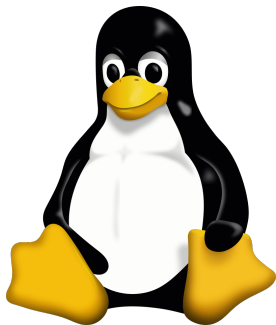


Linux – The Operating System of Freedom

Zoltán Szabó © Department of Statistics, LSE (Sept. 22, 2023)



- A bit of Linux history.
- Linux distributions.
- Installation.
- Applications.
- Ricing and phones.

Win
start

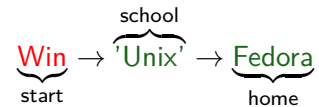


My journey

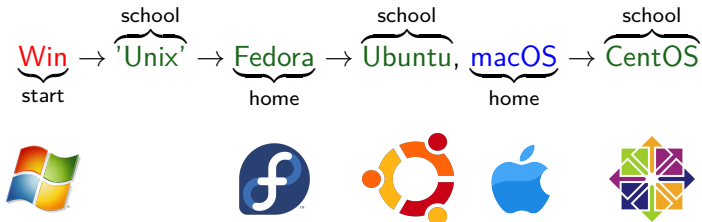
Win → 'Unix'
start school



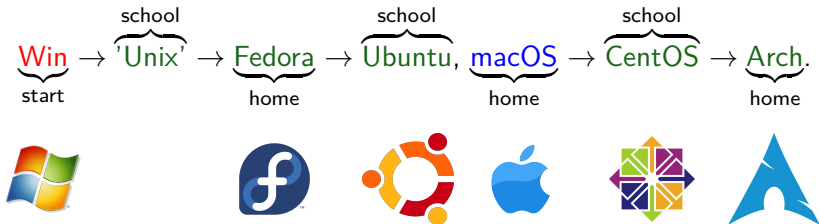
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My journey



Some fun (21Y Finish CS student)

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Newsgroups: comp.os.mimix
Body:
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One of the main secrets

free and open source \Rightarrow knowledge sharing \Rightarrow creativity can kick in \Rightarrow versatility!

In fact, Linux = GNU/Linux: Linus used the GNU development tools for his kernel, ...

- Late 1970s: companies started to spread proprietary software ⇒



- GNU project = GNU is Not Unix:
 - Goal: write a UNIX-like operating system entirely of free software.
 - Users are legally free (GPL)
 - 0 to use,
 - 1 to study,
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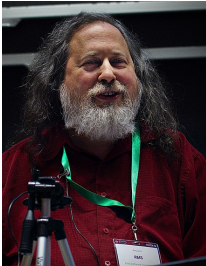


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- mass collaboration announced by Richard Stallman ('83; his website).

Richard (Matthew) Stallman: RMS – his hacker name;)



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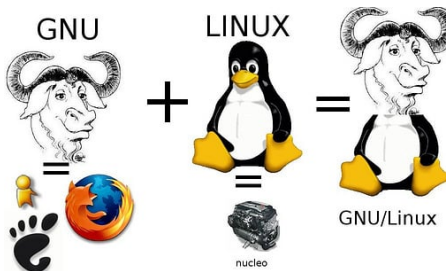
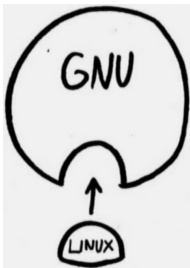
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- Creator of **GNU Emacs**: 'text editor' (**LISP** interpreter).

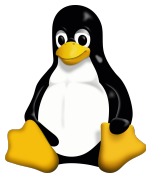


- 1 GNU utils: high-level utilities.
- 2 **Kernel:**
 - low-level 'stuff', written in C, GPLv2,
 - manages the CPU, memory, device drivers, file system, ...

- Tux (the mascot of the Linux kernel) := Torvalds UniX.



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- Author of Git (GPLv2):
 - distributed version control system,
 - gold standard in collaborative coding efforts,
 - developed for the Linux kernel ('05),
 - # of lines in the code of Linux kernel: ~35 million (2023).



