Computing Clouds Cloud Computing AMIs Workshop AMI

Guy Leonard

Workshop on Genomics
2025

“All Watched Over By Machines Of Loving Grace”

Richard Brautigan

Computing Clouds Cloud Computing AMIs Workshop AMI

Guy Leonard

Workshop on Genomics
2025

AMIs, the Cloud, and Computing

Fundamentals

The Human Interface to the Digital World

- You!
- Experience computing through:
  - GUIs
  - Touch and Voice
  - CLIs
- Technology exists to extend human capabilities
- User Experience (UX), Human-Computer Interface (HCI) and Accessibility

Fundamentals

The Human Interface to the Digital World

- How many computers are in this room?
  - ~70 laptops?
  - ~70 phones?
  - Tablets?
  - Smart Watches?
  - Routers
  - Other ‘smart’ devices?
  - Other microcontrollers/chips?
- Ubiquitous!
  - But do you know how they work?

Fundamentals

Bridging User Needs and System Capabilities

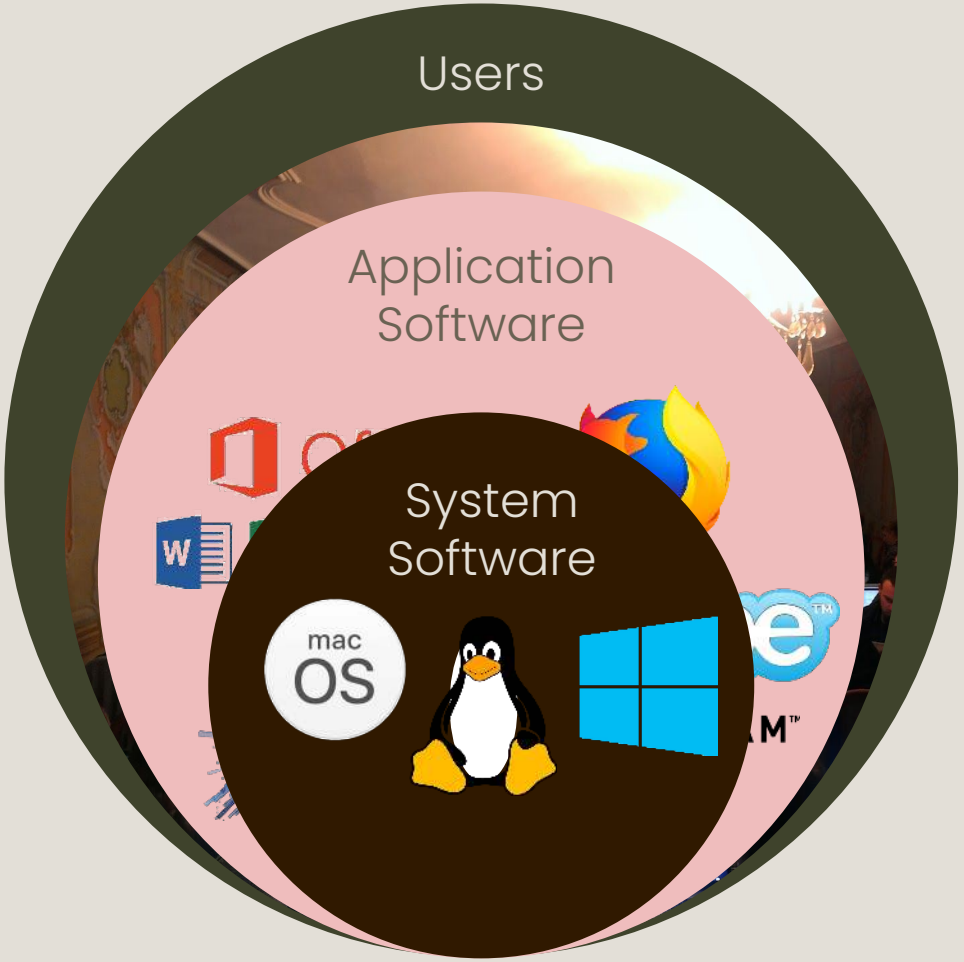
- Directly serves user requirements
- Productivity Tools
  - MS Office
- Creative Applications
  - Photoshop
- Scientific and Research Software
  - The next two weeks…
- Entertainment and Gaming

- Translates user intentions into computational actions

Fundamentals

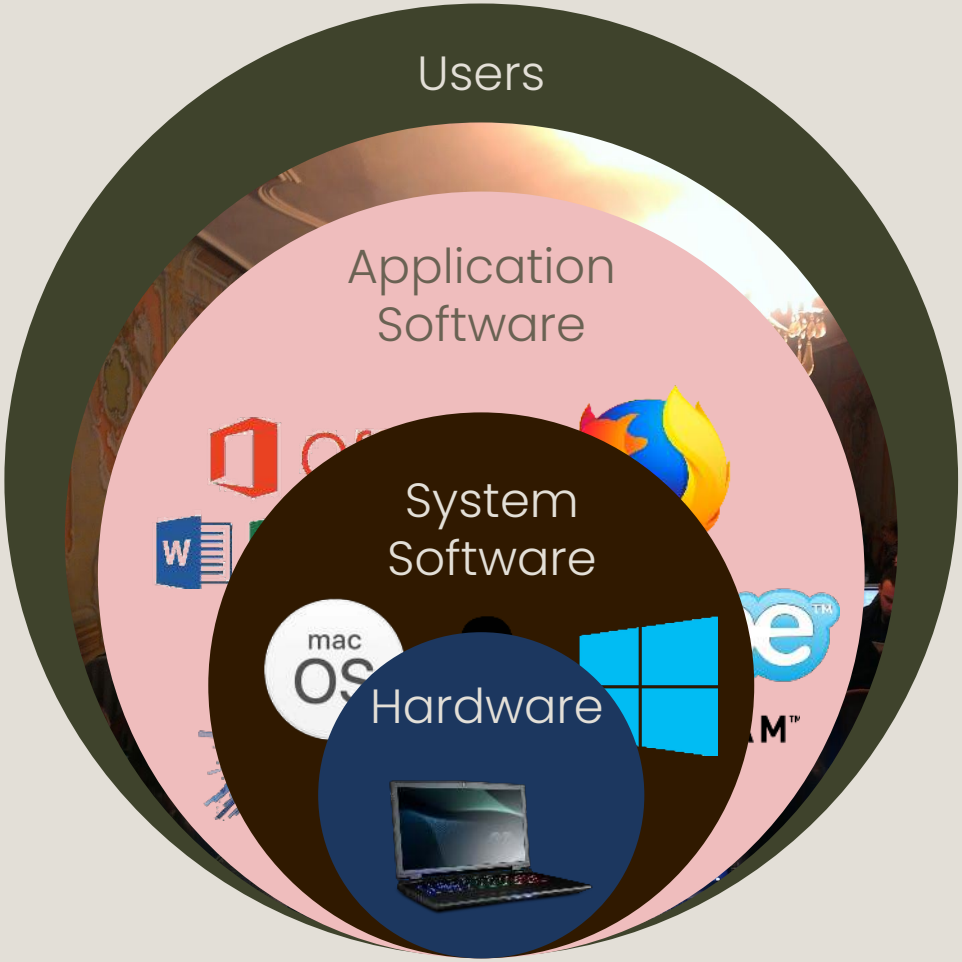
The Computational Translator

- Acts as an intermediary between hardware and application software
- Key Components:
  - Operating Systems
  - Device Drivers
  - Utility Programs
  - Runtime Environments
- Primary Functions:
  - Resource Management
  - Process Scheduling
  - Memory Allocation
  - Security and Access Control
- Compilers, Linkers and Assemblers



