

Ganzúa 1.01 Manual

Jesús Adolfo García Pasquel

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Chapter 1

Introduction

1.1 What is Ganzúa?

Ganzúa (picklock in Spanish) is a cryptanalysis tool for classical ciphers (monoalphabetic and polyalphabetic) that lets the user define almost completely arbitrary cipher and plain alphabets, allowing for the proper cryptanalysis of cryptograms obtained from non-English texts.

Ganzúa is an internationalized Java application, localized for English and Spanish. In other words, Ganzúa is a platform-independent computer program that can be adapted to various languages and regions without engineering changes, and as of this version it features English and Spanish interfaces from which to choose. It provides an environment for the cryptanalysis of monoalphabetic and polyalphabetic ciphers and was written to be used as a tool in an introductory cryptology course.

Ganzúa is open source software covered by the General Public License (GPL), which grants you many more rights than most software licenses, including access to the source code and freedom to change it.

Ganzúa was written in the Java programming language with the GNU EMACS editor in GNU/Linux and Mac OS X.

1.2 List of Features

- Features present for all ciphers:
 - Use almost arbitrary plain and cipher alphabets.
 - Obtain and display the standard relative frequencies of characters, bigrams and trigrams of languages.
 - Calculate the index of coincidence of cryptograms and languages.
 - Estimate the number of alphabets used to generate a cryptogram, based on the index of coincidence of the ciphertext and the one of the language.

- Enforced injective character substitution.
- Save and load ongoing cryptanalysis projects.
- Monoalphabetic cryptanalysis features:
 - Alphabet-wide substitution tools for the Caesar shift cipher and other monoalphabetic ciphers.
 - Obtain and display the relative frequencies of the characters, bigrams and trigrams of cryptograms.
- Polyalphabetic cryptanalysis features:
 - Alphabet-wide substitution tools for the Vigenère or Alberti ciphers.
 - Obtain and display the relative frequencies of the characters ciphered using each alphabet.
 - Perform the Kasiski Test on cryptograms.

Chapter 2

Installation

2.1 Requirements

To use Ganzúa you'll need a full implementation of the Java 2 Runtime Environment, Standard Edition (JRE) version 1.4 or higher with an implementation of the Java API for XML Processing (JAXP) version 1.2 or higher .

2.2 Supported Platforms

Ganzúa is a Java application and therefore platform-independent. It should run fine on any platform with a full implementation of the Java 2 Runtime Environment, Standard Edition (JRE) version 1.4 or higher with an implementation of the Java API for XML Processing (JAXP) version 1.2 or higher.

Ganzúa has been tested and is known to work on the following platforms:

- GNU/Linux, using Sun Microsystems' Java 2 Platform Standard Edition (J2SE) 5.0 JRE.
- GNU/Linux, using Sun Microsystems' JRE 1.4.2 and Xerces2 Java Parser version 2.6 for the implementation of the JAXP 1.2 specification.
- Mac OS X 10.3 Panther, using Apple's implementation of the JRE 1.4.1 (included in Mac OS X 10.3) and Xerces2 Java Parser version 2.6 for the implementation of the JAXP 1.2 specification.
- Windows 98/ME/XP using Sun Microsystems' J2SE 5.0 JRE.
- Windows 98/ME/XP using Sun Microsystems' JRE 1.4.2 and Xerces2 Java Parser version 2.6 for the implementation of the JAXP 1.2 specification.

If you are able to run Ganzúa successfully on some other platform, please contact me (see chapter 5) so it can be added to this section.

2.3 Installing Ganzúa

This section provides information on how to install Ganzúa in the different platforms it is known to work on. Feel free to skip the sections that do not deal with the platform you want to use.

2.3.1 GNU/Linux

Getting ready

In order to run Ganzúa, you'll need an implementation of the Java 2 Runtime Environment, Standard Edition (JRE) version 1.4 or higher. If you don't have one installed on your system, you'll need to get one of the implementations available for GNU/Linux. The one used to test Ganzúa was the implementation by Sun Microsystems, which can be found at <http://java.sun.com>, but you might want to get IBM's (<http://www.ibm.com>), Blackdown's (<http://www.blackdown.org>) or other. Preferably, install a JRE for the Java 2 Platform, Standard Edition (J2SE) 5.0 or higher, this way you may avoid updating the JAXP included with the JRE.

Installing Ganzúa

Now you are ready to install Ganzúa. To do so follow these steps:

1. Download the binary package from Ganzúa's site: <http://ganzua.sourceforge.net>
2. Extract the files from the package and place them where you want it to be installed. Check that the path to the installation directory does not include directories with names that contain caracteres outside the English alphabet or 0-9 (e.g. accented caracteres or ñ), otherwise the program may not work properly.

You should be able to run Ganzúa by invoking the command `java -jar ganzua.jar` from the directory Ganzúa was installed to.

Test your installation

Run Ganzúa and select Open from its File menu. Now select a cryptanalysis project from the examples found at the directory `GANZÚA_HOME/examples/projects/en` where `GANZÚA_HOME` stands for the directory Ganzúa was installed to.

If the project is opened successfully, congratulations, you may skip the rest of this chapter. But, if the project could not be opened and an error message was displayed asking you to update the version of the Java API for XML Processing (JAXP), quit the program and read the next section, which will guide you through this process.

Update your version of JAXP

If your implementation of the JRE does not include an implementation of the Java API for XML Processing (JAXP) version 1.2 or higher, you'll have to install one. The Xerces2 Java Parser (version 2.6 or higher) provides such implementation. To install it do the following:

1. Download the application `findEndorsedDirs.jar` from <http://ganzua.sourceforge.net>. This executable JAR will tell you which are the Java endorsed standards directories (the directories where you may put the implementation of JAXP) in your implementation of the JRE.
2. Download the latest release of the Xerces2 Java Parser from <http://xml.apache.org/xerces2-j/>
3. Extract the files from the compressed archive.
4. Run `findEndorsedDirs` with the command
`java -jar findEndorsedDirs.jar`
5. Copy all the JAR files (the files that end in `.jar`) from Xerces2's archive to any of the directories displayed by `findEndorsedDirs`. If the directory does not exist, create it.
6. Quit all active Ganzúa programs.
7. Run the test outlined in the previous section to confirm that the version of JAXP has been updated.

You will not need `findEndorsedDirs.jar` or the Xerces2 archive any more, so you may delete them.

If you have any problem, contact me (see chapter 5) so it can be addressed in the documentation in the future.

2.3.2 Mac OS X (10.3 or higher)

Getting ready

Apple's implementation of the Java 2 Runtime Environment, Standard Edition (JRE) version 1.4.1 (or higher) is included in Mac OS X 10.3 (or higher), but downloading any update to the Java platform available through Software Update may improve Ganzúa's performance and make the installation process easier. To run Software Update choose it from the Apple Menu, or choose System Preferences from the Apple menu, then choose Software Update from the View menu, and click Update Now.

Installing Ganzúa

Now you are ready to install Ganzúa. To do so follow these steps:

1. Download the Mac OS X package from Ganzúa's site: <http://ganzua.sourceforge.net>
2. Open the package and drag the folder that contains Ganzúa and some files and directories to wherever you want it installed to. Preferably place it in the *Applications* directory, since the program may not work properly otherwise.

Note that some of the files and directories in Ganzúa's folder are important to the program and you should not move or delete them from the installation directory. This is explained later on, in section 2.4.

That is it. Now you can run Ganzúa by double-clicking its icon.

