Biological data analysis (1)

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GMC
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Syllabus

- Introduction. Environment setup
- Programming basics: variables, flow control, functions
- Python basics. Documentation, IO, standard library
- Data manipulation
- Data visualizing
- Testing, dealing with errors and code style
- Advanced packages for data analysis (SciPy, Pandas, NumPy)
- Advanced programming
- Reproducible research, analysis presentation

Assessment

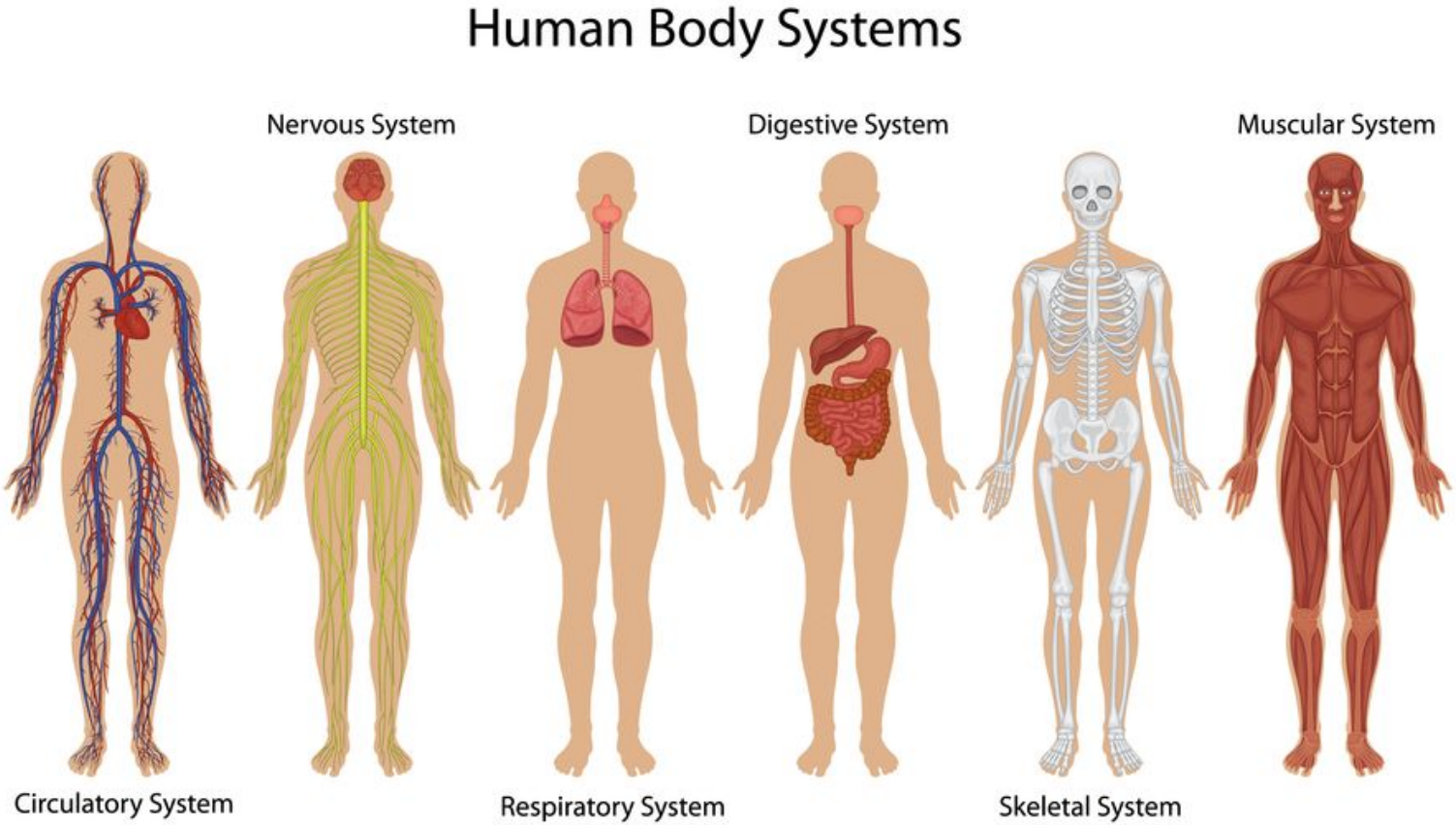
Cumulative score: four assessments during the semester.

Students will solve data analysis and programming exercises.

If cumulative score is lower then 5 students must take an exam. If cumulative score is 5 or more students can take an exam, in this case final score is the exam score.

Exam consists of theoretical and practical data analysis and programming questions and exercises.

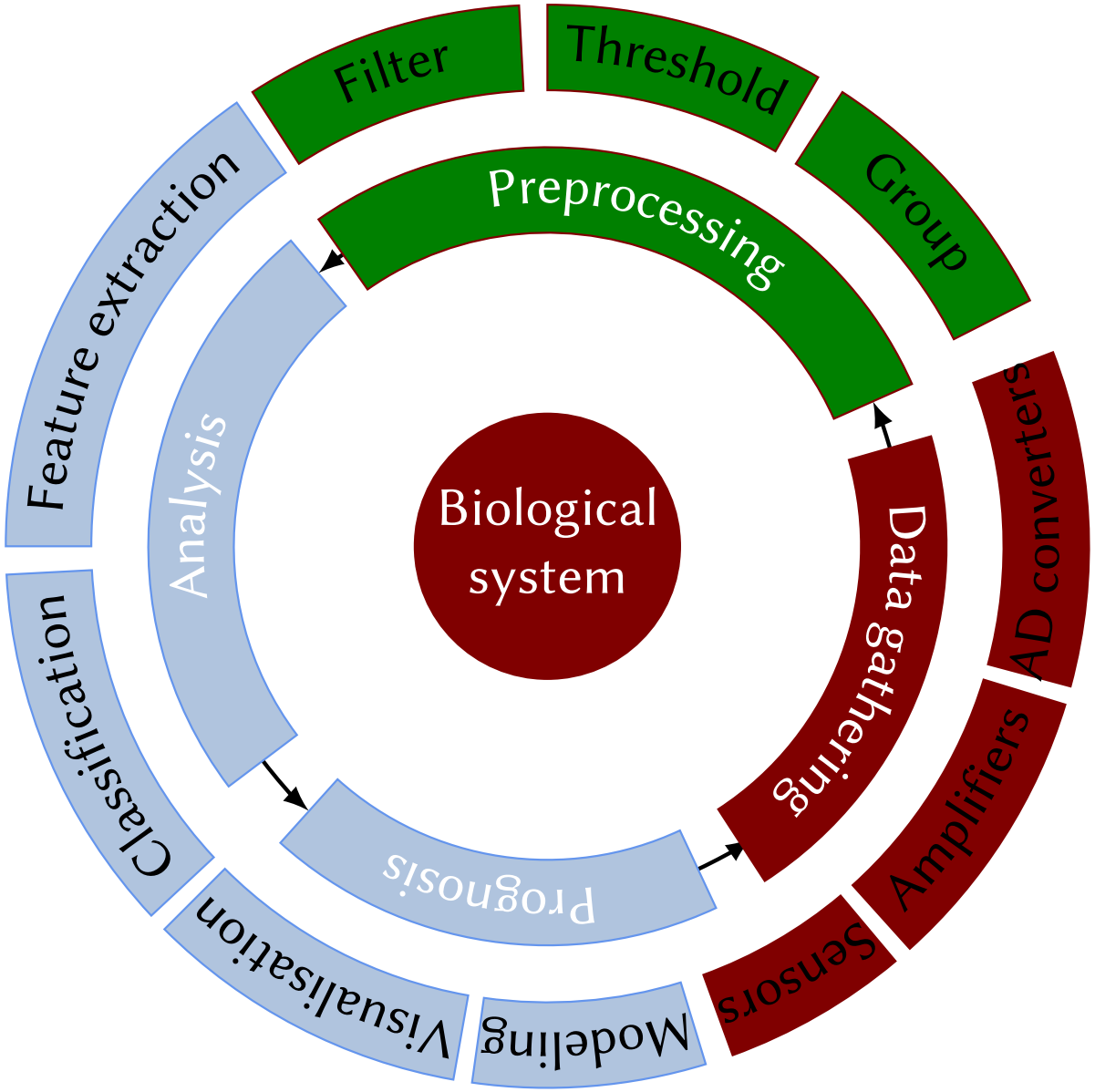
Biosystems


Human Body Systems
Nervous System
Digestive System
Muscular System
Circulatory System
Respiratory System
Skeletal System

