

## WORKING ON THE LINUX COMMAND LINE



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Linux basics

Basic command line commands

(More or less) Bash specific commands



# Linux basics



## Linus Usenet-Posting from 25. Aug. 1991 in group *comp.os.minix*

Hello everybody out there using minix -

I'm doing a (free) operating system (just a hobby, won't be big and professional like gnu) for 386(486) AT clones. This has been brewing since april, and is starting to get ready. I'd like any feedback on things people like/dislike in minix, as my OS resembles it somewhat (same physical layout of the file-system (due to practical reasons) among other things).

I've currently ported bash(1.08) and gcc(1.40), and things seem to work. This implies that I'll get something practical within a few months, and I'd like to know what features most people would want. Any suggestions are welcome, but I won't promise I'll implement them :-)

Linus (torvalds@kruuna.helsinki.fi)

PS. Yes – it's free of any minix code, and it has a multi-threaded fs. It is NOT portable (uses 386 task switching etc), and it probably never will support anything other than AT-harddisks, as that's all I have :-).

## Historical notes

- ▶ Developed by Linus Benedict Torvalds
- ▶ Inspired by UNIX derivate MINIX
- ▶ First linux kernel published on 17. Sep. 1991 (v0.01)
- ▶ Free OS under GNU GPL since Dec. 1992 (v0.12)



Linus Torvalds 2002



Linux mascot Tux

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## Linux concepts

- ▶ Multi-user multi-threading operating system
- ▶ use many UNIX concepts
- ▶ hierarchical file system
- ▶ identical interface for file, device and process input/output
- ▶ background processes
- ▶ user/group security, access control

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## Linux is running on . . .

- ▶ Available for a wide range of hardware architectures, e. g. x86/x64, ARM-family, PowerPC, RISC, SPARC, some Amiga and Atari. . .
- ▶ Installation on desktop/server PCs, mobile phones (Android), routers, embedded systems, NAS, . . .
- ▶ All of the Top500 supercomputers use Linux as OS

## What is a Linux distribution?

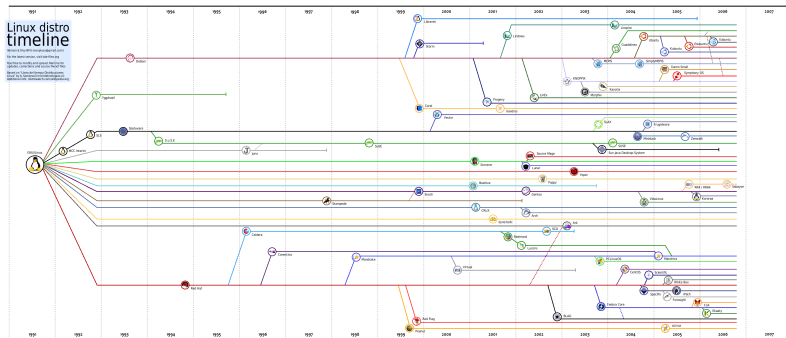
- ▶ Software collection around Linux kernel
- ▶ package manager for software installation
- ▶ provide software repositories, updates, ...
- ▶ Main distros: Debian, Ubuntu, RedHat
- ▶ more or less interoperability between different distributions (different package formats, standard file locations, directory layouts, ...)
- ▶ Standardization: Linux Standard Base (LSB), Filesystem Hierarchy Standard (FHS)



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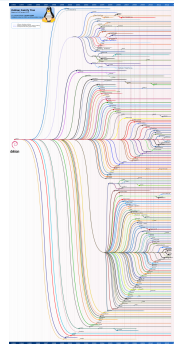
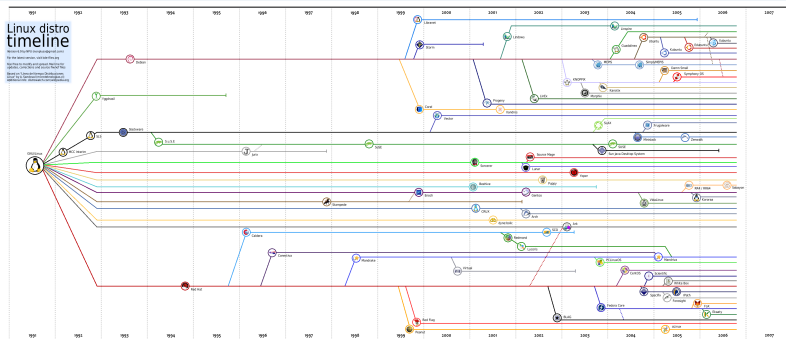
## Linux distro tree



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## Linux distro tree



## Basic file system (selection)

/	Filesystem root
/bin	Essential command binaries
/boot	Boot loader files (e. g., kernels)
/dev	Device files
/etc	Host-specific system-wide configuration files
/home	User's home directories, containing saved files, personal settings, etc.
/lib	Libraries essential for binaries in /bin/sbin
/root	Home directory for the root user
/sbin	Essential system binaries
/tmp	Directory for temporary files
/usr	Secondary hierarchy for read-only user data
/usr/bin	Non-essential command binaries
/usr/lib	Libraries for binaries in /usr/bin
/usr/local	Tertiary hierarchy for local data and apps
/usr/share	Architecture-independent (shared) data.
/var	Variable files
/var/log	Location for log files

## Virtual/Temporary file systems

/proc	Virtual file system providing process and kernel informations
/sys	Contains information about devices, drivers, and some kernel features.
/run	Run-time variable data.