Fundamentals

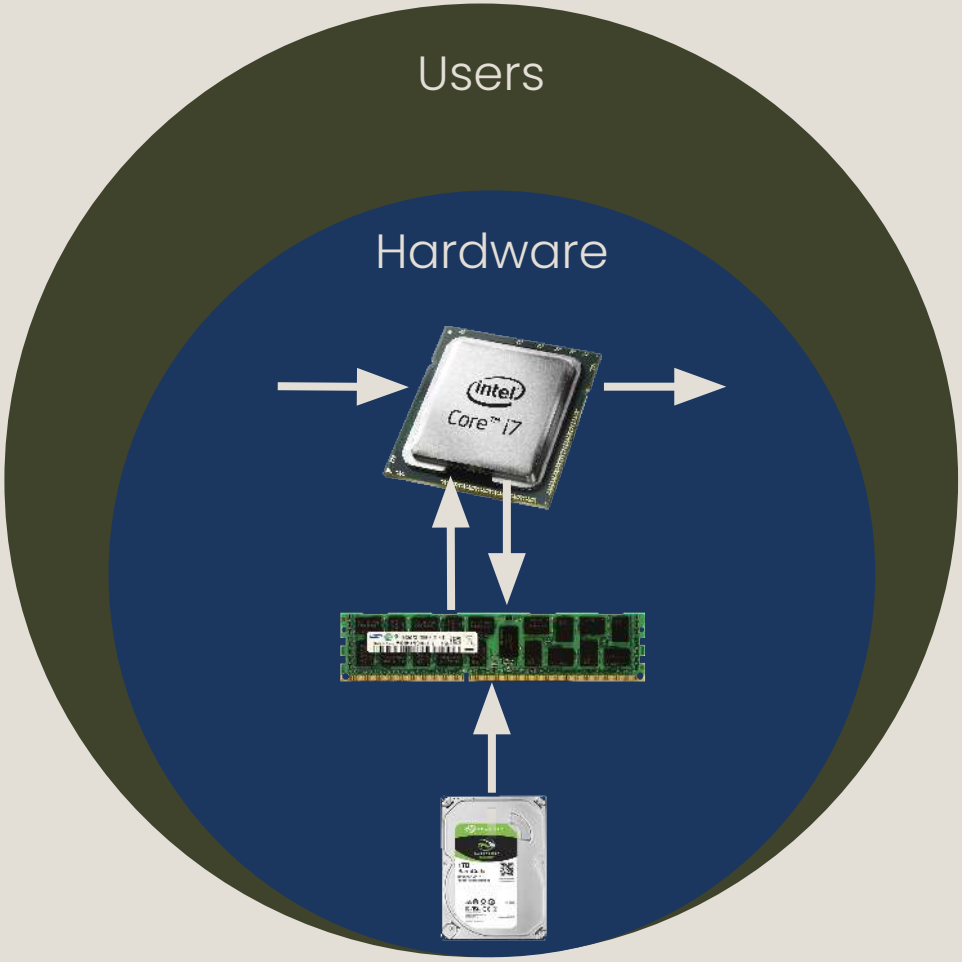
The Physical Foundation



Fundamentals

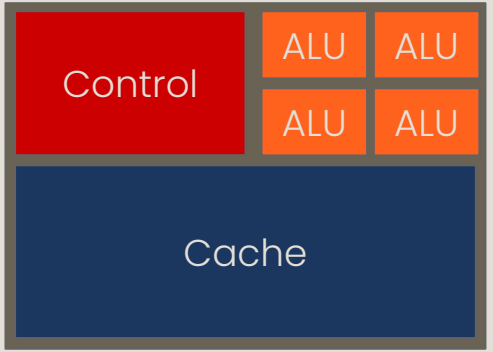
The Physical Foundation

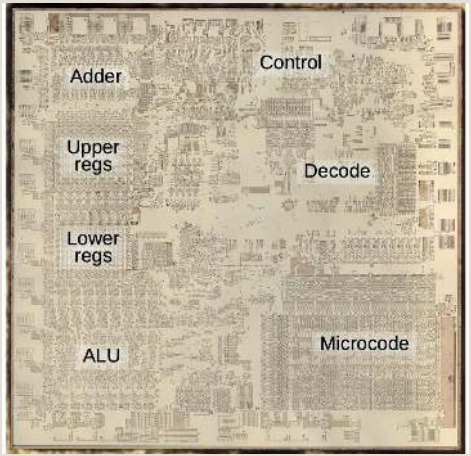
- Key Components:
  - Central Processing Unit (CPU)
  - Random Access Memory (RAM)
  - Storage Devices
  - Input/Output Devices
  - Network Interfaces
- "fetch-decode-execute" cycle to process program instructions
- Computer performance depends on cache size, clock speed and the number of cores



Fundamentals

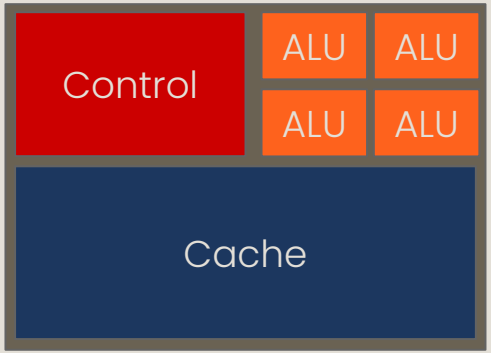
- ***CPU***
  - ***Control Unit***
    - "fetch-decode-execute"
    - Transfers data and instructions around the system
  - **Arithmetic Logic Unit (ALU)**
    - arithmetic and logical operations
  - **Cache**
    - small amount of high-speed random access memory (RAM)
  - **Clock**
    - Coordinates all the components, measured in Hertz (Hz)



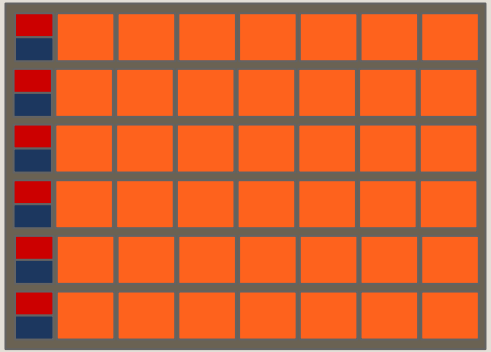


CPU vs GPU

- **Central Processing Unit**
  - Core computational operations
  - Low compute density
  - Complex Control Logic
  - Large Cache
  - Optimised for serial operations

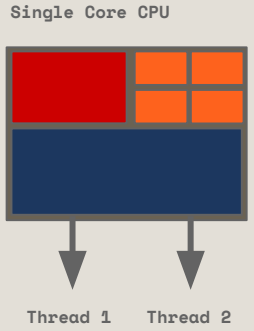


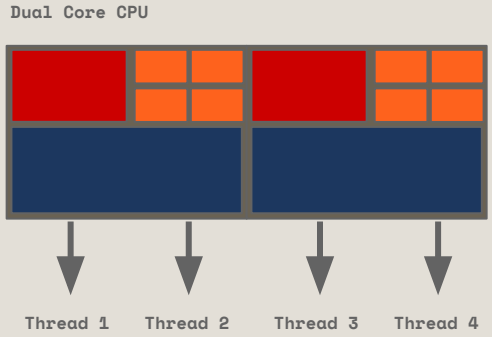
- **Graphical Processing Unit**
  - Specialised computational operations
  - High compute density
  - High computation per memory access
  - Built for parallel operations



CPU: Cores vs. Threads

- **What is a CPU Core?**
  - A core is an independent processing unit within a CPU.
  - Each core can execute its own instructions simultaneously.
  - Early CPUs had only one core, but modern CPUs have multiple cores for parallel execution.
  - More cores = better performance for multi-threaded applications.
- **What is a Thread?**
  - A thread is a sequence of instructions executed by a CPU.
  - Each physical core can run one or more threads.
  - Single-threaded applications: Run on one core at a time.
  - Multi-threaded applications: Can run across multiple cores for improved performance.

