Title of Paper
Label Conflict Detection using ArcGIS

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Abstract
A detailed mapping project that covers a large, complex area is prone to a number of issues not generally associated with maps of lesser complexity. Namely, labeling conflicts that can usually be detected visually are difficult to pick up when dealing with thousands of labels on top of complex feature datasets. The use of a search grid is useful, but still labeling conflicts will remain despite repeated passes as there is nothing to guarantee that all conflicts have been spotted and resolved. This paper examines the innovative use of data format conversion and raster modeling to pinpoint and highlight label conflicts. This method saved time and effort, but most importantly, it virtually guaranteed a final map product free of labeling conflicts.

Introduction to Labeling

Labels act as key points of reference for maps and cartographic products. Interstates, towns, metro stops, addresses, or landmarks can be easily identified on a site-specific basis when labels are used effectively. However, care must be taken when placing labels, as every label is an additional feature on a map that can be tripped over visually if the labeling is awkward in style, or if conflicts exist between labels. Many label style factors such as font, color, halo, transparency, and size contribute to whether or not a labeling style works effectively. However, determining the perfect labeling style is beyond the scope of this paper. This paper looks specifically at a novel method of detecting label conflicts that occur when automatically placed labels are accidentally placed on top of an existing label.

Labeling Conflicts

If every label was placed manually, then one wouldn't expect label conflicts to occur as the GIS user must physically look at every point where a label feature is being added. However, users often rely on the automatic labeling placement engine provided with ArcGIS to place their labels in an efficient manner, especially when hundreds or thousands of features must be labeled within a map or map series.

ArcGIS 9.0 allows a number of settings to be adjusted that may reduce or eliminate the occurrence of label conflicts. Feature weights, label weights and minimum buffer distances between labels are especially useful. However, these features work only on automatically labeled features, i.e. when the labels are redrawn every time a feature or layer is added or removed from the view. Unfortunately, the automatic label placement is not always optimal and must be manually adjusted by the user. The easiest way to move, rotate or otherwise adjust automatically generated labels around is to convert them to an annotation layer at the desired map scale. The annotation features can then be modified as

the user sees fit. However, in ArcGIS 9.0, as soon as labels become annotation layers, they are no longer recognized as having a “weight” associated with them. This nullifies any weight or buffer settings associated with them, and they aren’t recognized by subsequent layers of automatically generated labels as features to be avoided; potentially resulting in layer and layers of overlapping labels.

An additional source of label conflicts may arise when every feature of a layer must get a label, such as every subway stations in a city. By assigning conflicting or higher weights to surrounding features such as road centerlines or building footprints, there is the high probability that not every subway station will get a label due to feature weight conflicts. Therefore, when there are features that must get labels, especially on several layers, assigning weights may not be advisable. The safest way to make sure that every important feature gets a label is to turn off all layers other than the layer of interest when generating the automatic labels, and then converting the newly generated labels to annotation.

Note: Upon writing this paper, it was discovered that ArcGIS 9.1 addresses this problem, and seems to assign a weight to annotation classes, thereby eliminating a vast majority of all labeling conflicts. Therefore, the following method is not particularly useful for ArcGIS 9.1 users, but it may still be of interest to users of older versions of the software, or in the case where existing annotation layers have already been set up, but new data that must be labeled is being added to the project.

Label Conflict Detection

This paper demonstrates a method of converting labels into raster layers and then summarizing the raster layers. Any raster cell with a value over a certain threshold indicates that one or more labels are touching or overlapping. This method requires that every layer of label be placed on a separate annotation layer, and that those layers can be turned on and exported separately.

It should be noted that for this method, checking on the “place overlapping labels” option is not recommended. Only label conflicts between annotation layers are tested for, but not label conflicts within one annotation layer. If important features must get labels, but are spaced so closely together that labels are not generated automatically without using the “place overlapping labels”, then the user should seriously consider splitting the data set into two or more sets based on feature proximities. The labels would then get generated automatically, converted onto different annotation layers, and could then be tested according to this method.