Test your installation

Run Ganzúa and select Open from its File menu. Now select a cryptanalysis project from the examples found at the directory `GANZÚA_HOME/examples/projects/en` where `GANZÚA_HOME` stands for the directory Ganzúa was installed to.

If the project is opened successfully, congratulations, you may skip the rest of this chapter. But, if the project could not be opened and an error message was displayed asking you to update the version of the Java API for XML Processing (JAXP), quit the program and read the next section, which will guide you through this process.

Update your version of JAXP

If the JRE does not include an implementation of the Java API for XML Processing (JAXP) version 1.2 or higher, you'll have to install one, like the Xerces2 Java Parser. To install Xerces 2 you'll need to do the following:

1. Download the application `findEndorsedDirs.jar` from <http://ganzua.sourceforge.net>. This executable JAR will tell you which are the Java endorsed standards directories (the directories where you may put the implementation of JAXP) in your implementation of the JRE.
2. Download the latest release of the Xerces2 Java Parser from <http://xml.apache.org/xerces2-j/>
3. Extract the files from the compressed archive.
4. Run `findEndorsedDirs` by double-clicking the file `findEndorsedDirs.jar`
5. Copy all the JAR files (the files that end in `.jar`) from Xerces2's archive to any of the directories displayed by `findEndorsedDirs`. If the directory does not exist, create it.

6. Quit all active Ganzúa programs.
7. Run the test outlined in the previous section to confirm that the version of JAXP has been updated.

You will not need `findEndorsedDirs.jar` or the Xerces2 archive any more, so you may delete them.

If you have any problem, contact me (see chapter 5) so it can be addressed in the documentation in the future.

2.3.3 Windows

Getting Ready

In order to use Ganzúa, you'll need an implementation of the Java 2 Runtime Environment, Standard Edition (JRE) version 1.4 or higher. If you don't have one installed on your system, or all you have is the program named Microsoft Java Virtual Machine (which is **not** an implementation of the JRE), you'll need to get one of the implementations available for Windows. The one used to test Ganzúa was the implementation by Sun Microsystems, which can be found at <http://java.sun.com>, but you might want to get IBM's (<http://www.ibm.com>), or other. Preferably, install a JRE for the Java 2 Platform, Standard Edition (J2SE) 5.0 or higher, this way you may avoid updating the version of JAXP included with the JRE.

Installing Ganzúa

Now you are ready to install Ganzúa. To do so follow these steps:

1. Download the binary package from Ganzúa's site: <http://ganzua.sourceforge.net>
2. Extract the files from the package and place them where you want it to be installed. Check that the path to the installation directory does not include directories with names that contain characteres outside the English alphabet or 0-9 (e.g. accented characteres or ñ), otherwise the program may not work properly.

Note that some of the files and directories in Ganzúa's folder are important to the program and you should not move or delete them from the installation directory. This is explained later on, in section 2.4.

You should be able to run Ganzúa by double clicking `ganzua.jar` or using the command `java -jar ganzua.jar` from the directory Ganzúa was installed to.

Test your installation

Run Ganzúa and select Open from its File menu. Now select a cryptanalysis project from the examples found at the directory `GANZÚA_HOME/examples/projects/en` where `GANZÚA_HOME` stands for the directory Ganzúa was installed to.

If the project is opened successfully, congratulations, you may skip the rest of this chapter. But, if the project could not be opened and an error message was displayed asking you to update the version of the Java API for XML Processing (JAXP), quit the program and read the next section, which will guide you through this process.

Update your version of JAXP

If your implementation of the JRE does not include an implementation of the Java API for XML Processing (JAXP) version 1.2 or higher you'll have to install one. The Xerces2 Java Parser (version 2.6 or higher) provides such implementation. To install it do the following:

1. Download the application `findEndorsedDirs.jar` from <http://ganzua.sourceforge.net>. This executable JAR will tell you which are the Java endorsed standards directories (the directories where you may put the implementation of JAXP) in your implementation of the JRE.
2. Download the latest release of the Xerces2 Java Parser from <http://xml.apache.org/xerces2-j/>
3. Extract the files from the compressed archive.
4. Run `findEndorsedDirs` by double-clicking on `findEndorsedDirs.jar` or with the command
`java -jar findEndorsedDirs.jar`
5. Copy all the JAR files (the files that end in `.jar`) from Xerces2's archive to any of the directories displayed by `findEndorsedDirs`. If the directory does not exist, create it.
6. Quit all active Ganzúa programs.
7. Run the test outlined in the previous section to confirm that the version of JAXP has been updated.

You will not need `findEndorsedDirs.jar` or the Xerces2 archive any more, so you may delete them.

2.4 Configuring Ganzúa

This section will explain how Ganzúa's files are organized, what they contain and how to customize your installation.

2.4.1 Ganzúa's Files and Directories

2.4.1.1 Binary packages

If you downloaded a binary package you should have the following files and directories (folders). In the case of the Mac OS X package, there must be an application package instead of `ganzua.jar`.

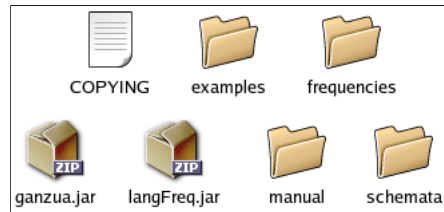


Figure 2.1: Binary package contents

COPYING text file with the GPL, Ganzúa's software license.

ganzua.jar an executable Java archive that contains Ganzúa.

In Mac OS X this file is inside the application package and can be accessed by selecting **Show Package Contents** from the contextual menu that appears after doing a Control-click on Ganzúa's icon in Finder.

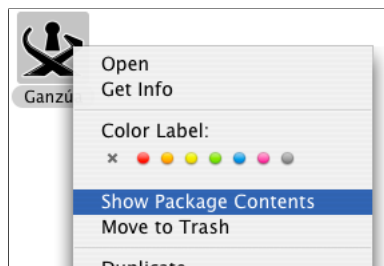


Figure 2.2: `ganzua.jar` is inside the application package in Mac OS X

langFreq.jar the utility to get the frequencies of characters, bigrams and trigrams of a language packed in an executable Java archive.

schemata a directory that contains the W3C XML schemata used to validate that the XML files used by Ganzúa (to load ongoing projects, relative frequencies of languages, etc.) are well formed.

frequencies a directory with relative frequencies of languages. This is the directory where Ganzúa looks for language frequencies by default.

examples a directory with examples.

manual the directory where you can find this manual in PDF format and the list of changes since previous versions.

2.4.1.2 Source Code Package

If you downloaded the source code package you should have the following files and directories:

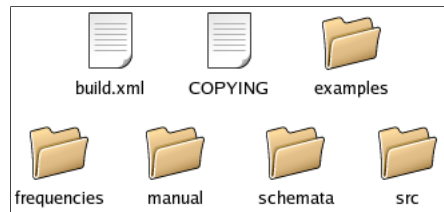


Figure 2.3: Source code package contents

COPYING text file with the GPL, Ganzúa's software license.

build.xml a buildfile used to compile Ganzúa using the Apache Ant build tool.

src the directory with Ganzúa's source code.

schemata a directory that contains the W3C XML schema files used to verify that the XML files used by Ganzúa (to load ongoing projects, relative frequencies of languages, etc.) are well formed. Just like in the binary packages.

frequencies a directory with relative frequencies of languages. This is the directory where Ganzúa looks for language frequencies by default. Just like in the binary packages.

examples a directory with examples. Just like in the binary packages.

manual the directory where you can find this manual in PDF format and the list of changes since previous versions.

