



# Introduction to Transcriptomics Analysis

## Class 01 - First Steps using a CLI in Linux



### **INSTRUCTOR:**

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# Outline of Topics

1. What is Linux?
  2. The terminal (or emulator)
  3. Files and directories
  4. Absolute and relative paths
  5. Basic command structure
  6. Users, groups and permissions
  7. Shortcuts
  8. Environmental variables
  9. Monitoring resources
  10. Networking
  11. Installing programs
- 
1. Navigating in the terminal
  2. Working with files and directories





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1. Navigating in the terminal
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# 1. What is Linux?

## A brief history of Unix

- UNICS—UNiplexed Information and Computing Service
- Developed in the 1970s
- Multiuser, multitasking computer OS



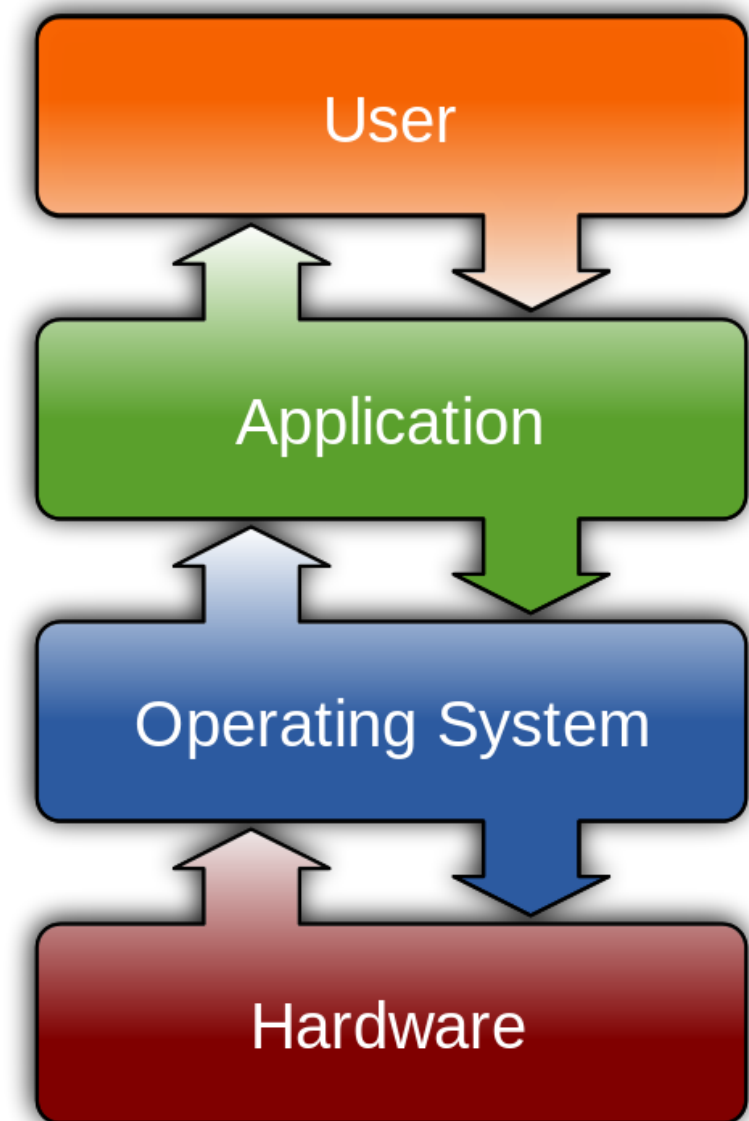
"Ken Thompson (sitting) and Dennis Ritchie at PDP-11 (2876612463)" by Peter Hamer - Licensed under CC BY-SA 2.0 via Commons - <https://commons.wikimedia.org/wiki/>



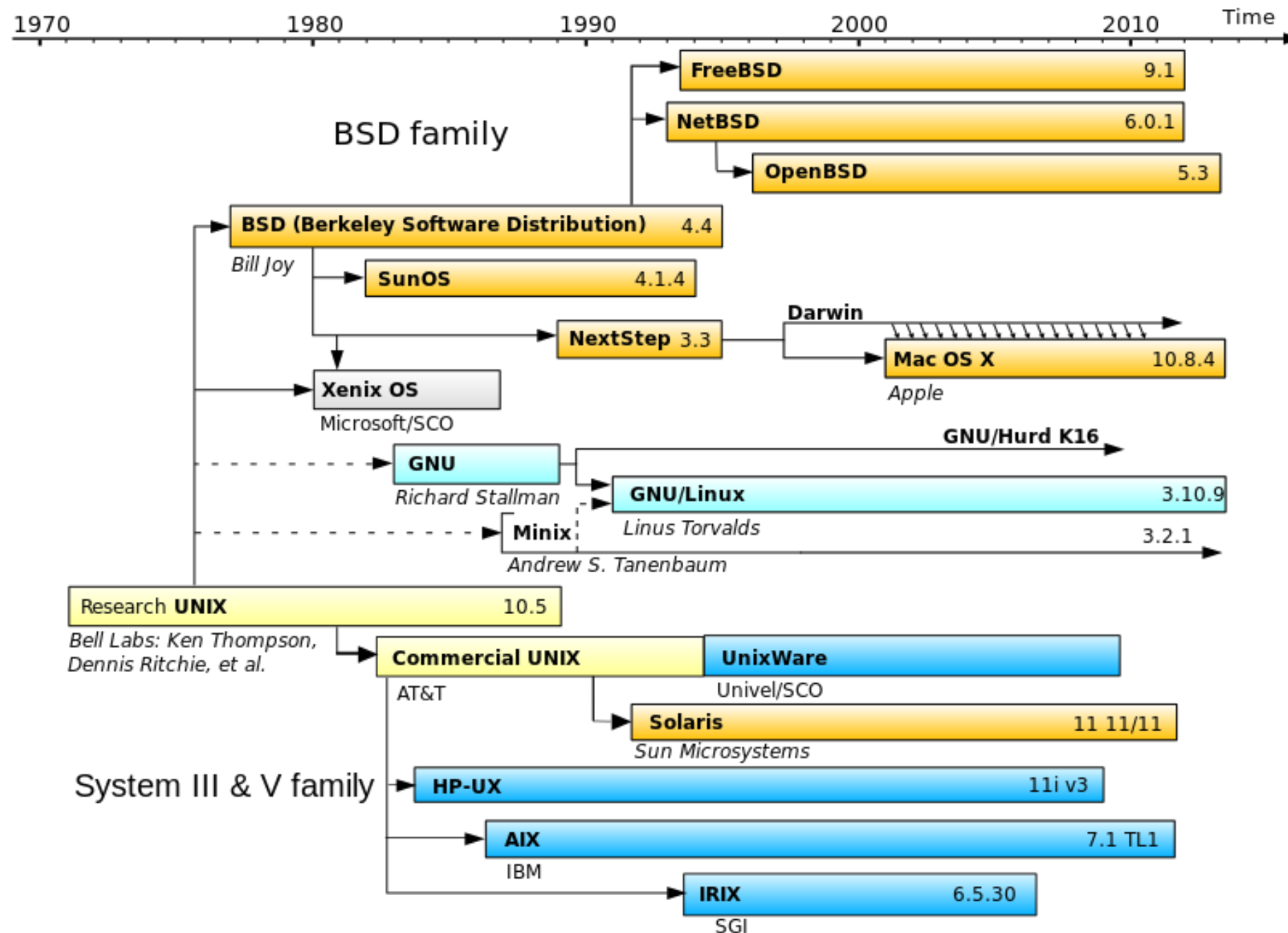
# 1. What is Linux?

## A brief history of Unix

- Universal interaction with mainframe
- Simultaneous passing of instructions
- MULTIUSER!

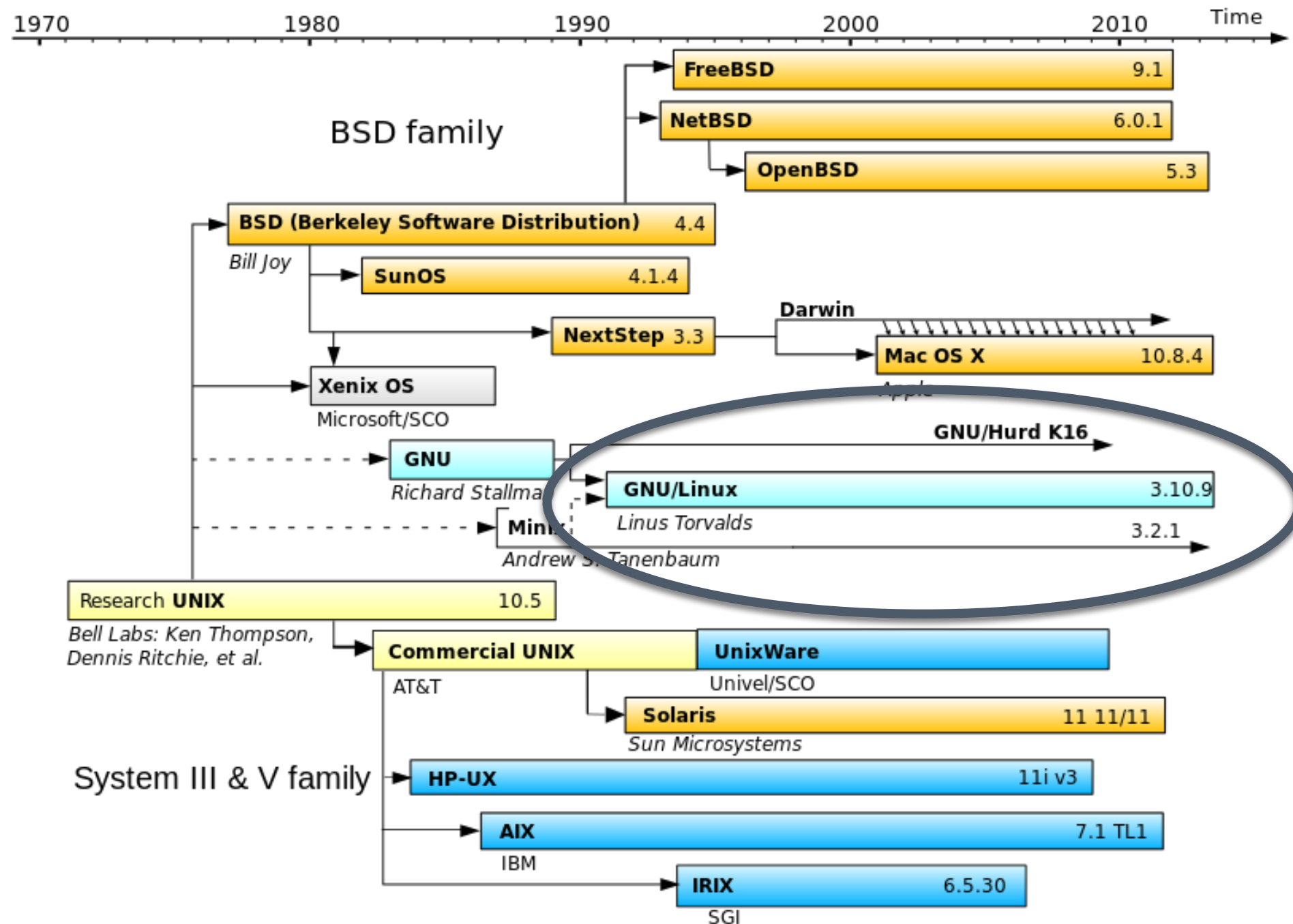


# 1. What is Linux?



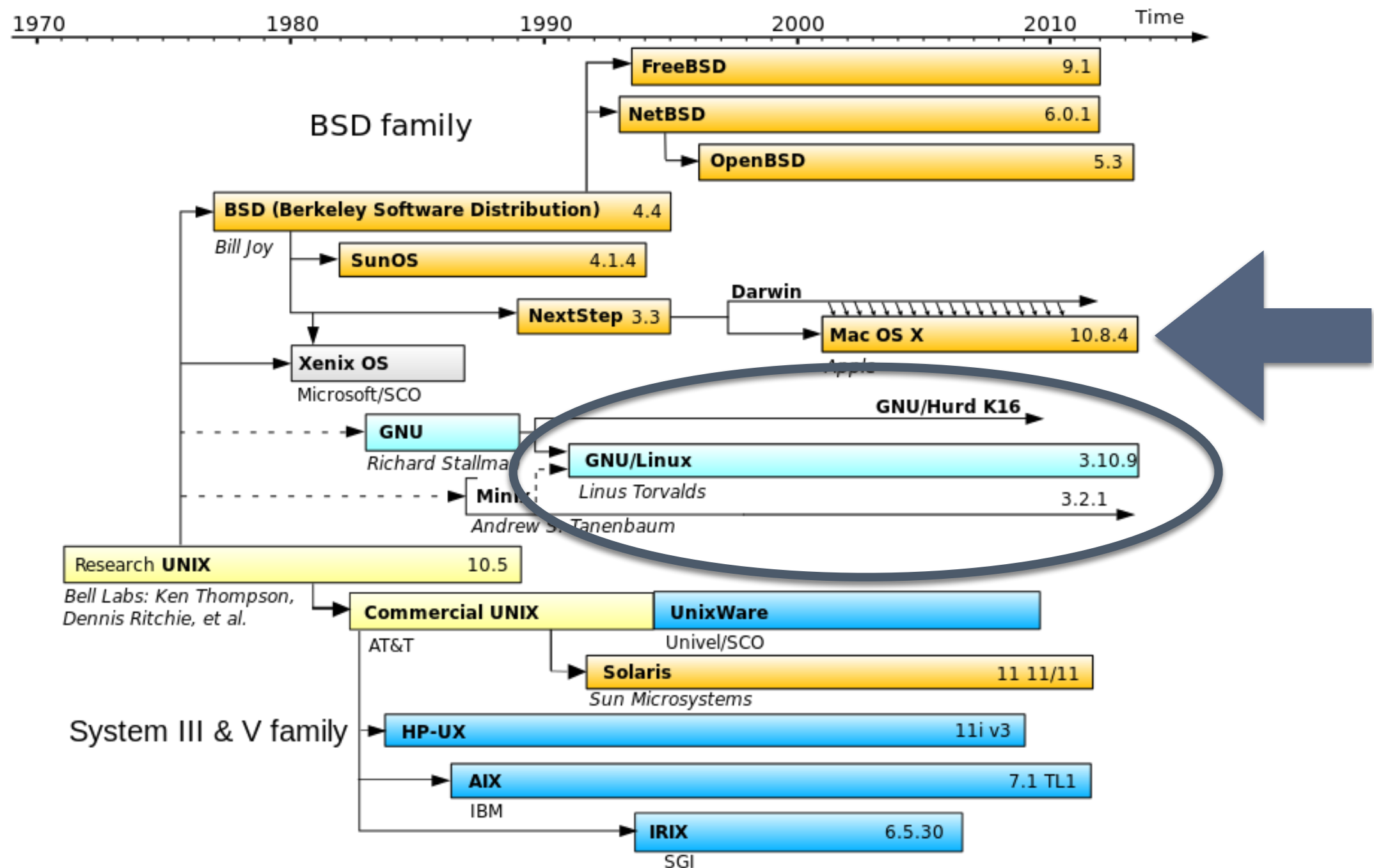
- "Unix timeline.en" by Guillem, Wereon, Hotmocha (copied from old version's history) Christoph S. (redrew the image with Inkscape) - Original image: Image:Unix.png. Licensed under Public Domain via Commons - [https://commons.wikimedia.org/wiki/File:Unix\\_timeline.en.svg#/media/File:Unix\\_timeline.en.svg](https://commons.wikimedia.org/wiki/File:Unix_timeline.en.svg#/media/File:Unix_timeline.en.svg)

# 1. What is Linux?



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# 1. What is Linux?



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# 1. What is Linux?

- Unix-like and POSIX compliant
- Free and open-source
- Designed for personal computers



"LinuxCon Europe Linus Torvalds 03" by Krd - Own work.  
Licensed under CC BY-SA 4.0 via Commons - [https://commons.wikimedia.org/wiki/File:LinuxCon\\_Europe\\_Linus\\_Torvalds\\_03.jpg#/media/File:LinuxCon\\_Europe\\_Linus\\_Torvalds\\_03.jpg](https://commons.wikimedia.org/wiki/File:LinuxCon_Europe_Linus_Torvalds_03.jpg#/media/File:LinuxCon_Europe_Linus_Torvalds_03.jpg)

# 1. What is Linux?

## Linux Distribution:

Distributions (often called distros for short) are **Operating Systems** including a large **collection of software applications** such as word processors, spreadsheets, media players, and database applications.

The operating system will consist of the **Linux kernel** and, usually, a **set of libraries** and **utilities** from the GNU Project, with graphics support from the X Window System.

# 1. What is Linux?

## Linux Distribution:

Different libraries and utilities.



