



Leibniz Supercomputing Centre  
of the Bavarian Academy of Sciences and Humanities

The background of the slide is a photograph of a modern, multi-story building with a glass and metal facade, likely a university or research center. The image is overlaid with a semi-transparent blue filter. The building has several windows and a prominent vertical structure on the right side.

# Introduction to GNU/Linux – Part 1

April 12<sup>th</sup>, 2023

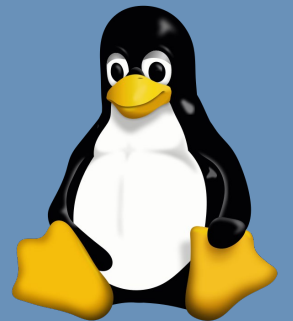
# Session Information

- The aim of this session is to provide an introduction to GNU/Linux
- You will probably benefit the most if you're not yet familiar with GNU/Linux, but if you plan to work on the AI, HPC and/or Compute Cloud infrastructure provided by LRZ -> by the end of this session, you should have a basic understanding of GNU/Linux-based systems
- If you have questions, please ask at any time



# What is GNU/Linux?

- Free and open-source operating system
- Alternative to  
Microsoft Windows, Apple macOS, Google Android ...
- Generally consists of the Linux kernel, libraries and tools,  
(possibly) a desktop environment and various applications  
(e.g. web browser, office suite, ...)
- Different distributions:  
Arch Linux, Debian, Fedora/RHEL, openSUSE/SLES, Ubuntu, ...



# GNU General Public License (GPL)

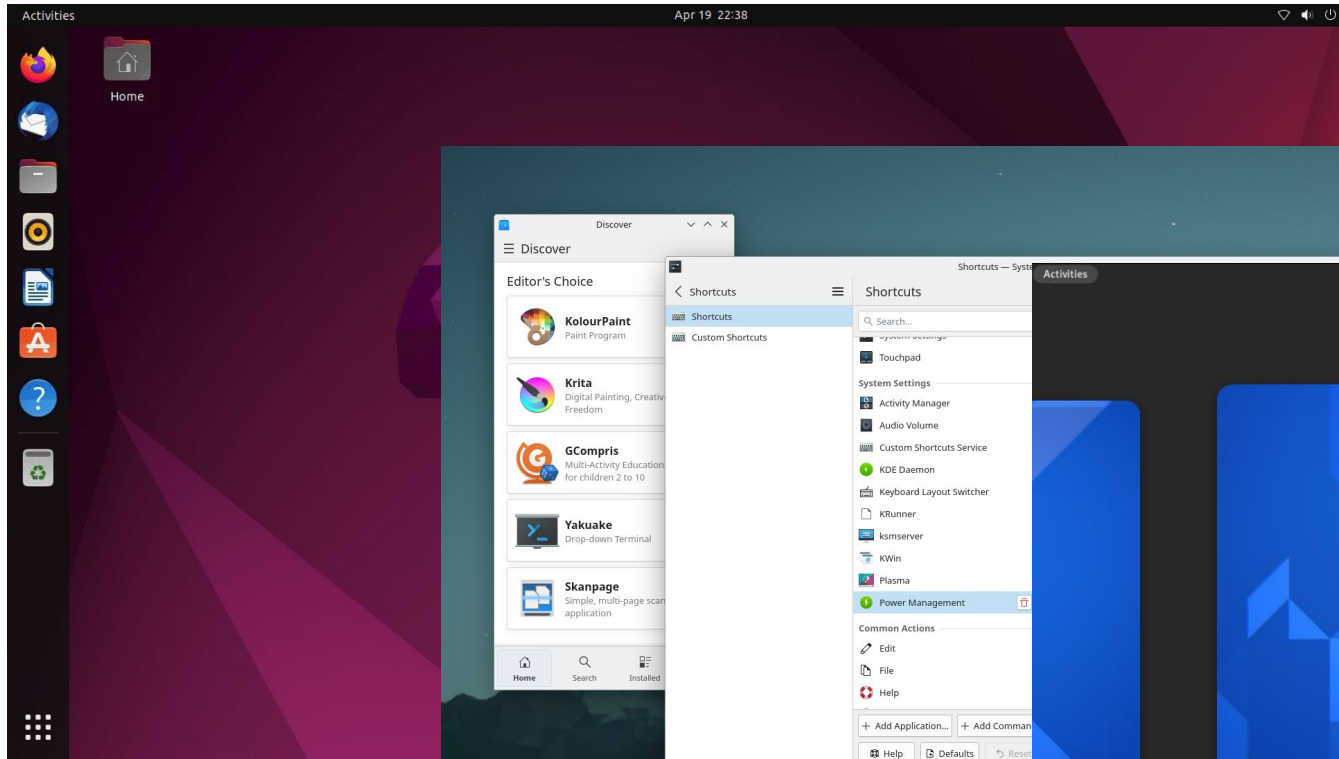
The powerful versatility of free and open-source software is rooted in their licenses, such as the GNU General Public License (GPL). This license grants four essential freedoms or rights to the users of the software:

- The freedom to “**use** a program as they wish, for any purpose”,
- the right to “**study** how the program works, and change it so it does the computing as they wish”,
- the freedom to “**share** and redistribute copies so they can help their neighbor” and finally
- the right to “**improve** the software and to distribute copies of their modified versions to others”.

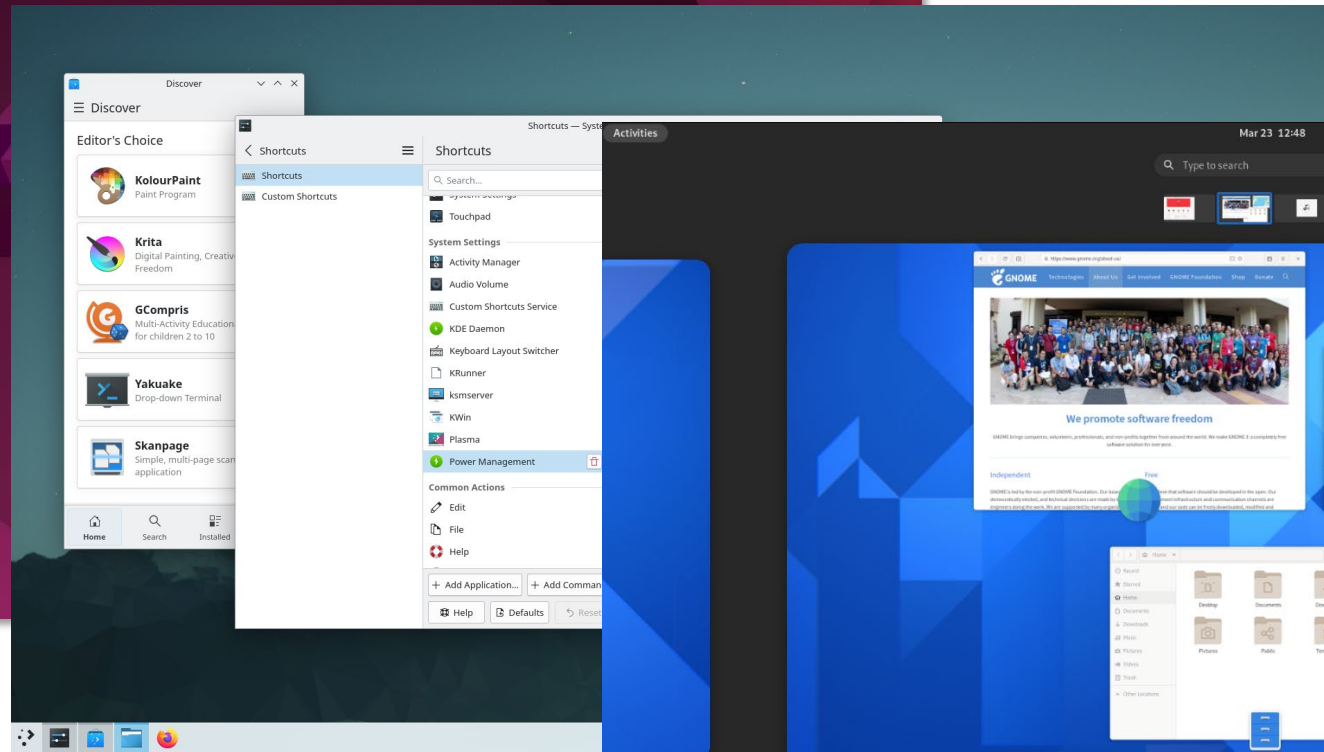
These rights are key for e.g. tuning software on a one-of-a-kind supercomputer, but also, more generally, in an environment where the goal is to create reproducible research and open science.