2.4.2 Required Files and Directories

To use Ganzúa you need the JAR files ganzua.jar and langFreq.jar, the schemata files they use and a default directory with language frequencies, the rest of the files are dispensable.

Ganzúa makes extensive use of XML (eXtensible Markup Language) files, they are used to save and load projects, language frequencies, and give instructions to the application langFreq.jar. XML files are similar to HTML files in that both are text files with markup tags. Ganzúa checks the structure of these files using W3C XML schemata (which are XML files themselves) that specify their build. This way, Ganzúa lets you access the data you have created and

make new Ganzúa-compatible documents with any text editor, and if you use an XML editor that can use W3C XML schemata, you can validate the documents as you write them.

You can rename or move the schemata and frequencies directories if you want to put the schemata with some other W3C XML schema files or if you just don't like them where they are, but you'll have to tell the program about the changes by editing a couple of configuration files.

Moving The Schemata and Language Frequencies Directories

If you move or rename the schemata and/or language frequencies directories, you'll have to close all active Ganzúa programs and edit two configuration files to notify the program about the changes.

The configuration files are inside the JAR files, one inside `ganzua.jar`, the other in `langFreq.jar`, both are named `config.properties` and have the same structure. To edit these files do as you would to edit a text file in a ZIP archive (JAR files can be handled as ZIP files). If you know how to use the EMACS editor you can use it to open the JAR files and edit the `config.properties` files directly.

If you change the name of the schemata directory or move it, you'll have to edit the line

```
#schemataDir = /usr/local/share/ganzua/schemata/
```

Remove the `#` character at the beginning of the line and change the path after the `=` character to the full path of the directory where you put the schemata.

If you change the name of the language frequencies directory or move it, you'll have to edit the line

```
#langFreqDir = /usr/local/share/ganzua/frequencies/
```

Remove the `#` character at the beginning of the line and change the path after the `=` character to the full path of the directory where you put the language frequencies.

Remember that this has to be done on both JAR files.

2.5 About The Source Code Package

Since this is an open source program, the source code is available at Ganzúa's site (<http://ganzua.sourceforge.net>) for you to download, modify, redistribute, etc. as specified in the General Public License (GPL).

To compile the source code you'll need a compiler for the Java programming language version 1.4 or higher, and the Apache Ant build tool (<http://ant.apache.org>) version 1.5 or higher.

During the development of Ganzúa version 1.01, two compilers were used:

- Sun Microsystems' Java 2 SDK, Standard Edition version 1.4.2 for Linux.
- Apple's implementation of the Java 2, Standard Edition platform, version 1.4.1 for Mac OS X.

There are two Apache Ant buildfiles in Ganzúa's source code package. The first one is at the root of the package and can be used to generate the executable JARs and documentation. The second one can generate the bytecode and is in the `src` directory. For more information on these build files use the command `ant -projecthelp` in the directories where the files are located.

If you plan to run Ganzúa outside of a JAR package (as compiled by the buildfile in the `src` directory) you'll have to edit the file `config.properties` found in `src/net/sourceforge/ganzua`, as explained in section 2.4.2, even if you don't move the schemata or language frequencies directories. To run the program this way, you should use the command

```
java net.sourceforge.ganzua.Analyzer
```

from the `src` directory (Analyzer is the name of the class that contains Ganzúa's main program), or

```
java net.sourceforge.ganzua.LangFreq
```

if you want to use the language frequencies utility.

Chapter 3

Using Ganzúa

This chapter explains Ganzúa's interface, how it is divided and shows how to use the features present for all of the supported ciphers.

To better understand the way the program works, you should open Ganzúa and try the features described in this chapter as you read them.

3.1 Interface

The following screenshots show the way Ganzúa's main window looks¹ on the platforms it has been tested and is known to work in (see section 2.2).

The labels on the images stand for:

1. Title bar
2. Menu bar
3. Main panel and ciphertext statistics tabs
4. Cipher selection area
5. Cipher specific tools area
6. Substitution area
7. Ciphertext and plaintext area

¹The program may have a different appearance, depending on the value of the JRE's default Look And Feel.

