Designing Associativity

1st assignment

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1. Speculation

In Digital Matter research studio, we are investigating 3D printing on elastic materials, such as fabric or particular plastics and membranes, in order to create specified three dimensional structures derived from two dimensional surfaces. Two different directions arise from this research. The first one refers to past references on the 3D printing topic and the second one to the way this procedure can produce programmable, accurate, realistic outcomes.
As a result, the question that derived out of this topic has two different guidelines. The first one is what were the previous attempts made on 3D printing. The second one is how to control the deformation arriving from a 3D printed pattern.

For the purposes of the first issue, we will collect data referring to which countries possess the highest amount of 3D printers. Thus we will have information on which countries have practiced more the 3D printing technology, in order to look further for more specific examples referring to 3D printing on elastic materials.
The relevant data were extracted by https://www.3dhubs.com/, a website where users can register their 3d printer as well as their location.

In order to figure out the percentage of the deformation of the structures, as well as how controllable this shape changing ability is, we are going to examine the different variables that play an important role. The thickness, the height and the shape of the 3D printed pattern, the type of the used filament, as well as the type and the percentage of tension of the stretched material are some of them.

During our research we applied a series of experiments aiming at observing the behaviour of elastic materials when predefined patterns are printed on them. Digital material from the implementation of these experiments is given as reference. Subsequently, we gathered the information about the deformation sustained by the prototype samples, depending on the forces exerted by the three-dimensional patterns. Those carefully conducted data were listed in a data base, in order to create appropriate diagrams using grasshopper, through which we will export significant conclusions for our research.

Its experiment was transacted with one variable each time. Thereafter we analyse the different kind of experiments we fulfilled. The deformation was measured according to height, length, width and curvature differences from the stretched state to the free form state. The data are represented in excel bases.

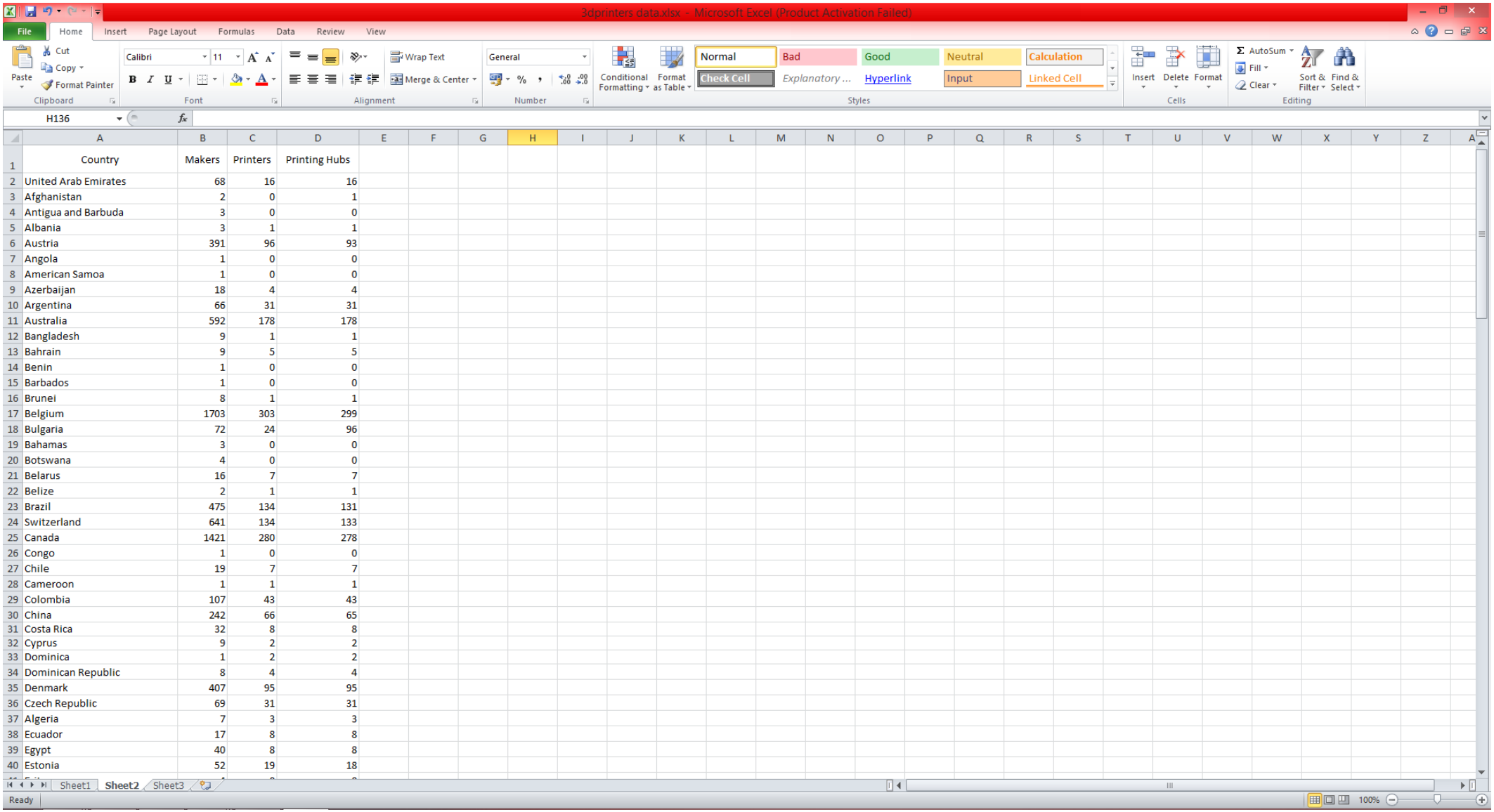
The experiment that we will try to visualize was conducted to examine the behaviour of the stretched material when different kind of patterns are applied on it. The patterns that were used are given below.

Mapping 3d printers

2. Data Mining

Step 1

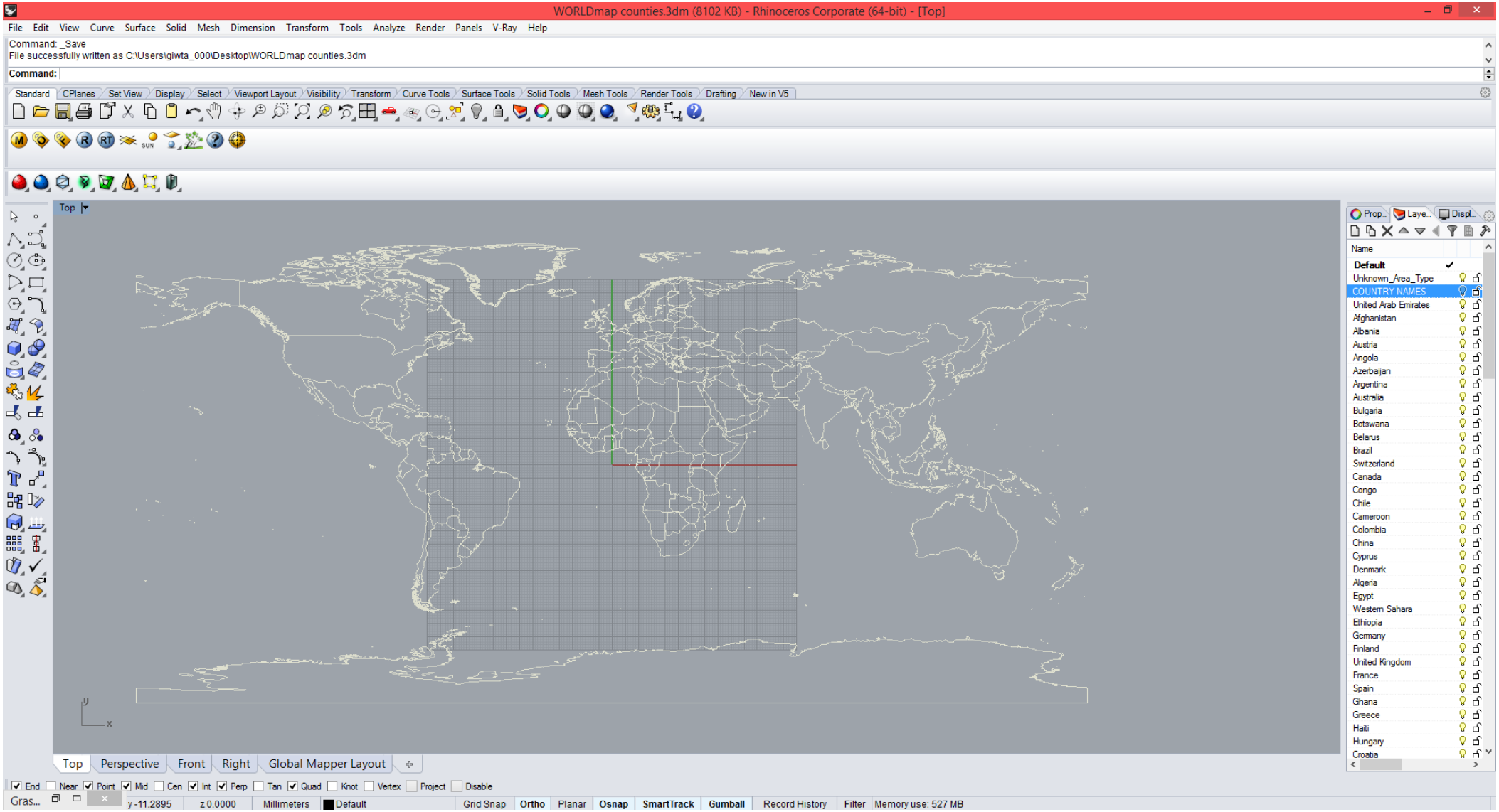
Data retrieved online by https://www.3dhubs.com/,. A chart was created by these data in Excel. The relative file is 3dprinters data.xlsx
We save the file as .csv so that grasshopper can read it. The file is 3dprinters data.csv



	Country	Makers	Printers	Printing Hubs
2	United Arab Emirates	68	16	16
3	Afghanistan	2	0	1
4	Antigua and Barbuda	3	0	0
5	Albania	3	1	1
6	Austria	391	96	93
7	Angola	1	0	0
8	American Samoa	1	0	0
9	Azerbaijan	18	4	4
10	Argentina	66	31	31
11	Australia	592	178	178
12	Bangladesh	9	1	1
13	Bahrain	9	5	5
14	Benin	1	0	0
15	Barbados	1	0	0
16	Brunei	8	1	1
17	Belgium	1703	303	299
18	Bulgaria	72	24	96
19	Bahamas	3	0	0
20	Botswana	4	0	0
21	Belarus	16	7	7
22	Belize	2	1	1
23	Brazil	475	134	131
24	Switzerland	641	134	133
25	Canada	1421	280	278
26	Congo	1	0	0
27	Chile	19	7	7
28	Cameroon	1	1	1
29	Colombia	107	43	43
30	China	242	66	65
31	Costa Rica	32	8	8
32	Cyprus	9	2	2
33	Dominica	1	2	2
34	Dominican Republic	8	4	4
35	Denmark	407	95	95
36	Czech Republic	69	31	31
37	Algeria	7	3	3
38	Ecuador	17	8	8
39	Egypt	40	8	8
40	Estonia	52	19	18

