

Métodos numéricos para escoamentos em nano e microescalas

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Schematic diagram of a basic MD code

Define initial positions and velocities $\vec{r}_i(t_0)$ and $\vec{v}_i(t_0)$

Calculate forces at current time t_n :

$$\vec{F}_i = - \vec{\nabla}_i U(\vec{r}_1, \vec{r}_2, \vec{r}_3, \dots, \vec{r}_{N_{\text{at}}})$$

Solve equations of motion for all particles in the system over a short timestep Δt .

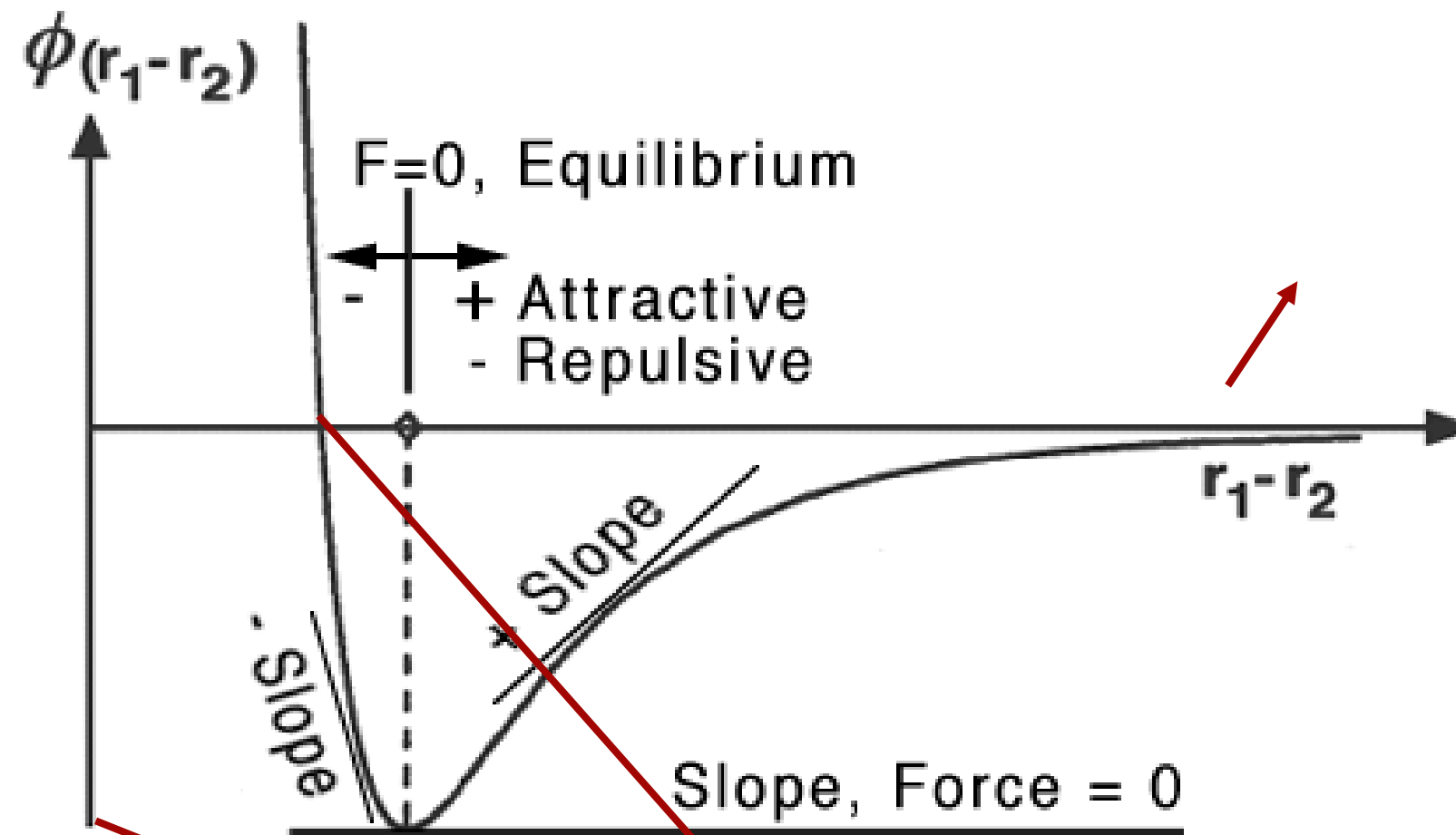
$$\vec{r}_i(t_n) \rightarrow \vec{r}_i(t_{n+1}) \quad \vec{v}_i(t_n) \rightarrow \vec{v}_i(t_{n+1})$$
$$t_{n+1} = t_n + \Delta t$$

Calculate desired physical quantities, write data to trajectory file

Is $t_{n+1} > t_{\text{max}}$?

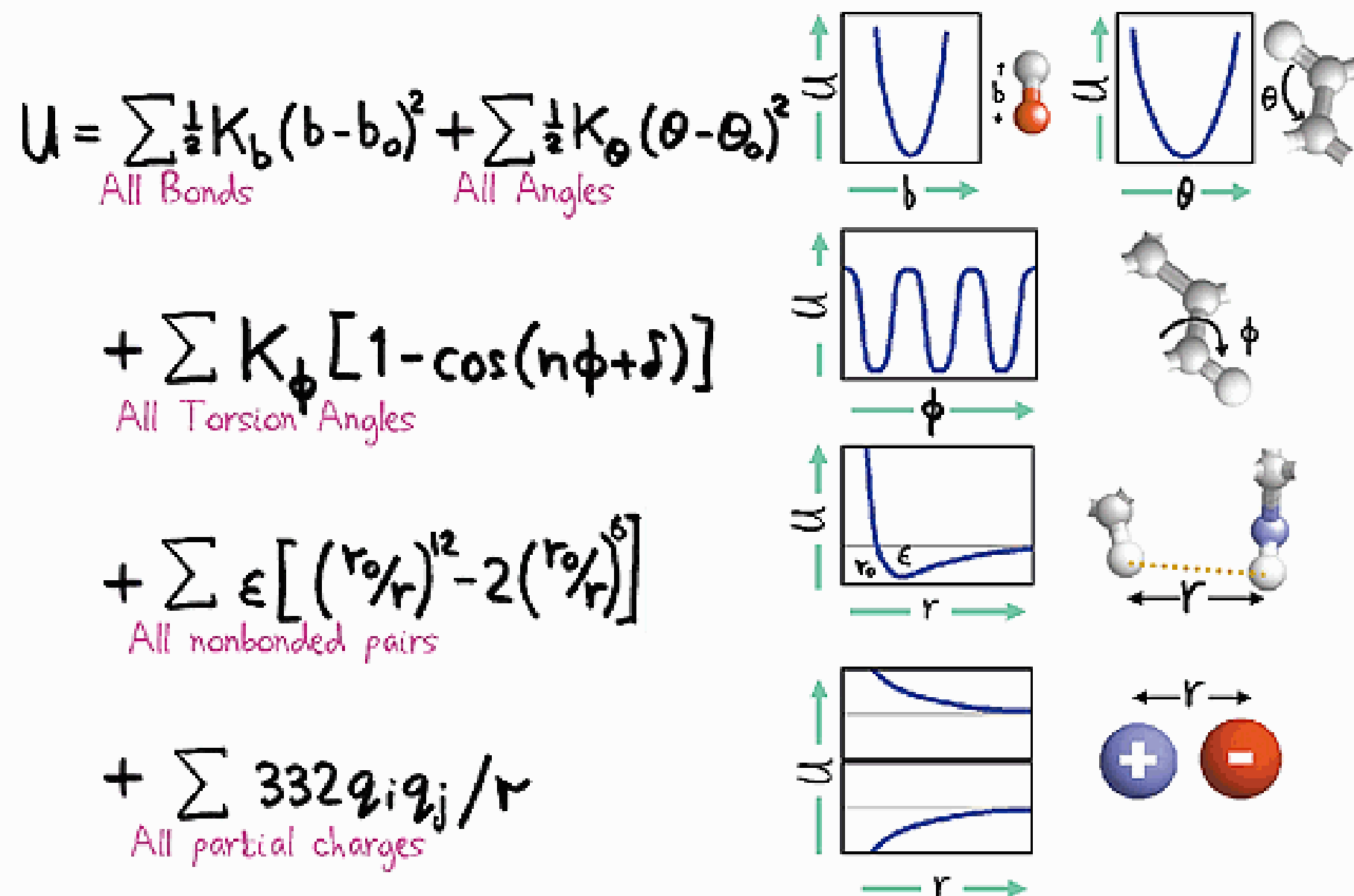
Write to the disc final atomic configuration & finish

