# ORIENTATION ANALYSIS ON POSSIBLE ROMAN CADASTRE LINES WITH THE USE OF GIS TOOLS

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In this paper we demonstrate the use of the GIS based 'Cadastre Grid software' (version 2.1) in the Beziers area. This software was originally designed and programmed in 1997. In December 1998 the second version was released; it provides more tools, making it even more useful for archaeological research on Roman Cadastre detection. The new tools relate to the orientation of sets of possible lines. Using them the user can freely digitise all the lines that could be used for Roman Cadastre detection and then reduce their number by selecting only those of the specified orientation. The software allows for a tolerance parameter. The user can make various interactive trial selections while processing the results. As this kind of GIS processing is very fast and accurate, it could easily be applied to large areas where this kind of analysis would previously have been laborious.

## Introduction

When processing numerous line segments that represent all possible cadastre directions, it is essential to isolate the most frequent perpendicular orientations, in order to reduce the overall process time. The method described by this paper is to use the orientation of each line segment to create a histogram, showing the distribution orientations, from which we retrieve some orientations, and the equivalent perpendicular orientations, indicated by peaks.

The second step of the process is to isolate only those lines that matchthe chosen orientation by using the software's built in filter. As this filtering could result in very few lines being selected, a tolerance factor is given to the filtering algorithm.

Finally, the third step is the thematic categorisation of the resulting set of lines, into a user-specified number of categories, using one of the existing methods. For the purposes of this paper, we used the 'equal count' method, as it describes the results better.

## Description of the new version of the Software

This new version of the 'Cadastre Grid Software' has several improvements and new features. Specialised for Roman Cadastre investigation, it offers the researchers many tools that help to create models of cadastre grids and make it possible to extract and isolate those lines that best fit the grid model.

A major effort has been made to enhance the algorithms of the older software versions. Both algorithms that generate the grid and select the lines were made more sophisticated, achieving significant reduction of computer processing time (up to 15%). Moreover, in the new selection algorithm, line selection is not based on the geographical centre of each line object, but on its ends. This makes the accuracy of selection equal to 100%.

The new version also enables the user to have multiple cadastre grid models and possible sets of lines loaded in memory. During the selection process the user is asked to choose which grid and which set of lines should be used, providing more flexibility to the user.

Apart from the above, a new option was added to the software, enabling the user to automatically update the orientation property of each line and select lines that match certain orientation values. The software enables the user to have multiple files in memory, as with previous options. By clicking the 'orientation button' or the 'selection button' the software displays a pop up window with all the loaded files, so that the user can select the file to be used in this process.

Finally, a 'save table' button was added that enables the user to save any generated files, without having to use Mapinfo tools.

## Processing Methodology - Example

We will describe this methodology, using the B•ziers area as an example. All possible Roman cadastre lines were digitised with the MapInfo GIS, and could be plotted in a map window. Clearly, the digitised lines have many orientations and we did not know the orientation of the cadastre that we are looking for.

Using the 'Cadastre Grid software' we automatically calculated the orientation of each line and stored this

