IIP (E.T.S. Ingeniería Informática)
Year 2014-2015

Lab activity 1. Introduction: Linux, Java, and BlueJ

Introducción a la Informática y a la Programación
Departamento de Sistemas Informáticos y Computación
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Contents

1 Objectives and work previous to lab session

In this lab activity, the student must get familiar with all the aspects of the working environment that will be used during all the course. Objectives that are aimed at this

lab session are:

- Knowing the Linux operating system and its more usual commands
- Knowing the file and directory Linux organisation and apply this knowledge to the lab sessions structure
- Using the Emacs text editor
- Learning how to edit, compile, and execute a Java code in Linux
- Learning how to edit, compile, and execute a Java code in the BlueJ IDE

The student must read in detail the whole document, in order to center in depth in the task to be developed in the lab. Since it is the first session, no previous knowledge is required.

2 The Linux operating system

An *Operating System* (abbreviately, *O.S.*) is a set of programs that allows an efficient management of the computer components, and that simplifies the achievement of the most relevant computer operations. An O.S. allows, for example, a simple manipulation of storage devices such as hard disks or DVD drives, human interaction devices such as mouse, keyboard, screen, etc., communication and connection (network) devices, and many more.

Some of the most relevant functions of modern operating systems are:

- Management of the computer resources: storage, input/output, CPU, communications, etc.
- Management of simultaneous users, that allows any user to feel that they are working by themselves (without other users in the same computer)
- Secure access control to the system, in a way that each user can access and manage only those system parts in which he or she is authorised.
- Make easier the interaction with the hardware and provide with graphical and text-based tools that allow the manipulation in the desired form.

In this lab we will use the Linux O.S. Linux is a free, opened (its source code is available and it is possible to modify it) and powerful (Unix-derived) O.S. Linux is widely spread in academia, enterprises, and public services (there is a plan for the Spanish public services to widely use Linux). From the multiple available Linux distributions, in this lab the CentOS 6.5 distribution is installed.

In Linux, like in other O.S. (like Windows or OS X), there are two basic ways of interacting:

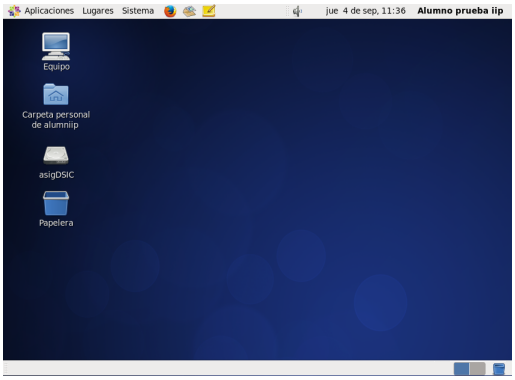


Figure 1: GNOME desktop.

- Text-based or *console*, i.e., writing on the keyboard system commands that are executed by the system.
- Graphical-based, using graphical user interfaces (GUI) such as Gnome, KDE, etc., which allow to use mouse and keyboard to manage the computer by using windows, menus, applications, etc. GNOME is the GUI installed in this lab.

Activity #1

1. Switch on the computer and choose the Linux O.S. option (Linux Estándar)
2. After some boot messages, a screen will appear asking for your username (`login`) and your password:
   - Username: the word before `@` in your UPV e-mail address (e.g., for `alumniip@inf.upv.es`, it will be `alumniip`).
   - Password: your DNI number (without letter); for non-Spanish students, your foreigner ID number **including the initial letter**

   First time you use the system, you will be asked to change the password; after changing it, the system closes session and asks for login and password again; you now must use the new password
3. After opening a session, the screen will show an aspect similar to that in Figure 1, i.e., a graphical desktop where some elements are present: menu bars, Firefox browser icon, and other icons on top; icons for `Equipo` (computer), `Carpeta Personal` (personal folder), `asigDSIC`[1], and `Papelera` (trash) on left center; a bar with the active desktop and the trash icon on bottom; clic the `Aplicaciones` (applications) menu and check the different available applications

[1] Direct access for a shared disk with folders for several DSIC subjects

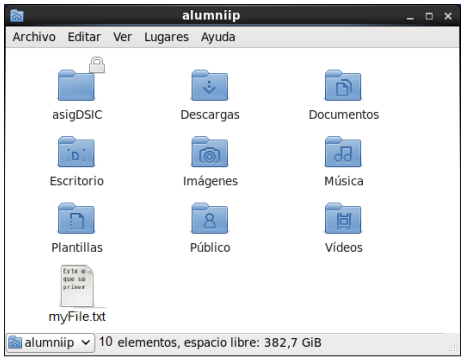


Figure 2: Personal folder for the user.