Free vs open; O := Odysee

Free software (a.k.a. FOSS, libre software):

- goal: to respect user freedom and privacy.

to *not constrain* the user

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- free \ni open-source, but
 - free \neq open-source: text, vid[O],
 - open source code can 'spy' on you,
privacy matters[O].



Free vs right to repair

- my experience: battery replacement in Surface Pro = 600€,
- [idea in 60s](#)_{vid[O]}: \$12.9 \ll \$1500 (MacBook Pro; repairing for 15Y@2023)



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 - standard for computing clusters (example: slurm).

Various distros (tree):

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- but minor differences.



Primary choice to make

point release vs rolling release.

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- Properties:
 - 1 occasional **big** changes,
 - 2 **end-of-life** date!

Point release: Linux distributions



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- **openSUSE: Leap,**
 - released 1×/year.

- Arch Linux:



- one-time installation with continuous upgrades,
- lightweight and flexible,
- follows the keep it simple (KISS) principle,
- designed to teach its user.

- other examples: [openSUSE](#) [Tumbleweed](#), [Gentoo](#).



Point release vs rolling release

point	rolling
	always up-to-date + (new software features, bug fixes, security patches)
	supports even very new hardware +
	more secure +
	no need to reinstall it +
	requires semi-decent internet -
	less suited for servers (where stability is max-ed) -

My choice: Arch (released in 2002)

- 0 rolling release.
- 1 great package manager (pacman),
 - fast,
 - allows parallel downloading.

[Package managers handle dependencies.]



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Both are searchable.

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- 4 Follow the instructions.

Downloading note

- .iso size:
 - 11 GB (MacOS Ventura) – for comparison.

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- .iso size:
 - 5.2 GB (Windows 11) – for comparison.
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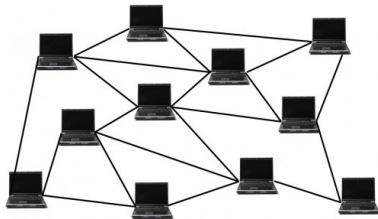
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- downloading:
 - [http](#); [torrent](#): this can be faster (⇐ sharing).



Notes on the boot process — a bit technical

- 1 system's **firmware** (such as **BIOS/UEFI/Coreboot/Libreboot**) $\xrightarrow{\text{starts}}$
- 2 **bootloader** (such as GRUB \Leftarrow GNU; **features & others**) $\xrightarrow{\text{loads}}$
- 3 the **kernel** (your operating system).

In practice:

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In practice:

- **firmware**:
 - probes for hardware, simple health checks,
 - it has a UI accessible with a magic key (Esc, F1/F2/...),
 - allows you to designate a boot device (USB/hard/CD/DVD drive, ...),
 - consults the GPT[†] partition table to identify the **ESP**[‡], and launches the target application (typically the bootloader).

[†]no chat 😊, [‡]EFI System Partition.

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In practice:

- **bootloader**:
 - gives a menu on which kernel / operating system to invoke.

```
GNU GRUB version 2.02

*Arch Linux, with Linux linux-lts
Arch Linux, with Linux linux-lts (fallback initramfs)
Arch Linux, with Linux linux
Arch Linux, with Linux linux (fallback initramfs)

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, `e' to edit the commands
before booting or `c' for a command-line. ESC to return previous
menu.
```

Instructions: for Arch – scary;)

- 1 Step-by-step text guide (official one).
- 2 Video guide:
 - `vid1[O]`: UEFI; check the YouTube comments as well!
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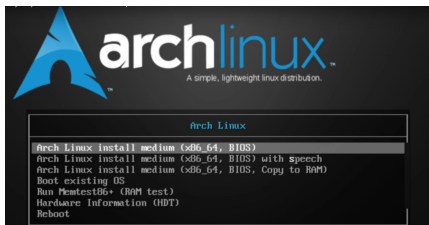
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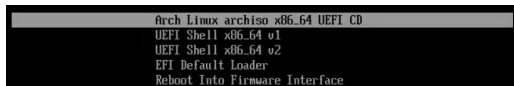
- firmware: BIOS (very old machine), UEFI (semi-new computer).
- partition table: BIOS \Rightarrow MBR (a.k.a. DOS, MS-DOS); UEFI \Rightarrow GPT.
- LVM: adjustable layout, LUKS: encryption.
- LUKS: your data can't be read even if your laptop is stolen.

