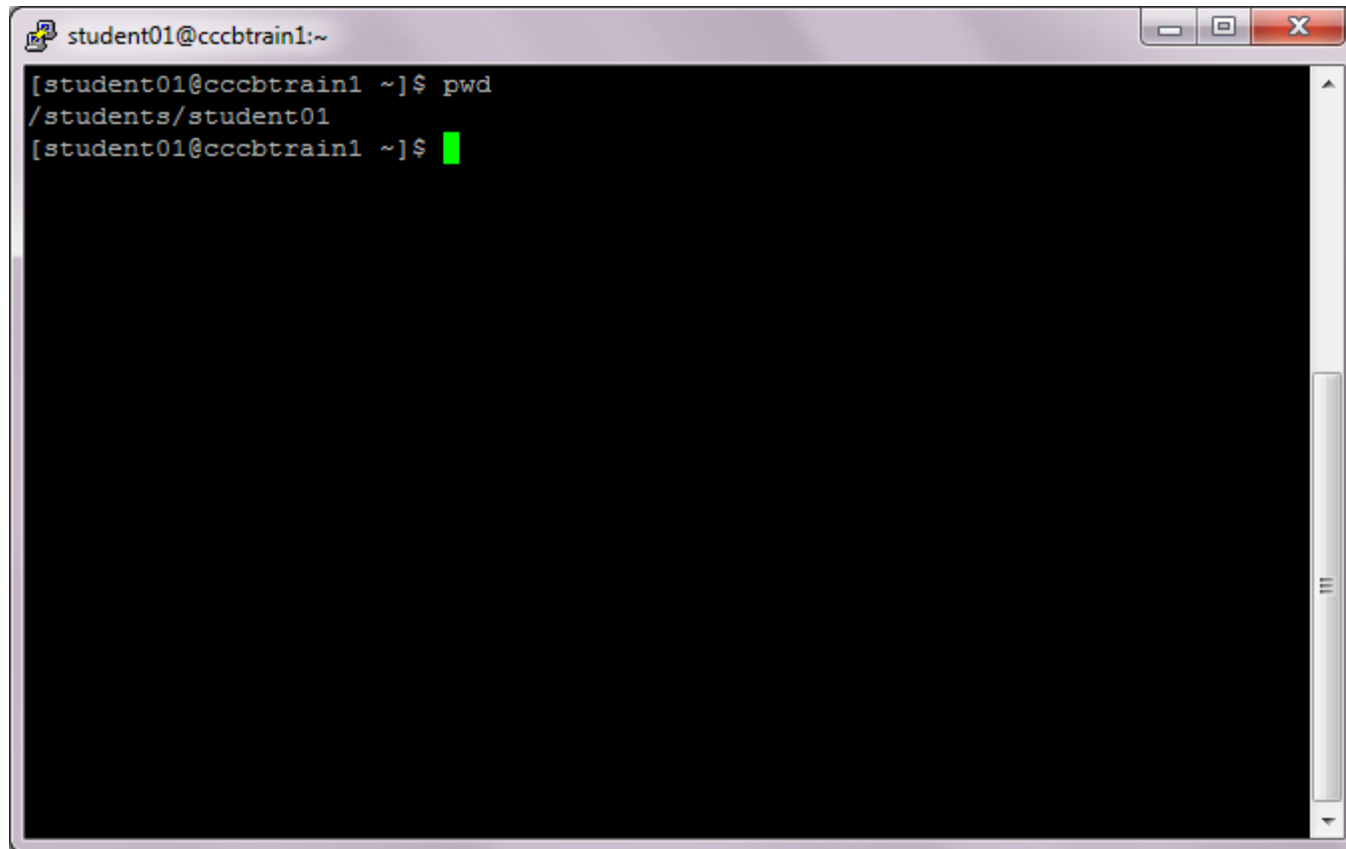
What exactly is a “shell”?

- After logging in, Linux/Unix starts another program called the **shell**
- The shell interprets commands the user types and manages their execution
 - The shell communicates with the internal part of the operating system called the **kernel**
 - The most popular shells are: tcsh, csh, korn, and bash
 - The differences are most times subtle
 - For this tutorial, we are using bash
- Shell commands are **CASE SENSITIVE!**

File System Organization



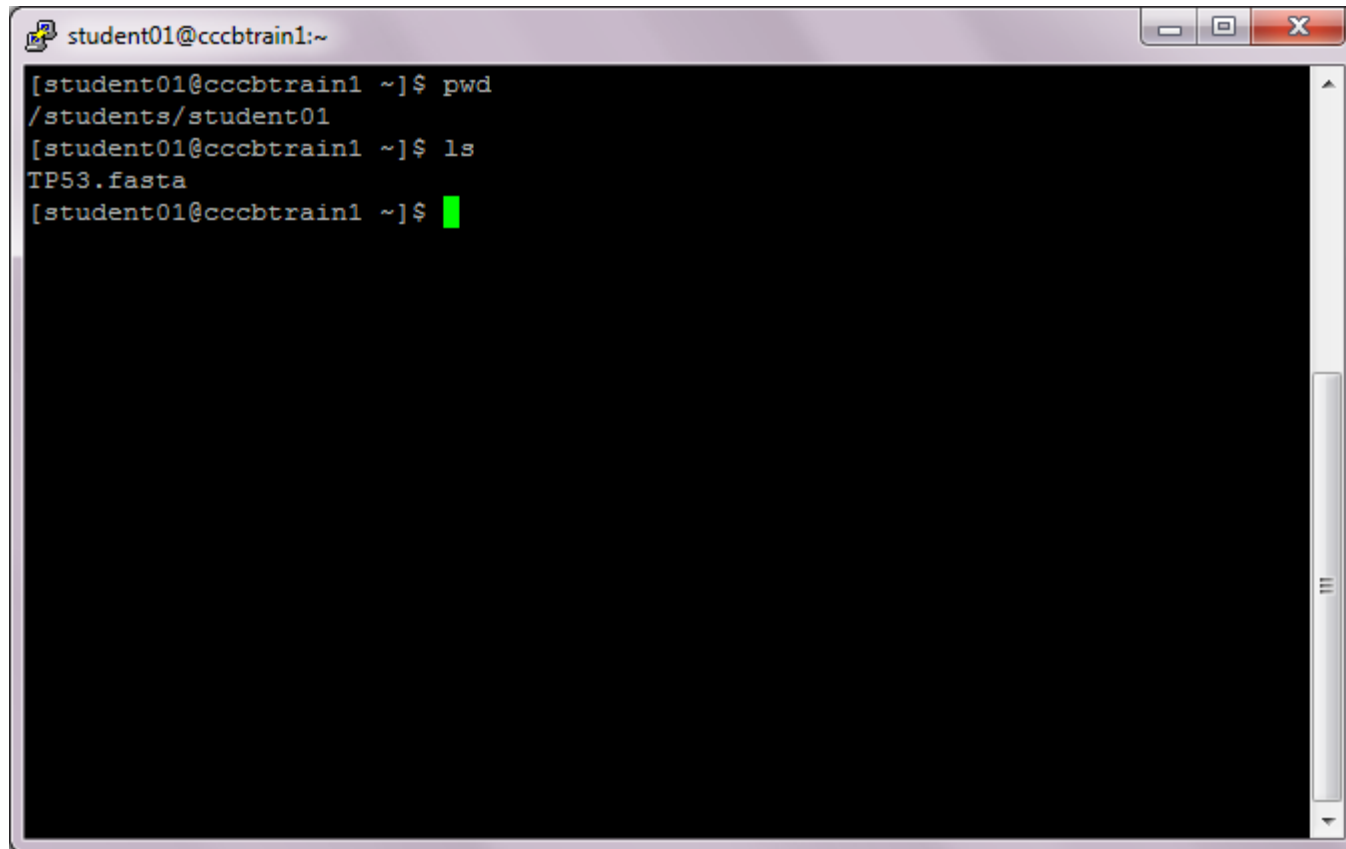
Basic Linux Command

A terminal window titled 'student01@cccbtrain1:~' with standard window controls. The terminal shows the command 'pwd' being executed, resulting in the output '/students/student01'. A green cursor is visible on the line following the command.

```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$
```