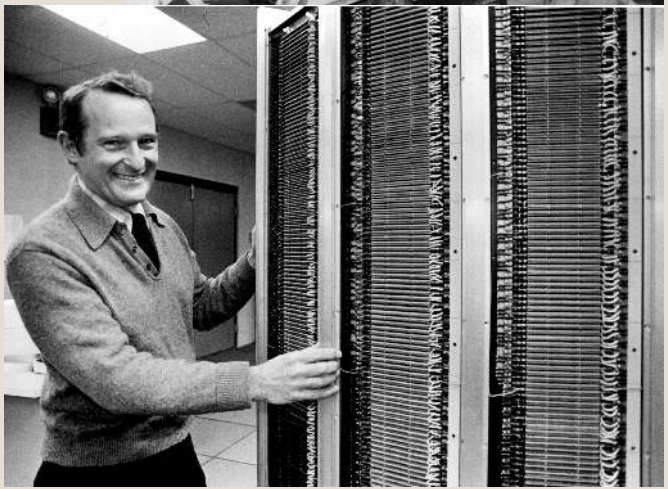


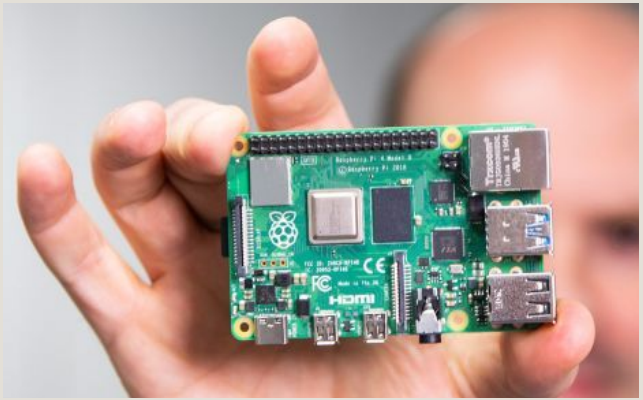


Mainframes & Supercomputers

- In 1978, the Cray-1 supercomputer cost $7 million, weighed 4762 kg and had a 115 kilowatt power supply. 1 CPU.

- The Raspberry Pi costs around $70 (CPU board, case, power supply, SD Card), weighs 50g uses a five watt power supply and is more than 4.5 times faster than the Cray-1. 1 CPU = 4 Cores



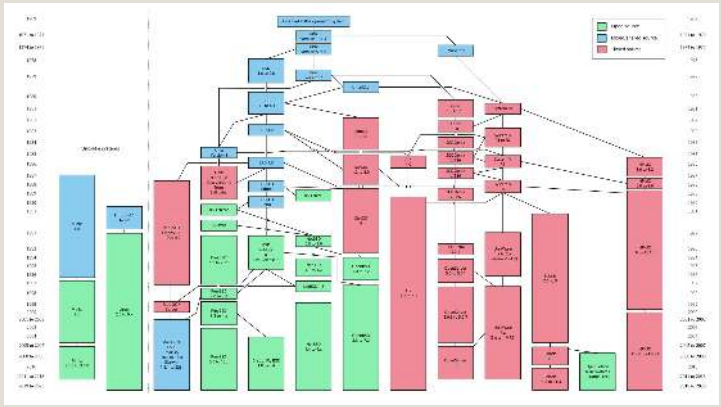


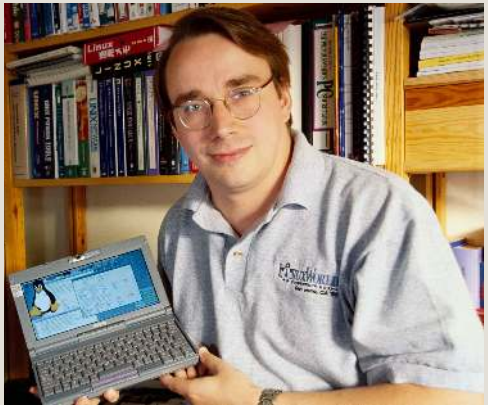
Virtual Computing and Terminals

- How did users access the mainframe computers?
  - Terminals!
    - Originally, a physical device (teletypewriters “TTYs”) that connected to a remote computer.
    - The term "terminal" comes from it being the endpoint of a session on a mainframe.
    - Allowed users to interact with powerful shared systems (early UNIX mainframes, minicomputers).
    - Eventually replaced by terminal emulators running inside modern operating systems.

Virtual Computing and Terminals

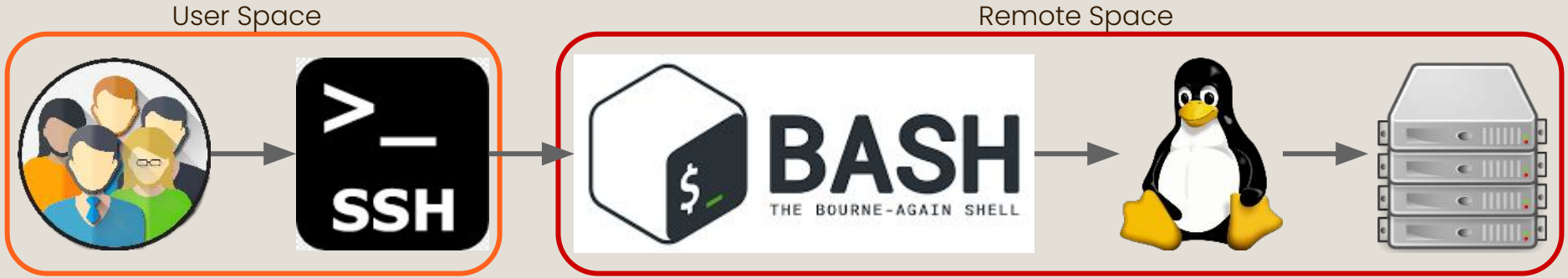
- What were the mainframes running?
- Rise of UNiplexed Information and Computing System (UniX)/Linux:
  - 1960s-1970s: UNIX was developed at Bell Labs.
  - 1980s: UNIX becomes the foundation of many academic and enterprise systems.
  - 1990s-Present: Linux, an open-source UNIX-like OS.





Virtual Terminals

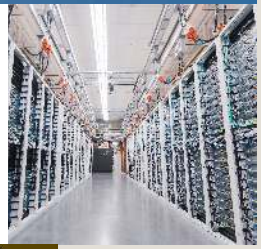
- With the advent of personal computers and super computers, terminals were no longer useful.
  - Telnet (1970s-1990s) – Early network-based remote access (unencrypted, insecure).
  - SSH (1995-present) – Secure, encrypted alternative for remote terminal access.
- What is the Shell?
  - The shell is a command-line interpreter that sits between the user and the operating system.



What is The Cloud?

- A shift from local to remote computing
- Key characteristics:
  - On-demand resource allocation
  - Pay-as-you-go models
  - Scalability and flexibility
- How old is it?
  - 1960s!
    - Data centres at DARPA
  - 1970s: IBM Time sharing
  - 1990s: VPNs
  - 2000s: Amazon etc

Is this it?



* The only generative AI content in these slides...