Instructions: BIOS or UEFI

BIOS:



UEFI:



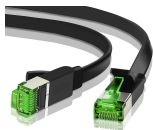
Installation hints

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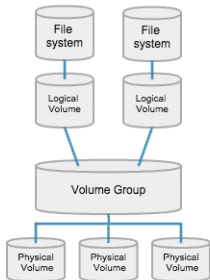


Installation hints

- 1 use ethernet: faster.



- 2 start simply: no encryption, no LVM.



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 - ① Live media/USB/image (Fedora, Ubuntu):
 - .iso writing, hardware support check, quick look at the system ✓,
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[†]Start with a DE before a WM.

- ③ partition formatting:
 - **ext4**: more settled – my choice,



- **btrfs**:
 - modern alternative,
 - supports compression \Rightarrow less space, increased storage lifespan,
 - copy-on-write \Rightarrow consistency even in case of power loss,
 - snapshot feature,
 - limited LUKS support.

\Rightarrow It is worth keeping an eye on it!

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- ⑤ **swap**:
 - helps if RAM is exhausted (but slower, $\times 1000!$); **size recommendations**.
 - 2 types:
 - ① swap partition: often preferred,
 - ② **swap file**: easier to resize, but less tested.

Installation hints – continued

- ⑥ good boot time ($\sim 11s$):
 - SSD matters: Samsung 970 EVO Plus \leftarrow my choice (for laptop).



Installation hints – continued

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- 7 Use a spare drive (to avoid the wrestling of the op. systems).

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- 9 Log your installation, usage, information sources (e.g. by Vimwiki)!
- 10 Post-installation:
 - think in terms of tasks not software, and use the native applications.
 - a weekly system update can be healthy.

Applications: categorized; some handy ones

Notations: **M** = '∈ main', **A** = '∈ AUR', **W** = web client, **P** = pip,
✓ = installed by default, *p* = proprietary.

- Web & mail:

- browser: **firefox** (**M**), **tor-browser** (**A**).
- e-mail: **ProtonMail** (**W**)[, **Tutanota** (**W**)], **thunderbird** (**M**).

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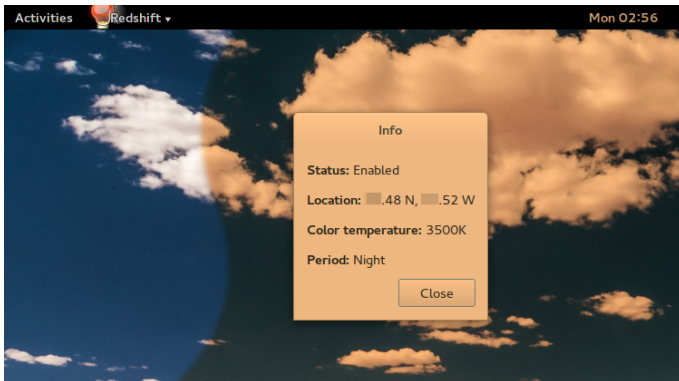
- Media:

- image viewer: **feh** (M), **gthumb** (M), **geeqie** (M).
- image editor: **gimp** (M).
- video player: **mplayer** (M), **vlc** (M)[, **mpv** (M), **celluloid** (M)].
- video editor: **kdenlive** (M).
- video downloader: **yt-dlp** (M).
- spotify:
 - player: **spotify_p**(A),
 - downloader: **spotdl** (P).
- audio editor: **tenacity** (A).