pwd - print name of current/working directory

Basic Linux Command

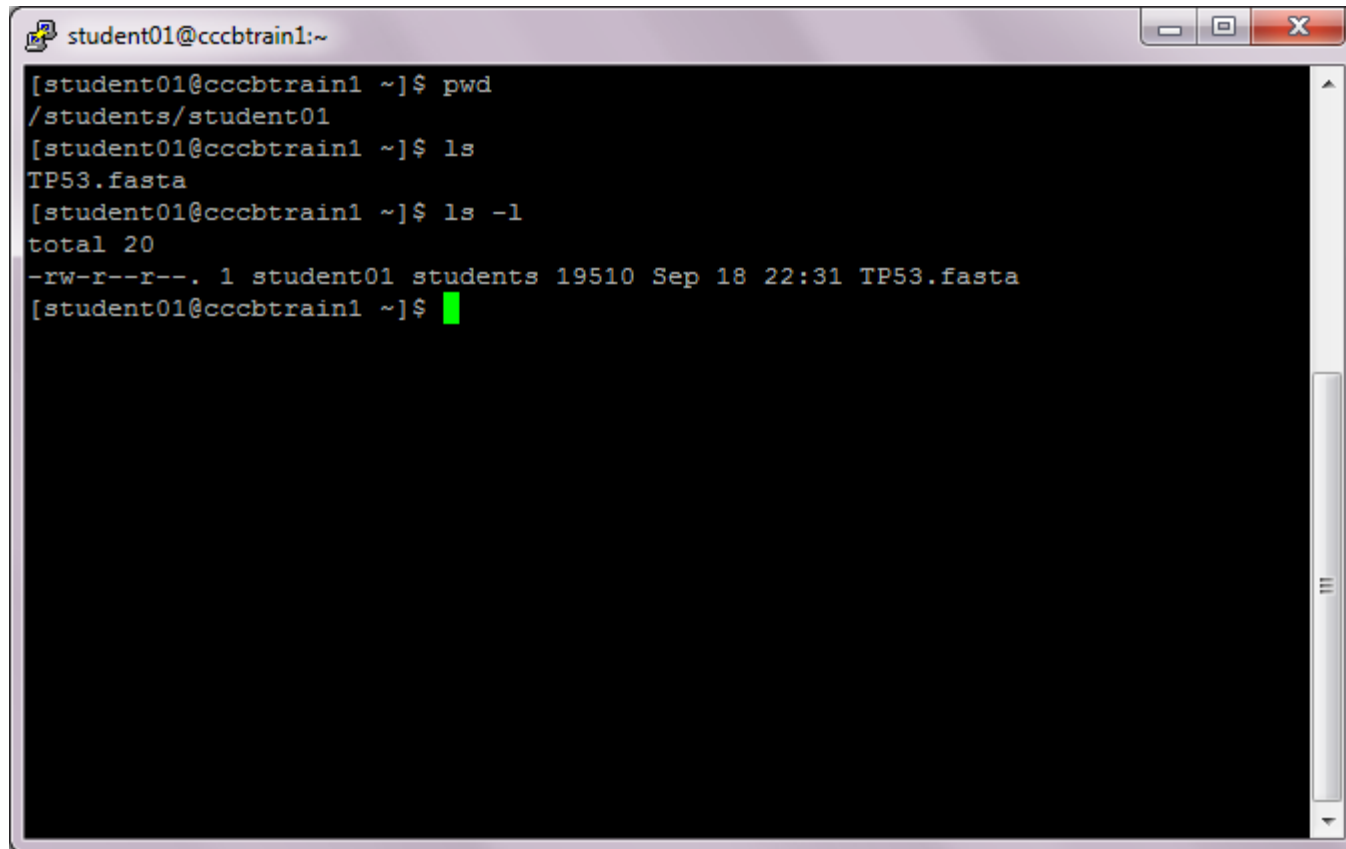


A terminal window titled 'student01@cccbtrain1:~' with standard window controls. The terminal shows the following commands and output:

```
[student01@cccbtrain1 ~]$ pwd
/students/student01
[student01@cccbtrain1 ~]$ ls
TP53.fasta
[student01@cccbtrain1 ~]$
```

ls - list directory contents

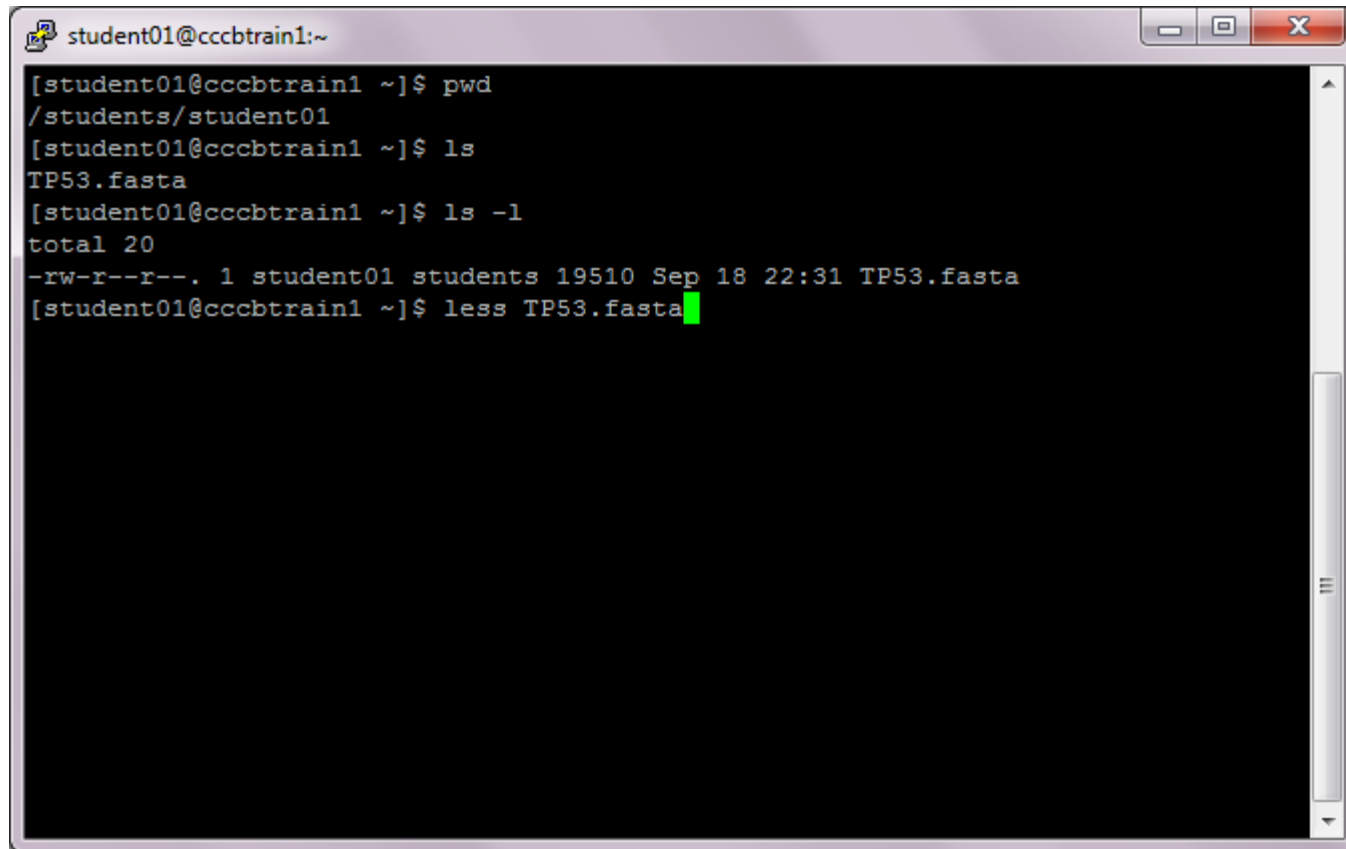
Basic Linux Command



```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$
```