3. Data Visualization

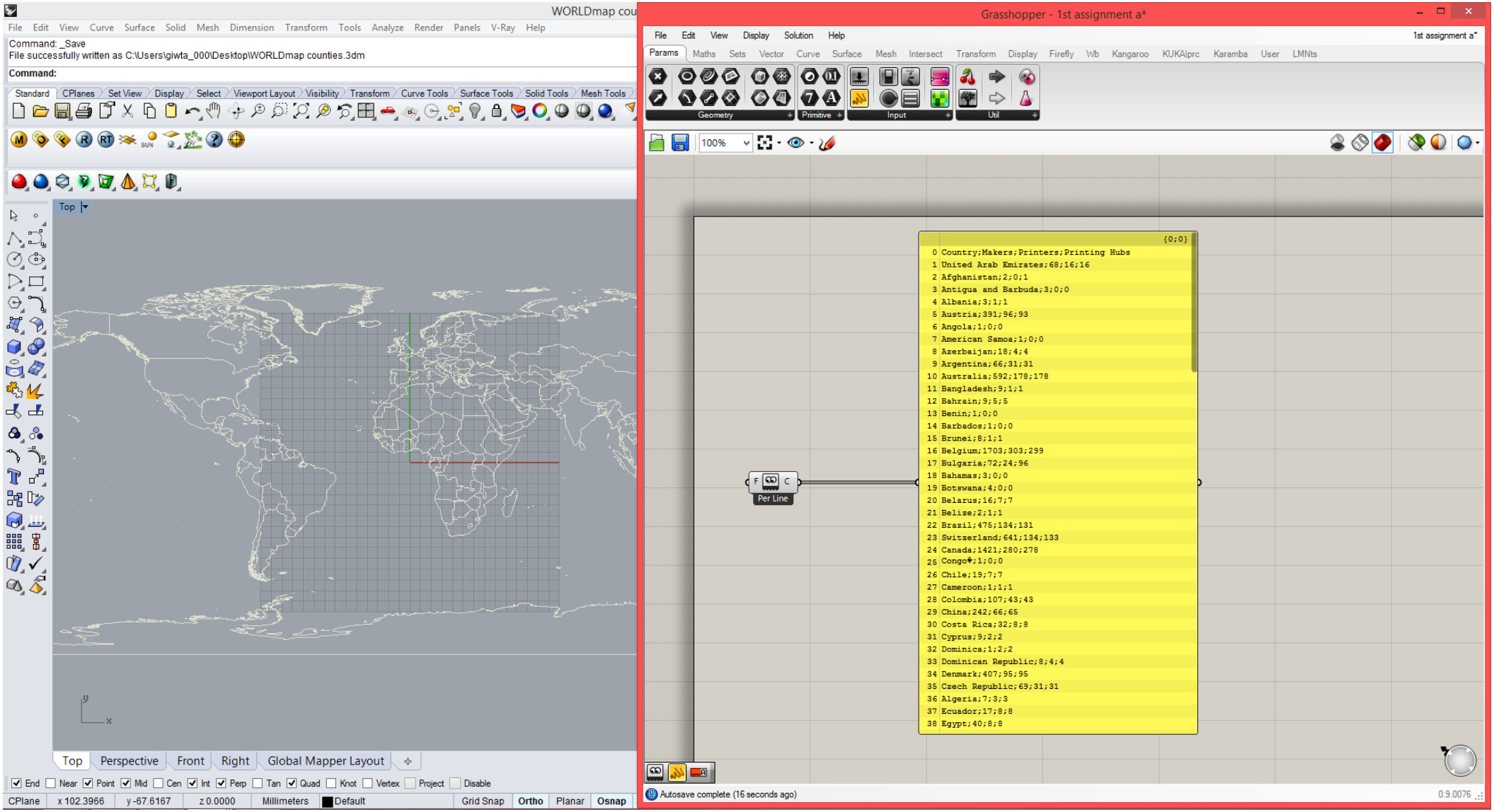
In order to visualize the number of 3d printers, makers and printing hubs per country, we downloaded a world map with a closed polyline for every country boundary and we named each layer according to the name of the country. (assignment 1 a.3dm)



3. Data Visualization

Step 2

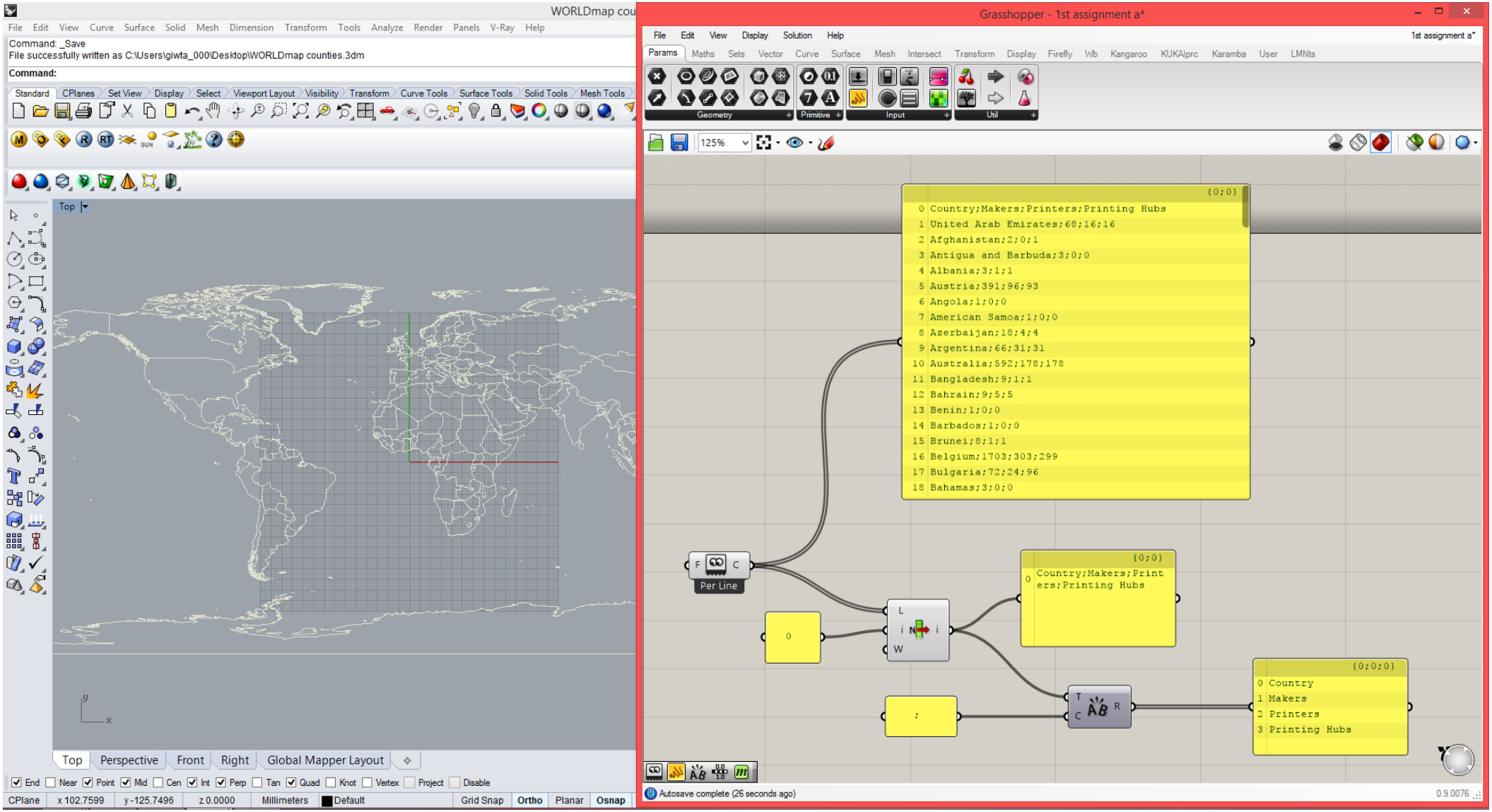
Insert the .csv file in Grasshopper and read it.



3. Data Visualization

Step 3

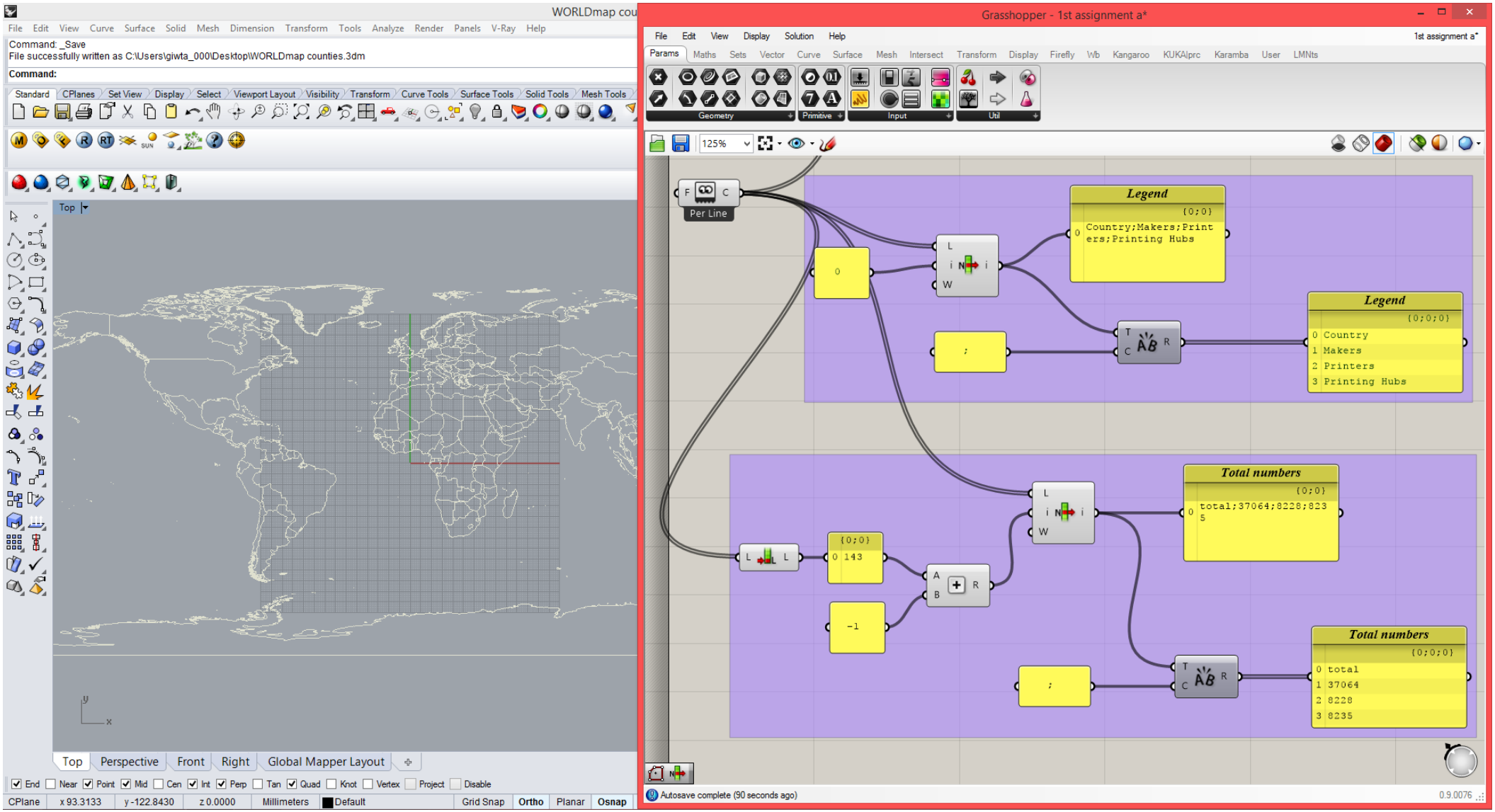
In order to isolate the first line as the legend, we select the item and then we separate the text with the “;”.