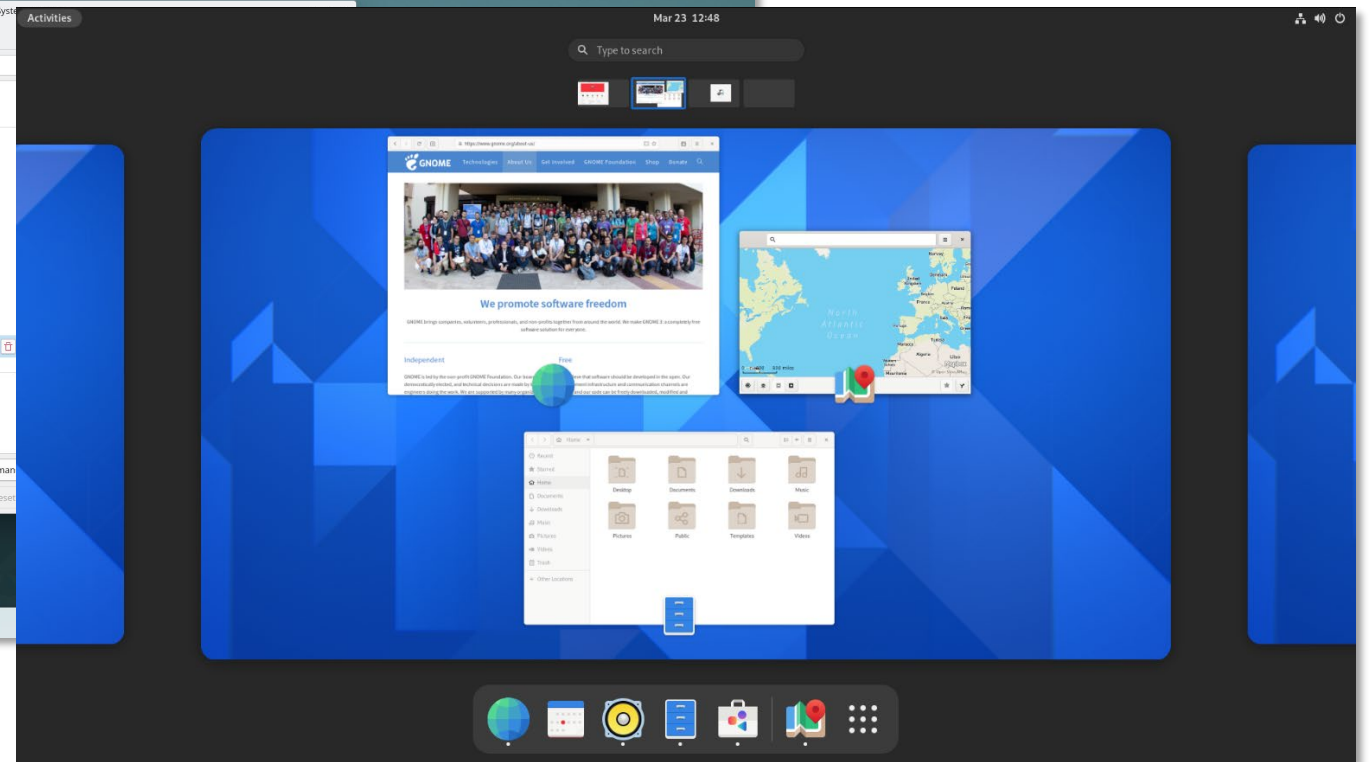
# Popular Desktop Environments



Ubuntu  
Desktop



KDE Plasma



GNOME Shell

... and several more.

# Linux totally dominates supercomputers

It finally happened. Today, all 500 of the world's top 500 supercomputers are running Linux.



By [Steven J. Vaughan-Nichols](#) for [Linux and Open Source](#) | [November 14, 2017](#) -- 20:04 GMT (20:04 GMT) | Topic: [Innovation](#)