ls -l use a long listing format

Basic Linux Command



```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta
```

less – quick file viewer

Basic Linux Command

```
student01@cccbrain1:~  
>gi|224589808:c7590868-7571720 Homo sapiens chromosome 17, GRCh37.p9 Primary Ass  
embly  
GATGGGATTGGGGTTTTCCCTCCCATGTGCTCAAGACTGGCGCTAAAAGTTTTGAGCTTCTCAAAAGTC  
TAGAGCCACCGTCCAGGGAGCAGGTAGCTGCTGGGCTCCGGGGACACTTTGCGTTCGGGCTGGGAGCGTG  
CTTTCACGACGGTGACACGCTTCCCTGGATTGGGTAAGCTCCTGACTGAACCTTGATGAGTCCTCTCTGA  
GTCACGGGCTCTCGGCTCCGTGTATTTTTCAGCTCGGGAATAATCGCTGGGGCTGGGGGTGGGGCAGTGGGG  
ACTTAGCGAGTTTGGGGGTGAGTGGGATGGAAGCTTGGCTAGAGGGATCATCATAGGAGTTGCATTGTTG  
GGAGACCTGGGTGTAGATGATGGGGATGTTAGGACCATCCGAACTCAAAGTTGAACGCCTAGGCAGAGGA  
GTGGAGCTTTGGGGAACCTTGAGCCGGCCATAAGCGTACTTCTTTGCACATCCACCGGTGCTGGGCGTA  
GGGAATCCCTGAAATAAAAGATGCACAAAGCATTGAGGTCTGAGACTTTTGGATCTCGAAACATTGAGAA  
CTCATAGCTGTATATTTTAGAGCCCATGGCATCCTAGTGAAAACCTGGGGCTCCATTCCGAAATGATCATT  
TGGGGGTGATCCGGGGAGCCCCAAGCTGCTAAGGTCCCACAACCTCCGGACCTTTGTCTTCTCTGGAGCGA  
TCTTTCAGGCAGCCCCCGGCTCCGCTAGATGGAGAAAATCCAATTGAAGGCTGTGAGTCGTGGAAGTGA  
GAAGTGCTAAACCAGGGGTTTGCCCGCCAGGCCGAGGAGGACCGTCGCAATCTGAGAGGCCCGGCAGCCC  
TGTTATTGTTTGGCTCCACATTTACATTTCTGCCTCTTGACAGCAGCATTTCCGGTTTCTTTTTGCCGGAG  
CAGCTCACTATTCACCCGATGAGAGGGGAGGAGAGAGAGAGAAAATGTCTTTAGGCCGGTTCTCTTAC  
TTGGCAGAGGGAGGCTGCTATTCTCCGCCTGCATTTCTTTTTCTGGATTACTTAGTTATGGCCTTTGCAA  
AGGCAGGGGTATTTGTTTTGATGCAAACCTCAATCCCTCCCCTTCTTTGAATGGTGTGCCCCACCCCGCG  
GGTCGCCTGCAACCTAGGCGGACGCTACCATGGCGTGAGACAGGGAGGGAAAAGAAGTGTGCAGAAGGCAA  
GCCCCGAGGTATTTTCAAGAATGAGTATATCTCATCTTCCCGGAGGAAAAAAAAAAGAATGGGTACGTC  
TGAGAATCAAATTTTGAAGAGTGCAATGATGGGTGTTTGATAATTTGTGCGGAAAAACAATCTACCTGT  
TATCTAGCTTTGGGCTAGGCCATTCCAGTTCAGACGCAGGCTGAACGTCGTGAAGCGGAAGGGGCGGGC  
CCGCAGGCGTCCGTGTGGTCTCCGTGCAGCCCTCCGGCCCCGAGCCGGTTCTTCTGGTAGGAGGCGGAA  
TP53.fasta
```


Basic Linux Commands

```
student01@cccbrain1:~  
>gi|224589808:c7590868-7571720 Homo sapiens chromosome 17, GRCh37.p9 Primary Ass  
embly  
GATGGGATTGGGGTTTTCCCTCCCATGTGCTCAAGACTGGCGCTAAAAGTTTTGAGCTTCTCAAAAGTC  
TAGAGCCACCGTCCAGGGAGCAGGTAGCTGCTGGGCTCCGGGGACACTTTGCGTTCGGGCTGGGAGCGTG  
CTTTCCACGACGGTGACACGCTTCCCTGGATTGGGTAAGCTCCTGACTGAACTTGATGAGTCCTCTCTGA  
GTCACGGGCTCTCGGCTCCGTGTATTTTTCAGCTCGGGAATAATCGCTGGGGCTGGGGGTGGGGCAGTGGGG  
ACTTAGCGAGTTTGGGGGTGAGTGGGATGGAAGCTTGGCTAGAGGGATCATCATAGGAGTTGCATTGTTG  
GGAGACCTGGGTGTAGATGATGGGGATGTTAGGACCATCCGAACTCAAAGTTGAACGCCTAGGCAGAGGA  
GTGGAGCTTTGGGGAACCTTGAGCCGGCCCTAAAGCGTACTTCTTTGCACATCCACCGGTGCTGGGCGTA  
GGGAATCCCTGAAATAAAAGATGCACAAAGCATTGAGGTCTGAGACTTTTGGATCTCGAAACATTGAGAA  
CTCATAGCTGTATATTTTAGAGCCCATGGCATCCTAGTGAAAACCTGGGGCTCCATTCCGAAATGATCATT  
TGGGGGTGATCCGGGGAGCCCCAGCTGCTAAGGTCCACAACTTCCGGACCTTTGTCTTCTCTGGAGCGA  
TCTTTCCAGGCAGCCCCCGGCTCCGCTAGATGGAGAAAATCCAATTGAAGGCTGTGAGTGTGGAAGTGA  
GAAGTGCTAAACCAGGGGTTTGCCCGCCAGGCCGAGGAGGACCGTCGCAATCTGAGAGGCCCGGCAGCCC  
TGTTATTGTTTGGCTCCACATTTACATTTCTGCCTCTTGCAGCAGCATTTCCGGTTTCTTTTTGCCGGAG  
CAGCTCACTATTCACCCGATGAGAGGGGAGGAGAGAGAGAGAAAATGTCTTTAGGCCGGTTCCTCTTAC  
TTGGCAGAGGGAGGCTGCTATTCTCCGCCTGCATTTCTTTTTCTGGATTACTTAGTTATGGCCTTTGCAA  
AGGCAGGGGTATTTGTTTTGATGCAAACCTCAATCCCTCCCCTTCTTTGAATGGTGTGCCCCACCCCGCG  
GGTCGCCTGCAACCTAGGCGGACGCTACCATGGCGTGAGACAGGGAGGGAAAAGAAGTGTGCAGAAGGCAA  
GCCCCGAGGTATTTTCAAGAATGAGTATATCTCATCTTCCCGGAGGAAAAAAAAAAGAATGGGTACGTC  
TGAGAATCAAATTTTGAAGAGTGCAATGATGGGTGTTTTGATAATTTGTGCGGAAAAACAATCTACCTGT  
TATCTAGCTTTGGGCTAGGCCATTCCAGTTCAGACGCAGGCTGAACGTCGTGAAGCGGAAGGGGCGGGC  
CCGCAGGCGTCCGTGTGGTCTCCGTGCAGCCCTCCGGCCCGAGCCGGTTCTTCTGGTAGGAGGCGGAA  
/AATA
```