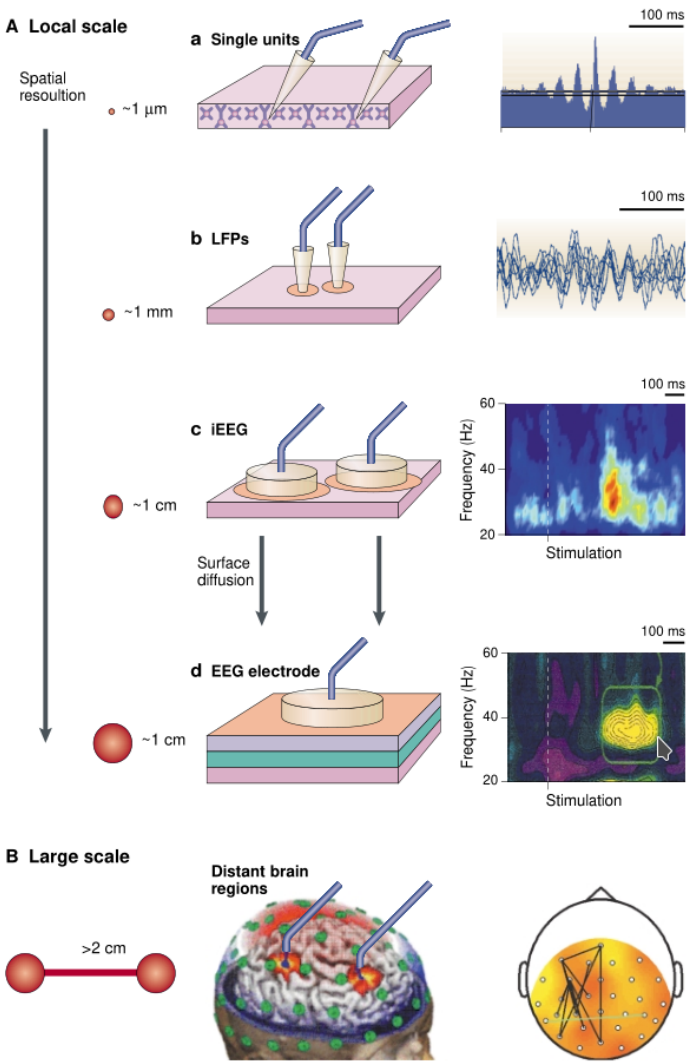
Objectives of Biological Data Analysis

- Information gathering — measurement of phenomena to interpret a system.
- Diagnosis — detection of malfunction, abnormality.
- Monitoring — obtaining continuous of periodic information about a system.
- Control — modification of the system based on the outcomes, generating feedback loop.
- Evaluation — quality control, quantification of the effects.

Biological data analysis



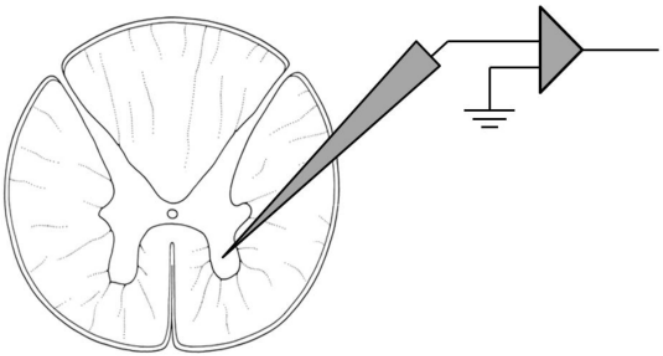
Biological Data Examples

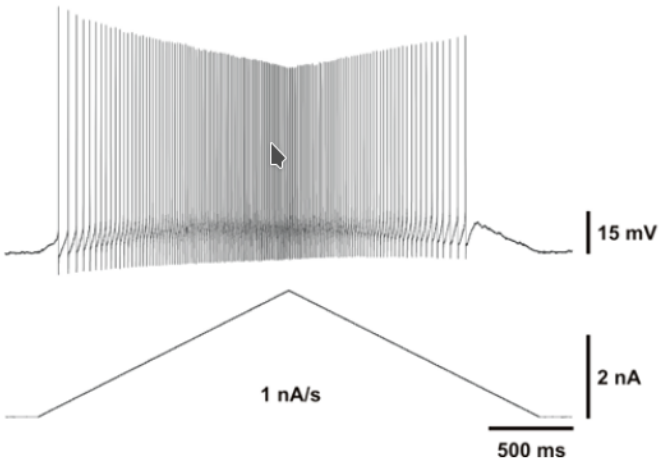


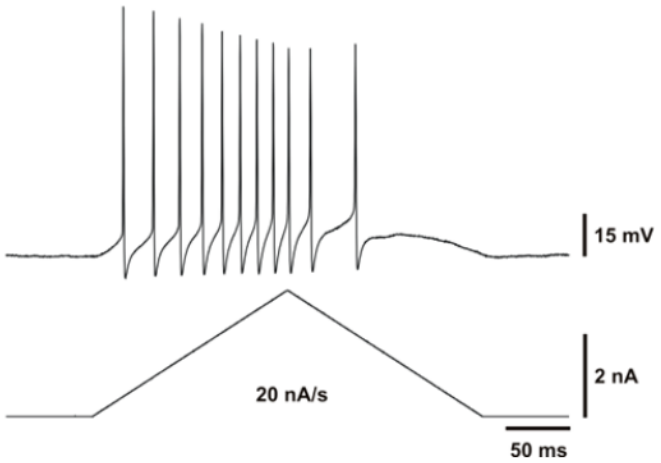
Varela et. al. 2002

Action Potential

- Hodgkin and Huxley (1939) conducted pioneering studies and proposed mathematical and electrical circuit models for the generation of action potentials