4. Make double click in `Carpeta Personal` and look at the window that opens; it contains your personal folder files and folders; by using the icons, the menus, or the mouse right button you can manage the contents (copy, paste, move, erase, etc.)

5. Open the Firefox browser and access to PoliformaT; download into your personal folder the file `myFile.txt` that you will have available in the folder `Recursos - Laboratorio - Práctica 1`; check that the file is in your personal folder, as in Figure 2

For using command line interaction with the O.S., you need a *terminal* or *console*, that execute a program called *shell*, which interprets text commands.

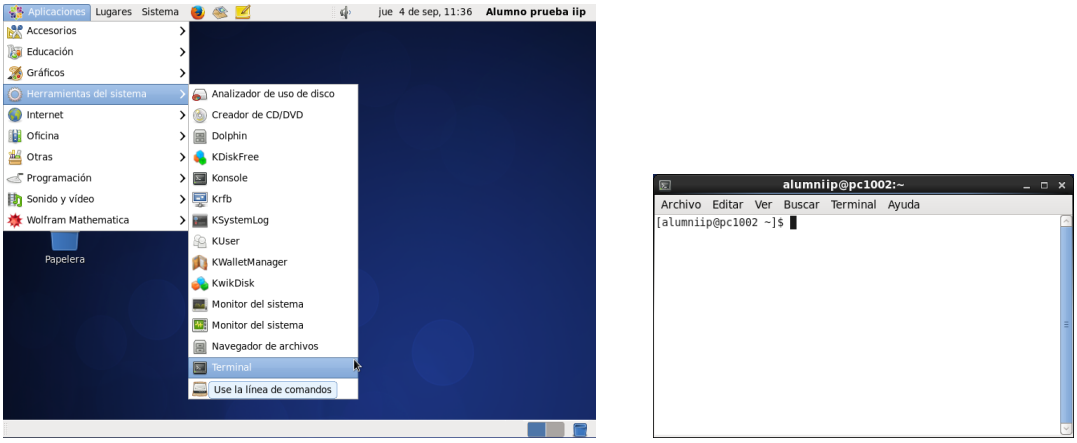
Activity #2

1. Start a terminal by using `Terminal` from the menu `Aplicaciones - Herramientas del sistema` (Figure 3(a)); it will appear a window, with an aspect similar to that in Figure 3(b), with a prompt that consists of your username, the identifier of the current computer you are working with, the current directory (folder), and the end character `$`; commands can be written after the `$` symbol.

In general, a command presents the form `command -options arguments`; after writing the command (with its possible options and arguments), it is executed by pressing enter. Before listing the most important commands and their effects, Section 3 describes how data is organised in Linux.

3 Files and directories

The basic information element in the system is the *file*. In a simplified manner, a file is a sequence of homogeneous information units that is in the computer. For example, there are character files, numerical files, command files, and, in general, files for all possible information that can be coded.



(a) Location of the terminal. (b) Terminal.

Figure 3: Initing a terminal in GNOME.

From the O.S. view, a file has a name that allows to recognise it, and a set of attributes such as its size, its last modification date, its owner, and *access permissions* (i.e., a definition of what can different users do with the file).

The O.S. recognises another element that allows to group inside other informational elements. These elements are called *directories* or *folders*, and, as its name indicates, they contain files and other directories.

There is the *root* directory, which includes hierarchically the rest of directories and files of the system. It is represented by the symbol `/` (slash).

The system set of directories and files build a hierarchical structure in which some directories contain files as well as directories, which can have a similar internal structure (i.e., they contain other files and directories). This hierarchical structure is usually represented as an inverted tree, with `/` as root, and with nodes that are directories or files. By similarity, this structure is called *directory tree of the system*.