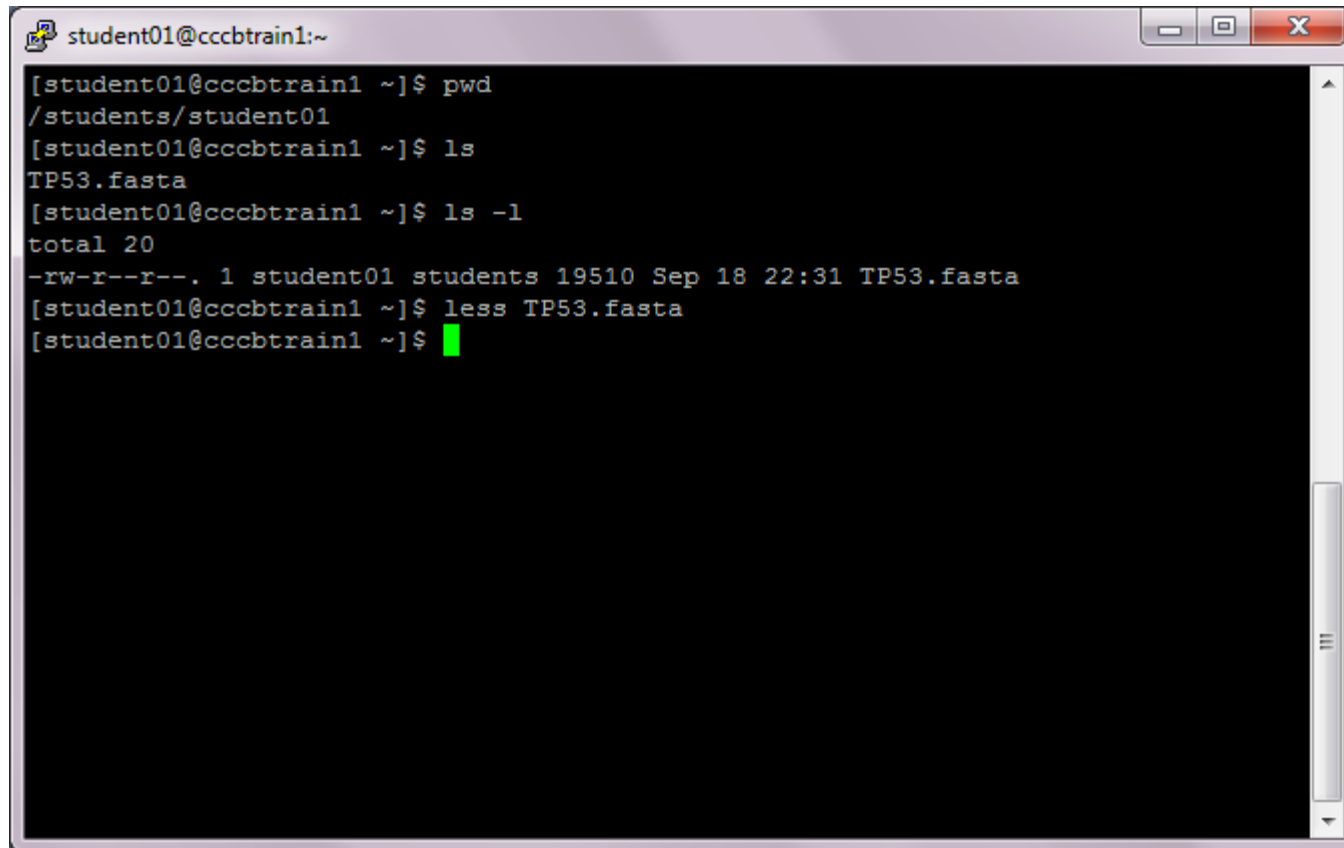
less – allows for simple text searching

Basic Linux Command

```
student01@ccbtrain1:~  
GGGAATCCCTGAAATAAAAGATGCACAAAGCATTGAGGTCTGAGACTTTTGGATCTCGAAACATTGAGAA  
CTCATAGCTGTATATTTTAGAGCCCATGGCATCCTAGTGAAAACCTGGGGCTCCATTCCGAAATGATCATT  
TGGGGGTGATCCGGGGAGCCCAAGCTGCTAAGGTCCCACAACCTCCGGACCTTTGTCTTCCTGGAGCGA  
TCTTTCCAGGCAGCCCCGGCTCCGCTAGATGGAGAAAATCCAATTGAAGGCTGTCACTCGTGGAAGTGA  
GAAGTGCTAAACCAGGGGTTTGCCCGCCAGGCCGAGGAGGACCGTCGCAATCTGAGAGGCCCGGCAGCCC  
TGTTATTGTTTGGCTCCACATTTACATTTCTGCCTCTTGACGACGATTTCCGGTTTCTTTTGGCGGAG  
CAGCTCACTATTCACCCGATGAGAGGGGAGGAGAGAGAGAGAAAATGTCTTTAGGCCGGTTCTCTTAC  
TTGGCAGAGGGAGGCTGCTATTCTCCGCCTGCATTTCTTTTCTGGATTACTTAGTTATGGCCTTTGCAA  
AGGCAGGGGTATTTGTTTGTATGCAAACCTCAATCCCTCCCCTTCTTTGAATGGTGTGCCCCACCCCGCG  
GGTCGCCTGCAACCTAGGCGGACGCTACCATGGCGTGAGACAGGGAGGGAAAGAAGTGTGCAGAAGGCAA  
GCCCCGAGGTATTTCAAGAATGAGTATATCTCATCTTCCCGGAGGAAAAAAAAAAGAATGGGTACGTC  
TGAGAATCAAATTTTGAAGAGTGCAATGATGGGTGTTTGATAATTTGTGGAATAACAATCTACCTGT  
TATCTAGCTTTGGGCTAGGCCATTCCAGTTCCAGACGACAGGCTGAACGTGCTGAAGCGGAAGGGGCGGGC  
CCGCAGGCGTCCGTGTGGTCTCCGTGCAGCCCTCCGGCCCGAGCCGTTTCTTCTGGTAGGAGGCGGAA  
CTCGAATTCATTTCTCCCGCTGCCCCATCTCTTAGCTCGCGTTTGTTCATTCCGCAGTTTCTTCCCATG  
CACCTGCCGCGTACCGGCCACTTTGTGCCGTACTTACGTCTATTTTTCTAAATCGAGGTGGCATTAC  
ACACAGCGCCAGTGACACAGCAAGTGACAGGAAGATGAGTTTTGGCCCTAACCGCTCCGTGATGCCT  
ACCAAGTCACAGACCCTTTTCATCGTCCCAGAAACGTTTCATCACGTCTCTTCCAGTCGATTCCCGACC  
CCACCTTTATTTTGTATCTCCATAACCATTTTGCCTGTTGGAGAACTTCATATAGAATGGAATCAGGCTGG  
GCGCTGTGGCTCACGCCTGCATTTGGGAGGCCGAGGCGGGCGGATTACTTGAGGATAGGAGTTCCAGAC  
CAGCGTGGCCAACGTGGTGAATCCCGCTCTCTACTAAAAATAAAAAATTAGCTGGGCGTGGTGGGTGC  
CTGTAATCCCAGCTATTCGGGAGGGTGAGGCAGGAGAATCGCTTGAACCCGGGAGGCAGAGGTTGCAGTG  
AGCCAAGATCGTGCCACTACACTCCAGCCTGGGCGACAAGAACGAACTCCGTCTCAAAAAAAGGGGGG  
:
```