Potencial Lennard-Jones

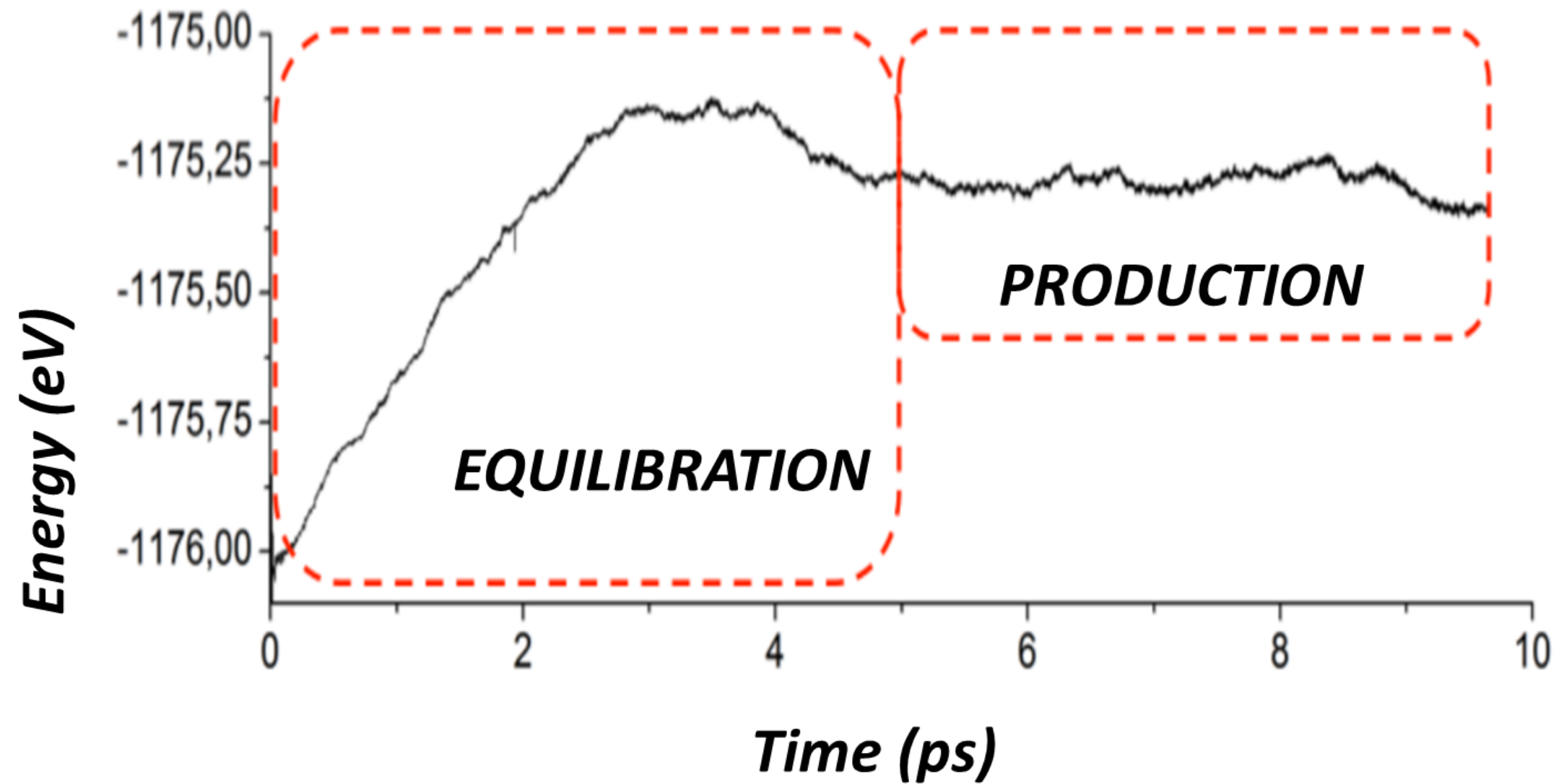


$$u(r) = 4\epsilon \left[\left(\frac{\sigma}{r} \right)^{12} - \left(\frac{\sigma}{r} \right)^6 \right]$$

Potenciais para moléculas complexas



Propriedades de equilíbrio



https://www.virtualbox.org/

Caixa de ent x | Inbox (11,82 x | Correio :: Ent x | IDEACÃO DC x | Universidade x | Brazil's budg x | Avisos x | Oracle VM V x

virtualbox.org

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VirtualBox

Welcome to VirtualBox.org!

VirtualBox is a powerful x86 and AMD64/Intel64 [virtualization](#) product for enterprise as well as home use. Not only is VirtualBox an extremely feature rich, high performance product for enterprise customers, it is also the only professional solution that is freely available as Open Source Software under the terms of the GNU General Public License (GPL) version 2. See "[About VirtualBox](#)" for an introduction.

Presently, VirtualBox runs on Windows, Linux, Macintosh, and Solaris hosts and supports a large number of [guest operating systems](#) including but not limited to Windows (NT 4.0, 2000, XP, Server 2003, Vista, Windows 7, Windows 8, Windows 10), DOS/Windows 3.x, Linux (2.4, 2.6, 3.x and 4.x), Solaris and OpenSolaris, OS/2, and OpenBSD.

VirtualBox is being actively developed with frequent releases and has an ever growing list of features, supported guest operating systems and platforms it runs on. VirtualBox is a community effort backed by a dedicated company: everyone is encouraged to contribute while Oracle ensures the product always meets professional quality criteria.

Download VirtualBox 6.1

Hot picks:

- Pre-built virtual machines for developers at [Oracle Tech Network](#)
- **Hyperbox** Open-source Virtual Infrastructure Manager [project site](#)
- **phpVirtualBox** AJAX web interface [project site](#)

News Flash

- **New July 14th, 2020, 2020 VirtualBox 6.1.12 released!**
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- **New July 14th, 2020, 2020 VirtualBox 6.0.24 released!**
Oracle today released a 6.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- **New July 14th, 2020 VirtualBox 5.2.44 released!**
Oracle today released a 5.2 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- **New June 5th, 2020, 2020 VirtualBox 6.1.10 released!**
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- **New May 15th, 2020, 2020 VirtualBox 6.1.8 released!**
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

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8/27/2020

https://www.virtualbox.org/

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Espelho da máquina virtual

Espelho da máquina virtual (entre com seu e-mail USP):