Each file or directory of the system is represented in an unique way by the sequence of directories that must be followed in the directory tree from the root `/` to the file or directory. These steps that must be used to get to the element is usually known as *path* of the file or directory. For example, the sequence: `/opt/bluej/LICENSE.txt` shows the complete path needed to arrive to the file name `LICENSE.txt`. Figure 4 shows an example directory tree for a system.

Any system user is, in a specific moment, in one of the system directories, which is called *working directory*. Being in a working directory means that the operations the user makes on files and directories are, by default, performed on the elements of that working directory. The user can change the current working directory (by using the command `cd`).

When initing a working session, the system automatically situates the user in a predetermined directory, the *home* directory. The path of this directory is stored in an environment variable for each user called `$HOME`.

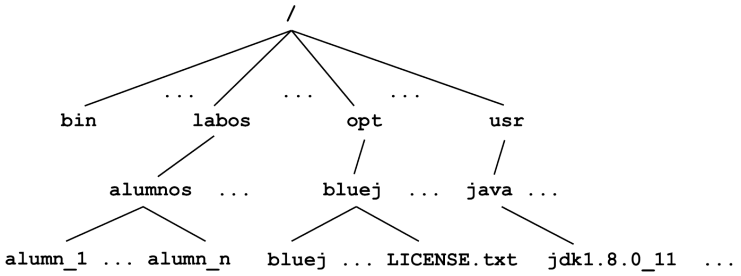


Figure 4: Directory tree

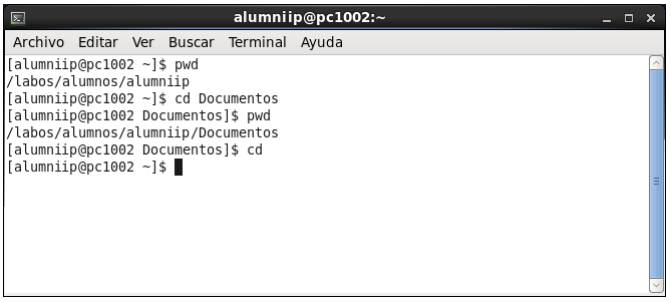


Figure 5: Change of the system prompt.

Then, for example, when a user `alumniip` executes the command `pwd` ("print working directory") after initing a session, the system will show the current directory, i.e., its home directory, something like `/labs/students/alumniip` (depending on the system).

Activity #3

1. Check in which directory you are by executing `pwd`
2. Change to directory `Documentos` by using the command `cd Documentos`; check with `pwd` that the change was done
3. The command `cd` without arguments returns to directory defined at your `$HOME`; notice that the console prompt changes, showing to you in which directory you are in each moment (see Figure 5)

4 Command features

Before describing the most usual commands, it is interesting to know some features related to its use: first, the format of the commands; second, the way the files and directories can be named; and finally how to refer to a set of files simultaneously.

4.1 Command format

Shell commands are written as individual words that the system recognises and execute. They may be written along with modifiers (options) that change the behaviour of the command.

For example:

- The command `ls` asks the system to list the names of the files that are in the current working directory.
- The command `ls hello.txt` asks the system to list the file with name `hello.txt` if it is in the current working directory.
- The command `ls -l -a` asks the system to list all the information (modifier `-l`) associated to the visible files and the invisible files (modifier `-a`) of the current working directory.

IMPORTANT TIP: Linux shell can accept partially written commands, that can be automatically completed; thus, after writing the initial letters of a command, pressing the tab key, the shell will try to complete the command (if there is no ambiguity).

For example: The command `ls -l he` is not complet if we like to know the features of the file `hello.txt`. If after writing `ls -l he` the tab key is pressed, then the Linux shell will try to complete the command, that will occur if the only file in the current working directory that starts with `he` is `hello.txt`, completing the order as `ls -l hello.txt`.

Apart from that, cursor keys (up and down, or equivalently `CTRL+P` and `CTRL+N`) can be used to retrieve commands previously written (command history).