Web Browser  
installed by default





# 1. What is Linux?

**Linux Distribution:** ... more than 600 distributions



# 1. What is Linux?

## **Linux Distribution:**

One can distinguish between:

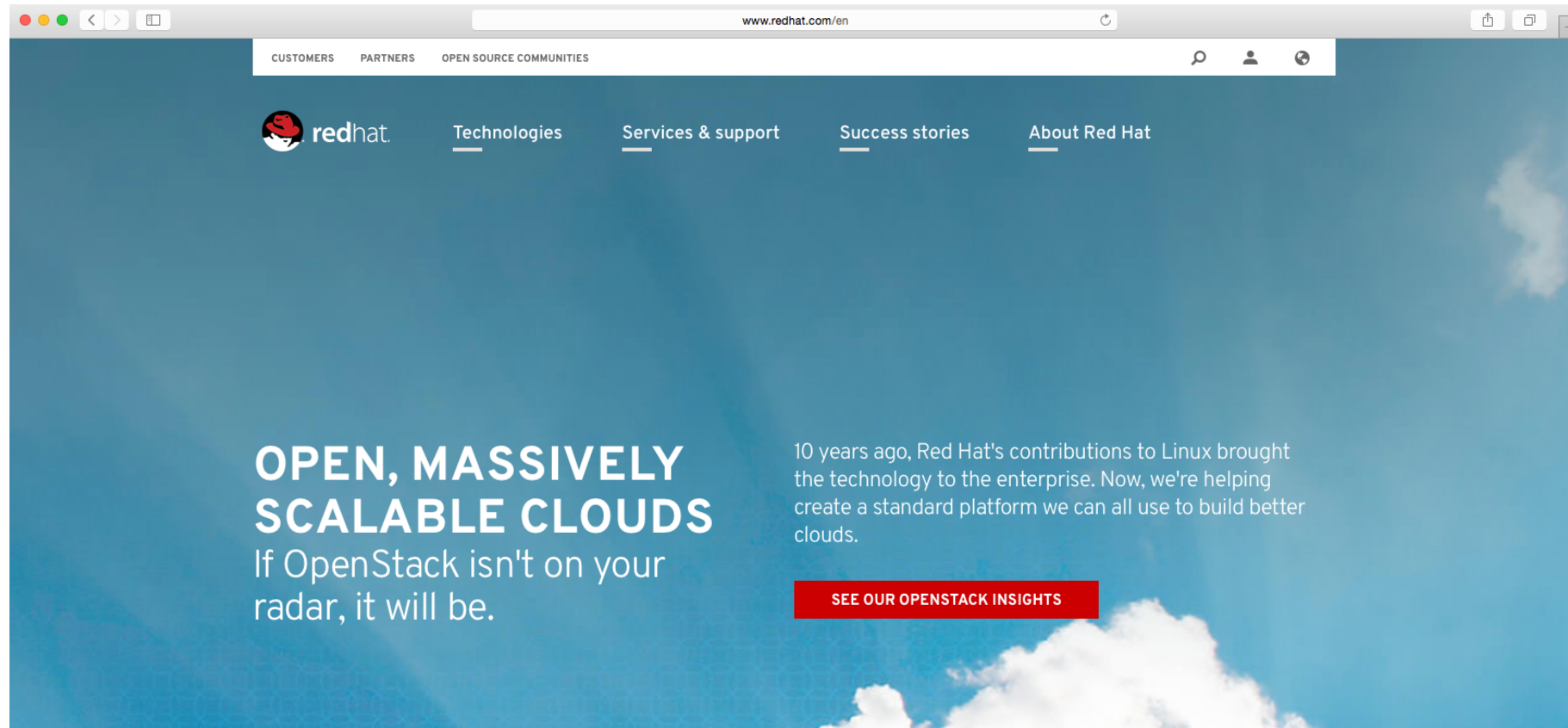
1) Commercially-backed distributions, such as:

Fedora (Red Hat),  
OpenSUSE (Novell),  
Ubuntu (Canonical Ltd.)  
Mandriva Linux (Mandriva)

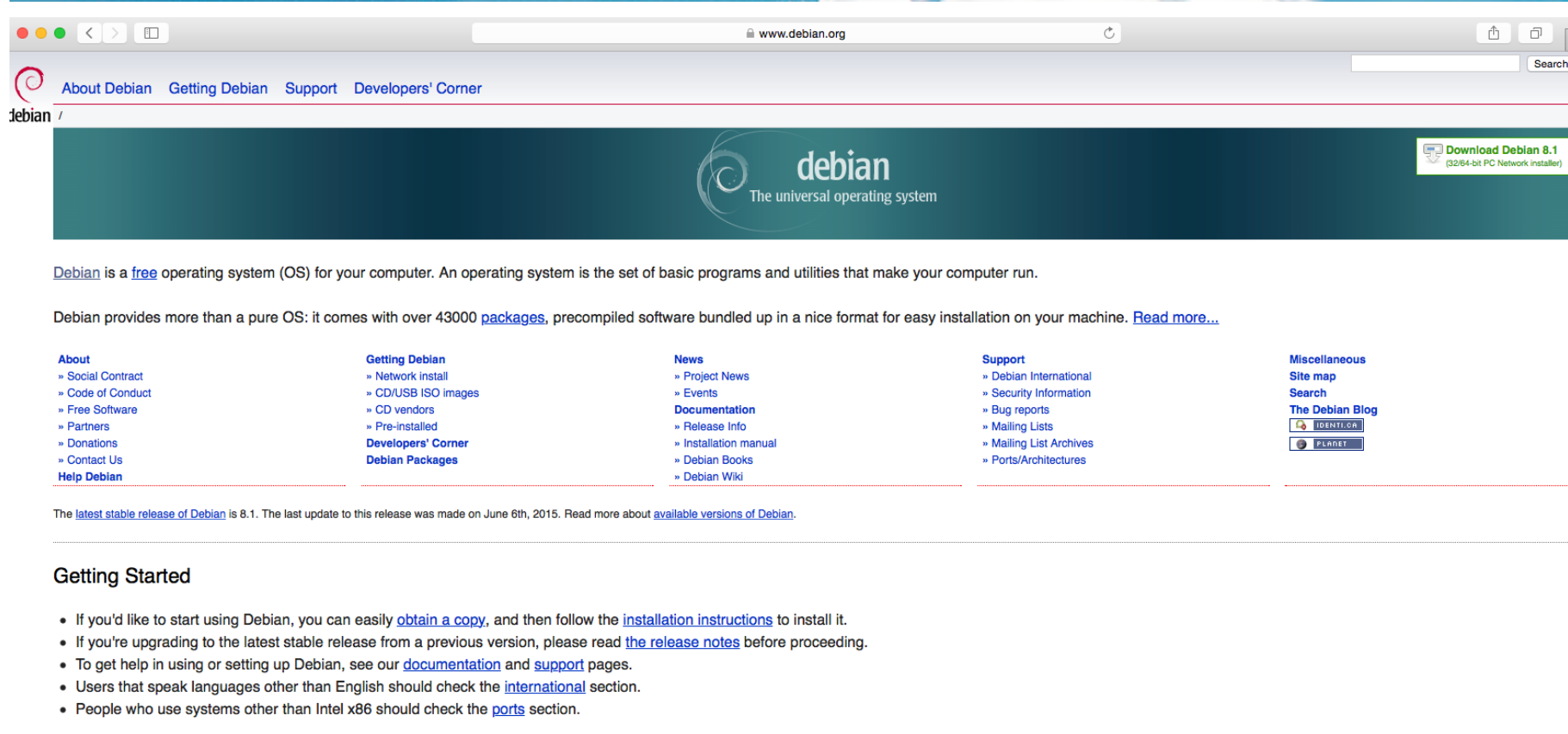
2) Entirely community-driven distributions, such as:

Debian.  
Gentoo.

# 1. What is Linux?



The screenshot shows the Red Hat website with a blue background and white clouds. The navigation bar includes links for CUSTOMERS, PARTNERS, OPEN SOURCE COMMUNITIES, and a search icon. The main heading reads "OPEN, MASSIVELY SCALABLE CLOUDS" with the subtext "If OpenStack isn't on your radar, it will be." To the right, a paragraph states: "10 years ago, Red Hat's contributions to Linux brought the technology to the enterprise. Now, we're helping create a standard platform we can all use to build better clouds." A red button labeled "SEE OUR OPENSTACK INSIGHTS" is positioned below the text.



The screenshot shows the Debian website with a green background. The navigation bar includes links for About Debian, Getting Debian, Support, and Developers' Corner. The main heading reads "debian" with the tagline "The universal operating system". A green button labeled "Download Debian 8.1 (32/64-bit PC Network installer)" is positioned on the right. Below the heading, a paragraph states: "Debian is a [free](#) operating system (OS) for your computer. An operating system is the set of basic programs and utilities that make your computer run." Another paragraph states: "Debian provides more than a pure OS: it comes with over 43000 [packages](#), precompiled software bundled up in a nice format for easy installation on your machine. [Read more...](#)"

<b>About</b> <ul style="list-style-type: none"><li>» Social Contract</li><li>» Code of Conduct</li><li>» Free Software</li><li>» Partners</li><li>» Donations</li><li>» Contact Us</li><li><a href="#">Help Debian</a></li></ul>	<b>Getting Debian</b> <ul style="list-style-type: none"><li>» Network install</li><li>» CD/USB ISO images</li><li>» CD vendors</li><li>» Pre-installed</li><li><b>Developers' Corner</b></li><li><b>Debian Packages</b></li></ul>	<b>News</b> <ul style="list-style-type: none"><li>» Project News</li><li>» Events</li><li><b>Documentation</b></li><li>» Release Info</li><li>» Installation manual</li><li>» Debian Books</li><li>» Debian Wiki</li></ul>	<b>Support</b> <ul style="list-style-type: none"><li>» Debian International</li><li>» Security Information</li><li>» Bug reports</li><li>» Mailing Lists</li><li>» Mailing List Archives</li><li>» Ports/Architectures</li></ul>	<b>Miscellaneous</b> <ul style="list-style-type: none"><li><b>Site map</b></li><li><b>Search</b></li><li><b>The Debian Blog</b></li><li></li><li></li></ul>
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The [latest stable release of Debian](#) is 8.1. The last update to this release was made on June 6th, 2015. Read more about [available versions of Debian](#).

## Getting Started

- If you'd like to start using Debian, you can easily [obtain a copy](#), and then follow the [installation instructions](#) to install it.
- If you're upgrading to the latest stable release from a previous version, please read [the release notes](#) before proceeding.
- To get help in using or setting up Debian, see our [documentation](#) and [support](#) pages.
- Users that speak languages other than English should check the [international](#) section.
- People who use systems other than Intel x86 should check the [ports](#) section.

# Outline of Topics

1. What is Linux?
  - 2. The terminal (or emulator)**
  3. Files and directories
  4. Absolute and relative paths
  5. Basic command structure
  6. Users, groups and permissions
  7. Shortcuts
  8. Environmental variables
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- 
1. Navigating in the terminal
  2. Working with files and directories



## 2. The Terminal

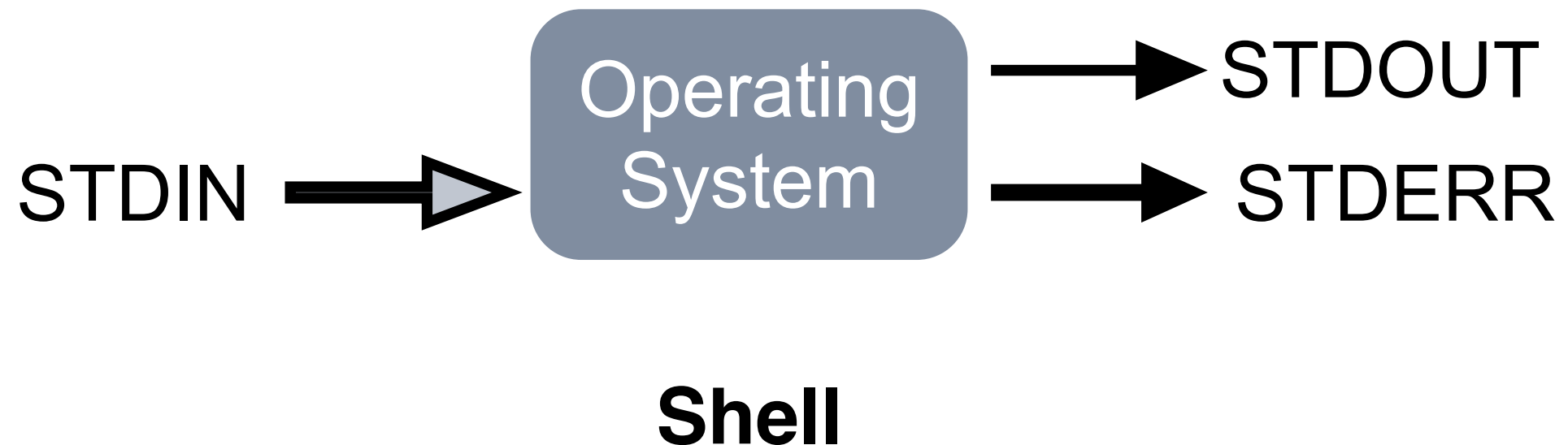
### What is a console ?

Computer terminal or system consoles are the **text entry and display device** for system administration messages, particularly those from the BIOS or boot loader, the kernel, from the init system and from the system logger. It is a **physical device consisting of a keyboard and a screen.**



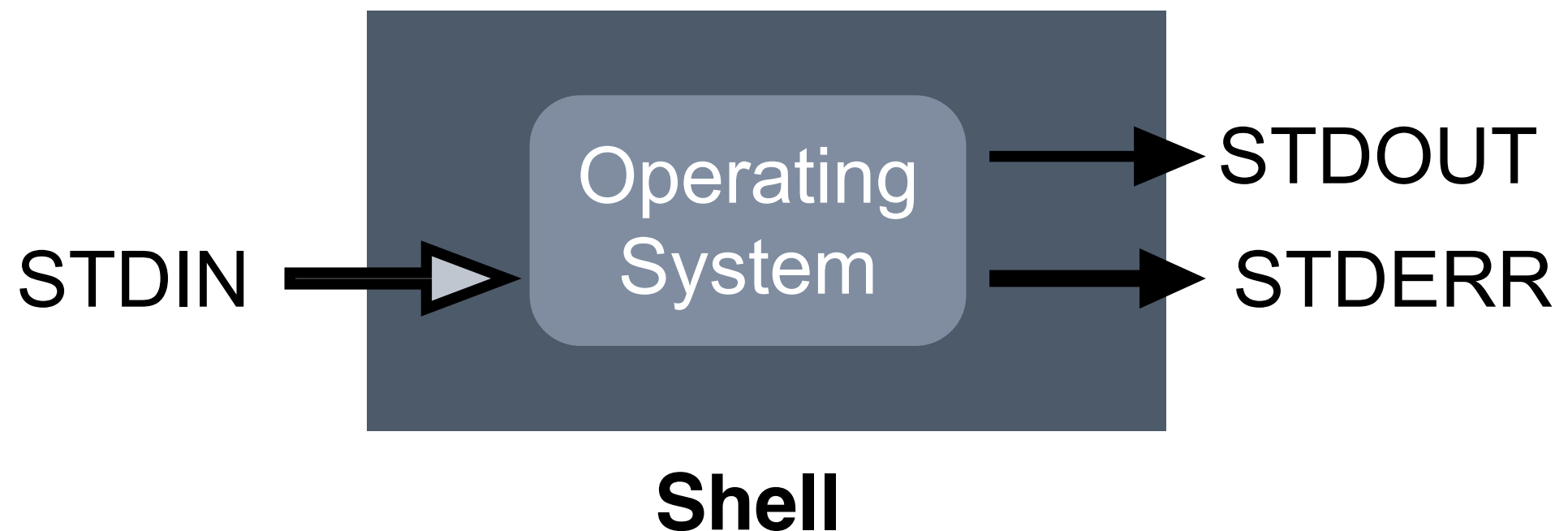
## 2. The Terminal

How do we interface with the operating system?



## 2. The Terminal

How do we interface with the operating system?

