



Unix History



What computers can run Unix?



Apple OS X Macs



Google's Android phones



Wireless internet routers



Airplane entertainment systems

The Terminal Window



the shell, the prompt, the command line

The Terminal Window

●							
ubuntu@ip-10-4-230-31:~/worki	ng\$ ls -la ~/						
total 444							
drwxr-xr-x 18 ubuntu ubuntu	4096 2012-01-09 22:50 .						
drwxr-xr-x 6 root root	4096 2011-11-14 17:12						
-rw 1 ubuntu ubuntu	3757 2012-03-12 12:11 .bash_history						
-rw-rr 1 ubuntu ubuntu	220 2011-05-18 10:00 .bash_logout						
-rw-rr 1 ubuntu ubuntu	3581 2011-11-14 17:16 .bashrc						
lrwxrwxrwx 1 root root	21 2011-11-14 12:25 bin ->//usr/proftpd/bin						
drwxrwxr-x 2 ubuntu ubuntu	4096 2011-11-14 17:16 .byobu						
drwxrwxr-x 4 ubuntu ubuntu	4096 2011-11-14 14:33 .cabal						
drwx 3 ubuntu ubuntu	4096 2011-11-14 11:37 .cache						
lrwxrwxrwx 1 root root	20 2011-11-14 12:23 conf ->//usr/nginx/conf						
-rwxrwxrwx 1 ubuntu ubuntu	992 2011-11-14 17:12 configure_freenx.sh						
drwx 3 ubuntu ubuntu	4096 2012-01-08 22:52 .emacs.d						
lrwxrwxrwx 1 root root	21 2011-11-14 12:25 etc ->//usr/proftpd/etc						
drwxr-xr-x 2 ubuntu ubuntu	4096 2011-11-14 12:51 .fontconfig						
drwx 2 ubuntu ubuntu	4096 2011-11-14 14:18 .gconf						
drwxr-xr-x 3 root root	4096 2011-11-14 16:58 .gem						
drwx 2 ubuntu ubuntu	4096 2011-11-14 14:51 .gnupg						
lrwxrwxrwx 1 root root	20 2011-11-14 12:23 html ->//usr/nginx/html						
lrwxrwxrwx 1 root root	25 2011-11-14 12:25 include ->//usr/proftpd/include						
drwxrwxr-x 4 ubuntu ubuntu	4096 2011-11-28 17:49 install						
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lrwxrwxrwx 1 root root	25 2011-11-14 12:25 libexec ->//usr/proftpd/libexec						
lrwxrwxrwx 1 root root	20 2011-11-14 12:23 logs ->//usr/nginx/logs						
drwxrwxr-x 2 ubuntu ubuntu	4096 2011-11-14 12:51 .m2						
drwxrwxr-x 2 ubuntu ubuntu	4096 2011-11-14 14:18 .matplotlib						
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-rw-rr 1 ubuntu ubuntu	6/5 2011-11-14 1/:16 .protile						
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Make it comfortable to work in:

- •Resize the window
- •Change your font size
- •Open multiple terminal windows

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487 raise Valuetroe ("Carrot six and motch literators!")	485 bc.bed = ***>1	Cychine27981-24-07 applietsBander & open skin.phylan Cychine27981-24-03 applietsBander & vi appliets.py
40 if bc2 and not _is_single_iterator.type(i_bc2):	to de 1442 et: sy(['s: 448 s2 11 191 16 16 16 17 197]))	Caythene27Mic25:07 ap-plotsimates open skin, plyine* Caythene27Mic25:07 ap-plotsimates open skin, plyine* Caythene27Mic25:07 ap-plotsimates open skin, plyine*
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451 r2_seqs_constructor = 1_seqs2(2) if 1_seqs2 else None	<pre>* Har() to valid for c in en() / inc(en)</pre>	Cyclement (Herd, Langueride La.L. Lot - Comparison - C
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201.		