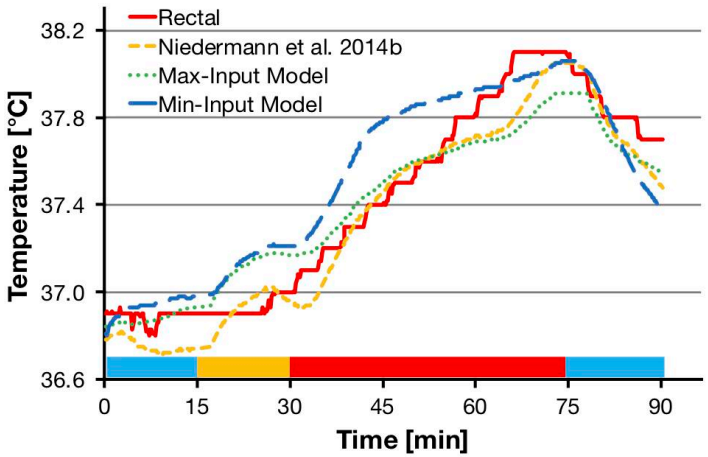


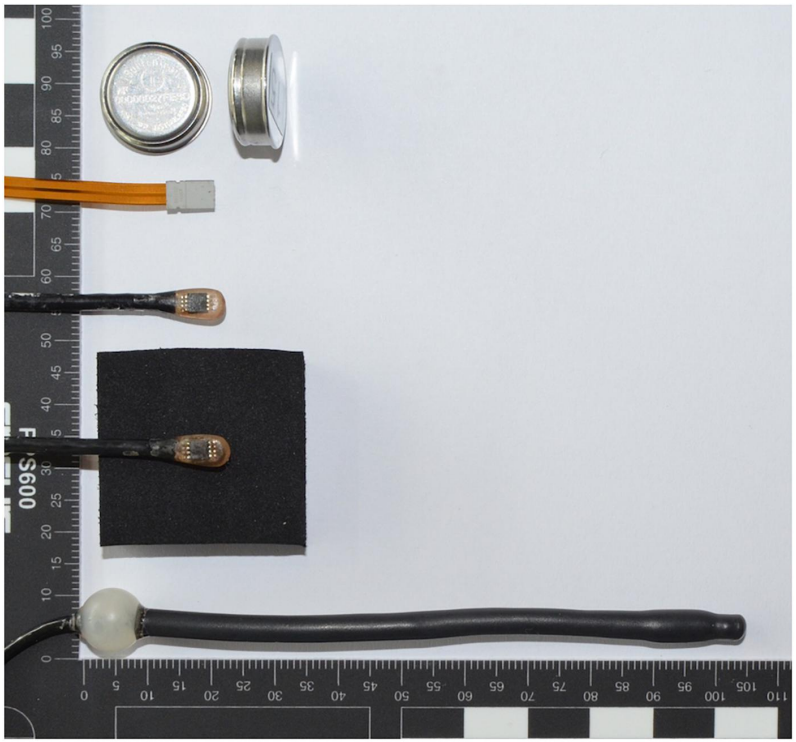


Buišas, 2012

Temperature

- Body temperature
- Surroundings temperature
- Object temperature

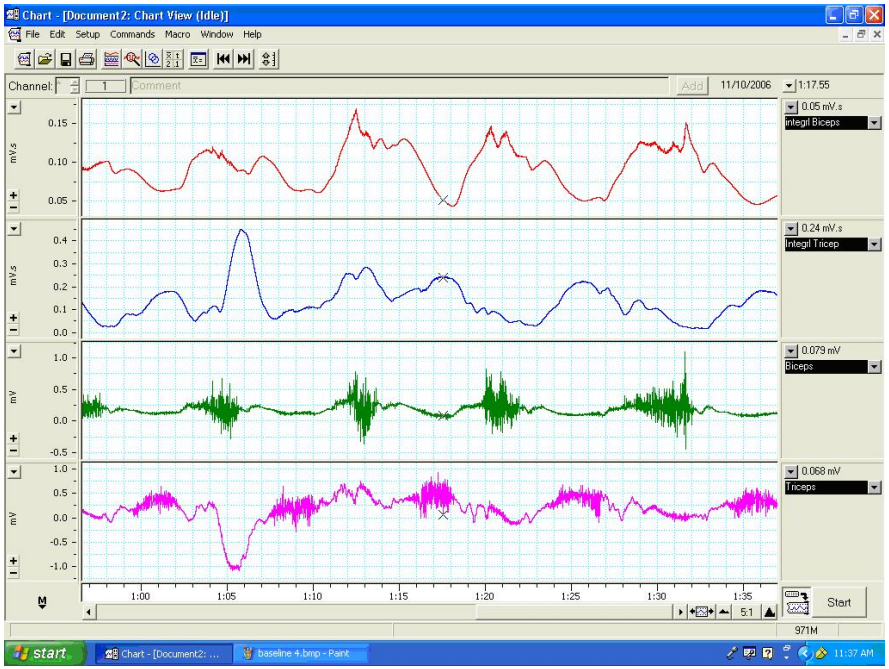


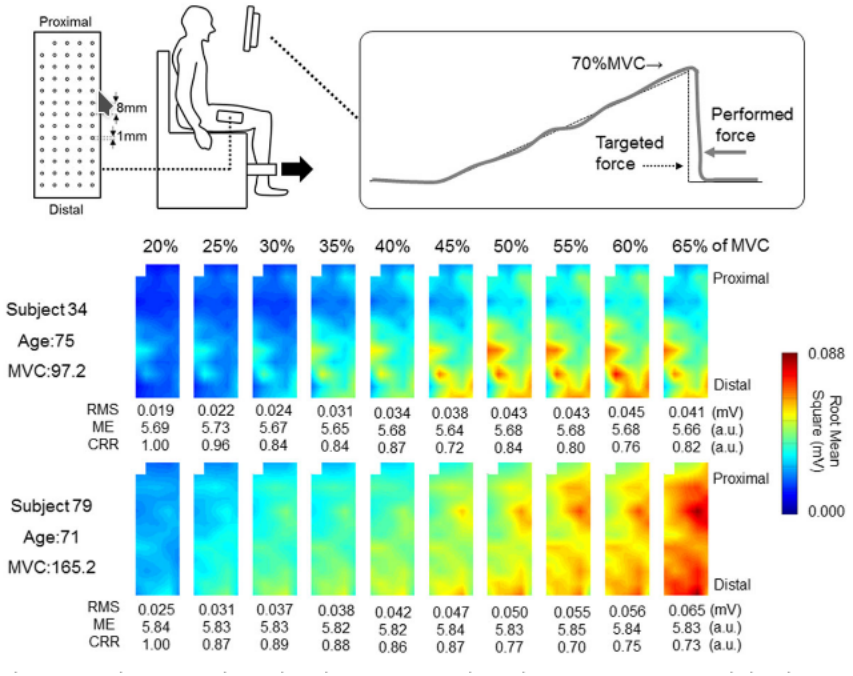


Eggenberger, 2018

Electromyography (EMG)

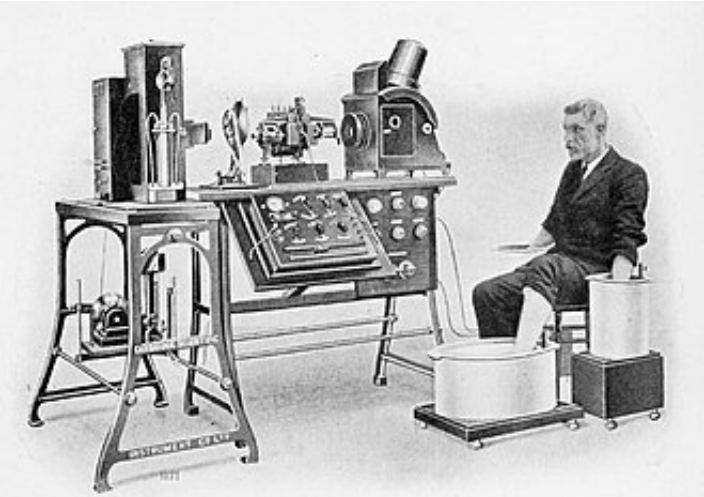
- Measurement of muscle electrical activity