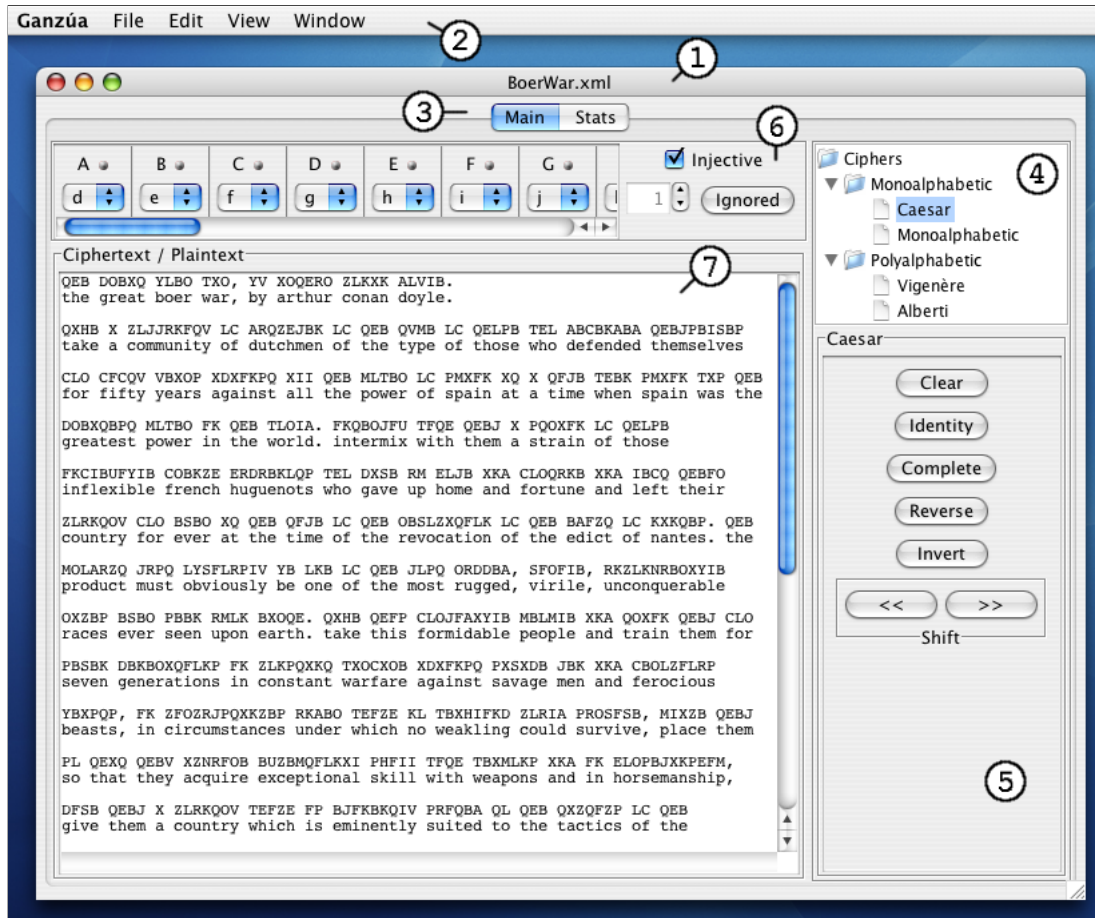


Figure 3.1: Ganzúa running on Mac OS X using the Aqua look and feel

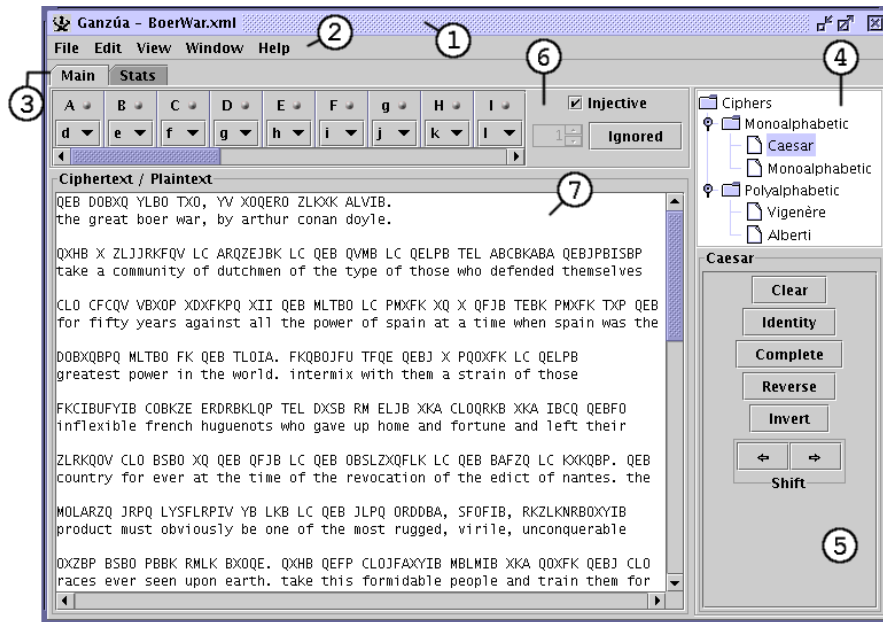


Figure 3.2: Ganzúa running on GNU/Linux using the Java look and feel

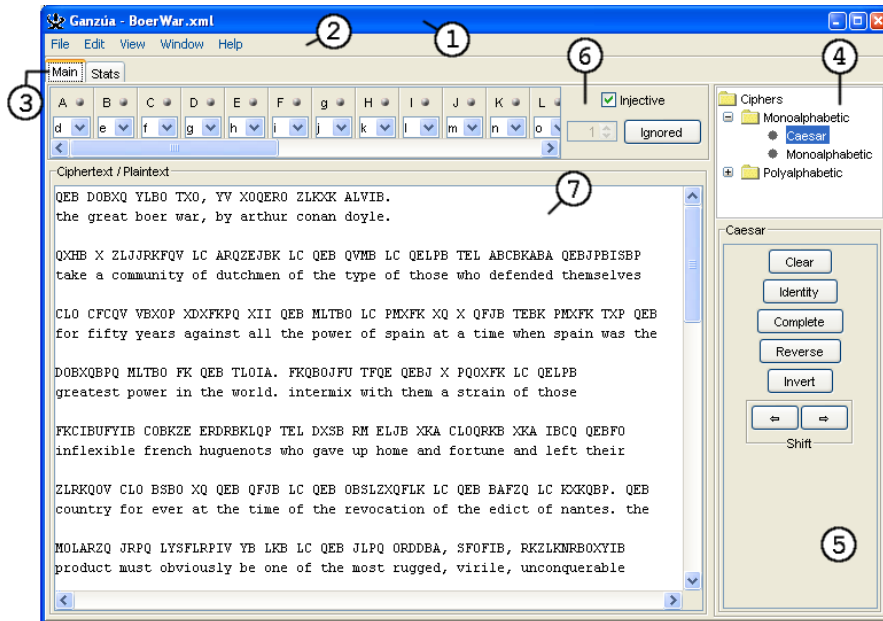


Figure 3.3: Ganzúa running on Windows XP using the Windows look and feel

3.2 Title and Menu Bars

The title bar displays the name of the file the cryptanalysis project you are working on is in. If you have not saved the project, then **Untitled** is displayed.

The menu bar has five menus, which are not the same for all platforms. The Ganzúa menu (available only in Mac OS X) contains program related options, like About, which displays information about this version of Ganzúa. On the rest of the platforms, About is in the Help menu, which is the only option that menu has, and that is the reason why it is not displayed in Mac OS X. Since almost every platform handles help documents its own way and Ganzúa is not targeted towards any platform in particular, but tries to address as many as possible; the help documents like this manual are provided in standard formats, like HTML and PDF, that you can read on your platform of choice. The only assistance that is provided in the program itself are tool-tips, that appear when the cursor is left over an item for an extended period of time.

The following sections explain the options in the menus that appear on all platforms.

3.2.1 File Menu

Open

Lets you open a cryptanalysis project. You used this option back in section 2.3 to test your installation of Ganzúa.

Try: Open the file `BoerWar.xml`, that can be found at `GANZÚA_HOME/examples/projects/en` where `GANZÚA_HOME` stands for the directory Ganzúa was installed to.

Open Ciphertext

Lets you open a cryptogram from a text file. When you choose this option, a dialog appears. This dialog lets you select a text file and the encoding used by the text file. The encoding defines a character set and the relationship between the characters and their representations in the file. If you don't know which encoding is used in your text files, probably you are using your system's default, which is automatically selected each time Ganzúa starts up.

Note that if you change the selected encoding, that change will remain until you quit Ganzúa or select a different encoding and will affect the rest of the text file related dialogs (those used by Save Ciphertext and Save Plaintext, explained later in this section).

Try: Open a text file, like Ganzúa's license which is the file named `COPYING` in the directory Ganzúa is installed in. If you opened `BoerWar.xml` as suggested previously, note how the contents of the substitution area change, the character substitutions are cleared and the name in the title bar changes to **Untitled**.

Important: Ganzúa was written to be used as a tool in an introductory cryptology course and is not meant to handle documents larger than a couple of pages long.

Open Language

Lets you open a file with a language's standard relative frequencies of characters, bigrams and trigrams. These files are typically stored in Ganzúa's **frequencies** folder (see section 2.4.1). By convention the first two letters of the frequencies files' name are the ISO 639 code of the language.

When you open a language, you define the plain alphabet, the way characters (in both the cipher and plain alphabet) are ordered and the data to be displayed in the Language Stats window (see section 3.2.4).

Important: When you open a language, the previous plain alphabet is discarded and so are any selected character substitutions.

Important: When you open a ciphertext file, the language data you were using previously in this session, if any, will remain until you open a new language or cryptanalysis project file.

Save

This option lets you save the cryptanalysis project you are working on to a file similar to the **BoerWar.xml** file mentioned earlier in this section. If the project has previously been saved or was opened from a file, the data on that file is updated.

The data saved includes the cipher selected in the cipher selection area, the language data (including character, bigram and trigram frequencies) if any, the substitution and the ciphertext.

Save As

Lets you save the current project to a different file.

Save Ciphertext

With this option you can save the project's ciphertext (the cryptogram) to a text file. When you choose this option, a dialog similar to the one displayed by Open Ciphertext appears. From this dialog you can choose the encoding to be used in the file. As with Open Ciphertext's dialog, if you change the selected encoding, this will change it on the rest of the text file related dialogs as well (those used by Open Ciphertext and Save Plaintext).

Save Plaintext

Lets you save the project's plaintext (the text that results from applying the substitution to the cryptogram) to a text file. As with Save Ciphertext and

Open Ciphertext, a dialog that lets you select the file's encoding will appear and any changes to the selected encoding will be reflected in those dialogs as well.

