Introduction to GNU/Linux

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SMU

What you will hear about

- What is GNU/Linux
- Finding your way around in Linux
  - Window manager, Shell (bash), directory structure, permissions
  - pwd, ls, man, apropos, cd, mkdir, cp, mv, rm, ln, env, export
- Some useful tools with example use cases
  - echo, cat, less, which, locate, wc, head, tail, grep, diff, b/gzip, tar, ssh, scp
- Connecting tools together
  - Bash scripting, stdin, stdout, stderr, pipes and redirection.
- Where to go when stuck.
- Writing your own, hello world example.

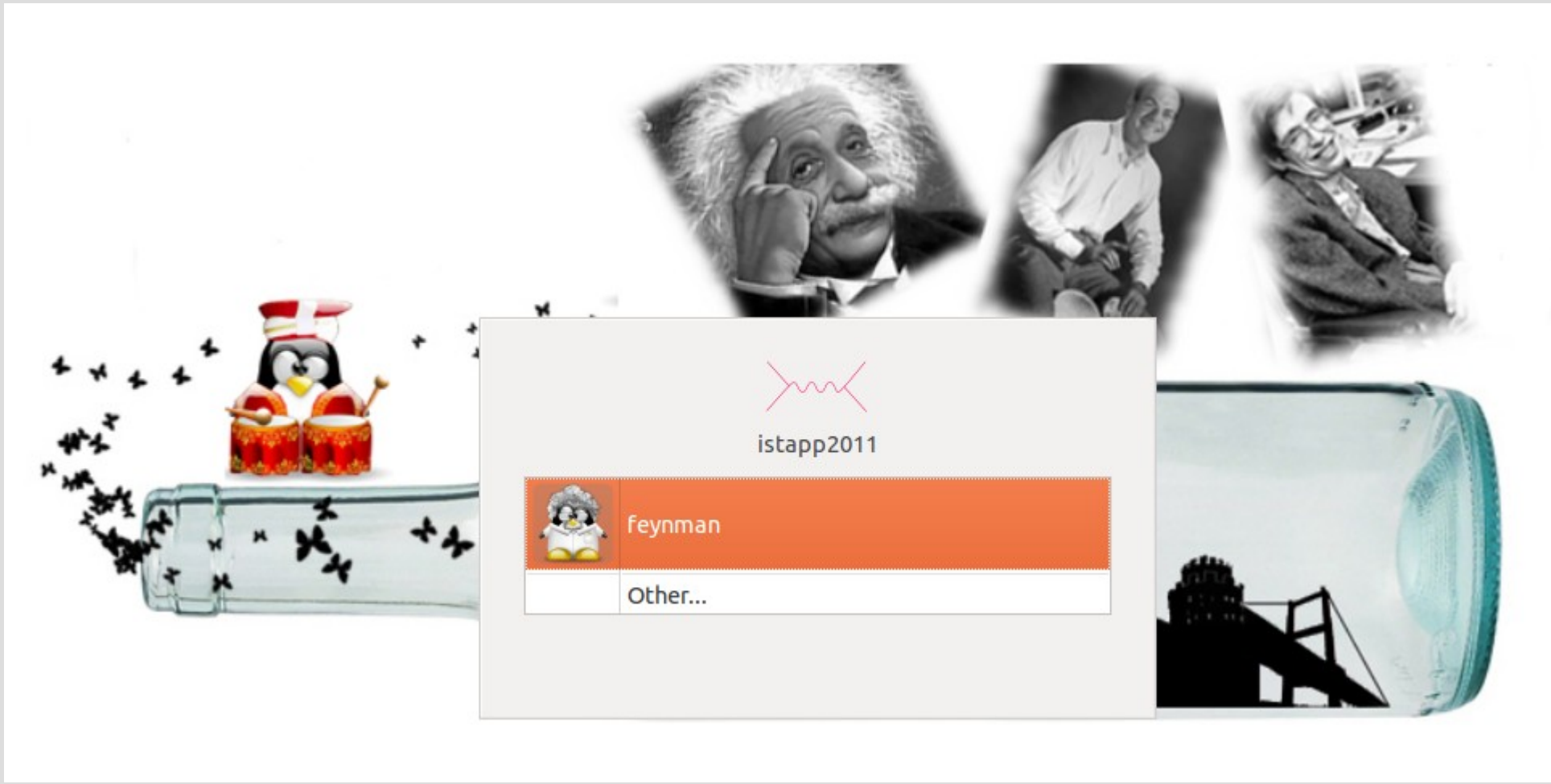
GNU/Linux

- Most people refer to GNU/Linux as „Linux“ which is actually only the *kernel* of the system.
- Linux is developed by Linus Trovalds. It manages hardware resources of the computers and how programs use them.
- GNU tools are open-source, free programs by Free Software Foundation.
- It is composed of >350 packages
- GNU and Linux together they form a complete, free and open-source operating system.

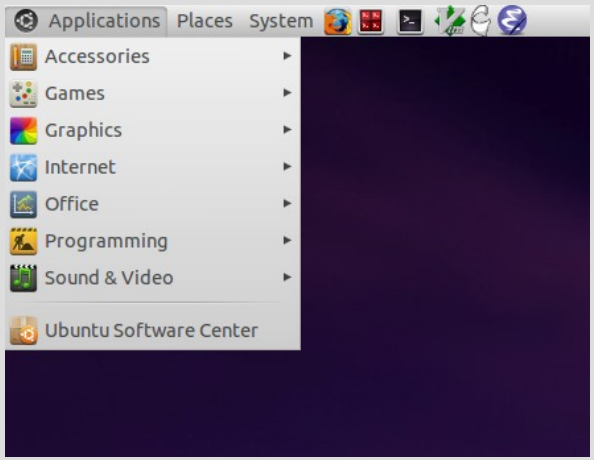
GNU/Linux

- There are many flavors of GNU/Linux. See http://en.wikipedia.org/wiki/List_of_Linux_distributions
- Heavily used in scientific computing. Scientific Linux is the most common version in HEP community.
- Intrinsically multi-user and arguably the most secure operating system.
- Many modern distributions have nice window managers such as Gnome and KDE for point-and-click interaction and convenient personal use.
- Due to open source nature and built-in compilers for numerous languages, many people develop commercial quality applications and make them available for free.
- Highly addictive. 

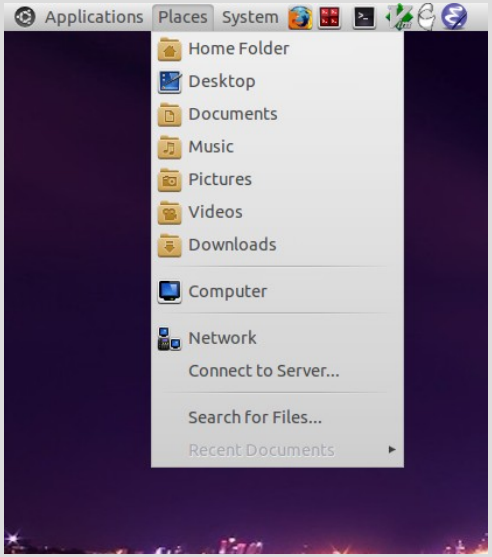
Login Screen



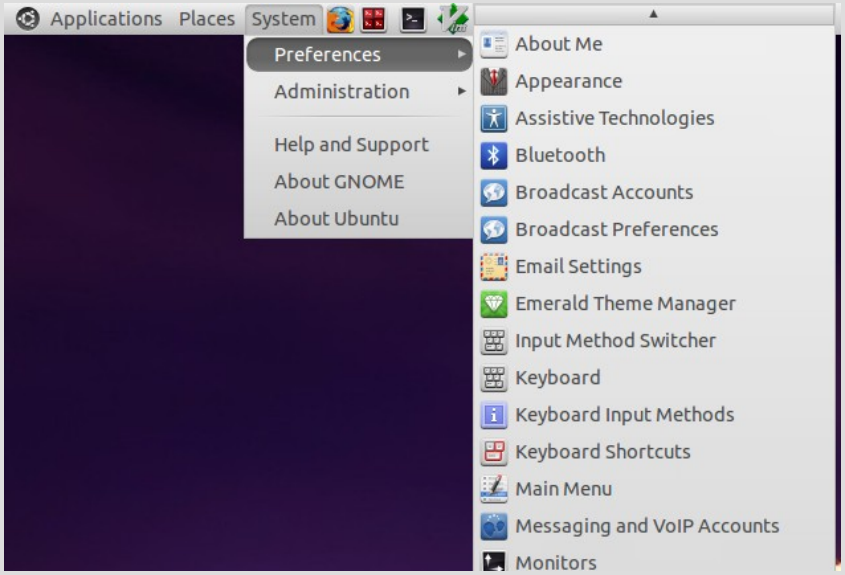
Gnome Desktop



Applications menu keep shortcuts for various applications in organized manner. Every application can also be started from command-line



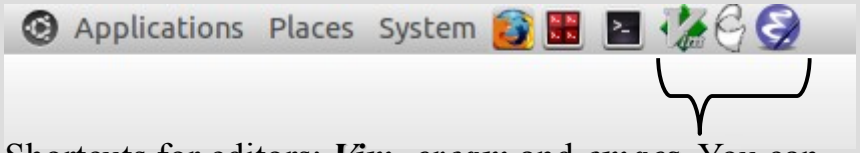
Places menu keep shortcuts for commonly used user directories.