3. Data Visualization

Step 4

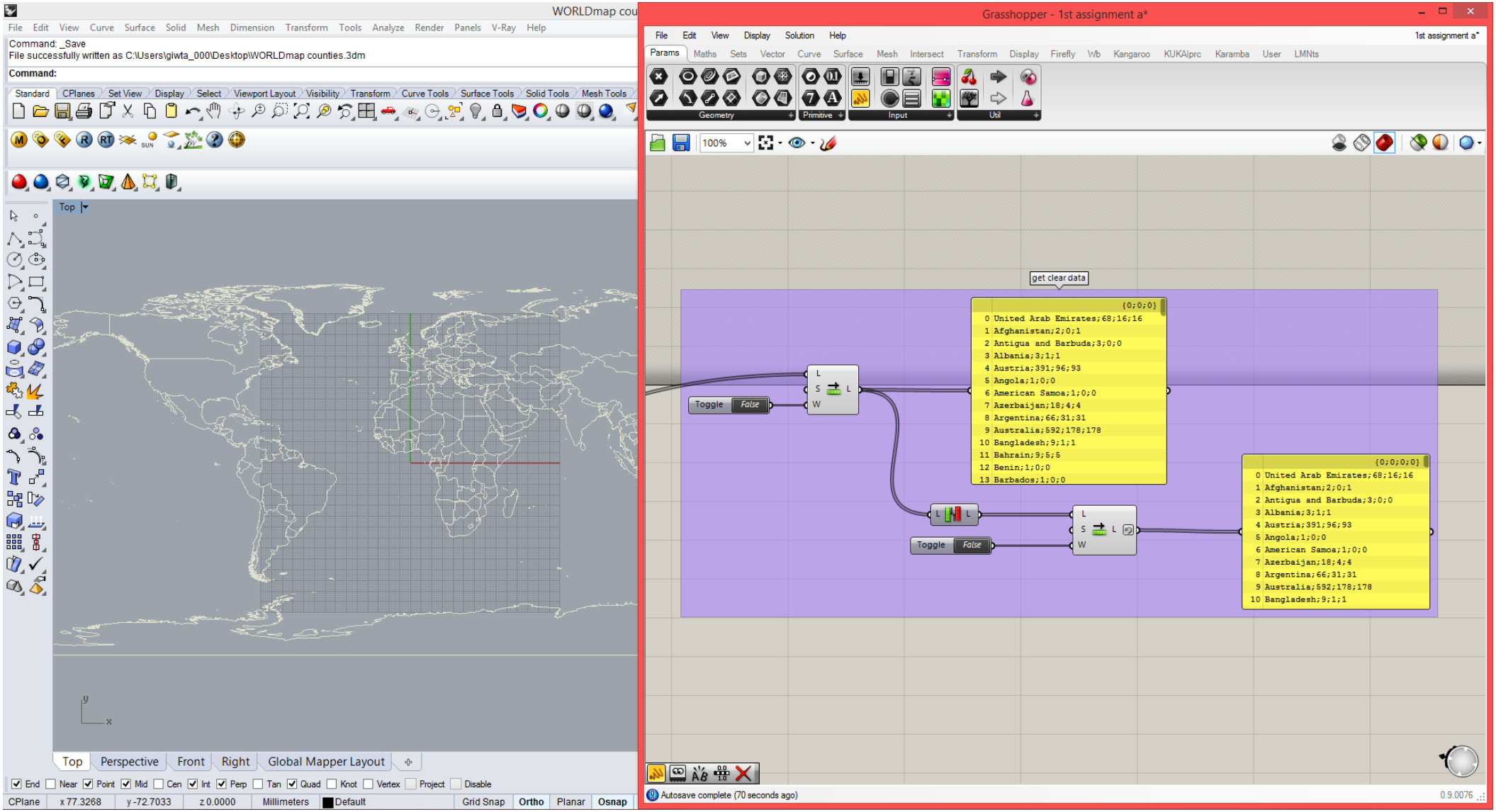
In order to isolate the last line as the total numbers, we select the item and then we separate the text with the “;”.



3. Data Visualization

Step 5

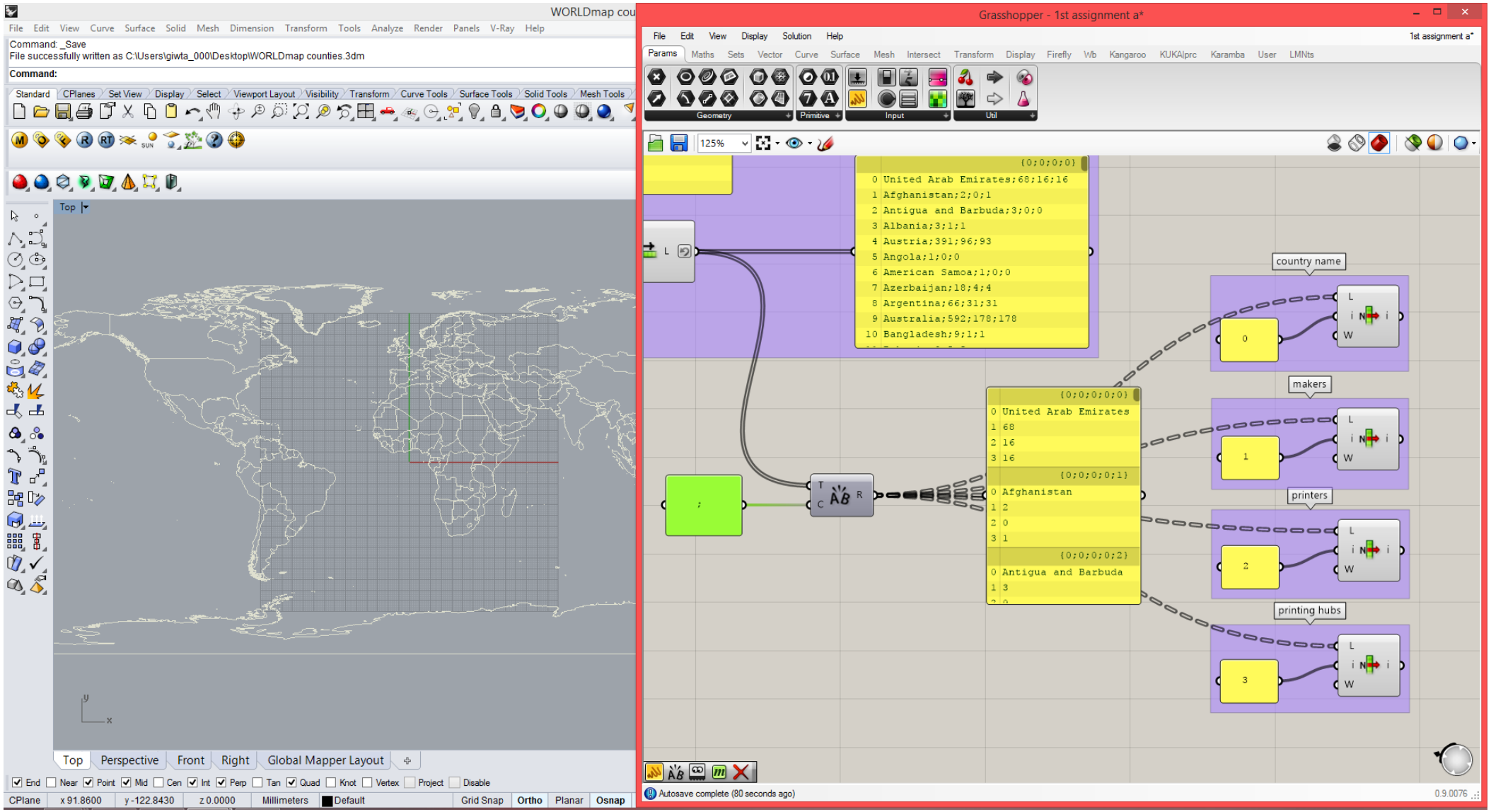
In order to get clear data, we shift and reverse the lists twice, so that we remove both the first and the last line of the list that not include data.



3. Data Visualization

Step 6

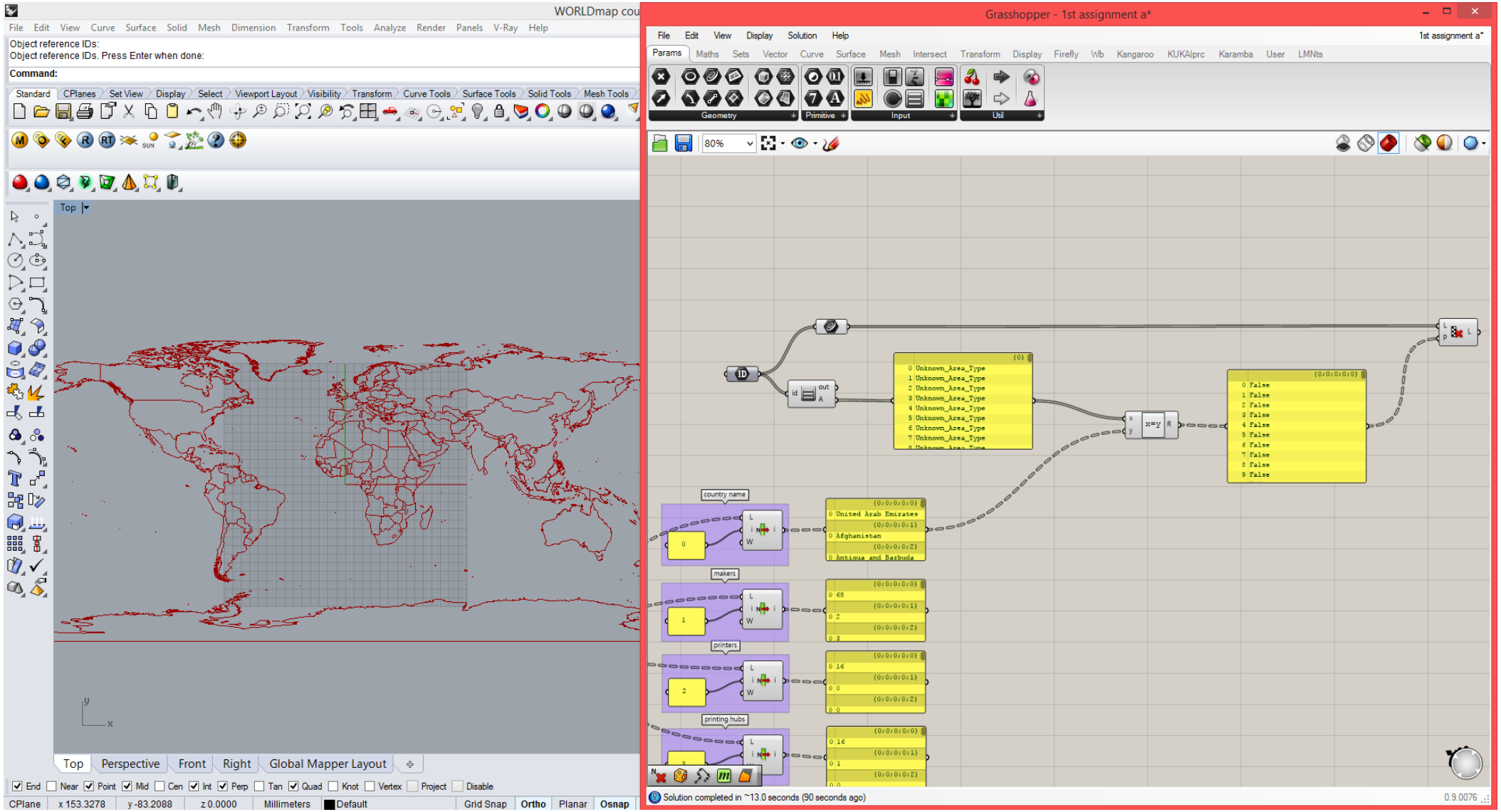
Then, we select separately all the values that belong in a category.



