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Automating the Lewinson-Zubin Handwriting Personality Assessment Scales

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Abstract

Throughout history, handwriting has been thought to be a window into peoples' character traits. Modern history of graphology culminated in the Lewinson-Zubin (L-Z) scales, a well-recognized system of handwriting analysis. Adopters of the L-Z scales include the CIA which used it during WWII to successfully recruit spies. This kind of application leads us to believe the scales can be a vital tool for government and private organizations. A major problem with the L-Z scales is that manual handwriting analysis is time consuming. Automating the analysis will greatly enhance its utility. This paper describes software implemented for this purpose. The software is built using Java 1.6, Java Advanced Imaging Library 1.1.3 and Netbeans 6.5. It allows users to load scanned handwritten documents to the computer screen, segment the image, compute one or more of the L-Z scales, and then save the profile in XML.

1. Introduction

Throughout history, the idea that handwriting can identify an individual's personality has fascinated scientists and laypeople alike. Around 330 B.C. Aristotle wrote:

…handwriting is the visible form of speech. Just as speech can have inflections of emotions, somewhere in handwriting is an expression of the emotions underlying the writer's thoughts, ideas, or desires. [15]

Although most of us can observe a link between handwriting and personality, even Aristotle dared not to say *how* one should interpret personality traits from handwriting. He only stated that these clues can be found *somewhere* in handwriting. Since Aristotle's reflection about the linkage between handwriting and character interpretation, graphology has weaved between the realms of science and pseudoscience. Our study concentrates on the scientific application of graphology, even though this can be a gray area.

The current scientific method of handwriting analysis started in the French Catholic clergy in the nineteenth century [2]. Abbe Jean Hippolyte Michon coined the term *graphology*, and founded a school of handwriting interpretation [12]. Michon's school was the source of modern graphology and the spread of the study of handwriting analysis throughout Europe [12].

The next great leap in the scientific evaluation of handwriting came from a man named Lugwig Klages. Lugwig Klages was "the first to create a complete and systematic theory of graphology" [12]. Klages classified personality traits by evaluating the up and down strokes of handwriting. For example, certain handwriting rhythms would indicate someone's intellectual passion, whereas certain letter forms would display someone's sense of inferiority [8]. A "normal" person would have a balance of contraction and release, whereas unstable people would have an unbalanced rhythm. Even though the system was developed, there did not exist an objective way of rating someone's entire personality.

Joseph Zubin and Thea Lewinson built upon Klages work and developed a system of scales, called the L-Z scales that evaluated the quantitative and qualitative aspects of handwriting. According to Lewinson-Zubin, there are four special characteristics of handwriting – vertical, horizontal, depth, and form – which are components by which each written letter can be evaluated. These four components yield the following dimensions of personality: the rational, the social-emotional, and the instinctual [7].

The vertical component concerns the height of the middle zone of a letter which emphasizes self importance.
The direction of the vertical lines belies the individual's mood level.

The horizontal is measured by the distance between letters and words. Also right/left slants are included in this measurement. Horizontal traits measure the relationship between the individual and his or her environment [7].

The depth component is the pressure of the writing and represents one's instinctual drives [7].
The form component measures the contour of the writing which can signify the degree of one's creativeness [7].

These four components are measured from 21 traits of handwriting rhythms that can be categorized as contracted, balanced, or released [7]. For example, the height that is accepted as representing rhythmic balance from the "middle zone" of a letter is three millimeters [7]. These 21 factors are called the L-Z scales. The problem with the L-Z scales is that the technique currently requires time consuming manual analysis. The software developed here will reduce the time it takes to sort through the data and allow a user to quickly analyze a handwriting sample using the Lewinson-Zubin (L-Z) scales. This software will:

- Load a scanned handwritten document to the computer screen.
- Allow users to crop images into lines, words and characters
- Compute one or more of the L-Z scales.
- Display and save the chart.

1.2 Case studies

During the Cold War years, the CIA's Office of Technical Service (OTS) developed tools that helped them conscript spies based on psychological assessment [14]. The tools would help psychologists quickly wade through a pool of potential spy recruits. The psychologists were looking for certain personality traits that motivate individuals to perform acts of espionage.

The CIA found that people having certain character traits would often respond positively to the question "Would you be willing to work for the CIA?" [14]. The danger of asking the wrong person would be reduced or eliminated.

In addition to using handwriting analysis to recruit spies, the CIA often used graphology as a psychological tool in evaluating world leaders [14]. According to *Spycraft*:

> . . .many Agency operational managers agreed that, as a supplement to direct assessment or in the absence of direct assessment opportunities, handwriting analysis done by trained graphologists contributes valuable insight into a target's mental state.