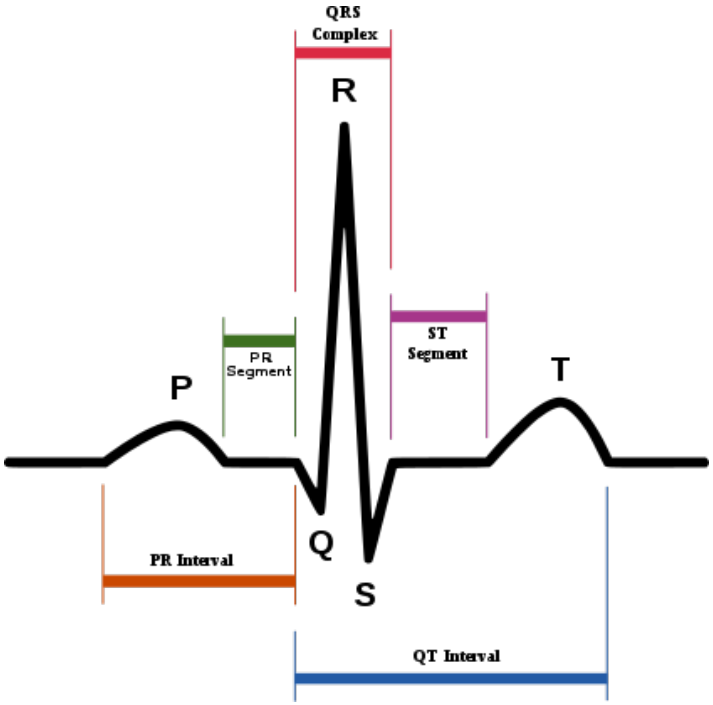


Watanabe, 2018

Electrocardiography (ECG)



Photograph of a Complete Electrocardiograph, Showing the Manner in which the Electrodes are Attached to the Patient, In this Case the Hands and One Foot Being Immersed in Jars of Salt Solution



Electroencephalography (EEG) and Magnetoencephalography (MEG)