<https://drive.google.com/file/d/1LBfsSdZ8HLWzjgRxsHeBxBK32O-0hOBc/>

Usuário: sampa

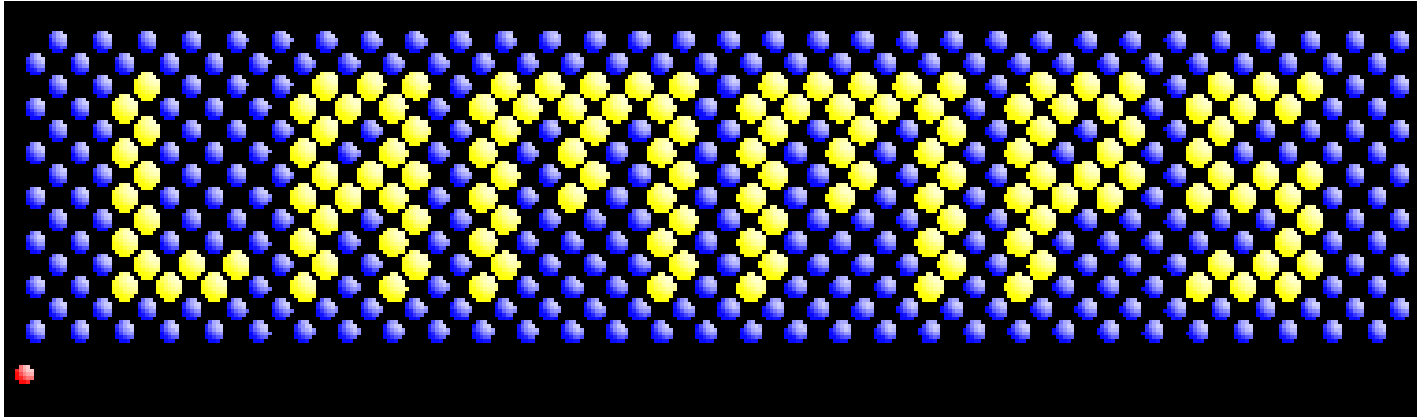
Senha: stds9

<https://github.com/Sampa-USP/mne2020>

LABORATÓRIO DINÂMICA MOLECULAR



DINÂMICA MOLECULAR

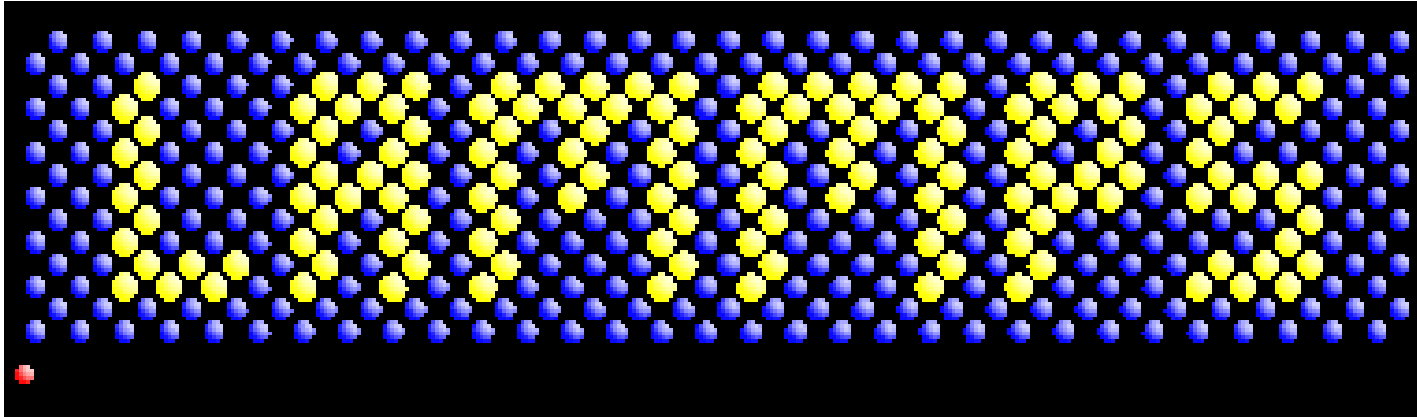


Lammps web-page:

<http://lammps.sandia.gov/>

- distribuição de código aberto
- roda em um único processador ou em paralelo
- distributed-memory message-passing parallelism (MPI)
- decomposição espacial do domínio de simulação para paralelismo
- C ++ altamente portátil
- bibliotecas opcionais usadas: MPI e FFT de processador único
- fácil de estender com novos recursos e funcionalidades

DINÂMICA MOLECULAR



Lammps web-page:

<http://lammps.sandia.gov/>

- executado a partir de um script de entrada
- Sintaxe para definir e uso de variáveis e fórmulas
- Sintaxe para repetição de execuções e quebra de loops
- Executa uma ou várias simulações simultaneamente (em paralelo) a partir de um script
- É possível usá-lo como biblioteca, invocar LAMMPS através da interface de biblioteca ou empacotador Python fornecido
- acoplar com outros códigos: LAMMPS chama outro código, outro código chama LAMMPS, o código guarda-chuva chama ambos

Pre-info

- **Arquivo de topologia:** descreve a geometria do sistema

- **Arquivo de entrada:**

Contém: configuração inicial
 integração
 potencial interatômico
 propriedades

0) Arquivo de topologia

LAMMPS topology of CH4.pdb using OPLS-AA force field

Atoms # full

5 atoms

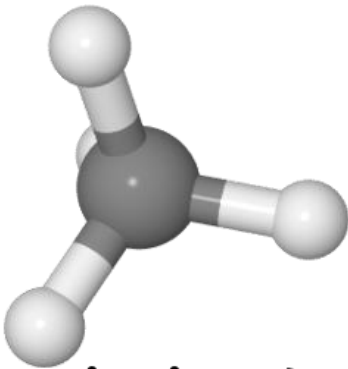
4 bonds

6 angles

2 atom types

1 bond types

1 angle types



-17.31900000

4.38100000

xlo xhi

-8.05000000

13.28000000

ylo yhi

-11.15300000

10.74300000

zlo zhi

Bonds # harmonic

| | | | | | | | |
|---|---|---|-------|---------|--------|---------|-----|
| 1 | 1 | 1 | -0.24 | -6.3750 | 2.8350 | 0.0000 | # C |
| 2 | 1 | 2 | 0.06 | -5.6190 | 2.1120 | 0.0000 | # H |
| 3 | 1 | 2 | 0.06 | -7.3190 | 3.2800 | 0.7430 | # H |
| 4 | 1 | 2 | 0.06 | -7.1930 | 1.9500 | 0.2200 | # H |
| 5 | 1 | 2 | 0.06 | -6.9470 | 2.5240 | -1.1530 | # H |

Angles # harmonic

| | | | | |
|---|---|---|---|---------|
| 1 | 1 | 1 | 2 | # C - H |
| 2 | 1 | 1 | 3 | # C - H |
| 3 | 1 | 1 | 4 | # C - H |
| 4 | 1 | 1 | 5 | # C - H |

Masses

| | | |
|---|--------|-----|
| 1 | 12.011 | # C |
| 2 | 1.008 | # H |

Pair Coeffs

| | | | |
|---|-------|-----|-----|
| 1 | 0.066 | 3.5 | # C |
| 2 | 0.030 | 2.5 | # H |

Bond Coeffs

| | | | |
|---|-------|------|---------|
| 1 | 340.0 | 1.09 | # C - H |
|---|-------|------|---------|

Angle Coeffs

| | | | |
|---|------|-------|-------------|
| 1 | 33.0 | 107.8 | # H - C - H |
|---|------|-------|-------------|

| | | | | | |
|---|---|---|---|---|-------------|
| 1 | 1 | 2 | 1 | 3 | # H - C - H |
| 2 | 1 | 2 | 1 | 4 | # H - C - H |
| 3 | 1 | 2 | 1 | 5 | # H - C - H |
| 4 | 1 | 3 | 1 | 4 | # H - C - H |
| 5 | 1 | 3 | 1 | 5 | # H - C - H |
| 6 | 1 | 4 | 1 | 5 | # H - C - H |

Lammps input script

Um script de entrada LAMMPS normalmente tem *4 partes*:

Inicialização

Definição de átomo

Configurações

Faça a simulação

As últimas 2 partes podem ser repetidas quantas vezes desejar. Ou seja execute uma simulação, altere algumas configurações, execute mais algumas, etc.

1) Initialization

Inclui os parâmetros que precisam ser definidos antes que os átomos sejam criados ou lidos de um arquivo.

Os comandos relevantes são: `units`, `dimension`, `newton`, `processors`, `boundary`, `atom_style`, `atom_modify`.

Se os parâmetros do campo de força aparecerem nos arquivos que serão lidos, esses comandos informam ao LAMMPS quais tipos de campos de força estão sendo usados:

`pair_style`, `bond_style`, `angle_style`, `dihedral_style`, `improper_style`.