- Text:
 - document viewer: `xdvi` (\checkmark , \in texlive), `xpdf` (M),
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 - .pdf annotation: `xournalpp` (M),
 - text editing: `texlive-most` (\LaTeX , group, M), `kile` (M) (\approx `WinEdtp`), `vim` (M), `libreoffice-still` (M), `notepadqq` (M).
- Chat & collaboration:
 - chat: `skypeforlinux-stable-binp`(A), `zoomp`(A), `teamsp`(A), `BigBlueButton` (W), `Jitsi Meet` (W), `qtox` (M),
 - version control: `git` (M),
 - calendar & reminder: `remind` (M).

- eye protection: **redshift** (M),



- eye protection: `redshift` (M),
- file manager: `thunar` (M)

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- firewall: `ufw` (M)

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- terminal: `tilix` (M),
- firewall: `ufw` (M),
- desktop environment: `gnome` (M, group), `qtile` (M, WM).

Desktop environments (DE)

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 - [windows manager](#), and
 - a bundle of applications (calendar, image viewer, file manager, ...).

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Examples follow

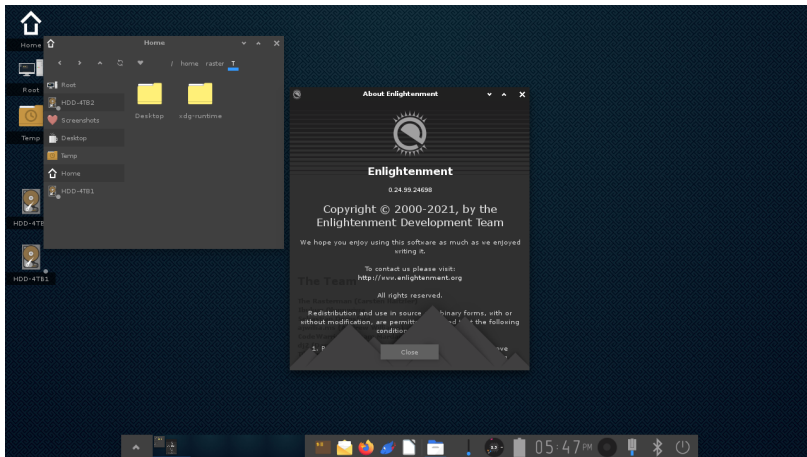
DE: GNOME



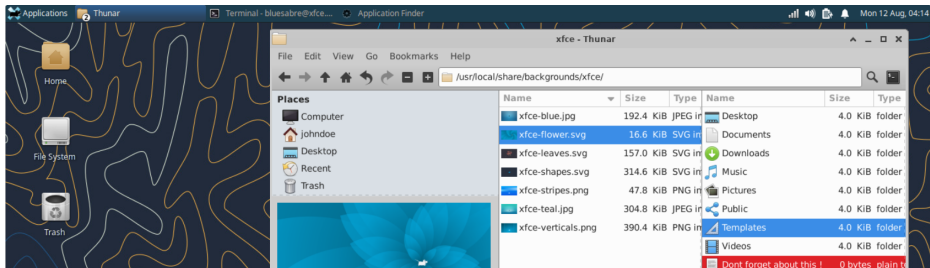
DE: GNOME – my desktop



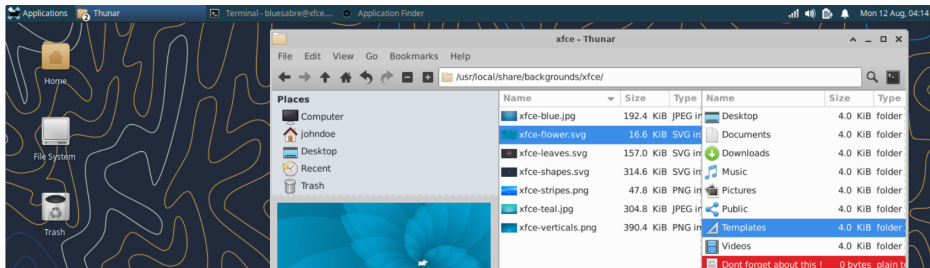
DE: Enlightenment



DE: Xfce



DE: Xfce



Extra DE inspiration

[unixporn](#) (screenshots).