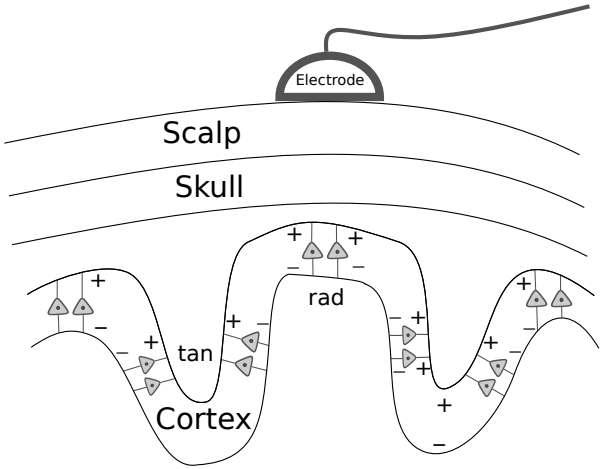
Delta <4Hz

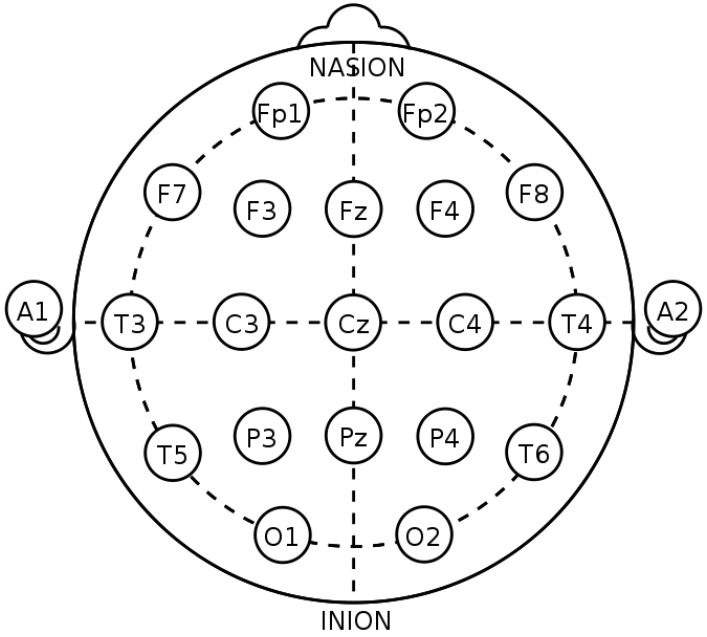
Theta 4-7Hz

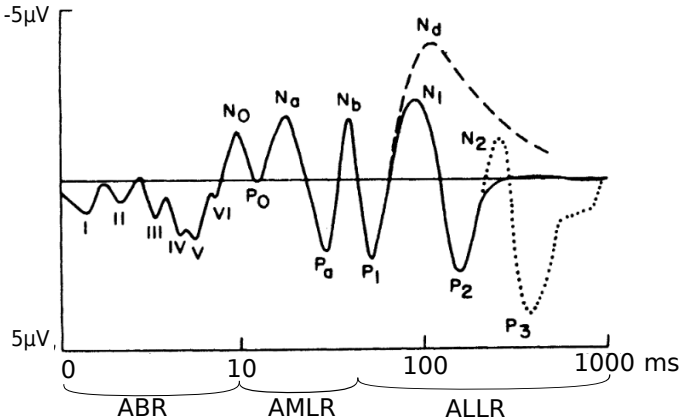
Alpha 8-15Hz

Beta 16-31 Hz

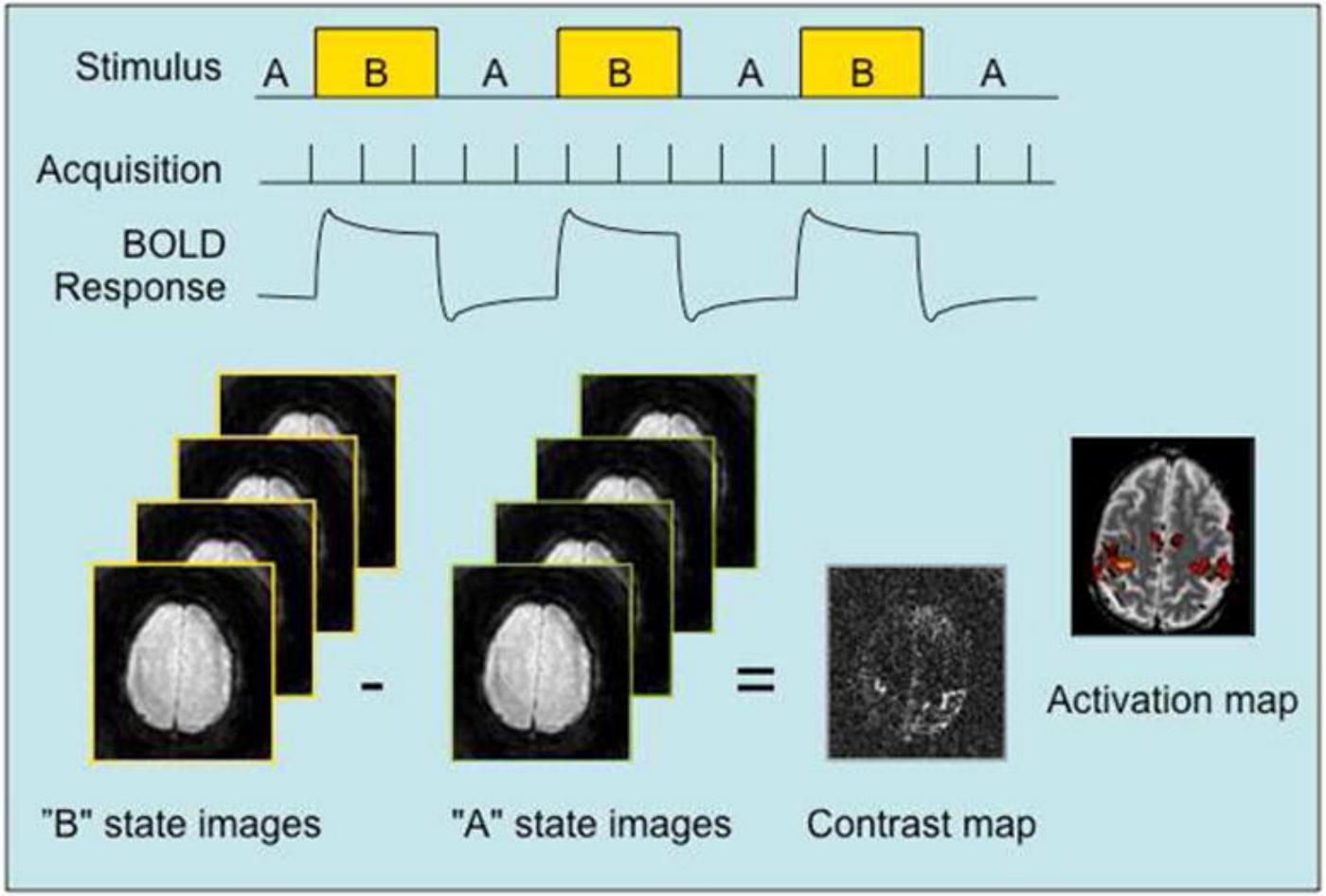
Gamma >31





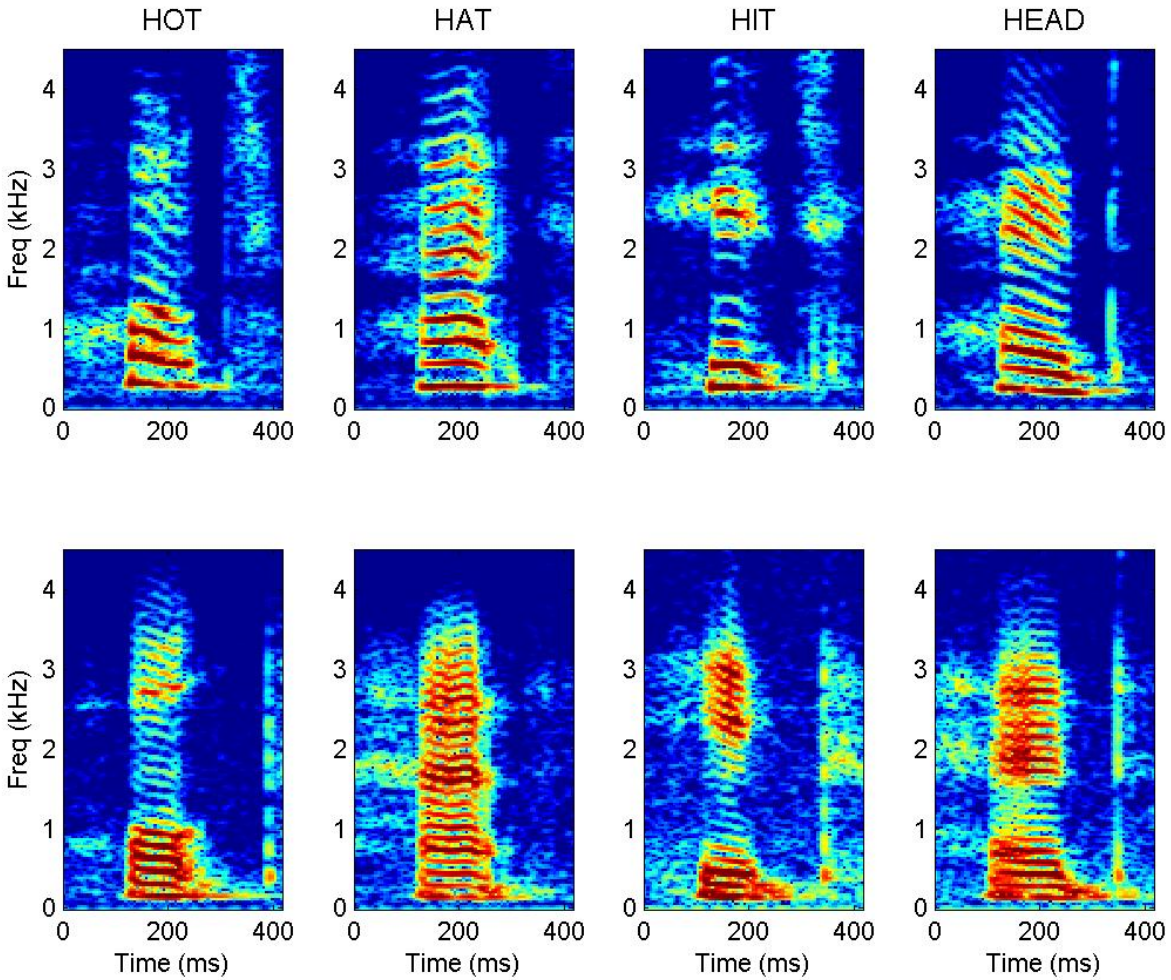


Functional magnetic resonance imaging (fMRI)



Glover, 2010

Speech



Schnupp, 2010

Questionnaire

Positive scale (min =1, max = 49)

- Delusions
- Conceptual disorganization
- Hallucinations
- Excitement
- Grandiosity
- Suspiciousness/persecution
- Hostility

Negative scale (min =1, max = 49)

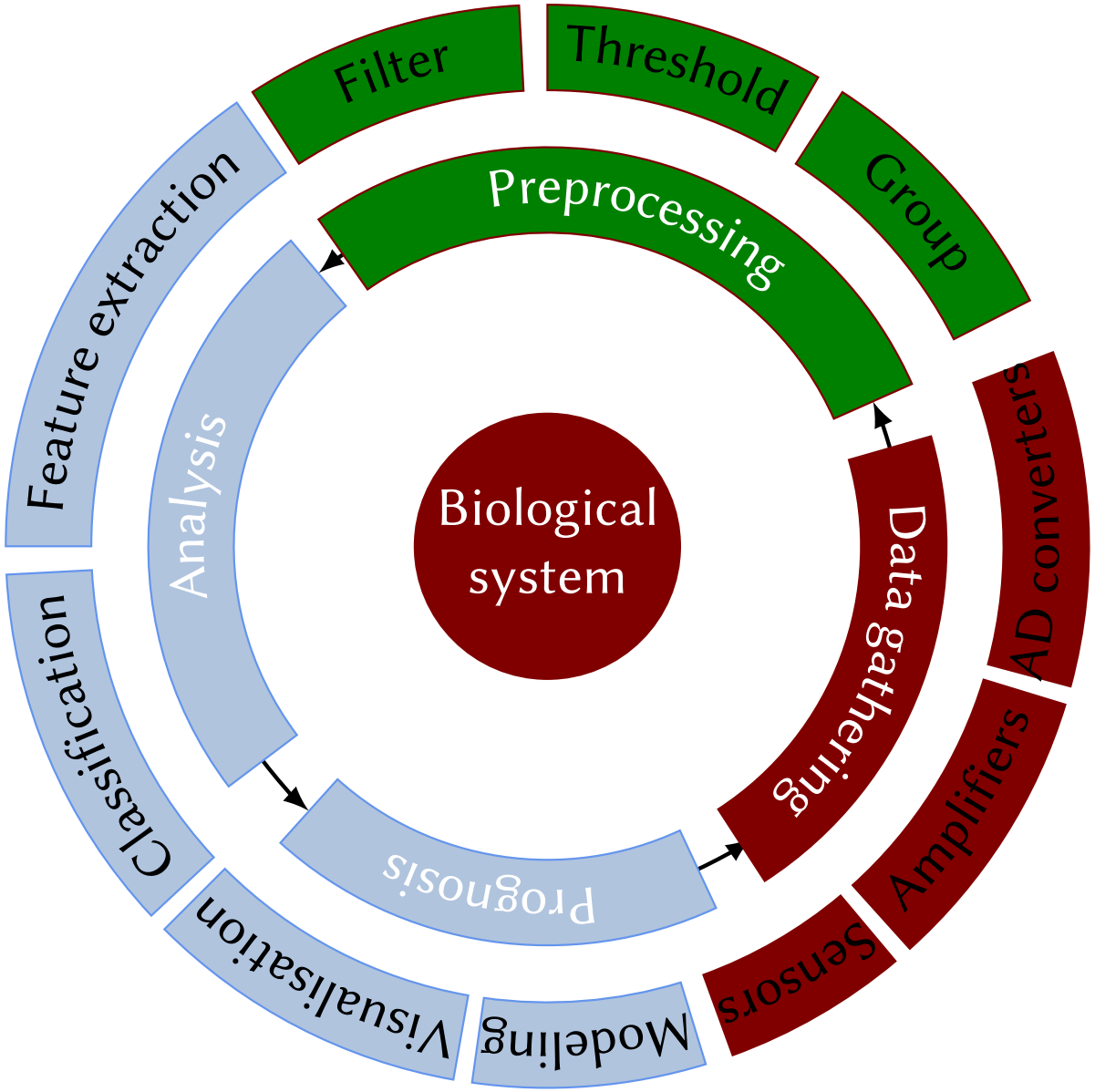
- Blunted affect
- Emotional withdrawal
- Poor rapport
- Passive/apathetic social withdrawal
- Difficulty in abstract thinking
- Lack of spontaneity and flow of conversation
- Stereotyped thinking