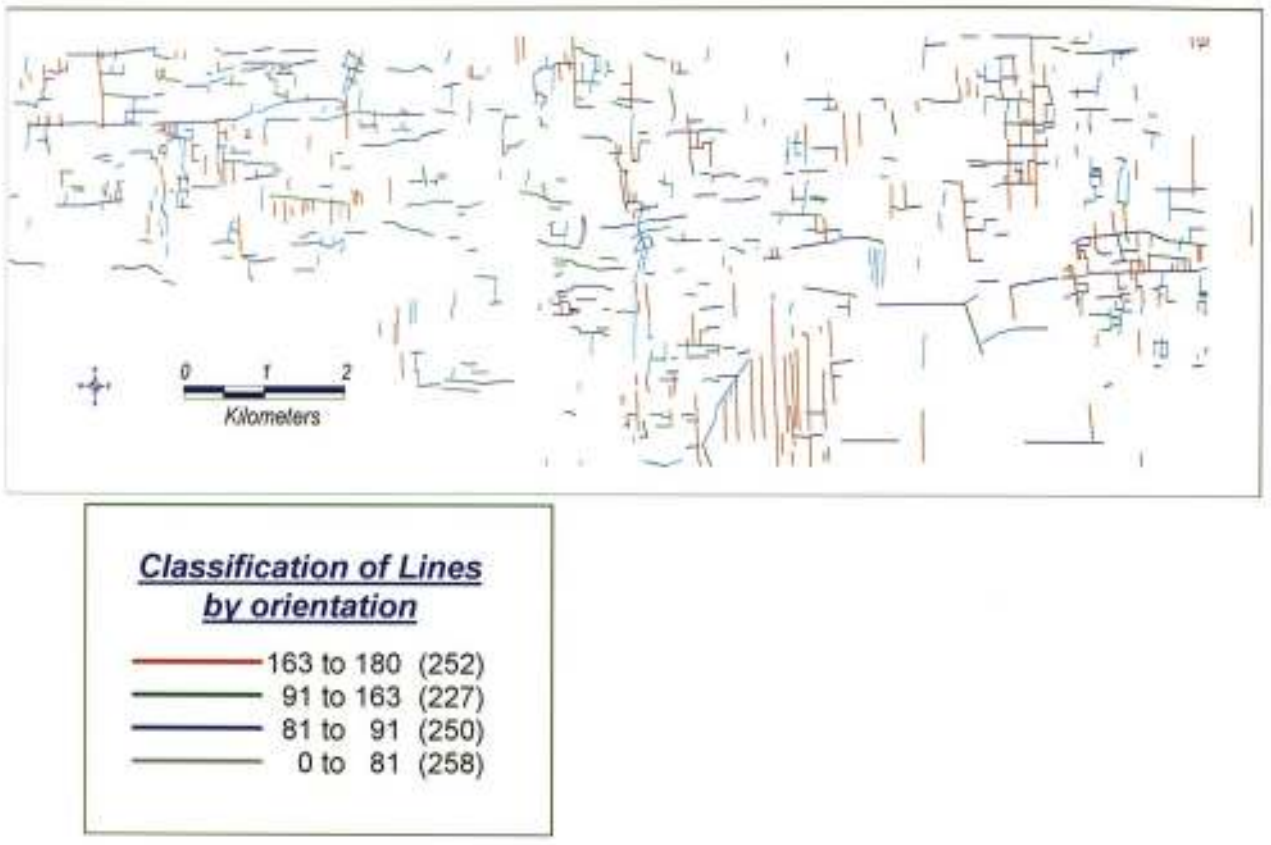



Figure 1. After updating the line's browser with the 'orientation' field we created a thematic representation, depending on the orientations. The legend, shows the ranges of the plotted lines. Of course, other ranges could have been selected, resulting to different number of categories. The categorization was made by the 'equal count' method. The numbers next to the range values, indicate the counting of lines

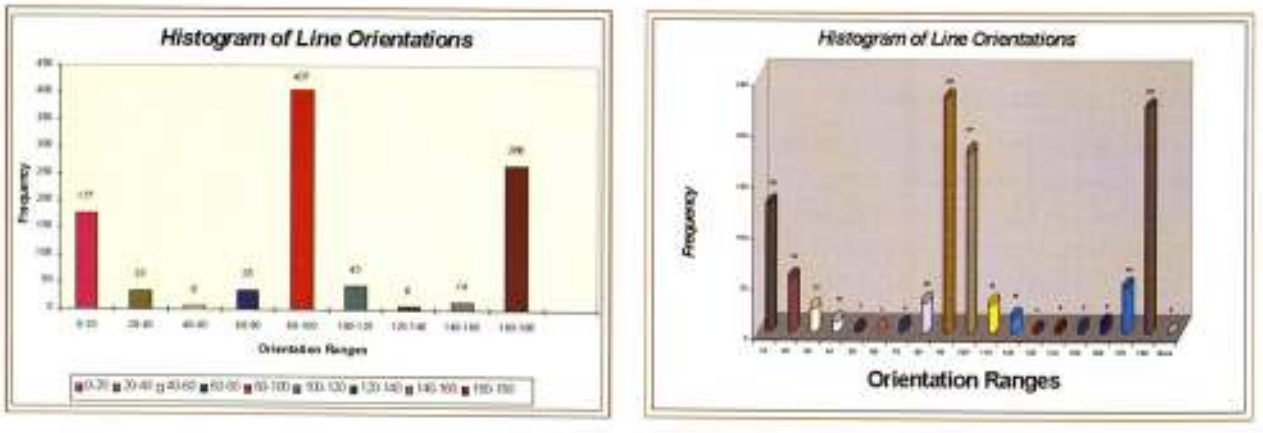
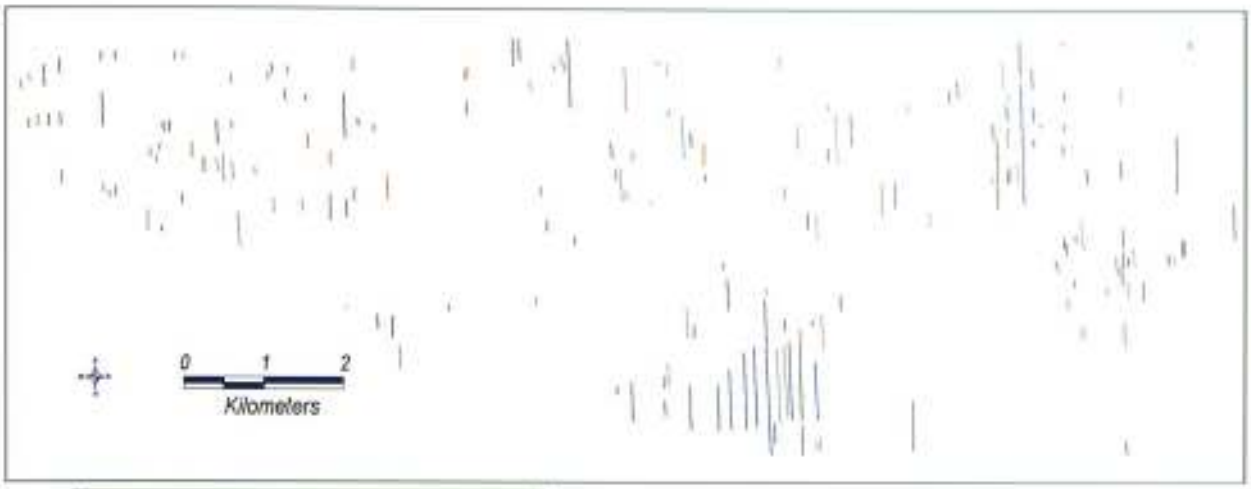