Obtain a cheat sheet

google "unix commands"



o gunzin filename uncompresses files compressed by azin

In UNIX everything is a file organized in a hierarchy





/home/catchen/working

Create a series of directories

```
ubuntu@ip-10-4-193-188:~$ mkdir shell
ubuntu@ip-10-4-193-188:~$ cd shell
ubuntu@ip-10-4-193-188:~/shell$ mkdir research
ubuntu@ip-10-4-193-188:~/shell$ ls
research
ubuntu@ip-10-4-193-188:~/shell$ cd research/
ubuntu@ip-10-4-193-188:~/shell/research$ mkdir seq
ubuntu@ip-10-4-193-188:~/shell/research$ ls
seq
ubuntu@ip-10-4-193-188:~/shell/research$ cd seq/
ubuntu@ip-10-4-193-188:~/shell/research/seq$ mkdir radtags
ubuntu@ip-10-4-193-188:~/shell/research/seq$ cd radtags/
ubuntu@ip-10-4-193-188:~/shell/research/seq/radtags$ ls
ubuntu@ip-10-4-193-188:~/shell/research/sea/radtags$ ls -la
total 8
drwxrwxr-x 2 ubuntu ubuntu 4096 2012-03-06 23:08 .
drwxrwxr-x 3 ubuntu ubuntu 4096 2012-03-06 23:08 ...
ubuntu@ip-10-4-193-188:~/shell/research/sea/radtags$ pwd
/home/ubuntu/shell/research/sea/radtaas
ubuntu@ip-10-4-193-188:~/shell/research/seq/radtags$
```

% mkdir shell % cd shell

Paths, cont

This shell view of the nested directories shell, research, seq, and radtags.....

ubuntu@ip-10-4-193-188:~\$ mkdir shell
ubuntu@ip-18-4-193-188:~\$ cd shell
ubuntu@ip-18-4-193-188:~/shell\$ mkdir research
ubuntu@ip-10-4-193-188:~/shell\$ ls
research
ubuntu@ip-18-4-193-188:~/shell\$ cd research/
ubuntu@ip-10-4-193-188:~/shell/research\$ mkdir seq
ubuntu@ip-10-4-193-188:~/shell/research\$ is
seq
ubuntu@ip-10-4-193-188:~/shell/research\$ cd seq/
ubuntu@ip-10-4-193-188:~/shell/research/seq\$ mkdir radtags
ubuntu@ip-10-4-193-188:~/shell/research/seq\$ cd radtags/
ubuntu@ip-10-4-193-188:~/shell/research/seq/radtags\$ is
ubuntu@ip-10-4-193-188:~/shell/research/seq/radtags\$ ls -la
total 8
drwxrwxr-x 2 ubuntu ubuntu 4096 2012-03-06 23:08 .
drwxrwxr-x 3 ubuntu ubuntu 4096 2012-03-06 23:08
ubuntu@ip-10-4-193-188:~/shell/research/seq/radtags\$ pwd
/home/ubuntu/shell/research/seq/radtags
ubuntu@ip-18-4-193-188: ~/shell/research/seq/radtags\$

.... is equivalent to this GUI view of the same directories

m < > /home/ut	ountu	÷ 🔺
Filename	▲ Size	Modified
🕨 💭 bin	21 B	11/14/11 4:25 AM
▶ 🔚 conf	20 B	11/14/11 4:23 AM
configure_freenx.sh	992 B	11/14/11 9:12 AM
▶ 🔚 etc	21 B	11/14/11 4:25 AM
🕨 💭 html	20 B	11/14/11 4:23 AM
▶ 🔚 include	25 B	11/14/11 4:25 AM
▶ 🚞 install	4.0 KB	11/28/11 9:49 AM
▶ 🔚 lib	21 B	11/14/11 4:25 AM
▶ 🔚 libexec	25 B	11/14/11 4:25 AM
▶ 💭 logs	20 B	11/14/11 4:23 AM
sbin	4.0 KB	11/14/11 4:25 AM
▶ 💭 share	23 B	11/14/11 4:25 AM
▼ 🚞 shell	4.0 KB	3/6/12 3:08 PM
v i research	4.0 KB	3/6/12 3:08 PM
🔻 🚞 seq	4.0 KB	3/6/12 3:08 PM
🔻 🥅 radtags	4.0 KB	3/6/12 3:08 PM
🕒 stacks-0.998.tar.gz	330.4 KB	1/9/12 8:12 AM
▶ 🚞 tmp	4.0 KB	1/8/12 8:42 PM
▶ 💭 var	21 B	11/14/11 4:25 AM
🔎 working	12 B	1/8/12 2:49 PM

And the radtags directory is uniquely identified by its path: /home/ubuntu/shell/research/seq/radtags

Absolute and relative paths

How do I get to the Hotel Zlaty Andel?



Absolute and relative paths

How do I get to the Hotel Zlaty Andel?