The Cloud

- **You have all been using it for most of your lives…**
  - Social Media
  - Email
  - Storage
  - Computing
- **Amazon Web Services**
  - Early 2000s - Scalability issues running e-commerce
  - Decouple components - sped up development & reduced bottlenecks
  - Infrastructure as a service: 2006+ = EC2, S3 = Cloud!

It's these things…

Data Centres

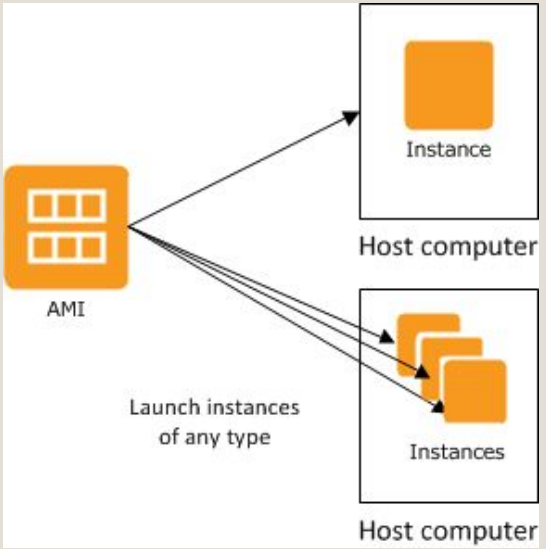
- Cloud servers are located in data centers all over the world
- Amazon Web Services
- Microsoft Azure
- Google Compute
- Other regions may have their own solutions...

Data Centres

- Cloud servers are located in data centers all over the world
- A data center is a facility housing many networked computers that work together to process, store, and share data
- By using cloud computing, users and companies do not have to manage physical servers themselves or run software applications on their own machines

AWS, AMI and EC2

- **Amazon Web Services (AWS)**
  - comprehensive cloud platform offering on-demand services
- **Amazon Elastic Compute Cloud (EC2)**
  - core compute service within AWS, providing resizable virtual servers on demand
- **Amazon Machine Image (AMI)**
  - a preconfigured virtual template used to launch EC2 instances, containing an operating system



AMI, Instance, Virtual Machines?!

- **Virtual Machine (VM)**
  - A software-based computer that runs an entire operating system (OS) in an isolated environment.
  - The VM shares the physical server's resources (CPU, memory, storage), but appears to the user like a standalone machine.
- **Amazon Machine Image (AMI)**
  - A template provided by Amazon Web Services (AWS) used to create EC2 instances.
  - Contains the operating system, software, and initial configuration.
  - Acts as the base "blueprint"; you launch instances from AMIs.
- **Instance (in AWS context)**
  - A running virtual server in AWS, launched from an AMI.
  - Receives compute resources (e.g., CPU, RAM, storage) allocated by AWS.
  - You can start, stop, reboot, or terminate an instance as needed.

Connecting to the Cloud

Remote Desktop (Guacamole)

Secure Shell (ssh)

R Studio Server

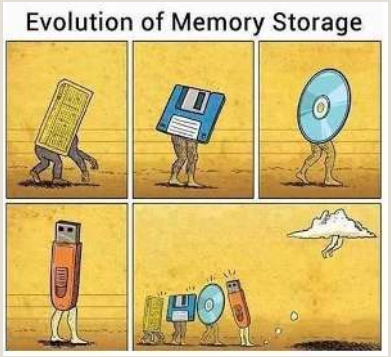
Jupyter Notebook

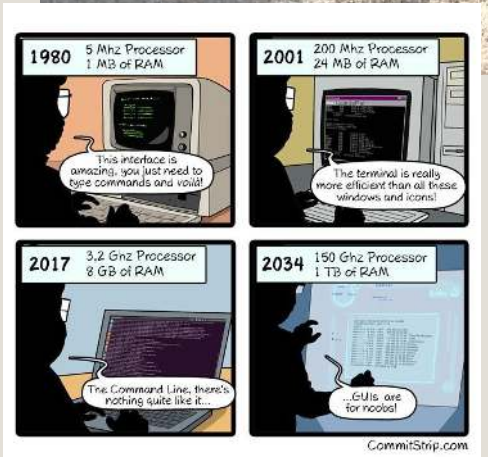
Takeaways

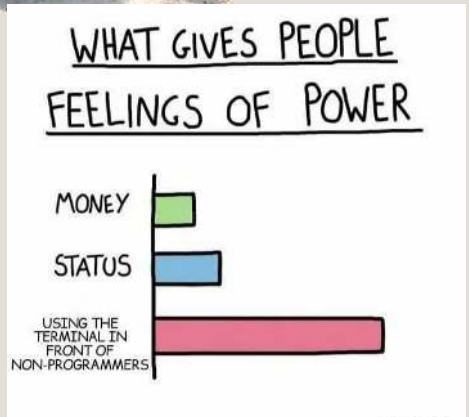

THERE IS NO CLOUD
IT'S JUST
SOMEONE ELSE'S COMPUTER


STOP
programming computers
Sand was never meant to think
this is very cruel to rocks


AN ENGINEER HELPING A DESIGNER
NO PROBLEM, WE CAN FIX THIS ON THE TERMINAL
WHOA, YOU'RE A HACKER!
NO, IT'S JUST THE TERMINAL.
WHERE ARE ALL THE BUTTONS, ICONS, AND DROPDOWN MENUS?
IS THIS... THE MATRIX?
YES.
PABLO STANLEY