## Further standard directories

/media	Mount points for removeable media
/mnt	Temporarily mounted filesystems
/opt	Optional application software
/srv	Data served by this host (e. g. web server)

## Typical Ubuntu file system hierarchy

```
kraehlit@linuxbox:/ $ tree -dL 1
-- bin -> usr/bin
-- boot
-- cdrom
-- dev
-- etc
-- home
-- lib -> usr/lib
-- lib32 -> usr/lib32
-- lib64 -> usr/lib64
-- libx32 -> usr/libx32
-- lost+found
-- media
-- mnt
-- opt
-- proc
-- root
-- run
-- sbin -> usr/sbin
-- srv
-- sys
-- tmp
-- usr
-- var
```

- ▶ Each user belongs to one or more groups
- ▶ Each Linux system keeps its own user/group database
- ▶ Centralized user management possible
- ▶ Standard administrator account: **root**
- ▶ Methods to execute a command as another user (e. g. root) available
- ▶ User: User-ID (uid) and user name
- ▶ Group: Group-ID (gid) and group name

```
kraehlit@lnxbox:/$ id
uid=1000(kraehlit) gid=1000(kraehlit) groups=1000(kraehlit),4(adm),24(cdrom),
27(sudo),30(dip),46(plugdev),116(lxd)
kraehlit@lnxbox:/$
```

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27(sudo),30(dip),46(plugdev),116(lxd)
kraehlit@lnxbox:/$
```

**Do not log in directly as administrator unless you really know what you are doing!**

If you need admin rights for a special command, use `sudo <command>`!

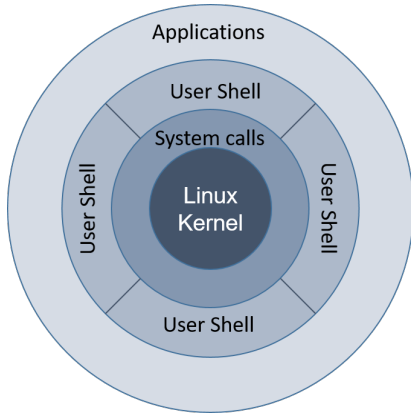
- ▶ **directories** and **devices** are **files** with special meaning
- ▶ type of files: - normal file c character device (modem, printer,...)  
d directory b block device (hard disc, usb stick,...)  
l link p pipe
- ▶ each file has a access control triple (read, write, execute) for owner, group, and other
- ▶ file names are case sensitive
- ▶ file suffix has no special meaning (other than on Microsoft Windows)
- ▶ use commands `chown`, `chgrp`, `chmod` to change owner, group and access rights

```
kraehlit@lnxbox:~$ ls -l
total 1032
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  4 20:13 Data1
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  4 20:13 Data2
-rw-rw-r-- 1 kraehlit kraehlit  0 Mar  4 20:14 File2.txt
-rw-rw-r-- 1 kraehlit kraehlit 1048576 Mar  4 20:16 file1
lrwxrwxrwx 1 kraehlit kraehlit  5 Mar  4 20:17 file1-link.txt -> file1
-rw-rw-r-- 1 kraehlit kraehlit  0 Mar  4 20:17 file2.TXT
-rw-rw-r-- 1 kraehlit kraehlit  0 Mar  4 20:14 file2.txt
```

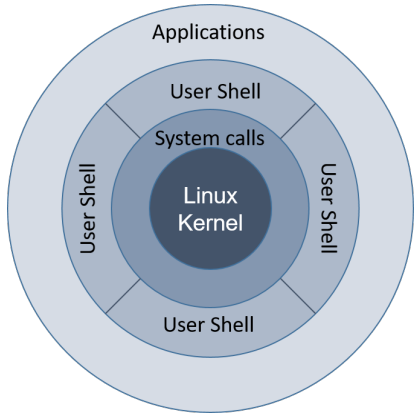
Annotations in the image:

- file owner: points to the owner name (kraehlit)
- file group: points to the group name (kraehlit)
- rights for other: points to the permissions for others (r--)
- rights for group: points to the permissions for the group (rw-)
- rights for owner: points to the permissions for the owner (rwx)
- file type: points to the first character of the permissions (d for directory, l for link, - for regular file)

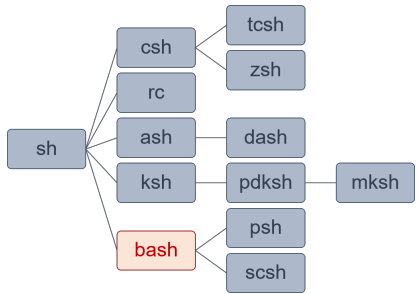
## Where the shell lives



## Where the shell lives



## Agony of the choice of shells



- ▶ default shell can be defined for each user
- ▶ shell can be changed after log in
- ▶ **bash** default shell on many systems



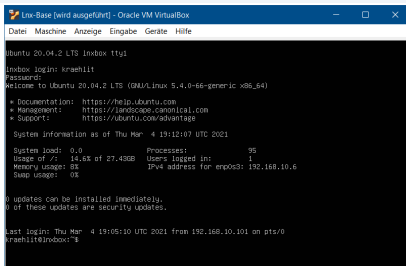
# Basic command line commands



## Open command line

- ▶ Login direct on the linux console
- ▶ Login over network via ssh or telnet (not secure)
- ▶ On a graphical linux wm open console/terminal

## Login direct on the linux machine (here VM)



```
lhx-base [wird ausgeführt] - Oracle VM VirtualBox
Datei Maschine Anzeige Eingabe Geräte Hilfe

Ubuntu 20.04.2 LTS lnxbox tty1
lnxbox login: kraehlitt
Password:
Welcome to Ubuntu 20.04.2 LTS (GNU/Linux 5.4.0-66-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

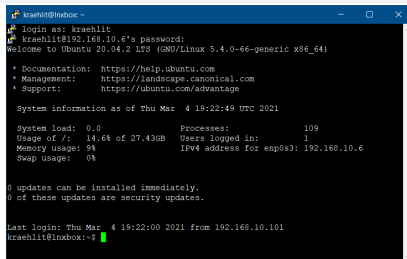
System information as of Thu Mar  4 19:12:07 UTC 2021

System load: 0.0          Processes:           95
Usage of /:  14.6% of 27.4GB    Users logged in:   1
Memory usage: 8k          IPv4 address for enp0s3: 192.168.10.6
Swap usage:  0k

0 updates can be installed immediately.
0 of these updates are security updates.