3.2.2 Edit Menu

Copy

Copies the selected text from the ciphertext and plaintext area. If you wish to copy selections from other places, like tables from the Language Stats window or the ciphertext statistics, use the keyboard shortcut displayed next to this option (for example, Command-C in Mac OS X) after making the selection. You can also drag your selection and drop it where you want it copied to. Note that some programs do not support drag and drop operations.

Add Characters To Cipher Alphabet

When you open a cryptogram from a text file (see section 3.2.1) the cipher alphabet is obtained from its characters. But most of the times, the files do not have occurrences of characters that appear in the cipher alphabet you want to use. For example if the letter Z is not used in the text file, the cipher alphabet generated when the file is opened will not include it.

Important: New line, space and control characters are considered special by Ganzúa and can not be part of the cipher or plain alphabets, any other character is valid.

To include the characters missing from the cipher alphabet, enter them one at a time² in the dialog that is displayed when you choose this option (figure 3.4). The dialog's Cancel button closes the dialog and cancels the addition of the character being displayed in the text field.

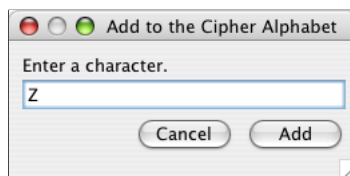


Figure 3.4: Add Characters to the Cipher Alphabet dialog

Try: If you open the BoerWar.xml project and click on the ciphertext statistics tab, you will be able to see that the characters W and G do not occur in the cryptogram and were added to the cipher alphabet using this command. Click on the Main tab, to go back to the main panel and add some lowercase letters to the cipher alphabet.

²Type in the character and press the Enter key or the Add button.

Add Characters To Plain Alphabet

If the language frequencies files available do not contain the plain alphabet you want to use, or are missing some character, you can add them by choosing this option. Note that this is for substitution purposes only. You will not get the benefits you get when your plain alphabet comes from a language frequencies file, like the relative frequencies of the characters. How to make your own language frequencies files is explained later in the manual.

To include characters, enter them one at a time, just like you would if you were adding them to the cipher alphabet.

Remove Characters From Cipher Alphabet

This option lets you remove characters from the cipher alphabet and cryptogram. When you select this option, a window with a list of the characters in the cipher alphabet is displayed. After selecting³ the characters you want to remove, press the Remove button, this will remove the characters from the cipher alphabet and any occurrence of these in the ciphertext.

Important: Ganzúa does not include an undo command, so be careful when you perform operations like removing characters, and save your work often.

Try: Open the BoerWar.xml project and remove the punctuation characters.

Group Characters

Lets you group the cryptogram's characters in blocks separated by space characters. This is one of the reasons the space character is considered special and can not be part of the cipher alphabet. If it were, this operation would alter the relative frequencies of the cryptogram.

Try: Group the ciphertext characters of the project BoerWar.xml

Uppercase Ciphertext

Converts all the characters in the ciphertext to uppercase. This operation is equivalent to opening a new cryptogram with an uppercased version of the ciphertext. This means that you will lose all the character substitution information, including characters you added to the cipher alphabet. If the current project's ciphertext is already made up of uppercase characters exclusively (like BoerWar.xml), then this command will not do anything to the current project.

³To select more than one character, use the conventional keys used to add items to selections on your platform. For example Shift-click .

Lowercase Ciphertext

Converts all the characters in the ciphertext to lowercase. Like Uppercase Ciphertext, this operation is equivalent to opening a new cryptogram with a lowercased version of the ciphertext, so you will lose all the character substitution information. If all of the project's ciphertext characters are lowercase, then this command will do nothing to the current project.

Set Plaintext as Ciphertext

Sets the project's plaintext as the ciphertext. This operation is equivalent to opening a ciphertext file that contains this project's plaintext. Like in the cases of Uppercase Ciphertext and Lowercase Ciphertext, this means you will lose all the character substitution information, including the characters added to the cipher alphabet.

This command may be useful if you are using Ganzúa to cipher text instead of cryptanalyzing it.

Try: Open the BoerWar.xml project and use this command.

3.2.3 View Menu

This menu contains options that change the way the ciphertext and plaintext area displays its contents. You can access these options from a contextual menu that you can trigger on this area (with a Control-click in Mac OS X or a right-click on other platforms, for example).

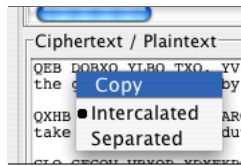


Figure 3.5: Ciphertext area contextual menu

Intercalated

In this mode, the ciphertext's lines are displayed with the corresponding plaintext line immediately under.

Separated

In this mode the ciphertext and plaintext are displayed in separate areas.

3.2.4 Window Menu

This menu lets you display Ganzúa's secondary windows.

Show Language Stats

Displays the Language Stats window, which contains tables with the language's standard relative frequencies of characters, bigrams and trigrams. These frequencies correspond to those in the language file that was opened most recently, if no language file has been opened, then this window contains no data.

The data presented in the tables can be sorted alphabetically or by frequency by clicking on the tables' header. For example, if you are looking at the table with the relative frequencies of the characters and click on the label of the column with the characters, the data will be ordered alphabetically and if you click on the label of the frequencies column the data will be ordered by frequency from the most frequent to the least. The data can also be displayed in reverse order by doing a Shift-click instead of a click on the labels.

Try: Open the BoerWar.xml project and sort the language statistics.

Show Ignored Characters

Displays the characters from the cipher alphabet that are being ignored. How to set a character as ignored and what this means is explained in section 3.3.

3.3 Substitution Area

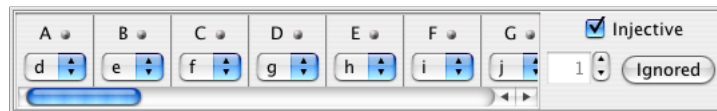


Figure 3.6: Substitution area

The substitution area is the section of Ganzúa that displays the relation between the characters in the cipher alphabet and those in the plain alphabet. It contains a region with character substitution elements, a checkbox that handles whether to enforce one-to-one substitution, a button that opens the Ignored Characters window and a control that lets the user select the substitution to be displayed, using the number of the alphabet it belongs to (enabled only for polyalphabetic ciphers).

Each character substitution element displays the character from the cipher alphabet to be replaced at the top, to the right there is a button that allows the user to add it to the set of ignored characters and at the bottom a combo box used to select a replacement character from those in the plain alphabet.

When a character is ignored, it is almost as having it removed from the cryptogram and cipher alphabet. The relative frequencies of the ciphertext are calculated as if those characters did not exist, they are removed from the substitution area, but they are included in the plaintext as they appear in the

ciphertext. For example in the project BoerWar.xml the punctuation marks are ignored.

The checkbox sets whether the substitution is forced to be injective (one-to-one) or not. If it is checked, the user is allowed to choose a replacement character only among those in the plain alphabet that have not been selected as replacements already, otherwise all the characters in the plain alphabet are available.

The button labeled Ignored works like Show Ignored Characters in the Window menu, it opens the window that displays the cipher alphabet characters being ignored and lets the user remove them from that set.

3.4 Ciphertext Statistics Panel

The ciphertext statistics panel contains the cryptogram's index of coincidence, tables with its character's relative frequencies and an estimate of the number of alphabets used in the cipher to obtain the ciphertext.

The estimate of the number of alphabets is obtained using the index of coincidence of the cryptogram and that of the language. If the language's index of coincidence is not available, or if the number of characters in the cipher alphabet is greater than that of the language's, no estimate will be shown.