System menu keeps links for system administration and preferences. This is where you configure and personalize your desktop.

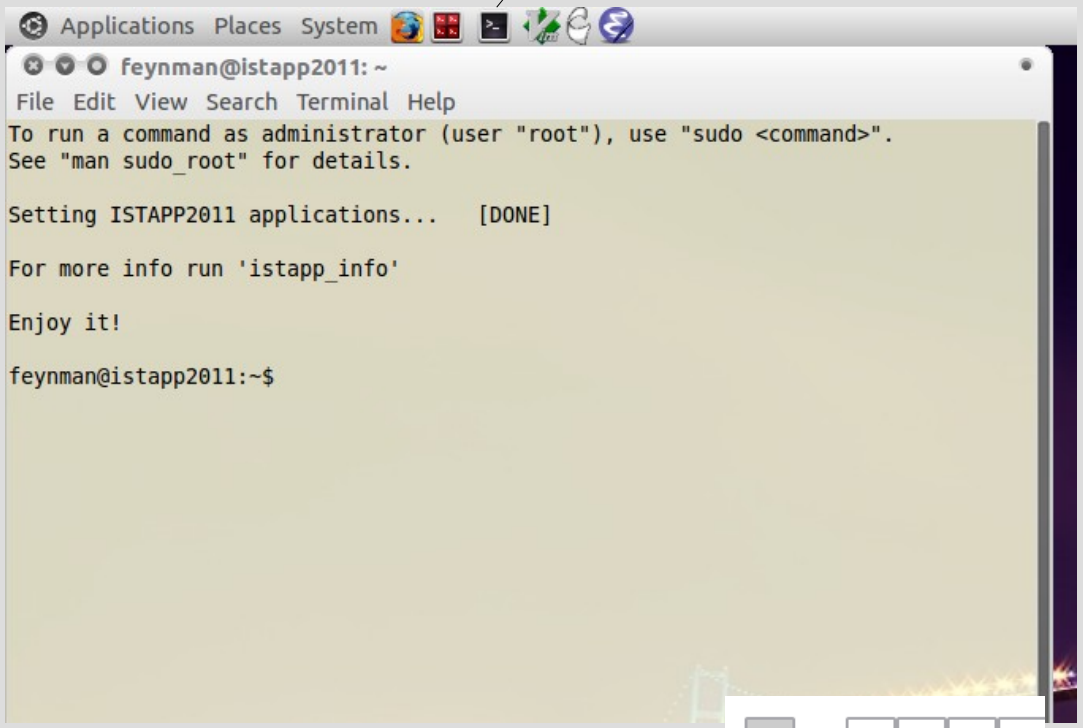
Shell

Quick start panel



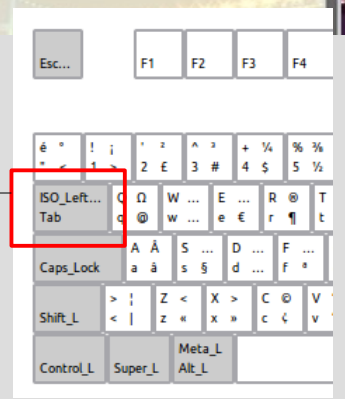
Shortcuts for editors; ***Vim***, ***cream*** and ***emacs***. You can also use ***nedit, gedit*** or ***nano*** from command-line. See http://www.gnu.org/software/emacs/tour/ for an introduction to ***emacs*** and http://tips.webdesign10.com/another-vim-tutorial for ***vim***

Starts gnome-terminal (shell)



Shell is the command-line for the Linux. Although it might look scary at the beginning you once you get used to it, you will see that it is very powerful.
The default shell for many distributions is Bourne-again shell (bash). It has auto-complete feature. If you press Tab button in keyboard, it will complete command or path, or list possibilities if multiple choices exist.

Tab button does auto-complete in bash



pwd, ls and Directory Structure

pwd prints the directory you are in

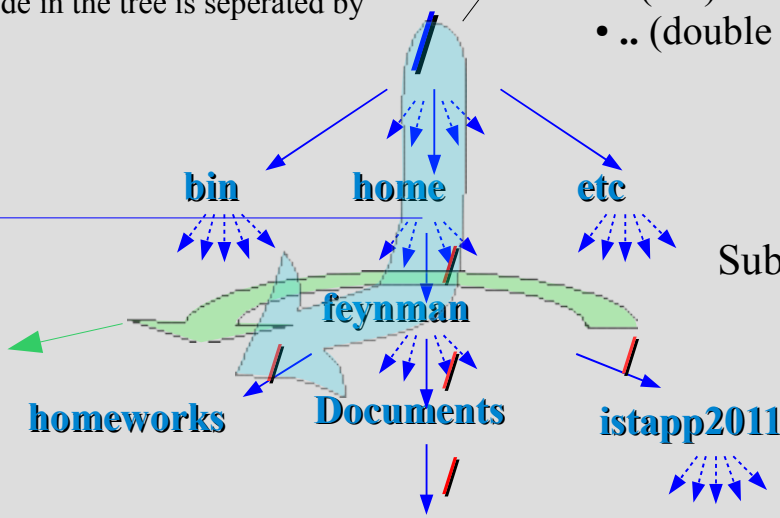
```
Enjoy it!

feynman@istapp2011:~$ pwd
/home/feynman
feynman@istapp2011:~$
```

Your location in directory tree.
Each node in the tree is seperated by a /

•**root** directory. Top level in the directory tree. Everything resides below that
There are two special directories in each node
• **.** (dot) refers to the directory itself
• **..** (double dots) refers to the parent directory

An absolute path. Same from any location
/home/feynman/homeworks

A relative path. From /home/feynman/istapp2011
../homeworks



Sub-directories. Seperated by /

Files are the last nodes in the tree

ls lists the contents of current directory

```
feynman@istapp2011:~$ ls
Desktop    Downloads  istapp2011  Pictures  Templates
Documents  homeworks  Music       Public    Videos
feynman@istapp2011:~$ ls /
bin    dev  home        lib         mnt   root     srv
boot   etc  initrd.img  lost+found  opt   sbin     sys
cdrom  hep  istapp      media       proc  selinux  tmp
feynman@istapp2011:~$
```

It can take a path as an argument. The path can be relative, i.e. with respect to current directory, or absolute i.e. with respect to root directory.

Arguments, --help, man apropos

```
feynman@istapp2011:/$ ls --help
Usage: ls [OPTION]... [FILE]...
List information about the FILEs (the current directory by default).
Sort entries alphabetically if none of -cftuvSUX nor --sort.

Mandatory arguments to long options are mandatory for short options too.
  -a, --all                  do not ignore entries starting with .
  -A, --almost-all           do not list implied . and ..
      --author               with -l, print the author of each file
  -b, --escape               print C-style escapes for nongraphic characters
      --block-size=SIZE      use SIZE-byte blocks.  See SIZE format below
  -B, --ignore-backups       do not list implied entries ending with ~
  -c                         with -lt: sort by, and show, ctime (time of last
                               modification of file status information)
                               with -l: show ctime and sort by name
                               otherwise: sort by ctime
  -C                         list entries by columns
      --color[=WHEN]         colorize the output.  WHEN defaults to `always'
                               or can be `never' or `auto'.  More info below
  -d, --directory            list directory entries instead of contents,
                               and do not dereference symbolic links
  -D, --dired                generate output designed for Emacs' dired mode
  -f                         do not sort, enable -aU, disable -ls --color
  -F, --classify             append indicator (one of */=>@|) to entries
      --file-type            likewise, except do not append `*'
      --format=WORD          across -x, commas -m, horizontal -x, long -l,
                               single-column -1, verbose -l, vertical -C
```

```
LS(1)                          User Commands                          LS(1)

NAME
       ls - list directory contents

SYNOPSIS
       ls [OPTION]... [FILE]...

DESCRIPTION
       List  information  about  the FILEs (the current directory by default).
       Sort entries alphabetically if none of -cftuvSUX nor --sort.

       Mandatory arguments to long options are  mandatory  for  short  options
       too.

       -a, --all
              do not ignore entries starting with .

       -A, --almost-all
              do not list implied . and ..

       --author
              with -l, print the author of each file

       -b, --escape
              print C-style escapes for nongraphic characters

       --block-size=SIZE
              use SIZE-byte blocks.  See SIZE format below
```