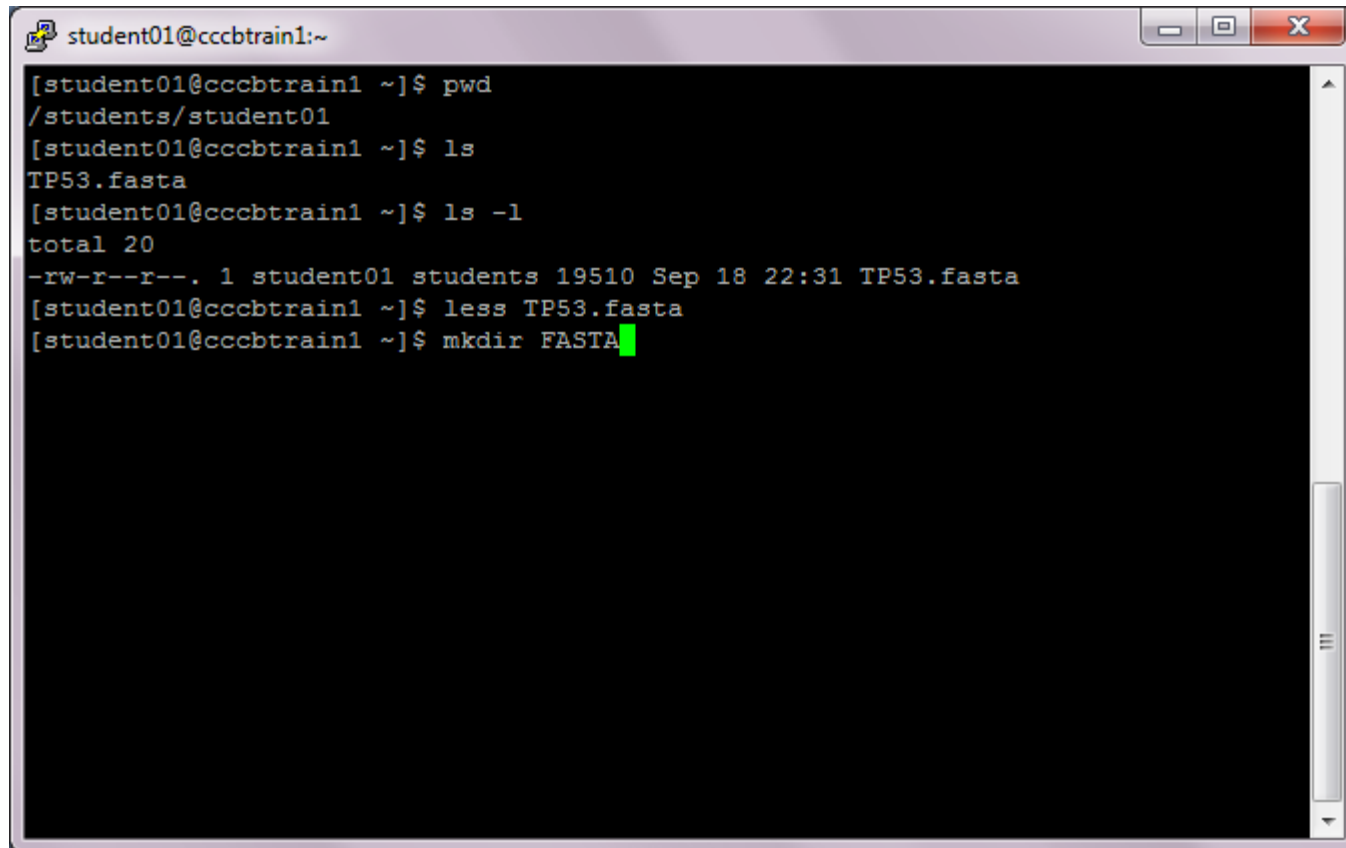
less – allows for simple text searching

Basic Linux Command



```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$
```

Basic Linux Command



```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA
```

mkdir – make directories

Basic Linux Command

```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA  
[student01@cccbtrain1 ~]$ ls  
FASTA TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 24  
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$
```

mkdir – make directories

Basic Linux Command

```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
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-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA  
[student01@cccbtrain1 ~]$ ls  
FASTA TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 24  
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/
```

Basic Linux Command

```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA  
[student01@cccbtrain1 ~]$ ls  
FASTA TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 24  
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/  
[student01@cccbtrain1 ~]$ ls  
FASTA  
[student01@cccbtrain1 ~]$
```

Basic Linux Command

```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ pwd  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
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[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA  
[student01@cccbtrain1 ~]$ ls  
FASTA TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 24  
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/  
[student01@cccbtrain1 ~]$ ls  
FASTA  
[student01@cccbtrain1 ~]$ cd FASTA/
```


Basic Linux Command

```
student01@cccbtrain1:~/FASTA
[student01@cccbtrain1 ~]$ pwd
/students/student01
[student01@cccbtrain1 ~]$ ls
TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 20
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta
[student01@cccbtrain1 ~]$ less TP53.fasta
[student01@cccbtrain1 ~]$ mkdir FASTA
[student01@cccbtrain1 ~]$ ls
FASTA  TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 24
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/
[student01@cccbtrain1 ~]$ ls
FASTA
[student01@cccbtrain1 ~]$ cd FASTA/
[student01@cccbtrain1 FASTA]$
```

Basic Linux Command

```
student01@cccbtrain1:~/FASTA
[student01@cccbtrain1 ~]$ pwd
/students/student01
[student01@cccbtrain1 ~]$ ls
TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 20
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta
[student01@cccbtrain1 ~]$ less TP53.fasta
[student01@cccbtrain1 ~]$ mkdir FASTA
[student01@cccbtrain1 ~]$ ls
FASTA  TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 24
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/
[student01@cccbtrain1 ~]$ ls
FASTA
[student01@cccbtrain1 ~]$ cd FASTA/
[student01@cccbtrain1 FASTA]$ ls
TP53.fasta
[student01@cccbtrain1 FASTA]$
```

Basic Linux Command

```
student01@cccbtrain1:~/FASTA
[student01@cccbtrain1 ~]$ pwd
/students/student01
[student01@cccbtrain1 ~]$ ls
TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 20
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FASTA  TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 24
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/
[student01@cccbtrain1 ~]$ ls
FASTA
[student01@cccbtrain1 ~]$ cd FASTA/
[student01@cccbtrain1 FASTA]$ ls
TP53.fasta
[student01@cccbtrain1 FASTA]$ pwd
/students/student01/FASTA
[student01@cccbtrain1 FASTA]$
```

Basic Linux Command

```
student01@cccbtrain1:~/FASTA
[student01@cccbtrain1 ~]$ pwd
/students/student01
[student01@cccbtrain1 ~]$ ls
TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 20
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta
[student01@cccbtrain1 ~]$ less TP53.fasta
[student01@cccbtrain1 ~]$ mkdir FASTA
[student01@cccbtrain1 ~]$ ls
FASTA  TP53.fasta
[student01@cccbtrain1 ~]$ ls -l
total 24
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/
[student01@cccbtrain1 ~]$ ls
FASTA
[student01@cccbtrain1 ~]$ cd FASTA/
[student01@cccbtrain1 FASTA]$ ls
TP53.fasta
[student01@cccbtrain1 FASTA]$ pwd
/students/student01/FASTA
[student01@cccbtrain1 FASTA]$ cd ..
```