Last login: Thu Mar  4 19:05:10 UTC 2021 from 192.168.10.101 on pts/0
kraehlitt@lnxbox:~$
```

## Login via ssh



```
kraehlitt@lnxbox ~
login as: kraehlitt
kraehlitt@192.168.10.6's password:
Welcome to Ubuntu 20.04.2 LTS (GNU/Linux 5.4.0-66-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

System information as of Thu Mar  4 19:22:49 UTC 2021

System load: 0.0          Processes:           109
Usage of /:  14.6% of 27.4GB    Users logged in:   1
Memory usage: 9k          IPv4 address for enp0s3: 192.168.10.6
Swap usage:  0k

0 updates can be installed immediately.
0 of these updates are security updates.

Last login: Thu Mar  4 19:22:00 2021 from 192.168.10.101
kraehlitt@lnxbox:~$
```

After login, the current directory is your home directory

## Command `ls`

- ▶ `ls` lists the directory content
- ▶ output is adjusted by flags
- ▶ Listed files can be adjusted with a search string  
e. g. use `ls -l a*` to list only files starting with »a«
- ▶ well known windows command `dir` works on most system also (internal redirected to `ls`)

## Command: `ls -l`

```
kraehlit@lnxbox:~$ ls -l
total 1032
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar 4 20:13 Data1
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar 4 20:13 Data2
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar 4 20:14 file2.txt
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-rw-rw-r-- 1 kraehlit kraehlit 0 Mar 4 20:17 file2.TXT
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar 4 20:14 file2.txt
kraehlit@lnxbox:~$
```

## Command: `ls -la`

```
kraehlit@lnxbox:~$ ls -la
total 1060
drwxr-x--- 5 kraehlit kraehlit 4096 Mar 4 20:18 .
drwxr-xr-x 3 root root 4096 Mar 4 18:45 ..
-rw----- 1 kraehlit kraehlit 51 Mar 4 19:06 .bash_history
-rw-r--r-- 1 kraehlit kraehlit 220 Feb 25 2020 .bash_logout
-rw-r--r-- 1 kraehlit kraehlit 3771 Feb 25 2020 .bashrc
drwx----- 2 kraehlit kraehlit 4096 Mar 4 18:46 .cache
-rw-r--r-- 1 kraehlit kraehlit 807 Feb 25 2020 .profile
-rw-r--r-- 1 kraehlit kraehlit 0 Mar 4 18:46 .sudo_as_admin_successful
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar 4 20:13 Data1
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kraehlit@lnxbox:~$
```

## Command: **cd** (change directory)

<code>cd</code>	Change to the users home directory
<code>cd ~</code>	dito
<code>cd .</code>	does nothing (».« symbols the current directory)
<code>cd ..</code>	move up one directory (»..« symbols the parent directory)
<code>cd /tmp</code>	Change to the directory <code>/tmp</code> (absolute path)
<code>cd sdir</code>	change to subdirectory <code>sdir</code> of the current directory
<code>cd ./sdir</code>	dito
<code>cd sdir/ssdir</code>	change to the subsubdirectory <code>sdir1/ssdir</code>
<code>cd ../udir</code>	go to the directory <code>udir</code> of the parent directory
<code>pwd</code>	Output the current working directory



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<code>cd ../udir</code>	go to the directory <code>udir</code> of the parent directory
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Question: What is the working directory after the following command?

```
kraehlit@lnxbox:~$ cd /usr/local/bin/../../share
```



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Question: What is the working directory after the following command?

```
kraehlit@lnxbox:~$ cd /usr/local/bin/../../share
kraehlit@lnxbox:/usr/share$ pwd
/usr/share
kraehlit@lnxbox:/usr/share$ █
```



► For most commands: flag `-h` or `-help` print command help

► Further help methods:

`man <command_name>`

show man page of command

`apropos <search_string>`

search man pages for search string

`whatis <command_name>`

short info for command

## Command: `ls -help`

```

kraehlit@lnxbox:~$ ls --help
Usage: ls [OPTION]... [FILE]...
List information about the FILES (the current directory by default).
Sort entries alphabetically if none of -cftuvSUX nor --sort is specified.

Mandatory arguments to long options are mandatory for short options too.
-a, --all                do not ignore entries starting with .
-A, --almost-all        do not list implied . and ..
--author                 with -l, print the author of each file
-b, --escape             print C-style escapes for nongraphic characters
--block-size=SIZE       with -l, scale sizes by SIZE when printing them;
                        e.g., '--block-size=M'; see SIZE format below
-B, --ignore-backups    do not list implied entries ending with ~
-c                       with -lt: sort by, and show, ctime (time of last
                        modification of file status information);
                        with -l: show ctime and sort by name;
                        otherwise: sort by ctime, newest first
-C                       list entries by columns
--color[=WHEN]          colorize the output; WHEN can be 'always' (default
                        if omitted), 'auto', or 'never'; more info below
-d, --directory         list directories themselves, not their contents
  
```

## Command: `man ls`

```

kraehlit@lnxbox:~$ man ls
LS(1)                                User Commands                                LS(1)
NAME
  ls - list directory contents

SYNOPSIS
  ls [OPTION]... [FILE]...