- Almost all programs in Linux have arguments to alter their behavior.
- Most of them will display a summary of available arguments with the –help argument. For example ***ls –help***
- Many have detailed information available through manual (man) or information (info) pages.
- Man and info pages are accessible through ***man*** and ***info*** commands. See ***man ls*** for example.
- Man and info pages also contain information about system functions that are used in programming.
- You can use ***apropos*** command to search for keywords in man files.

cd, mkdir, rmdir, permissions

```
feynman@istapp2011:~$ cd homeworks/
feynman@istapp2011:~/homeworks$ ls
feynman@istapp2011:~/homeworks$ mkdir homework1
feynman@istapp2011:~/homeworks$ ls
homework1
feynman@istapp2011:~/homeworks$ cd homework1/
feynman@istapp2011:~/homeworks/homework1$ ls
feynman@istapp2011:~/homeworks/homework1$ cd ../../istapp2011/delphes/
feynman@istapp2011:~/istapp2011/delphes$ cd /istapp/
feynman@istapp2011:/istapp$
```

```
feynman@istapp2011:/istapp$ cd /home/feynman/homeworks/
feynman@istapp2011:~/homeworks$ ls
homework1
feynman@istapp2011:~/homeworks$ rmdir homework1/
feynman@istapp2011:~/homeworks$ ls
feynman@istapp2011:~/homeworks$
```

```
feynman@istapp2011:/$ ls -l
drwxr-xr-x   2 root root  4096 2010-12-31 01:25 /bin
drwxr-xr-x   3 root root  4096 2011-01-27 00:18 /boot
drwxr-xr-x 143 root root 12288 2011-02-03 01:56 /etc
drwxr-xr-x   9 root root  4096 2010-12-31 03:55 /hep
drwxr-xr-x   3 root root  4096 2010-12-30 23:35 /home
drwx------  12 root root  4096 2011-01-28 02:02 /root
```

Permissions in triplets for ***user***, ***group***, and ***others***
- ***d*** is for directory and ***l*** is for links
- ***r*** is for reading (4)
- ***w*** is for writing (2)
- ***x*** for accessing or executing (1)

Triplet of letter defines whether user, group or others have permissions for required actions. It is also possible to represent triplets as a three digit octal number. Values in brackets give the value of the flag in octal base. Thus ***rwxr-xr-x*** is 755 in octal base. (Different file systems might have different access control mechanisms!)

- Moving inside the directory tree is done by ***cd*** command.
- It takes a directory path, either absolute or relative, as argument.
- Without parameters it takes you to your home directory (***/home/feynman*** in our example)
- New directories in a directory tree is created by ***mkdir*** command. It takes a directory path as argument.
- A directory can be removed by ***rmdir*** command. Directory to be removed must be empty.
- User must have proper access permissions to be able to these actions.
- ***ls -l*** lists permissions owners and sizes of files and directories.

cp, ln, mv, rm

```
feynman@istapp2011:~$ cp Documents/pythia8_worksheet.pdf istapp2011/
feynman@istapp2011:~$ ls istapp2011/
comphep_workdir  delphes  mg_me  pythia8_worksheet.pdf
feynman@istapp2011:~$ mv istapp2011/pythia8_worksheet.pdf py8_manual.pdf
feynman@istapp2011:~$ ls
Desktop    Downloads  istapp2011  Pictures  py8_manual.pdf  Videos
Documents  homeworks  Music       Public    Templates
feynman@istapp2011:~$ cp -r homeworks/ myHWbackup
feynman@istapp2011:~$ ls
Desktop    Downloads  istapp2011  myHWbackup  Public          Templates
Documents  homeworks  Music       Pictures    py8_manual.pdf  Videos
feynman@istapp2011:~$ mv myHWbackup/ HomeworksBackup
feynman@istapp2011:~$ ls
Desktop    Downloads  HomeworksBackup  Music     Public          Templates
Documents  homeworks  istapp2011       Pictures  py8_manual.pdf  Videos
```

```
feynman@istapp2011:~$ rm py8_manual.pdf
feynman@istapp2011:~$ ls
Desktop    Downloads  HomeworksBackup  Music     Public     Videos
Documents  homeworks  istapp2011       Pictures  Templates
feynman@istapp2011:~$ rm -rf HomeworksBackup/
feynman@istapp2011:~$ ls
Desktop    Downloads  istapp2011  Pictures  Templates
Documents  homeworks  Music       Public    Videos
feynman@istapp2011:~$
```

<u>DO NOT DO</u> ***rm -rf ~/* !!!***

- Files and directories can be copied with ***cp*** command. Use ***cp -r <src> <dest>*** to copy <src> directory into <dest>
- Instead of copying you can use ***ln -s <src> <dest>*** command to create link (shortcut) of a file or directory <src> in/with name <dest>
- Moving or renaming a file or directory is done by ***mv*** command. Use ***mv <oldname> <newdir/newname>*** to move a directory or file to new location *newdir* with a new name *newname*. Omit *newdir* to rename a file or directory.
- Deleting a file is done by ***rm <file>*** command. ***rm -rf <dest>*** deletes files, directories and any files or sub-directories in them recursively.

Environment variables

```
feynman@istapp2011:~$ env
MANPATH=/hep/root/share/man:/usr/local/man:/usr/local/share/man:/usr/share/man
ORBIT_SOCKETDIR=/tmp/orbit-feynman
SSH_AGENT_PID=1863
TERM=xterm
SHELL=/bin/bash
XDG_SESSION_COOKIE=2acb5fd2e6ac1bfb0090561f0000000f-1296690967.817940-910163478
WINDOWID=71303171
OLDPWD=/home/feynman/istapp2011
GNOME_KEYRING_CONTROL=/tmp/keyring-6eGM6I
GTK_MODULES=canberra-gtk-module
USER=feynman
LD_LIBRARY_PATH=/hep/root/lib/root
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=
40;33;01:or=40;31;01:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;
32:*.tar=01;31:*.tgz=01;31:*.arj=01;31:*.taz=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz
=01;31:*.txz=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.dz=01;31:*.gz=01;31:*.lz=01;
31:*.xz=01;31:*.bz2=01;31:*.bz=01;31:*.tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.deb=01
;31:*.rpm=01;31:*.jar=01;31:*.rar=01;31:*.ace=01;31:*.zoo=01;31:*.cpio=01;31:*.7z
=01;31:*.rz=01;31:*.jpg=01;35:*.jpeg=01;35:*.gif=01;35:*.bmp=01;35:*.pbm=01;35:*.
pgm=01;35:*.ppm=01;35:*.tga=01;35:*.xbm=01;35:*.xpm=01;35:*.tif=01;35:*.tiff=01;3
5:*.png=01;35:*.svg=01;35:*.svgz=01;35:*.mng=01;35:*.pcx=01;35:*.mov=01;35:*.mpg=
01;35:*.mpeg=01;35:*.m2v=01;35:*.mkv=01;35:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.
mp4v=01;35:*.vob=01;35:*.qt=01;35:*.nuv=01;35:*.wmv=01;35:*.asf=01;35:*.rm=01;35:
*.rmvb=01;35:*.flc=01;35:*.avi=01;35:*.fli=01;35:*.flv=01;35:*.gl=01;35:*.dl=01;3
5:*.xcf=01;35:*.xwd=01;35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.axv=01;35:*.anx=0
1;35:*.ogv=01;35:*.ogx=01;35:*.aac=00;36:*.au=00;36:*.flac=00;36:*.mid=00;36:*.mi
di=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;36:*.wav=00;36:*
.axa=00;36:*.oga=00;36:*.spx=00;36:*.xspf=00;36:
SSH_AUTH_SOCK=/tmp/keyring-6eGM6I/ssh
LIBPATH=/hep/root/lib/root
DEFAULTS_PATH=/usr/share/gconf/gnome.default.path
SESSION_MANAGER=local/istapp2011:@/tmp/.ICE-unix/1803,unix/istapp2011:/tmp/.ICE-u
nix/1803
USERNAME=feynman
XDG_CONFIG_DIRS=/etc/xdg/xdg-gnome:/etc/xdg
```

You can define your variables or modify existing ones with ***export*** command.