3. Data Visualization

Step 7

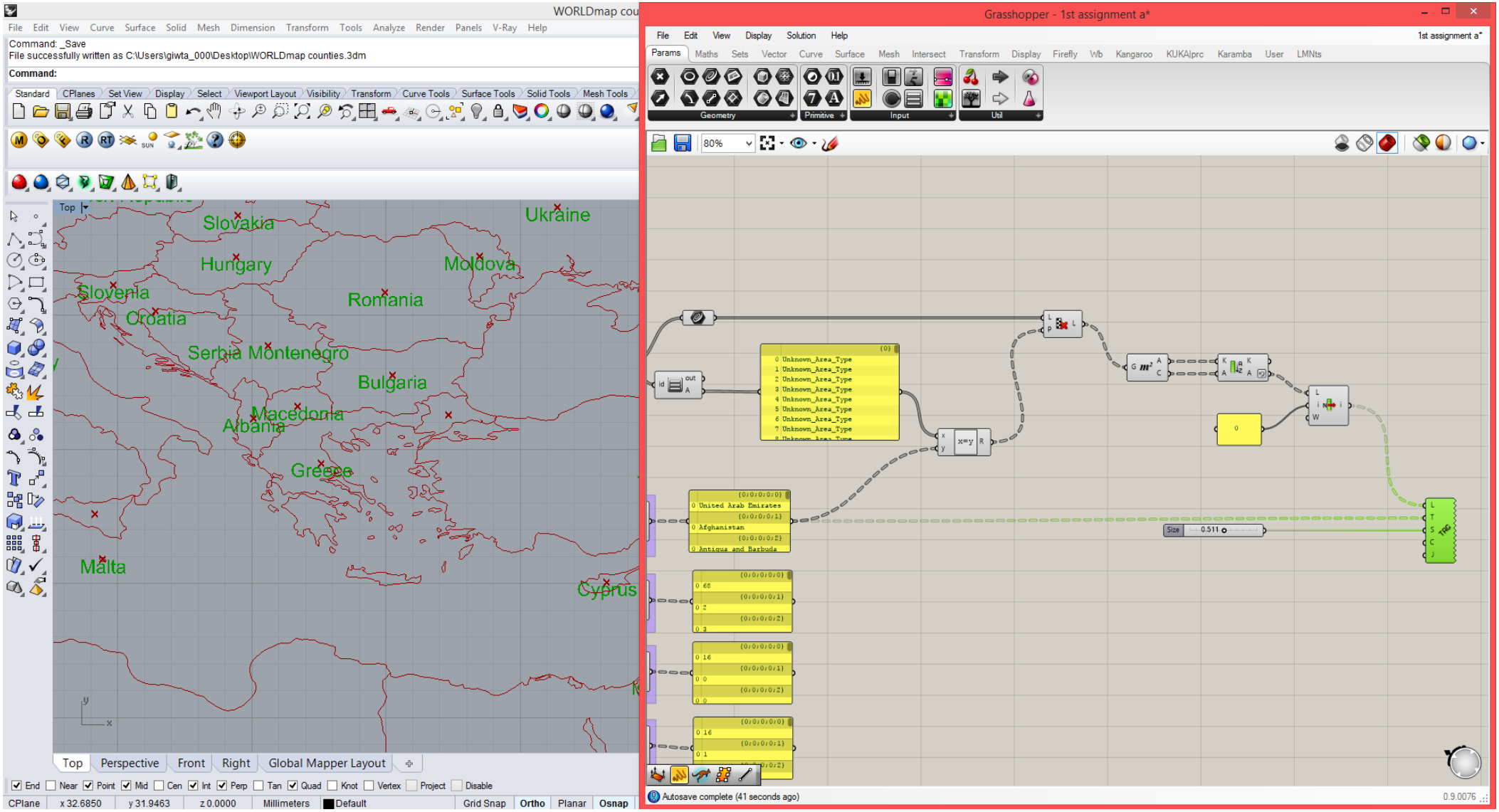
We reference all the polylines of the map in Grasshopper. Only the boundaries of the countries that interest us belong in layers named as the country name so we find and delete the rest using the x=y expression.



3. Data Visualization

Step 8

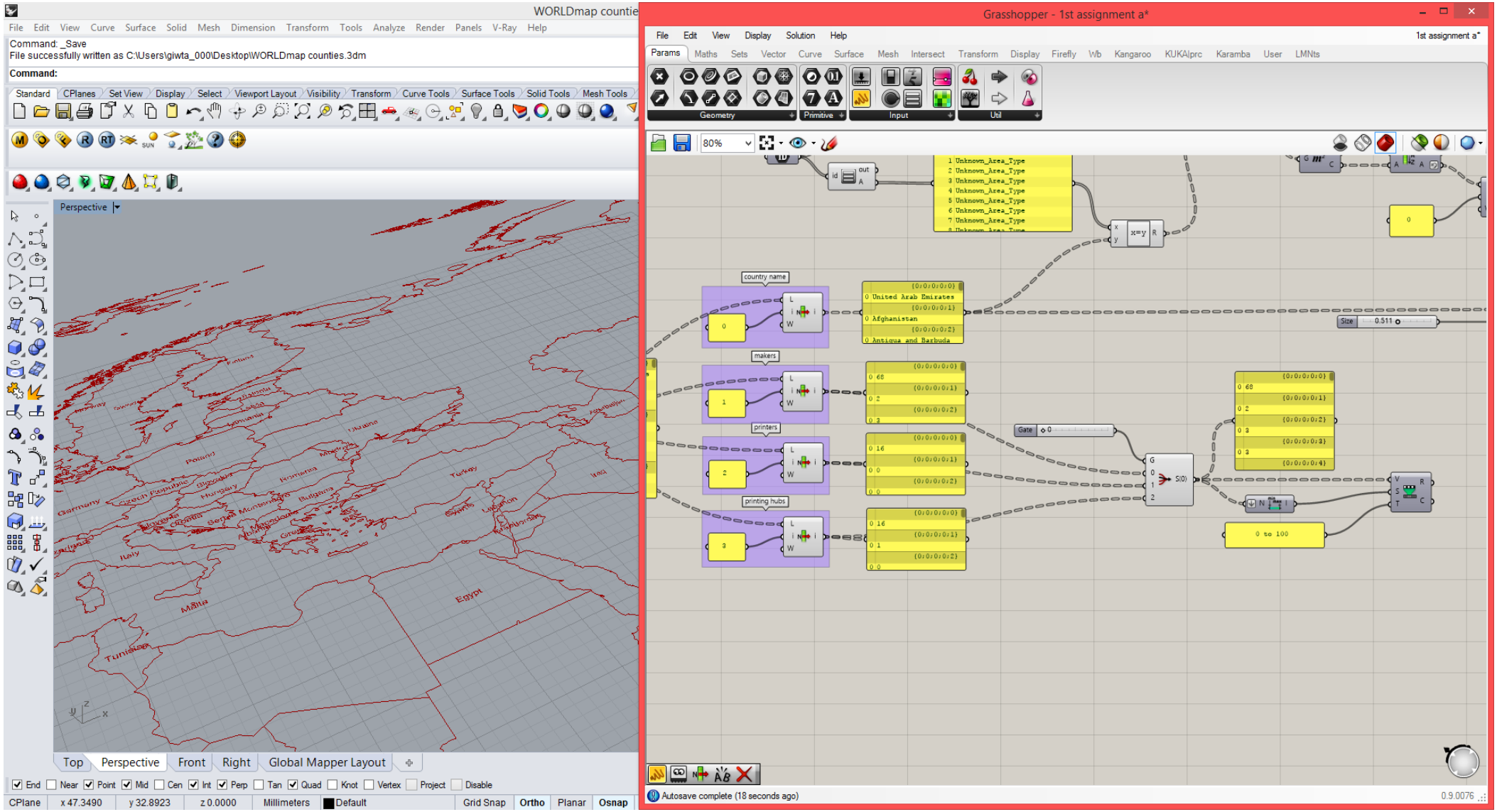
We write the names of the countries in the middle of the area of each country. We use the area component in order to find the centroid of each area. At the same time, a lot of countries have multiple boundaries, for example islands, so if we don t want to have the name written twice or more, we sort the areas of each boundary from largest to smallest (reverse sort list) and select only the first item for the text component.