Absolute Path



/home/catchen/working

Relative Path?





Special files -- 'dot dot'



Relative Path





Absolute Path:/home/catchen/working/fooRelative Path:../working/foo



Absolute Path:/home/catchen/working/fooAbsolute Path:/home/catchen/research/foo



Relative Path:. . /working/fooRelative Path:. /foo

Absolute and relative paths

ubuntu@ip-10-4-193-188:~\$ mkdir shell ubuntu@ip-10-4-193-188:~\$ cd shell ubuntu@ip-10-4-193-188:~/shell\$ mkdir research ubuntu@ip-10-4-193-188:~/shell\$ Is research ubuntu@ip-10-4-193-188:~/shell\$ cd research/ ubuntu@ip-10-4-193-188:~/shell/research\$ mkdir seq ubuntu@ip-10-4-193-188: ~/shell/research\$ is seq ubuntu@ip-10-4-193-188:~/shell/research\$ cd seq/ ubuntu@ip-10-4-193-188:~/shell/research/seq\$ mkdir radtags ubuntu@ip-10-4-193-188:~/shell/research/seq\$ cd radtaqs/ ubuntu@ip-10-4-193-188: ~/shell/research/seg/radtags\$ ls ubuntu@ip-10-4-193-188:~/shell/research/seg/radtags\$ is -la total 8 drwxrwxr-x 2 ubuntu ubuntu 4096 2012-03-06 23:08 . drwxrwxr-x 3 ubuntu ubuntu 4096 2012-03-06 23:08 ... ubuntu@ip-10-4-193-188:~/shell/research/seg/radtags\$ pvd /home/ubuntu/shell/research/seg/radtags ubuntu@ip-10-4-193-188: ~/shell/research/seq/radtags\$

Special Files

dot

dot dot

% ls .

% ls ../../

Binary programs - ls, cp, mkdir, etc.



$\Theta \Theta \Theta$

133×24 wbuntu@ip-10-140-6-74: ~ - ssh - 133×24

ubuntu@ip-10-140-6-74:~\$ ls /bin

bash	csh
bunzip2	dash
busybox	date
bzcat	dbus-cleanup-sockets
bzcmp	dbus-daemon
bzdiff	dbus-uuidgen
bzegrep	dd
bzexe	df
bzfgrep	dir
bzgrep	dnesg
bzip2	dnsdomainname
bzip2recover	domainname
bzless	dumpkeys
bzmore	echo
cat	ed
chacl	egrep
chgrp	false
chmod	fgconsole
chown	fgrep
chvt	findant
ф	fuser
cpio	fusermount
ubuntu@ip-10-1	40-6-74:~\$

getfacl	lsblk
grep	lsmod
gunzip	mkdir
gzexe	mknod
gzip	mktemp
hostname	more
init-checkconf	mount
initctl2dot	mountpoint
ip	mt
kbd_mode	mt-gnu
kill	mv
ksh	nano
less	nc
lessecho	nc.openbsd
lessfile	netcat
lesskey	netstat
lesspipe	nisdomainname
ln	ntfs-3g
loadkeys	ntfs-3g.probe
login	ntfs-3g.secaudi
lowntfs-3g	ntfs-3g.usermap
ls	ntfscat

ntfsck ntfscluster ntfsamp ntfsdecrypt ntfsdump_logfile ntfsfix ntfsinfo ntfsls ntfsmftalloc ntfsmove ntfstruncate ntfswipe open openvt pidof ping ping6 plymouth plymouth-upstart-bridge s-3g.secaudit ps pwd

readlink m rmdir mano run-parts rzsh sed setfacl setfont setupcon sh sh.distrib zdiff sleep static-sh stty su sync tailf tar tcsh tempfile zsh4 touch

true ulockmgr_server umount uname uncompress unicode_start vdir which ypdomainname zcat zanp zegrep zfgrep zforce zgrep zless zmore znew zsh

R_M



ls /bin %

rbash

Relative and absolute paths

A shortcut to your 'home', tilde:

Moving through the filesystem:

cd

Knowing where you are:

pwd

% pwd

% ls ~/ % cd ~/ % cd

Relative and absolute paths

/home/tgac/shell/research/seq/radtags

gac@Genotyping2: ~/shell/research/seq/radtags - ssh - 105×23	● ○ ○ ec2-54-213-252-8	80.us-west-2.compute.amazonav Get a donation keyl
tgac@Genotyping2:~\$ mkdir shell tgac@Genotyping2:~\$ cd shell taac@Genotyping2:~{shell\$ mkdir research	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	/bi610 ‡ 🔺 Q
tgac@Genotyping2:~/shell\$ mkdir research tgac@Genotyping2:~/shell\$ cd research/ tgac@Genotyping2:~/shell/research\$ mkdir seq tgac@Genotyping2:~/shell/research\$ cd seq/ tgac@Genotyping2:~/shell/research/seq\$ ls tgac@Genotyping2:~/shell/research/seq\$ mkdir radtags tgac@Genotyping2:~/shell/research/seq\$ ls radtags tgac@Genotyping2:~/shell/research/seq\$ ls -la total 12 drwxrwxr-x 3 tgac tgac 4096 Nov 4 09:34 . drwxrwxr-x 3 tgac tgac 4096 Nov 4 09:34 . drwxrwxr-x 3 tgac tgac 4096 Nov 4 09:34 . drwxrwxr-x 3 tgac tgac 4096 Nov 4 09:34 radtags tgac@Genotyping2:~/shell/research/seq\$ cd radtags tgac@Genotyping2:~/shell/research/seq\$ radtags tgac@Genotyping2:~/shell/research/seq\$ radtags tgac@Genotyping2:~/shell/research/seq*radtags\$ pwd /home/tgac/shell/research/seq/radtags\$	Filename .bash_history .bash_logout .bashrc .bashrc .cache .my.cnf .mysql_history .profile v ishell v ishell v iseq > radtags	Modified 110 B Today, 1:11 PM 220 B Yesterday, 3:58 PM 3.6 KB Yesterday, 3:58 PM Yesterday, 4:06 PM 69 B Yesterday, 3:58 PM 0 B Yesterday, 3:58 PM 675 B Yesterday, 3:58 PM Today, 1:36 PM Today, 1:36 PM Today, 1:37 PM 12 B Yesterday, 4:18 PM
	12 Files	en e

Are you typing? You're doing it wrong.

Tab-completion:

- Tab once to complete uniquely
- Tab twice to see all possible completions

Up-arrow:

• Previous commands can be found by pressing "up-arrow"

'history'

% cd /etc
% ls c <tab>

				bi6:	10@ij	0-17	72-31-1	17–121: /etc — ssh — 92×40
bi610@ip-17	72-	31-17	7-121:~/	/shell/	/rese	eard	ch/seq/	/radtags\$ cd /etc/
bi610@ip-17	72-	-31-17	7-121:/@	etc\$ ls	s -l			
total 868								
-rw-rr	1	root	root	15070	Apr	4	04:30	a2ps.cfg
-rw-rr	1	root	root	2563	Apr	4	04:30	a2ps-site.cfg
drwxr-xr-x	3	root	root	4096	Apr	16	18:26	acpi
-rw-rr	1	root	root	2981	Apr	16	18:25	adduser.conf
-rw-rr	1	root	root	10	Apr	16	18:27	adjtime
drwxr-xr-x	2	root	root	4096	Jun	20	22:23	alternatives
drwxr-xr-x	8	root	root	4096	Jun	20	21:30	apache2
drwxr-xr-x	3	root	root	4096	Apr	16	18:25	apm
drwxr-xr-x	3	root	root	4096	Apr	16	18:26	apparmor
drwxr-xr-x	8	root	root	4096	Jun	19	22:10	apparmor.d
drwxr-xr-x	3	root	root	4096	Jun	19	22:00	apport
drwxr-xr-x	6	root	root	4096	Apr	16	18:27	apt
-rw-r	1	root	daemon	144	0ct	21	2013	at.deny
-rw-rr	1	root	root	2177	Apr	9	01:03	bash.bashrc
-rw-rr	1	root	root	45	Mar	22	20:57	bash_completion
drwxr-xr-x	2	root	root	4096	Jun	20	21:44	bash_completion.d
-rw-rr	1	root	root	356	Jan	1	2012	bindresvport.blacklist
-rw-rr	1	root	root	321	Apr	16	16:07	blkid.conf
lrwxrwxrwx	1	root	root	15	Jun	3	20:54	<pre>blkid.tab -> /dev/.blkid.tab</pre>
drwxr-xr-x	2	root	root	4096	Apr	16	18:26	byobu
drwxr-xr-x	3	root	root	4096	Apr	16	18:25	ca-certificates
-rw-rr	1	root	root	7464	Apr	16	18:26	ca-certificates.conf
drwxr-xr-x	2	root	root	4096	Apr	16	18:26	calendar
drwxr-s	2	root	dip	4096	Apr	16	18:26	chatscripts
drwxr-xr-x	4	root	root	4096	Apr	16	18:27	cloud
drwxr-xr-x	2	root	root	4096	Apr	16	18:25	console-setup
drwxr-xr-x	2	root	root	4096	Jun	19	22:10	cron.d
drwxr-xr-x	2	root	root	4096	Jun	19	22:10	cron.daily
drwxr-xr-x	2	root	root	4096	Apr	16	18:25	cron.hourly
drwxr-xr-x	2	root	root	4096	Apr	16	18:25	cron.monthly
-rw-rr	1	root	root	722	Feb	9	2013	crontab
drwxr-xr-x	2	root	root	4096	Jun	20	22:23	cron.weekly
-rw-rr	1	root	root	54	Apr	16	18:26	crypttab
drwxr-xr-x	4	root	root	4096	Apr	16	18:26	dbus-1
-rw-rr	1	root	root	2969	Feb	23	14:30	debconf.conf
-rw-rr	1	root	root	11	Feb	20	02:43	debian_version
drwxr-xr-x	3	root	root	4096	Jun	20	22:23	default