Activity #4

1. Execute the previously listed `ls` orders in your `$HOME` directory and check if the results are those expected
2. Employ up and down cursor keys to verify that the previously written commands appear after the prompt

4.2 File and directory access

In Linux, files and directories can be accessed in an order using two formats:

- **Absolute:** the name of the file or directory is preceded by the path from the root directory. For example, the command `ls /opt/bluej/` asks the system to list the name of the files that are present in the indicated directory.
- **Relative:** in this case, knowing the current working directory, the access to the file or directory uses the sequence of directories from the working directory to the desired resource. For example, if the working directory is `/opt/` and the

command is `ls -l bluej/LICENSE.txt` this command asks the system to list all the information (modifier `-l`) associated to the file `LICENSE.txt`, which is in the path indicated by the current working directory and the directories specified in the command (i.e., `/opt/bluej/LICENSE.txt`).

It is important to know some special system references that are used for special directories, which are:

- `..` reference to the parent directory of a given one.
- `.` reference to the current directory.

Activity #5

1. Use the `ls` command to list all information related to directory `/opt/` by using the `..` reference in order to access to `/opt/` from your `$HOME` directory

4.3 Wildcards

Some special characters, known as *wildcards*, are used when writing file and directory names in commands, in order to give them a special meaning. Its use allows to name a set of files with a common syntactic feature, which allows the application of the same command to groups of files or directories, instead to a single one. The most important are:

- `?`: represents any single character, thus, for example, the command `ls hello?.txt` will list the name of the files that present a single character (any of them) in the place of `?`
- `*`: represents any character sequence, thus, for example, the command `ls hello*` lists the names of all the files that begin with the sequence `hello`

In any time it is needed to interpret literally any wildcard, it must be written between double quotation marks. For example, the command `ls pract2."*"` will obtain the name (if it exists) of the file whose name is exactly `pract2.*`.

5 Common commands

In this section some of the most usual shell commands are described. They are grouped attending to their functionality and described in a short way.

5.1 Help and information of other commands

The following commands allow to obtain information of other commands, using the command system database:

- `whatis CmdName`. Shows a brief summary of the mission of `CmdName`
- `apropos CmdName`. Shows the database entries in which `CmdName` appears
- `man CmdName`. Manual entry for `CmdName`; you can exit by pressing the `q` key

Activity #6

1. Check the `ls` command information by using `whatis`, `apropos`, and `man`

5.2 Directory working

You must get properly structured your `$HOME` directory, and the following commands will allow you to do so.

- `pwd` show the path from the root directory to the current working directory
- `ls dir` list files and directories inside `dir`; when `dir` is not specified, is the working directory; with option `-a` shows hidden files (usually system files, their names start with `.`); with option `-l` shows more data of each item (size, owner, access permissions, date of creation,...), with the format:
  - Item type (first letter of first column): `d` means directory, `-` regular file
  - Permissions (rest of letters of first column): three groups of three symbols, groups for owner, group, and other; the symbols mean, in this order, read, modify, and execute; they can be `-` (no permission) or `r` (read permission), `w` (modification permission), and `x` (execution permission)
  - Number of links (second column)
  - Owner (third column)
  - Group (fourth column)
  - Size in bytes (fifth column)
  - Date and hour of last modification (variable size)
  - Name
- `mkdir dir` create an empty directory following the specifications of `dir`
- `du dir` shows the space occupied by directory `dir` and all its internal files and directories; option `-c` shows a total; option `-h` offers a letter associated to the size (`M` for megabytes, `G` for gigabytes,...); option `--exclude=dirName` excludes directory `dirName` from size calculations
- `cd dir` change from the current directory to the reference directory `dir`; if `dir` is omitted, changes to `$HOME`; if `dir` is `..`, changes to the parent of the working directory
- `rmdir dir` remove `dir` only if it is empty

Activity #7

1. Create in your `$HOME` directory the `iip` directory, and inside of this, create the subdirectory `labact1`
2. Change to `labact1` and, by using an only command, create the subdirectory `labact2` inside `iip`
3. Change to your `$HOME` directory and, with an only command, create subdirectory `test` inside `iip`
4. List the contents of the `iip` directory, including hidden files; result must be similar to:

```
total 20
drwxr-xr-x  5 alumniip alumnos 4096 sep  4 15:47 .
drwx------ 33 alumniip alumnos 4096 sep  4 15:45 ..
drwxr-xr-x  2 alumniip alumnos 4096 sep  4 15:45 labact1
drwxr-xr-x  2 alumniip alumnos 4096 sep  4 15:47 labact2
drwxr-xr-x  2 alumniip alumnos 4096 sep  4 15:47 test
```

5. Show the total size, in megabytes, of your personal directory (`$HOME`) excluding the `asigDSIC` directory

5.3 File working

The following commands are used for file manipulation.