DESCRIPTION
  List information about the FILES (the current directory by default).
  Sort entries alphabetically if none of -cftuvSUX nor --sort is speciD
  fied.

  Mandatory arguments to long options are mandatory for short options
  too.

  -a, --all
      do not ignore entries starting with .

  -A, --almost-all
      do not list implied . and ..
  
```

## Copy/Move/Delete/Create

<code>cp &lt;src&gt; &lt;dest&gt;</code>	Copy file <code>src</code> to <code>dest</code>
<code>cp &lt;src1&gt; &lt;src2&gt; &lt;dest&gt;</code>	Copy files into directory <code>dest</code>
<code>cp -r &lt;src&gt; &lt;dest&gt;</code>	Copy directories recursive
<code>mkdir &lt;dir&gt;</code>	Create directory
<code>mv &lt;src&gt; &lt;dest&gt;</code>	Move file <code>src</code> to <code>dest</code>
<code>mv &lt;src1&gt; &lt;src2&gt; &lt;dest&gt;</code>	Move files into directory <code>dest</code>
<code>rm &lt;files&gt;</code>	Delete given files
<code>rm -r &lt;files&gt;</code>	Delete given files/directories recursive
<code>rmdir &lt;dir&gt;</code>	Delete empty directory

## Find files

<code>find [options] &lt;pattern&gt;</code>	find files (more on next slide)
<code>locate &lt;search pattern&gt;</code>	search files in database
<code>whereis &lt;command&gt;</code>	search for <code>command</code> in binary search path



## Powerfull tool: **find**

- ▶ search file based on name pattern, permissions, age, age relative to another file, ...
- ▶ combination of search expressions with logic operators
- ▶ execute command for each found file

## basic usage

```

kraehlit@lnxbox:~/usr/share/doc$ find -name *.conf
./tmux/example_taux.conf
./adduser/examples/adduser.local.conf
./adduser/examples/adduser.local.conf.examples/adduser.conf
./busybox-static/examples/mdev.conf
./gpgconf/examples/gpgconf.conf
./sudo/examples/pam.conf
./sudo/examples/sudo.conf
./sudo/examples/syslog.conf
./procpss/examples/sysctl.conf
./rsync/examples/rsyncd.conf
./apt/examples/apt.conf
./gnupg/examples/gpgconf.conf
./apt-utils/examples/ftp-archive.conf
./apt-utils/examples/apt-ftparchive.conf
./rsyslog/examples/tmpfiles.d/xconsole.conf
./rsyslog/examples/rsyslog.d/xconsole.conf
./rsyslog/examples/rsyslog.d/console.conf
kraehlit@lnxbox:~/usr/share/doc$
kraehlit@lnxbox:~/usr/share/doc$ find -name *console.conf
./rsyslog/examples/tmpfiles.d/xconsole.conf
./rsyslog/examples/rsyslog.d/xconsole.conf
./rsyslog/examples/rsyslog.d/console.conf
kraehlit@lnxbox:~/usr/share/doc$
    
```

## extend usage with command execution

```

kraehlit@lnxbox:~$ find . -name test*.txt -exec echo {} \;
./Data1/test_4.txt
./Data1/test_1.txt
./Data1/test_5.txt
./Data1/test_3.txt
./Data1/test_2.txt
kraehlit@lnxbox:~$ find . -name test*.txt -exec rm -v {} \;
removed './Data1/test_4.txt'
removed './Data1/test_1.txt'
removed './Data1/test_5.txt'
removed './Data1/test_3.txt'
removed './Data1/test_2.txt'
kraehlit@lnxbox:~$ find . -name test*.txt -exec echo {} \;
kraehlit@lnxbox:~$
    
```

## Working with text files

`cat [options] <file(s)>`

Output file(s)

`grep [options] <regex-pattern> [file(s)]`

Search for `regex-pattern` in files

`more <file(s)>`

display file(s) page by page

`less [options] <file(s)>`

display file(s) page by page (enhanced `more`)

`sort [options] <file(s)>`

sort lines of text files



## Working with text files

<code>cat [options] &lt;file(s)&gt;</code>	Output file(s)
<code>grep [options] &lt;regex-pattern&gt; [file(s)]</code>	Search for <code>regex-pattern</code> in files
<code>more &lt;file(s)&gt;</code>	display file(s) page by page
<code>less [options] &lt;file(s)&gt;</code>	display file(s) page by page (enhanced <code>more</code> )
<code>sort [options] &lt;file(s)&gt;</code>	sort lines of text files

## Archiver and compress

<code>tar &lt;action&gt; [options] &lt;file(s)&gt;</code>	archiving utility (default suffix <code>.tar</code> )
<code>gzip [options] &lt;file&gt;</code>	Compress/expand file (default suffix <code>.gz</code> )
<code>bzip2 [options] &lt;file&gt;</code>	Compress/expand file (default suffix <code>.bz</code> or <code>.bz2</code> )

### Some frequently used `tar` commands:

- `tar -czvf <archiv-name.tgz> <files/directories>`  
Archive all given files and directories in a tar archive and compress the archive with `gzip`
- `tar -cjvf <archiv-name.tar.bz> <files/directories>`  
Dito, but compress with `bzip2`
- `tar -xzvf <archiv-name.tgz>`  
Decompress given archiv using `gzip` and unpack into the current directory



command `ps ufx` – display processes of the current user