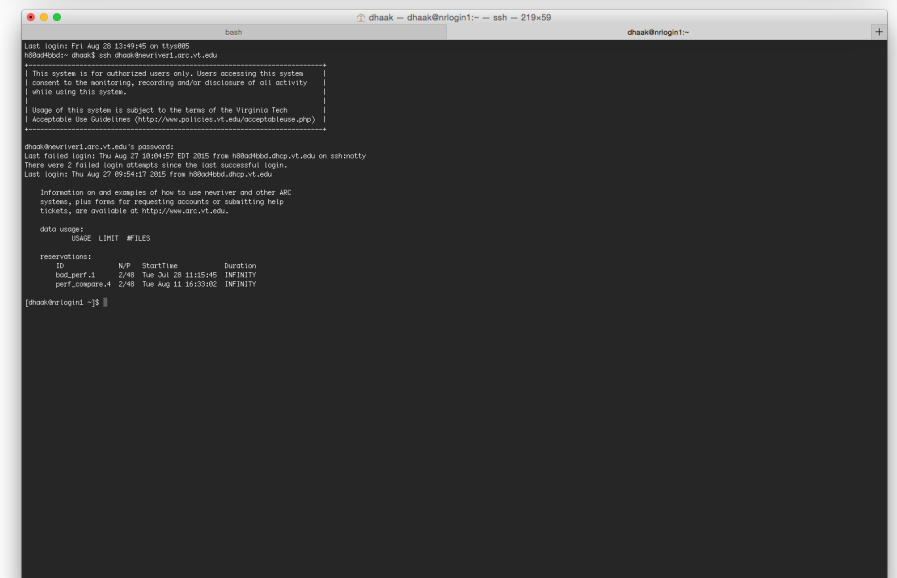




## 2. The Terminal

**Shell:** Software that provides an interface with the OS. There are two categories:

1. **Graphical User Interface (GUI):**
2. **Command-line interface (CLI):**

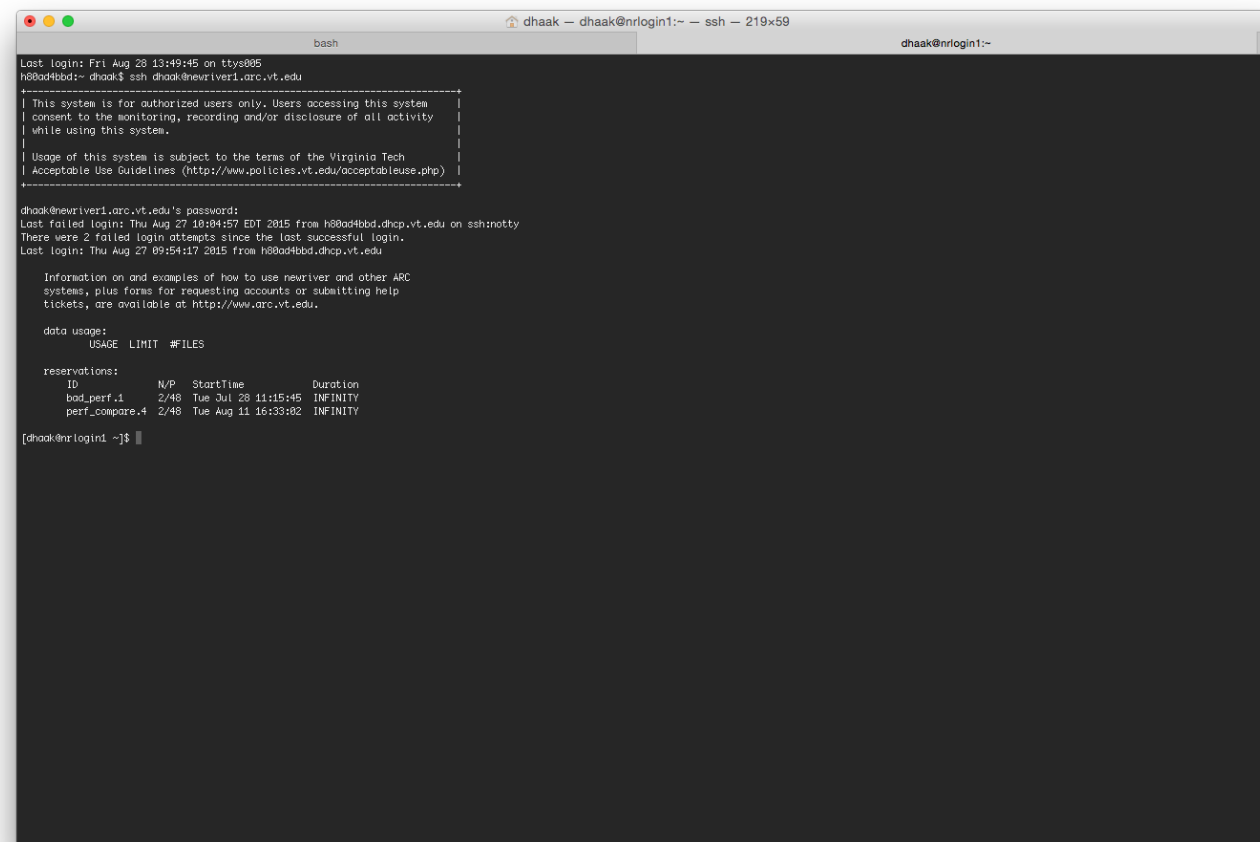


## 2. The Terminal

### Command-line interface (CLI):

Mechanism for **interacting** with a computer operating system or software by typing **commands** to perform specific tasks.

The command-line interpreter may be run in a **text terminal** or in a **terminal emulator** window as a remote shell client such as PuTTY.



```
bash
Last login: Fri Aug 28 13:49:45 on ttys005
h00adHb0d:~ dhaak$ ssh dhaak@newriver1.arc.vt.edu
-----
| This system is for authorized users only. Users accessing this system |
| consent to the monitoring, recording and/or disclosure of all activity |
| while using this system. |
| Usage of this system is subject to the terms of the Virginia Tech |
| Acceptable Use Guidelines (http://www.policies.vt.edu/acceptableuse.php) |
-----
dhaak@newriver1.arc.vt.edu's password:
Last failed login: Thu Aug 27 18:04:57 EDT 2015 from h00adHb0d.dhcp.vt.edu on sshnotty
There were 2 failed login attempts since the last successful login.
Last login: Thu Aug 27 09:54:17 2015 from h00adHb0d.dhcp.vt.edu

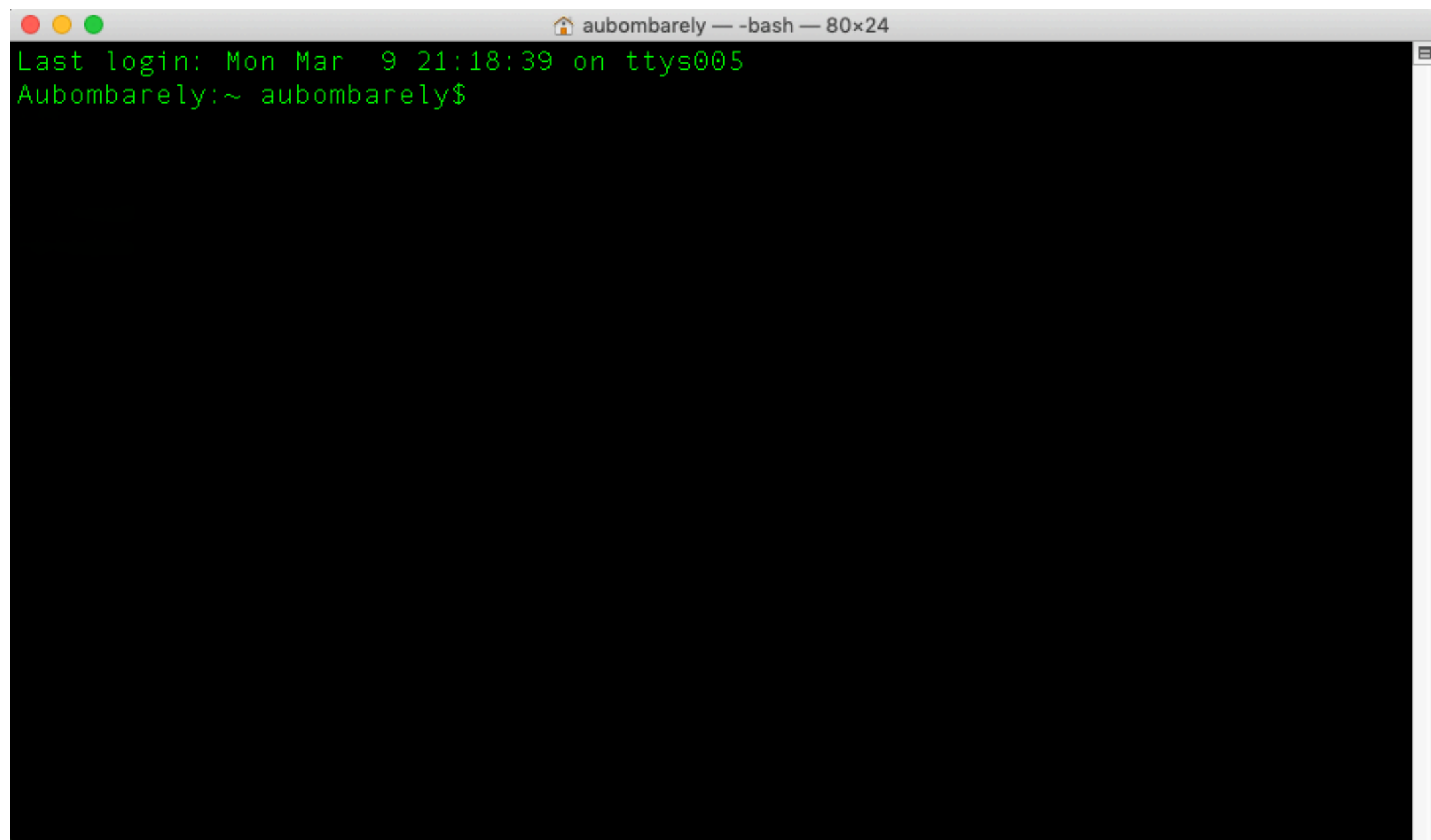
Information on and examples of how to use newriver and other ARC
systems, plus forms for requesting accounts or submitting help
tickets, are available at http://www.arc.vt.edu.

data usage:
  USAGE  LIMIT  #FILES
-----
reservations:
  ID      N/P  StartTime  Duration
  ----
  bad_perf.1  2/48  Tue Jul 28 11:15:45  INFINITY
  perf_compare.4  2/48  Tue Aug 11 16:33:02  INFINITY

[dhaak@nrlogin1 ~]$
```

## 2. The Terminal

### Bash-Bourne again shell



```
aubombarely — -bash — 80x24
Last login: Mon Mar  9 21:18:39 on ttys005
Aubombarely:~ aubombarely$
```

A screenshot of a terminal window. The title bar at the top shows a home icon, the text "aubombarely — -bash — 80x24", and three window control buttons (red, yellow, green). The terminal content is displayed on a black background with green text. The first line shows the last login message: "Last login: Mon Mar 9 21:18:39 on ttys005". The second line shows the shell prompt: "Aubombarely:~ aubombarely\$".

## 2. The Terminal

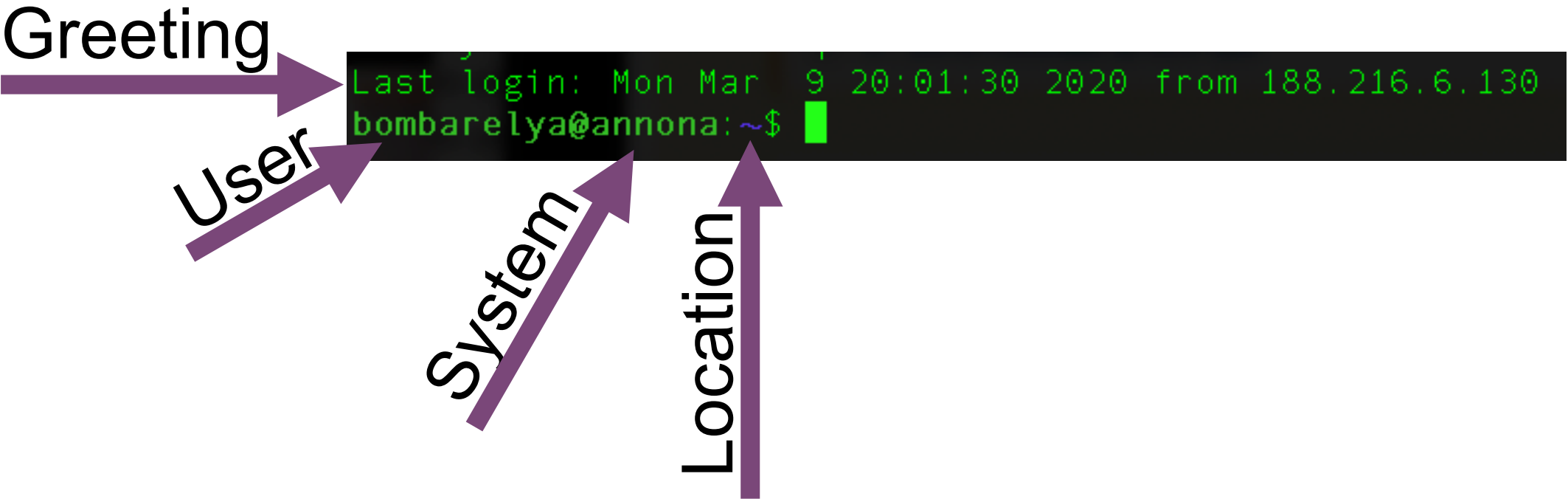
### Bash-Bourne again shell

Greeting

User

System

Location



A terminal window with a black background and green text. The text shows a login message: "Last login: Mon Mar 9 20:01:30 2020 from 188.216.6.130" followed by a prompt "bombarelya@annona: ~\$". Four purple arrows point to different parts of the prompt: "Greeting" points to the space before the prompt, "User" points to "bombarelya", "System" points to "@annona", and "Location" points to "~\$".

```
Last login: Mon Mar 9 20:01:30 2020 from 188.216.6.130
bombarelya@annona: ~$
```

## 2. The Terminal

**Bash-Bourne again shell**

Check your shell type:

```
userid$ echo $SHELL
```

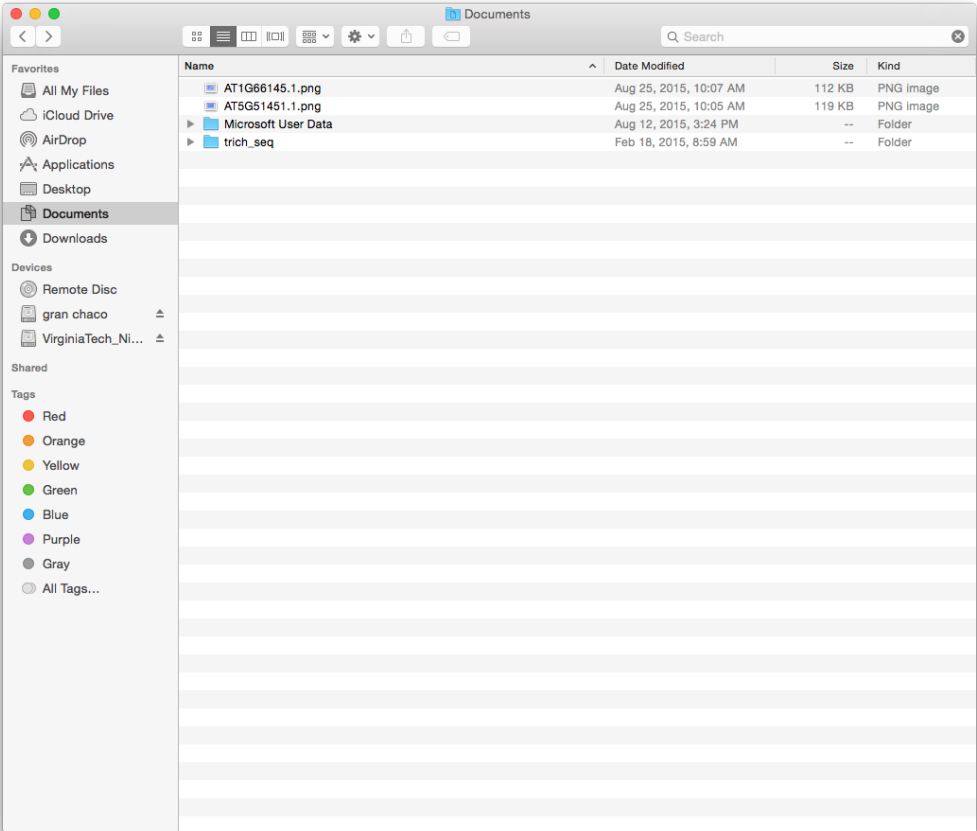
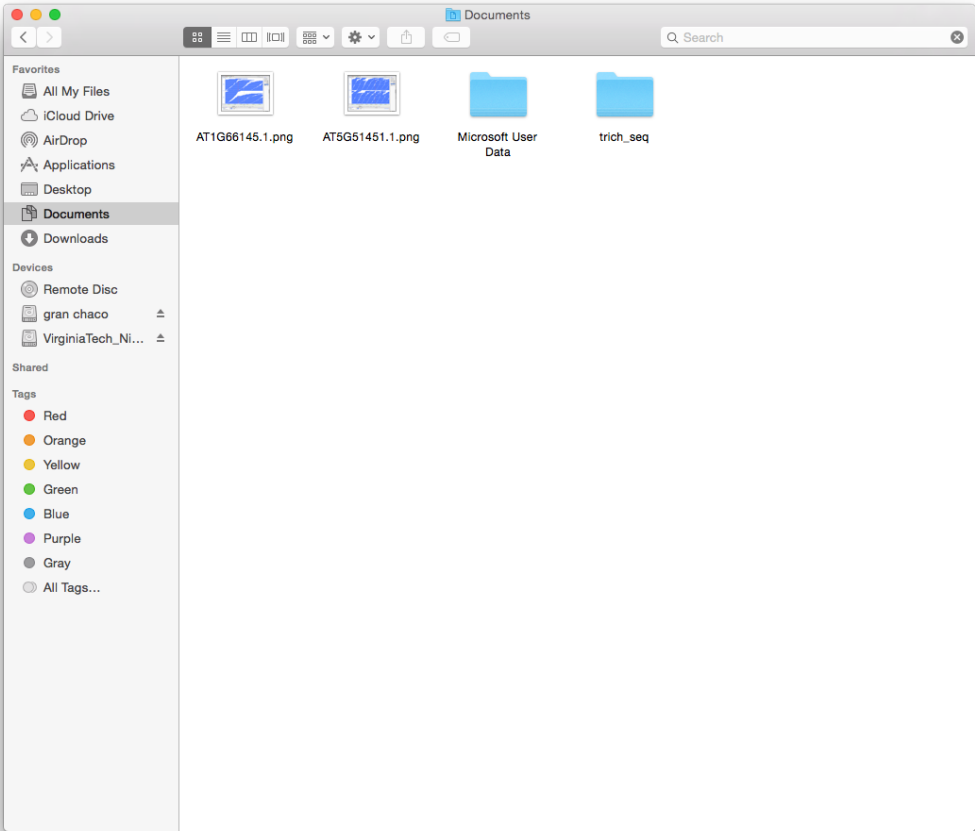
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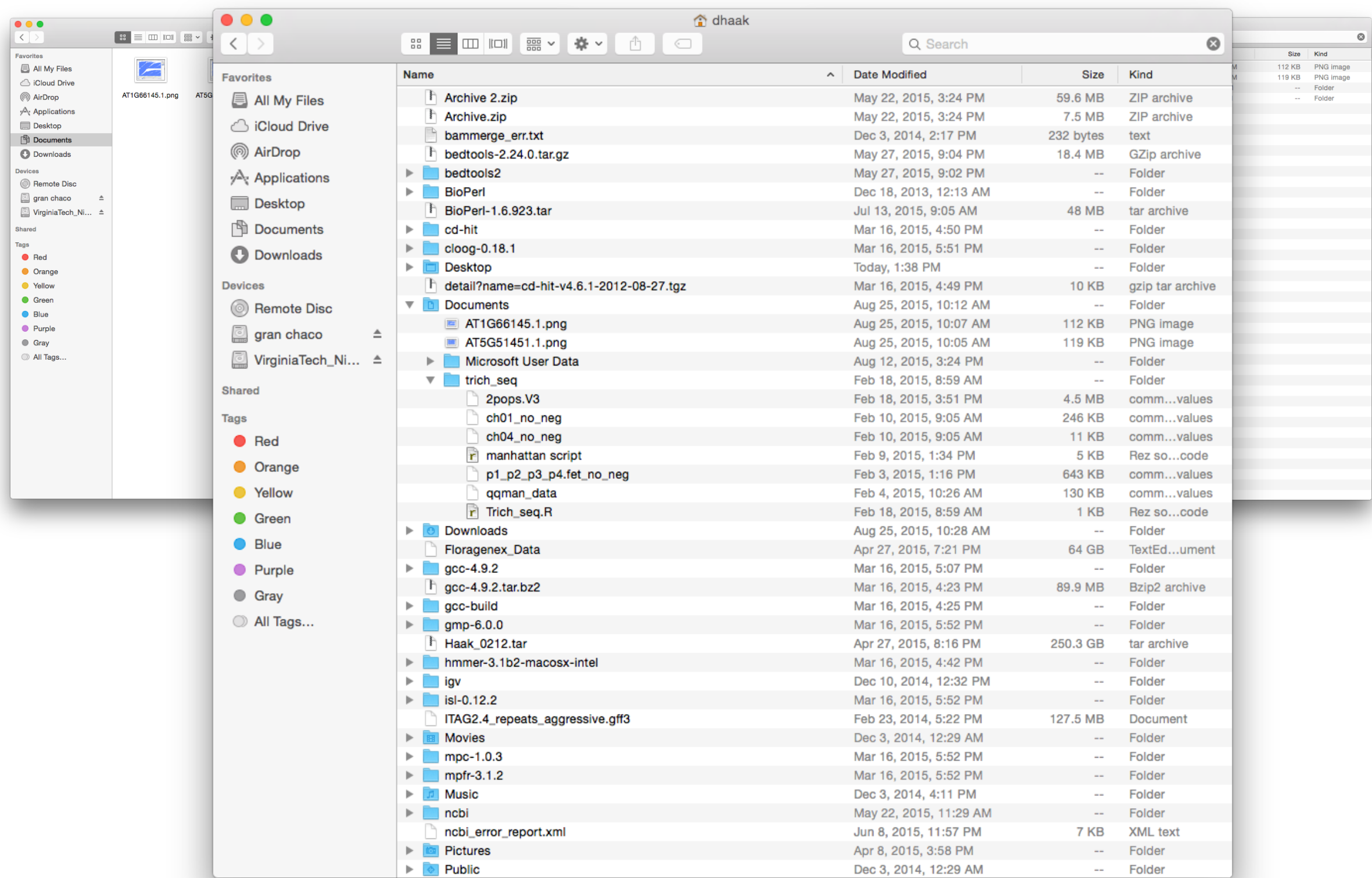