- `cp OrgFile DstFile` copies `OrgFile` to `DstFile`; if `DstFile` is a directory name, copies `OrgFile` inside `DstFile`
- `mv OrgFileDir DstFileDir` change name of file or directory `OrgFileDir` to `DstFileDir`; if `DstFileDir` is an existing directory, moves file `OrgFileDir` into directory `DstFileDir`
- `rm FileName` removes file `FileName`; with option `-i` asks user confirmation; with option `-r`, when `FileName` is a directory, removes the directory and all its contents
- `cat TextFileName` shows the contents of `TextFileName`; several files can be passed and they will be shown concatenated; if any file does not exist, it produces an error
- `more TextFileName` shows the contents of `TextFileName` page by page, from the first one to the last one; pressing space key makes it advance one page, and pressing `p` key makes it go back one page; exit is achieved by pressing `q`
- `less TextFileName` is a more powerful version of `more`, that allows to show the contents of `TextFileName` page by page but allowing forward and backward movements, pattern search, etc.; it is only available in Linux

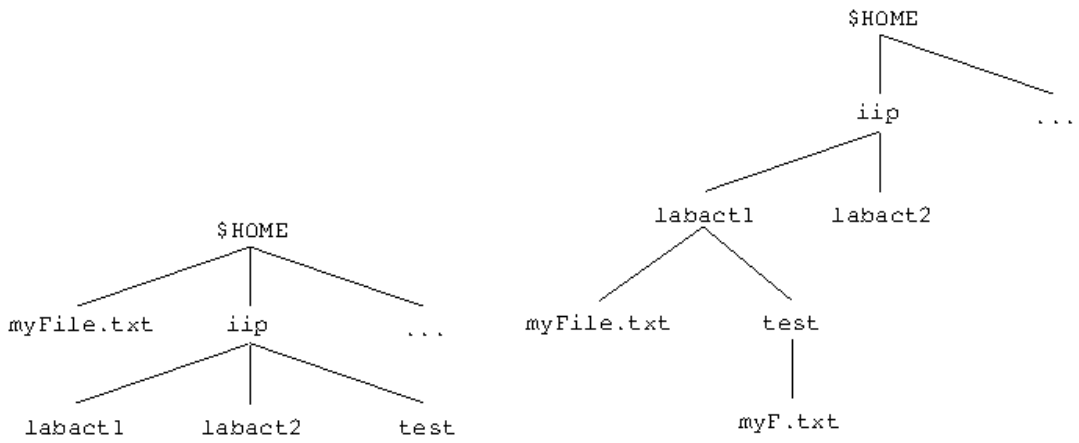
- `wc TextFileName` shows the total number of lines, words, and characters of `TextFileName`; options `-l`, `-w`, and `-c` allow to obtain only the number of lines, words, or characters respectively

Activity #8

1. From your `$HOME` directory, check that the directory structure for that directory is that shown in Figure 6(a)
2. Copy the file `myFile.txt` to directory `iip/labact1`; check the contents of that directory
3. Erase the `myFile.txt` file from your `$HOME`
4. Change to `iip/labact1` and create a copy of the file `myFile.txt` called `myFile2.txt`; check the contents of the directory and, by using the `cat` command, show the contents of the files `myFile.txt` and `myFile2.txt`
5. From `iip/labact1` and, by using an only command, create a copy of `myFile.txt` into directory `iip/test`
6. With an only command, move the `myFile2.txt` file into directory `iip/test`; check the contents of the subdirectories `labact1` and `test`
7. Change to `iip/test`; change the name of the file `myFile2.txt` to `myF.txt`; check the contents of the directory and show the contents of `myF.txt`
8. From `iip/test`, erase file `myFile.txt`; check that is actually erased
9. Show the contents of the file `myF.txt` by using the commands `more` and `less`
10. Show the number of lines, words, and characters of the file `myF.txt`
11. Change to `iip` and move directory `test` into directory `labact1`; check that the directory tree in your `$HOME` is that shown in Figure 6(b)
12. Change to your `$HOME` directory and erase the `.mozilla` directory; erasing this kind of directories (system hidden directories that are automatically generated by some applications, like the Mozilla browsers), is something that you must make often in order to avoid an overflow of your disk quota (which is 100Mb)