Figure 2. A frequency histogram, is required in order to choose the most common orientation. The output of this selection is used as an initial value at the 'Cadastre Grid Software' to isolate the desired set of lines. At Beziers area (South France) we distinguised the orientation of 178 degrees and the perpendicular one of 88 degrees




**Classification of Lines by Orientation**

179,82 to 179,89 (42)
177,51 to 179,82 (52)
175,44 to 177,51 (47)
173,02 to 175,44 (48)

Figure 3. A tollerance value is also used, to increase the selection range and thus, the total number of selected lines. The above map shows line sets of the first orientation value (178 deg) with a tolerance of 5 degrees

Having given a range of 5 degrees, the GIS should have selected orientations between 173 and 183 degrees. As we can see from the legend bellow, the ranges are between 173° and 180°, as the orientations range from 0 to 180 degrees from the North


**Classification of Lines by Orientation**

178,27 to 178,99 (11)
177,8 to 178,27 (11)
177,35 to 177,8 (11)
177,02 to 177,35 (12)

Figure 4. The above maps shows line sets of the first orientation value (178 deg) with a tolerance of 1 degree (177° to 197°)

value in a new field of the line's table. Using this field, we created a four category thematic map of these lines (Fig. 1). As one can see from the legend of the map, the orientations vary from 0 to 180 degrees. Orientations greater than 180 degrees, can be described by values reduced by 180 degrees (e.g. 210 degrees = 30 degrees).

By creating a histogram of the line orientations, we can visualise the most common orientations. In the top histogram of figure 2 we have used ranges of 20 degrees, while in the bottom one of 10 degrees. From both histograms we extracted the orientations of 88 degrees and 178 degrees (=88 degrees +90 degrees).

The next step of this process is the selection of the lines that match the extracted orientations. Knowing that the surviving lines of cadastre grids maintain a general direction, but not the exact direction of the grid, we introduced the tolerance factor. By clicking the 'selection button', the user is prompted to select the file that should be used for the selection process.

At the bottom of this pop-up window, the user enters the 'orientation' and 'tolerance' values. Figure 3 shows line sets of the first orientation value (178 degrees) with a tolerance of 5 degrees.

Having given a range of 5 degrees, the GIS should have selected orientations between 173 and 183 degrees. As we can see from the legend below, the ranges are between 173 and 180, as the orientations range from 0 to 180 degrees from the North. Finally, figure 4 demonstrates the same set of lines as figure 3, but the selection tolerance is 1 degree. Therefore, as we can see from the legend of the thematic map, we have orientations between 177 degrees and 179 degrees and the total number of lines is 43.

Thus the user is able to enter different sets of orientation / tolerance values, and use the resulting set of lines to select which lines fit the created cadastre grid model. Using the above process different models of grids and sets of lines can be generated and compared in order to obtain the most probable grid.

## Conclusions

The main idea of this cadastre exploration software is to help scholars in their Roman cadastre research, by speeding up the creation of cadastre grid models and the selection of all the digitised lines that best fit the grid.

Different tools have been employed by this software to help scholars experiment with different Roman cadastre grid models and select the best ones, depending on the line selection results. The number of lines selected, compared to the total number of digitised lines, is an indication of the quality of the grid model.

Of course, lines with orientation very different from that of the test grid cannot be lines of the grid and therefore we try to exclude them from the initial line set. This new software helps the user to analyse the orientations of the line set and isolate the lines that follow a user defined orientation and tolerance.

## References

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