Try: Open the BoerWar.xml project, see the number of alphabets estimate, add the characters in the Ignored Characters window and check the estimate again.

The relative frequencies tables contain different data depending on the chosen cipher. In the case of monoalphabetic ciphers the tables show the relative frequencies of characters, bigrams and trigrams, while for polyalphabetic ciphers, the relative frequencies of the characters ciphered with each alphabet is displayed.

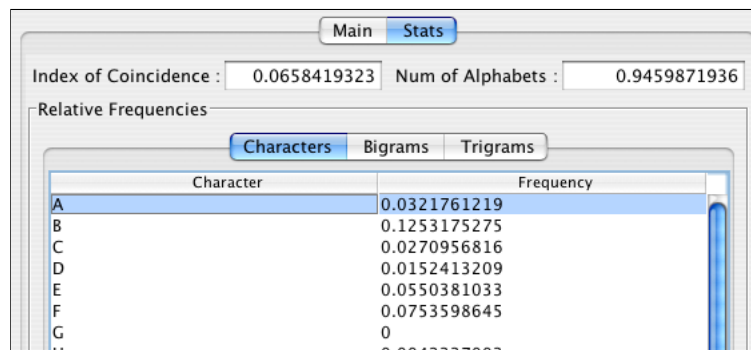


Figure 3.7: Cryptogram statistics (monoalphabetic)

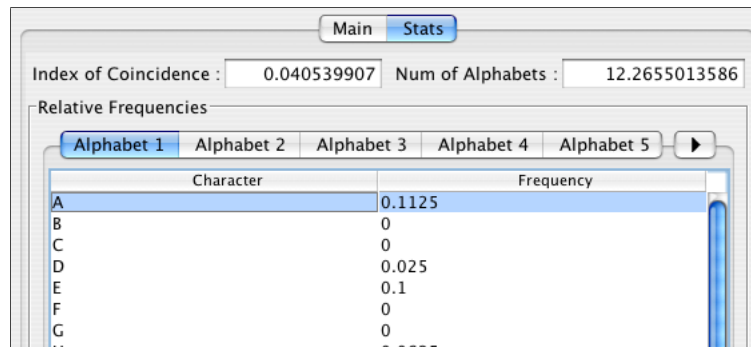


Figure 3.8: Cryptogram statistics (polyalphabetic)

Try: Open the BoerWar.xml project, and click on the Stats tab to pen the ciphertext statistics panel. Now open the main panel and select one of the polyalphabetic ciphers from the cipher selection area. Open the ciphertext statistics panel again and note the changes.

Remember: The contents of the tables can be sorted alphabetically or by frequency as explained in section 3.2.4. The contents of the tables may be copied (e.g., to a spreadsheet) by selecting and doing a drag-and-drop of your selection or using the keyboard shortcut (see section 3.2.2). To select all of the entries in the table you can use your platform's conventional keyboard shortcut, for example Command-A in Mac OS X or Control-A in GNU/Linux.

3.5 Cipher Selection and Tools Area

The cipher selection area lets the user choose the cipher specific tools he wants to use for his cryptanalysis project, whether one or more alphabets will be used and the information that will be displayed in the ciphertext statistics panel.

3.5.1 Monoalphabetic

Ganzúa has two groups of tools for monoalphabetic ciphers: the group for monoalphabetic ciphers in general and those for the Caesar cipher.

Caesar Cipher Tools

The kind of substitution in which the alphabet is simply shifted a number of positions is called the Caesar cipher or Caesar shift cipher. In Ganzúa, the tools to solve cryptograms obtained using this method are in the Caesar category. A description of the buttons in the tools area for the Caesar cipher is given next.

Clear: Clears the replacement characters from the selection.

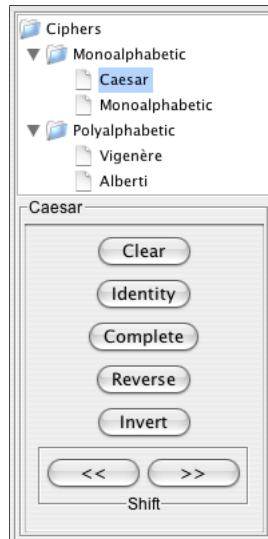


Figure 3.9: Cipher selection and tools area

Identity: Clears the current substitution and selects one as close to the identity as possible. This is, if the plain alphabet contains the character from the cipher alphabet, that character is chosen, if the character is not in the plain alphabet, but the upper/lowercased character is, then that character is assigned as the substitution.

Complete: Arbitrarily assigns substitution characters to the characters for which they have not been selected. The replacements are selected from those in the plain alphabet that have not been chosen. The substitution characters are selected in alphabetical order.

Reverse: Takes the current substitution and reverses the order in which the replacement characters appear. In other words, the character that replaces the first character in the cipher alphabet will be the replacement of the last, etc.

Invert: Select a substitution as close to the inverse of the current as possible. Takes those cipher alphabet characters that are in the plain alphabet too and whose substitution characters are in the cipher alphabet as well, and inverts the relation (sets the character being substituted as the substitution and the substitution as the substituted). The upper and lower case characters are considered the same way the Identity button does.

Shift: This control lets you shift the substitution characters to the left or right.

Try: Open the project BoerWar.xml and click the Clear button. If you don't know or remember why the punctuation symbols remain, read section 3.3.

Now click the Identity button and shift the selection to the right three positions. This is the substitution that was used to get the cryptogram, so if you click the Invert button you'll get the original text.

Monoalphabetic Cipher Tools

The tools for monoalphabetic ciphers in general, are the same as those available for the Caesar cipher, except that the shift tool is not available.

If you are working in this mode and find that you need to use the shift tool, select Caesar from the cipher selection area. None of your data will be lost. The same holds for changing from Caesar to Monoalphabetic.

3.5.2 Polyalphabetic

When you choose a polyalphabetic cipher, a control labeled Num. Alphabets will appear at the top of the the cipher specific tools section. That control lets you select the number of alphabets to use in the cipher. Do not confuse the function of this control with the one in the substitution area, that is used to select the substitution to be displayed, using the number of the alphabet it belongs to.

Ganzúa has two groups of tools for polyalphabetic ciphers: the group for the Vigenère cipher and the one for the Alberti cipher.

Vigenère Cipher Tools

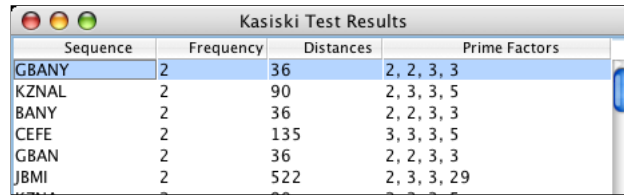
In the Vigenère cipher, each alphabet used differs from the others only by a shift, so many of the tools provided for this cipher are similar to those of the Caesar cipher.

Open the project WHeights.xml, see how the different sections of Ganzúa look for polyalphabetic ciphers (like the substitution area, the ciphertext statistics, etc.) and test what the tools for the Vigenère cipher do as you read their descriptions below.

Num. Alphabets: This tool lets you select the number of alphabets to work with and is available for all of the polyalphabetic ciphers.

Kasiski: Performs the Kasiski test. Finds all the repeated character sequences of length two or more in the cryptogram, the number of times they appear, the distance between occurrences and the prime factors of those distances. Once the test has been finished, the Kasiski Test Results window is opened and the data is presented in a table. The data may be sorted by length of sequence or frequency by clicking on the column headers.

Group: Groups the cryptogram's characters in blocks separated by space characters, just like the Group Characters in the Edit menu.