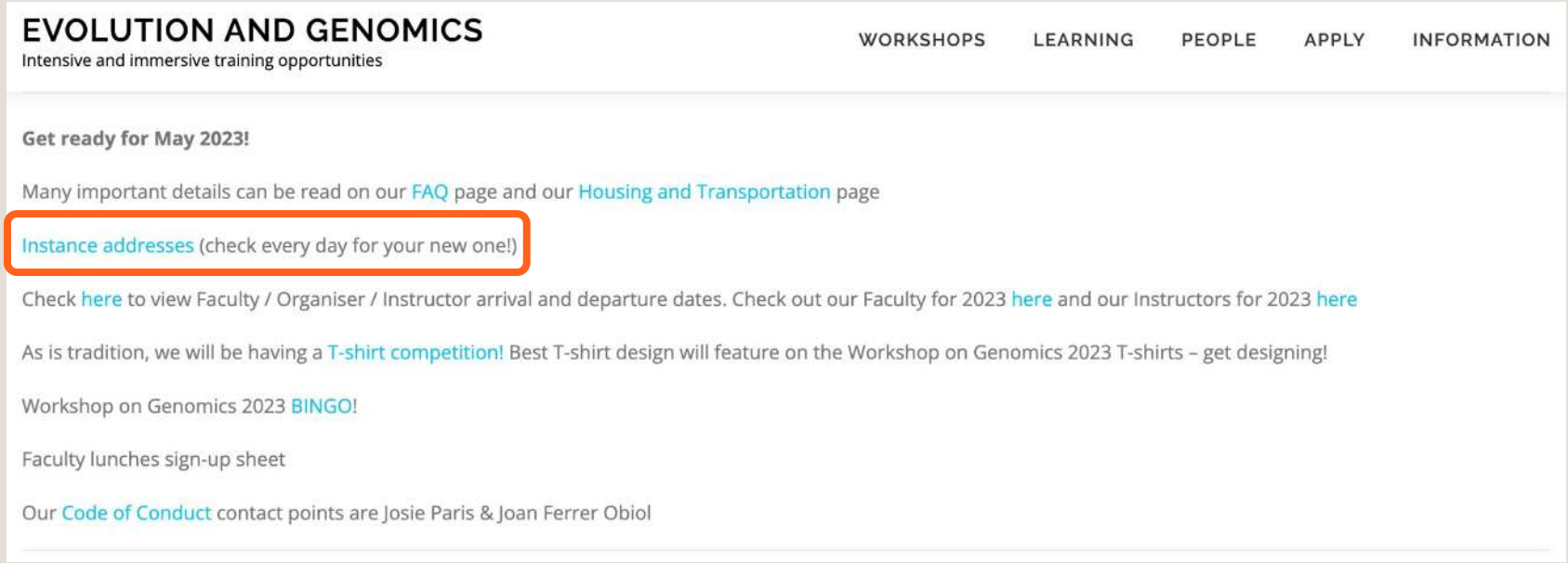

Evolution of Memory Storage


1980 5 Mhz Processor 1 MB of RAM
This interface is amazing, you just need to type commands and voila!
2001 200 Mhz Processor 24 MB of RAM
The terminal is really more efficient than all these windows and icons!
2017 3.2 Ghz Processor 8 GB of RAM
The Command Line, there's nothing quite like it...
2034 150 Ghz Processor 1 TB of RAM
...GUIs are for noobs!
CommitStrip.com


WHAT GIVES PEOPLE FEELINGS OF POWER
MONEY
STATUS
USING THE TERMINAL IN FRONT OF NON-PROGRAMMERS

Connecting to your Instance

↪ https://evomics.org/2025-workshop-on-genomics/



EVOLUTION AND GENOMICS
Intensive and immersive training opportunities

WORKSHOPS LEARNING PEOPLE APPLY INFORMATION

Get ready for May 2023!

Many important details can be read on our FAQ page and our Housing and Transportation page

Instance addresses (check every day for your new one!)

Check here to view Faculty / Organiser / Instructor arrival and departure dates. Check out our Faculty for 2023 here and our Instructors for 2023 here

As is tradition, we will be having a T-shirt competition! Best T-shirt design will feature on the Workshop on Genomics 2023 T-shirts – get designing!

Workshop on Genomics 2023 BINGO!

Faculty lunches sign-up sheet

Our Code of Conduct contact points are Josie Paris & Joan Ferrer Obiol

Connecting to your Instance (AMI)

- Find your name and check your instance address

- Check how to connect to your instance using guacamole, ssh and the RStudio server

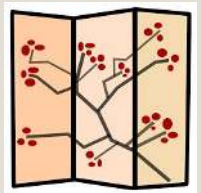
	A	B	C	D	E	F	G
1	**Instance number**	**First Name**	**Last Name**	**Instance address**	**Guacamole connection**	**ssh connection**	**RStudio server connection**
2	1	Joan	Ferrer Obiol	3.238.107.169	3.238.107.169:8080/guacamole	ssh genomics@3.238.107.169	3.238.107.169:8787

Connecting through SSH

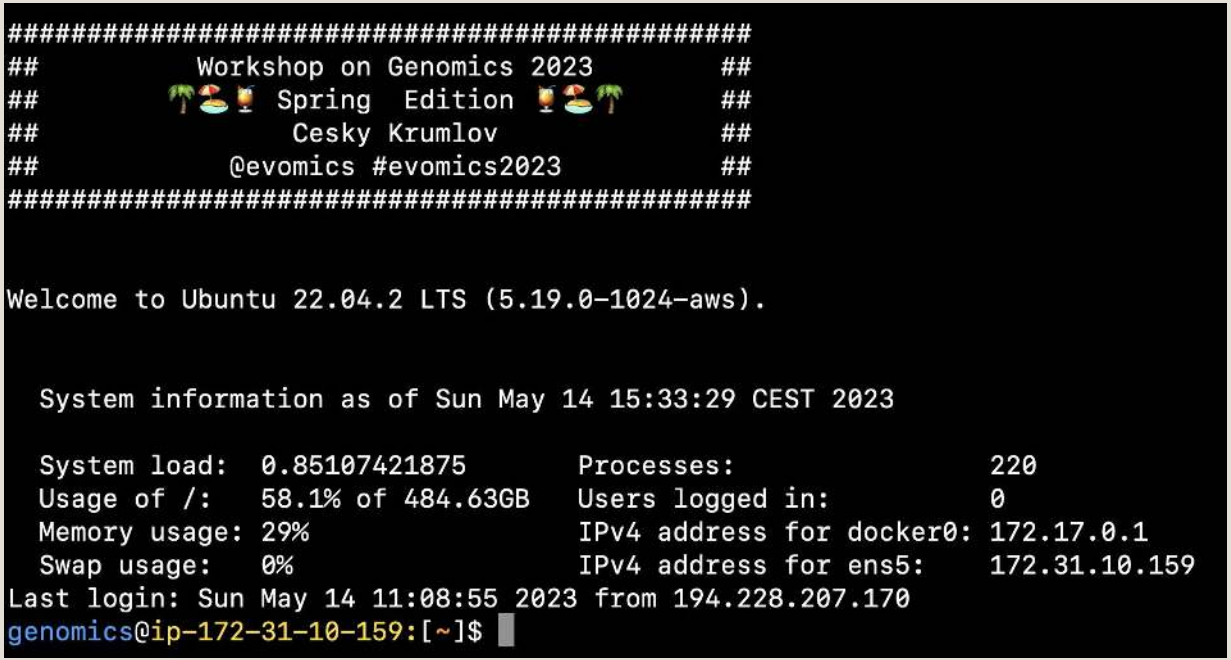
- Open your preferred terminal on your laptop
- Type ssh genomics@[instance address]
- Enter the password

```
[apples-MacBook-Pro.local@apple[~]$ ssh genomics@3.238.107.169
genomics@3.238.107.169's password:
```



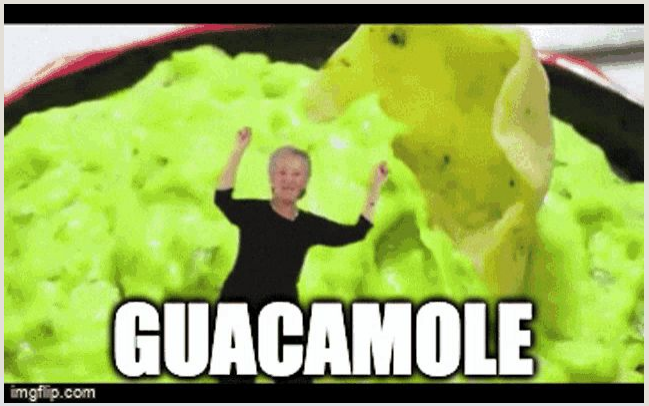
Connecting through SSH

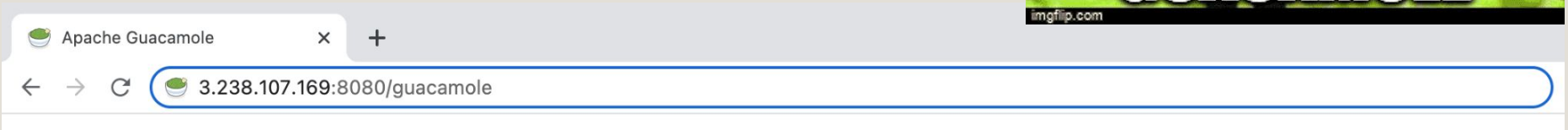


Connecting to Guacamole

- Open your preferred internet browser (i.e. chrome, firefox)