3. Data Visualization

Step 9

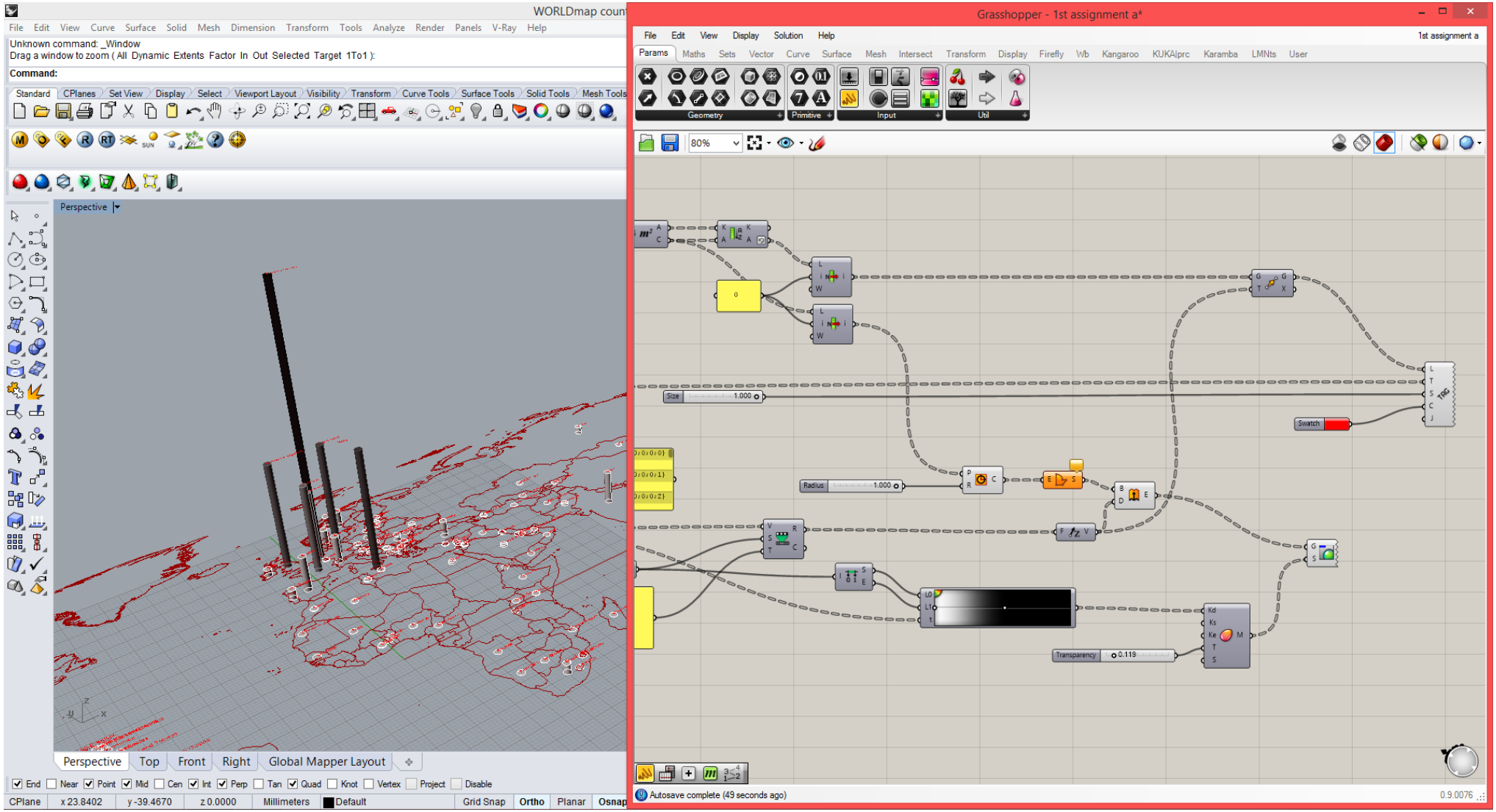
We want to use the values that we have in order to extrude the boundary of every country according to the numbers on 3d printers etc. These numbers vary a lot, so we remap them from 0 to 100, in order to have a more controlled extrusion. Then we use the Stream Filter component in order to control which data is being used every time.



3. Data Visualization

Step 10

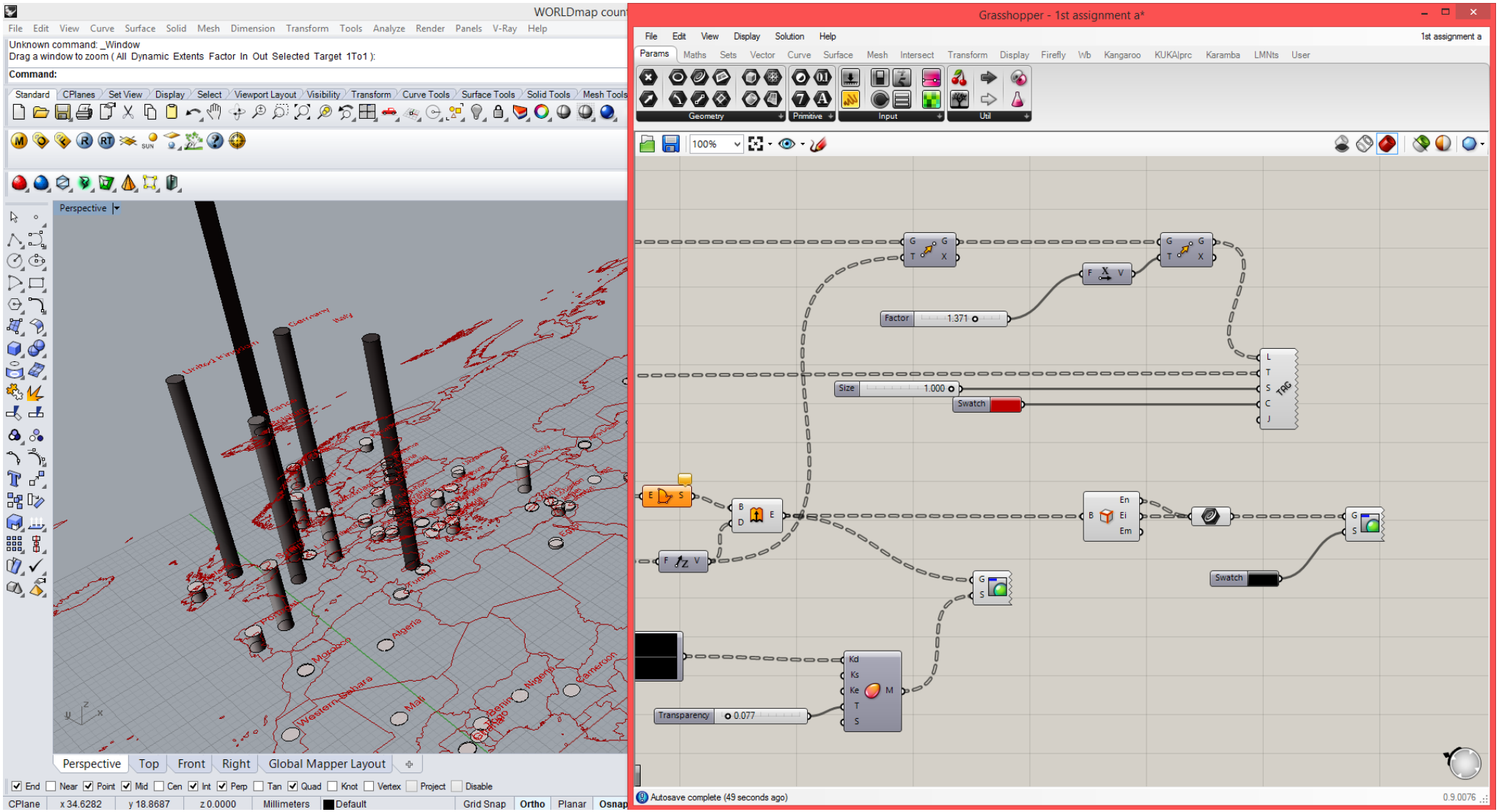
Finally, in order to visualize the data, we use the centroids of every country area to extrude a tube with a height relative to the data. Also, we use a gradient to enhance the effect of the difference of height. The names of the countries are moved on the top side of the tubes.



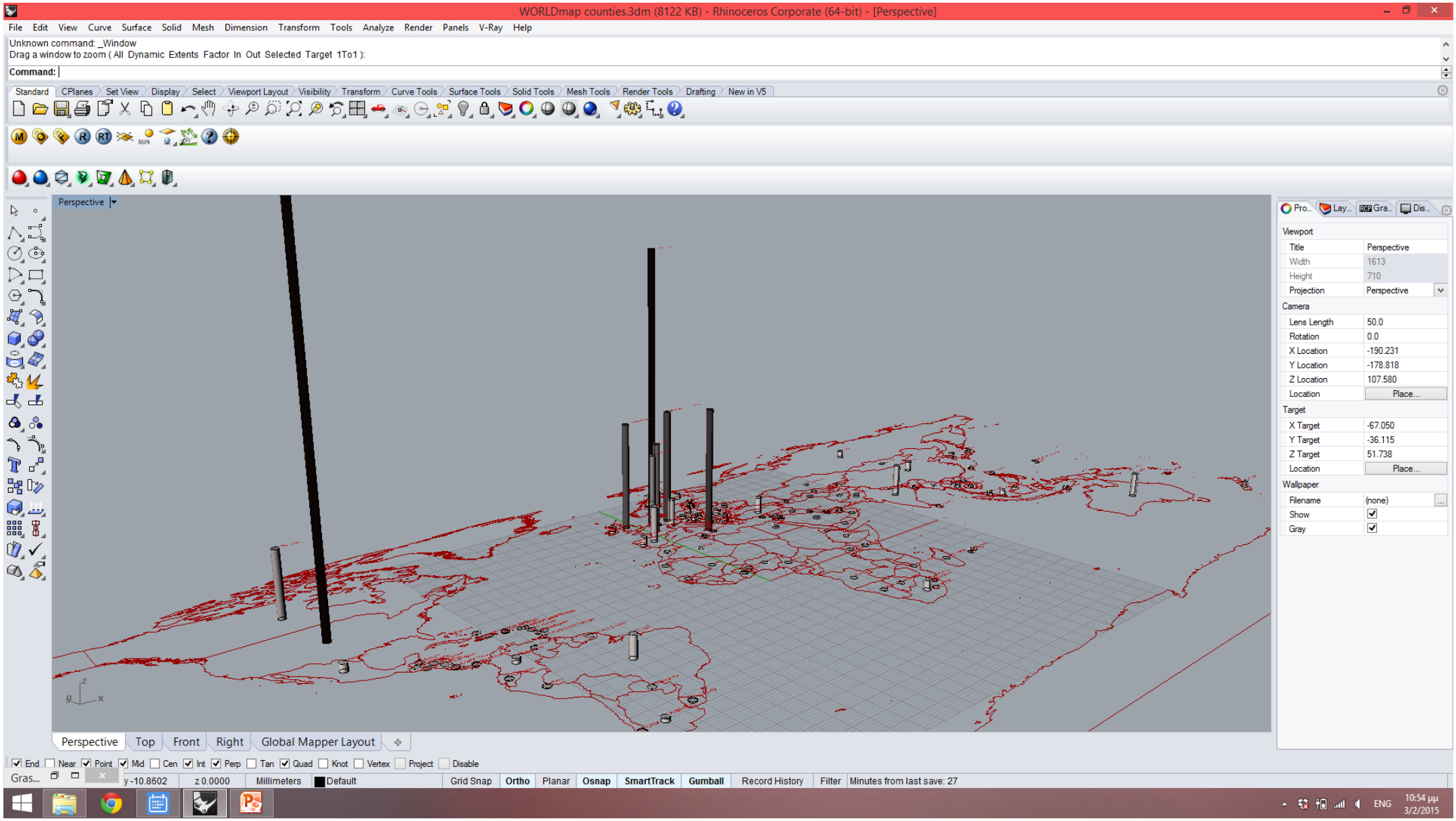
3. Data Visualization

Step 11

Some last corrections on the colour of the edges and the position of the names.