General Psychopathology scale (min = 16, max = 112)

- Somatic concern
- Anxiety
- Guilt feelings
- Tension
- Mannerisms and posturing
- Depression
- Motor retardation
- Uncooperativeness
- Unusual thought content
- Disorientation
- Poor attention
- Lack of judgment and insight
- Disturbance of volition
- Poor impulse control
- Preoccupation
- Active social avoidance

Opler, 2017

Biological data analysis



Quiz

- Linux, Windows, Mac
- Git
- Python2, Python3, IPython
- Pip, conda
- Numpy, pandas, matplotlib, seaborn
- Idle, JupyterLab, Visual Studio Code, PyCharm, vim
- Latex, markdown

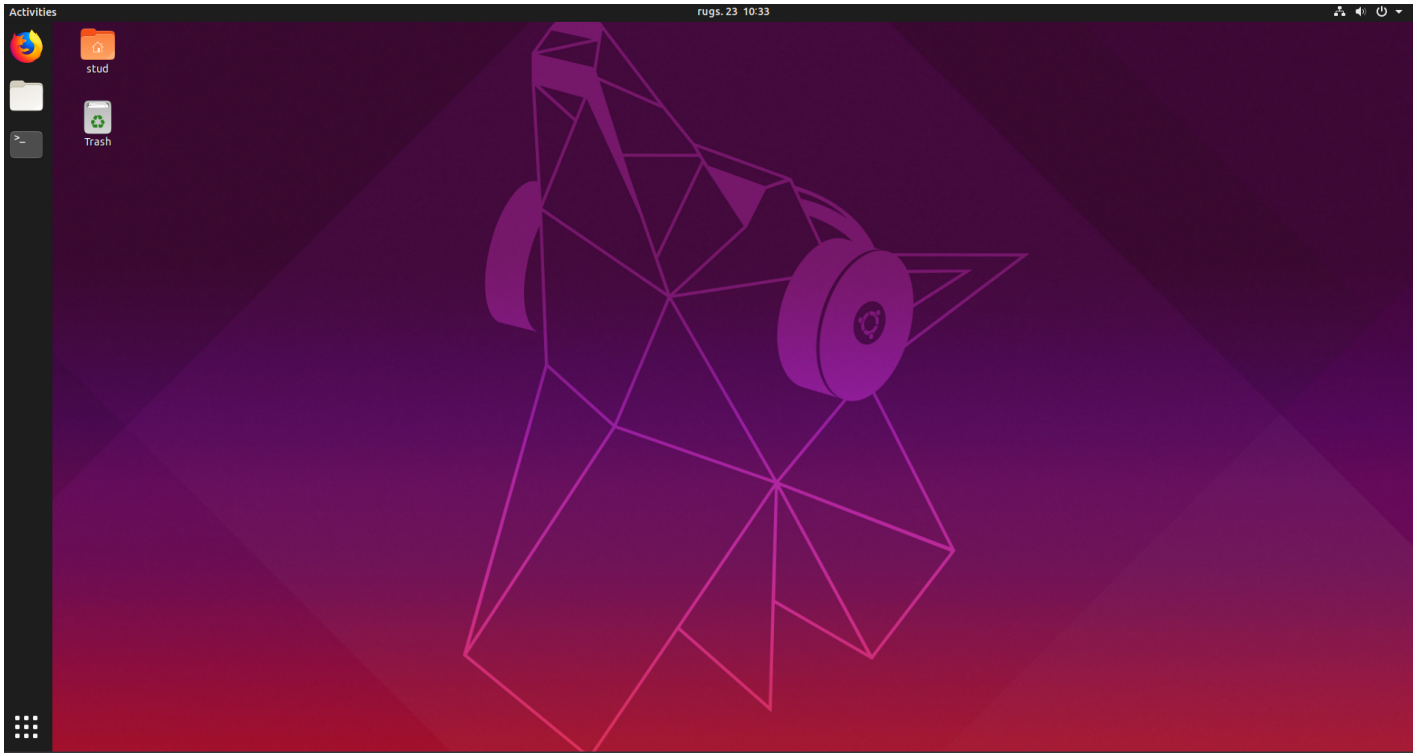
Linux introduction

- Virtual machine (Virtualbox)
- www.distrowatch.com
- https://docs.microsoft.com/en-us/windows/wsl/install-win10