```
kraehlit@lnxbox:~$ ps ufx
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
kraehlit  3447  0.0  0.2  14052  5960 ?        Ss   06:55   0:00 sshd: kraehlit@pts/0
kraehlit  3448  0.0  0.2   7564  5816 pts/0    Ss   06:55   0:00 \_ -bash
kraehlit  3603  0.0  0.1   7648  3292 pts/0    R+   07:47   0:00 \_ ps ufx
kraehlit  2315  0.0  0.2  14056  5960 ?        Ss   00:23   0:00 sshd: kraehlit@pts/1
kraehlit  2316  0.0  0.2   7816  5892 pts/1    Ss+  00:23   0:00 \_ -bash
kraehlit   918  0.0  0.2   7028  4936 tty1     S+   Mar06   0:00 -bash
kraehlit   697  0.0  0.4  18580  9688 ?        Ss   Mar06   0:00 /lib/systemd/systemd --user
kraehlit   699  0.0  0.1  103148 3324 ?        S    Mar06   0:00 \_ (sd-pam)
kraehlit@lnxbox:~$
```

command `ps auxx` – display all processes

```
kraehlit@lnxbox:~$ ps auxx
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         2  0.0  0.0         0      0 ?        Ss   Mar06   0:00 [kthreadd]
root         3  0.0  0.0         0      0 ?        I<   Mar06   0:00 \_ [rcu_gp]
root         4  0.0  0.0         0      0 ?        I<   Mar06   0:00 \_ [rcu_par_gp]
root         6  0.0  0.0         0      0 ?        I<   Mar06   0:00 \_ [kworker/0:0H-kblockd]
root         9  0.0  0.0         0      0 ?        I<   Mar06   0:00 \_ [mm_percpu_wq]
root        10  0.0  0.0         0      0 ?        S    Mar06   0:00 \_ [ksoftirqd/0]
root        11  0.0  0.0         0      0 ?        I    Mar06   0:06 \_ [rcu sched]
```

With command `kill <PID>` you can terminate a process

command `htop`

```

kraehlit@lnxbox: ~
CPU[          ] 0.0%] Tasks: 31, 19 thr; 1 running
Mem[|||||] 133M/1.92G] Load average: 0.06 0.02 0.00
Swp[          ] 0K/6.00G] Uptime: 09:30:39

  PID USER      PRI  NI  VIRT   RES   SHR  S  CPU% MEM%   TIME+  Command
 3649 kraehlit   20    0  5140   3744  3128  R   0.7  0.2   0:00.23  htop
 3447 kraehlit   20    0 14052   5960  4484  S   0.0  0.3   0:00.29  sshd: kraehlit@pts/0
 522  root       0  -20  9352   8736  4316  S   0.0  0.4   0:03.44  /usr/bin/atop -R -w /var/log/atop/atop_20210304 600
    1 root       20    0   99M  11548  8532  S   0.0  0.6   0:02.20  /sbin/init maybe-ubiquity
 326  root      19   -1 51684  15404 14272  S   0.0  0.8   0:00.36  /lib/systemd/systemd-journald
 357  root      20    0 21512   5576  3952  S   0.0  0.3   0:01.00  /lib/systemd/systemd-udevkd
 366  systemd-n 20    0 26792   7728  6768  S   0.0  0.4   0:00.25  /lib/systemd/systemd-networkd
 479  root      RT    0  209M  17992  8200  S   0.0  0.9   0:00.38  /sbin/multipathd -d -s
 480  root      RT    0  209M  17992  8200  S   0.0  0.9   0:00.00  /sbin/multipathd -d -s
 481  root      RT    0  209M  17992  8200  S   0.0  0.9   0:00.06  /sbin/multipathd -d -s
 482  root      RT    0  209M  17992  8200  S   0.0  0.9   0:02.10  /sbin/multipathd -d -s
 483  root      RT    0  209M  17992  8200  S   0.0  0.9   0:00.00  /sbin/multipathd -d -s
 484  root      RT    0  209M  17992  8200  S   0.0  0.9   0:00.00  /sbin/multipathd -d -s
 478  root      RT    0  209M  17992  8200  S   0.0  0.9   0:02.99  /sbin/multipathd -d -s
 497  systemd-r 20    0 24092  12392  8344  S   0.0  0.6   0:00.24  /lib/systemd/systemd-resolved
 505  systemd-t 20    0  90196  6092   5284  S   0.0  0.3   0:00.00  /lib/systemd/systemd-timesyncd
 498  systemd-t 20    0  90196  6092   5284  S   0.0  0.3   0:00.19  /lib/systemd/systemd-timesyncd
 523  root      20    0  232M  9392   8436  S   0.0  0.5   0:00.73  /usr/lib/accounts-service/accounts-daemon
 539  root      20    0  232M  9392   8436  S   0.0  0.5   0:00.01  /usr/lib/accounts-service/accounts-daemon

F1Help F2Setup F3Search F4Filter F5Tree F6SortBy F7Nice F8Nice +F9Kill F10Quit
  
```

Alternativ `top` is a less graphical version (exit with `q`) or `atop`

command `free` – display RAM usage

```
kraehlit@lnxbox:~$ free -ht
              total        used         free       shared  buff/cache   available
Mem:          1.9Gi         131Mi        1.3Gi         1.0Mi         504Mi        1.6Gi
Swap:         6.0Gi           0B         6.0Gi
Total:        7.9Gi         131Mi        7.3Gi
```

command `df` – display disk usage