2) Definição dos átomos

- Existem 3 maneiras de definir átomos no LAMMPS. Leia-os a partir de um arquivo de dados ou reinicie por meio dos comandos `read_data` ou `read_restart`.
 - Esses arquivos podem conter informações de topologia molecular.
 - Ou crie átomos em uma rede (sem topologia molecular), usando estes comandos: `lattice`, `region`, `create_box`, `create_atoms`.
 - Todo o conjunto de átomos pode ser duplicado para fazer uma simulação maior usando o comando `replicate`.
-

3) Configurações

Uma vez que os átomos e a topologia molecular são definidos, uma variedade de configurações pode ser especificada: **force field coefficients, simulation parameters, output options, etc.**

Os coeficientes do campo de força são definidos por esses comandos (eles também podem ser definidos nos arquivos de leitura): **pair_coeff, bond_coeff, angle_coeff, dihedral_coeff, improper_coeff, kspace_style, dielétrico, special_bonds.**

Vários parâmetros de simulação são definidos por estes comandos: **neighbor, neigh_modify, group, timestep, reset_timestep, run_style, min_style, min_modify.**

3) Configurações

As correções impõem uma variedade de condições de contorno, integração de tempo e opções de diagnóstico.

O comando **fix** vem em vários sabores.

Vários cálculos podem ser especificados para execução durante uma simulação usando os comandos **compute**, **compute_modify** e **variable**.

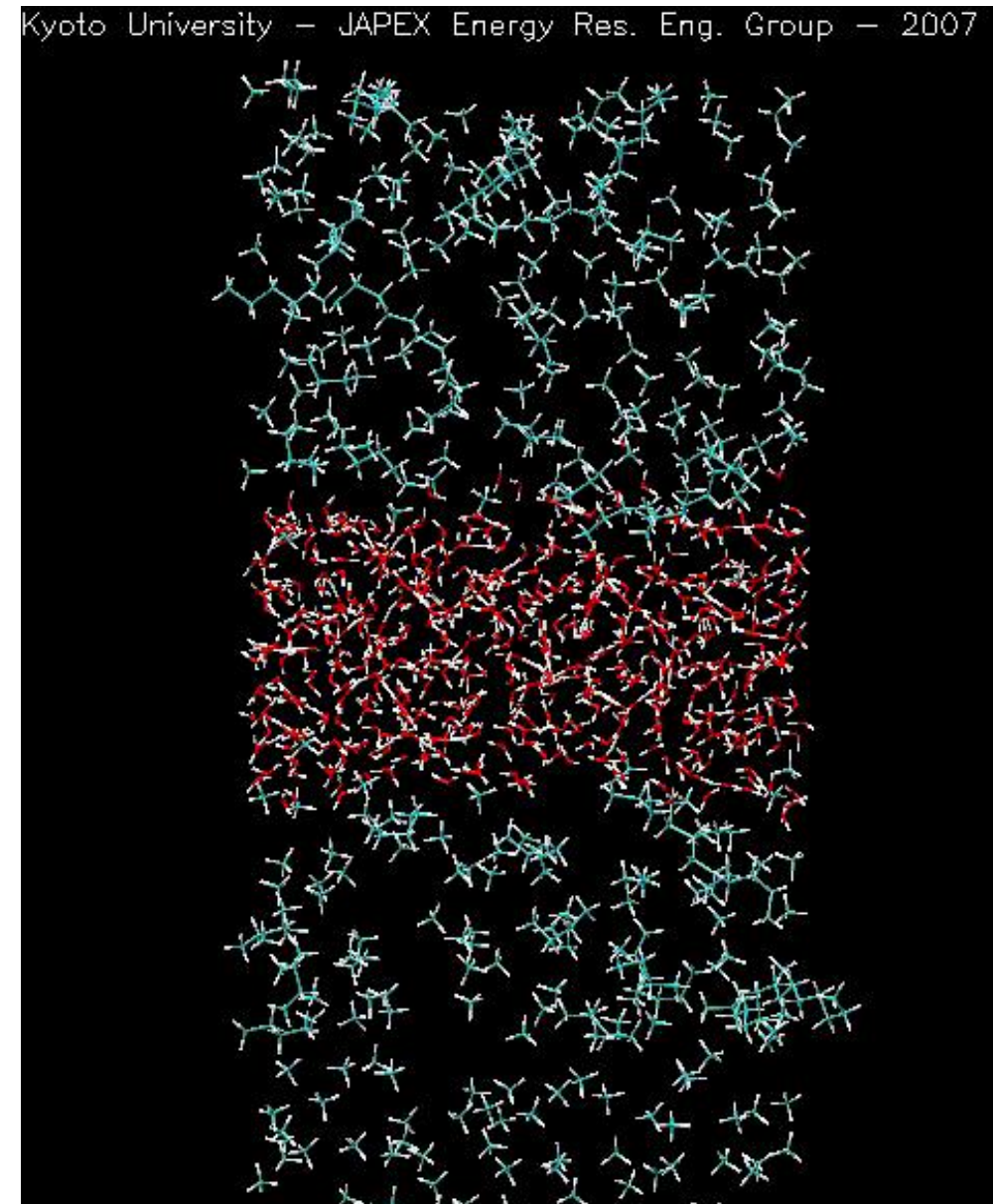
As opções de saída são definidas pelos comandos **thermo**, **dump** e **restart**.

4) Run a simulation

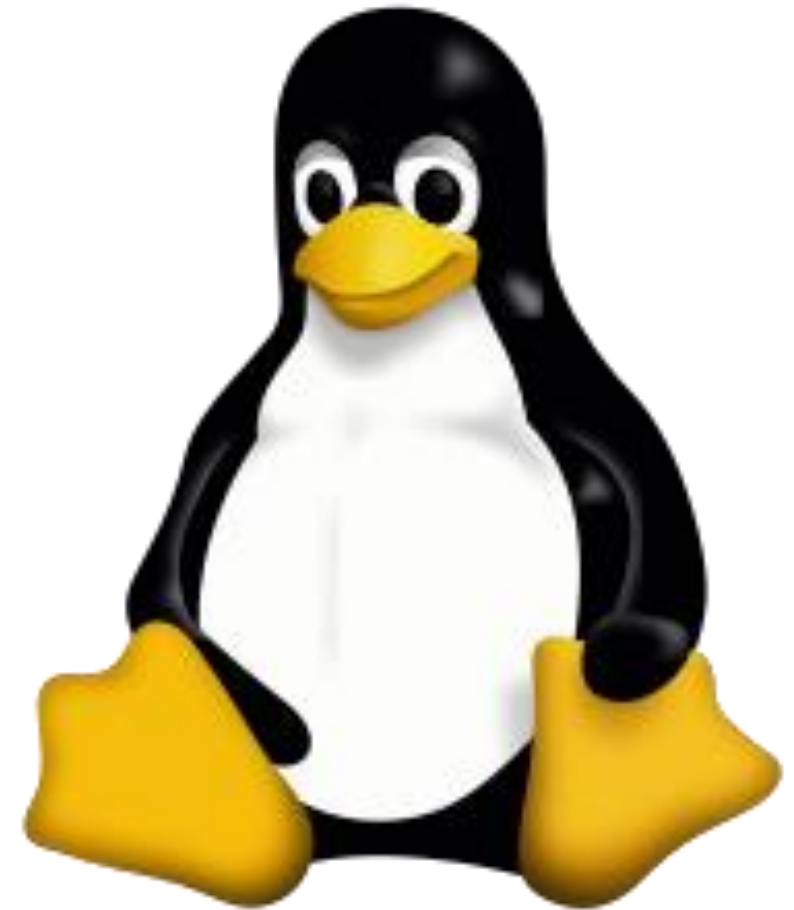
- Uma simulação de dinâmica molecular é executada usando o comando ***run***.
 - A minimização de energia (estática molecular) é realizada usando o comando ***minimize***
 - Uma simulação de temperatura paralela (troca de réplicas) pode ser executada usando o comando ***temper***.
-

Caso Interface Água-Óleo & CO₂

- ✓ Realistic models of crude oil
- ✓ Water, CO₂ and N₂
- ✓ Diffusion
- ✓ Viscosity
- ✓ Interface free energy tension
- ✓ Thermodynamics
(T and P database)



Nano tutorial: Introdução ao Linux



Origem

Linux é um clone do UNIX.

Livre e totalmente compatível com o UNIX.

Livre não é o mesmo que gratuito.

Escrito em C.