Window managers (WM)

- It allows handling windows (open, close, min/max-ze, move, resize, ...).
- It can be part of a DE or standalone.
- Idea: WMs can be even snappier than DEs.

Window managers (WM)

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- Idea: WMs can be even snappier than DEs.
- 3 types:
 - ① **stacking** (a.k.a. floating),
 - ② **tiling**: non-overlapping windows,
 - ③ **dynamic**: allows switching between **tiling** and **floating** layout.

- Stacking:
 - Mutter → GNOME,
 - KWin → KDE,
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 - it uses Python;
 - various (69) **widgets**.

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Examples follow

```

main.c (/7/i3/src) - Vim
}
/* Set up i3 specific atoms like I3_SOCKET_PATH and I3_CONFIG_PATH */
x_set_i3_atoms();

struct ev_io *xcb_watcher = calloc(sizeof(struct ev_io));
struct ev_io *xcb = calloc(sizeof(struct ev_io));
struct ev_check *xcb_check = calloc(sizeof(struct ev_check));
struct ev_prepare *xcb_prepare = calloc(sizeof(struct ev_prepare));

ev_io_init(xcb_watcher, xcb_get_event, xcb_get_file_descriptor(conn), EV_READ);
ev_io_start(main_loop, xcb_watcher);

if (xcb_supported) {
    ev_io_init(xcb, xcb_get_event, ConnectionNumber(xcbfdpy), EV_READ);
    ev_io_start(main_loop, xcb);

    /* Flush the buffer so that libev can properly get new events */
    fflush(xcbfdpy);
}

ev_check_init(xcb_check, xcb_check_cb);
ev_check_start(main_loop, xcb_check);

ev_prepare_init(xcb_prepare, xcb_prepare_cb);
ev_prepare_start(main_loop, xcb_prepare);

xcb_flush(conn);

manage_existing_windows(root);

if (!disable_signalhandler)
    setup_signal_handler();

/* Ignore SIGPIPE to survive errors when an IPC client disconnects
 * while we are sending him a message */
signal(SIGPIPE, SIG_IGN);

/* Autostarting exec-lines */
if (Autostart) {
    struct Autostart *exec;
    TAILQ_FOREACH(exec, &autostarts, autostarts) {
        LOG("auto-starting '%s'", exec->command);
        start_application(exec->command);
    }
}

/* Autostarting exec_always-lines */
struct Autostart *exec_always;
TAILQ_FOREACH(exec_always, &autostarts_always, autostarts_always) {
    LOG("auto-starting '%s'", exec_always->command);
    start_application(exec_always->command);
}

ev_loop(main_loop, 0);
src/main.c 464,9 992

```

x200: wplayer 502/E05.avi MPPlayer



x200: git log

```

commit 487742172b3802bad4615418f4b48556bfef1496
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 22:18:00 2011 +0200

    Add missing function prototype for strndup on Darwin (Thanks Marcus)

commit 3da3a691063f7c4c7f09461bbe948fa48abeb5fd
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 15:21:57 2011 +0200

    i3-config-wizard: use Fgetln on Darwin, use strndup from FreeBSD on Darwin (Thanks Mar

commit 02df1b8e991a795ed2152918778f6d0e928a71cac
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 15:18:45 2011 +0200

    use memmem and strndup from FreeBSD on Darwin (Thanks Marcus)

commit fc983adb9956ff95e9019bef8bb0e7c2e21d1133b
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 15:17:24 2011 +0200

    makefile: link -liconv on Darwin (Thanks Marcus)

commit 7512f633a79c290f4e6f0287fb2b1cd889f028b42
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Fri Jul 15 19:21:39 2011 +0200

    #1

```

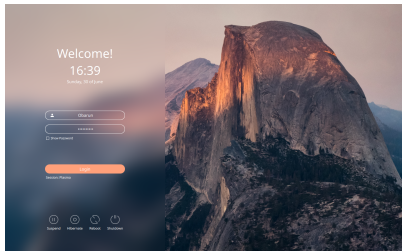
1 2 3 4 2011-14:00:10:0e23:21:7:16ff:fe1a:f9b6 | 2.3 GB | BHPG: no | VPH: no | U: down | E: 192.168.1.42 (1000 fbit/s) | BRT: 74,15% [P] | 0 | 0,03 | 2011-07-22 15:42:32