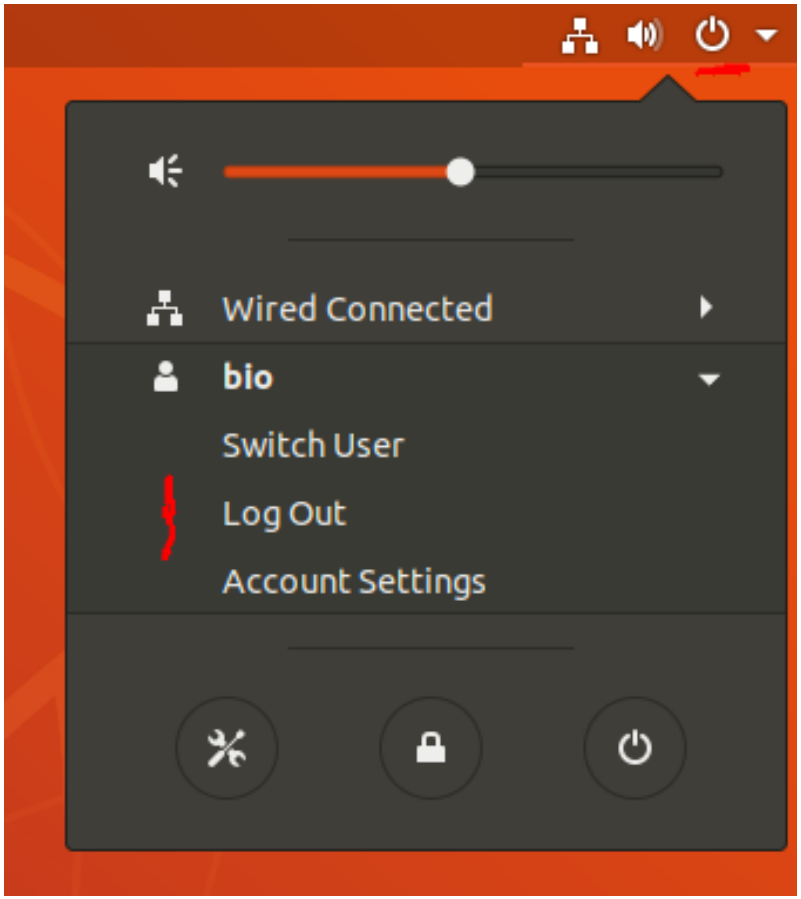
Data span: Last 12 months Go

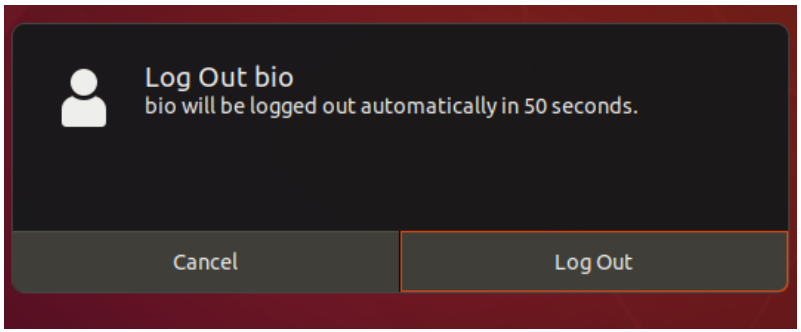
Rank	Distribution	HPD*
1	MX Linux	3913▲
2	Manjaro	3248▼
3	Mint	2135▼
4	elementary	1665▼
5	Ubuntu	1393▼
6	Debian	1318▲
7	Solus	983–
8	Fedora	979–
9	openSUSE	809–
10	Zorin	757–
11	deepin	683–
12	antiX	635▲
13	KDE neon	628▲
14	CentOS	607–
15	ReactOS	584▼
16	Arch	583–
17	ArcoLinux	517▲
18	Parrot	474–
19	Kali	468▼
20	PCLinuxOS	464–