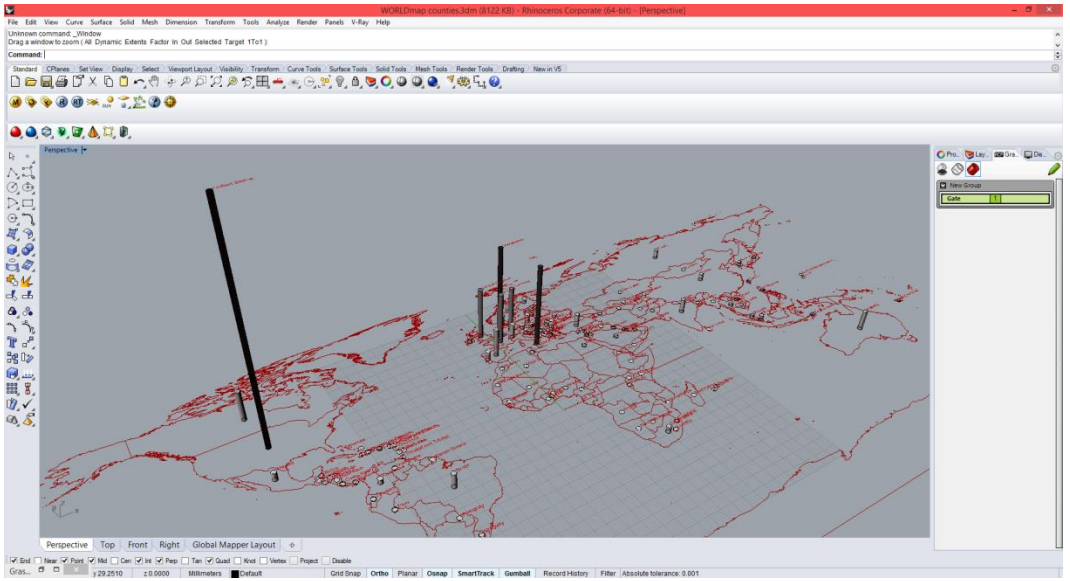
3. Data Visualization

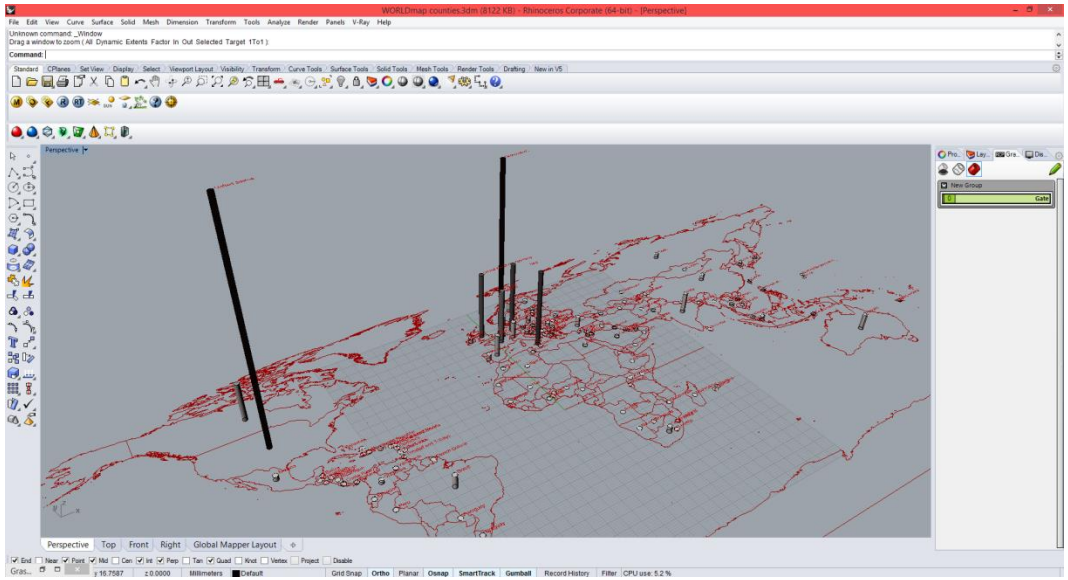


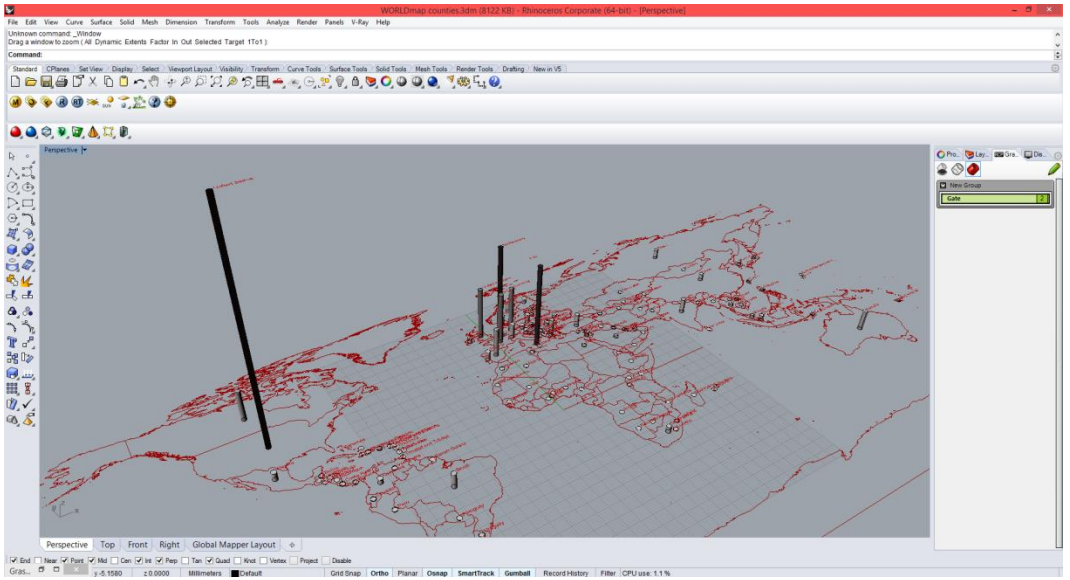
3. Data Visualization

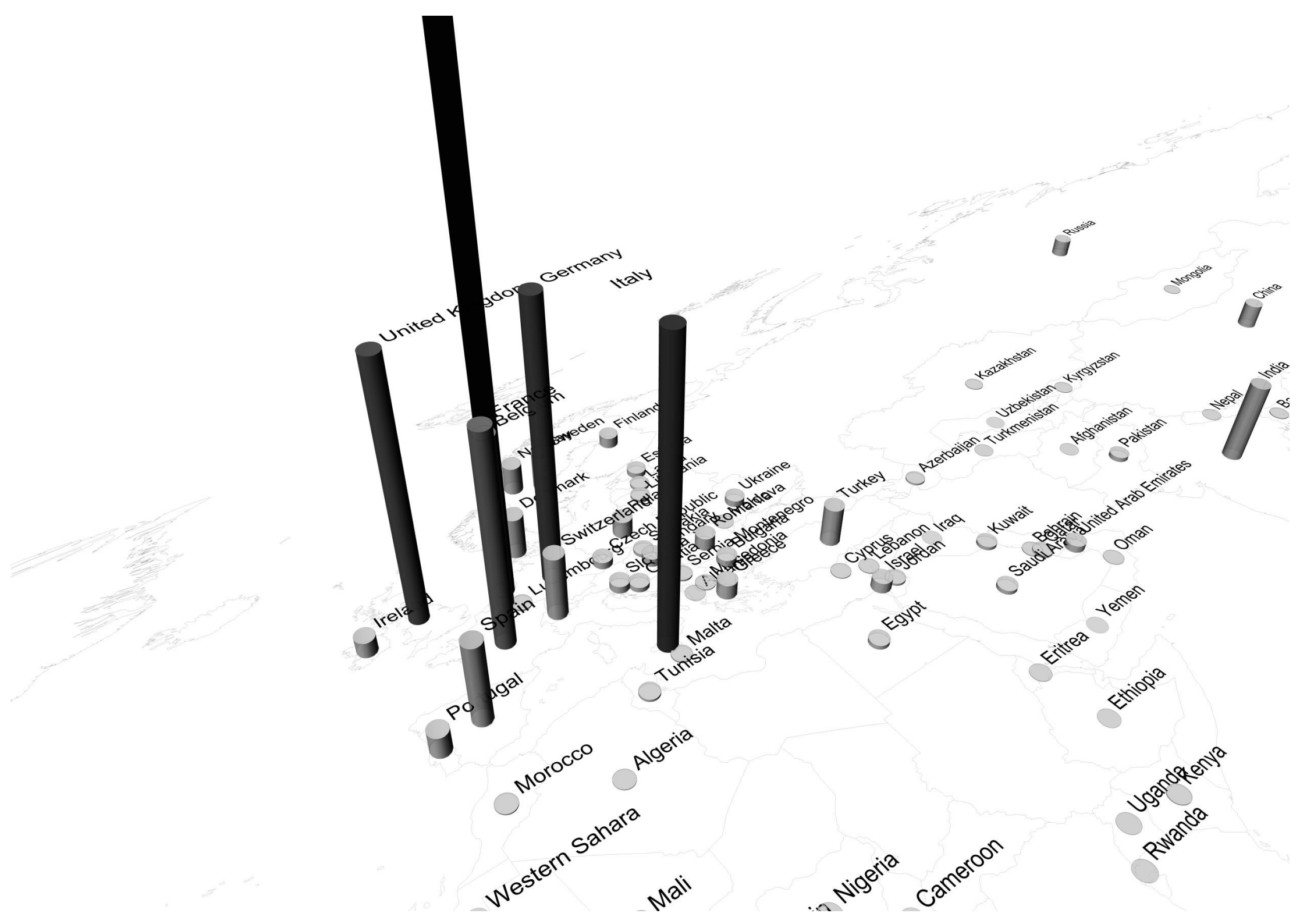
Step 12

We Publish to remote panel the slider that controls the parameter being observed each time, so that we can change it directly from Rhino.