5.4 Input/output redirection

Most commands accept data from keyboard (standard input), process that data, and show results on the screen (standard output). The following techniques allow to redirect input/output in order to obtain input from a file or record output into a file.



(a) At the beginning. (b) At the end.

Figure 6: Directory tree for your `$HOME` directory.

- `Cmd > DstFile` sends to file `DstFile` the output of `Cmd`; if `DstFile` does not exist, it is created; otherwise, its contents are overwritten
- `Cmd >> DstFile` like the previous one but adding the output at the end of `DstFile`
- `Cmd 2> DstFile` sends to file `DstFile` the error output of `Cmd`
- `Cmd < OrgFile` take as standard input for `Cmd` the contents of the file `OrgFile`
- $\texttt{Cmd}_1$ `|` $\texttt{Cmd}_2$ sends the output of $\texttt{Cmd}_1$ as input for $\texttt{Cmd}_2$
- `tee` $\texttt{DstFile}_1 \ldots \texttt{DstFile}_n$ copies its standard input to its standard output and to all the files that are passed as arguments; by combining `tee` and `|`, the output of a command can be sent to a file and, at the same time, be shown on the screen

Activity #9

1. Change to `iip/labact1/test` and execute the command `ls -la > list`; check that the listing of the directory `test` is not shown on the screen but written into `list`
2. Execute the following commands:

   ```
   date > output
   ls -l >> output
   ```

   and check that the current date (`date` command) and, after that, the directory listing, get written into the file `output`
3. Execute the command `cat myF.txt myF2.txt` that shows on the screen the contents of `myF1.txt` and an error that says that `myF2.txt` does not exist

4. Execute the command `cat myF.txt myF2.txt > out 2> err` and check that the standard output is redirected into `out` and the error output into `err`
5. Execute the command `wc < out` that counts the number of lines, words, and characters of the file `out`
6. Execute the command `who | wc -l` that counts the number of lines of the result of the command `who`
7. Execute the command `ls -l | tee list` that shows the directory listing for `test` on the screen and, at the same time, writes it into the file `list`

5.5 Access control, security and privileges

The following commands allow to change system password and permissions of a file (who can access and what s/he can do on the file).

- `passwd` changes password
- `chmod mask name` changes the access permissions for file or directory `name` following the pattern given by `mask`

Activity #10

1. By using the `man` command, check the help on the two previous commands

5.6 Basic system management

Other commands employed for managing the system are the following.

- `who` shows the name of the current system users
- `whoami` shows the name of the user that executed the command
- `&` when written after a command, the command is executed concurrently in background, without blocking the terminal while it is being executed
- `ps` lists active processes
- `kill -9 procid` terminates immediately the process with id `procid`
- `env` shows user environment and it allows its modification
- `exit` ends the current session (closes terminal)

Activity #11

1. Execute in background the command `kcalc` (scientific calculator)
2. List all the active processes and kill the `kcalc` process by using the `kill` command

6 Edition, compilation, and execution in command line

Programs installed in the system can be executed from the command line by writing its name and using the appropriate parameters. This is the case of Emacs, a text editor that is usually distributed in Linux systems, and the Java compilers installed in the lab computers and that will be used in the current session.

Emacs can be executed using as parameter the name of the file to be edited, that will be created if it does not exist, and will be opened to be modified.

For example, the following command:

```
emacs Hello.java &
```

opens a window to edit the file named `Hello.java`, without blocking the system terminal. This editor has the usual options for file management, text editing, and others: `File`, `Editor`, ...