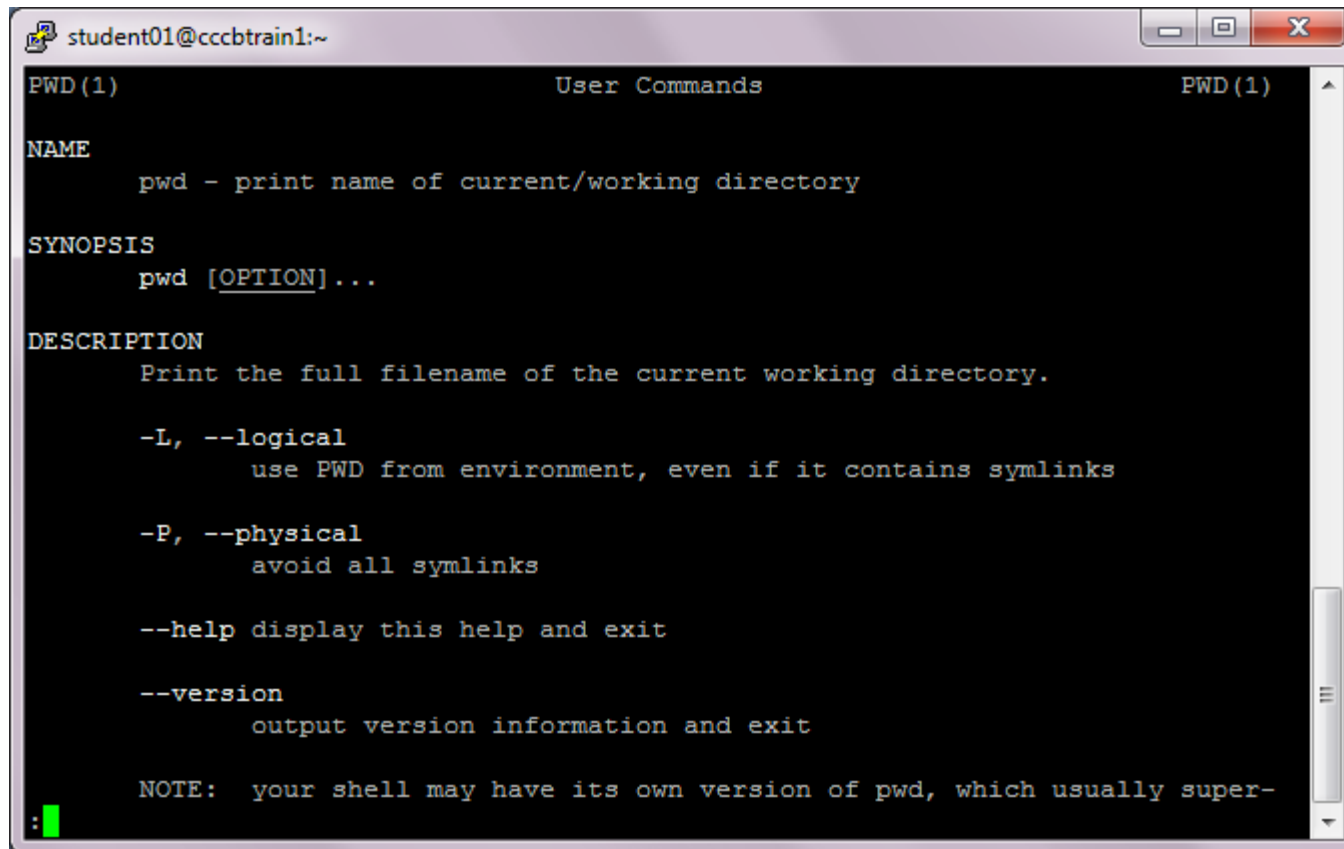
Basic Linux Command

```
student01@cccbtrain1:~  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA  
[student01@cccbtrain1 ~]$ ls  
FASTA TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 24  
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/  
[student01@cccbtrain1 ~]$ ls  
FASTA  
[student01@cccbtrain1 ~]$ cd FASTA/  
[student01@cccbtrain1 FASTA]$ ls  
TP53.fasta  
[student01@cccbtrain1 FASTA]$ pwd  
/students/student01/FASTA  
[student01@cccbtrain1 FASTA]$ cd ..  
[student01@cccbtrain1 ~]$
```

Basic Linux Command

```
student01@cccbtrain1:~  
/students/student01  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA  
[student01@cccbtrain1 ~]$ ls  
FASTA TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 24  
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/  
[student01@cccbtrain1 ~]$ ls  
FASTA  
[student01@cccbtrain1 ~]$ cd FASTA/  
[student01@cccbtrain1 FASTA]$ ls  
TP53.fasta  
[student01@cccbtrain1 FASTA]$ pwd  
/students/student01/FASTA  
[student01@cccbtrain1 FASTA]$ cd ..  
[student01@cccbtrain1 ~]$ man pwd
```

Basic Linux Command

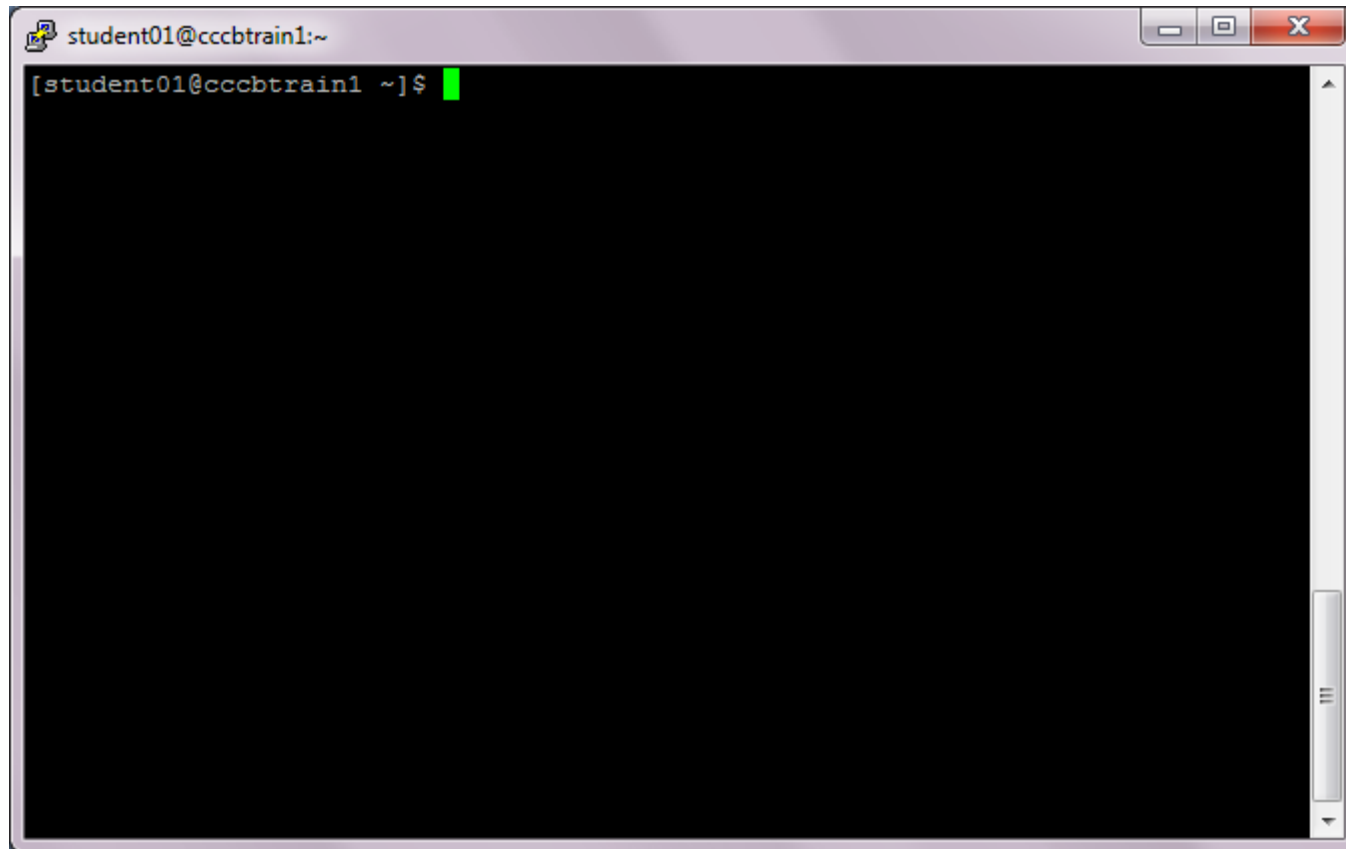


```
student01@cccbrain1:~  
PWD (1) User Commands PWD (1)  
NAME  
    pwd - print name of current/working directory  
SYNOPSIS  
    pwd [OPTION]...  
DESCRIPTION  
    Print the full filename of the current working directory.  
  
    -L, --logical  
        use PWD from environment, even if it contains symlinks  
  
    -P, --physical  
        avoid all symlinks  
  
    --help display this help and exit  
  
    --version  
        output version information and exit  
  
NOTE: your shell may have its own version of pwd, which usually super-  
:
```