Sequence	Frequency	Distances	Prime Factors
GBANY	2	36	2, 2, 3, 3
KZNAL	2	90	2, 3, 3, 5
BANY	2	36	2, 2, 3, 3
CEFE	2	135	3, 3, 3, 5
GBAN	2	36	2, 2, 3, 3
JBMI	2	522	2, 3, 3, 29

Figure 3.10: Kasiski Test Results window

Subst 1: Copies the substitution for alphabet 1 to the currently selected alphabet.

Clear: Clears the current alphabet's substitution.

Identity: Clears the current alphabet's substitution and selects one as close to the identity as possible, just like the monoalphabetic version.

Complete: Arbitrarily assigns substitution characters to the characters for which they have not been selected in this alphabet, just like its monoalphabetic counterpart.

Reverse: Takes the current alphabet's substitution and reverses the order in which the replacement characters appear.

Invert: Select a substitution as close to the inverse of the current alphabet's as possible, just like its monoalphabetic counterpart.

Shift: Shift this alphabet's substitution characters to the left or right.

Alberti Cipher Tools

The tools for the Alberti cipher, are the same as those available for the Vigenère cipher, except that the shift tool is not available.

If you are working in this mode and find that you need to use the shift tool, select Vigenère from the cipher selection area. None of your data will be lost. The same holds for changing from Vigenère to Alberti.

Important: When you change from a polyalphabetic cipher to a monoalphabetic cipher all the substitutions but the one for the first alphabet will be lost.

3.6 Language and Country Settings

By default, Ganzúa will use your platform's preferred language and country conventions on its interface. If that language is not supported yet⁴, English will be used.

⁴As of version 1.01 Ganzúa supports only two languages: English and Spanish.

If you want Ganzúa to use some other language or country settings than the defaults and without changing your defaults, you may specify them as command line options. In order to do this you'll have to run Ganzúa from a command line terminal.

For example, to run the program in Spanish with Mexico's conventions you would use the command:

```
java -jar GANZÚA_HOME/ganzua.jar -l es -c MX
```

Where `GANZÚA_HOME` is the directory Ganzúa was installed to. `-l` is used to specify the language using its ISO 639 code and `-c` sets the country conventions using the countries two character ISO 3166 code. You do not have to use both arguments, you may use `-l` and omit `-c` and vice versa.

In Mac OS X you may set this arguments in the application package. To do this, open the file `Info.plist` with a text editor and insert the following two lines in line 29, under `<string>1.4+</string>`.

```
<key>Arguments</key>
<string>-l es -c MX</string>
```

Replace `es` and `MX` with the codes for the language and country you want to use. As with the command line, you may use `-l` or `-c` by themselves.

3.7 Important Things to Consider

This section lists some things you should keep in mind when using Ganzúa in addition to the bits pointed out previously.

When you open a cryptogram from a text file, the cipher alphabet is obtained from the characters that appear in it and are not considered special characters⁵. The first thing you should do after opening the cryptogram is to check that the cipher alphabet contains all the characters you want to use and only those, since most of the times the files lack characters you want. Failure to do this may unnecessarily complicate the cryptanalysis process. For information on how to add, remove or ignore cipher alphabet characters, read sections 3.2.2 and 3.3.

If you plan to use Ganzúa for polyalphabetic ciphers, you should also remember that the results of the Kasiski Test include every sequence of characters of length two or more that is repeated in the ciphertext. This means that all the subsequences of up to length two are included in the results. So, for example, if you see the sequence ABCDE with frequency of 2 among the results and the sequence BCD with frequency 3, then two of those are subsequences of the ABCDE sequences.

Check Ganzúa's home page (<http://ganzua.sourceforge.net>) for updates, bug fixes and answers to frequently asked questions. Also read chapter 5 for information on how to contact the author, should you find any bugs, errors in the documentation, etc.

⁵Spaces, line breaks and control characters are considered special characters.

Chapter 4

The Language Frequencies Utility

Ganzúa includes files with the standard relative frequencies of some languages, but probably not for the language and/or alphabet you want to use. The language frequencies utility `langFreq.jar` can get the standard relative frequencies of a language from a text file for an arbitrary alphabet. It is a command line utility, which means that it does not provide a graphical user interface and in order to use it you'll need a terminal¹.

For the relative frequencies to be representative of the language, the text files you get them from must be as big as possible. The files used to get the language frequencies included with Ganzúa were obtained from novels downloaded from Project Gutenberg's site (<http://www.promo.net/pg/>). Specifically, the statistics for the English language were obtained from *David Copperfield* by Charles Dickens and those of the Spanish language from *El Ingenioso Hidalgo Don Quijote de la Mancha* by Miguel de Cervantes Saavedra. Unlike Ganzúa, that is not meant to be used with large documents, this utility can handle big text files.

The information about the text file and the alphabet you want to use should be placed in an XML file like the ones in Ganzúa's `examples/alphabetRules/en` directory. These XML documents are instances of the `AlphabetRules.xsd` schema. They are called alphabet rules because they specify the characters to be included in the alphabet and how those that will not be included should be handled.

If you find the next section difficult to follow or would like to know a bit about XML before you start writing your own XML files, skim through one of the many XML tutorial available on the Internet, like the one at <http://www.w3schools.com>

¹In Mac OS X the terminal can be found in Applications/Utilities

4.1 Alphabet Rules XML Files

Open one of the example alphabet rules files (`examples/alphabetRules/en`) with your favorite text editor (or XML editor) so you can see a complete example as the different sections of this kind of XML file are explained.

```
<?xml version="1.0" encoding="UTF-8"?>
```

The first line must indicate the encoding used by the XML file. If you don't know which encoding you are using, it is probably your system's default. You can use Ganzúa to find out which is your platform's default encoding (see Open Ciphertext in section 3.2.1).

```
<alphabetRules xmlns="http://ganzua.sourceforge.net/rules"
               xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
               xsi:schemaLocation="http://ganzua.sourceforge.net/rules
                                   ../schemas/AlphabetRules.xsd"
               language="en" country="GB"
               source="/home/user/cprfd10.txt" sourceEncoding="ISO-8859-15">
```

The next few lines include the opening tag of the `alphabetRules` element and its attributes. The only attributes you should modify² are those that specify characteristics of the text file you'll get the relative frequencies from:

language two character ISO 639 code of the language the text file is in.

country two character ISO 3166 code of the country the text in the file originated from. This attribute is used to identify the differences in the use of a language by different countries, for example the English spoken in the United Kingdom and the United States of America.
This attribute is not required, so you may omit it entirely.

source the text file's full path.

sourceEncoding the Encoding used in the text file.

The next elements specify the characters that make up the alphabet. This can be done in two different ways:

- List all of the characters in the alphabet
- Specify a set of characters to include (even if they do not appear in the text file) and a set of characters to ignore.
Any character in the text file that is not among the ignored characters will be considered part of the alphabet.

²Change the value in quotation marks, but keep the marks.

If you want to simply list all of the characters you want in the alphabet, use the `includeExclusively` element.

```
<includeExclusively>
  <character char="A" />
  <character char="B" />
  <character char="C" />
  <character char="D" />
  :
</includeExclusively>
```

Each `character` element specifies a character to be included in the alphabet in its `char` attribute. Any character in the text file that is not in the `includeExclusively` element will be ignored when the program gets the relative frequencies. `GB_lowercase.xml` and `GB_uppercase.xml` are examples of alphabet rules files that use this tag.