export PATH=${HOME}/bin:${PATH}
export ROOTSYS=/hep/root

- Shells have some variables called ***Environment variables.***
- They are typically used for configuring programs.
- ***env*** command lists currently defined variables.
- Shell replaces ***${VARIABLE}*** with the value of the respective variable.
- Most of them have a special meaning. Most notable ones
  - ***${PATH}*** lists the directories that are searched for the entered command.
  - ***${LD_LIBRARY_PATH}*** lists the directories that are searched for the shared libraries that the program uses.
  - ***${HOME}*** contains path to your home directory

echo, cat, less

```
feynman@istapp2011:~$ echo "my home directory is ${HOME}"
my home directory is /home/feynman
feynman@istapp2011:~$ cat testfile.txt
This is a test file.
feynman@istapp2011:~$ cat testfile2.txt
This is another test file.
feynman@istapp2011:~$ cat testfile.txt testfile2.txt
This is a test file.
This is another test file.
feynman@istapp2011:~$
```

- ***echo*** command prints the argument to screen. It can expand variables. Good for piping programs or giving feedback.
- ***cat*** prints the selected files or your input to the screen. Can be used for merging files, sending them to the other programs for processing.
- ***less*** displays the selected text file(s). It can browse the file forward and backward direction, search for a given pattern and do more. See ***man less***. Most common uses are reading ascii files or buffering program outputs.

head, tail and wc

```
feynman@istapp2011:~$ head process.dat
############################################################
# Copyright (C) 2002-2009, CompHEP Collaboration
#
#         Data file for symb_script.pl
#       For the symb_batch script version 1.0
############################################################

#  You have to set the model number, which you are going to use.
#  The model number corresponds to the string number of the model
#  in the CompHEP model menu in the GUI mode.
feynman@istapp2011:~$ tail process.dat
#keep diagrams with: t,b,Z,A
keep diagrams with:

#  If you enter no, s_comphep generates diagrams and does not
#  do symbolic calculations.
make symbolic calculations(yes/no): yes

#  If you enter no, comphep calculates all squared diagrams,
#  but n_comphep will not be created.
make n_comphep generator(yes/no): yes
feynman@istapp2011:~$ wc process.dat
  48  242 1579 process.dat
feynman@istapp2011:~$
```

- Sometimes you are interested in only first or last couple of lines of a file.
- ***head*** and ***tail*** commands print beginning or end of a file. You can use ***-n*** or ***-c*** arguments to specify the length in terms of lines or bytes.
- ***tail -f*** will make tail to follow file, that is it will append the changes to the end of file. It is good for watching the logs or output of your programs.
- You can count the bytes, characters, lines in a file or find the longest line with ***wc***

which and locate

```
feynman@istapp2011:~$ which locate
/usr/bin/locate
feynman@istapp2011:~$ locate pythia8_worksheet.pdf
/home/feynman/Documents/pythia8_worksheet.pdf
feynman@istapp2011:~$ locate testfile
/home/feynman/testfile.txt
/home/feynman/testfile2.txt
/usr/include/qt4/Qt/qtestfilelogger.h
/usr/include/qt4/QtTest/qtestfilelogger.h
/usr/share/perl5/Mail/Mailer/testfile.pm
feynman@istapp2011:~$
```

- ***which*** command tells you the absolute path of a command that you can execute which implies that only the paths in ***${PATH}*** is searched for executables. It is handy at finding the location of executables, and figuring out which binary is actually used since there may be several binaries with the same name in the ***${PATH}***.
- ***locate*** command shows all the files or directories that contain the pattern. It uses an index database and is independent of ***${PATH}***. It can only give locate the files that were present when the database was created. Most common use-case is locating files.

grep and Regular Expressions

```
feynman@istapp2011:~/istapp2011/delphes$ grep -ir "jetptresol" *
interface/FuncDef.h:  //Analyze->Draw(temp.c_str(),"(JetPTResol.NonSmearePT >0 && JetPTReso
l.NonSmearePT < 20)");
interface/FuncDef.h:  //string all = min + " && " + max + " && abs(JetPTResol.Eta) < 0.5";
Resolutions_ATLAS.cpp:  ExRootTreeBranch *branchjet = treeWriter->NewBranch("JetPTResol", R
ESOLJET::Class());
Resolutions_ATLAS.cpp:  ExRootTreeBranch *branchtaujet = treeWriter->NewBranch("TauJetPTRes
ol", TAUHAD::Class());
Resolutions.cpp:  ExRootTreeBranch *branchjet = treeWriter->NewBranch("JetPTResol", RESOLJE
T::Class());
Resolutions.cpp:  ExRootTreeBranch *branchtaujet = treeWriter->NewBranch("TauJetPTResol", T
AUHAD::Class());
routines/resolutions_atlas.C:  string cut = "abs(JetPTResol.Eta)<0.5";
routines/resolutions_atlas.C:  string cut = "abs(JetPTResol.Eta)<2.0 && abs(JetPTResol.Eta)
>1.5";
routines/resolutions_atlas.C:      sprintf(tempMin,"JetPTResol.E > %d",binMin);
routines/resolutions_atlas.C:      sprintf(tempMax,"JetPTResol.E < %d",binMax);
routines/resolutions_atlas.C:      //sprintf(tempName,"JetPTResol.dE/JetPTResol.SmearedPT>>
hdE%d",i);
routines/resolutions_atlas.C:      //sprintf(tempName,"JetPTResol.dE>>hdE%d",i);
routines/resolutions_atlas.C:      sprintf(tempName,"JetPTResol.dE_reco>>hdE%d",i);
routines/resolutions_atlas.C:      //sprintf(tempName,"JetPTResol.dE2/JetPTResol.SmearedPT>
>hdE2%d",i);
routines/resolutions_atlas.C:      //sprintf(tempName,"JetPTResol.dE2/JetPTResol.SmearedPT>
>hdE2%d",i);
routines/resolutions_atlas.C:      sprintf(tempName,"JetPTResol.dE2_reco>>hdE2%d",i);
routines/resolutions_atlas.C:  TH1F *tauEnergy =MakeNormTH1F(20,0.8,1,Analyze,"TauJetPTReso
l.EnergieCen>>tauEnergy",1, 0, 1,2,false);
routines/resolutions_atlas.C:  TH1F *NumTrack =MakeNormTH1F(6,0,6,Analyze,"TauJetPTResol.Nu
mTrack>>NumTrack",1, 0, 1,2,false);
routines/resolutions.C:      sprintf(tempMin,"JetPTResol.PT > %d",binMin);
routines/resolutions.C:      sprintf(tempMax,"JetPTResol.PT < %d",binMax);
routines/resolutions.C:      sprintf(tempName,"(JetPTResol.SmearedPT)>>hETSoverET%d",i);
routines/resolutions.C:  TH1F *tauEnergy =MakeNormTH1F(20,0.8,1,Analyze,"TauJetPTResol.Ener
gieCen>>tauEnergy",1, 0, 1,2,false);
routines/resolutions.C:  TH1F *NumTrack =MakeNormTH1F(6,0,6,Analyze,"TauJetPTResol.NumTrack
>>NumTrack",1, 0, 1,2,false);
```

Basic regex information
- . (dot) matches any single character
- *[ ]* defines a set. It only matches characters in the set
- ^ defines the beginning of a line except in a set, in which case negates the set
- *$* defines end of a line
- *?* means zero or one of the previous item.
- + means one or more of previous item
- * means zero or more of previous item

- grep is a powerful tool that is used for searching patterns in files.
- You can use it for searching a keyword (variable or function) in a large set of source files.
- It can use regular expressions in searches. Regular expressions are a to express patterns.
- They have a special syntax. See man grep, man 7 regex and search on the internet.
- I strongly encourage you to learn basics of regular expressions.