Basic Linux Command

```
student01@cccbtrain1:~  
[student01@cccbtrain1 ~]$ ls  
TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 20  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ less TP53.fasta  
[student01@cccbtrain1 ~]$ mkdir FASTA  
[student01@cccbtrain1 ~]$ ls  
FASTA TP53.fasta  
[student01@cccbtrain1 ~]$ ls -l  
total 24  
drwxr-xr-x. 2 student01 students 4096 Sep 18 23:11 FASTA  
-rw-r--r--. 1 student01 students 19510 Sep 18 22:31 TP53.fasta  
[student01@cccbtrain1 ~]$ mv TP53.fasta FASTA/  
[student01@cccbtrain1 ~]$ ls  
FASTA  
[student01@cccbtrain1 ~]$ cd FASTA/  
[student01@cccbtrain1 FASTA]$ ls  
TP53.fasta  
[student01@cccbtrain1 FASTA]$ pwd  
/students/student01/FASTA  
[student01@cccbtrain1 FASTA]$ cd ..  
[student01@cccbtrain1 ~]$ man pwd  
[student01@cccbtrain1 ~]$ clear
```


Basic Linux Command

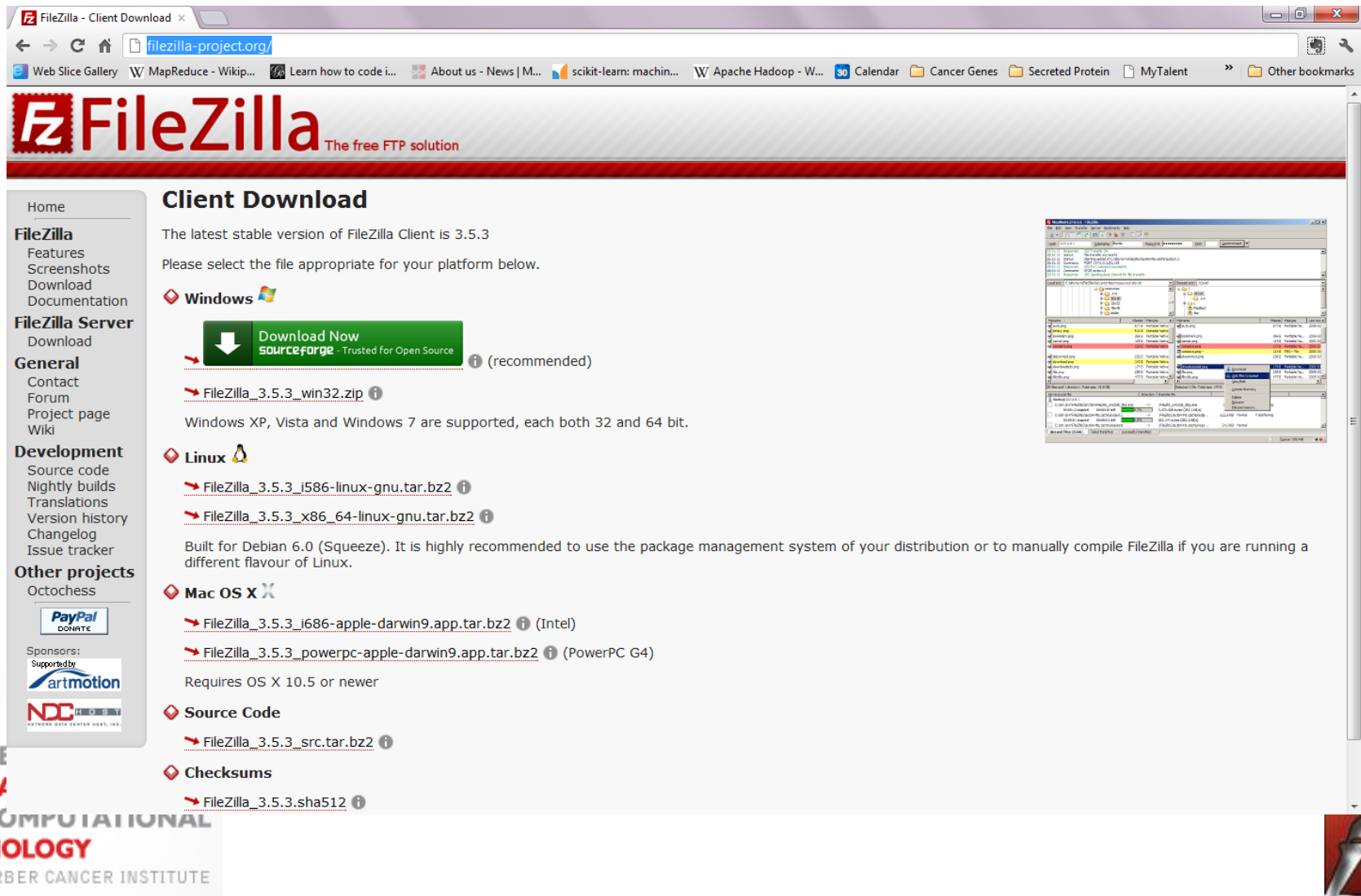


Cloud Computing

How to get files up and down the Cloud?

How to get files up and down the Cloud?

Download FileZilla at: <http://filezilla-project.org/>



FileZilla The free FTP solution

Client Download

The latest stable version of FileZilla Client is 3.5.3

Please select the file appropriate for your platform below.

Windows

[Download Now](#) **sourceforge** - Trusted for Open Source (recommended)

[FileZilla_3.5.3_win32.zip](#)

Windows XP, Vista and Windows 7 are supported, each both 32 and 64 bit.

Linux

[FileZilla_3.5.3_i586-linux-gnu.tar.bz2](#)

[FileZilla_3.5.3_x86_64-linux-gnu.tar.bz2](#)

Built for Debian 6.0 (Squeeze). It is highly recommended to use the package management system of your distribution or to manually compile FileZilla if you are running a different flavour of Linux.