O kernel é o componente comum a todas as distribuições.

Kernel + ferramentas GNU formam o básico do Linux.

Linus Torvalds – Lançado em 17/09/1991

TUX - Torvalds **UniX**,



10 / 10

Largest cloud service providers
are Linux Foundation project
contributors and members

| | | | | | |
|----|--|------------|-----------|-----------|--------|
| 1 | Supercomputer Fugaku - Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D, Fujitsu RIKEN Center for Computational Science Japan | 7,299,072 | 415,530.0 | 513,854.7 | 28,335 |
| 2 | Summit - IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband, IBM DOE/SC/Oak Ridge National Laboratory United States | 2,414,592 | 148,600.0 | 200,794.9 | 10,096 |
| 3 | Sierra - IBM Power System AC922, IBM POWER9 22C 3.1GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband, IBM / NVIDIA / Mellanox DOE/NNSA/LLNL United States | 1,572,480 | 94,640.0 | 125,712.0 | 7,438 |
| 4 | Sunway TaihuLight - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway, NRCPC National Supercomputing Center in Wuxi China | 10,649,600 | 93,014.6 | 125,435.9 | 15,371 |
| 5 | Tianhe-2A - TH-IVB-FEP Cluster, Intel Xeon E5-2692v2 12C 2.2GHz, TH Express-2, Matrix-2000, NUDT National Super Computer Center in Guangzhou China | 4,981,760 | 61,444.5 | 100,678.7 | 18,482 |
| 6 | HPC5 - PowerEdge C4140, Xeon Gold 6252 24C 2.1GHz, NVIDIA Tesla V100, Mellanox HDR Infiniband, Dell EMC Eni S.p.A. Italy | 669,760 | 35,450.0 | 51,720.8 | 2,252 |
| 7 | Selene - DGX A100 SuperPOD, AMD EPYC 7742 64C 2.25GHz, NVIDIA A100, Mellanox HDR Infiniband, Nvidia NVIDIA Corporation United States | 272,800 | 27,580.0 | 34,568.6 | 1,344 |
| 8 | Frontera - Dell C6420, Xeon Platinum 8280 28C 2.7GHz, Mellanox InfiniBand HDR, Dell EMC Texas Advanced Computing Center/Univ. of Texas United States | 448,448 | 23,516.4 | 38,745.9 | |
| 9 | Marconi-100 - IBM Power System AC922, IBM POWER9 16C 3GHz, Nvidia Volta V100, Dual-rail Mellanox EDR Infiniband, IBM CINECA Italy | 347,776 | 21,640.0 | 29,354.0 | 1,476 |
| 10 | Piz Daint - Cray XC50, Xeon E5-2690v3 12C 2.6GHz, Aries interconnect, NVIDIA Tesla P100, Cray/HPE Swiss National Supercomputing Centre [SCS] Switzerland | 387,872 | 21,230.0 | 27,154.3 | 2,384 |

Distribuições

Debian:

Ubuntu (user-friendly).

Slackware:

OpenSUSE.

Suse Linux Enterprise.

Red Hat:

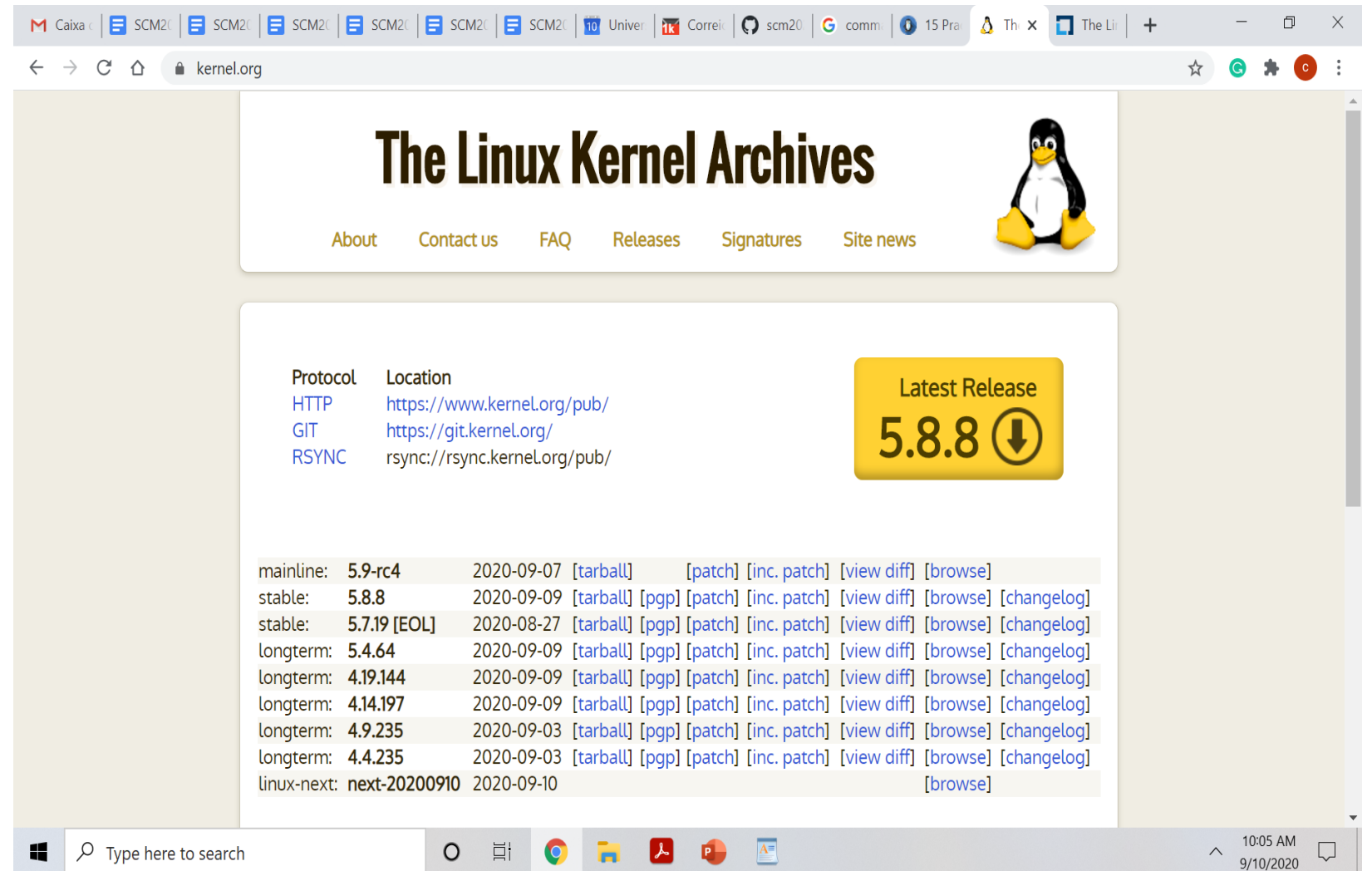
Red Hat Enterprise.

CentOS.

Fedora.

Gentoo.