The CIA evaluated samples from Stalin, Yuri Andropov (former director of the KGB), and more recently, Burmese prodemocracy leader Aung San Suu Kyi when he was being held as a political prisoner. The psychological evaluation based on these handwriting samples helped give the US preliminary background of the psychological makeup of these key leaders. As a result, certain diplomatic decisions were made based on these assessments.

It's not difficult to see how these same tactics could help the US fight terrorism. According Craig Whitlock of the the Washington Post, it has been difficult for the US to recruit spies from Al-Qaeda, "Relying on Cold War tactics such as cash rewards for tips failed to take into account the religious motivations of Islamist radicals and produced few results."[15].

If the US can't wave cash in front of the eyes of terrorists and expect results, they should appeal to the idealism of the organization. The US could use handwriting analysis software to target potential spy recruits within Al Qaeda and other terrorist organizations.

2. Methodology

In order to implement the software, a thorough evaluation of the Lewinson-Zubin system was necessary. The following subsections detail the research which formed the viewpoint behind the software's algorithms and design.

2.1 Understanding the nature of handwriting analysis

Some of the L-Z scales have a more technical and scientific approach than others. Therefore, the L-Z scales that were more quantifiable were selected to be implemented for the project. Out of the four components that characterize handwriting, three are geometric in nature: height, width, and pressure exerted. The fourth component is form, which has to do with the shape, contour, and styling of handwriting. Measures of contraction and expansion exist in the form category, but become convoluted within an individual's artistic style of handwriting.

The dimensions of the horizontal, vertical, and depth components are enveloped and wrapped within a writer's individual artistic expression. The form category integrates all the factors of a personality and encompasses the other components. [7]

Handwriting form from a personality assessment point of view may be one of the most interesting components because it shows the artistic and expressive manner of an individual. It depicts the flavor, outlook, and color of an individual's "modus operandi". However, the form has a more subjective nature which becomes difficult to write into an objective algorithm.

In attempting to standardize or gauge distinctions in the handwriting samples, a statistical approach was taken. This approach was to analyze particular letters that had shared characteristics, enabling letter recognition when isolated. With this bare minimum set of shared characteristics, an "essential letter form" emerges. So instead of having a completely aesthetic judgment, a guideline becomes available to show deviations in form contraction and expansion. This systematic design enables classification similar to the horizontal, vertical and depth categorization.

However, even though an "essential letter form" gives the form analysis a good starting point, the form component still does not have the degree of definition and measurability as the other components. Therefore, since the vertical, horizontal, and depth components are geometric in nature, the first choice of implementation was reduced to a subset of these scales. The scales will be analyzed as follows:

Form component		
Letter	Measurement	Input
D	Contraction of width of stroke.	Single character

Vertical component		
Letter	Measurement	Input
G	Height of the middle zone.	Single line
H	Proportion of upper, middle and lower zone.	Single line, character
I	Direction of the line.	Single line
J	Fluctuation of the line.	Single line
L	Space between lines.	Two lines

Horizontal component		
Letter	Measurement	Input
M	Space between letters.	Two letters
O	Direction of slant.	Single character
P	Fluctuation of slant.	Single character
R	Distance of words.	Two words

2.2 The hybrid human-machine approach

The best approach for evaluating certain scales is to combine automated processing with input from an expert. This software is designed to be used in combination with a professional graphologist. The process of segmenting words and letters can be hard for a machine to distinguish and needs expert input to help the computer correctly analyze the sample.

The program is designed to analyze scanned images of handwritten documents. Upon loading, all images are converted into binary black and white pixel images. It is difficult for the program to identify different letters, words and lines by pixel analysis without human intervention. Therefore, the human decision process guides the system to better accuracy.

The smallest measurable element in handwriting analysis is a letter, but some of the L-Z scales apply to words, lines, and even paragraphs. Once the limits of the evaluation are set by a handwriting expert, the remaining analysis process is automated.

2.3 Illustrating the need for human interaction

Scale R from the horizontal category is an example of an analysis that should require human interaction. Scale R measures the distance between words. Words that have at least one pixel of space between them will be distinguished as two separate words. See figure 2 for visual clarification.

Figure 2. Words separated by empty pixels.

Figure 3 below illustrates why human interaction is necessary. From the user's point of view it is clear that there are two words, but from the system's point of view it is unclear. When the software scans the columns and determines there are no spaces, it erroneously concludes that the image has only one word. In this situation, the user must aid in segmenting the words.

Figure 3. Words without defined space between them.