After writing and saving the program, it must be translated from the high-level language it is written into a sequence of instructions that can be understood by the operating system and the processor. This process is known as *compilation*. To compile the edited program, write in the command line:

```
javac Hello.java
```

Where `javac` means "java compiler". If the program is correctly written, without compilation errors, another file with the same name (`Hello`) but with extension `.class` will appear in the current directory. The program can be executed by using the Java Virtual Machine (JVM) using the following command:

```
java Hello
```

where `java` is the call for the virtual machine and `Hello` is the name of the class that was edited in the file `Hello.java` and that was compiled into `Hello.class`.

In summary:

- the command `javac Hello.java`, generates the file `Hello.class` which contains the "bytecodes" resulting from the compilation of the program
- the command `java Hello` causes the execution of the Java Virtual Machine, which executes the "bytecodes" of the file `Hello.class`, executing consequently the initial program

Activity #12

1. Change to `iip/labact1` and create with *Emacs* the file `Hello.java` with the following source code:

```
public class Hello {
  public static void main(String[] args) {
       System.out.println("Hello all");
  }
}
```

2. Compile to bytecodes the `Hello.java` file
3. List the contents of the working directory to check that the `Hello.class` file appears; in that case, execute the `Hello` class by calling the JVM
4. Execute the `Hello` class and make it write its output into a text file (choose the name you prefer) instead of the standard output; check that the file is created and check its contents

7 Edition, compilation and execution in BlueJ

BlueJ is a Java programming IDE, created initially by the *BlueJ* team of the Monash University, Melbourne (Australia), and the Kent University, Canterbury (United Kingdom), and which was created with the purpose of being used in introductory courses to the Java language.

Using a quite simple graphical interface, *BlueJ* allows to develop any Java application. In *BlueJ*, the directory that keeps all the files of the Java application is called **project**. It contains the source codes (with `.java` extension) and the bytecodes (with `.class` extension).

Although the *BlueJ* complete functionalities will be detailed in the second lab activity, and you will employ it in the rest of the lab sessions, now it is described how to edit, compile, and execute a Java program.

For executing *BlueJ* you can access to the menu `Aplicaciones - Otras - BlueJ 3.1.1` or write on the command line:

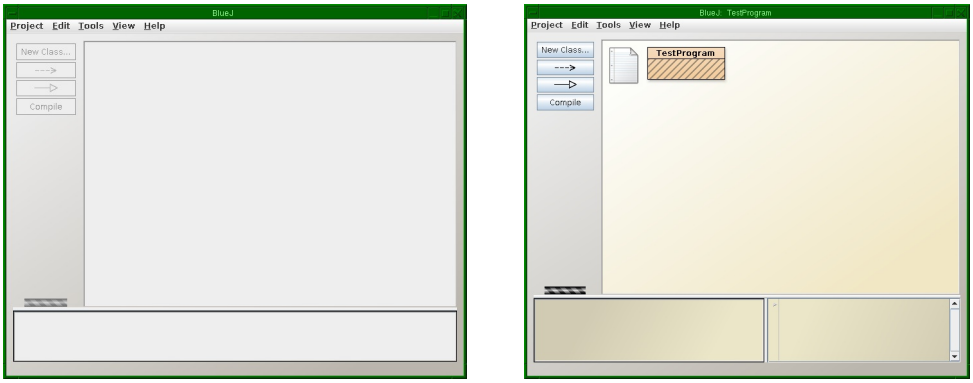
```
bluej &
```

After calling to *BlueJ*, it appears automatically in a window, the *BlueJ main window* (Figure 7(a)). Notice that its central zone is empty.

In the upper part of the main window there is a menu that allows to access to some operations: on the project (`Project`), edition operations (`Edit`), *BlueJ* tools (`Tools`), viewing (`View`), and help (`Help`).