Android

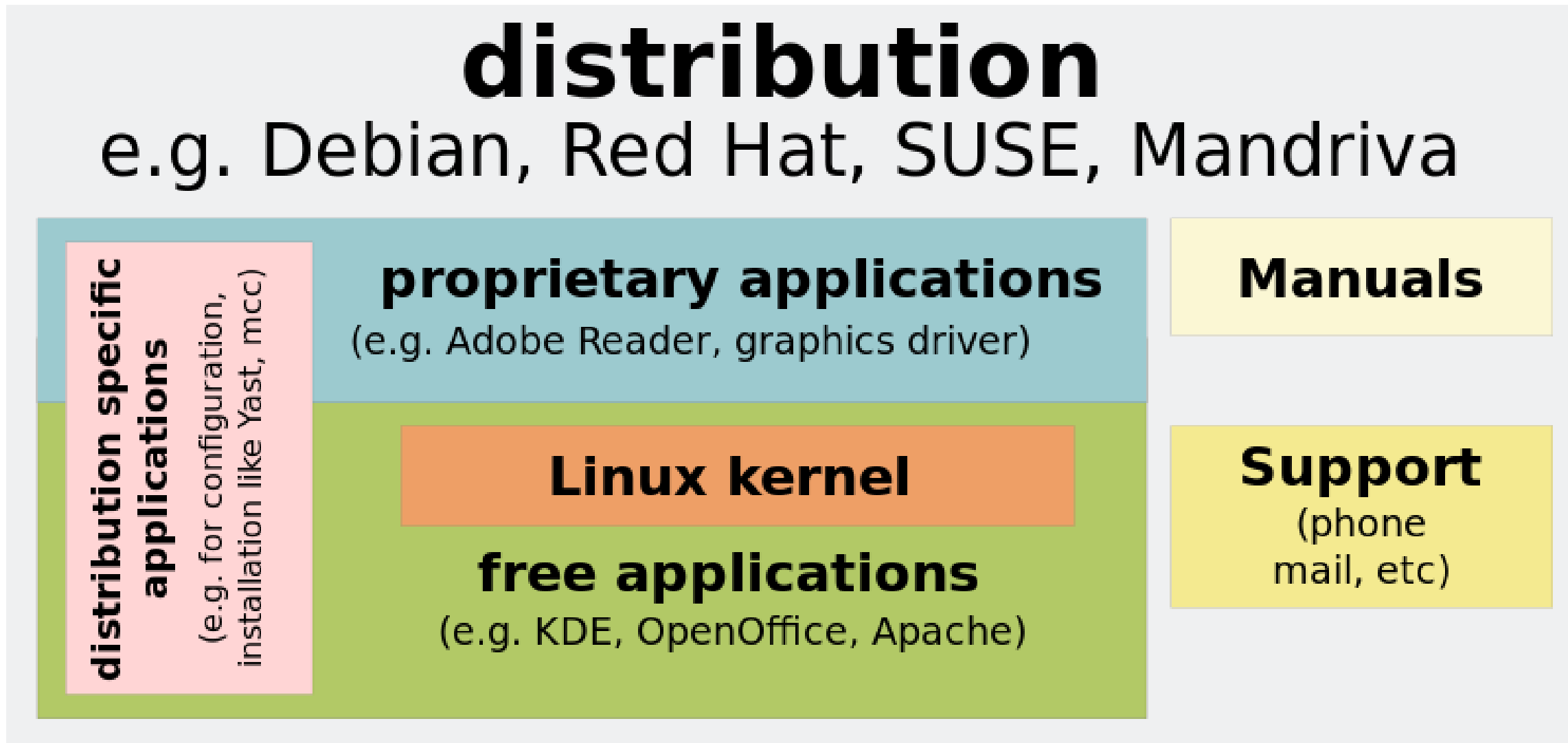


Arch Linux / Itens também pesquisados



Distribuições

Componentes de uma distribuição.



Vantagens do Linux

Plataforma estável.

Raramente resets são necessários, poucos system crash.

Escalável.

Milhões de CPUs:

TOP1: Tianhe-2 (MilkyWay-2), 3.120.000 cores, e 2.736.000 placas aceleradoras (Xeon-Phi), 33 PetaFlops.

476 máquinas no TOP500 + 16 máquinas UNIX (492).

Windows?

TOP187: Magic Cube, 30.720 cores, 0,180 PetaFlops.

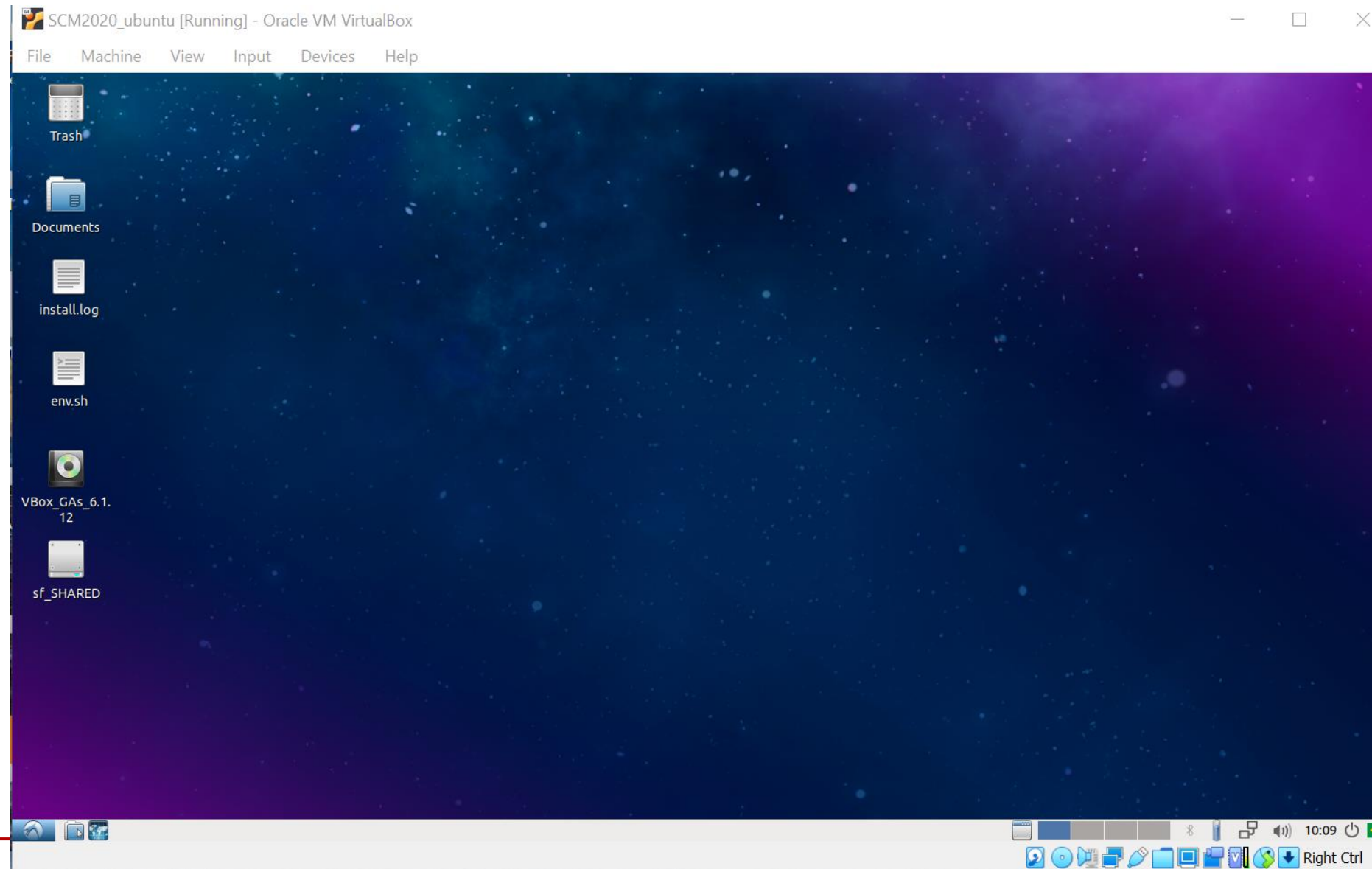
Apenas 3 máquinas no TOP500.

Se busca performance, o Linux é indiscutível.

Para uso pessoal há limitações.