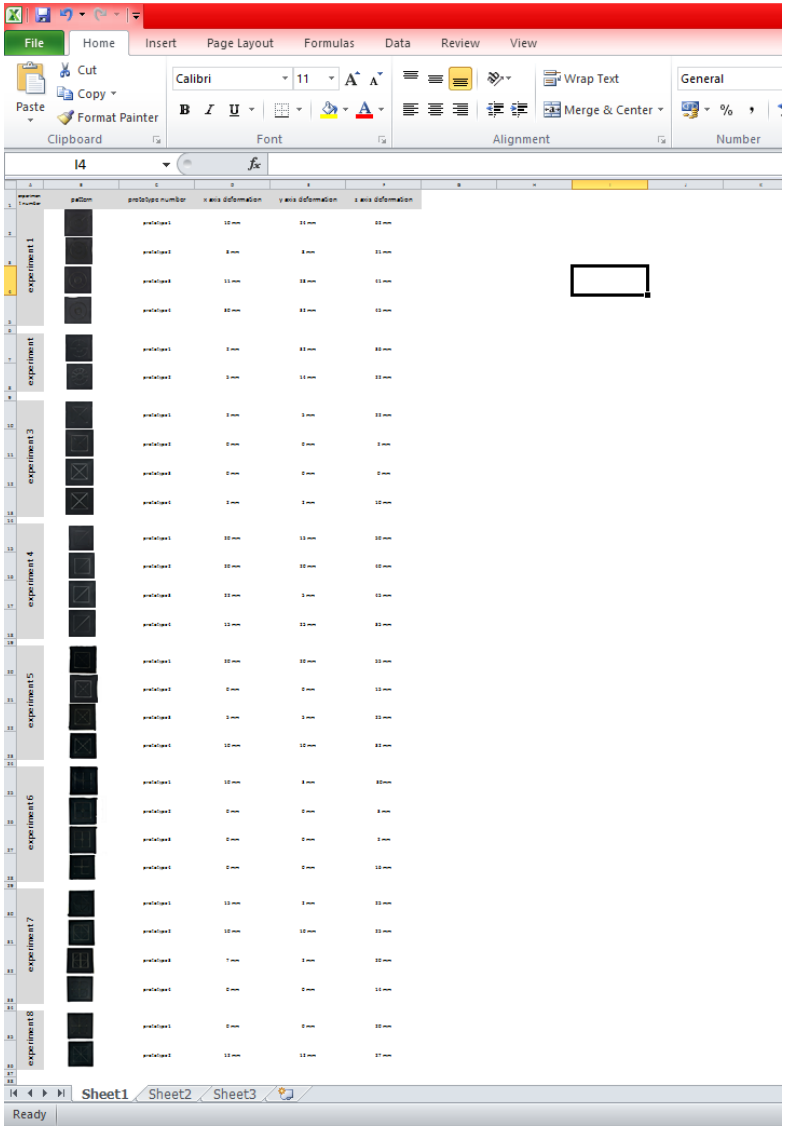


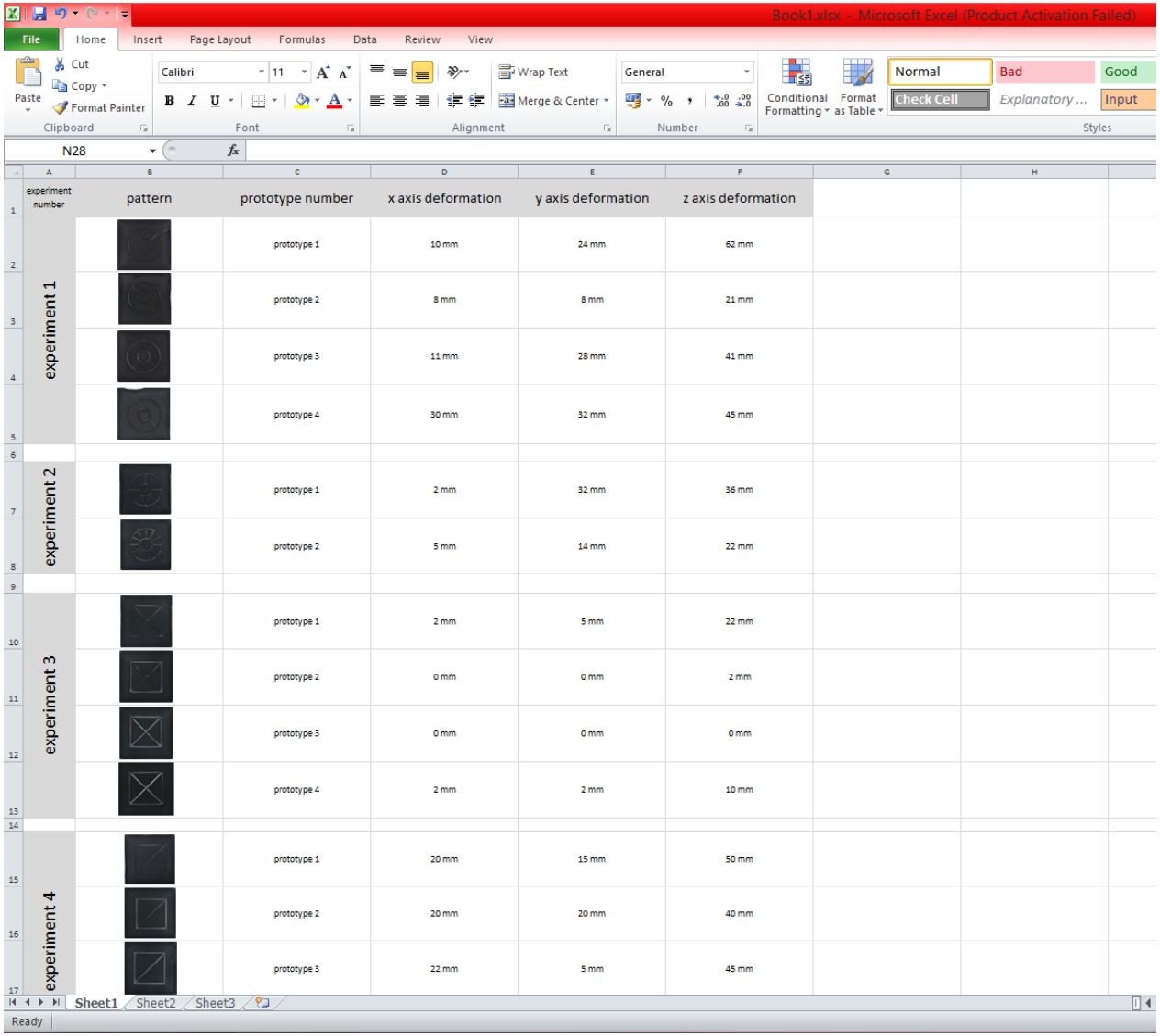

United Kingdom
Germany
Italy
France
Belgium
Sweden
Finland
Denmark
Switzerland
Ireland
Spain
Portugal
Malta
Tunisia
Morocco
Algeria
Western Sahara
Mali
Nigeria
Cameroon
Ukraine
Turkey
Cyprus
Lebanon
Israel
Jordan
Iraq
Kuwait
Egypt
Russia
Mongolia
China
Kazakhstan
Uzbekistan
Kyrgyzstan
Turkmenistan
Azerbaijan
Afghanistan
Pakistan
Nepal
India
United Arab Emirates
Oman
Yemen
Eritrea
Ethiopia
Uganda
Kenya
Rwanda

Experiment charts

2. Data Mining

Step 1
Data generated by an experiment held during our research for our studio.

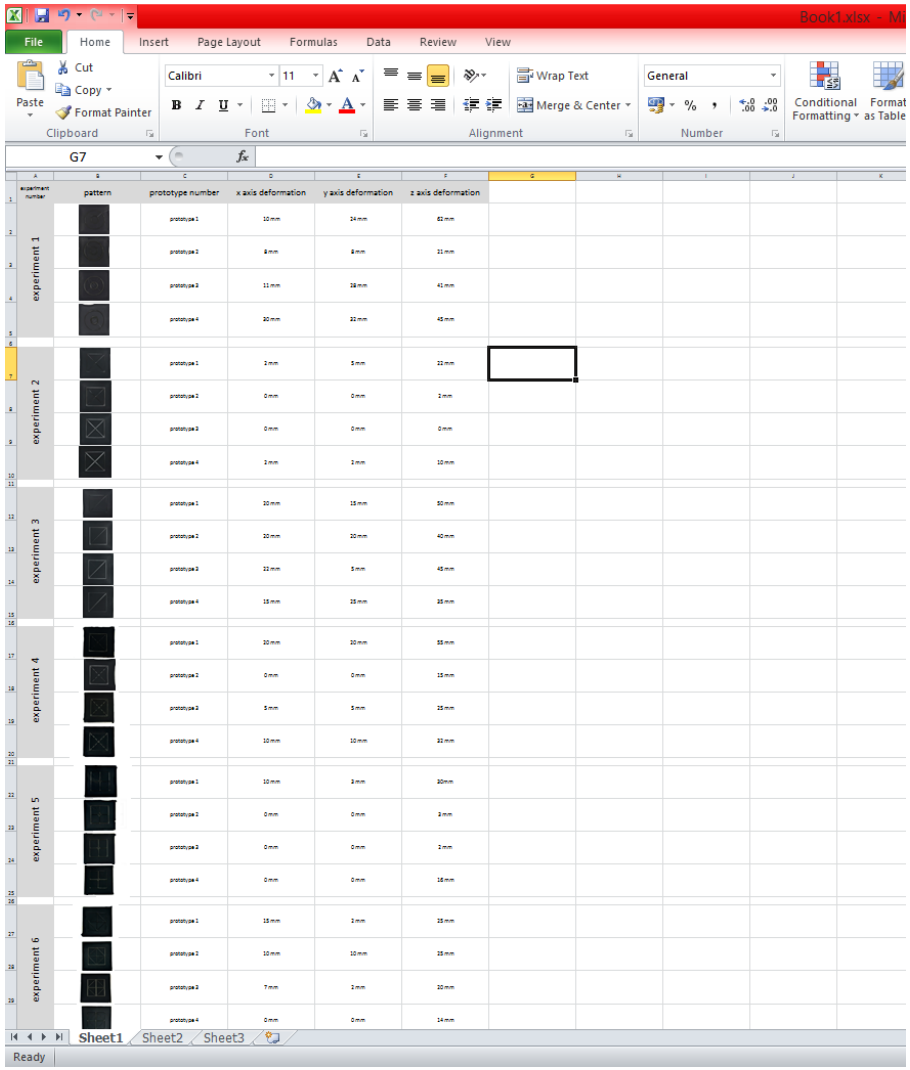


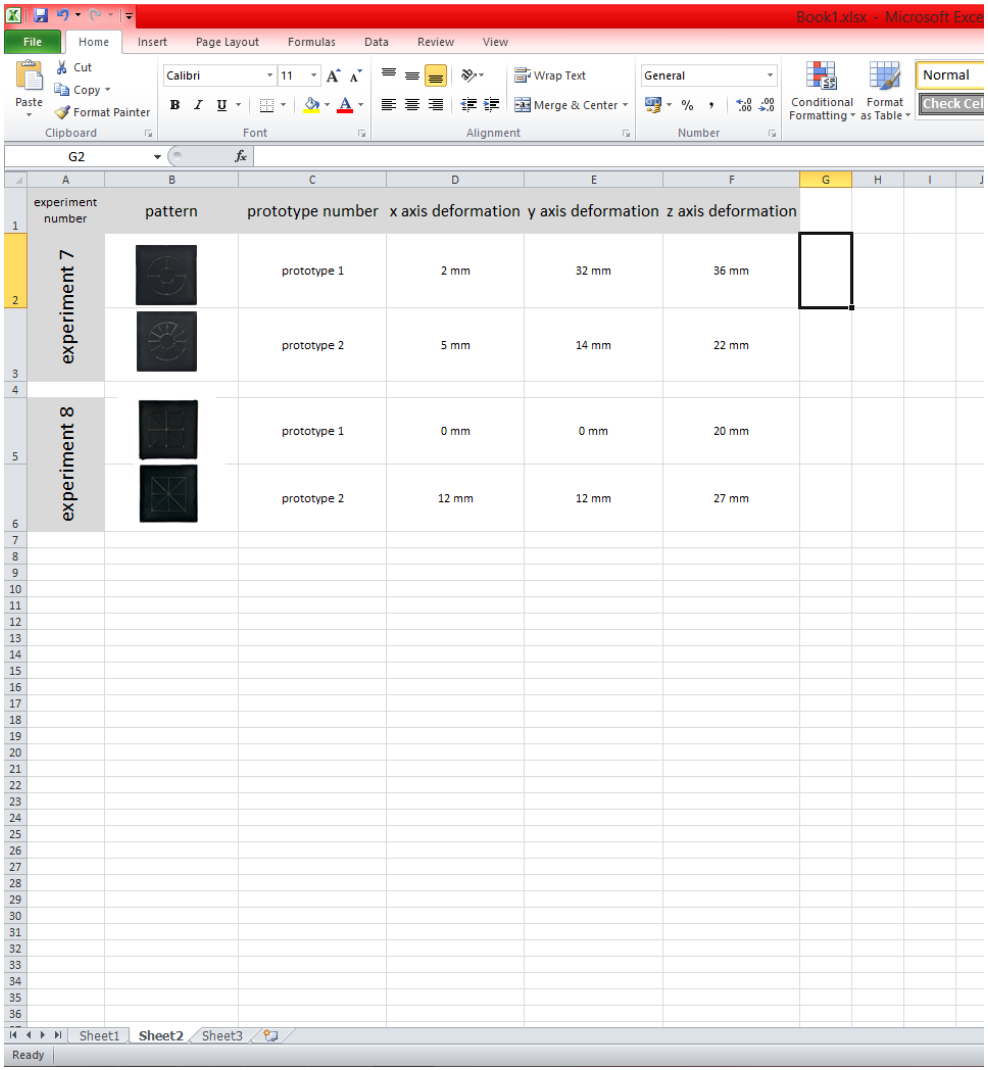


experiment number	pattern	prototype number	x axis deformation	y axis deformation	z axis deformation
experiment 1		prototype 1	10 mm	24 mm	62 mm
		prototype 2	8 mm	8 mm	21 mm
		prototype 3	11 mm	28 mm	41 mm
		prototype 4	30 mm	32 mm	45 mm
experiment 2		prototype 1	2 mm	32 mm	36 mm
		prototype 2	5 mm	14 mm	22 mm
experiment 3		prototype 1	2 mm	5 mm	22 mm
		prototype 2	0 mm	0 mm	2 mm
		prototype 3	0 mm	0 mm	0 mm
		prototype 4	2 mm	2 mm	10 mm
experiment 4		prototype 1	20 mm	15 mm	50 mm
		prototype 2	20 mm	20 mm	40 mm
		prototype 3	22 mm	5 mm	45 mm