- Paste your instance address followed by :8080/guacamole



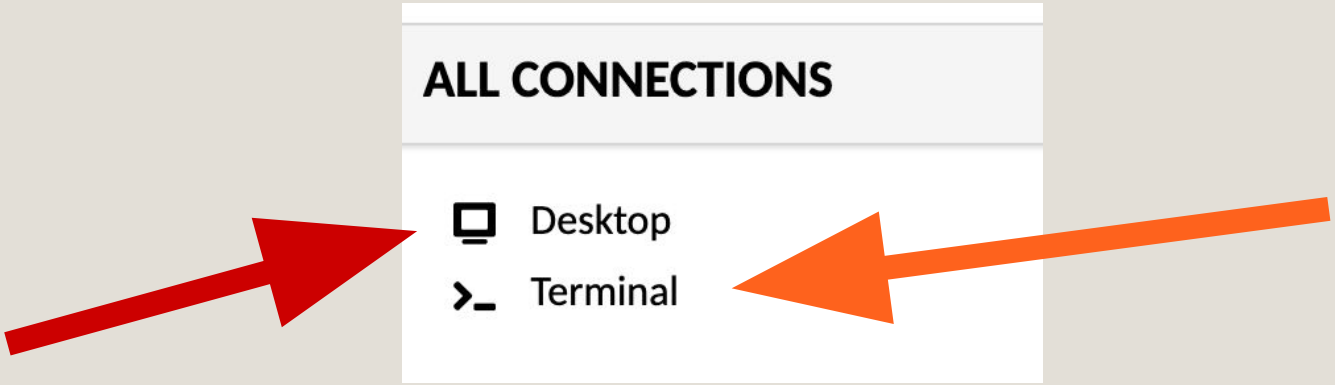


Connecting to Guacamole

↪ Enter the username “genomics” and the password (on the flip-chart/whiteboard)

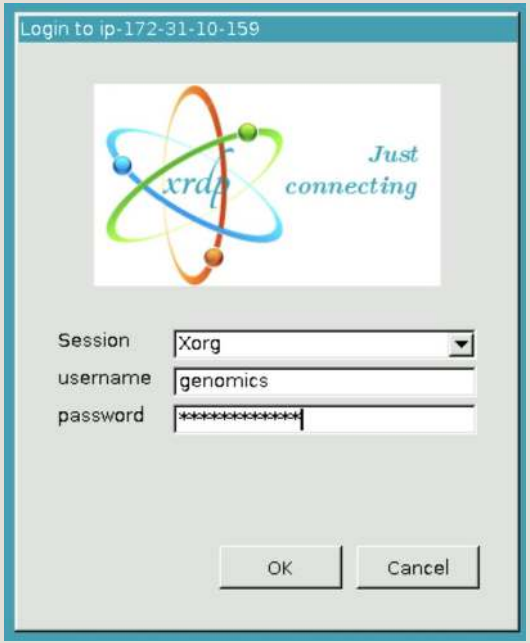
Connecting to Guacamole Desktop

↪ Open your preferred internet browser (i.e. chrome, firefox)



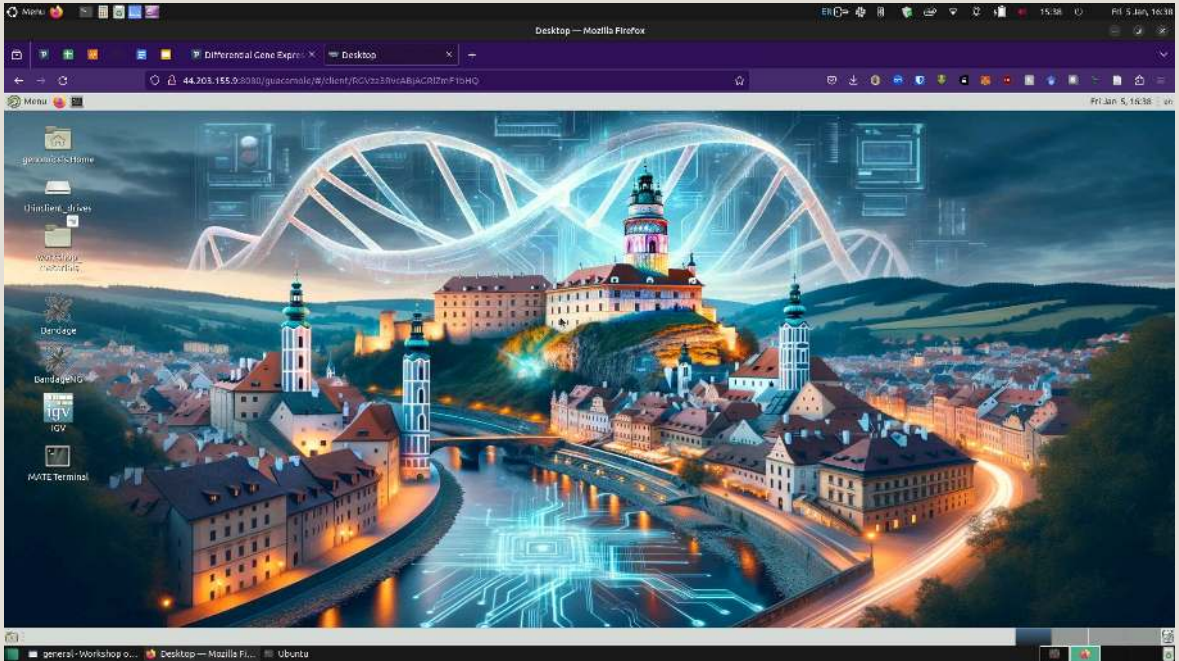
Connecting to Guacamole Desktop

- Enter the username “genomics” and password again



Connecting to Guacamole Desktop

- Open a terminal window using the terminal icon

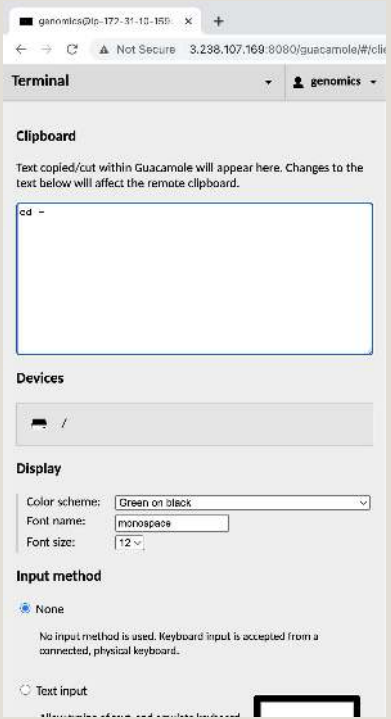


Copying and Pasting

Copying and Pasting

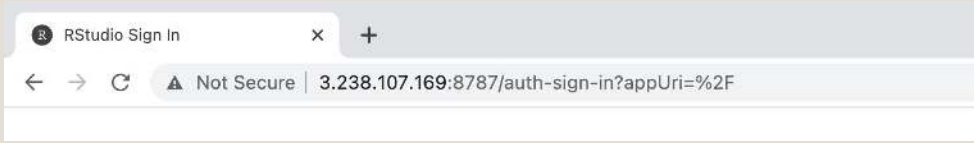
But if you need it:

- ↪ Press Ctrl+Alt+Shift (Mac: Ctrl+Opt+Shift)
- ↪ Paste the text in the pop-up box
- ↪ Press Ctrl+Alt+Shift (Mac: Ctrl+Opt+Shift) again
- ↪ Paste into the instance using right click



Connecting to R-Studio Server

- Open your preferred internet browser (e.g. Chrome, Firefox)
- Paste your instance address followed by :8787
- Username: genomics
- Password: On the whiteboard in the Prelate