% pwd
% ls c <tab><tab>

Three variants to 1s

ls -1	ls –la	ls –lh
provides a long listing	includes <i>all</i> files, even hidden files	displays file sizes in <i>human</i> readable numbers

Four ways to view a text file

more	head	tail	cat
view a text file one screen full at a time	view the top I5 lines of a file	view the last I5 lines of a file	spit the whole file at once
space-bar: scroll q: quit	-n num controls the number of lines	-n num controls the number of lines	

Explore the file hierarchy

- I. Move to the directory /etc
 - What is the first line of the file 'hosts' in the directory /etc?
 - What is the relative file path to get to /var/log from here?
 - What is the absolute path?
- 2. Move to the directory /var/log/
 - What is the contents on line 73 of the dmesg file?
 - Without changing directories, what is the second line of the cpuinfo file in the proc directory?
 - What is the command to read this file with a relative path?
 - An absolute path?

3. Move back to the root, what directories do you see?

4. Move back home, what are three ways to move home from the root?

Copy example files

Return to the directory in your home called 'shell'.

TSV file: ~/workshop_data/unix/batch_1.genotypes_1.loc.gz

FASTQ file: ~/workshop_data/unix/s_1_sequence.txt.gz

Tar Archive: ~/workshop_data/unix/samples.tar.gz

What is a tar archive?



tar = tape archive

Compress / Decompress gzip / gunzip

batch_l.genotypes_l.loc.gz

s_l_sequence.txt.gz

Gzipped Tar archiveTar archivetar xvfztar xvfsamples.tar.gzsamples.tar

Sequencing on Illumina's Flow cell



Sequencing on Illumina's Flow cell, ctd.





Sequencing on Illumina's Flow cell, ctd.



Phred Quality Score





Ngamphiw, et al. doi:10.1186/1471-2105-9-S12-S9 http://en.wikipedia.org/wiki/FASTQ_format

The FASTQ File Format

FASTA

>chromosome7 TTTGTCTGCAGGGGGGACACGTCAAAGTCAAACGCAGGCAAGTTTGTGTTTATGTCCAGTGGATCTTTTGATTTT ACATACTGCAGGGTCAGGAGGATTATCTCCTCTGCAAGGTAACGCCTGCTGTAACCGTTGTTCTTCATCCTTTT CCTAACTGCAGGGCTGTCTTGTCAGGTCTGACAAGACATATGCAGGGCTCAATTTGAGATAATTGCTCAATATA

FASTQ

@Sequence_137
TTTGTCTGCAGGGGGGACACGTCAAAGTCAAACGCAGGCAAGTTTGTGTTTATGTCCAGTGGATCTTTTGATTTT
+Sequence_137
<?@DDDDDHFHHFBB@GGIACFHGGHBGHGCDHBEAHACHI=@CH.=7ACAHHADECDBCC66(6>@C>5@CACCA

@HWI-ST0747:162:C03AJACXX:3:1108:19763:106771 1:N:0:

TTTGTCTGCAGGGGGGACACGTCAAAGTCAAACGCAGGCAAGTTTGTGTTTTATGTCCAGTGGATCTTTTGATTTT +

<?@DDDDDHFHHFBB@GGIACFHGGHBGHGCDHBEAHACHI=@CH.=7ACAHHADECDBCC66(6>@C>5@CACCA

ASCII Code

| 0 | <nul></nul> | 32 | <spc></spc> | 64 | @ | 96 | , | 128 | Ä | 160 | + | 192 | ; | 224 | ± |
|----|---|----|-------------|----|---|-----|-------------|-----|---|-----|--------|-----|----------|-----|-------|
| 1 | <soh></soh> | 33 | I | 65 | A | 97 | a | 120 | â | 161 | 0 | 193 | i | 225 | |
| 2 | <stx></stx> | 34 | | 66 | В | 98 | b | 130 | c | 162 | ¢ | 194 | - | 226 | |
| 3 | <etx></etx> | 35 | # | 67 | C | 99 | c | 131 | É | 163 | £ | 195 | | 227 | ,
 |
| 4 | <eot></eot> | 36 | \$ | 68 | D | 100 | d | 132 | Ñ | 164 | s
s | 196 | f | 228 | %o |
| 5 | <enq></enq> | 37 | % | 69 | E | 101 | e | 133 | Ö | 165 | • | 197 | ≈ | 229 | Â |
| 6 | <ack></ack> | 38 | & | 70 | F | 102 | f | 134 | Ü | 166 | 1 | 198 | Δ | 230 | Ê |
| 7 | <bel></bel> | 39 | | 71 | G | 103 | q | 135 | á | 167 | ß | 199 | « | 231 | Á |
| 8 | <bs></bs> | 40 | (| 72 | н | 104 | ĥ | 136 | à | 168 | ® | 200 | * | 232 | Ë |
| 9 | <tab></tab> | 41 |) | 73 | I | 105 | i | 137 | â | 169 | © | 201 | | 233 | È |
| 10 | <lf></lf> | 42 | * | 74 | J | 106 | j | 138 | ä | 170 | TM | 202 | | 234 | Í |
| 11 | <vt></vt> | 43 | + | 75 | К | 107 | k | 139 | ã | 171 | , | 203 | À | 235 | Î |
| 12 | <ff></ff> | 44 | , | 76 | L | 108 | [| 140 | å | 172 | | 204 | Ã | 236 | Ï |
| 13 | <cr></cr> | 45 | - | 77 | М | 109 | m | 141 | ς | 173 | ≠ | 205 | Õ | 237 | Ì |
| 14 | <\$0> | 46 | | 78 | N | 110 | n | 142 | é | 174 | Æ | 206 | Œ | 238 | Ó |
| 15 | <si></si> | 47 | / | 79 | 0 | 111 | 0 | 143 | è | 175 | Ø | 207 | œ | 239 | Ô |
| 16 | <dle></dle> | 48 | 0 | 80 | Ρ | 112 | р | 144 | ê | 176 | 00 | 208 | - | 240 | ¢. |
| 17 | <dc1></dc1> | 49 | 1 | 81 | Q | 113 | q | 145 | ë | 177 | ± | 209 | _ | 241 | Ò |
| 18 | <dc2></dc2> | 50 | 2 | 82 | R | 114 | r | 146 | í | 178 | ≤ | 210 | w | 242 | Ú |
| 19 | <dc3></dc3> | 51 | 3 | 83 | S | 115 | S | 147 | ì | 179 | ≥ | 211 | н | 243 | Û |
| 20 | <dc4></dc4> | 52 | 4 | 84 | Т | 116 | t | 148 | î | 180 | ¥ | 212 | ` | 244 | Ù |
| 21 | <nak></nak> | 53 | 5 | 85 | U | 117 | u | 149 | ï | 181 | μ | 213 | , | 245 | 1 |
| 22 | <syn< td=""><td>54</td><td>6</td><td>86</td><td>V</td><td>118</td><td>v</td><td>150</td><td>ñ</td><td>182</td><td>9</td><td>214</td><td>÷</td><td>246</td><td>^</td></syn<> | 54 | 6 | 86 | V | 118 | v | 150 | ñ | 182 | 9 | 214 | ÷ | 246 | ^ |
| 23 | <etb></etb> | 55 | 7 | 87 | W | 119 | w | 151 | ó | 183 | Σ | 215 | <u> </u> | 247 | ~ |
| 24 | <can></can> | 56 | 8 | 88 | х | 120 | х | 152 | ò | 184 | Π | 216 | ÿ | 248 | - |
| 25 | | 57 | 9 | 89 | Y | 121 | У | 153 | ô | 185 | п | 217 | Ÿ | 249 | |
| 26 | | 58 | : | 90 | Z | 122 | z | 154 | ö | 186 | ſ | 218 | / | 250 | |
| 27 | <esc></esc> | 59 | ; | 91 | [| 123 | { | 155 | õ | 187 | а | 219 | € | 251 | 0 |
| 28 | <fs></fs> | 60 | < | 92 | \ | 124 | 1 | 156 | ú | 188 | 0 | 220 | < | 252 | |
| 29 | <gs></gs> | 61 | = | 93 |] | 125 | } | 157 | ù | 189 | Ω | 221 | > | 253 | ** |
| 30 | <rs></rs> | 62 | > | 94 | ^ | 126 | ~ | 158 | û | 190 | æ | 222 | fi | 254 | |
| 31 | <us></us> | 63 | ? | 95 | _ | 127 | | 159 | ü | 191 | ø | 223 | fl | 255 | ~ |