A study area in Alexandria, Virginia (USA) is used to illustrate this method, with the following data layers requiring labels: building addresses, floodplains, streets and hydrologic features. To begin the method, zoom to the extent of the map in layout view, and turn off all features layers and annotation layers and make sure that the background color is white. Note that TIFF images are exported from layout view, not the data view. If the original TIFF images were exported from data view, then a world file option would

have been present, which would remove a step later on in the process. However, three issues make exporting the TIFF images from the final layout view preferable. These include: the relatively low resolution available for export from data view, potential issues with annotation scales in the data view when the annotation scales are not exactly equal to the final map view scale or if the map reference scale is not set up correctly, and TIFF export process does not work well if there is a rotation angle on the view.

From the layout view, each layer of labels must be converted to annotation one at a time. The annotation layer must be unlinked from the features, so that the features can be turned off while the annotation remains on. Each layer of annotation is then exported separately as TIFF images at approximately 100 dpi, as this captures the label information at an appropriate resolution without making the file size unmanageable. The result is 5 TIFF files without world files, which must be read in to ArcGIS and converted into raster grid files.

The grid files must be reclassified into only 2 classes, so that every cell with a value < 255 (ie. shades of grey) is classified as 0, and all cells that were originally white (255), get a value of 1 (see Figure 1). To see the current cell classification, change the symbology from RGB composite to stretched. The reclassification will essentially turn the grid into a Boolean image with only white or black cells, which is an integral part of the method. Every cell that is black has a cell value of zero (0), while all white cells get a value of one (1). The raster grid files are then added together using the raster calculator.

Figure 1. Reclassifying the grayscale image into a Boolean image.

In this case, since there are 5 layers of data, any cell that has a value smaller than: white times the number of data layers, minus one layer of black, or (1 x 5) - 1 = 4, is a cell that has more than one black cell in the data stack (see Figure 2).

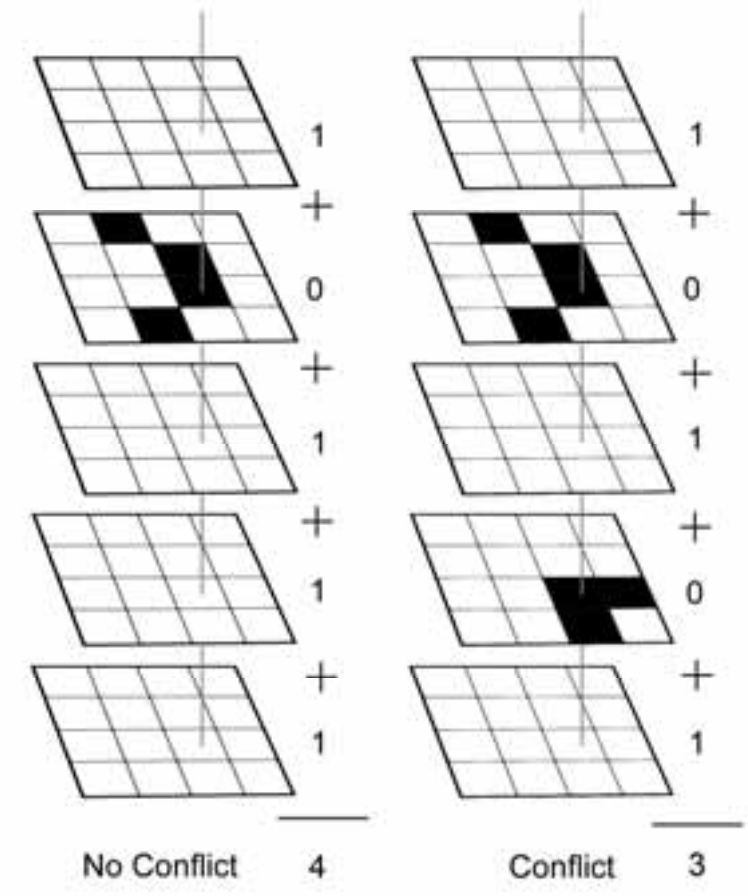

Figure 2. Layer addition to identify conflicts.