# 3. Files and Directories

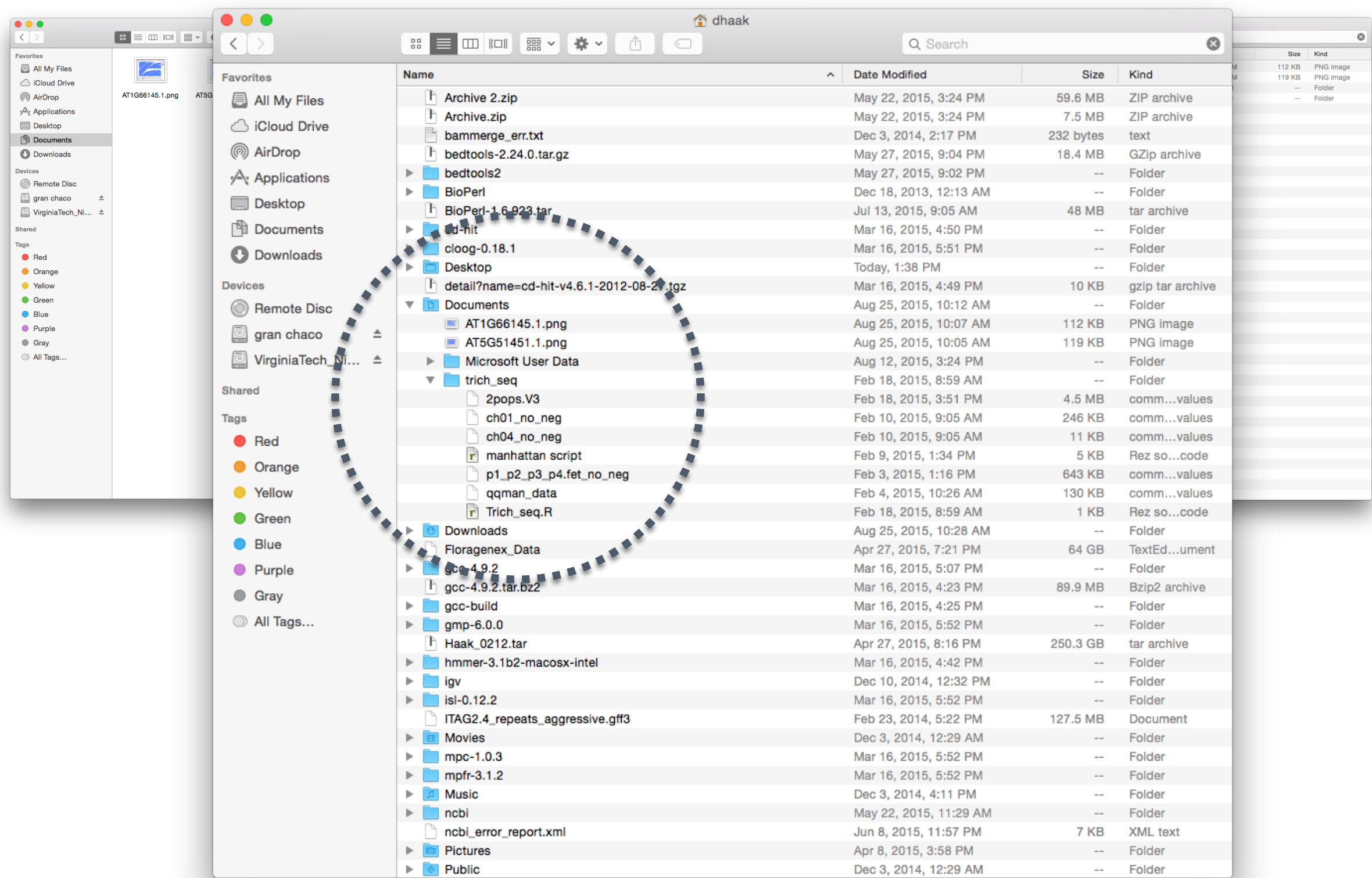




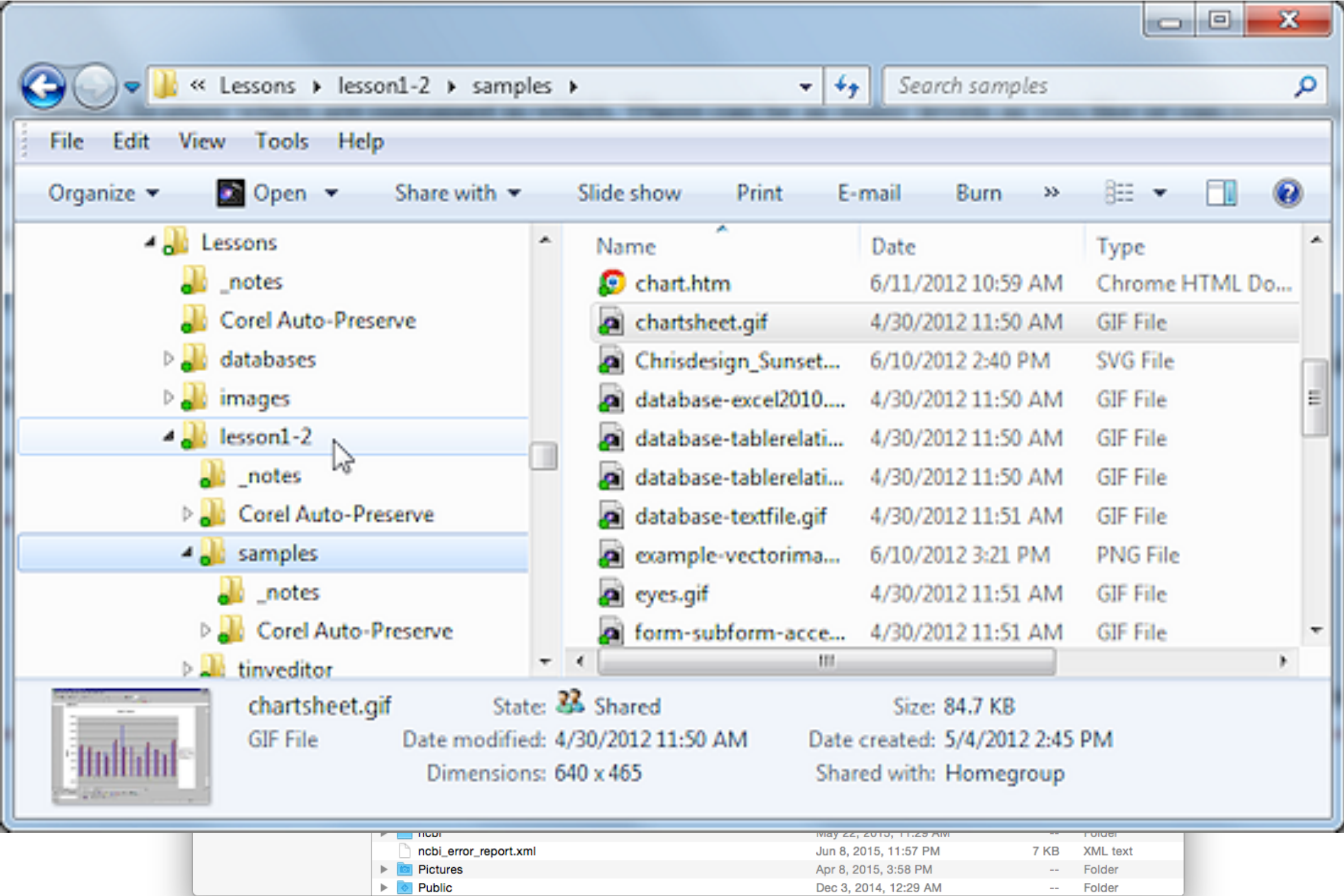
# 3. Files and Directories



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### 3. Files and Directories

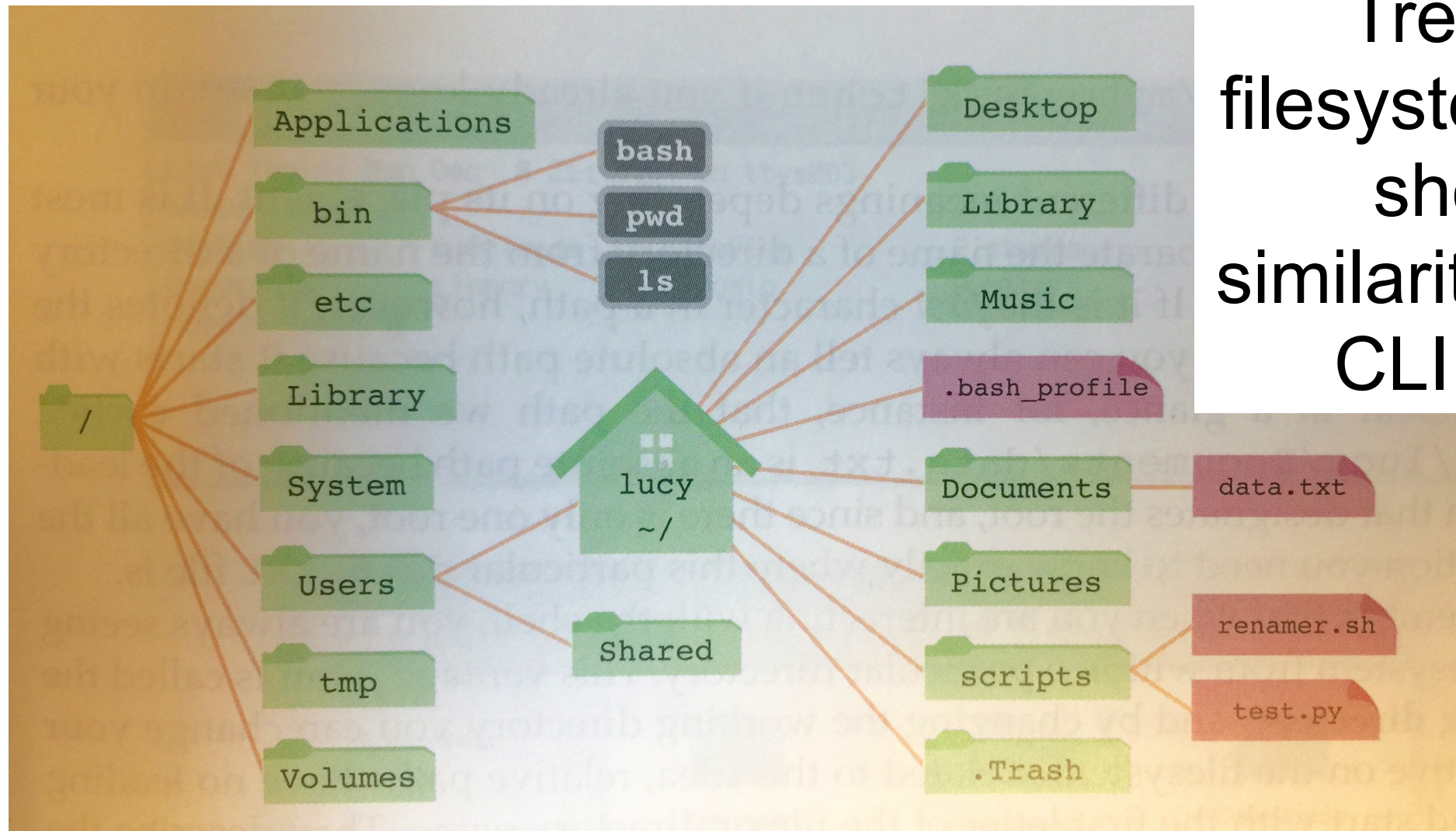


### 3. Files and Directories

- Is file access convenient?
- What about repeated access?
- What about speed?
- Cross platform use?

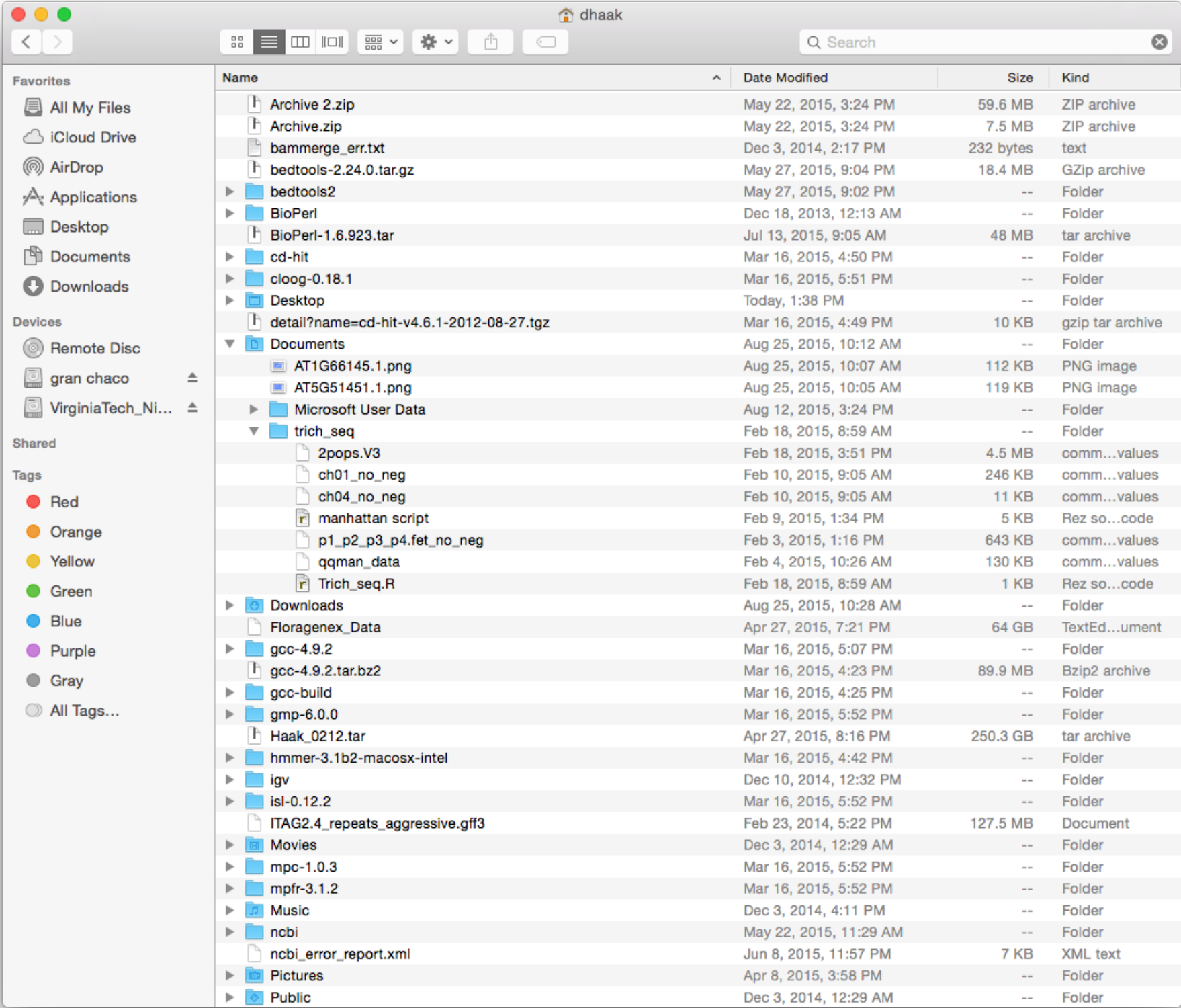


### 3. Files and Directories



Tree format  
filesystem structure  
shows the  
similarities between  
CLI and GUI

# 3. Files and Directories





# 3. Files and Directories

Back/Forward

Path

View

Action

Group

Share

Edit Tags

Search

Favorites

AirDrop

Desktop

Applications

Recents

Documents

Google Drive

aubombarely

iCloud

iCloud Drive

Locations

Aubombarely

Macintosh HD

Remote Disc

AirPort Time...

