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Extracting Elevations from a DEM along a Polyline Feature Class and Graphing Precisely Exaggerated or Unexaggerated Elevation Profiles in Adobe Illustrator

Part A of this note describes how to use the "Stack Profile" tool in ArcGIS 10.2 to extract DEM elevation data along a polyline feature class, as would be needed to create river Long Profiles or topographic profiles of roads or trails, and store them in text format. Part B describes how to graph and scale these data in Adobe Illustrator.

A. Creating an Excel text file that contains data for an elevation vs. distance graph (i.e. a topographic profile, long profile, etc.)

1) Ensure that the polyline and DEM share the same spatial reference. If not, project one to match the other. I recommend working with UTM projections, so that both horizontal and vertical units are in meters.

2) In ArcMap, *Select the polyline feature for which you want an elevation profile*, e.g. a river, stream, trail, etc.

3) Making sure first that the 3D Analyst extension is turned on, Open the 3D Analyst Tools in ArcToolbox (do this within the ArcMap window), find the "Functional Surface" toolbox and open the "Stack Profile" tool. Read the tool help file. The tool "*Creates a table and optional graph denoting the profile of line features over one or more multipatch, raster, TIN, or terrain surfaces*".

4) Within the Stack Profile tool, ***use the drop-down down arrow icon*** on the "Input Line Features" line to input the feature class of interest. **Do not use the folder icon to input the Line Feature – doing so causes the tool to ignore your selected polyline and perform the analysis on ALL of the polylines in the input feature class.**

5) Similarly, use the drop-down arrow of the "Profile Targets" line to select the DEM that contains the elevation measurements.

6) Give a name and location for the Output Table, and fill in a name for the "Output Graph Name", which, when the tool finishes, will provide a visual check on the result.

The tool creates an "info" folder and table that can't be read by other software, but that can be exported to .dbf format that can then be read by Excel.

7) Find this new table using the "List by Source" view of the ArcMap Table of Contents, right-click on it, select "Data>Export…" and browse to a location to save the exported table. After giving it a file name, use the drop-down to "Save as Type:" "dBASE Table", which Excel can read.

8) Open the new DBF file in Excel and delete all but the "FIRST_DIST" and "FIRST_Z" columns. Format these two columns as "number" with 2 decimal places, and then switch their order so the FIRST_Z column is to the left of the FIRST_DIST column. Delete any blank columns that are to the left of the FIRST_Z column.

9) Save the Excel table in .XLSX (or .XLS), then *Save As…* .TXT (tab delimited text).

B. Using Adobe Illustrator to create scaled topographic profiles

One way of presenting topographic profiles is to show them with no "vertical exaggeration", i.e. the vertical and horizontal scales of the profile graph are the same. Alternatively, profiles can be "exaggerated" so that the vertical scale is larger than the horizontal scale by some "exaggeration factor". A profile with an exaggeration factor of 2, for example, has a vertical scale that is twice ("2X") that of the horizontal scale, which produces steepened slopes and exaggerated vertical relief.

For anything other than casual inspection, interpretation of profiles is greatly hindered when the exaggeration factor is unknown or unstated. Although ArcMap can graph profiles, without custom add-ons it does so without revealing the exaggeration factor; other software is needed. Used in tandem, MS Excel and Adobe Illustrator (AI) can do the job. AI (ver. CS5) is a good choice because: 1) it contains a quantitative, non-uniform scaling tool, 2) I know how to use it.

1) Open AI, Create a "New Document" (File>New…) with Units of Centimeters, Letter Size, and landscape orientation.