Interfaces Gráficas

Unity (novos Ubuntu):



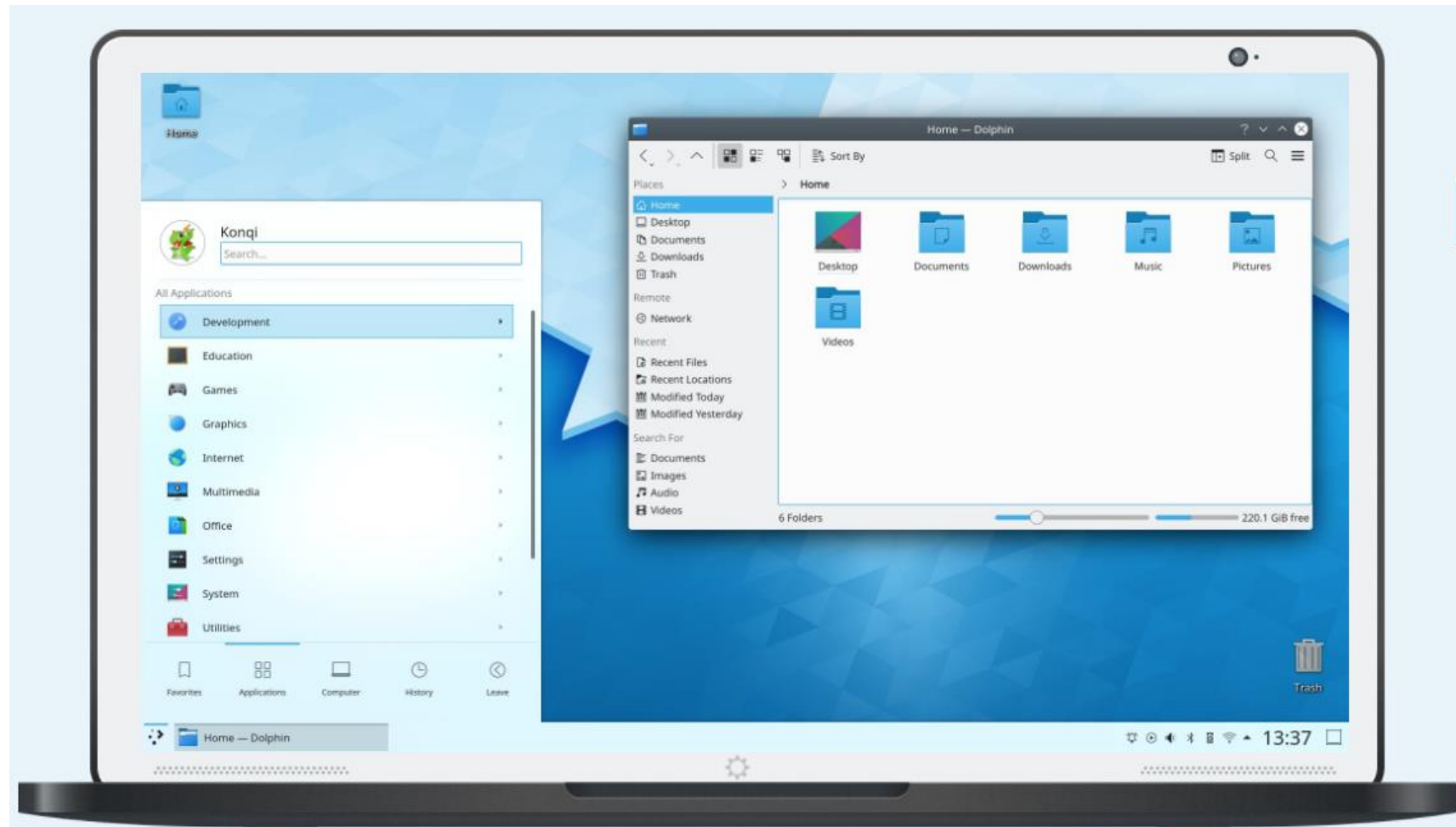
Interfaces Gráficas

Gnome 3:



Interfaces Gráficas

KDE (Plasma 01/09/2020)



Fragmentação

Todas essas opções levam a uma grande fragmentação.

Problemas de compatibilidade em programas pré-compilados.

Dificuldade na instalação de programas não compilados.

Demanda mais tempo do usuário.

Mas se compilado corretamente a performance é superior.

Terminal

Para as simulações deste curso o uso do terminal é indispensável.

```
root@musang:~# cd /bin/
root@musang:/bin# ls
Mail@      dirname*      id*           ntfs-3g*     sha224sum*   umount*
[*         dmesg*        install*     ntfs-3g.probe* sha256sum*   uname*
arch*      dnsdomainname@ ipmask*      ntfsclust*   sha384sum*   uncompress@
ash*       domainname@   join*        ntfscluster* sha512sum*   unexpand*
awk@       du*           kill*        ntfscomp*    shred*       uniq*
base64*    echo*         killall*     ntfsfix*     shuf*        unlink*
basename*  ed@           ksh*         ntfsinfo*    sleep*       users*
bash*      egrep@        link*        ntfsls*      sln@         usleep*
bunzip2@   env*          ln*          od*           sort*        vdir*
bzipcat@   expand*       loadkeys*    paste*       split*       wc*
bzip2*     expr*        login*       pathchk*     stat*        which*
bzip2recover* factor*       logname*     ping*         stty*        who*
cat*       false*       ls*          ping6*        su*          whoami*
chgrp*     fgrep@       lsmmod@      pinky*        sulogin@    yes*
chmod*     fmt*         mail@        pr*           sum*         ypdomainname@
chown*     fold*        md5sum*      printenv*     sync*        zcat*
chroot*    free*        mkdir*       printf*       tac*         zcmp*
cksum*     ftp*         mkfifo*      ps*           tail*        zdiff*
comm*      fusermount*  mknod*       ptx*          tar*         zegrep*
compress@  gawk@        more*        pwd*          tar-1.13*    zfgrep*
cp*        gawk-3.1.5*  mount*       readlink*     tar-1.16.1@ zforce*
cpio*      getopt*      mt@          rksh@         tcsh*        zgrep*
csh@       ginstall@    mt-GNU*      rm*           tee*         zless*
csplit*    grep*        mt-st*       rmdir*        telnet*      zmore*
cut*       groups*      mv*          rpm*          test*        znew*
date*      gunzip*      nail@        rzip*         touch*       zsh*
dd*        gzexe*       netstat*     sed*          tr*          zsh-4.3.6@
df*        gzip*        nice*        seq*          true*
dialog*    head*        nisdomainname@ setterm*      tsort*
dir*       hostid*      nl*          sh@           tty*
dircolors* hostname*    nohup*       sha1sum*     unlockmgr_server*
```

Comandos principais

Navegação:

ls (list)

cd (change directory)

pwd (print work directory)

clear (limpa o terminal)

Comandos principais

Gerenciando arquivos e extraindo informações:

mkdir (make directory)

touch

mv (move)

rm (remove)

cp (copy)

cat (concatenate)

Comandos principais

Gerenciando arquivos e extraindo informações:

head

tail

comm, cmp (compare)

grep

Comandos principais

Processos:

ps (process status), top

kill

which

source

wget

chmod

Comandos principais

Processos:

echo

tar

wc (word count)

man CMD (manual)

apt-get update/updgrade/install

python

Editores de texto

Várias opções de editores de texto, tanto gráficos como de terminal. Algumas delas são:

Gráficos:

- gedit.
- gVim.
- emacs.
- kate.

Terminal:

- vim.
- emacs.
- nano.

Terminal

Comandos básicos.

Referências para comandos básicos de terminal:

<http://community.linuxmint.com/tutorial/view/100>

[http://www.pas.rochester.edu/~pavone/particle-
www/telescopes/ComputerCommands.htm](http://www.pas.rochester.edu/~pavone/particle-
www/telescopes/ComputerCommands.htm)

<http://www.ee.surrey.ac.uk/Teaching/Unix/>

<https://help.ubuntu.com/community/UsingTheTerminal>

http://linuxcommand.org/lc3_learning_the_shell.php

Terminal

Comandos básicos.

ls: lista os arquivos do diretório atual.

```
james@josephson:~/work> ls
cpmd  disorder  isaacs-2.5  lammps  lammps.tgz  RINGS  siesta  VAC  vasp
james@josephson:~/work> ls -lha
total 415G
drwxr-xr-x 10 james users 125 2013-04-17 15:47 .
drwxr-xr-x 14 james users 4.0K 2013-07-29 14:52 ..
drwxr-xr-x  3 james users  33 2012-02-09 19:38 cpmd
drwxrwxrwx  4 james users  80 2012-10-11 14:57 disorder
drwxr-xr-x  7 james users 4.0K 2012-06-25 03:10 isaacs-2.5
drwxr-xr-x  8 james users  91 2013-07-25 14:14 lammps
-rw-r--r--  1 james users 415G 2013-04-19 14:14 lammps.tgz
drwxr-xr-x  9 james users 123 2013-05-30 18:39 RINGS
drwxrwxr-x  3 james 1001  19 2012-02-03 18:36 siesta
drwxr-xr-x  6 james users  60 2012-11-09 09:54 VAC
drwxr-xr-x  6 james users  64 2012-10-17 16:20 vasp
james@josephson:~/work> █
```