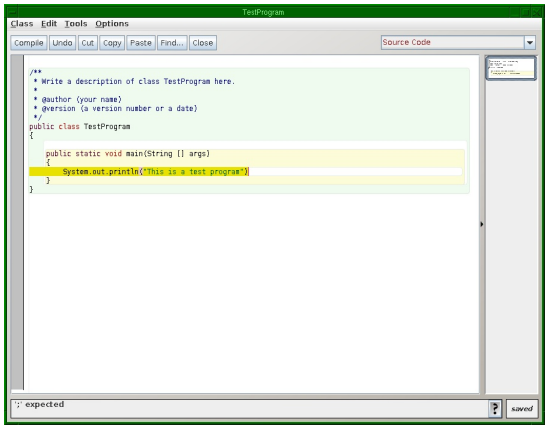
To create a new *BlueJ* project, select the option `Project - New` from the menu and give a name to it.

For creating a class in a project you must click on the button `New Class...` and a name and type (in our examples, we will always choose `Class`). In *BlueJ* main window appears the icon of the created class (Figure 7(b)), that appears with strips since it is not compiled yet.



(a) *BlueJ* main window. (b) Project view example.

Figure 7: *BlueJ* windows.



(a) Class menu. (b) Class compilation with errors.

Figure 8: `HelloBlueJ` class compilation.

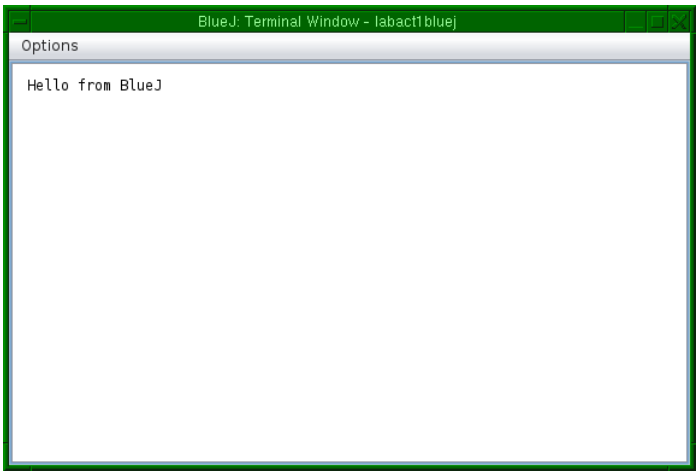
After creating the class, when its icon is pointed and clicked with the mouse right button, the *class menu* (the operations that can be used on the class) is shown (Figure 8(a)). For editing a class the option `Open Editor` from the menu class can be selected. As an alternative, double click on the class icon can be used.

With respect to how compiling a class, there are different ways: from the editor, from the class menu, or from the `Tools` menu of *BlueJ*. If the compiler detects any error, the corresponding line appears shadowed, and a message error will appear in the *information zone* as well (bottom part of the screen) (Figure 8(b)). In this case, when the button with the symbol "`?`" (right part of the information zone) is clicked, more information can be obtained about the detected error.

As was said before, when a class is clicked by using the mouse right button, the class menu appears. From the operations that shows this menu, the call to the `main` method must be highlighted, since *allows to execute a class from its menu* (Figure 9(a)).

(a) Class menu.

(b) Call to `main` method.



(c) Result on the terminal window.

Figure 9: Execution of the class `HelloBlueJ`.

In Figure 9(b), the main method call window for the class `HelloBlueJ` is shown. When the program asks data from the keyboard or shows results on the screen, a text terminal appears automatically (Figure 9(c)). If it does not appear, select the option `View - Show terminal` from the menu.

Activity #13

1. From `iip/labact1`, call to *BlueJ* without parameters and create the project (which is actually a directory) `labact1bluej`, by using the option `Project - New`

2. Create the class `HelloBlueJ`, and open the editor to write the following code:

```
public class HelloBlueJ {
  public static void main(String[] args) {
       System.out.println("Hello from BlueJ");
  }
}
```

3. Compile the class, correct the compilation errors, and check what happens in the central part of the *BlueJ* main window

4. Execute the `main` method of the `HelloBlueJ` class and check that the result is that shown in the Figure 3(b); you can save that result into a text file with the option `Options - Save to` from the terminal window menu

IMPORTANT NOTICE: when finishing the activity, **DO NOT SWITCH OFF THE COMPUTER**; choose `Cerrar sesión` from the `Sistema` menu, and choose `Cerrar sesión` in the window that appears; after closing GNOME, the login screen will appear again.