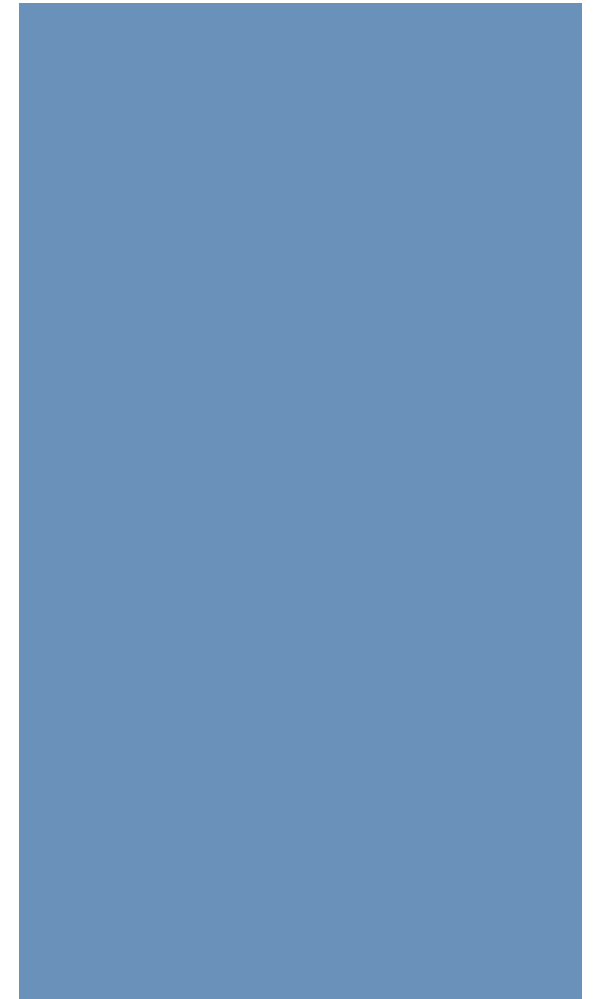
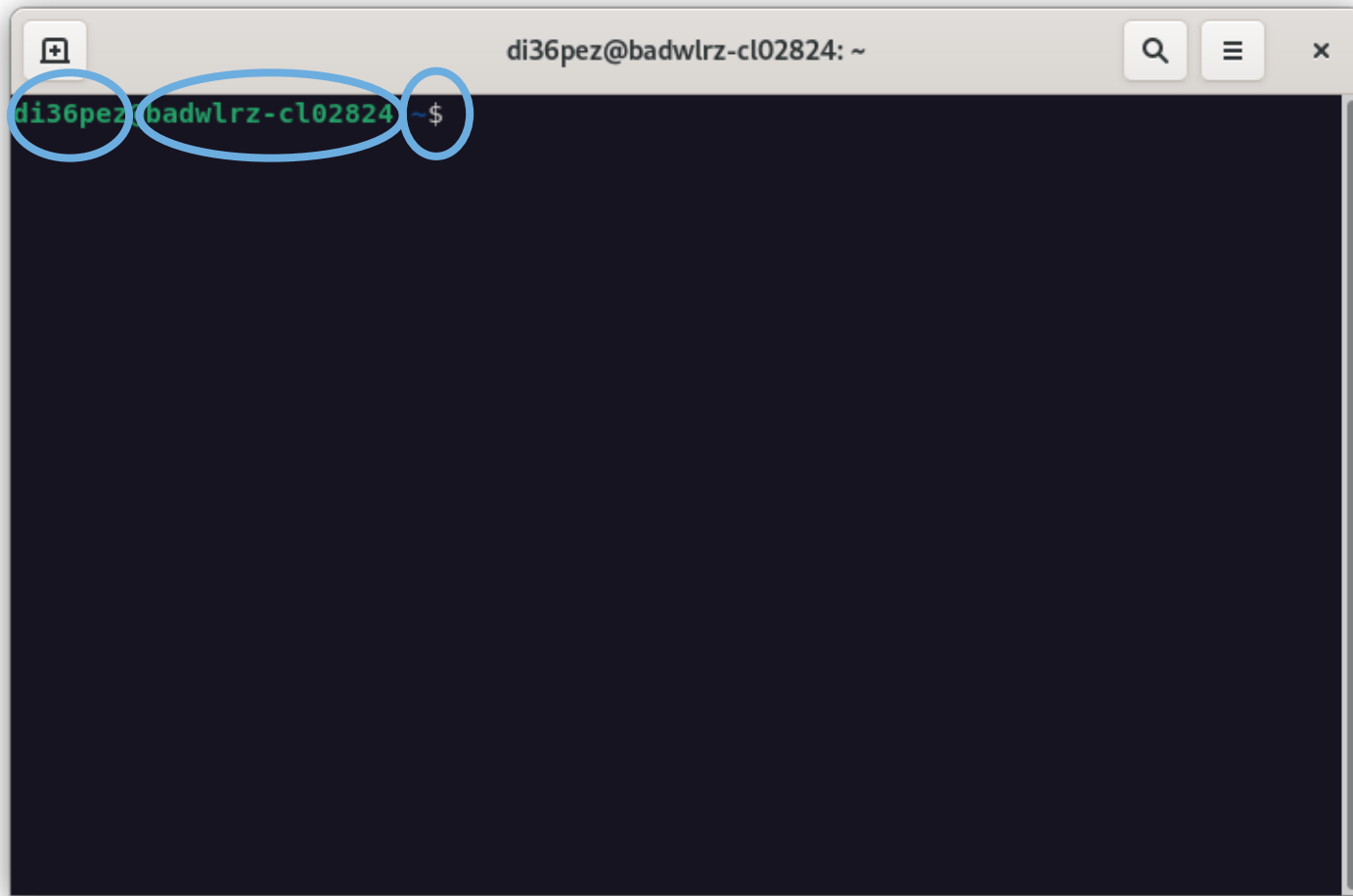
# It's time to get started!