Highlighting Label Conflicts

This summary raster layer has to be spatially adjusted back to the project coordinates using the georeferencing module of spatial analyst. To identify the two ground control points needed to have the correct shift and scale applied to the point conflict layer, use the summary grid as a point of reference and compared that to the fully annotated map. Make sure that the reference scale of the map is set to be the exact same as the scale of the final map. The spatial adjustment links are set up accordingly, hit “rectify”, and then the summary raster is adjusted.

Converting the summary raster to polygons and eventually to points will allow greater symbolization flexibility at the points where label conflicts occur. Reclassify the summary raster so that all cells less than your threshold get a value of one (1), while everything else gets a value of “Nodata” (see Figure 3). The reclassified grid is then

converted to features using Spatial Analyst (raster to feature module), converting the grids into point features. Note: only cells with data are converted to points, which is why converting all non-conflict cells is important. These points are considered to be the final point conflict layer.

Figure 3. Reclassifying to isolate only conflicts.

Once the conflict point layer has been created, it must be symbolized to effectively show where label conflicts occur. By symbolizing the points with a red bull's eye or an appropriate contrasting color, the conflicts are highlighted, and can then be addressed on an individual basis by the user. When each conflict is resolved, the corresponding point should be deleted. When all the points have been deleted, the map will be free of label conflicts (see Figure 4).

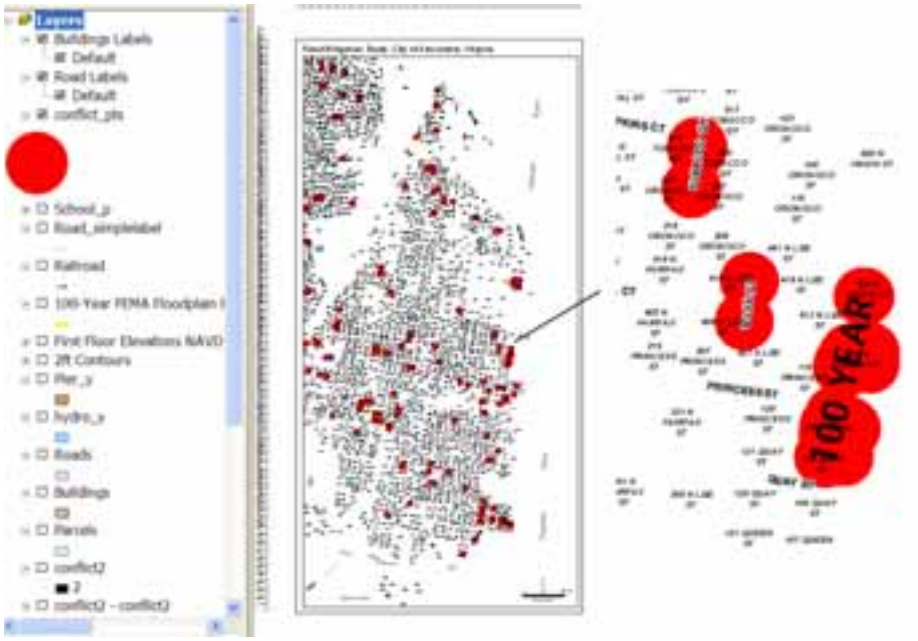

Figure 4. Highlighted areas indicate where label conflicts occur.

Final Map Production

The end result of this method is a map that is guaranteed to be free of label conflicts between annotation layers (see Figure 5). The user can rest assured that the map viewers will be able to appreciate all the information presented by the map, without having to worry about any overlapping labels that slipped through the QA/QC process.

Figure 5. Final graphic with all label conflicts resolved.

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