http://xkcd.com/208/

diff, b/gzip

```
feynman@istapp2011:~/istapp2011/delphes$ diff -b -B Resolutions.cpp Resolutions_ATLAS.cpp
34,35c34,35
< /// \file Resolution.cpp
< /// \brief Resolution for CMS
---
> /// \file Resolution_ATLAS.cpp
> /// \brief Resolution for Atlas
84,85c84
<                //cout << "eta du tau = " << gen1->Eta << endl;
<                  //if(fabs(gen1->Eta)<2.5)tauhad=true;
---
>                  //if(fabs(gen1->Eta)<2.5) tauhad=true;
110c109
< void PairingJet(TLorentzVector &JETSm, const TLorentzVector &JET, const TClonesArray *branc
hJet)
---
> void PairingJet(TLorentzVector &JETSm, const TLorentzVector &JET, const TClonesArray *branc
hJet, const float dR=0.25)
124c123
<           if(deltaRtest < 0.25)
---
>           if(deltaRtest < dR)
198c197
<   sprintf(appName,"Resolution");
---
>   sprintf(appName,"Resolution_ATLAS");
239c238
<   TFile *outputFile = TFile::Open(outputfilename.c_str(), "RECREATE"); // Creates the file,
 but should be closed just after
---
>   TFile *outputFile = TFile::Open(outputfilename.c_str(), "RECREATE");// Creates the file,
but should be closed just after
244a244,245
>   //chainGEN.Add("all_dijets_atlas_kt.root");
>   //chainGEN.Add("all_dijets_atlas_kt_2.root");
247a249,250
```

```
feynman@istapp2011:~$ ls -l UpdateNotes*
-rw-r--r-- 1 feynman feynman 30210 2011-02-04 15:31 UpdateNotes_copy.txt
-rw-r--r-- 1 feynman feynman 30210 2011-02-04 15:30 UpdateNotes.txt
feynman@istapp2011:~$ bzip2 UpdateNotes.txt
feynman@istapp2011:~$ gzip UpdateNotes_copy.txt
feynman@istapp2011:~$ ls -l UpdateNotes*
-rw-r--r-- 1 feynman feynman 10668 2011-02-04 15:31 UpdateNotes_copy.txt.gz
-rw-r--r-- 1 feynman feynman  9504 2011-02-04 15:30 UpdateNotes.txt.bz2
feynman@istapp2011:~$ bunzip2 UpdateNotes.txt.bz2
feynman@istapp2011:~$ gunzip UpdateNotes_copy.txt.gz
feynman@istapp2011:~$ ls -l UpdateNotes*
-rw-r--r-- 1 feynman feynman 30210 2011-02-04 15:31 UpdateNotes_copy.txt
-rw-r--r-- 1 feynman feynman 30210 2011-02-04 15:30 UpdateNotes.txt
feynman@istapp2011:~$
```

- ***diff <file1> <file2>*** gives the differences between file1 and file2. In output < refers to file1 and > refers to file2
- You can use ***diff*** on your backup and modified files to figure out problems.
- ***diff -bB*** ignores spaces and empty lines when doing comparison.
- You can compress files with ***bzip2*** or ***gzip*** to reduce disk usage or network transfer duration.
- Uncompression can be done with ***bunzip2*** and ***gunzip.***

tar and scp

```
feynman@istapp2011:~$
feynman@istapp2011:~$ tar -jcvf istap2011Comphep.tar.bz2 istapp2011/comphep_workdir/
istapp2011/comphep_workdir/
istapp2011/comphep_workdir/cascade
istapp2011/comphep_workdir/archiv
istapp2011/comphep_workdir/mix
istapp2011/comphep_workdir/num_batch.pl
istapp2011/comphep_workdir/models/
istapp2011/comphep_workdir/models/prtcls9.mdl
istapp2011/comphep_workdir/models/prtcls6.mdl
istapp2011/comphep_workdir/models/prtcls8.mdl
```

```
feynman@istapp2011:~$ scp istap2011Comphep.tar.bz2 kama@lxplus.cern.ch:~/
The authenticity of host 'lxplus.cern.ch (137.138.141.154)' can't be established.
RSA key fingerprint is a4:9f:57:6b:d5:4e:4d:56:85:ba:99:db:8c:2a:8e:b7.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'lxplus.cern.ch,137.138.141.154' (RSA) to the list of known hosts.
kama@lxplus.cern.ch's password:
istap2011Comphep.tar.bz2                      100%  149KB 149.4KB/s   00:00
feynman@istapp2011:~$ scp kama@lxplus.cern.ch:~/histos.tar.bz2 .
Warning: Permanently added the RSA host key for IP address '137.138.5.217' to the list of kno
wn hosts.
kama@lxplus.cern.ch's password:
histos.tar.bz2                                100%   15KB  14.9KB/s   00:01
feynman@istapp2011:~$
```

- ***tar -cf <archiveName> <targets>..*** creates an archive with archiveName.
- ***tar -xf <archiveName> <fileName>*** extracts ***fileName*** from archive ***archiveName.*** If ***fileName*** is empty, extracts everything in the archive.
- ***-z*** or ***-j*** arguments compresses the output with gzip or bzip2 respectively. ***-v*** prints the names of files and directories while ***-t*** tests the archive.
- Files can be securely transferred between different computers through the network by using ***scp.***
- scp user1@hostA:<srcFile> user2@hostB:<destFile> will copy srcFile in hostA to destFile in hostB

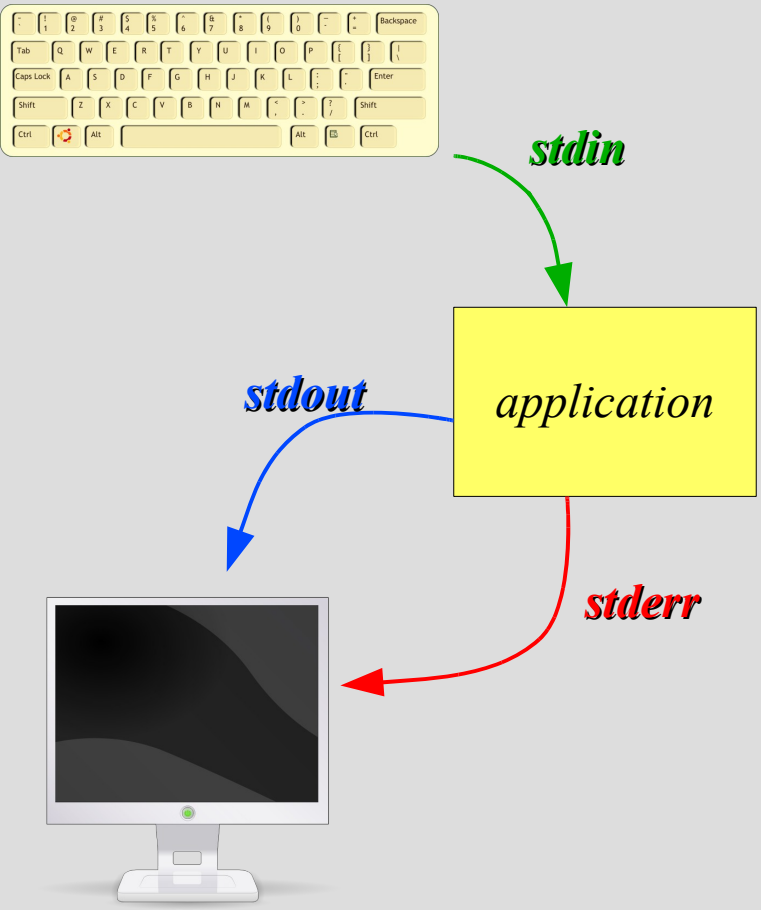
ssh and ssh-keygen

```
feynman@istapp2011:~$ ssh -X kama@lxplus.cern.ch
Warning: Permanently added the RSA host key for IP address '137.138.210.238' to the list of k
nown hosts.
kama@lxplus.cern.ch's password:
Last login: Wed Dec  1 19:02:23 2010 from 14-130.104-92.cust.bluewin.ch
********************************************************************************
*      LXPLUS Public Login Service         Website:  http://cern.ch/plus       *
*    Scientific Linux CERN 5.5 x86_64      Support:   helpdesk@cern.ch         *
*                                                                              *
*    Reminder: You have agreed to comply with the CERN computing rules         *
*                                      http://cern.ch/ComputingRules           *
********************************************************************************
Tue  1st Jan 2011: Old /etc/motd messages moved to /etc/motd-archive/
Tue  1st Feb 2011: Today lxplus will use a new
                   authentication.
                   The migration should be tra
                   http://cern.ch/ssb/ServiceC
********************************************************************************

[lxplus439] /afs/cern.ch/user/k/kama > xeyes
```


```
feynman@istapp2011:~$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/feynman/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/feynman/.ssh/id_rsa.
Your public key has been saved in /home/feynman/.ssh/id_rsa.pub.
The key fingerprint is:
c1:8e:28:6c:fe:e0:41:5a:7c:77:f2:43:ff:06:68:7c feynman@istapp2011
```