```
kraehlit@lnxbox:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            941M   0  941M   0% /dev
tmpfs           197M  1.2M  196M   1% /run
/dev/sda3       28G   4.1G   22G  16% /
tmpfs           984M   0  984M   0% /dev/shm
tmpfs           5.0M   0   5.0M   0% /run/lock
tmpfs           984M   0  984M   0% /sys/fs/cgroup
tmpfs           197M   0  197M   0% /run/user/1000
/dev/sr0        59M   59M   0 100% /mnt/cdrom
```

To add a hard disk or removeable media use `mount [options] <device> <mount-point>`

# (More or less) Bash specific commands



## Globbing patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern



## Globbering patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ mkdir experiment-{1,2,3}{a,b,c}  
kraehlit@lnxbox:~/Data1$
```

## Globbering patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ mkdir experiment-{1,2,3}{a,b,c}  
kraehlit@lnxbox:~/Data1$ ls -l  
total 36  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c  
kraehlit@lnxbox:~/Data1$
```

## Globbering patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 36  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-2?  
kraehlit@lnxbox:~/Data1$
```

## Globbering patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-2?  
kraehlit@lnxbox:~/Data1$ ls -l  
total 24  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c  
kraehlit@lnxbox:~/Data1$
```

## Globbing patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 24  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-1[b-z]
```

## Globbing patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 24  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-1[b-z]  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 16  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c
```

## Globbering patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 16  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-{1a,3c}  
kraehlit@lnxbox:~/Data1$
```

## Globbering patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 16  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3c  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-{1a,3c}  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 8  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
kraehlit@lnxbox:~/Data1$
```



## Globbing patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 8  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-3*  
kraehlit@lnxbox:~/Data1$
```

## Globbering patterns

?	question mark	represent any <i>single</i> character
*	asterisk	represent any number of characters
[...]	square brackets	specifies a range of characters
{...}	curly brackets	list of pattern

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 8  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:33 experiment-3b  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm -r experiment-3*  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l  
total 0  
kraehlit@lnxbox:~/Data1$
```

## Redirect stdout to file

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l > output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat output.txt  
total 36  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3c  
-rw-rw-r-- 1 kraehlit kraehlit    0 Mar  7 11:58 output.txt  
kraehlit@lnxbox:~/Data1$
```

## Redirect stdout and append to file

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l >> output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat output.txt  
total 36  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3c  
-rw-rw-r-- 1 kraehlit kraehlit    0 Mar  7 11:58 output.txt  
total 40  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3c  
-rw-rw-r-- 1 kraehlit kraehlit  636 Mar  7 11:58 output.txt
```

## Redirect stderr to file

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm experiment-4a > output.txt  
rm: cannot remove 'experiment-4a': No such file or directory  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l output.txt  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 12:07 output.txt  
kraehlit@lnxbox:~/Data1$ █
```



## Redirect stderr to file

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm experiment-4a > output.txt  
rm: cannot remove 'experiment-4a': No such file or directory  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l output.txt  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 12:08 output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm experiment-4a >& output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ █
```



## Redirect stderr to file

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm experiment-4a > output.txt  
rm: cannot remove 'experiment-4a': No such file or directory  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l output.txt  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 12:08 output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm experiment-4a >& output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l output.txt  
-rw-rw-r-- 1 kraehlit kraehlit 61 Mar  7 12:08 output.txt  
kraehlit@lnxbox:~/Data1$ cat output.txt  
rm: cannot remove 'experiment-4a': No such file or directory  
kraehlit@lnxbox:~/Data1$ █
```



## Duplicate output and print on stdout and file

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l | tee output.txt  
total 36  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3c  
-rw-rw-r-- 1 kraehlit kraehlit    0 Mar  7 12:11 output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ █
```



## Duplicate output and print on stdout and file

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls -l | tee output.txt  
total 36  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3c  
-rw-rw-r-- 1 kraehlit kraehlit    0 Mar  7 12:11 output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat output.txt  
total 36  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-1c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-2c  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3a  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3b  
drwxrwxr-x 2 kraehlit kraehlit 4096 Mar  7 11:58 experiment-3c  
-rw-rw-r-- 1 kraehlit kraehlit    0 Mar  7 12:11 output.txt
```

Several pipes can be connected

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat /var/log/syslog | grep service
```

## Several pipes can be connected

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat /var/log/syslog | grep service  
Mar  7 06:47:31 lnxbox systemd[1]: logrotate.service: Succeeded.  
Mar  7 06:47:32 lnxbox dbus-daemon[508]: [system] Successfully activated service 'org.freedesktop.fwupd'  
Mar  7 06:47:32 lnxbox systemd[1]: fwupd-refresh.service: Succeeded.  
Mar  7 06:47:32 lnxbox systemd[1]: man-db.service: Succeeded.  
Mar  7 06:47:33 lnxbox dbus-daemon[508]: [system] Activating via systemd: service name='org.freedesktop.PackageKit' unit='packagekit.service' requested by ':1.38' (uid=0 pid=3162 comm="/usr/bin/gdbus call --system --dest org.freedesktop" label="unconfined")  
Mar  7 06:47:33 lnxbox dbus-daemon[508]: [system] Successfully activated service 'org.freedesktop.PackageKit'  
Mar  7 06:47:42 lnxbox systemd[1]: apt-daily.service: Succeeded.  
Mar  7 06:47:45 lnxbox systemd[1]: apt-daily-upgrade.service: Succeeded.  
Mar  7 06:52:39 lnxbox systemd[1]: packagekit.service: Succeeded.  
Mar  7 07:59:20 lnxbox systemd[1]: getty@tty1.service: Succeeded.  
Mar  7 07:59:20 lnxbox systemd[1]: getty@tty1.service: Scheduled restart job, restart counter is at 2.  
Mar  7 08:16:12 lnxbox systemd[1]: motd-news.service: Succeeded.  
Mar  7 08:47:32 lnxbox systemd[1]: fwupd.service: Succeeded.  
kraehlit@lnxbox:~/Data1$
```

