Author: Jan.Clement@wur.nl
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Top10Smart: Multi Layer raster data as promising solution for multi scale maps

Introduction

Large feature datasets (polygons, lines points) for scale 1:10.000 have a bad performance when they are displayed on larger scales. Small elements are drawn but not visible because of the screen resolution. Most base maps for scale 1:10.000 are not multi scale maps. Multi scale for feature data is complex because you have to add behaviour rules to separate features and this is depending on the surrounding areas. A raster solution has some promising advantages when used as a multi scale map. Normally one would choose hardware solutions for server performance but then the data is still not multi scale . We have developed a solution that overcomes these problems. For this experiment we have used a topographic map of the Netherlands with the name of “Top10NL”. This dataset consists of millions of features.

Problem Statement

Top10NL is the base map in the Netherlands that all GIS-people use. Drawing this map on scales 1:5000 – 1:25.000 is acceptable but for the larger scales the performance is very poor. The dataset is simply not designed for large scale displaying . We found out that with a high resolution raster version of the Top10NL drawing on each scale gives a great performance. Small scale feature data gives also good performance but in not integrated into one map.

The disadvantage of displaying high resolution 2.5m raster maps is that because of the pixel structure of the map on large scales the image can become fuzzy for the eye.
In order to take advantage of the performance of raster datasets and overcome the disadvantages we had to make the raster smart (multi scale) so that the displaying problem was solved.

Solution

We found out that for performance improvement raster conversion was a nice solution for drawing simple legends for the base map on larger scales. To solve the multi scale problem was the next step. We developed a solution in several steps. In each step we added new functionality.
1. use a limited number (4) of classes
2. we increased the number of classes to 200 and introduced the multi scale
3. we created a tree layer version with raster line objects and 300 classes
4. we created a 50m buffer infrastructure resulting in 600 classes

Ad 1) The first generation of high resolution Top10-raster maps contain 4 classes:
1. urban,
2. agriculture
3. water
4. forest and nature

Aggregation was done in spatial analyst and the area patches were 5ha or bigger. In web services we added for infrastructure a feature layer with major roads. When the scale was 1:50.000 we used the original Top10 base map.

Ad 2) The second generation was two level 2.5m raster multi-scale map. We combined the aggregated version with the not aggregated 2.5 meter map containing 43 classes. The combined map contained 4x43 classes and each class can be grouped with other classes to create suitable legends for several scales. In this map we only used area features and the start scale was 1:25.000 we still added infrastructure a feature layer with major roads in webservices

The third generation we added water ditches and the start scale was 1:10.000

In the present generation we made an extra step and added also three lines and buffer for infra structure. Also 7 classes for the base version instead the 4 we used in the first generation. The water ditches en tree lines were given a separate code depending on the area value so that we can hide the raster line elements. The number of values in this multi scale raster is about 600. This gives a lot of displaying possibilities for web mapping applications as well as background maps. In ArcGIS on scale 1:10.000 or less it looks great. With the 2.5m resolution almost all elements from the original are present in this raster map. The original topographical map gives not much more extra value. The buffer for major infra structure is suitable for displaying to a scale of 1:500.000

With conversion you lose some information usually. But with the 2.5m resolution even the smallest elements like bicycle roads are in the raster map. Spin off of the conversion of the high resolution raster is that spatial analyst applications can use the Top10Smart data.

How to make a Multi scale raster from feature based Top10NL base map:
step 1: Integration of the several input feature Top10NL layers. This is necessary because overlapping feature to raster conversion gives wrong results and for the process it is necessary to work with a data raster with a link to the polygon input
The base maps were organized in several polygon feature layers and these features can be overlapped e.g. with bridges over water and other roads. For the final result we need only to top land use in one polygon feature layer.

step2: Polygon to data raster conversion 2.5m on FID to create a link to polygon information which can be very handy in the process.
The created polygon feature layer with 3 million features was converted to a data raster on FID. FID is the link to the unique polygon record and the polygon attributed were joined to make selection in the following steps.

Step3: Filter local infrastructure and small water bodies: by removing these elements larger land use areas were generated and that is for generalization an advantage. Local infrastructure and small water bodies were removed by shrink operation with the neighboring FID (value of the area). The result was a new data raster that can be used to aggregate land use patches and zonal majority.

Step 4: Aggregation to 10ha patches with 25m raster to give the generalized layer in the multi level raster data. It is also the key for multi scale
Aggregation was done on a 7 classes land use map with urban, grass land, arable land, heather, forest, sand and water. Small elements were removed and with a buffer zone 10 ha urban areas were created. This is the map for the biggest scale.

Step 5: Zonal majority of aggregation result with 2.5m data raster to enable the combination with the original raster map later.
To make the 25m aggregation map somewhat smoother the 2.5m data raster without local infrastructure and small water bodies (this was the input for the aggregation on 25m basis) was used for zonal majority.

Step 6: Combine the aggregation 2.5m with the original gives multi layer raster data. This enables the use of more legends for several scales.
With de original data raster an 2.5m land use map was built with 43 land uses classes. This map was combined with de aggregated 2.5m version and this gives a 2 layer multi scale raster map.

Step 6: Add line raster elements to the combined raster this gives more classes and possibilities to display the map on several scales.
The Top10NL base map contain also line elements like tree rows, water ditches and railroads. Each element has broad classes and this was used to buffer in input. After this the buffer elements were converted to a raster and merged to the combined raster in an additional data layer.

Step 7: Add major roads and railway buffers to the combined raster will give the possibility to dimension the infrastructure because on larger scales small elements are no longer visible in a raster map.
For the large scales the railways and major roads we buffered 50 meter tot create an extra infra buffer and added this also to the combine raster for the forth data layer.

Final result: **Multi Layer raster data for multi scale maps**
The combined raster is the basis for the multi scale maps. Numerous of layer files can be designed to web mapping applications and as background image. With ArcGIS SDE the performance is great and this concept can be applied for many other base maps in the world.

Conclusion
Multi Layer raster data for multi scale maps have a lot of potential and gives a great performance in web mapping and as background image for ArcGIS.
Numerous scaled layers are possible. Top10Smart is very handy for people who want to have a fast background map but cartographic people maybe want to use the polygon version for nicer pictures.
Disadvantage is that it takes a lot of time to create such a detailed 2.5m raster. We ran also into many software problems that had to be solved in the conversion process. Most of the conversion was done with ArcGIS Desktop and Python but for some spatial analyst tools we had to step back in time and used AML in Arcinfo workstation.