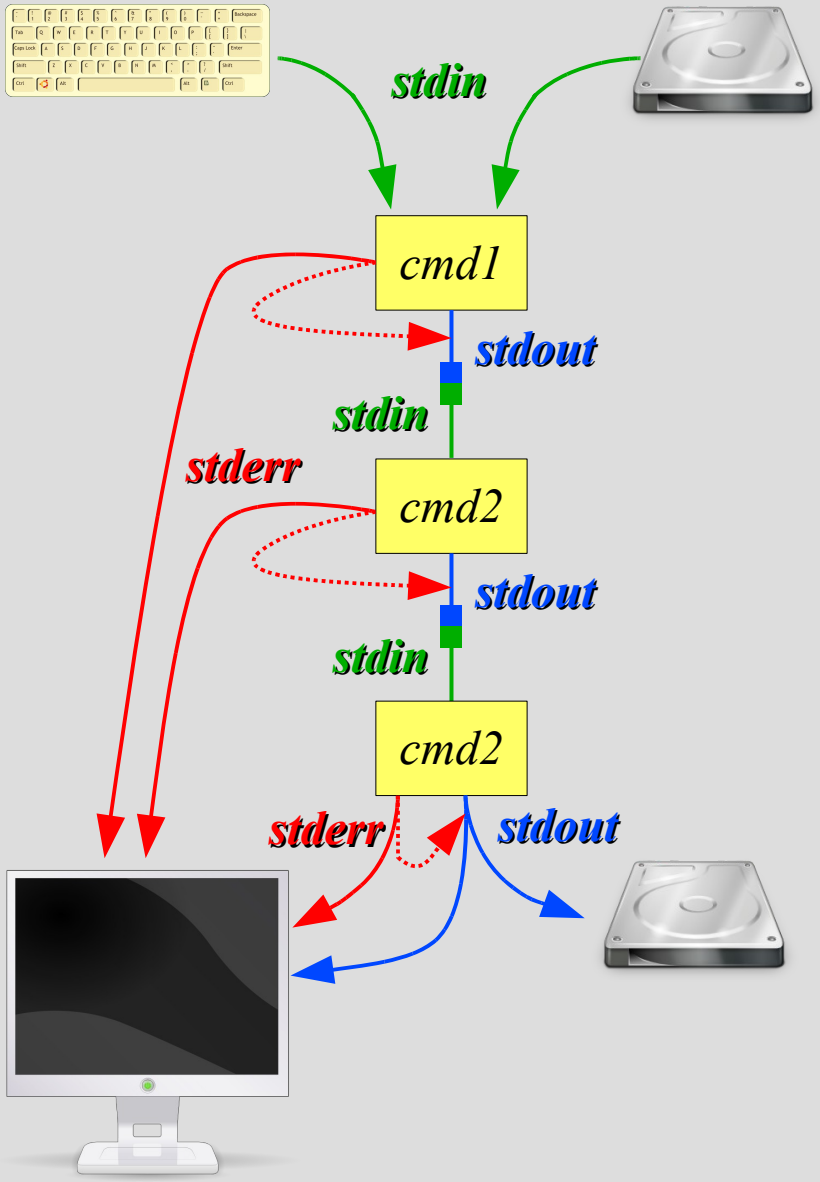
- ***ssh*** enables you to login a remote machine or execute commands there.
- It opens an encrypted communication channel which can transmit on both ways.
- It starts a shell on remote machine which you can use as if you are using it locally.
  It can forward X11 (***-X***) connections (i.e. GUIs) or arbitrary ports in both ways (***-L*** or ***-R***).
- ***ssh-keygen*** can be used for creating ***~/.ssh/id_rsa*** and ***~/.ssh/id_rsa.pub***. Append the contents of ***id_rsa.pub*** to ***~/.ssh/authorized _keys*** file in the remote machine to enable password-less login from current host.

stdin, stdout, stderr,



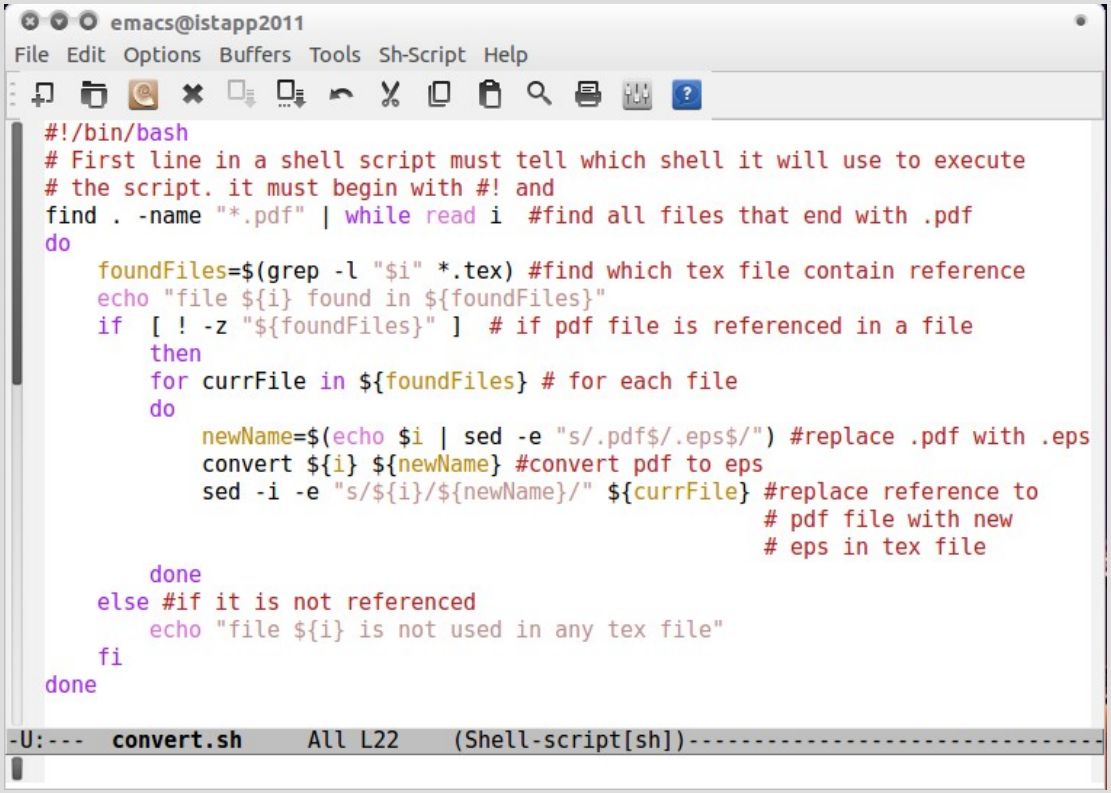
- Linux has one input and two output streams defined for interactions with the programs.
- stdin is the input data that goes into the program and typically comes from keyboard.
- stdout is the stream where program writes its output data and typically printed on the screen.
- stderr is the stream where program writes error or diagnostic messages and typically printed on the screen. It is independent of stdout and can be redirected seperately. (see next slide)

redirection and pipes



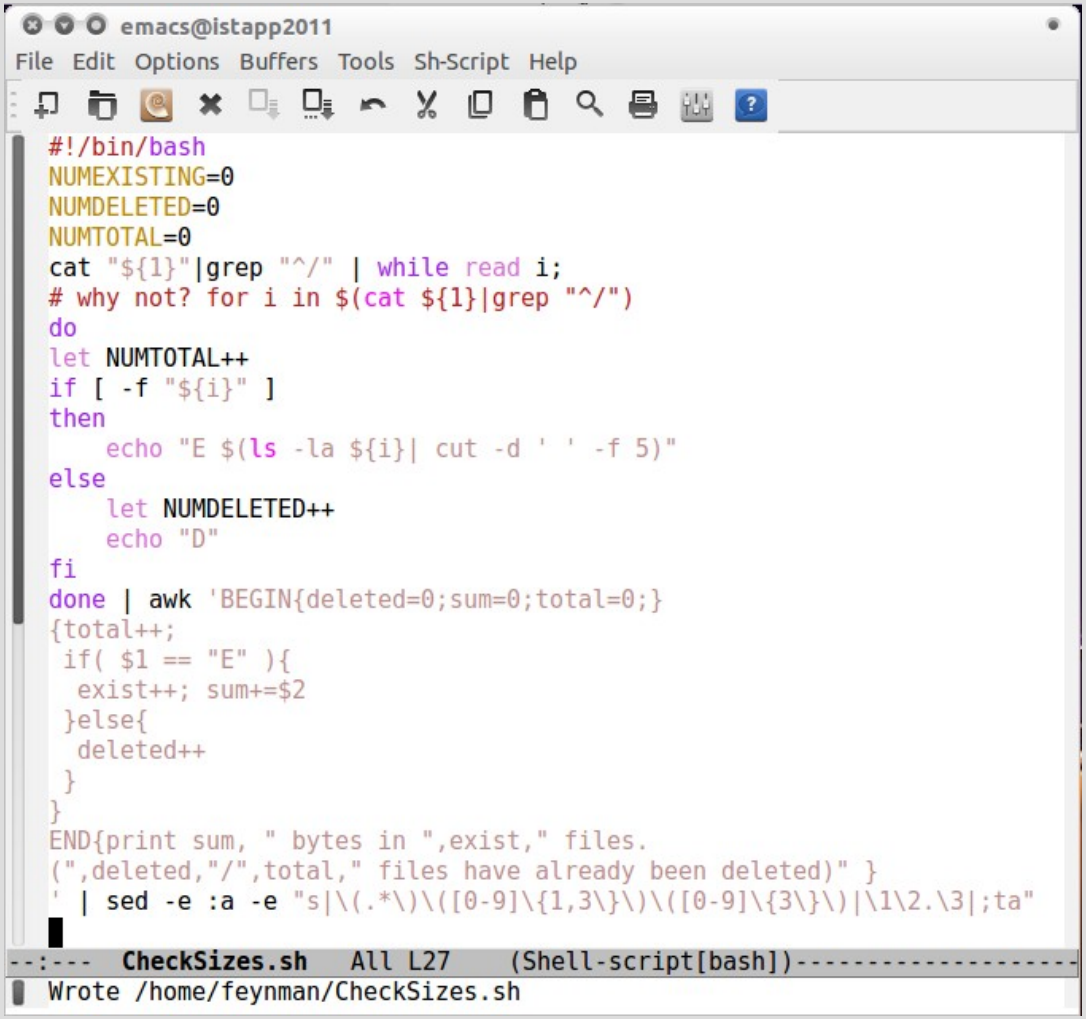
- It is possible to redirect ***stdout*** and ***stderr*** to files and files to ***stdin.***
- ***grep "mySearchString" *.cpp > found*** will overwrite the output of the grep into *found.* Using >> instead of > will append the results rather than overwriting.
- ***command < inFile >outFile*** will redirect ***inFile*** to ***stdin*** of ***command*** and its ***stdout*** to ***outFile.***
- ***cmd 2>&1*** will redirect
- It is possible to redirect ***stdout*** of a program to ***stdin*** of another program through "piping".
- ***cmd1 | cmd2*** will connect ***stdout*** of ***cmd1*** to ***stdin*** of ***cmd2***. In this manner you can connect different commands together to do complicated tasks.