Several pipes can be connected

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat /var/log/syslog | grep service | sort +5
```

## Several pipes can be connected

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat /var/log/syslog | grep service | sort +5  
Mar  7 06:47:33 lnxbox dbus-daemon[508]: [system] Activating via systemd: service na  
me='org.freedesktop.PackageKit' unit='packagekit.service' requested by ':1.38' (uid=  
0 pid=3162 comm="/usr/bin/gdbus call --system --dest org.freedesкто" label="unconfi  
ned")  
Mar  7 06:47:33 lnxbox dbus-daemon[508]: [system] Successfully activated service 'or  
g.freedesktop.PackageKit'  
Mar  7 06:47:32 lnxbox dbus-daemon[508]: [system] Successfully activated service 'or  
g.freedesktop.fwupd'  
Mar  7 06:47:45 lnxbox systemd[1]: apt-daily-upgrade.service: Succeeded.  
Mar  7 06:47:42 lnxbox systemd[1]: apt-daily.service: Succeeded.  
Mar  7 06:47:32 lnxbox systemd[1]: fwupd-refresh.service: Succeeded.  
Mar  7 08:47:32 lnxbox systemd[1]: fwupd.service: Succeeded.  
Mar  7 07:59:20 lnxbox systemd[1]: getty@tty1.service: Scheduled restart job, restar  
t counter is at 2.  
Mar  7 07:59:20 lnxbox systemd[1]: getty@tty1.service: Succeeded.  
Mar  7 06:47:31 lnxbox systemd[1]: logrotate.service: Succeeded.  
Mar  7 06:47:32 lnxbox systemd[1]: man-db.service: Succeeded.  
Mar  7 08:16:12 lnxbox systemd[1]: motd-news.service: Succeeded.  
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kraehlit@lnxbox:~/Data1$
```

## Conditions

<code>com1 ; com2</code>	Execute <code>com1</code> , then <code>com2</code>
<code>com1 &amp;&amp; com2</code>	Execute <code>com2</code> only, if <code>com1</code> was successful
<code>com1    com2</code>	Execute <code>com2</code> only, if <code>com1</code> failed
<code>com1 &amp;</code>	Execute <code>com1</code> and move it to the background
<code>(com1 ; com2)</code>	Execute both commands in the same shell

## Examples

## Conditions

<code>com1 ; com2</code>	Execute <code>com1</code> , then <code>com2</code>
<code>com1 &amp;&amp; com2</code>	Execute <code>com2</code> only, if <code>com1</code> was successful
<code>com1    com2</code>	Execute <code>com2</code> only, if <code>com1</code> failed
<code>com1 &amp;</code>	Execute <code>com1</code> and move it to the background
<code>(com1 ; com2)</code>	Execute both commands in the same shell

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ touch file4 ; ls -l  
total 0  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:05 file1  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:05 file2  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:05 file3  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:06 file4  
kraehlit@lnxbox:~/Data1$ █
```

## Conditions

<code>com1 ; com2</code>	Execute <code>com1</code> , then <code>com2</code>
<code>com1 &amp;&amp; com2</code>	Execute <code>com2</code> only, if <code>com1</code> was successful
<code>com1    com2</code>	Execute <code>com2</code> only, if <code>com1</code> failed
<code>com1 &amp;</code>	Execute <code>com1</code> and move it to the background
<code>(com1 ; com2)</code>	Execute both commands in the same shell

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm file4 && echo "---File deleted---"  
---File deleted---  
kraehlit@lnxbox:~/Data1$ █
```



## Conditions

<code>com1 ; com2</code>	Execute <code>com1</code> , then <code>com2</code>
<code>com1 &amp;&amp; com2</code>	Execute <code>com2</code> only, if <code>com1</code> was successful
<code>com1    com2</code>	Execute <code>com2</code> only, if <code>com1</code> failed
<code>com1 &amp;</code>	Execute <code>com1</code> and move it to the background
<code>(com1 ; com2)</code>	Execute both commands in the same shell

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ rm file4 && echo "---File deleted---"  
---File deleted---  
kraehlit@lnxbox:~/Data1$ rm file4 >& /dev/null || echo "---Could not delete file---"  
---Could not delete file---  
kraehlit@lnxbox:~/Data1$ █
```

## Conditions

<code>com1 ; com2</code>	Execute <code>com1</code> , then <code>com2</code>
<code>com1 &amp;&amp; com2</code>	Execute <code>com2</code> only, if <code>com1</code> was successful
<code>com1    com2</code>	Execute <code>com2</code> only, if <code>com1</code> failed
<code>com1 &amp;</code>	Execute <code>com1</code> and move it to the background
<code>(com1 ; com2)</code>	Execute both commands in the same shell

## Examples

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ( ls -l; date '+%d.%m.%Y %H:%M:%S' ) > output.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ cat output.txt  
total 0  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:05 file1  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:05 file2  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:05 file3  
-rw-rw-r-- 1 kraehlit kraehlit 0 Mar  7 18:13 output.txt  
07.03.2021 18:13:06  
kraehlit@lnxbox:~/Data1$ █
```

## General remarks

- ▶ bash has local and global variables
- ▶ global variables are set in config files, e. g.  
~/ .bashrc, ~/ .profile (user specific)  
/etc/bash.bashrc, /etc/profile (system wide)



## General remarks

- ▶ bash has local and global variables
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~/ .bashrc, ~/ .profile (user specific)  
/etc/bash.bashrc, /etc/profile (system wide)