WM: Qtile



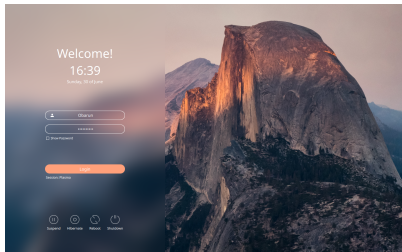
Login/display manager

- It gives graphical login – if you prefer not using/starting from tty:)
- Popular choices: (i) SDDM: [tutorial](#)[O] ([further inspiration](#))



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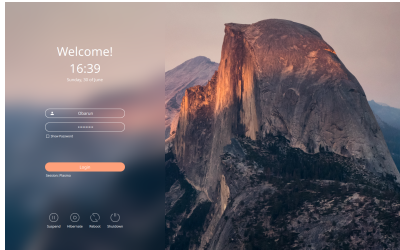


```
F1 shutdown F2 reboot

                                debian11
                                < GNOME on Xorg                                >
login:
password:
```

Login/display manager

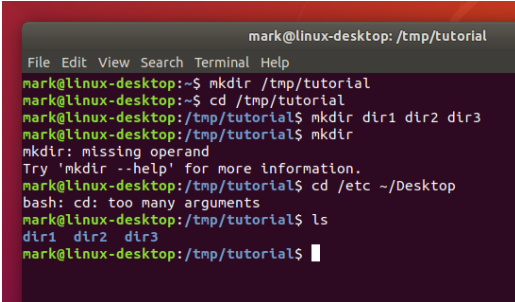
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Terminal: used for instance @ Arch install

Command shell:

- like Jupyter notebook,
- interaction with the operating system,

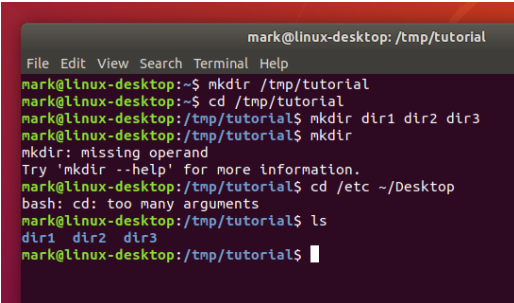


```
mark@linux-desktop: /tmp/tutorial
File Edit View Search Terminal Help
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mark@linux-desktop:/tmp/tutorial$ mkdir dir1 dir2 dir3
mark@linux-desktop:/tmp/tutorial$ mkdir
mkdir: missing operand
Try 'mkdir --help' for more information.
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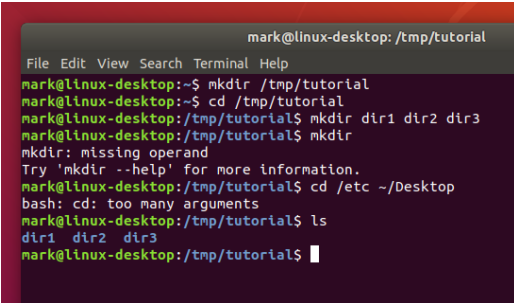
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```

- Google Colab: !shellcommand,
- **virtual console** = text terminal + login prompt (ttyX = Ctrl+Alt+FX, X ∈ [7]).

- Examples:

- \$ `cd` : change the current working directory,
- \$ `ls` : list directory content,
- \$ `pwd` : print the name of the current directory,
- \$ `cp` : copy files & directories,
- \$ `mv` : move or rename files and directories,
- \$ `touch` : create file,
- \$ `mkdir` : create directory,
- \$ `man` : manual page of a command.

Command line (CLI) – continued

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⇒

- shell/bash **scripting**.
- lot of **automation** possibilities.

Superb text editor: Vim

- modal editor $\xrightarrow{\text{change}}$ **i** = input mode, **Esc** = command mode,
- highly customizable & efficient,
- keyboard-driven, language-like.

Example:

:q : quit ← most difficult;),
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yy : yank line, ...



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dw	:	d elete w ord,
cw	:	c hange w ord,
d3w	:	d elete 3 w ords,
di(:	d elete i nside p arentheses,
dd	:	d elete l ine,
p	:	p aste,
y	:	y ank (copy),
yy	:	y ank l ine, ...

- cross-platform.



Vim – continued (free ⇒)

- integration to [browser](#), [Jupyter notebook](#), ...
- evolution: vi → Vim → [Neovim](#) (community-developed),



- personal Wiki: [vimwiki](#),
- tutorials: \$ vimtutor and

Name	Vids
ThePrimeagen	link₁ , link₂ , link₃ , link₄ , link₅ , link₆
Missing Semester	link [O]
DistroTube	link₁ [O], link₂ [O]
Ben Awad	link

Hint: How to ask on forums?

- **Netiquette**[O]; **discussion** → **guide**.
- **DIY mentality**:
 - the community is friendly and helps *if* you put in effort,
 - ⇒ **read & do your research first!**



Odysee (with **LBRY**) / YouTube channels: good educators

Name	Odysee	YouTube	
DistroTube	link	link	
Learn Linux TV	—	link	
Eric Murphy	link	link	
Brodie Robertson	link	link	
EF - Linux Made Simple	link	link	(less active nowadays [†])
OldTechBloke	link	link	(less active nowadays [†])
Mental Outlaw	link	link	(Linux, privacy)
Luke Smith	link	link	(less active nowadays [†])
VeronicaExplains	—	link	(less active [†])
MobileTechReview	—	link	laptop & mobile reviews
Naomi Brockwell: NBTv	link	link	privacy
Louis Rossmann	link	link	right to repair

[†] but her/his past videos are nice.

- system monitor: CPU, memory, swap space, disk storage, temperature, processes, network interfaces, battery power, system messages, e-mail, . . .

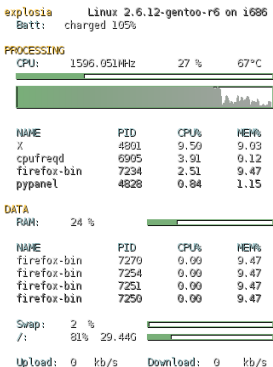
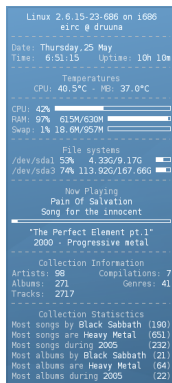
- system monitor: CPU, memory, swap space, disk storage, temperature, processes, network interfaces, battery power, system messages, e-mail, . . .
- Example (further inspiration):