Shell (bash) scripting



- Shells provide basic functionality of computing languages such as conditionals, variables, loops.
- Using these constructs together with the existing tools you can quickly do a lot of things with a little work.
- There are a lot of information about shell scripting on the web.
- I suggest you to take a look at Advanced Bash-Scripting Guide (abs guide)

Another example

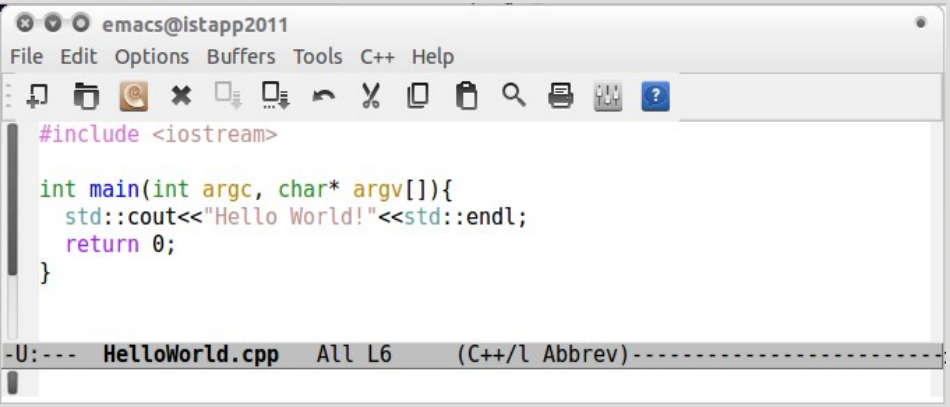


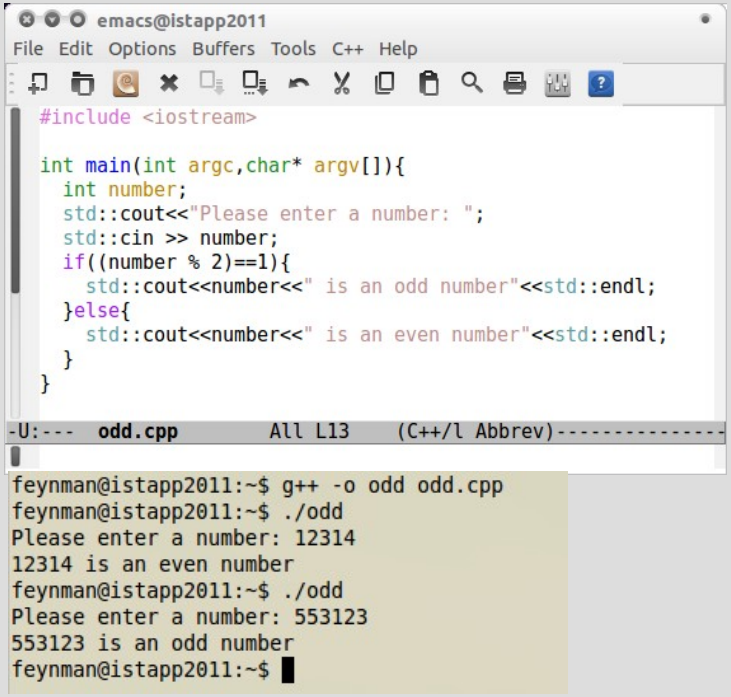
- This script gets a fileName which contains paths of some other files which may or may not exist and counts number of total, existing and deleted files, calculates the size of existing files and prints the sum with thousands seperator.
- What are ***cut, let*** and ***awk*** doing?
- Why not using ***for*** loop instead of ***while***?
- Can it be improved?
- Try to understand what ***sed*** does and how it works!

Where to go

- If stuck, try ***man*** or ***info.***
- http://tldp.org/ Contains lots of guides and HOWTOs about Linux. Take a look at some of them.
- Ask Google (or your favorite search engine) for quicker answers.
- Advanced Bash-Scripting Guide (abs guide) might answer a lot of questions about shell scripting.
- sed is a stream editor that uses regular expressions. It is really powerful. See http://www.grymoire.com/Unix/Sed.html as an introduction. Also see http://www.gnu.org/software/sed/manual/sed.html
- Awk is a power tool for Linux. It uses a data-driven approach. See http://www.gnu.org/manual/gawk/index.html.