## Commands for variable handling

<code>&lt;var&gt; = &lt;value&gt;</code>	set local variable <code>var</code> to <code>value</code>
<code>export &lt;var&gt; = &lt;value&gt;</code>	set variable <code>var</code> to <code>value</code> and make it global
<code>export</code>	show all global variables
<code>set</code>	show all global and local variables
<code>unset &lt;var&gt;</code>	delete variable <code>value</code>



## General remarks

- ▶ bash has local and global variables
- ▶ global variables are set in config files, e. g.  
~/`.bashrc`, ~/`.profile` (user specific)  
/etc/`bash.bashrc`, /etc/`profile` (system wide)

## Commands for variable handling

<code>&lt;var&gt; = &lt;value&gt;</code>	set local variable <code>var</code> to <code>value</code>
<code>export &lt;var&gt; = &lt;value&gt;</code>	set variable <code>var</code> to <code>value</code> and make it global
<code>export</code>	show all global variables
<code>set</code>	show all global and local variables
<code>unset &lt;var&gt;</code>	delete variable <code>value</code>

## Additional notes

- ▶ To load variables from file use `. <file>` or `source <file>`
- ▶ To access variable on command line or script use `$<var>`



## Some system and dynamic variables

\$HOME	Path of the home directory of the current user
\$LOGNAME	Login name of the current user
\$PWD	Current path
\$OLDPWD	Previous current path
\$?	Exit code of the last command (0 means successful)
\$!	PID of the last started background process

## Some system and dynamic variables

\$HOME	Path of the home directory of the current user
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\$PWD	Current path
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\$?	Exit code of the last command (0 means successful)
\$!	PID of the last started background process

## Examples

```
kraehlit@lnxbox:~$  
kraehlit@lnxbox:~$ echo -e "\n${LOGNAME}'s homedir is $HOME \n"  
kraehlit's homedir is /home/kraehlit  
kraehlit@lnxbox:~$ █
```

## Some system and dynamic variables

\$HOME	Path of the home directory of the current user
\$LOGNAME	Login name of the current user
\$PWD	Current path
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\$?	Exit code of the last command (0 means successful)
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## Examples

```
kraehlit@lnxbox:~$  
kraehlit@lnxbox:~$ echo -e "\n${LOGNAME}'s homedir is $HOME \n"  
  
kraehlit's homedir is /home/kraehlit  
  
kraehlit@lnxbox:~$  
kraehlit@lnxbox:~$ cd /usr/local/bin  
kraehlit@lnxbox:/usr/local/bin$  
kraehlit@lnxbox:/usr/local/bin$ cd /var/log  
kraehlit@lnxbox:/var/log$  
kraehlit@lnxbox:/var/log$ █
```



## Some system and dynamic variables

\$HOME	Path of the home directory of the current user
\$LOGNAME	Login name of the current user
\$PWD	Current path
\$OLDPWD	Previous current path
\$?	Exit code of the last command (0 means successfull)
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## Examples

```
kraehlit@lnxbox:~$  
kraehlit@lnxbox:~$ echo -e "\n${LOGNAME}'s homedir is $HOME \n"  
  
kraehlit's homedir is /home/kraehlit  
  
kraehlit@lnxbox:~$  
kraehlit@lnxbox:~$ cd /usr/local/bin  
kraehlit@lnxbox:/usr/local/bin$  
kraehlit@lnxbox:/usr/local/bin$ cd /var/log  
kraehlit@lnxbox:/var/log$  
kraehlit@lnxbox:/var/log$ cd $OLDPWD  
kraehlit@lnxbox:/usr/local/bin$
```

## Command history

- ▶ bash saves a history of the last used command line entries
- ▶ command `history` shows the last executed commands (with a number)
- ▶ to re-execute a command of the history list use `!<number>`
- ▶ re-execute the last command use `!!`
- ▶ to run two commands back use `!-2`
- ▶ to go through the history list use *page-up/page-down* key
- ▶ search in the history list: use *ctrl+r* and input search string

## Tab completion

- ▶ tab completion works for commands, files, directories, command arguments, ...
- ▶ functionality depends on distribution and system settings



## for loop

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.txt file2.txt file3.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ █
```

## for loop

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.txt file2.txt file3.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ for i in file*.txt ; do  
> cp $i `basename $i .txt`.bak  
> done  
kraehlit@lnxbox:~/Data1$
```

## for loop

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.txt file2.txt file3.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ for i in file*.txt ; do  
> cp $i `basename $i .txt`.bak  
> done  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.bak file1.txt file2.bak file2.txt file3.bak file3.txt  
kraehlit@lnxbox:~/Data1$ █
```

## for loop

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.txt file2.txt file3.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ for i in file*.txt ; do  
> cp $i `basename $i .txt`.bak  
> done  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.bak file1.txt file2.bak file2.txt file3.bak file3.txt  
kraehlit@lnxbox:~/Data1$ █
```

## while loop

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ while who | grep kraehlit >> /dev/null;  
> do  
> echo "kraehlit is logged in";  
> sleep 5  
> done  
kraehlit is logged in  
kraehlit is logged in  
kraehlit is logged in  
^C  
kraehlit@lnxbox:~/Data1$ █
```

## for loop

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.txt file2.txt file3.txt  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ for i in file*.txt ; do  
> cp $i `basename $i .txt`.bak  
> done  
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ ls  
file1.bak file1.txt file2.bak file2.txt file3.bak file3.txt  
kraehlit@lnxbox:~/Data1$ █
```

## while loop

```
kraehlit@lnxbox:~/Data1$  
kraehlit@lnxbox:~/Data1$ while true ; do  
> echo "in endless loop"  
> sleep 2  
> done  
in endless loop  
in endless loop  
in endless loop  
^C  
kraehlit@lnxbox:~/Data1$ █
```



```
$ [ whereis my brain?  
sh: 2: [: missing ]
```