Network

Tags

Green

Orange

Gray

Red

All Tags...

Name	Date Modified	Size	Kind
2015_SAFRON	26 Oct 2016 at 14:05	--	Folder
2015_SALAMANDERS	20 Dec 2018 at 23:12	--	Folder
2015_SWITCHGRASS	7 Oct 2016 at 17:50	--	Folder
2015_TOBACCO_PY	8 Jul 2015 at 05:27	--	Folder
2015_TOBACCO_SHENGMING	10 Oct 2017 at 16:42	--	Folder
2016_AFRICANVIOLET	7 Apr 2016 at 05:06	--	Folder
2016_ATHA_HDA19MUT	16 Aug 2016 at 15:46	--	Folder
2016_AVOCADO_GBS	27 Nov 2018 at 22:42	--	Folder
2016_BCUCULLATA_INVASIVE	11 May 2016 at 0	--	Folder
2016_BEGONIA_DOMESTICATION	19 Mar 2016 at 0	--	Folder
2016_FLOWEREVODEVO	3 Mar 2016 at 20	--	Folder
2016_GENOMARCHDB	16 Sep 2016 at 2	--	Folder
2016_MEDICAGO_GOMEZK	19 Aug 2019 at 2	--	Folder
2016_NZZ_UNIMI	5 Oct 2016 at 17	--	Folder
2016_OLIVEGBS	9 Dec 2019 at 18	--	Folder
2016_PETUNIA_HYBRIDA	22 Jan 2018 at 2	--	Folder
2016_RBRBINDINGDOM	14 Oct 2016 at 1	--	Folder
2016_SEQCAPTURE	12 Oct 2016 at 0	--	Folder
2016_SNAPDRAGON_ERAMOSA	20 Nov 2016 at 2	--	Folder
2016_SOLANACEAE_GENOMEARCH	10 Jun 2016 at 1	--	Folder
2016_THYMUS_EXPLOREGENOME	31 Aug 2018 at 1	--	Folder
2017_ALTERNATIVE_GBS	14 Nov 2018 at 1	--	Folder
2017_AVOCADO_GENOME	16 Apr 2019 at 2	--	Folder
2017_BENTHAMIANA_KVITKO	3 Apr 2018 at 18	--	Folder
2017_CHERIMOYA_GENOME	12 Feb 2020 at 2	--	Folder
2017_GUAVA_GENOME	16 Jul 2019 at 11	--	Folder
2017_PAWPAW_GENOME	29 Jan 2020 at 1	--	Folder
2017_PCINAMOMI_MANOSALVA	19 May 2018 at 1	--	Folder
2017_PETUNIA_DOMESTICATION	2 Mar 2020 at 10	--	Folder
2017_SINAPIS_MANZANEDA	4 Feb 2019 at 14	--	Folder
2017_SUAVEOLENTES	3 Mar 2020 at 22	--	Folder
2017_SWITCHGRASS_4x8x_LINKAI	19 May 2017 at 1	--	Folder
2017_WILD_PETUNIAS_FREITAS	6 Dec 2018 at 19	--	Folder
2017_WILD_SINNINGIAS_ROSSINI	14 Jun 2017 at 2	--	Folder
2018_AVOCADO_PLIEGO	13 Jan 2020 at 0	--	Folder
2018_MONOPTEROS	27 Apr 2019 at 0	--	Folder
2018_VANILLA	19 May 2018 at 1	--	Folder
2019_EGGPLANT_RESEQ	12 May 2019 at 1	--	Folder
2019_MANGO_GENOME	1 Mar 2020 at 20	--	Folder
2019_MIRACLE_FRUIT	6 Aug 2019 at 12	--	Folder
2019_OLIVE_KOUBOURIS	5 Feb 2020 at 18	--	Folder
2019_PEAR_MASIERO	5 Jul 2019 at 10:	--	Folder
2019_TOMATO_BENVENUTTO	15 Jul 2019 at 17	--	Folder

Macintosh HD > Users > aubombarely > Documents > USA\_work > PROJECTS

78 items, 55.04 GB available

PROJECTS — -bash — 84x39

drwxr-xr-x	8	aubombarely	staff	256B	Apr	7	2016	2016_AFRICANVIOLET
drwxr-xr-x	4	aubombarely	staff	128B	Aug	16	2016	2016_ATHA_HDA19MUT
drwxr-xr-x	6	aubombarely	staff	192B	Nov	27	2018	2016_AVOCADO_GBS
drwxr-xr-x	14	aubombarely	staff	448B	May	11	2016	2016_BCUCULLATA_INVASIVE
drwxr-xr-x	4	aubombarely	staff	128B	Mar	19	2016	2016_BEGONIA_DOMESTICATION
drwxr-xr-x	10	aubombarely	staff	320B	Mar	3	2016	2016_FLOWEREVODEVO
drwxr-xr-x	4	aubombarely	staff	128B	Sep	16	2016	2016_GENOMARCHDB
drwxr-xr-x	10	aubombarely	staff	320B	Aug	19	2019	2016_MEDICAGO_GOMEZK
drwxr-xr-x	29	aubombarely	staff	928B	Oct	5	2016	2016_NZZ_UNIMI
drwxr-xr-x	23	aubombarely	staff	736B	Dec	9	18:11	2016_OLIVEGBS
drwxr-xr-x	8	aubombarely	staff	256B	Jan	22	2018	2016_PETUNIA_HYBRIDA
drwxr-xr-x	22	aubombarely	staff	704B	Oct	14	2016	2016_RBRBINDINGDOM
drwxr-xr-x	3	aubombarely	staff	96B	Oct	12	2016	2016_SEQCAPTURE
drwxr-xr-x	27	aubombarely	staff	864B	Nov	20	2016	2016_SNAPDRAGON_ERAMOSA
drwxr-xr-x	33	aubombarely	staff	1.0K	Jun	10	2016	2016_SOLANACEAE_GENOMEARCH
drwxr-xr-x	7	aubombarely	staff	224B	Aug	31	2018	2016_THYMUS_EXPLOREGENOME
drwxr-xr-x	6	aubombarely	staff	192B	Nov	14	2018	2017_ALTERNATIVE_GBS
drwxr-xr-x	13	aubombarely	staff	416B	Apr	16	2019	2017_AVOCADO_GENOME
drwxr-xr-x	37	aubombarely	staff	1.2K	Apr	3	2018	2017_BENTHAMIANA_KVITKO
drwxr-xr-x	9	aubombarely	staff	288B	Feb	12	21:47	2017_CHERIMOYA_GENOME
drwxr-xr-x	16	aubombarely	staff	512B	Jul	16	2019	2017_GUAVA_GENOME
drwxr-xr-x	17	aubombarely	staff	544B	Jan	29	10:00	2017_PAWPAW_GENOME
drwxr-xr-x	8	aubombarely	staff	256B	May	19	2018	2017_PCINAMOMI_MANOSALVA
drwxr-xr-x	15	aubombarely	staff	480B	Mar	2	10:04	2017_PETUNIA_DOMESTICATION
drwxr-xr-x	13	aubombarely	staff	416B	Feb	4	2019	2017_SINAPIS_MANZANEDA
drwxr-xr-x	16	aubombarely	staff	512B	Mar	3	22:41	2017_SUAVEOLENTES
drwxr-xr-x	9	aubombarely	staff	288B	May	19	2017	2017_SWITCHGRASS_4x8x_LINKAI
drwxr-xr-x	17	aubombarely	staff	544B	Dec	6	2018	2017_WILD_PETUNIAS_FREITAS
drwxr-xr-x	3	aubombarely	staff	96B	Jun	14	2017	2017_WILD_SINNINGIAS_ROSSINI
drwxr-xr-x	5	aubombarely	staff	160B	Jan	13	09:34	2018_AVOCADO_PLIEGO
drwxr-xr-x	23	aubombarely	staff	736B	Apr	27	2019	2018_MONOPTEROS
drwxr-xr-x	6	aubombarely	staff	192B	May	19	2018	2018_VANILLA
drwxr-xr-x	69	aubombarely	staff	2.2K	May	12	2019	2019_EGGPLANT_RESEQ
drwxr-xr-x	9	aubombarely	staff	288B	Mar	1	20:05	2019_MANGO_GENOME
drwxr-xr-x	4	aubombarely	staff	128B	Aug	6	2019	2019_MIRACLE_FRUIT
drwxr-xr-x	23	aubombarely	staff	736B	Feb	5	18:46	2019_OLIVE_KOUBOURIS
drwxr-xr-x	11	aubombarely	staff	352B	Jul	5	2019	2019_PEAR_MASIERO
drwxr-xr-x	27	aubombarely	staff	864B	Jul	15	2019	2019_TOMATO_BENVENUTTO



## 3. Files and Directories

### Home versus root

```
bombarelya@annona:~$ ls -lh
total 24K
drwxrwxr-x 3 bombarelya bombarelya 4.0K Jan  9 17:09 Avocado
drwxrwxr-x 3 bombarelya bombarelya 4.0K Feb 11 21:37 Cherimola
drwxrwxr-x 3 bombarelya bombarelya 4.0K Nov  6 12:51 Mango
drwxrwxr-x 5 bombarelya bombarelya 4.0K Jan 17 16:12 perl5
drwxrwxr-x 3 bombarelya bombarelya 4.0K Feb 28 15:09 R
drwxrwxr-x 6 bombarelya bombarelya 4.0K Feb 19 10:58 Suaveolentes
```

Home directory  
~/bombarelya  
/data/bombarelya

```
bombarelya@annona:/$ ls -lh
total 8.1G
drwxr-xr-x  2 root root 4.0K Sep 20 14:55 altos
drwxr-xr-x  2 root root 4.0K Feb 11 09:23 bin
drwxr-xr-x  4 root root 4.0K Feb 20 06:40 boot
drwxr-xr-x  2 root root 4.0K Sep 20 14:23 cdrom
drwxr-xr-x 19 root root 4.0K Mar  9 09:30 data
drwxr-xr-x 20 root root 4.1K Feb 16 09:16 dev
drwxr-xr-x 116 root root 4.0K Mar  9 20:23 etc
drwxr-xr-x  3 root root 4.0K Sep 20 14:32 home
lrwxrwxrwx  1 root root   33 Feb 19 06:49 initrd.img -> boot/initrd.img-4.15.0-88-generic
lrwxrwxrwx  1 root root   33 Feb 19 06:49 initrd.img.old -> boot/initrd.img-4.15.0-76-generic
drwxr-xr-x 22 root root 4.0K Nov  6 12:57 lib
drwxr-xr-x  2 root root 4.0K Aug  5 2019 lib64
drwx----- 2 root root 16K Sep 20 14:23 lost+found
drwxr-xr-x  2 root root 4.0K Aug  5 2019 media
drwxr-xr-x  2 root root 4.0K Aug  5 2019 mnt
drwxr-xr-x  2 root root 4.0K Aug  5 2019 opt
dr-xr-xr-x 702 root root   0 Feb 16 09:14 proc
drwx----- 4 root root 4.0K Feb 11 08:18 root
drwxr-xr-x 26 root root 980 Mar  9 20:27 run
drwxr-xr-x  2 root root 12K Feb 11 09:23 sbin
drwxr-xr-x  4 root root 4.0K Sep 20 14:32 snap
drwxr-xr-x  2 root root 4.0K Aug  5 2019 srv
-rw-----  1 root root 8.0G Sep 20 14:24 swap.img
dr-xr-xr-x 13 root root   0 Feb 16 09:14 sys
drwxrwxrwt 16 root root 4.0K Mar  9 20:22 tmp
drwxr-xr-x 10 root root 4.0K Aug  5 2019 usr
drwxr-xr-x 13 root root 4.0K Aug  5 2019 var
lrwxrwxrwx  1 root root   30 Feb 19 06:49 vmlinuz -> boot/vmlinuz-4.15.0-88-generic
lrwxrwxrwx  1 root root   30 Feb 19 06:49 vmlinuz.old -> boot/vmlinuz-4.15.0-76-generic
```

Root directory  
/bin, /sbin, /dev  
/data, /home

### 3. Files and Directories

## Home versus root



```
bombarelya@annona: ~$
```

Home directory  
~/bombarelya  
/data/bombarelya



```
bombarelya@annona: /$
```

Root directory  
/bin, /sbin, /dev  
/data, /home

# Outline of Topics

1. What is Linux?
2. The terminal (or emulator)
3. Files and directories
- 4. Absolute and relative paths**
5. Basic command structure
6. Users, groups and permissions
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## 4. Absolute and Relative Paths

**ABSOLUTE PATH:** Location of a file **from root (/)**



Latham Hall, 311  
220 Ag Quad Ln.  
Blacksburg, VA 24060  
USA

**RELATIVE PATH:** Location of a file **from working dir**



Room 311

## 4. Absolute and Relative Paths

Relative filepath depends of the working directory

```
bombarelya@annona:~/Avocado$ ls RNASeq_PliegoC/
```

Absolute filepath starts at root

```
[bombarelya@annona:~/Avocado$ ls /data/bombarelya/Avocado/RNASeq_PliegoC/
```



## 4. Absolute and Relative Paths

Find the present working directory

```
pwd
```

Change the working directory

```
cd <directory>
```

Goes to the root

```
cd /
```

/home/user

```
cd ~
```

up one dir

```
cd ..
```

What does this do?

```
cd
```

## 4. Absolute and Relative Paths

Create a directory

```
mkdir dirname
```

Create an empty file

```
touch filename
```

# Outline of Topics

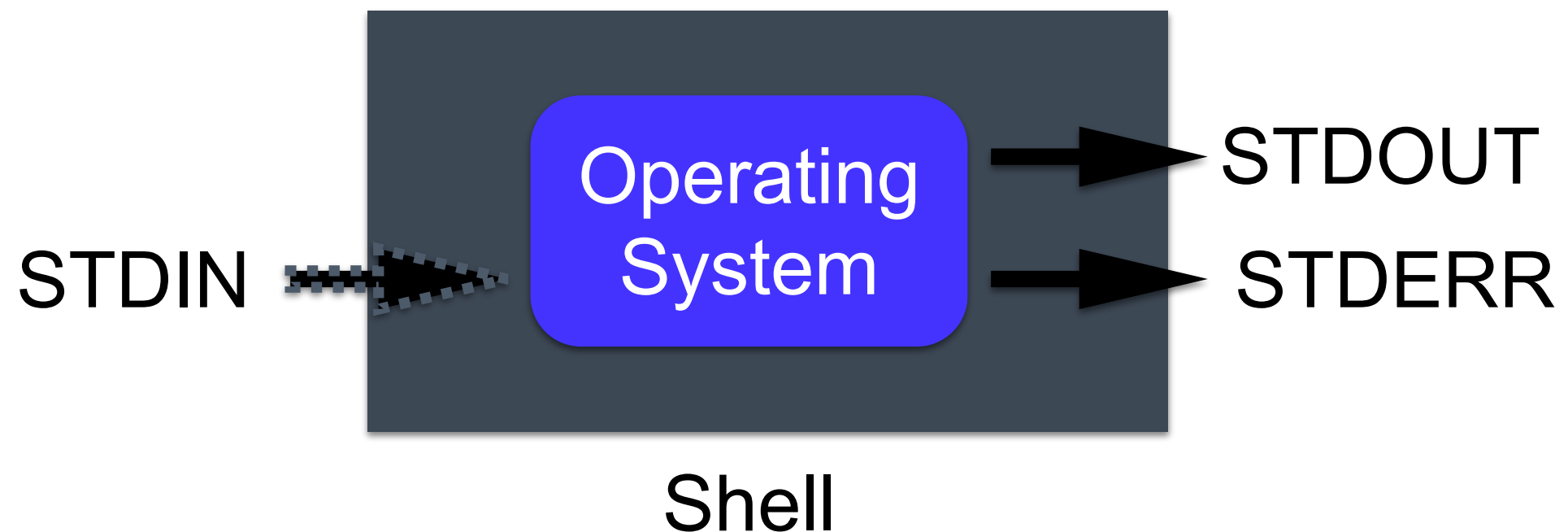
1. What is Linux?
2. The terminal (or emulator)
3. Files and directories
4. Absolute and relative paths
- 5. Basic command structure**
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1. Navigating in the terminal
2. Working with files and directories



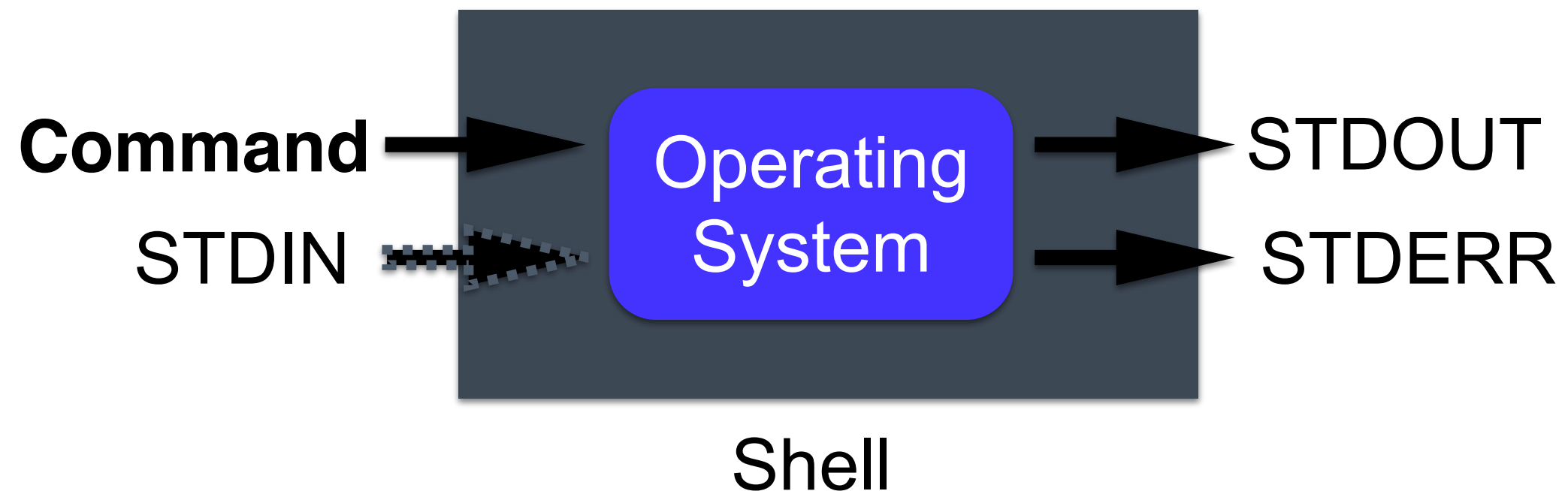
## 5. Basic Command Structure

How do we interface with the operating system?