GUI

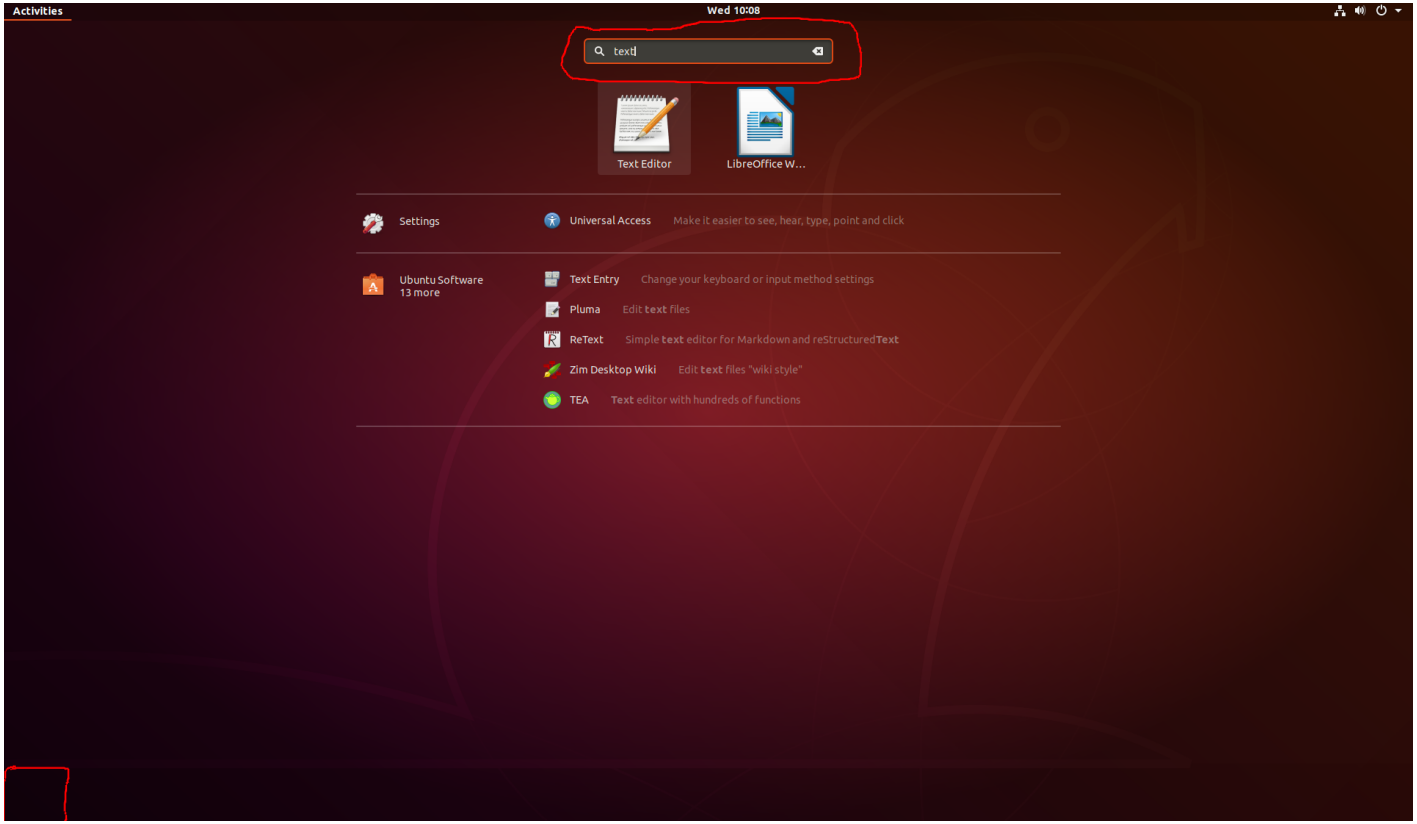


Log Out

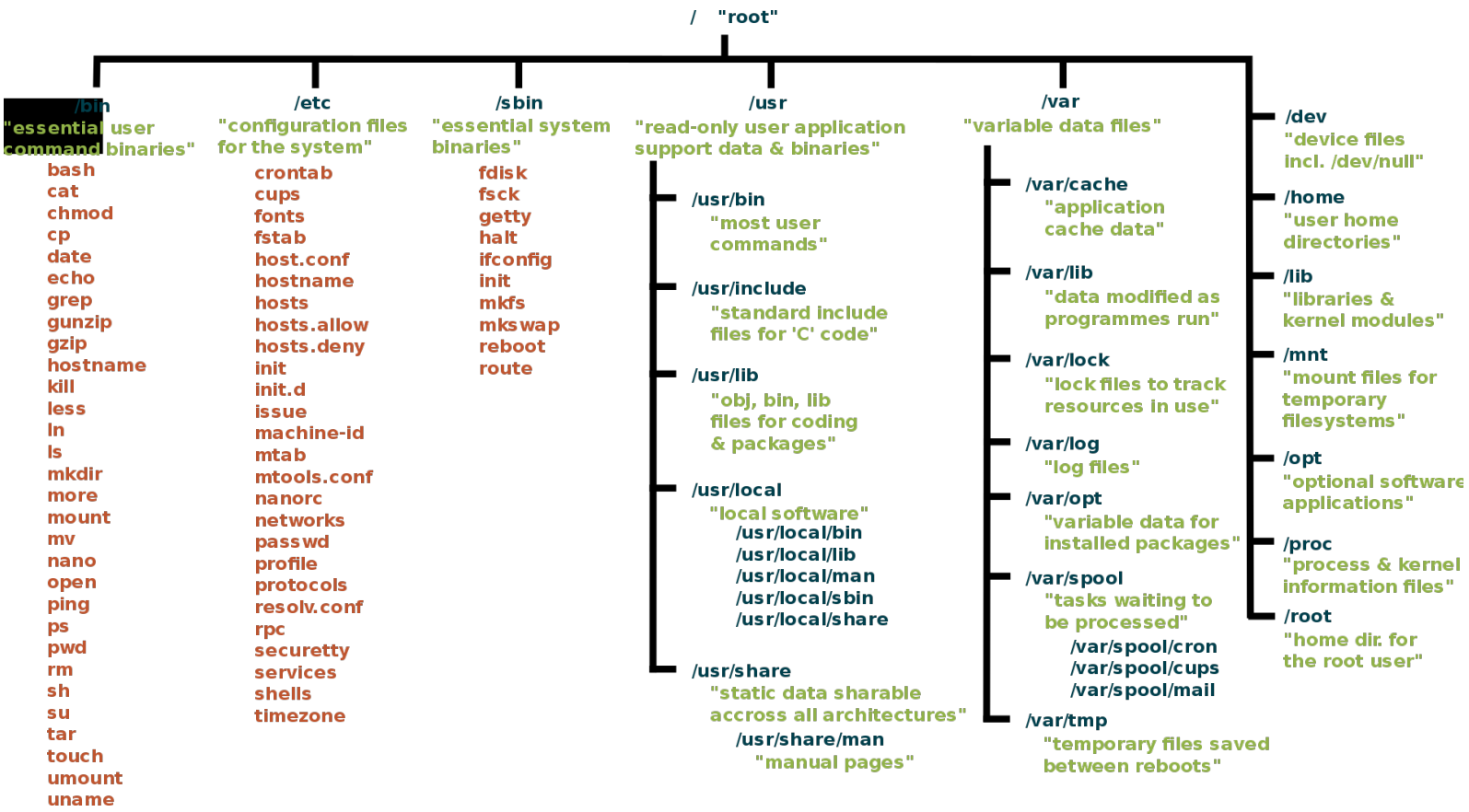

Wired Connected
bio
Switch User
Log Out
Account Settings


Log Out bio
bio will be logged out automatically in 50 seconds.
Cancel
Log Out

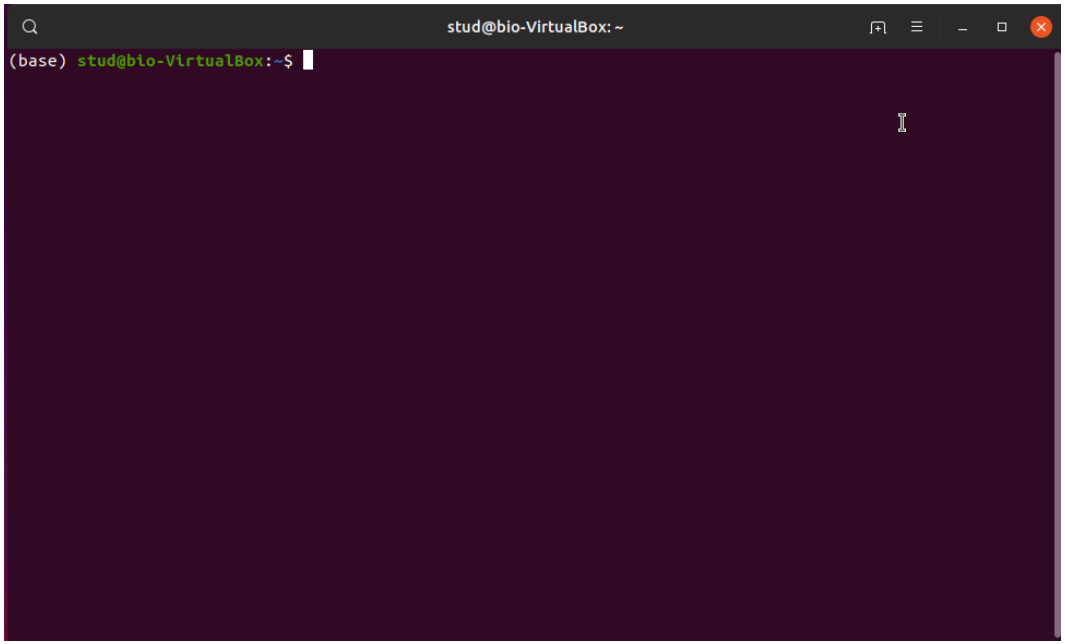
Start


Activities
Wed 10:08
text
Text Editor
LibreOffice W...
Settings
Universal Access
Make it easier to see, hear, type, point and click
Ubuntu Software
13 more
Text Entry
Change your keyboard or input method settings
Pluma
Edit text files
ReText
Simple text editor for Markdown and reStructuredText
Zim Desktop Wiki
Edit text files "wiki style"
TEA
Text editor with hundreds of functions

Linux file system



Terminal, konsole, shell



- Terminal — text input output environment (tty - teletypewriter)
- Konsole — physical terminal
- Shell — command line interpreter (Bash, fish, zsh)
- ”text window” on linux system (under X11): terminal emulator, connected to a virtual terminal, identified by a tty file, inside which runs a shell.

Basic commands: documentation

```
1  man man
2
3  MAN(1)                Manual pager utils
4
5  NAME
6        man - an interface to the system reference manuals
7
8  SYNOPSIS
9        man [man options] [[section] page ...] ...
10       man -k [apropos options] regexp ...
11       man -K [man options] [section] term ...
12       man -f [whatis options] page ...
13       man -l [man options] file ...
14       man -w|-W [man options] page ...
15
16 DESCRIPTION
17       man  is  the  manual pager.  Each page argument
18       given to man is normally the name of a program, utility or function.
```

- vi, less navigation
- lkjh — arrows
- / — search (n(ext), N)
- C-d(own), D-u(p) — scroll

Basic commands: navigation

```
1  cd ~/Documents/      # go to Documents direcotry
2  cd /                 # go to root directory
3  cd ..                # go one directory up
4  cd .                 # current directory
5  cd ../../            # go two diretories up (relative path)
6  cd -                 # go to previuos location
7  ls                   # view contents of directory
8  pwd                  # get path of current directory
```

Permissions

|directory| user | group | all |
| d | rwx | rwx | rwx |

- -rw-rw-r– 1 user group size data filename
- drwxrwxrwx 1 user group size data filename
- chmod u+x filename
- chown filename

Basic commands: create and remove

```
1 touch filename          # create empty file named filename
2 rm filename             # remove file named filename
3 mkdir dirName           # create directory named dirName
4 rm -rf dirName          # remove direcotry recursively
5 cp -r folderName place  # copy folder to place
6 mv file newfile         # move file to other place or rename it
```

Basic commands: view

```
ls              # view contents of home directory
cat filename    # view contents of filename
less filename   # view contents of filename in less
head filename   # view first 5 rows of file
tail filename   # view last 5 rows of file
```

Basic commands: search

```
1 grep the test.txt
2 find .
3 find . -type d
4 find . -type f
5 find . -name '*.pdf'
```

Basic commands: pipe

```
1 man ls | grep -- -a
```

Basic commands: write to file

```
1 echo "sentence a b c" >> newFile  # creates new file
2 echo "second sentence" > newFile  # appends to file
```

Combine all

```
1 wc -l $(find . -name '*LY*.csv') | sort -n >> newfile.txt
```

Basic commands: edit files

```
# open file in vim editor (Terminal)
vim fileName

# open file in nano editor (Terminal)
nano fileName

# open file in gedit editor (GUI, depends on Linux distribution)
# similar to notepad
gedit fileName
```

Basic commands: bashrc

```
1 gedit .bashrc
```

Basic commands: google, duckduckgo

- filetype, site, intitle
- "", -, ,*
- bang!
- author:,
- ...

```
1  alias goy='googler -t y1'
2  alias define='googler -n 2 define'
```

Basic commands: translate

```
1  alias tel='trans -s en -t lt'
2  alias tle='trans -s lt -t en'
```