2) From the "Object" menu at the top of the screen, select "Graph>Type>" and select the "Scatter Graph" icon, as shown below. Accept all of the other defaults (shown below) and click OK. Nothing appears to have happened – the screen is still blank. Read on…
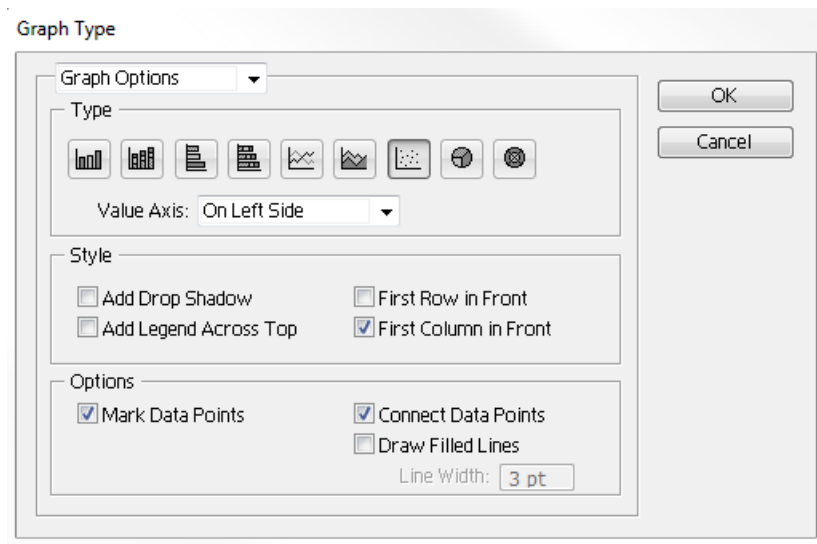
3) From the main Toolbar, choose the "Scatter Graph" Tool (shown below left, highlighted in red) and use the tool to drag a box open on the screen by clicking and holding the mouse button in the upper left corner of the screen, dragging the mouse to the lower right corner, and letting go of the mouse button. This creates an empty graph, with axes labeled from 0 to 1, and opens a small window (shown below) for adding data.
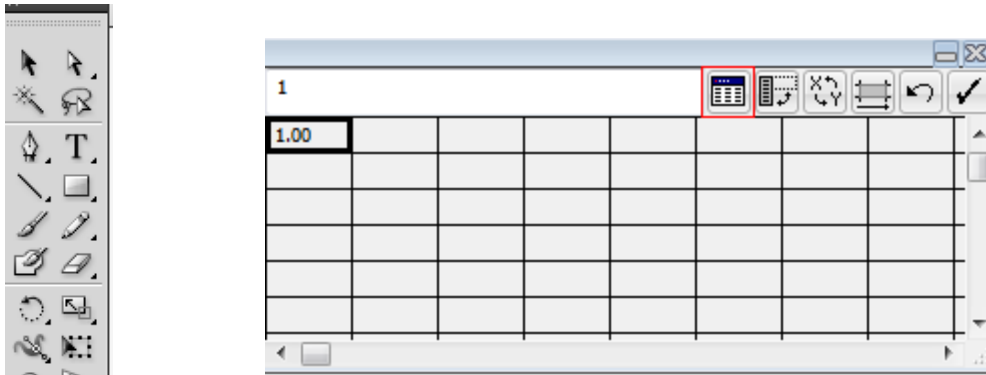
4) Use the "Import Data" icon, outlined in red above, to import the previously created .TXT version of the topo. profile data from Step **A** above.

5) A topographic profile appears on screen with increments and labels on the vertical and horizontal axes that come from the imported data. These are, of course, elevation in meters on the y-axis and horizontal meters along the x-axis. These can be adjusted by going back to the "Object>Graph>Type…" window and using the drop-down on the "Graph Options" to adjust the increments on the "Value Axis" and "Bottom Axis". Choices are extremely limited (this is not really graphing software) and results are rudimentary but these can be further adjusted once scaling is achieved. Don't do any editing yet, read on…

6) Save your graph.

7) Open the AI INFO window by Selecting "Info" from the "Window" menu at the top of the screen.

8) Deselect all graph elements by choosing one of the arrow tools at the top of the main toolbar and clicking on the screen somewhere.