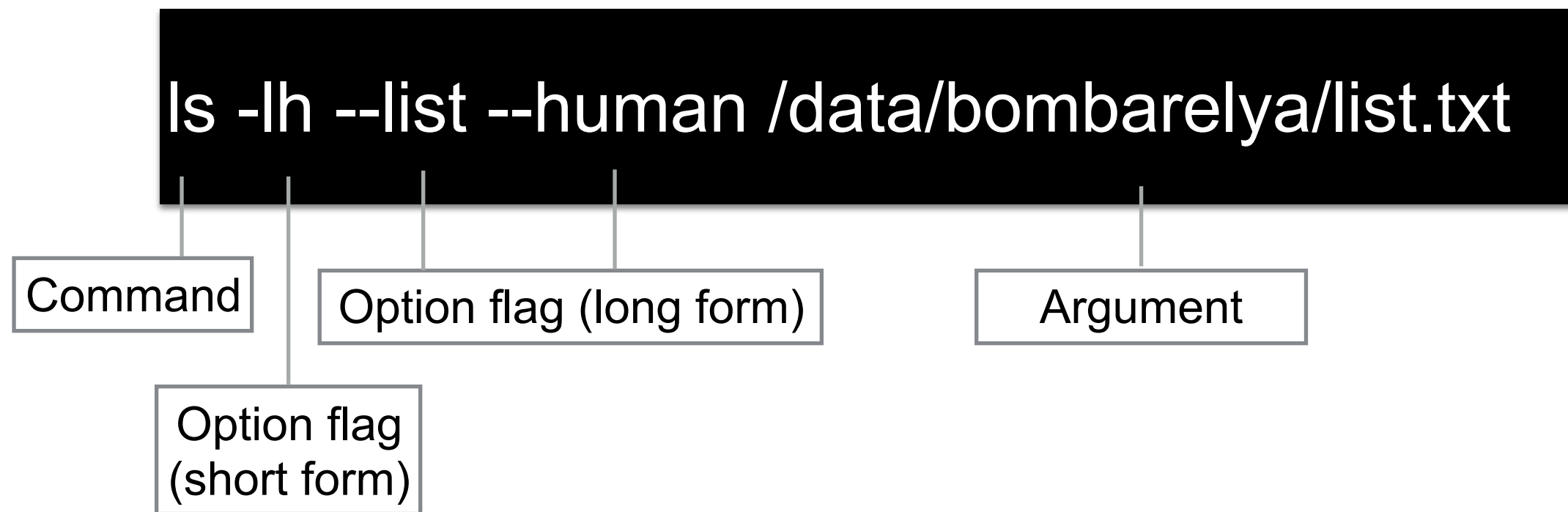
## 5. Basic Command Structure

How do we interface with the operating system?



## 5. Basic Command Structure

### Anatomy of a UNIX command



## 5. Basic Command Structure

### Exercise 1

The behavior of a command can be modified using **options** such as `-l` or `-a`.

1. Create a directory with the name “exercise01”
2. Change the working directory to “exercise01”
3. Create an empty file with the name “test01.txt”.
4. Create another empty file with the name “”test02.txt

## 5. Basic Command Structure

### Exercise 1

5. Run **ls**, without options (1), with **-lh** (2), with **-l -h** (3) and with **-lha** (4).

What are the differences in the output?

## 5. Basic Command Structure

### Special characters in bash:

Character	Meaning
SPACE	Separate commands and arguments
# HASH	Comment
; SEMICOLON	Command separator to run multiple commands
. DOT	Source command OR filename component OR current directory
.. DOUBLE DOTS	Parent directory
' SINGLE QUOTES	Use expression between quotes
, COMMA	Concatenate strings
\ BACKSLASH	Escape for single character
/ SLASH	Filename path separator
* ASTERISK	Wildcard for filename expansion
>, <, >> CHARACTERS	Redirection input/outputs
PIPE	Pipe outputs between commands
! BANG	Run a command

## 5. Basic Command Structure

### Special characters in bash:

```
ls Solanum lycopersicum
```

Bash interprets spaces as separators

```
ls 'Solanum lycopersicum'  
ls Solanum\lycopersicum
```

Use single quotes or escape '\ ' for special characters

## 5. Basic Command Structure

### Special characters in bash:

The wildcard '\*' is your friend

```
ls ~/*txt
```

Lists all text files in your directory

```
ls ~/D*p
```

Lists files/directories in your home folder that start with D and end with p

Note: With great power comes great responsibility



## 5. Basic Command Structure

### Getting more information for a command:

```
man <command>
```

```
man ls
```

note: use “q” to exit the interface.

## 5. Basic Command Structure

Tracing your steps:

```
$ history
```

# Outline of Topics

1. What is Linux?
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11. Networking
12. Installing programs

1. Navigating in the terminal
2. Working with files and directories



## 6. User, groups and permissions

```
bombarelya@annona:~/Suaveolentes$ ls -lh
total 52K
-rw-rw-r-- 1 bombarelya bombarelya 792 Feb 16 12:44 00_source.log
drwxrwxr-x 356 bombarelya bombarelya 20K Feb 14 18:16 00_sources
drwxrwxr-x 2 bombarelya bombarelya 4.0K Feb 17 17:22 01_suaveolentes
drwxrwxr-x 2 bombarelya bombarelya 4.0K Feb 16 17:39 02_chloroplast
drwxrwxr-x 2 bombarelya bombarelya 20K Feb 17 17:09 benthamiana
```

## 6. User, groups and permissions

```
bombarelyya@annona:~/Suaveolentes$ ls -lh
total 52K
-rw-rw-r-- 1 bombarelyya bombarelyya 792 Feb 16 12:44 00_source.log
drwxrwxr-x 356 bombarelyya bombarelyya 20K Feb 14 18:16 00_sources
drwxrwxr-x 2 bombarelyya bombarelyya 4.0K Feb 17 17:22 01_suaveolentes
drwxrwxr-x 2 bombarelyya bombarelyya 4.0K Feb 16 17:39 02_chloroplast
drwxrwxr-x 2 bombarelyya bombarelyya 20K Feb 17 17:09 benthamiana
```

permissions

# 6. User, groups and permissions

```
bombarelya@annona:~/Suaveolentes$ ls -lh
total 52K
-rw-rw-r-- 1 bombarelya bombarelya 792 Feb 16 12:44 00_source.log
drwxrwxr-x 356 bombarelya bombarelya 20K Feb 14 18:16 00_sources
drwxrwxr-x 2 bombarelya bombarelya 4.0K Feb 17 17:22 01_suaveolentes
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drwxrwxr-x 2 bombarelya bombarelya 20K Feb 17 17:09 benthamiana
```

permissions	Links
-------------	-------

# 6. User, groups and permissions

bombarelyya@annona:~/Suaveolentes\$ ls -lh

total 52K

-rw-rw-r--	1	bombarelyya	bombarelyya	792	Feb 16 12:44	00_source.log
drwxrwxr-x	356	bombarelyya	bombarelyya	20K	Feb 14 18:16	00_sources
drwxrwxr-x	2	bombarelyya	bombarelyya	4.0K	Feb 17 17:22	01_suaveolentes
drwxrwxr-x	2	bombarelyya	bombarelyya	4.0K	Feb 16 17:39	02_chloroplast
drwxrwxr-x	2	bombarelyya	bombarelyya	20K	Feb 17 17:09	benthamiana

permissions	Links	Group Name
-------------	-------	------------

## 6. User, groups and permissions

bombarelyya@annona:~/Suaveolentes\$ ls -lh									
total 52K									
-rw-rw-r--	1	bombarelyya	bombarelyya	792	Feb 16	12:44	00_source.log		
drwxrwxr-x	356	bombarelyya	bombarelyya	20K	Feb 14	18:16	00_sources		
drwxrwxr-x	2	bombarelyya	bombarelyya	4.0K	Feb 17	17:22	01_suaveolentes		
drwxrwxr-x	2	bombarelyya	bombarelyya	4.0K	Feb 16	17:39	02_chloroplast		
drwxrwxr-x	2	bombarelyya	bombarelyya	20K	Feb 17	17:09	benthamiana		
Permissions	Links	Group Name	User Name						



# 6. User, groups and permissions

bombarelya@annona:~/Suaveolentes\$ ls -lh

total 52K

-rw-rw-r--	1	bombarelya	bombarelya	792	Feb 16 12:44	00_source.log
drwxrwxr-x	356	bombarelya	bombarelya	20K	Feb 14 18:16	00_sources
drwxrwxr-x	2	bombarelya	bombarelya	4.0K	Feb 17 17:22	01_suaveolentes
drwxrwxr-x	2	bombarelya	bombarelya	4.0K	Feb 16 17:39	02_chloroplast
drwxrwxr-x	2	bombarelya	bombarelya	20K	Feb 17 17:09	benthamiana

permissions	Links	Group Name	User Name	Size
-------------	-------	------------	-----------	------

# 6. User, groups and permissions

bombarelya@annona:~/Suaveolentes\$ ls -lh						
total 52K						
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drwxrwxr-x	356	bombarelya	bombarelya	20K	Feb 14 18:16	00_sources
drwxrwxr-x	2	bombarelya	bombarelya	4.0K	Feb 17 17:22	01_suaveolentes
drwxrwxr-x	2	bombarelya	bombarelya	4.0K	Feb 16 17:39	02_chloroplast
drwxrwxr-x	2	bombarelya	bombarelya	20K	Feb 17 17:09	benthamiana
permissions	Links	Group Name	User Name	Size	Date	

# 6. User, groups and permissions

bombarelyya@annona:~/Suaveolentes\$ ls -lh						
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-rw-rw-r--	1	bombarelyya	bombarelyya	792	Feb 16 12:44	00_source.log
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drwxrwxr-x	2	bombarelyya	bombarelyya	4.0K	Feb 17 17:22	01_suaveolentes
drwxrwxr-x	2	bombarelyya	bombarelyya	4.0K	Feb 16 17:39	02_chloroplast
drwxrwxr-x	2	bombarelyya	bombarelyya	20K	Feb 17 17:09	benthamiana
permissions	Links	Group Name	User Name	Size	Date	Filename

# 6. User, groups and permissions

bombarelya@annona:~/Suaveolentes\$ ls -lh

total 52K

-rw-rw-r--	1	bombarelya	bombarelya	792	Feb 16 12:44	00_source.log
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drwxrwxr-x	2	bombarelya	bombarelya	4.0K	Feb 17 17:22	01_suaveolentes
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drwxrwxr-x	2	bombarelya	bombarelya	20K	Feb 17 17:09	benthamiana

permissions

Links

Group Name

User Name

Size

Date

Filename

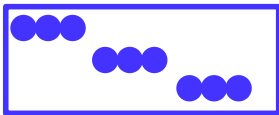
Symbol	Meaning
-	regular file
d	directory
l	link
c	special file
s	socket
p	named pipe
b	blocked device

# 6. User, groups and permissions

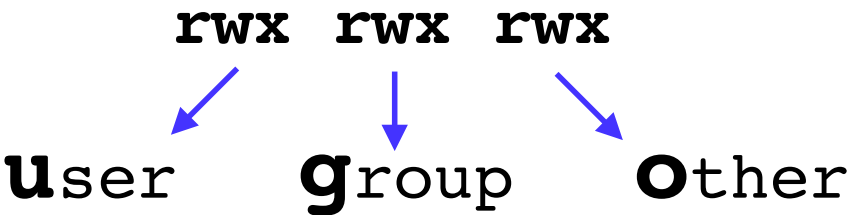
```
bombarelya@annona:~/Suaveolentes$ ls -lh
```

total 52K						
-rw-rw-r--	1	bombarelya	bombarelya	792	Feb 16 12:44	00_source.log
drwxrwxr-x	356	bombarelya	bombarelya	20K	Feb 14 18:16	00_sources
drwxrwxr-x	2	bombarelya	bombarelya	4.0K	Feb 17 17:22	01_suaveolentes
drwxrwxr-x	2	bombarelya	bombarelya	4.0K	Feb 16 17:39	02_chloroplast
drwxrwxr-x	2	bombarelya	bombarelya	20K	Feb 17 17:09	benthamiana

permissions	Links	Group Name	User Name	Size	Date	Filename
-------------	-------	------------	-----------	------	------	----------



Symbol	Meaning
-	regular file
d	directory
l	link
c	special file
s	socket
p	named pipe
b	blocked device



## 6. User, groups and permissions

### Permissions:

Information about the file:

```
ls -l;           ls -l <target>
```

Examples:

```
-r--r--r--  
-rwxr--r--  
drw-rw-r--
```

→ Readable for everyone

→ Readable for everyone, writable or executable only for the user-owner

→ Dir readable and writable for user and group, readable for everyone.

To change the owner/group:

```
chown owner:group file
```

To change permissions:

```
chmod [ugo] [+-=] [rwx] file  
chmod [0-7] [0-7] [0-7] file
```

```
| rwx | rwx | rwx |  
| 421 | 421 | 421 |
```



## 6. User, groups and permissions

### Permissions:

**sudo**, is a program for Unix-like computer operating systems that allows users to run programs with the security privileges of another user (normally the superuser, or root). Its name is a concatenation of the su command (which grants the user a shell for the superuser) and "do", or take action.

```
sudo cp ./myscript.pl /usr/local/bin
```

## 5. Basic Command Structure

### Exercise 2

1. List the permissions for the directory “exercise01”
2. Change the permissions to “r- - r - - r - -”
3. Change the working dir to “exercise01”

What happened? Why?

# Outline of Topics

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## 7. Manipulating files

### Recap movement commands:

Find the present working directory

`pwd`

Change the working directory

`cd`

List files in the working directory

`ls`

## 7. Manipulating files

### Reading text files:

**less** — view sections of a file via scrolling

```
less file.txt
```

note 1: “q” to quit!

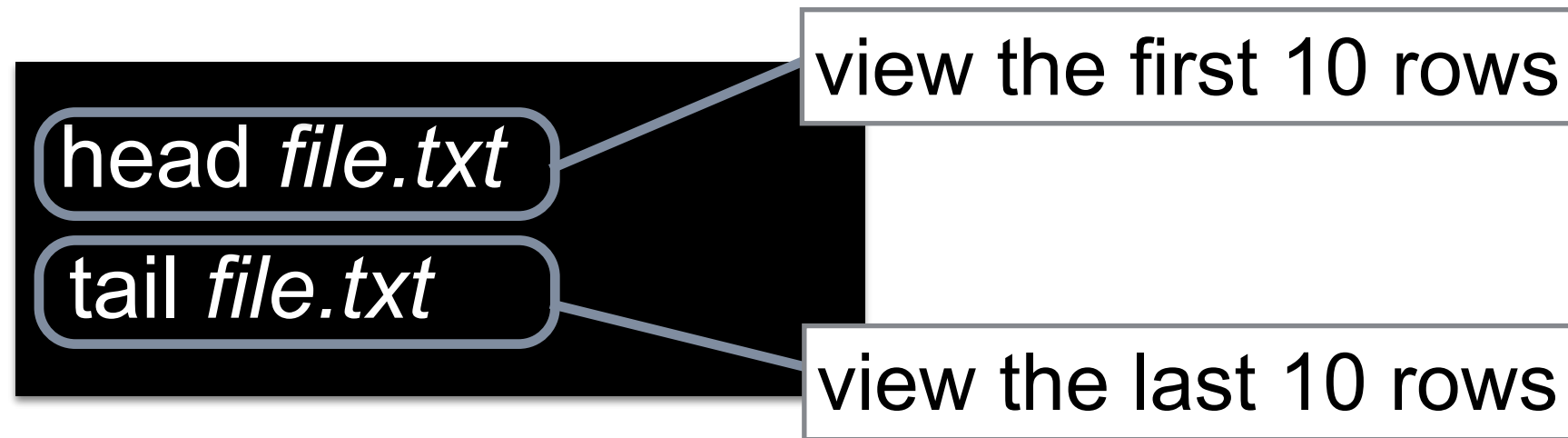
note 2: SPACE to scroll forward N lines!

note 3: less -N <file> open the file with the line number

note 4: less +n -N <file> opens to a particular line number

## 7. Manipulating files

### Reading text files:



note 1: use `-n X` to view more than the default 10 lines

(e.g., `head -n 20 file.txt` to view 20 lines)

## 7. Manipulating files

### Manipulating text files:

**cat** — combine multiple files



```
cat file1.txt file2.txt
```

Combines and prints the file.

```
cat file1.txt file2.txt > combined_file.txt
```

Combines the files and redirects the STDOUT to a new file.