- GNU/Linux: choose your favorite terminal application
- macOS: launch Terminal
- Windows:
  - Windows 10/11: both 'Command Prompt' (cmd.exe) and 'Powershell' should allow you to directly connect to remote systems (via SSH)
  - Windows 10/11: Windows Subsystem for Linux (WSL)  
<https://docs.microsoft.com/en-us/windows/wsl/install>
  - Alternatively (especially on older versions of Windows):
    - Git BASH (as part of Git for Windows) or MSYS2  
<https://gitforwindows.org/>      <https://www.msys2.org/>
    - MobaXterm  
<https://mobaxterm.mobatek.net/>

Explore a shell environment!



# A Unix-like Shell in a Terminal Application



# File System Hierarchy Standard (FHS)

- On a Unix-like system (pretty much) everything is a file
- All files and directories appear (somewhere) under the root directory “/”, even if stored on different – possibly remote – devices. There are no drive letters like on other operating systems.
- Use `pwd` to get the name of the current working directory
- Use `ls` to list all files and directories in the current directory
- Use `ls /` to list all files and directories in the root directory
- Use `ls /any/other/dir` to list all files and directories in the specified directory

On Unix-like systems:  
try the commands introduced on the left.

# Exploring the File System

```
[root@localhost ~]# pwd
/root
[root@localhost ~]# ls
dos      hello.c
[root@localhost ~]# ls /
bin      etc      lib      linuxrc  mnt      proc     run      sys      usr
dev      home    lib32    media    opt      root     sbin     tmp      var
[root@localhost ~]#
```

- /bin\*: command binaries (e.g. ls)
- /etc: configuration files
- /home: (regular) users' home directories
- /lib\*: libraries (for binaries in /bin et al.)
- /media: mount points for removable media
- /mnt: mounted filesystems
- /root: home directory of the root user
- /sbin\*: system binaries
- /usr: secondary hierarchy for read-only user data
- /var: variable, i.e. changing files

\* On modern systems, these (and /libXX) are only symlinks/shortcuts. Their former contents have been merged into their respective /usr/... counterparts, which they then point to.

# Detailed Listing of All Files



```
[root@localhost ~]# ls /usr
bin                libexec
i486-buildroot-linux-uclibc  local
include           sbin
lib               share
lib32             var
lib64
```

```
[root@localhost ~]# ls /home
```

Use the `l` and `a` options with `ls` (i.e. `ls -la`) to get a detailed listing of all files in your current (home) directory (we will cover most of this information later).

Can you spot the differences to the previous listing (using just `ls`)?

```
[root@localhost ~]# ls -la
total 20
drwx-----   3 root   root    135 Oct 24 19:34 .
drwxrwxrwx   19 root   root    457 Feb 27 13:44 ..
-rw-----   1 root   root      0 Jul  8  2017 .Xauthority
-rwxr-xr-x   1 root   root     28 Jun 24  2017 .xsession
drwxr-xr-x   3 root   root    163 Aug 20  2011 dos
-rw-r--r--   1 root   root    242 Jul 15  2017 hello.c
[root@localhost ~]#
```

# General Command Syntax



This command syntax can serve as general example to distinguish different components:

```
$ ls -la /home
```

`ls` is the **command**

with the (short) **options** (also **switches** or **flags**) `-la` and

the **argument** `/home`

Options generally start with either a single dash `-` (short, as above) or two dashes `--` (long).

- There are two common, local ways to find out how a command works and which options it accepts... (you can find many additional resources online, recommendations are <https://www.mankier.com/> and <https://tldr.sh/>)
  1. Pass the `--help` option to the command:  
`$ ls --help`
  2. Read a command's manual (man pages), using the `man` command:  
`$ man ls`  
(use the arrow keys to move up and down, press `q` to quit the man page)
- What effect does the `-h` option have on the `ls` command?
- Can you spot other interesting options?

# At the outset...



- At this point, you should have an initial understanding of what a GNU/Linux operating system is, you should have access to a (Unix-like) shell environment on your *local* machine.
- First steps were taken to explore a GNU/Linux system. You have encountered the very first commands to interact with the shell environment and you know how to get additional help for such commands.
- These are already the very basic skills that allow you to start working on remote systems using the Secure Shell (SSH).
- You will continue – and gain more experience – working with GNU/Linux systems in one of our later sessions (navigate the file system, file manipulation and ownership, characteristics of the shell environment, useful commands & concepts, ...).