9) Grab the rectangle tool for the main toolbar (shown with the red box below) and draw a rectangle that is one x-axis increment wide and one y-axis increment tall by dragging a rectangle from the graph origin to the first increment on each axis. An example is shown below, where the black rectangle is 25 meters high and 200 meters wide (in map units).
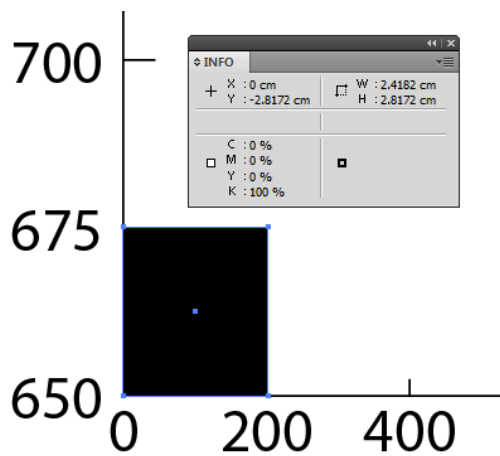
The **physical size** of the rectangle in Illustrator units, as given in the INFO window (H and W values), is 2.8172 cm high and 2.4182 cm wide. The vertical scale of this graph is thus 2.8172cm/25m, or 1:887.4 (this dimensionless ratio says that one vertical unit on the graph is equal to 887.4 vertical units on the ground). The horizontal scale is 2.4182cm/200m, or 1:8,270.6. The vertical exaggeration is thus 8,270.6/887.4, or 9.32; the vertical scale is 9.32 times greater than the horizontal scale. ***To remove this vertical exaggeration and produce an unexaggerated profile, the vertical scale needs to be reduced by to 10.73% (100/9.32) of its current value.***

10) Select all elements of the graph using Ctrl-A.

11) Double click on the "Scale Tool" of the main toolbar (shown below with red box) to open the Scale window. Select "Non-Uniform" and enter the appropriate vertical scale reduction, as calculated above and shown below.
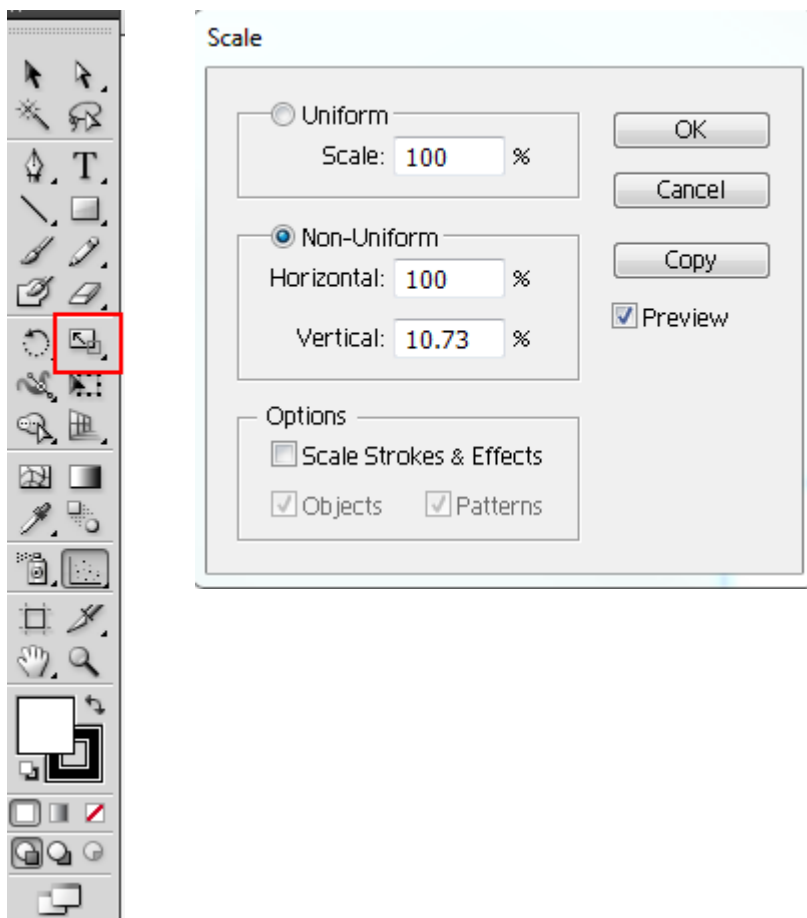
12) The resulting topographic profile, which now has no vertical exaggeration, has labels and tick marks that are difficult to read and need to be reformatted to be legible. *To edit anything the graph first needs to be "Ungrouped", which is done by: 1) selecting all elements (Ctrl-A) and 2) choosing "Ungroup" from the "Object" menu at the top of the screen.* Before doing so, you may want to make a copy of the graph and paste it in somewhere else on the page so it retains it "Graph" characteristics. This copy can also be used to create vertically exaggerated profiles (e.g. 2X) by using the scale tool again (e.g. Non-Uniform scaling, with Horizontal at 100% and Vertical at 200%).