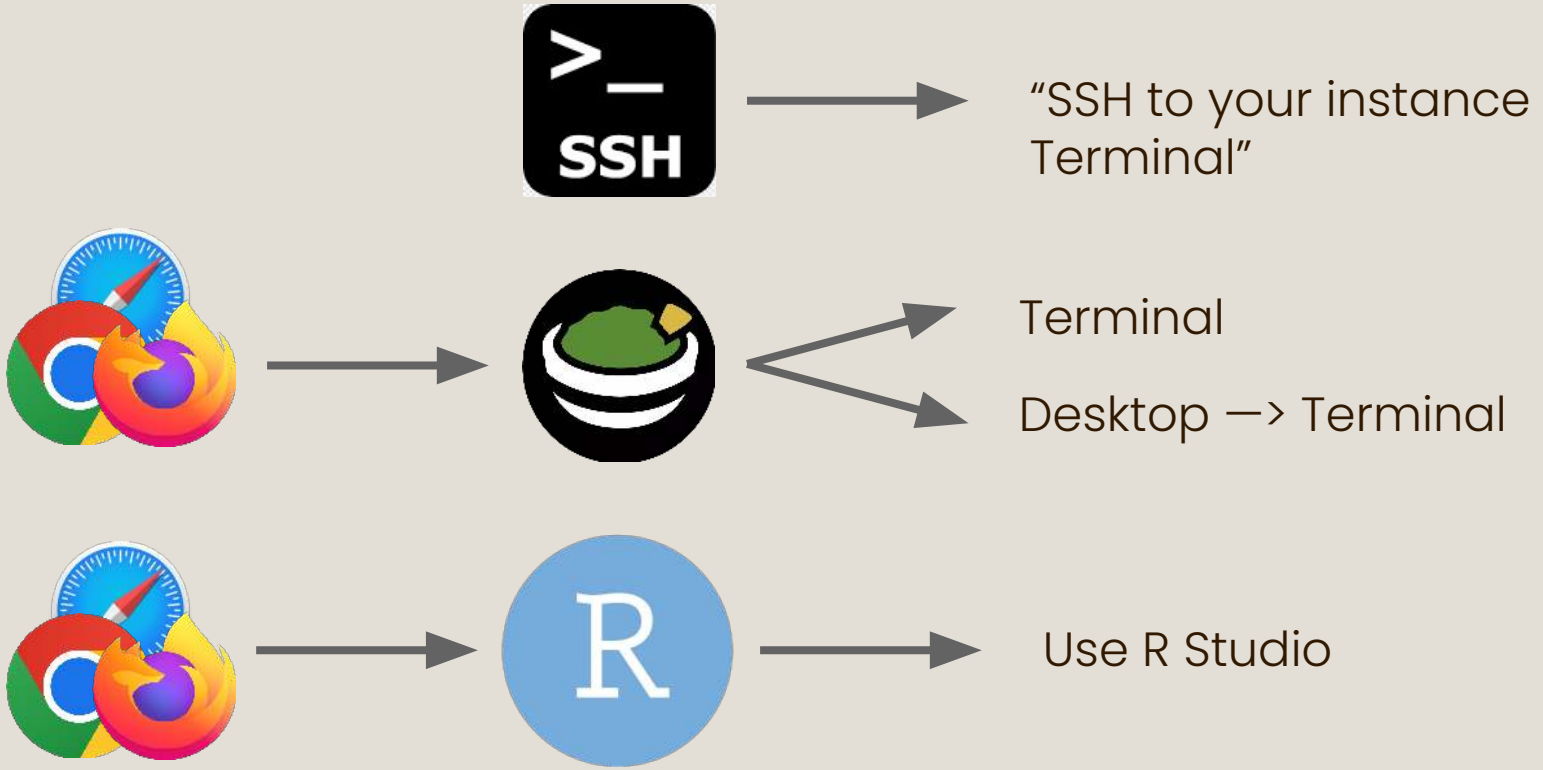


Your Daily AMI

- The instance IP address will **change** *every day* after we stop and restart the instances.

- Each morning, you will need to return to the “Instance address spreadsheet” on the webpage, retrieve your new address and login again using the type of connection you need

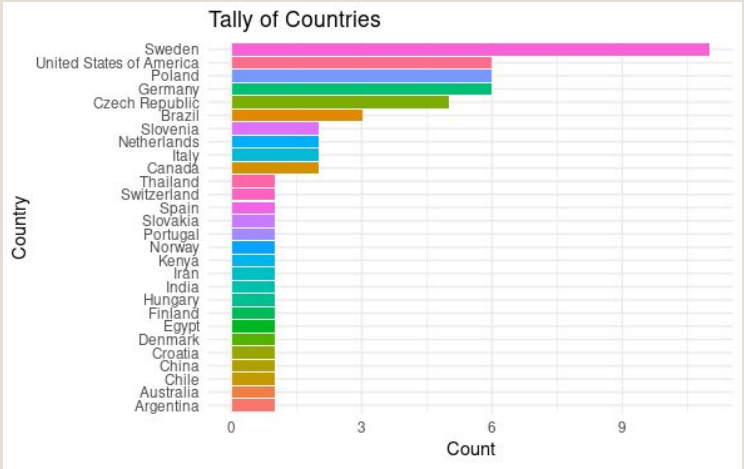
I forgot how do I connect?



Keyboard Troubles!

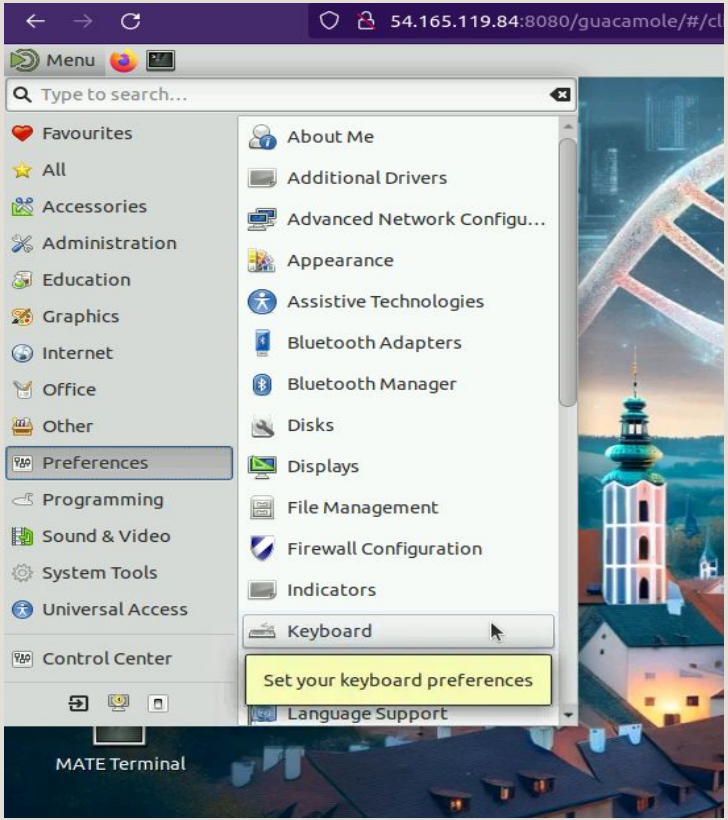
- **Make sure that you can type the following characters:**