8 bits = 2^8 combinations = 256

001 0

 $0x2^7 + 1x2^6 + 1x2^5 + 1x2^4 + 1x2^3 + 0x2^2 + 0x2^1 + 1x2^0 = 121 = \mathbf{y}$

 $1x10^{2}+2x10^{1}+1x10^{0} = 121 = \mathbf{y}$

The FASTQ File Format, ctd

@HWI-ST0747:162:C03AJACXX:3:1108:19763:106771 1:N:0: TTTGTCTGCAGGGGGGACACGTCAAAGTCAAACGCAGGCAAGTTTGTGTTTTTGTCCAGTGGATCTTTTGATTTT +

<?@DDDDDHFHHFBB@GGIACFHGGHBGHGCDHBEAHACHI=@CH.=7ACAHHADECDBCC66(6>@C>5@CACCA

Quality Scores

| SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS | | | | | | | | |
|---|---------------|----------|-----------|----------|-----|-----|--|--|
| ••••••••••••••••••••••••••••••••••••••• | | | | | | | | |
| ····· | | | | | | | | |
| •••••••••••••••••••••••••••••••••••••• | | | | | | | | |
| LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL | | | | | | | | |
| !"#\$%&'()*+,/0123456789:;<=>?@ABCDEFGHIJKLMNOPORSTUVWXYZ[\]^ `abcdefghijklmnopgrstuvwxyz{ }~ | | | | | | | | |
| | Ì | | | | | | | |
| 33 | 59 | 64 | 73 | | 104 | 126 | | |
| | | | | | | | | |
| S - Sanger | Phred+33, ra | aw reads | typically | (0, 40) | | | | |
| X – Solexa | Solexa+64, ra | aw reads | typically | (-5, 40) | | | | |
| I - Illumina 1.3+ | Phred+64, ra | aw reads | typically | (0, 40) | | | | |
| J - Illumina 1.5+ | Phred+64, ra | aw reads | typically | (3, 40) | | | | |
| with 0=unused, 1=unused, 2=Read Segment Quality Control Indicator (bold) | | | | | | | | |
| (Note: See discussion above). | | | | | | | | |
| L - Illumina 1.8+ | Phred+33, ra | aw reads | typically | (0, 41) | | | | |

ASCII values 33 - 73 = 0 - 40

'F' = 70 70 - 33 = **37**

The FASTQ File Format, ctd

@HWI-ST0747:162:C03AJACXX:3:1108:19763:106771 1:N:0: TTTGTCTGCAGGGGGGACACGTCAAAGTCAAACGCAGGCAAGTTTGTGTTTTTGTCCAGTGGATCTTTTGATTTT +

<?@DDDDDHFHHFBB@GGIACFHGGHBGHGCDHBEAHACHI=@CH.=7ACAHHADECDBCC66(6>@C>5@CACCA

70 - 33 = **37**

| Phred Quality Score | Probability of incorrect base call | Base call accuracy |
|---------------------|------------------------------------|--------------------|
| 10 | 1 in 10 | 90% |
| 20 | 1 in 100 | 99% |
| 30 | 1 in 1000 | 99.9% |
| 40 | 1 in 10000 | 99.99% |
| 50 | 1 in 100000 | 99.999% |

Count raw reads:

grep "@" s_1_sequence.txt
grep -c "@" s_1_sequence.txt

grep -v "@" s_1_sequence.txt
grep -v -c "@" s_1_sequence.txt

Count reads with barcode:

grep -c "^CGATA" s_1_sequence.txt



STDIN, STDOUT, STDERR

The Shell's Killer App: Pipes



The Shell's Killer App: Pipes, ctd.