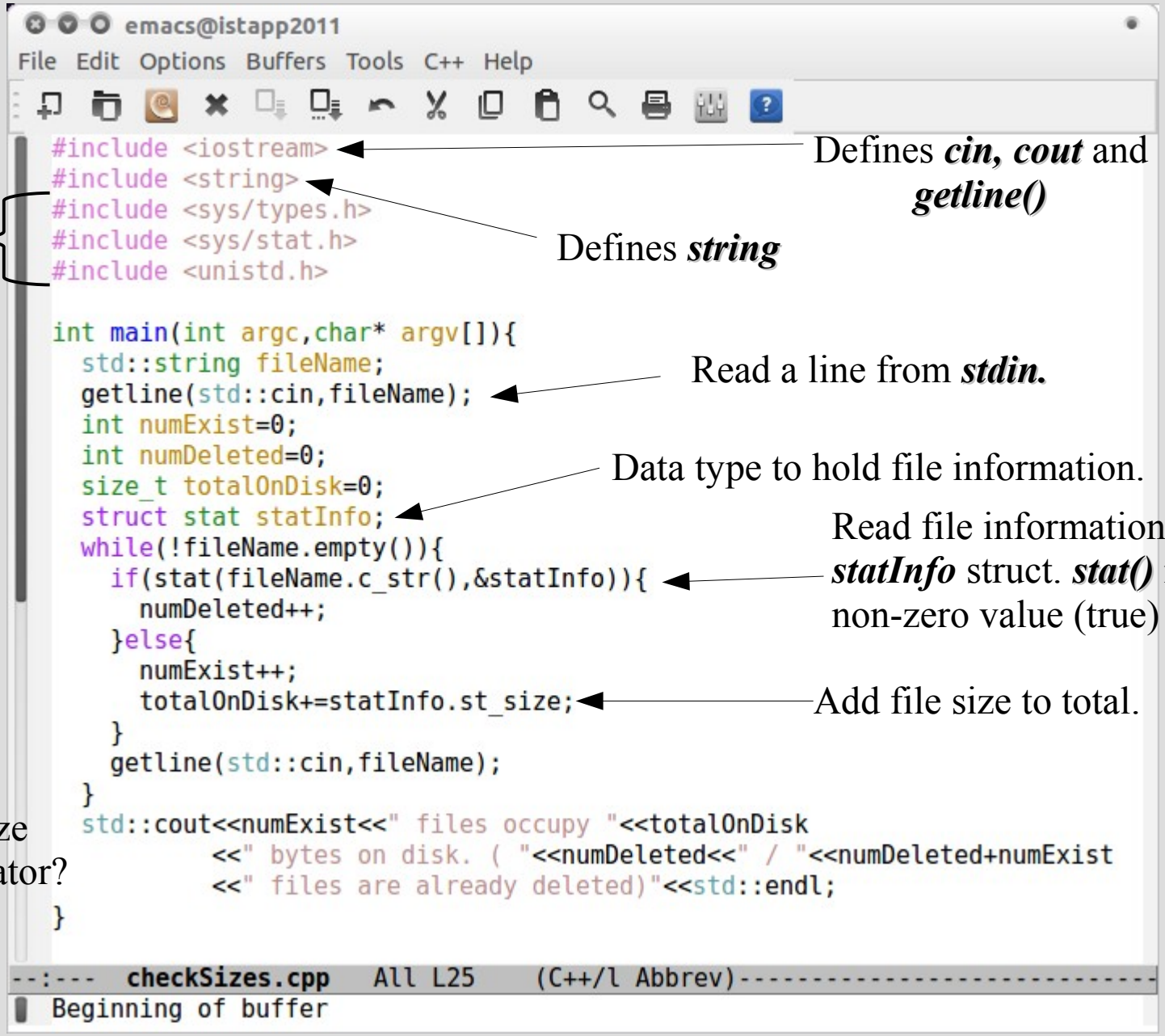
Hello World example





- Linux natively supports c/c++. If GNU tools and shell scripting is not enough, you can write your own programs
- ***gfortran, gcc*** and ***g++*** are Fortran, C and C++ compilers of the GCC suite, respectively.
- In C/C++ every program has an entry function with a signature of either ***int main(void)*** or ***int main(int argc, char* argv[]).***
- In C++ iostream library provides two stream objects, cout and cin to access stdin and stdout.
- We will talk about C++ in ROOT lectures in the afternoon.

CheckSizes with c++



Needed for ***stat()***
See ***man 2 stat***

Defines ***cin, cout*** and ***getline()***

Defines ***string***

Read a line from ***stdin.***

Data type to hold file information.

Read file information into ***statInfo*** struct. ***stat()*** returns a non-zero value (true) on failure.

Add file size to total.

Can you print total size with thousands separator?

Last words

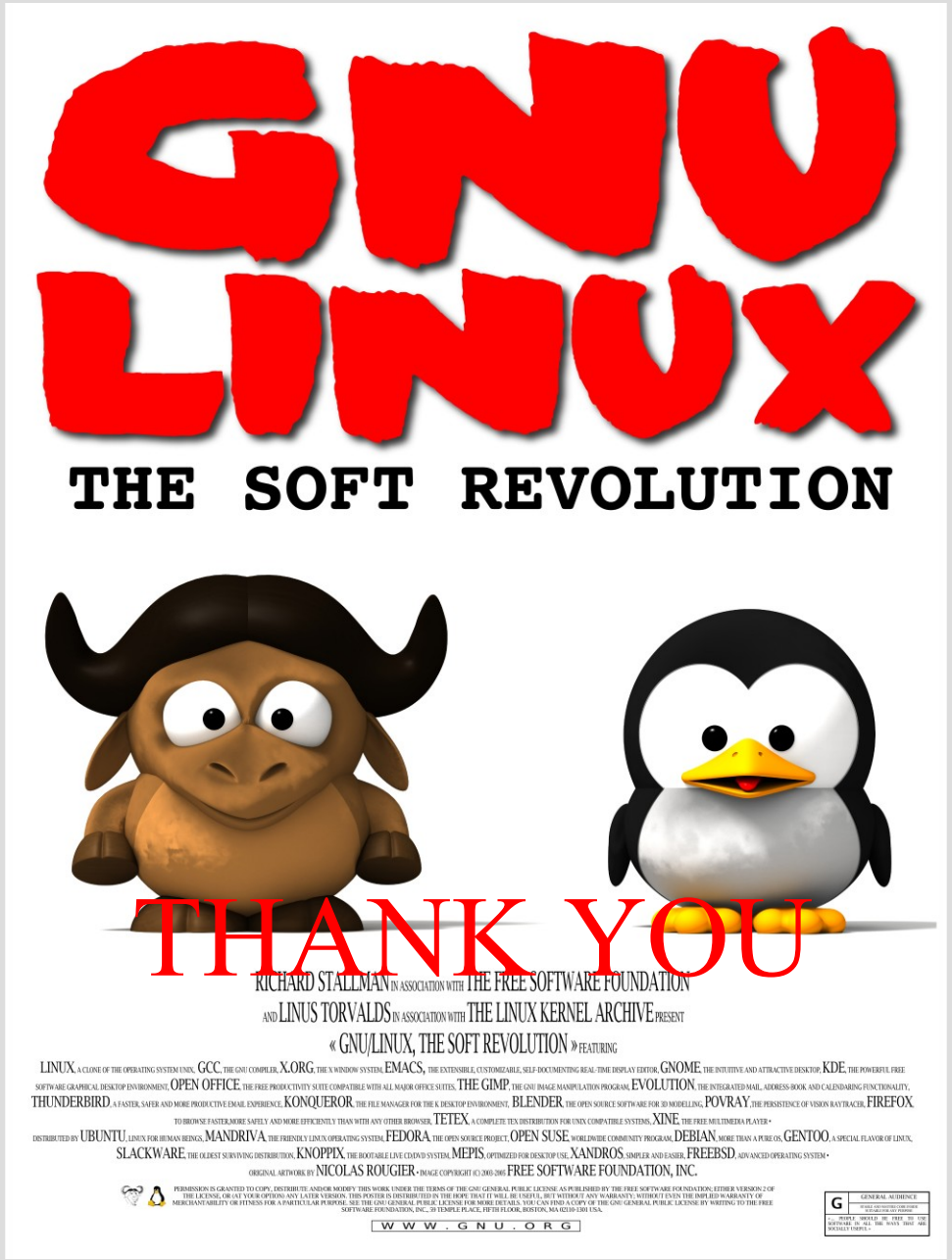
- GNU/Linux is a big topic and can not be covered in 45 minutes.
- I skipped most of the details and tried to explain basics that you might need when you start using Linux. There are some more, useful commands that I did not mention.
- Improving your knowledge about Linux and programming languages will provide you alternative solutions for your problems regardless of whether you work on theory or experiment.
- Please take a look at the references in the talk.

Finally

- "I checked it very thoroughly," said the computer, "and that quite definitely is the answer. I think the problem, to be quite honest with you, is that you've never actually known what the question is."
- "But it was the Great Question! The Ultimate Question of Life, the Universe and Everything," howled Loonquawl.
- "Yes," said Deep Thought with the air of one who suffers fools gladly, "but what actually is it?"
- A slow stupefied silence crept over the men as they stared at the computer and then at each other.
- "Well, you know, it's just Everything ... Everything ..." offered Phouchg weakly.
- "Exactly!" said Deep Thought. "So once you know what the question actually is, you'll know what the answer means."

from Hitchhikers Guide to Galaxy

There are enormous amount of information about GNU/Linux and programming on the web. If you phrase the question correctly, you can find answers to your problem!


GNU
LINUX
THE SOFT REVOLUTION
THANK YOU
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AND LINUS TORVALDS IN ASSOCIATION WITH THE LINUX KERNEL ARCHIVE PRESENT
« GNU/LINUX, THE SOFT REVOLUTION » FEATURING
LINUX, A CLONE OF THE OPERATING SYSTEM UNIX. GCC, THE GNU COMPILER. X.ORG, THE X WINDOW SYSTEM. EMACS, THE EXTENSIBLE, CUSTOMIZABLE, SELF-DOCUMENTING REAL-TIME DISPLAY EDITOR. GNOME, THE INTUITIVE AND ATTRACTIVE DESKTOP. KDE, THE POWERFUL FREE SOFTWARE GRAPHICAL DESKTOP ENVIRONMENT. OPEN OFFICE, THE FREE PRODUCTIVITY SUITE COMPATIBLE WITH ALL MAJOR OFFICE SUITES. THE GIMP, THE GNU IMAGE MANIPULATION PROGRAM. EVOLUTION, THE INTEGRATED MAIL, ADDRESS-BOOK AND CALENDARING FUNCTIONALITY. THUNDERBIRD, A FASTER, SAFER AND MORE PRODUCTIVE EMAIL EXPERIENCE. KONQUEROR, THE FILE MANAGER FOR THE K DESKTOP ENVIRONMENT. BLENDER, THE OPEN SOURCE SOFTWARE FOR 3D MODELLING. POVRAY, THE PERSISTENCE OF VISION RAYTRACER. FIREFOX, TO BROWSE FASTER,MORE SAFELY AND MORE EFFICIENTLY THAN WITH ANY OTHER BROWSER. TETEX, A COMPLETE TEX DISTRIBUTION FOR UNIX COMPATIBLE SYSTEMS. XINE, THE FREE MULTIMEDIA PLAYER •
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