2.4 Automatic functions and optimizing collaboration

There are three possible methods for the user during handwriting examination. Two of the them are a result of the human-machine interaction approach. One method can automatically detect the segments between words and lines. The second method involves user-participation in the segmentation process. The third method allows the user to manually enter data and/or override data entered into the L-Z scale results table.

One automatic function in the program is the boundary function. The function is called when scale R is evaluated, as explained in section 2.3. When the automatic segmentation is applied the user can accept or reject the results from the program. The user can then enter the appropriate results directly into the table. Utilizing the boundary function, scale R could be calculated as well as scale S (Restriction of Margin Area), and scale N (Breadth of Letters). See scale N and scale S in figure 4 below:

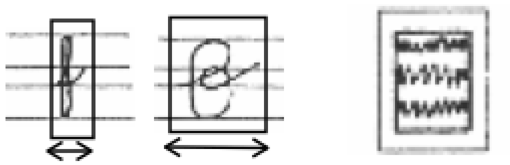


Figure 4. Scales N and S respectively.

2.4 Collection of data points

The program flow (see figure 1 in the appendix) has been designed to require preprocessing work from the user in order to begin calculating scales from the horizontal and vertical category. The user must plot certain data points on the image that identify the top, middle, base and bottom lines of the handwriting. Once those data points have been collected from the user, the system can then do the mathematical calculations on the data.

The results derived from such calculations yield a linear approximation of the points. The collection of the data points themselves have a subjective nature because they depend on the user's expert eye to select points of interest. For this same reason a linear regression approximation of the least squares is suitable. The approximation has the equation of y=ax + b:

$$a = \frac{\sum_{i}^{n} y_i - \left(\sum_{i}^{n} x_i\right) b}{n}$$

$$b = \frac{n\sum_{i}^{n} x_i y_i - \left(\sum_{i}^{n} x_i\right)\left(\sum_{i}^{n} y_i\right)}{n\sum_{i}^{n} x_i^2 - \left(\sum_{i}^{n} x_i\right)^2}$$

Figure 5. Formula for line approximation.

The formula in figure 5 is used to determine the approximation line based on the points input from the user. This line is then drawn on the image.

Figure 6 demonstrates how the user drawn points would look like and how the line approximations would be displayed.

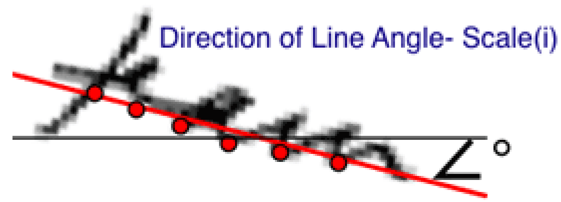


Figure 6. User drawn points.

Here is the psuedocode for implementing the scale:

Line = y= ax + b

If slope a = 0, then
line y = constant = b,
∴ line is horizontal
call function to apply scale value
Else a≠0 then
∴ line creates a right triangle with
x component(x1-x0) and y component(y1-y0)
hypotenuse = sqrt [(x-comp)ˆ2 + (y-comp)ˆ2]
slant ∠ = arcsine(y-comp/hypotenuse)
call function to apply scale value

Once the program has gathered the preprocessed information of the top, middle, base, and bottom lines, the program must apply the functions to calculate the scales listed below:

<u>Ratios of heights of the calculated approximated lines</u>
Scale G: Height of the middle zone.
Scale H: Proportion of upper, middle, and lower zone;

<u>Degree of angle from reference axis X and Y</u>
Scale I: Direction of line.
Scale O: Direction of slant.

3. System overview

The interface was designed so the user could intuitively use the program. Simplicity was kept in mind when designing the layout of the panels and buttons. A "dashboard" concept was used so most tools and views are easily available. In to create a productive workspace, an environment was built that allows several images to be loaded and cropped.

The following sections detail the main functions of the program.

3.1 Load a scanned handwritten document to the computer screen.

Our software allows the graphologist to scan in an image of a handwriting sample. The image will then be displayed to the user allowing them to crop the section to evaluate.

3. 2 Allow users to crop images into lines, words and characters

The user can evaluate a single character, two adjacent characters, one word, two words, or a line of words.

Once the image is cropped, the cropped image will be displayed on the scratch pad. The scratch pad is a separate work area that holds the cropped images to be analyzed. Once an image is cropped a new tab is opened and the scratchpad image is inserted into that tab.

3.3 Compute one or more of the L-Z scales.

The user selects the active tab to be analyzed and then clicks the “run analysis” button. This launches the L-Z pop up analysis pane. In this window there is a slider with four options. The four options are marked “top”, “middle”, “baseline” and “bottom”. The user will select each one of them and mark the data points on the image.