The Shell's Killer App: Pipes, ctd.



So what is the purpose of the program **cat**?

cut

cut -f 10 batch_1.genotypes_1.loc

cut, capture the output

cut -f 1-10 batch 1.genotypes 1.loc > genos

cut, pipe the output to grep

cut -f 2 <u>batch 1.genotypes 1.loc</u> | grep -c "nnxnp"

cut -f 1-10,15,17 batch 1.genotypes 1.loc | grep "nnxnp" > genos2

Examine a marker, translating the output

cat <u>batch 1.genotypes 1.loc</u> | tr " "," | grep "^96053"

s_l_sequence.txt.gz Decompress the file

- Count the number of raw reads (250,000) Ι.
- Count the number of reads with barcode CGATA 2. (19,501)
- gunzip

ls

- 3. Capture all FASTQ records for ACCAT into a file called sample 01.fq (you should get 18352 records, 73408 lines)
- 4. Determine the count of all barcodes in the file
- 286 CTAGT 7900 TCAGA 10659 ACTGC 10931 TGACC 11536 GAGAT 11871 CTGAA 14409 CGGCG 14508 TGGTT 18226 GAAGC 18352 ACCAT 18375 TCGAG 19501 CGATA 23012 AATTT 26336 GCATT 31136 CTAGG I. Use **head** when building a command, **cat** once the command is working Look at the **-n** option for the **head** command, the **-I** option for **wc** 2. The "^" character means "must occur at beginning of line" in a grep search >3.
 - 4. Look at the grep options: -c, -v, -A, -B
 - Read the man pages for **sort** and **unig** to learn how to combine them
- man more cat WC head cut grep sort uniq

Problem Set #I

Danger Is. #04 vs Middleton Is. #16 Fst



| # | Batch ID | Locus | ID | Pop 1 ID | Pop 2 ID | Chr | BP Colum | n Overall P | i Fst 🛛 Fisher's P | Odds Ratio |
|----|----------|-------|----|----------|----------|-----|-----------|---------------|--------------------|------------|
| 2 | 7894 | 2 | 3 | groupI | 11832 | 19 | 0.428182 | -0.0076252913 | 0.191294 | 0.687192 |
| 2 | 7896 | 2 | 3 | groupI | 11900 | 83 | 0.328622 | 0.1775694587 | 4.35747e-08 | 5.44667 |
| 2 | 9611 | 2 | 3 | groupI | 49756 | 48 | 0.090426 | -0.1127451906 | 0.00109115 | 0.0898072 |
| 2 | 9611 | 2 | 3 | groupI | 49765 | 57 | 0.0132887 | -0.1522407447 | 0.518395 | 0.493113 |
| 2 | 9611 | 2 | 3 | groupI | 49766 | 58 | 0.0133776 | -0.1563725438 | 0.520033 | 0.501401 |
| •• | • | | | | | | | | | |
| 2 | 7083 | 2 | 3 | groupIX | 20172984 | 57 | 0.0480227 | -0.1249752728 | 0.0230205 | 0.152263 |
| 2 | 7083 | 2 | 3 | groupIX | 20173004 | 77 | 0.0181808 | -0.1405892833 | 0.27288 | 0.355556 |
| 2 | 7083 | 2 | 3 | groupIX | 20173016 | 89 | 0.0424072 | -0.1243625038 | 0.0442229 | 0.17037 |
| 2 | 7083 | 2 | 3 | groupIX | 20173018 | 91 | 0.148072 | 0.2305903127 | 2.24832e-07 | 13.2936 |
| 2 | 7084 | 2 | 3 | groupIX | 20172960 | 29 | 0.388239 | -0.0102170169 | 0.307185 | 0.758001 |
| 2 | 7084 | 2 | 3 | groupIX | 20172995 | 64 | 0.368259 | -0.0130602425 | 0.233889 | 0.70084 |
| 2 | 7084 | 2 | 3 | groupIX | 20173013 | 82 | 0.0121578 | -0.1359057575 | 0.51309 | 0.46472 |