Mac OS X

[FileZilla_3.5.3_i686-apple-darwin9.app.tar.bz2](#) (Intel)

[FileZilla_3.5.3_powerpc-apple-darwin9.app.tar.bz2](#) (PowerPC G4)

Requires OS X 10.5 or newer

Source Code

[FileZilla_3.5.3_src.tar.bz2](#)

Checksums

[FileZilla_3.5.3.sha512](#)

FileZilla Client Download

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File Transfer with FileZilla

sftp://cccbtrain1.no-ip.org

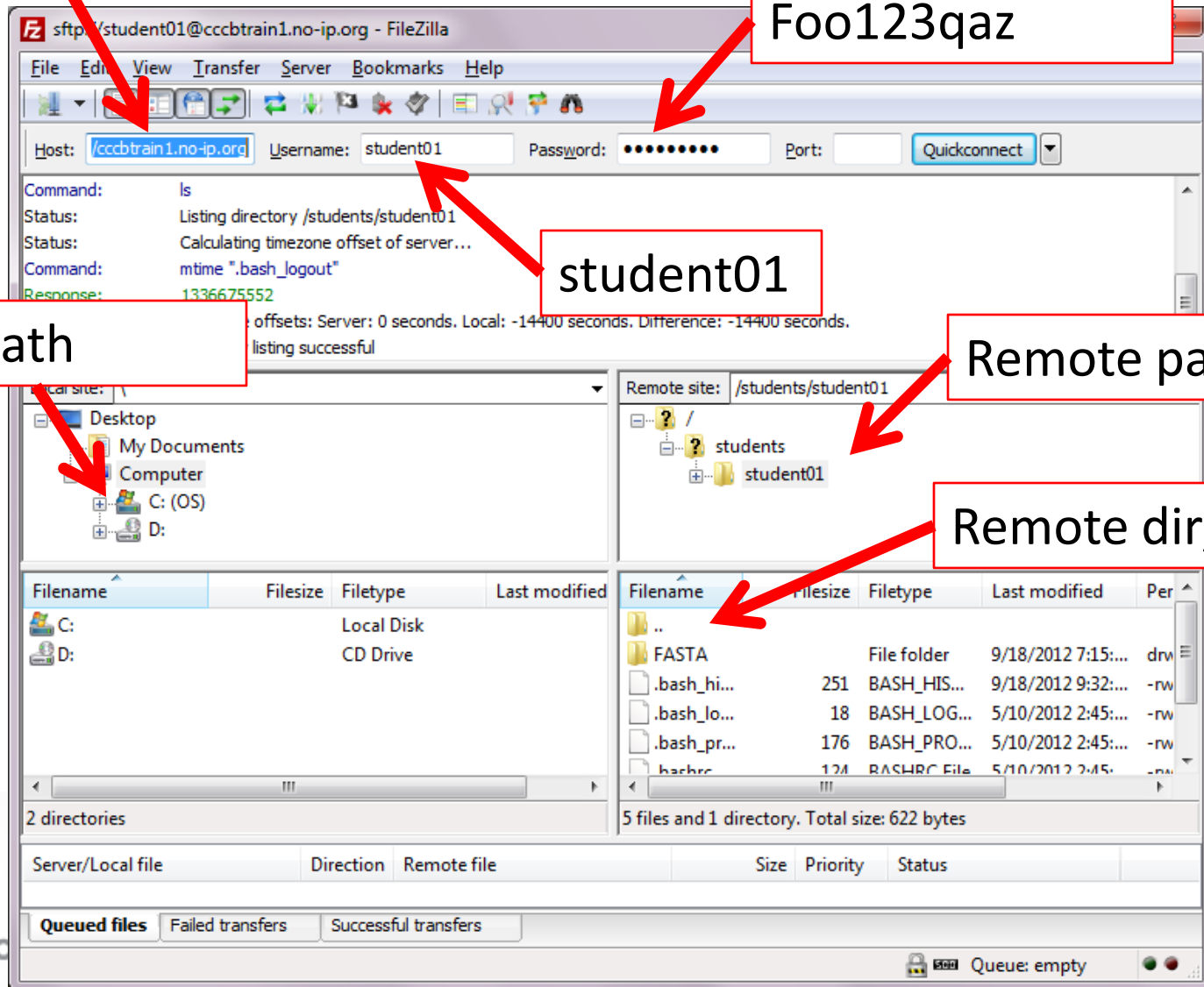
Foo123qaz

student01

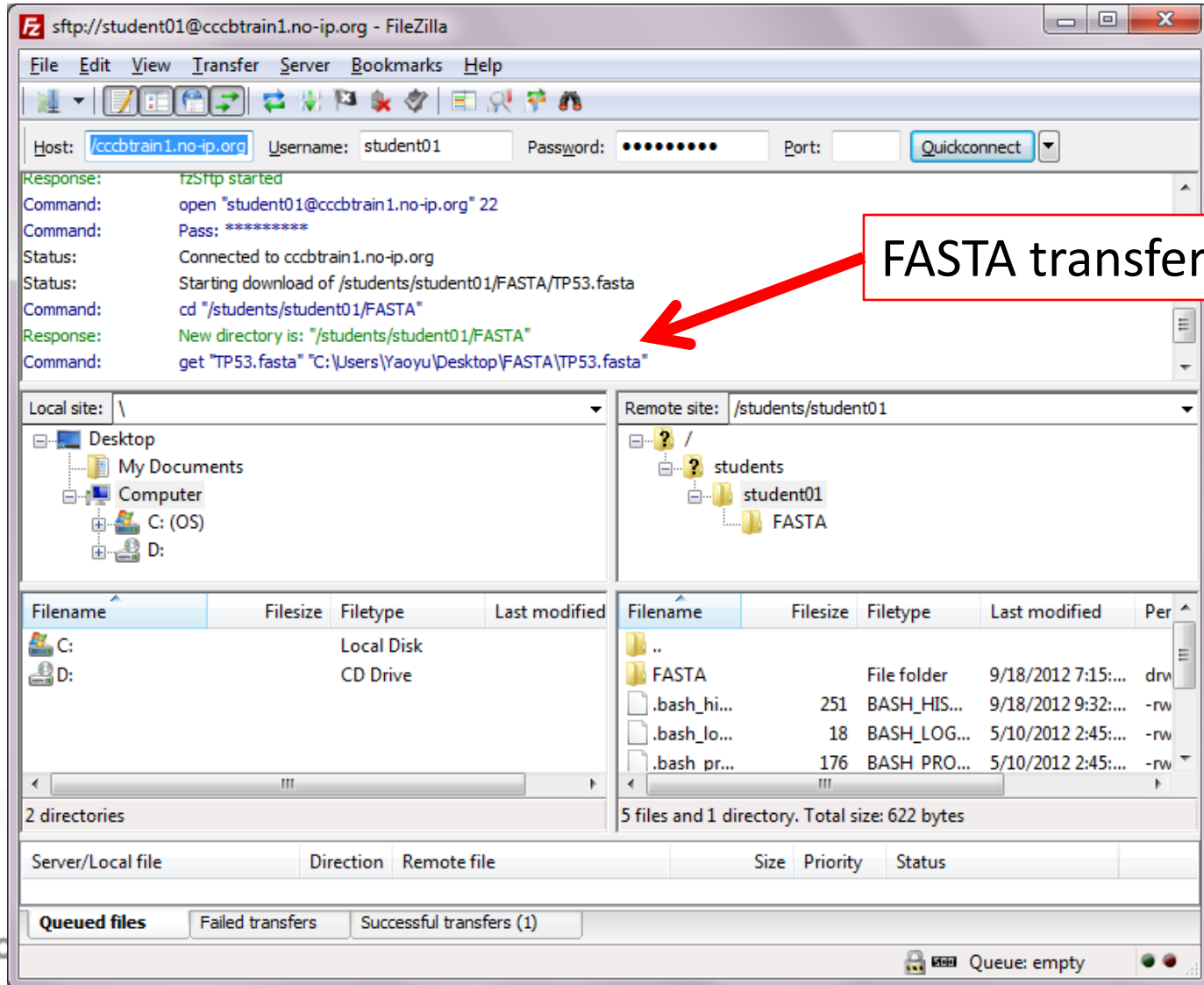
Local path

Remote path

Remote dir/files



File Transfer with FileZilla



Session Summary

- **Cloud Computing** are remotely hosted computational resources and ubiquitous accessible by internet
- Amazon Web Service (AWS) and Elastic Compute Cloud (EC2) provides cloud computing service and storage by demand
- Linux-based Cloud servers can be accessed through SSH (Secure SHell) by PuTTY
- Files can be transferred up and down the Cloud Server by SFTP using programs such as FileZilla

Download R at:
[/apps/R-installation](#)