Terminal

Comandos básicos.

pwd: mostra o diretório atual.

```
james@josephson:~/work> pwd
/home/james/work
james@josephson:~/work> █
```

cd: entra no diretório apontado (cd .. ; cd ~)

```
james@josephson:~/work> ls
cpmd  disorder  isaacs-2.5  lammps  lammps.tgz  RINGS  siesta  VAC  vasp
james@josephson:~/work> cd lammps/
james@josephson:~/work/lammps> ls
CNT+Graph  NTC+H2O  REAX  SiO2  SiO2-Reservoir  Water
james@josephson:~/work/lammps> cd ..
james@josephson:~/work> ls
cpmd  disorder  isaacs-2.5  lammps  lammps.tgz  RINGS  siesta  VAC  vasp
james@josephson:~/work> cd ~
james@josephson:~> ls
bin                dmidecode          makefile_lib_ice_paralelo  recursos           test128vasp.o5500
C_MT_PBE.psp       Dropbox            mpd.hosts              recursos.record    tmp
cpmd.DM.out        dropbox.py         mpitune                Screenshot.png    total.dat
CPMD.tgz           espresso-5.0.tar.gz nautilus-dropbox_0.7.1_amd64.deb test128vasp.e5499  work
Desktop            fstab              pacotes                test128vasp.e5500
desligamento.txt  makefile_ice_paralelo q.x                   test128vasp.o5499
james@josephson:~> █
```


Terminal

Comandos básicos.

mkdir: cria diretório.

```
james@josephson:~/work> ls
cpmd  disorder  isaacs-2.5  lammps  lammps.tgz  RINGS  siesta  VAC  vasp
james@josephson:~/work> mkdir teste
james@josephson:~/work> cd teste
james@josephson:~/work/teste> ls
james@josephson:~/work/teste> █
```

rm: remove arquivos (rm -rf remove diretórios).

```
james@josephson:~/work/teste> cd ..
james@josephson:~/work> ls
cpmd  disorder  isaacs-2.5  lammps  lammps.tgz  RINGS  siesta  teste  VAC  vasp
james@josephson:~/work> rm -rf teste/
james@josephson:~/work> ls
cpmd  disorder  isaacs-2.5  lammps  lammps.tgz  RINGS  siesta  VAC  vasp
james@josephson:~/work> █
```

Terminal

Comandos básicos.

cp: copia arquivos.

```
jalmeida@cobalto:~/work$ ls
lamps
jalmeida@cobalto:~/work$ ls ..
bin  FreeEnergyTutorial.tar.gz  graphene.mdf  job  pacotes  PDPD  q  temp  work
jalmeida@cobalto:~/work$ mkdir teste
jalmeida@cobalto:~/work$ cp ../graphene.mdf ./teste/
jalmeida@cobalto:~/work$ cd teste/
jalmeida@cobalto:~/work/teste$ ls
graphene.mdf
jalmeida@cobalto:~/work/teste$ █
```

mv: move arquivos.

```
jalmeida@cobalto:~/work/teste$ ls ../../
bin  FreeEnergyTutorial.tar.gz  graphene.mdf  job  pacotes  PDPD  q  temp  work
jalmeida@cobalto:~/work/teste$ mv ../../job ./
jalmeida@cobalto:~/work/teste$ ls
graphene.mdf  job
jalmeida@cobalto:~/work/teste$ ls ../../
bin  FreeEnergyTutorial.tar.gz  graphene.mdf  pacotes  PDPD  q  temp  work
jalmeida@cobalto:~/work/teste$ █
```

Terminal

Comandos básicos.

df -h: Mostra o uso de disco.

```
james@josephson:~/work/teste> df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/sda2        96G   41G   56G   43% /
devtmpfs        32G   168K   32G    1% /dev
tmpfs           32G     0   32G    0% /dev/shm
/dev/sda1       124M    61M   57M   52% /boot
/dev/sda4       152G   3.1G  149G    3% /data1
/dev/sdb1       3.0T   1.6G   3.0T    1% /cluster
/dev/loop0      2.9G   2.9G     0  100% /mnt/iso1
service1-ib1:/storage
                25T   18T   7.2T   72% /home
james@josephson:~/work/teste> █
```

Terminal

Comandos básicos.

top: Mostra o uso de cpu, memória e processos.

```
top - 21:36:48 up 7 days, 9:39, 1 user, load average: 32.01, 32.15, 32.54
Tasks: 1109 total, 33 running, 1076 sleeping, 0 stopped, 0 zombie
Cpu(s): 47.2%us, 0.2%sy, 0.0%ni, 52.6%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Mem: 258342M total, 67509M used, 190833M free, 1M buffers
Swap: 7999M total, 0M used, 7999M free, 8183M cached
```

| PID | USER | PR | NI | VIRT | RES | SHR | S | %CPU | %MEM | TIME+ | COMMAND |
|-------|---------|----|----|-------|------|------|---|------|------|-----------|-----------|
| 38931 | mplima | 20 | 0 | 2160m | 1.9g | 6824 | R | 100 | 0.8 | 1857:51 | transampa |
| 38932 | mplima | 20 | 0 | 2160m | 1.9g | 6832 | R | 100 | 0.8 | 1857:51 | transampa |
| 38936 | mplima | 20 | 0 | 2160m | 1.9g | 5268 | R | 100 | 0.8 | 1857:51 | transampa |
| 56037 | padilha | 20 | 0 | 1359m | 1.1g | 21m | R | 100 | 0.4 | 177:47.01 | openmx |
| 38921 | mplima | 20 | 0 | 3095m | 2.8g | 4768 | R | 100 | 1.1 | 1857:51 | transampa |
| 38922 | mplima | 20 | 0 | 3094m | 2.8g | 6812 | R | 100 | 1.1 | 1857:51 | transampa |
| 38923 | mplima | 20 | 0 | 3094m | 2.8g | 6828 | R | 100 | 1.1 | 1857:51 | transampa |
| 38924 | mplima | 20 | 0 | 2160m | 1.9g | 6836 | R | 100 | 0.8 | 1857:51 | transampa |
| 38925 | mplima | 20 | 0 | 3300m | 2.2g | 6824 | R | 100 | 0.9 | 1857:51 | transampa |
| 38926 | mplima | 20 | 0 | 3094m | 2.8g | 6816 | R | 100 | 1.1 | 1857:51 | transampa |
| 38927 | mplima | 20 | 0 | 3300m | 2.4g | 6828 | R | 100 | 0.9 | 1857:51 | transampa |
| 38928 | mplima | 20 | 0 | 3094m | 2.8g | 6836 | R | 100 | 1.1 | 1857:50 | transampa |
| 38929 | mplima | 20 | 0 | 3300m | 2.4g | 6824 | R | 100 | 0.9 | 1857:51 | transampa |
| 38930 | mplima | 20 | 0 | 2160m | 1.9g | 6812 | R | 100 | 0.8 | 1857:51 | transampa |
| 38933 | mplima | 20 | 0 | 3300m | 2.4g | 6820 | R | 100 | 0.9 | 1857:51 | transampa |
| 38934 | mplima | 20 | 0 | 2160m | 1.9g | 6812 | R | 100 | 0.8 | 1857:50 | transampa |
| 38935 | mplima | 20 | 0 | 3094m | 2.8g | 6824 | R | 100 | 1.1 | 1857:51 | transampa |
| 56033 | padilha | 20 | 0 | 1358m | 1.0g | 18m | R | 100 | 0.4 | 179:31.61 | openmx |
| 56034 | padilha | 20 | 0 | 1357m | 1.1g | 23m | R | 100 | 0.4 | 177:38.55 | openmx |
| 56035 | padilha | 20 | 0 | 1351m | 1.0g | 20m | R | 100 | 0.4 | 176:58.44 | openmx |