Note: You can use `cat file.txt` to view the contents of a file, but should you?

## 7. Manipulating files

### Manipulating text files:

**mv** — move and/or rename a file

```
mv file1.txt file1_new.txt
```

Renames the file in the present location

```
mv file1.txt ~/Desktop/scripts/file1_new.txt
```

Renames the file and moves to a different directory.



## 7. Manipulating files

### Manipulating text files:

**cp** — copy a file

```
cp file1.txt file1_copy.txt
```

Copies a file in the pwd.

```
cp file1.txt ~/Desktop/file1_copy.txt
```

Copies a file to a new location.

## 7. Manipulating files

### Manipulating text files:

**touch** — marks a new timestamp on a file or creates an empty file if none exists



```
touch existing_file.txt
```

Mark a new timestamp

```
touch new_file.txt
```

Creates a new *empty* file in the pwd

**NB:** use filenames in lowercase with underscores rather than spaces

## 7. Manipulating files

### Manipulating text files:

**mkdir** — creates a new *empty* directory

**rmdir** — removes an *empty* directory

**mkdir trimmed**

Make a new directory

**mkdir -p reads/trimmed**

**rmdir trimmed**

Makes a new directory  
'trimmed' and parent  
directory 'reads'

Removes a directory  
adding -Rf removes the  
directory and all files

## 7. Manipulating files

### Manipulating text files:

**rm** — removes files

```
rm file1.txt
```

removes a file in  
the pwd

```
rm -rf trimmed/
```

removes a directory and all  
of the contents (recursive 'r'  
and forced 'f')

```
rm *.sam
```

removes all files ending  
in .sam in the pwd

**NB:** With great power comes great  
responsibility.

## 7. Manipulating files

### Manipulating text files:

**locate** — find a file quickly not resident on all systems

**find** — find a file with more options but slower



```
locate file.txt
```

find file by name

```
find file.txt
```

find file by name, age, owner,  
permissions, timestamp, file  
type, location...etc

**NB:** locate is a global search  
whereas find is local.

## 7. Manipulating files

COMMAND	USE	EXAMPLE
ls	List information	ls -lha /home
pwd	Print working directory	pwd
cd	Change directory	cd ..
less	Open a text file	less file.txt
head / tail	Print the first / last 10 lines	head file.txt
cat	Concatenate and print two files	cat file1.txt file2.txt
mv	Move (rename) a file	mv from/file.txt to/file.txt
cp	copy files	cp file1.txt file1_copy.txt
touch	Create an empty file or new timestamp	touch test.txt
mkdir	Create a new directory	mkdir test_dir
rmdir	Remove an empty directory	rmdir test_dir
rm -rf	Remove a directory and files	rm -rf test_dir
locate	Find files by name	locate file.txt
find	Find files by multiple categories	find ./test file.txt

## 7. Manipulating files

### Exercise 3

1. Download the file “Araport11\_genes.201606.pep.fasta.gz” using the following command:

```
wget https://www.arabidopsis.org/download\_files/Genes/Araport11\_genome\_release/Araport11\_blastsets/Araport11\_genes.201606.pep.fasta.gz
```

2. Unzip the file using the command  
`gunzip Araport11_genes.201606.pep.fasta.gz`
3. Print the first ten lines

## 7. Manipulating files

### Exercise 3

4. Create a new directory called “Sequences”
5. Move the “Araport11\_genes.201606.pep.fasta” file into the new directory
6. Print the last twenty lines



## 7. Manipulating files

### Controlling the STDOUT:

#### 1. Redirecting into a file

Use of “>” symbol - Create and add (it overwrites!!!)

```
doej@annona:~$ ls > test_capture_ls.txt
```

Use of “>>” symbol - Append

```
doej@annona:~$ ls >> test_capture_ls.txt
```

## 7. Manipulating files

### Controlling the STDOUT:

#### 2. Redirecting into a new command (pipe)

Use of “|” symbol -Pipe the STDOUT of a command into a new one

```
[doej@annona:~$ ls exercise01/ | grep 01  
test01.txt
```

## 7. Manipulating files

### Other commands to extract information from files:

COMMAND	USE	EXAMPLE
grep	Print matching lines as STDOUT	grep 'ATG' myfile
cut	Cut columns and print as STDOUT	cut -f1 myfile
sort	Sort lines and print as STDOUT	sort myfile
uniq	Select uniq words (-c to count uniq).	uniq -c myfile
sed	Replace occurrences, print lines STDOUT	sed 's/ATG/CTG/' myfile
wc	Word count	wc myfile

## 7. Manipulating files

### Exercise 4

NOTE: To execute the exercise 4, it is necessary to know what a FASTA file is. For more information check:

[https://en.wikipedia.org/wiki/FASTA\\_format](https://en.wikipedia.org/wiki/FASTA_format)

```
>AT1G01010.1 | NAC domain containing protein 1 | Chr1:3760-5630 FORWARD LENGTH=429 | 201606
MEDQVGFGRPNDEELVGHYLRNKIEGNTSRDVEVAISEVNICSYDPWNLRFQSKYKSRD
AMWYFFSRRENNKGNRQSRTTVSGKWKL TGESVEVKDQWGFCSEGFRGKIGHKRVLVFLD
GRYPDKTKSDWVIHEFHLDLPEHQRTYVICRLEYKGDDADILSAY AIDPTPAFVPNMTS
SAGSVVNQSRQRNSGSYNTYSEYDSANHGQQFNENSNIMQQQPLQGSFNPLLEYDFANHG
GQWLSDYIDLQQQVPYLAPYENESEMIWKHVIEENFEFLVDERTSMQQHYSDHRPKKPV
GVLPDDSSDTETGSMIFEDTSSSTD SVGSSDEPGHTRIDDIPSLNII EPLHNYKAQE QPK
QQSKEKVISSQKSECEWKMAEDSIKIPPSTNTVKQSWIVLENAQWNYLKNMIIGVLLFIS
VISWIILVG
>AT1G01020.1 | ARV1 family protein | Chr1:6915-8666 REVERSE LENGTH=245 | 201606
MAASEHRCVGCGRVKS LFIQYSPGNIRLMKCGNCKEVADEYIECERMIIFIDLILHRPK
VYRHVLYNAINPATVNIQHLLWKLVFAYLLLD CYRSLLLRKSDEESSFSDSPVLLSIKVL
IGVLSANAAFIISFAIATKGLLNEVSRREIMLGIFISSYFKIFLLAMLVWEFPM SVIFF
VDILLTNSMALKVMTESMTRCIAVCLIAHLIRFLVGQIF EPTIFLIQIGSLLQYMSY
FFRIV
>AT1G01020.2 | ARV1 family protein | Chr1:7315-8666 REVERSE LENGTH=191 | 201606
MAASEHRCVGCGRVKS LFIQYSPGNIRLMKCGNCKEVADEYIECERMIIFIDLILHRPK
VYRHVLYNAINPATVNIQHLLWKLVFAYLLLD CYRSLLLRKSDEESSFSDSPVLLSIKVL
IGVLSANAAFIISFAIATKGLLNEVSRREIMLGIFISSYFKIFLLAMLVCCSFTSHLIP
NIEVPNFLSIP
```

## 7. Manipulating files

### Exercise 4

1. Using the file from the Exercise 3  
“Araport11\_genes.201606.pep.fasta” print  
all the lines with the “>” symbol
2. Print all the lines with the sequence  
“LCLCL”
3. Count how many sequences are in the file  
with grep

## 7. Manipulating files

### Exercise 4

4. Using the redirection symbol, capture all the sequence IDs from the file in a new file names “seqids.txt”
5. Using the pipe command print only the first ten sequence IDs
6. Count how many “kinases” are in the *Arabidopsis thaliana* proteome

# Outline of Topics

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7. Manipulating files
- 8. Shortcuts**
9. Environmental variables
10. Monitoring resources
11. Networking
12. Installing programs

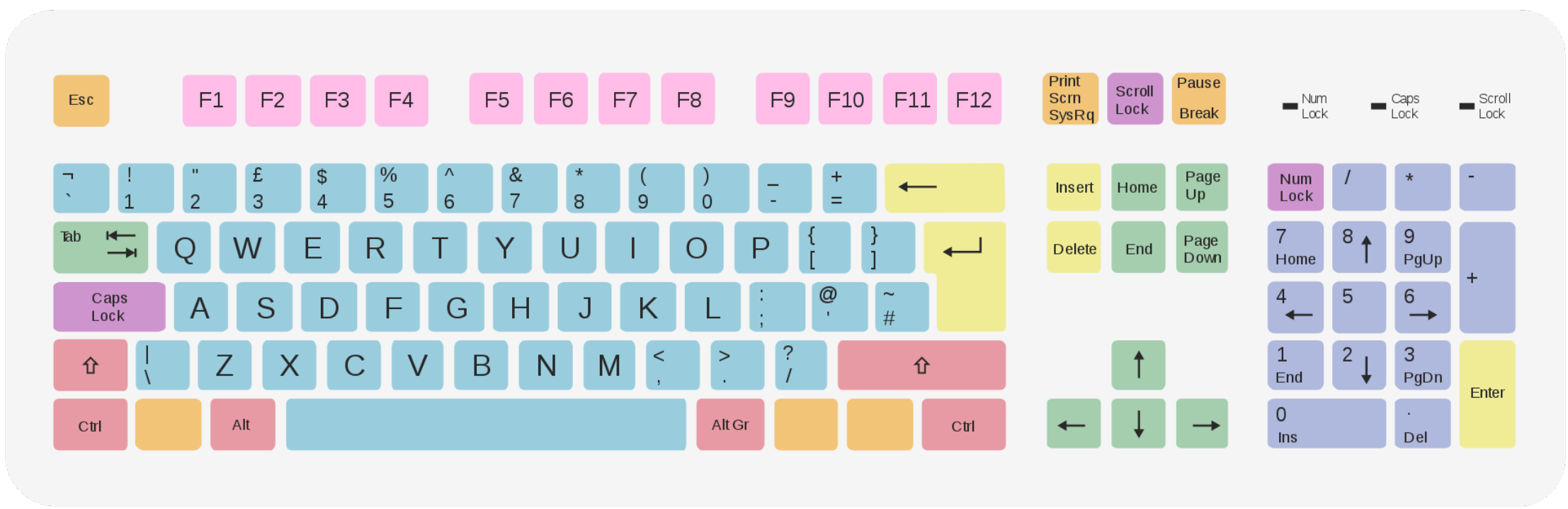
1. Navigating in the terminal
2. Working with files and directories



# 8. Shortcuts

Shortcuts are combinations of keys with specific functions

MODIFIER KEY + CHARACTER KEY



- Character keys
- Enter and editing keys
- Navigation keys
- Numeric keypad
- Modifier keys
- System and GUI keys
- Function keys
- Lock keys



## 8. Shortcuts



Tab to autocomplete names  
or show all matches

```
doej@annona:~$ ls  
exercise01  
doej@annona:~$ cd e
```

Type "cd e"

↓ Push Tab

```
[doej@annona:~$ ls  
exercise01  
[doej@annona:~$ cd exercise01/
```

It will autocomplete

## 8. Shortcuts



Tab to autocomplete names  
or show all matches

```
doej@annona:~/exercise01$ less test0
```

Type “less te”

↓ Push Tab

```
test01.txt test02.txt
```

It gives you two options

↓ Type 1 + push Tab

```
doej@annona:~/exercise01$ less test01.txt
```

It will autocomplete

## 8. Shortcuts



Up arrow to move up in history  
Down arrow to move back in history

Command history is in:

`~/.bash_history`

## 8. Shortcuts

COMMAND	ACTION
Tab	Autocomplete files or folder names
↑	Scroll up in the command history
↓	Scroll down in the command history
Ctrl + a	Go to the beginning of the active line
Ctrl + e	Go to the end of the line active line
Ctrl + u	Clear the line up to the cursor
Ctrl + c	Kill the active process
Ctrl + d	Exit the current shell
Ctrl + z	Put the active process in the background. Use command fg to recover it.

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1. Navigating in the terminal
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## 9. Environmental Variables

There are two types of variables in a Linux shell:

### 1) System variables

Variables defined by the system such as home dir or the executable path.

### 2) User defined variables

Variables defined by the user during a bash session.

# 9. Environmental Variables

## System variables

SYSTEM VARIABLE	MEANING
SHELL	Shell name
BASH	Shell name
BASH_VERSION	Shell version
COLUMNS	Number of columns printed on the screen
LINES	Number of lines printed on the screen
HOME	Home directory
LOGNAME	Login name
OSTYPE	Operating system type
PATH	Path directories
PS1	Prompt settings
PWD	Current working directory
USERNAME	Username currently logged in to the system

## 9. Environmental Variables

### Commands to interact with system variables

**set** — prints the commands for setting environmental variables

**env** — prints the environmental variables

**set**  
**env**

```
~ — bombarelya@annona: ~ — ssh bombarelya@159.149.160.131 ...SA_work/PROJECTS/2019_MANGO_GENOME/01_Genome — zandr@annona: ~ — -bash ~ — -bash
bombarelya@annona:~$ env
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=30;4
;42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=01;31:*.lha=01;31:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.
01;31:*.tzo=01;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=01;31:*.z
01;31:*.bz2=01;31:*.bz=01;31:*.tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.war=01;31:*.ear=01;31:*.sar=0
*.alz=01;31:*.ace=01;31:*.zoo=01;31:*.cpio=01;31:*.7z=01;31:*.rz=01;31:*.cab=01;31:*.wim=01;31:*.swm=01;31:*.dwm=01;31:*.esd=01;31:*.
=01;35:*.mjpg=01;35:*.mjpeg=01;35:*.gif=01;35:*.bmp=01;35:*.pbm=01;35:*.pgm=01;35:*.ppm=01;35:*.tga=01;35:*.xbm=01;35:*.xpm=01;35:*.t
01;35:*.png=01;35:*.svg=01;35:*.svgz=01;35:*.mng=01;35:*.pcx=01;35:*.mov=01;35:*.mpg=01;35:*.mpeg=01;35:*.m2v=01;35:*.mkv=01;35:*.web
;35:*.mp4=01;35:*.m4v=01;35:*.mp4v=01;35:*.vob=01;35:*.qt=01;35:*.nuv=01;35:*.wmv=01;35:*.asf=01;35:*.rm=01;35:*.rmvb=01;35:*.flc=01
.fli=01;35:*.flv=01;35:*.gl=01;35:*.dl=01;35:*.xcf=01;35:*.xwd=01;35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.ogv=01;35:*.ogx=01;35:*.a
36:*.flac=00;36:*.m4a=00;36:*.mid=00;36:*.midi=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;36:*.wav=00;36:*.oga=00
*.spx=00;36:*.xspf=00;36:
SSH_CONNECTION=188.216.6.130 57267 159.149.160.131 22
LESSCLOSE=/usr/bin/lesspipe %s %s
LANG=en_US.UTF-8
XDG_SESSION_ID=922
USER=bombarelya
PWD=/data/bombarelya
HOME=/data/bombarelya
SSH_CLIENT=188.216.6.130 57267 22
XDG_DATA_DIRS=/usr/local/share:/usr/share:/var/lib/snapd/desktop
SSH_TTY=/dev/pts/0
MAIL=/var/mail/bombarelya
TERM=xterm-256color
SHELL=/bin/bash
SHLVL=1
LOGNAME=bombarelya
XDG_RUNTIME_DIR=/run/user/1001
PATH=/data/bombarelya/.local/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
LESSOPEN=| /usr/bin/lesspipe %s
_=/usr/bin/env
OLDPWD=/data/bombarelya/Suaveolentes
```



## 9. Environmental Variables

### Commands to interact with system variables

**echo** — prints the environmental variable **value**

All caps for an  
env variable

```
echo $PATH
```

\$ calls the  
variable  
**value**

Shows the PATH to  
executables. Using  
quotes here is not  
absolute but good  
practice.

## 9. Environmental Variables

### Commands to interact with system variables

**export** — Create an env. variable for all child processes

NO SPACES!

Adds old  
PATH values

```
export PATH=/home/user/scripts:$PATH
```

Adds a program  
executable dir (/home/  
user/scripts/) to the  
executable PATH.