Figure 6. GUI close up of Toolbar.

After these points are marked, the regression line is calculated using the least-squares method. This function is a linear combination of one or more model parameters called regression coefficients. A linear regression equation with one independent variable represents a straight line. In addition, boundary points for top, bottom, left and right portions of an image are generated automatically by analyzing each image with the imageBoundary class.

The user will then select which filter to implement.

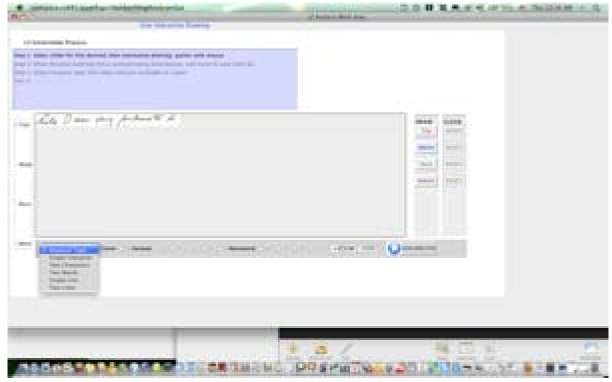


Figure 7. Screenshot of the GUI for L-Z analysis.

The combination of the sloping lines and the boundary points are used to measure and calculate the selected L-Z scales.

Once the filter(s) is selected, the user will click the “run analysis” button. The results will open in a pop up window where the value of the scales will be displayed. The user can choose to “accept” or “reject” the results. If they accept the results the values will be saved into a table. If they are rejected, no information is saved. The user can also enter information directly into the table overriding any existing values.

3.4 Display and save the chart.

The user can create new projects and save them. A project consists of one or more original images and their corresponding cropped images to analyze.

Once the user is done with the analysis, they will be able to display and save the chart using xml.

3.5 Project Management Implementation

There will be two xml files created and used by the application. HAG.xml (Handwriting Analizer GUI) is the application configuration file, listing all projects created by the user and indicating, by the defltId property, which is the most recent project. Here is the HAG.xml example:

```
<com.pace.cs691.team9.project.project.ConfigContainer>
  <defltId>675301128</defltId>
  <configurations>
    <com.pace.cs691.team9.project.project.Config>
      <projName>myProject.xml</projName>
      <projLoc>C:\temp</projLoc>
      <id>675301128</id>
    </com.pace.cs691.team9.project.project.Config>
  </configurations>
</com.pace.cs691.team9.project.project.ConfigContainer>
```

HAG.xml will always be saved in the application workspace.

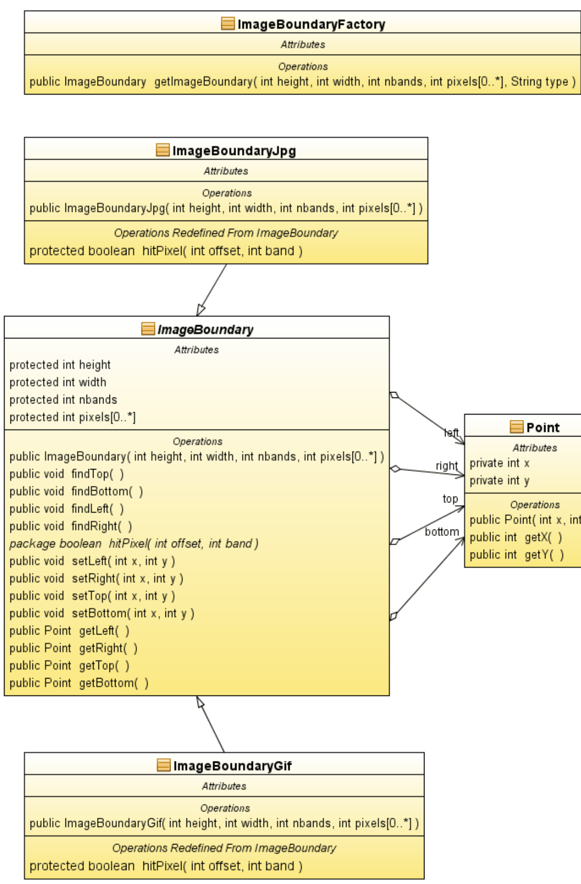
The other xml file would be created and named by the user, for example, “myProject.xml”. It is the actual project configuration. It stores information about the state of a project - containers, tabs, and images.

4. Tools

The tools used in designing the GUI and the filters include Java 1.6 , JAI (Java Advanced Imaging Library) 1.1.3 and Netbeans 6.5. Versions of code were managed using Subversion 1.5.