Remember: New line, space and control characters are considered special by Ganzúa and may not be part of the cipher or plain alphabets, any other character is valid.

Do not put special characters inside `includeExclusively`.

To let `langFreq.jar` add characters to the cipher alphabet as it finds them in the text file, use the `include` and `ignore` elements. In the following example, some characters are specified using references to Unicode Standard characters (e.g. `
` for the line feed character) or entities (e.g. `"` for the character `"`). The entities used to reference Unicode characters are of the form `&#NUM;` where `NUM` is the decimal number (not hexadecimal) of the character in the Unicode charts. If you wish to learn more about Unicode, visit <http://www.unicode.org>.

```
<include>
  <character char="A" />
  <character char="B" />
  <character char="C" />
  <character char="D" />
  :
</include>
<ignore>
  <character char=" " /> <!-- space -->
  <character char="&#9;" /> <!-- horizontal tab -->
  <character char="&#10;" /> <!-- line feed -->
  <character char="&#13;" /> <!-- carriage return -->
  <character char="&#13;&#10;" /> <!-- new line -->
  <character char="&quot;" /> <!-- quote -->
  <character char="-" />
```

```

      :
</ignore>

```

All of the characters in the `include` tag will be in the alphabet even if they do not appear in the text file.

The characters in the `ignore` element will not be added to the alphabet even if they appear in the text file.

Important: Do not put characters that appear in the `include` element inside `ignore`. Doing so will make those characters appear in the alphabet but be ignored when the relative frequencies are obtained. They will have a frequency of 0 and will not appear in bigrams or trigrams.

Since new line, space and control characters are considered special by Ganzúa, they should not appear in the `include` element and should always be ignored. In the example above the space, tab, line feed, carriage return and new line characters are ignored. If you use the `include` tab, at the very least these characters should appear in the `ignore` element.

`GB_lowerIgnr.xml` and `GB_upperIgnr.xml` are examples of alphabet rules files that use the `include` and `ignore` tags.

The next elements tell `langFreq.jar` to handle occurrences of a given character as a different character. The utility does not do this automatically. If your alphabet contains uppercase character exclusively (as in an `includeExclusively` element), only those characters will be considered and any occurrence of a lowercase character will be handled as if it did not exist. That is, unless the `replace` element specifies that the lowercase character should be handled like a character in the alphabet.

```

<replace>
  <occurrences ofChar="a" byChar="A" />
  <occurrences ofChar="b" byChar="B" />
  <occurrences ofChar="c" byChar="C" />
  <occurrences ofChar="d" byChar="D" />
  :
</replace>

```

This way you could make the utility consider the character Ñ as N, etc.

Note that if you specify that a character should count as one to be ignored in `replace`, it will be ignored. You should also remember that `langFreq.jar` does not replace the characters recursively. If the following is inside a `replace` element:

```

  <occurrences ofChar="a" byChar="A" />
  <occurrences ofChar="A" byChar="X" />

```

The occurrences of the character `a` in the text file will count as `A`, and those of `A` as `X`, but `a` will not count as `X`.

All of the examples of alphabet rules files provided with Ganzúa use the `replace` element.

4.2 Using langFreq.jar

Once you have a text file to get relative frequencies from and an alphabet rules XML file for it, you'll be able to use langFreq.jar .

As mentioned earlier, langFreq.jar is a command line utility. Open a command line terminal and change to the directory that contains your alphabet rules file. Now use the command:

```
java -jar GANZÚA_HOME/langFreq.jar alphabetRules.xml
```

Where GANZÚA_HOME is the directory that contains langFreq.jar and alphabetRules.xml is the name of your alphabet rules XML file. This will make langFreq.jar parse your XML file, report if it finds errors in its construction and if that is not the case, generate a language frequencies XML file. Then the program will report the directory the file was written to and its name. By default the utility will try to place the new language frequencies file in Ganzúa's language frequencies directory, but if you are not allowed to write to that directory, it will be placed in your home directory. The file will be named using the two character code of the language and a number.

If you want to specify the directory and name of the file langFreq.jar should write to, use the -o option. For example

```
java -jar GANZÚA_HOME/langFreq.jar -o frequencies.xml alphabetRules.xml
```

This will make langFreq.jar put the language frequencies in the file frequencies.xml in the current directory.

If you make new language frequencies files, please consider donating them to the Ganzúa project, specially if they are of languages for which none are provided. Chapter 5 explains how you may contribute to Ganzúa.

Chapter 5

Contribute

There are many ways in which you can contribute to the improvement of Ganzúa.

- **Report any bug you find**, even if it is a minor issue.
- **Report errors in the documentation**, even if it is a misspelled word.
- **Donate language frequencies files**, specially of languages for which Ganzúa does not include any.
- **Localize Ganzúa**. In other words, translate the text files Ganzúa gets the labels for its interface from. This is easier than it sounds and you would be giving access to people that do not speak English or Spanish. Details on how to do this are provided in section 5.1. Anyone should be free to use Ganzúa, regardless of their language.
- **Translate Ganzúa's documentation**.
- **Implement new features**. If you add new features to Ganzúa I'll be happy to receive your code.

If you do any of the above, please contact Ganzúa's author at agarciap@users.sourceforge.net. Remember that Ganzúa is free software and can not be improved without your help. Also, if you are requesting help, a feature or a bug fix, do not forget to be polite. When you contact the author, please do so in English or Spanish.

5.1 Localize Ganzúa

Ganzúa gets all the labels for its interface from properties files. These are the ISO-8859-1 (ISO-Latin-1) encoded text files with extension **properties** found in the JAR file. You may extract the JAR file with any application you would use to expand a ZIP archive. The properties files have names of the form **name_lc.properties** where **lc** is the ISO 639 code of the language the labels

are in. If the file contains country specific use of a language, the files are named `name_lc_CC.properties` where CC is the two letter ISO 3166 code of the country.

When you translate a properties file, the first thing you should do is copy the file you want to translate from to one with the appropriate name for the translated file. For example, if you want to translate `name_en.properties` to Portuguese, then the file with the translation should be in `name_pt.properties` or `name_pt_BR.properties` if the translation will have Brazil specific use of the language.

The properties files contain lines like:

```
# A comment
key = Some text
```

The character # indicates the beginning of a comment. The text following # will be ignored by the program, so there is no need to translate it. The lines important to Ganzúa are those that contain key-value pairs separated by the character =. The key is used by Ganzúa to retrieve the translated text, so you should never translate the key, only the text after the character =. You should also remember that \n represents a line break, \t a tab and some times FN and NUM are used as place-holders for file names or numbers. The place-holders will be replaced by Ganzúa and should not be translated or modified.

Ganzúa needs your properties files to be encoded in ISO-8859-1. To convert your files you may need the `native2ascii` tool provided in most Java development kits (see section 2.5).

To run Ganzúa using an expanded `ganzua.jar` follow the instructions in section 2.5 (Note that you will not need to compile Ganzúa, since `ganzua.jar` contains the compiled program). This may be useful while you are editing/testing your properties files.

For Ganzúa to be localized for your particular language or region, you should translate, properly name and encode in ISO-8859-1 all of the properties files.

If you are having problems localizing Ganzúa, contact me thoroughly explaining the issue.

5.2 Notes About the Source Code

The following are some things you should know if you want to edit the source code.

- The source code files are encoded using the UTF-8 character set
- The properties files use ISO-8859-1.
- Ganzúa's source code is fully documented using doc comments, which means that you can generate the documentation in HTML format using the Javadoc tool. You can do this with the docs target of the ant build file (use the command `ant docs`).

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