## 9. Environmental Variables

### Commands to interact with system variables

What about adding multiple new paths

```
export PATH=/home/user/scripts:/home/user/software:$PATH
```

Paths are separated by  
a ':' including \$PATH

```
export PATH=/home/user/scripts:$PATH  
export PATH=/home/user/software:$PATH
```

## 9. Environmental Variables

### User defined variables

Syntax is important

This creates a defined variable that is a shortcut to login to BlueRidge

```
TEST_VAR='~/bashrc'
```

```
echo $TEST_VAR
```

Returns the value of the variable.

```
cat $TEST_VAR
```

Executes the command.

Note: Remove unwanted variables with:  
**unset** 'variable name'.

## 9. Environmental Variables

### Commands to interact with system variables

**source** —execute commands from a file name

```
source home/user/scripts/myscript.sh
```

Will execute the shell  
script 'myscript.sh'

## 9. Environmental Variables

### Commands to interact with system variables

COMMAND	MEANING
env	Print environment variables
set	Print shell variables
echo	Print environment variable <b>value</b>
export	Create an env. variable available to all child processes
alias	Provide a short name for a long string
source	Execute commands from a file name

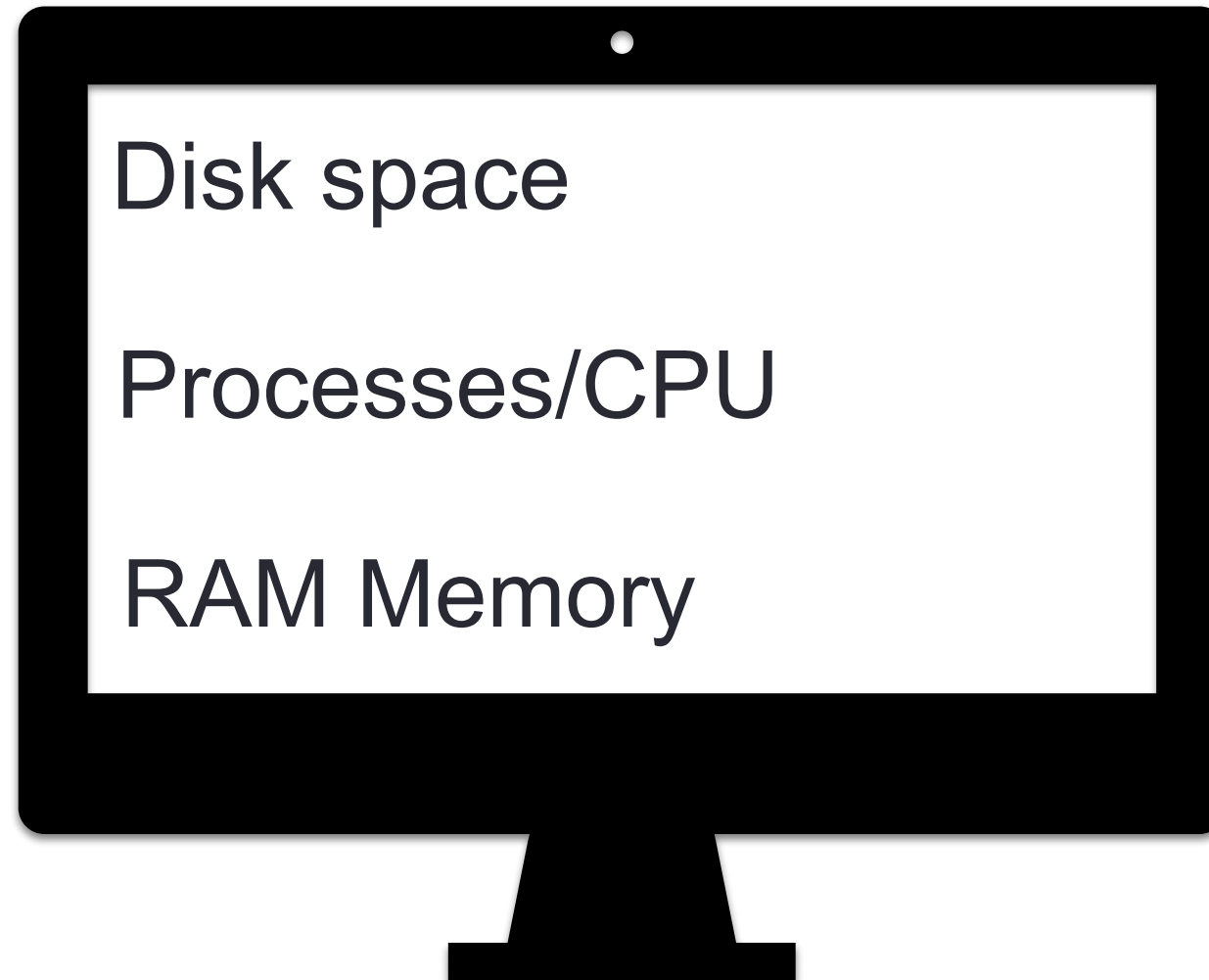
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## 10. Monitoring resources





## 10. Monitoring resources

### How much disk space is available?

**df** — disk free prints available disk space for all the partitions

```
[bombarelya@annona:~$ df -lh
Filesystem      Size  Used Avail Use% Mounted on
udev            126G   0    126G   0% /dev
tmpfs           26G    2.5M   26G    1% /run
/dev/sdb2       879G   17G   818G    2% /
tmpfs           126G   0    126G   0% /dev/shm
tmpfs           5.0M   0     5.0M   0% /run/lock
tmpfs           126G   0    126G   0% /sys/fs/cgroup
/dev/loop1      92M    92M     0 100% /snap/core/8592
/dev/sdb1       511M   6.1M  505M    2% /boot/efi
/dev/sdd1       11T    6.1T   4.3T   59% /data
tmpfs           26G   0     26G   0% /run/user/1001
/dev/loop2      92M    92M     0 100% /snap/core/8689
tmpfs           26G   0     26G   0% /run/user/1006
tmpfs           26G   0     26G   0% /run/user/1013
```

Note: Use `df -lh` to print in human readable form

## 10. Monitoring resources

### How much disk space I am using?

**du** — disk usage prints the disk space used by a directory

```
[doej@annona:~$ du -lh
4.0K    ./exercise01
4.0K    ./cache
4.0K    ./gnupg/private-keys-v1.d
8.0K    ./gnupg
36K     .
```

Note: Use `du -lh` to print in human readable form

## 10. Monitoring resources

### Which process are being run?

**top** — prints real time processes

```
top - 00:25:27 up 22 days, 15:10,  1 user,  load average: 2.42, 2.01, 2.20
Tasks: 691 total,   2 running, 389 sleeping,   0 stopped,   0 zombie
%Cpu(s):  3.1 us,  0.0 sy,  0.0 ni, 96.9 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 26378531+total, 1369348 free, 1157384 used, 26125857+buff/cache
KiB Swap: 8388604 total, 8370684 free,  17920 used, 26078164+avail Mem
```

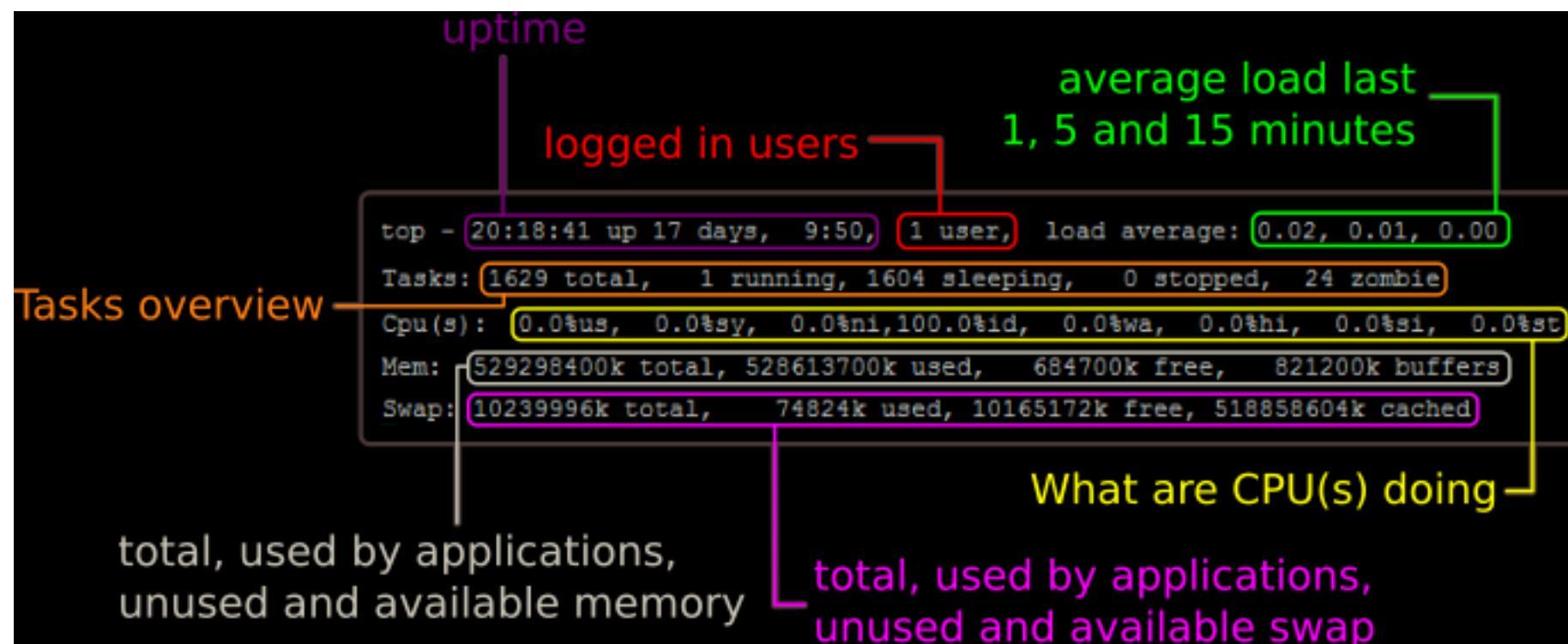
PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
4661	bombare+	20	0	4433200	37976	5164	R	199.7	0.0	2:58.13	iqtree
4740	doej	20	0	43452	4568	3232	R	1.0	0.0	0:00.19	top
1	root	20	0	78324	9376	6736	S	0.0	0.0	1:24.34	systemd
2	root	20	0	0	0	0	S	0.0	0.0	0:00.54	kthreadd
4	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/0:0H
7	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	mm_percpu_wq
8	root	20	0	0	0	0	S	0.0	0.0	0:17.52	ksoftirqd/0

Note: Use “q” to exit/quit

## 10. Monitoring resources

### Which process are being run?

**top** — prints real time processes



## 10. Monitoring resources

### Which process are being run?

**top** — prints real time processes

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
20661	root	20	0	16240	2464	940	R	1.3	0.0	0:01.26	top
259	root	20	0	0	0	0	S	0.3	0.0	35:09.29	[events/0]
1	root	20	0	19352	1356	1136	S	0.0	0.0	1:21.78	/sbin/init
2	root	20	0	0	0	0	S	0.0	0.0	0:01.72	[kthreadd]
3	root	RT	0	0	0	0	S	0.0	0.0	185:39.80	[migration/0]
4	root	20	0	0	0	0	S	0.0	0.0	2:19.44	[ksoftirqd/0]
5	root	RT	0	0	0	0	S	0.0	0.0	0:00.00	[stopper/0]
6	root	RT	0	0	0	0	S	0.0	0.0	7:47.93	[watchdog/0]
7	root	RT	0	0	0	0	S	0.0	0.0	140:04.82	[migration/1]
8	root	RT	0	0	0	0	S	0.0	0.0	0:00.00	[stopper/1]
9	root	20	0	0	0	0	S	0.0	0.0	0:45.51	[ksoftirqd/1]
10	root	RT	0	0	0	0	S	0.0	0.0	8:30.42	[watchdog/1]

## 10. Monitoring resources

### Which process are being run?

**ps aux** — report a snapshot of the current processes.

```
[doej@annona:~$ ps aux
```

USER	PID	%CPU	%MEM	VSZ	RSS	TTY	STAT	START	TIME	COMMAND
root	1	0.0	0.0	78324	9376	?	Ss	Feb16	1:24	/sbin/init
root	2	0.0	0.0	0	0	?	S	Feb16	0:00	[kthreadd]
root	4	0.0	0.0	0	0	?	I<	Feb16	0:00	[kworker/0:0H]
root	7	0.0	0.0	0	0	?	I<	Feb16	0:00	[mm_percpu_wq]
root	8	0.0	0.0	0	0	?	S	Feb16	0:17	[ksoftirqd/0]
root	9	0.0	0.0	0	0	?	I	Feb16	30:06	[rcu_sched]
root	10	0.0	0.0	0	0	?	I	Feb16	0:00	[rcu_bh]
root	11	0.0	0.0	0	0	?	S	Feb16	0:02	[migration/0]
root	12	0.0	0.0	0	0	?	S	Feb16	0:04	[watchdog/0]
root	13	0.0	0.0	0	0	?	S	Feb16	0:00	[cpuhp/0]
root	14	0.0	0.0	0	0	?	S	Feb16	0:00	[cpuhp/1]
root	15	0.0	0.0	0	0	?	S	Feb16	0:02	[watchdog/1]

Note: Use “q” to exit/quit

## 10. Monitoring resources

### How much memory is available?

**free mem** — get a detailed report on the system's memory usage

```
[doej@annona:~$ free mem -g
```

	total	used	free	shared	buff/cache	available
Mem:	251	1	1	0	249	248
Swap:	7	0	7			

Note: Use -g to see the results in Gb

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## 11. Networking

### Checking internet connection:

**ping** — test the ability of the source computer to reach a specified destination computer

```
ping www.google.com  
ping www.unimit.it  
ping 159.149.160.131
```

Note: Stop the process with CTR + C

## 11. Networking

### Connecting to a remote host:

**ssh** — create a secure shell connection from the terminal.

```
ssh userid@servername  
ssh userid@serverip  
ssh userid@servername -p portname
```

```
username: does  
remote host: 159.149.160.131  
port: 22
```

## 11. Networking

### Connecting to a remote host:

**ssh** — create a secure shell connection from the terminal.

```
ssh doej@159.149.160.131 -p 22
```

username: does

remote host: 159.149.160.131

port: 22

## 11. Networking

### Copy a file FROM a remote host:

**scp** — copy a file from a host to your computer

```
scp username@address:<file_path> <local_location>
```

username: does

remote host: 159.149.160.131

port: 22

## 11. Networking

### Copy a file TO a remote host:

**scp** — copy a file from your computer to a host

```
scp <local_location> username@address:<remote>
```

username: does

remote host: 159.149.160.131

port: 22

## 11. Networking

### Download a file from a public FTP site:

**wget** — Download a file from a public site

```
wget ftp://ftp.solgenomics.net/genomes/Solanum_lycopersicum/  
annotation/ITAG3.2_release/ITAG3.2_proteins.fasta
```

## 11. Networking

### Download a file from a public FTP site:

**wget** — transfer information to or from a web based location ***not available by default on OS X***

```
wget ftp://ftp.solgenomics.net/tomato_genome/annotation/  
ITAG2.4_release/ITAG2.4_assembly.gff3
```

**curl** — transfer information to or from a web based location

```
curl -O "ftp://ftp.solgenomics.net/tomato_genome/annotation/  
ITAG2.4_release/ITAG2.4_assembly.gff3"
```

Note: curl option -O keeps the original file name. Use option -o to rename the file on download (eg, curl "http" -o xyz.txt)

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## 12. Installing programs

### Ways to Install Programs:

#### 1) Using **Packages Managers**

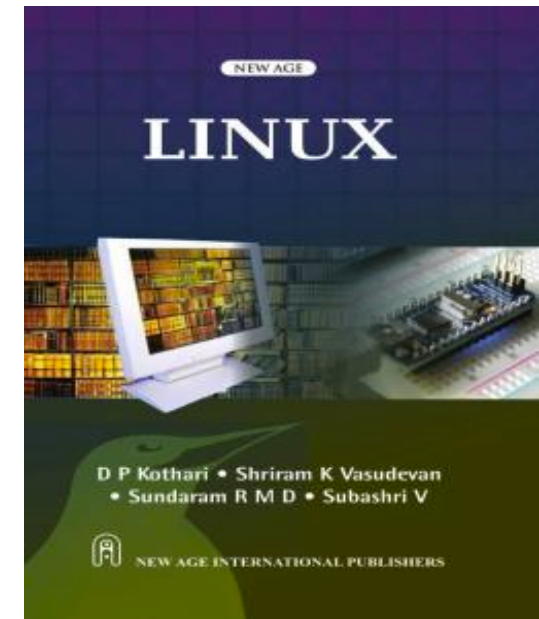
- 1.1) Graphical package manager  
(Example: Synaptic for Ubuntu).
- 1.2) High level command-line package manager  
(Example: apt for Debian, Yum for Red Hat)
- 1.3) Low level command-line package manager  
(Example: dpkg for Debian, rpm for Red Hat)

#### 2) Moving **Executable** file program to the PATH\* and the libraries need to their corresponding locations.

- 2.1) Precompiled.
- 2.2) From-source.

## Recommended Reading

- Author: Shriram, K V
- Book: Linux
- Publisher: New Age International
- ISBN: 81-224-3438-X, 978-81-224-3438-5
- Date:12/01/2014
- Free ebook from [lib.vt.edu](http://lib.vt.edu)
- Chapter 1, 2, 3



## Recommended Reading

- Author: Shotts, William E
- Book: The Linux command line : a complete
- Publisher: No Starch Press
- ISBN: 1-59327-389-4, 978-1-59327-389-7
- Date: 2011
- Free ebook from [lib.vt.edu](http://lib.vt.edu)
- Section 1.1, 1.2, 1.3, 1.4, 1.9