5. Java classes

The following uml diagram depicts a subset of the java classes written to carry out the handwriting analysis. These classes are used to find boundary pixels for a binary image and are used in the calculation of the L-Z scales.



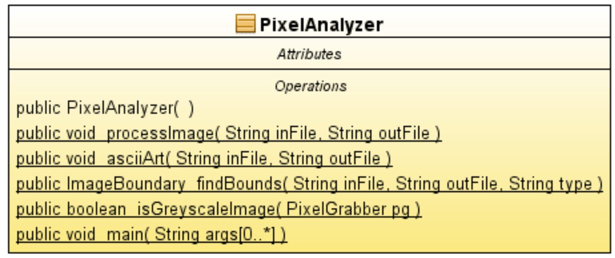


Figure 6. UML diagram of Java classes.

In addition to these classes we have the following java classes in our project. The project is broken up into different packages by functionality. Package namespace is com.pace.cs691.team9. Package sections are gui for the gui itself, gui.image for image analysis classes and project for the project management classes.

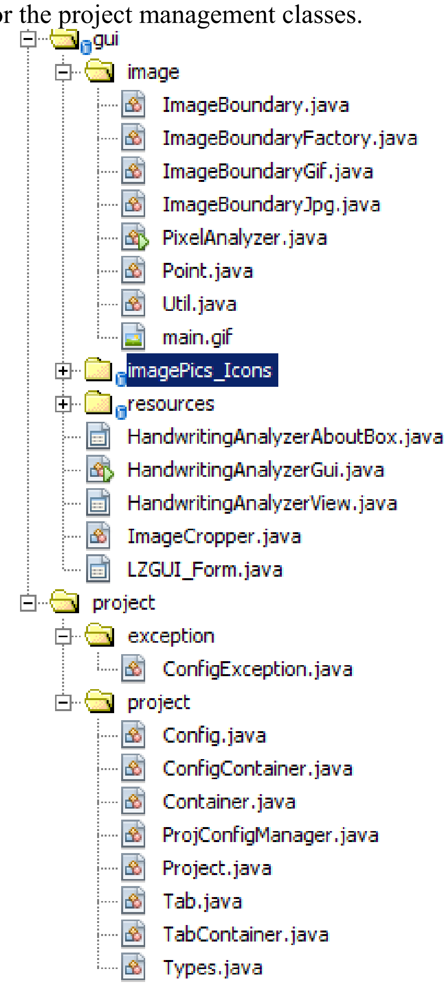


Figure 7. Java classes.

6. Conclusion

As stated earlier, the goal of this software is to facilitate the process of performing handwriting analysis. It is not intended at this point to fully automate the process. In spite of the requirement for human intervention, the Handwriting Analyzer GUI provides many benefits. It provide the user an environment that is intuitive, simple, and useful, making handwriting analysis easier, faster and more objective. It also provides the ability to consolidate information regarding a profile in one place, in essence functioning as a management tool as well as an analysis tool. But the most important benefit of the tool is perhaps, yet unrealized. By providing a technology-based approach to handwriting analysis, this tool potentially opens up the largely hitherto ignored field of Graphology to wider interest and adoption. As new interest spawns this eventually will evolve to new research and development , possibly providing new techniques and applications in new fields . The Graphology tool in its current form has many conceivable applications .

Law enforcement, particularly the CIA could greatly benefit from its usage. As a byproduct of the technology a faster more objective tool will aid law enforcement agencies by making them more efficient.

7. Recommendations

The main goal of this software is to speed the manual analysis of handwriting. If graphologists can use the software to speed their manual process, the software is progressing in the right direction.

However, this software must *only* be used by a licensed graphologist who has specialized training in the interpretation of Lewinson-Zubin method. The software should not be used as a standalone tool. The use of the tool should follow these ethical guidelines:

- Attributes tested should be specifically related to issues of national security.
- Testing must not be unduly invasive of privacy.
- Results must be kept confidential

An individual's reputation could easily be ruined if they were publicly categorized into a narcissist or psychopath category.

A handwriting analyst must make the final determination regarding the quantity of letters or samples that are sufficient to make a qualified determination. The certified analyst must also be able to override any of the tool's assessments.

If the above guidelines are followed, then the software could be a vital new tool for helping the CIA speed the processing of handwriting analysis.

8. Future Enhancements

The following enhancements are recommended:

- Implementing the remaining L-Z scales.
- Administration system to manage saved profiles and organize them based on analysis results.
- Use with a writing tablet that directly inputs handwriting samples.
- Multipoint cropping.
- Multiple user logins with different access levels.
- Allowing the user to draw the division between two words.

9. References

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Appendix

Figure 1. Program Flow.