```
Linux 2.6.15-23-686 on i686
eirc @ druuna

-----
Date: Thursday, 25 May
Time: 6:51:15 Uptime: 10h 10m
-----
Temperatures
CPU: 40.5°C - MB: 37.0°C
-----
CPU: 42% ██████████
RAM: 97% 615M/630M ██████████
Swap: 1% 18.0M/957M ██████████
-----
File systems
/dev/sda1 53% 4.39G/9.17G ██████████
/dev/sda3 74% 113.92G/167.66G ██████████
-----
Now Playing
Pain Of Salvation
Song for the innocent
-----
*The Perfect Elemen pt.1*
2000 - Progressive metal
-----
Collection Information
Artists: 98 Compilations: 7
Albums: 271 Genres: 41
Tracks: 2717
-----
Collection Statistics
Most songs by Black Sabbath (180)
Most songs are Heavy Metal (651)
Most songs during 2005 (232)
Most albums by Black Sabbath (21)
Most albums are Heavy Metal (64)
Most albums during 2005 (22)
```


Ricing: Conky

- system monitor: CPU, memory, swap space, disk storage, temperature, processes, network interfaces, battery power, system messages, e-mail, . . .
- Example (further inspiration):



Ricing: Conky on desktop

Root 21.0GiB/50.8GiB Home 24.2GiB/50.8GiB

BATTERY charged

13:52
Monday, 01 February 2016

CPU 15%

Load: 0.72
Processes: 0/227

firefox 11.25
Xorg 0.58
lyx 0.33
plugin-containe 0.25

RAM 64%

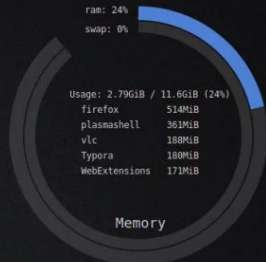
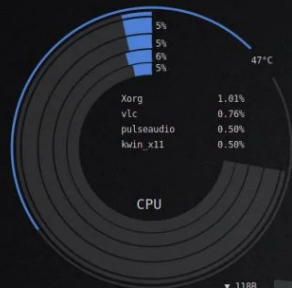
firefox 31.07
thunderbird 7.94
spider 5.12
dropbox 4.65

TO-DO LIST (2)

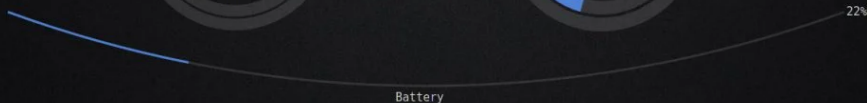
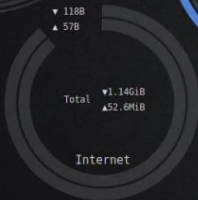
- x Computer Methods Assignments
- x Meet the DDP guide

13:52

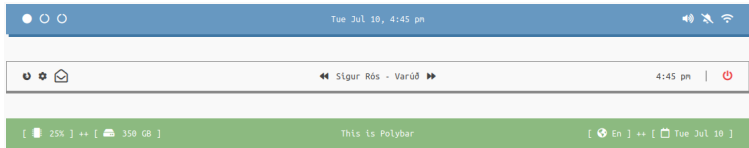
Ricing: Conky on desktop



SSID: MyAccessPoint
Wifi Signal: 83%
Public IP: 196.244.192.6
Local IP: 192.168.1.6

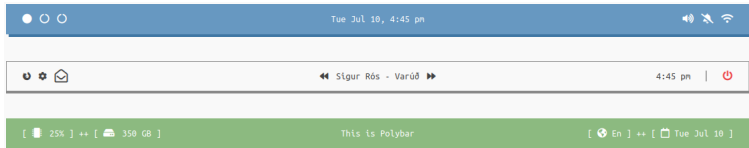


Ricing: Polybar (link₁, link₂)



- fast replacement of the status bar,
- date, time, keyboard layout, backlight, volume, MPD, network, CPU, ...

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Example follows.

Polybar example



Compositors: for Xorg (a.k.a. X), Wayland

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 - add effects like transparency, animations or blur,
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- Example: **Picom**, **Hyprland**, **Wayfire**. **Related fun[O]** with Gnome extensions.
- For Hyprland: **website**, **wiki**; **demo** (screenshot):



Compositor: HyperInd_{vid}

1 2 3 4 |

● Motley Crew - Post Malone

△ 6.0.10-linux2-1

📶 Nest Wi-Fi_5G

🌡 69°C

🌧 18%

🔋 100%

🔋 50%

🕒 07:56 AM



4

Compositor: Wayfire^{vid}



Simple •

92% 39% 79% (8.461B)

System tray icons including network, volume, and power.

18:52:48 489.88/s 64% 68% 100%

Linux phones (security & privacy; beta!)

- 1 Librem 5:
 - by Purism, running PureOS.



2 PinePhone, PinePhone Pro:

- by Pine64,
- PinePhone Pro: [Wiki](#); various op. systems \ni Arch;)
- recipe: [vid₁](#), [vid₂](#), [vid₃](#), [vid₄](#), [vid₅](#).



My choice (more stable and transparent communication)



- Linux history, user freedom



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- distributions, installation, applications



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- DE ← WM ← CLI; Vim



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- Linux phones.

Are you ready to **own your computer**