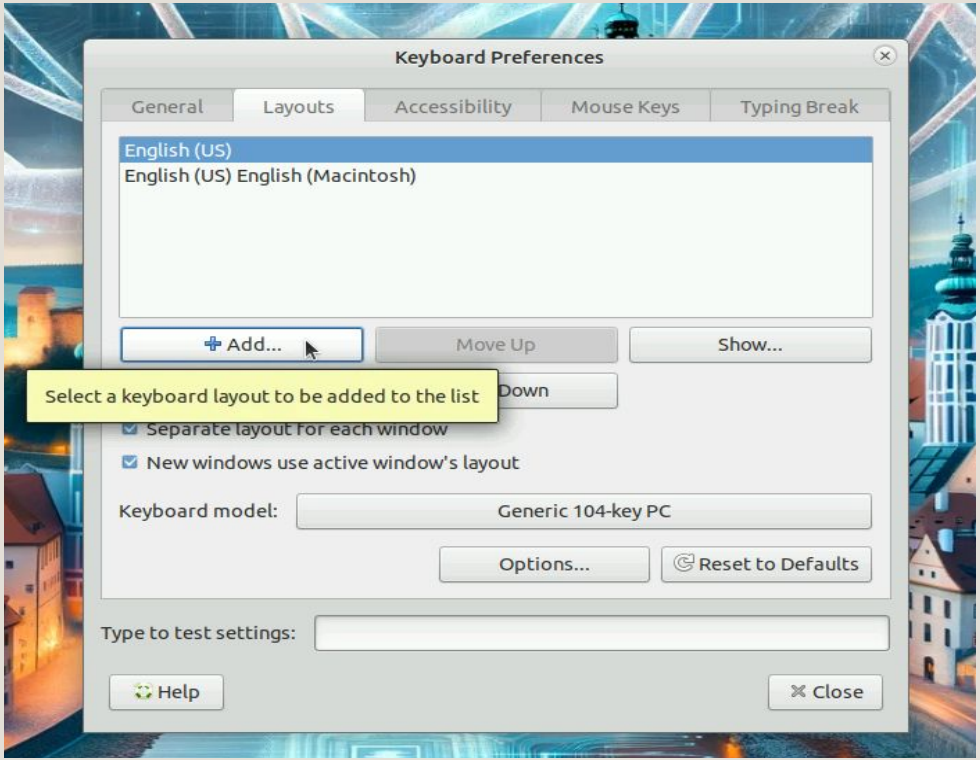
- tilde (~)
- backslash (\)
- pipe (|)
- carat (^)



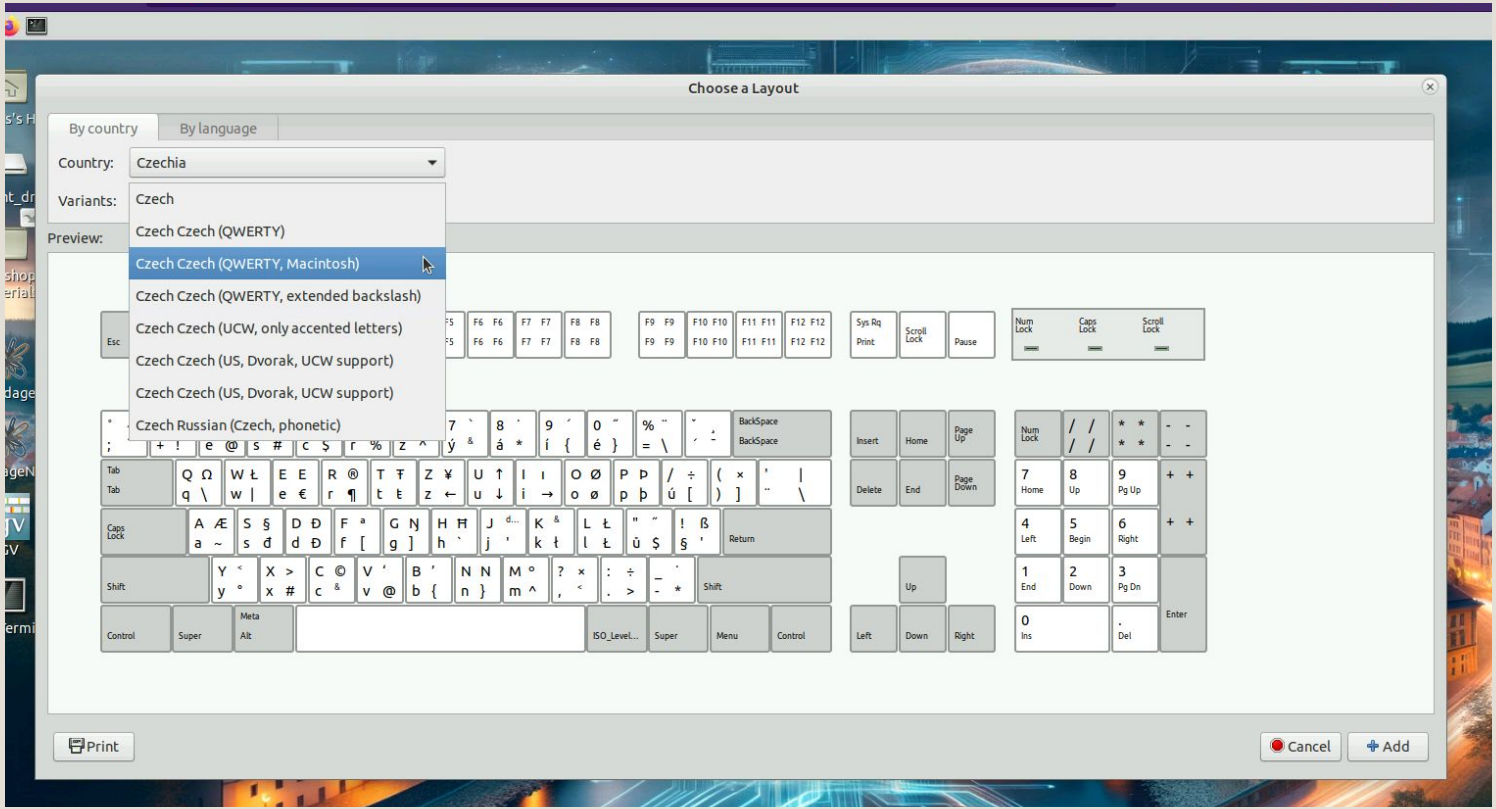
- If you can’t type these characters, please get our attention!

Keyboard Troubles!





Keyboard Troubles!

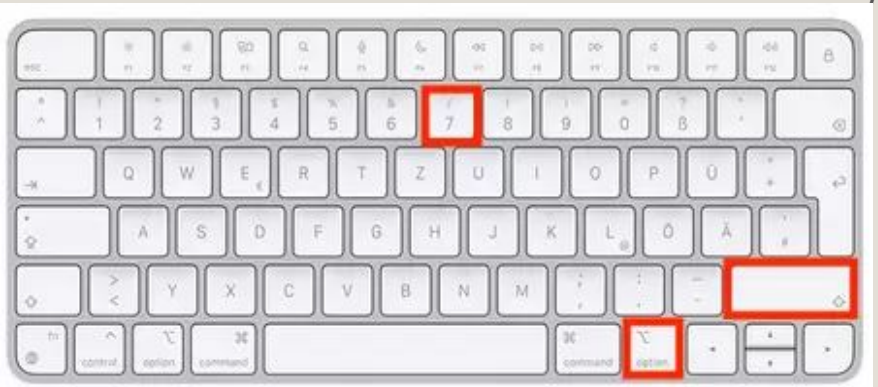


Tilde ~

tilde
/ˈtɪldə,ˈtɪldi/

Backslash \

backslash
/ˈbakslaʃ/



Pipe |

vertical bar
pipe

Carat ^

^

Caret
/kɛɹət/