2. Data Mining

Most of our experiments contain four prototypes to be compared. Two of them contain only two. In order to be able to manipulate the data better, we separate the experiments in different sheets in the Excel file according to the number of prototypes.
File name: charts.xlsx

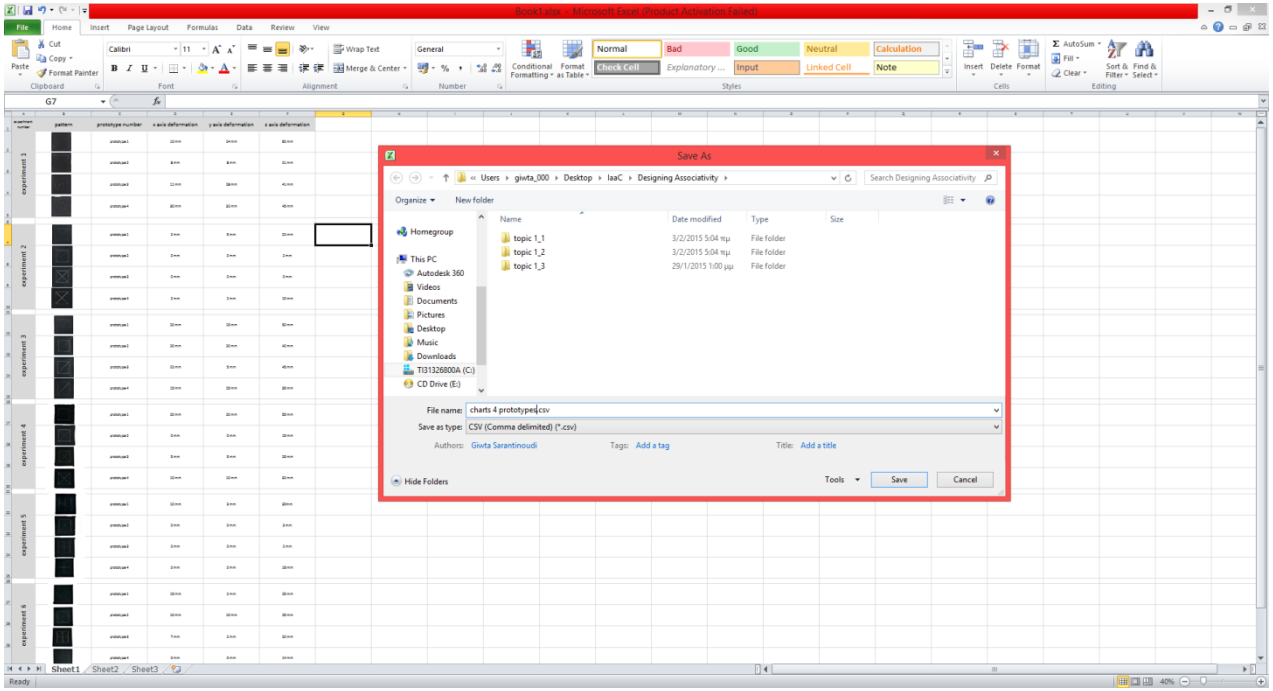


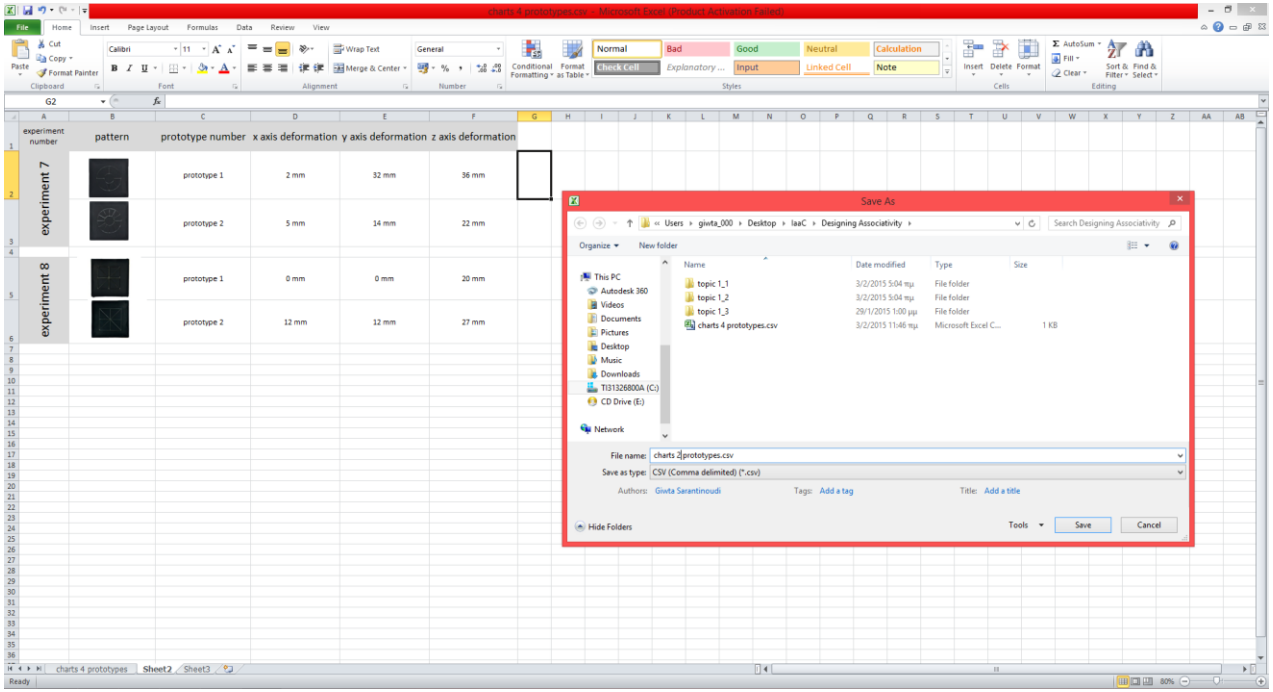


3. Data Visualization

The chart in the Excel file needs to be saved in a format that can be read by Grasshopper, such as a .csv file. Each Excel sheet is being saved as a different as a .csv file.

File names: charts 2 prototypes.csv
charts 4 prototypes.csv

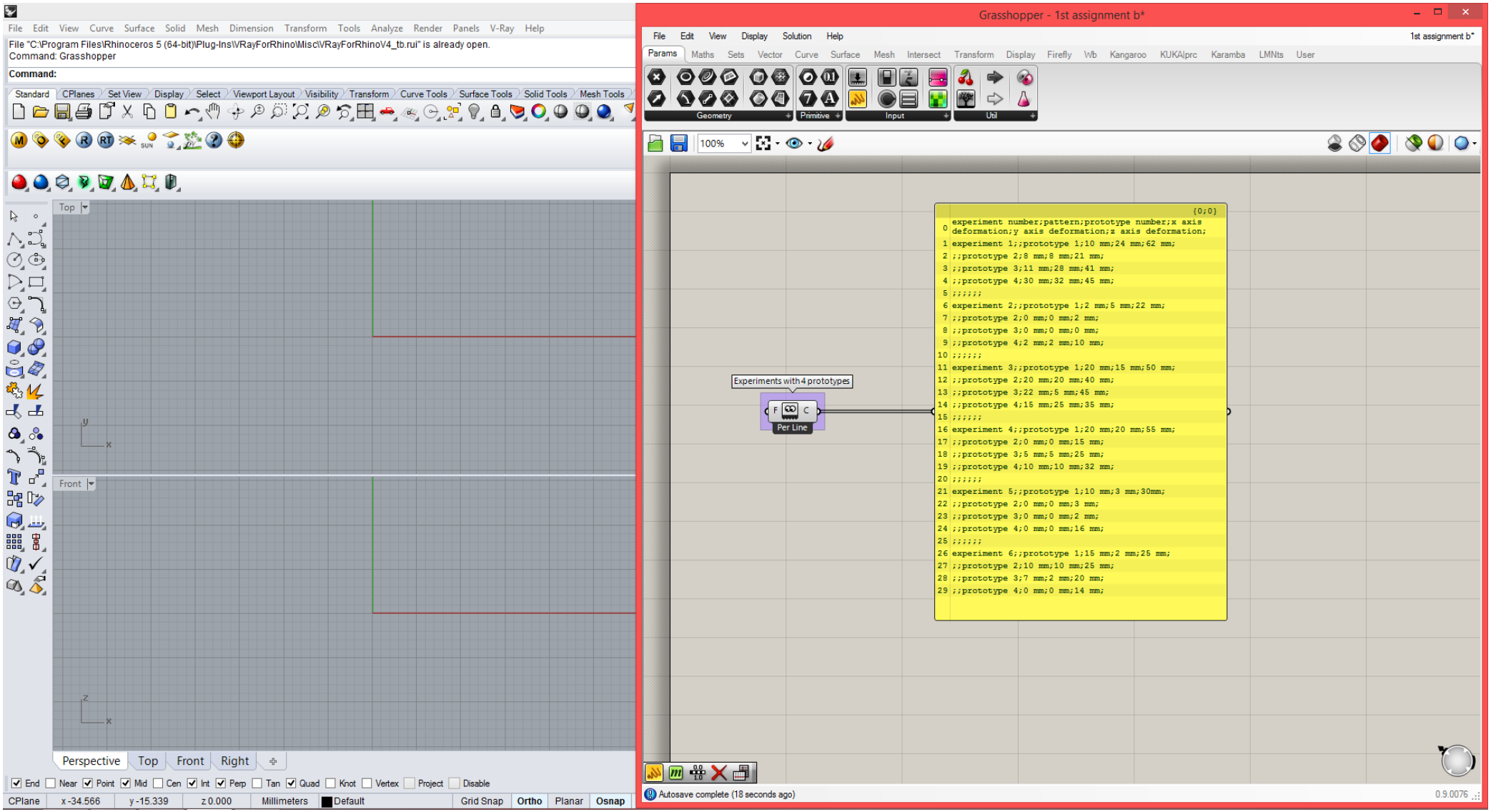




3. Data Visualization

Step 2

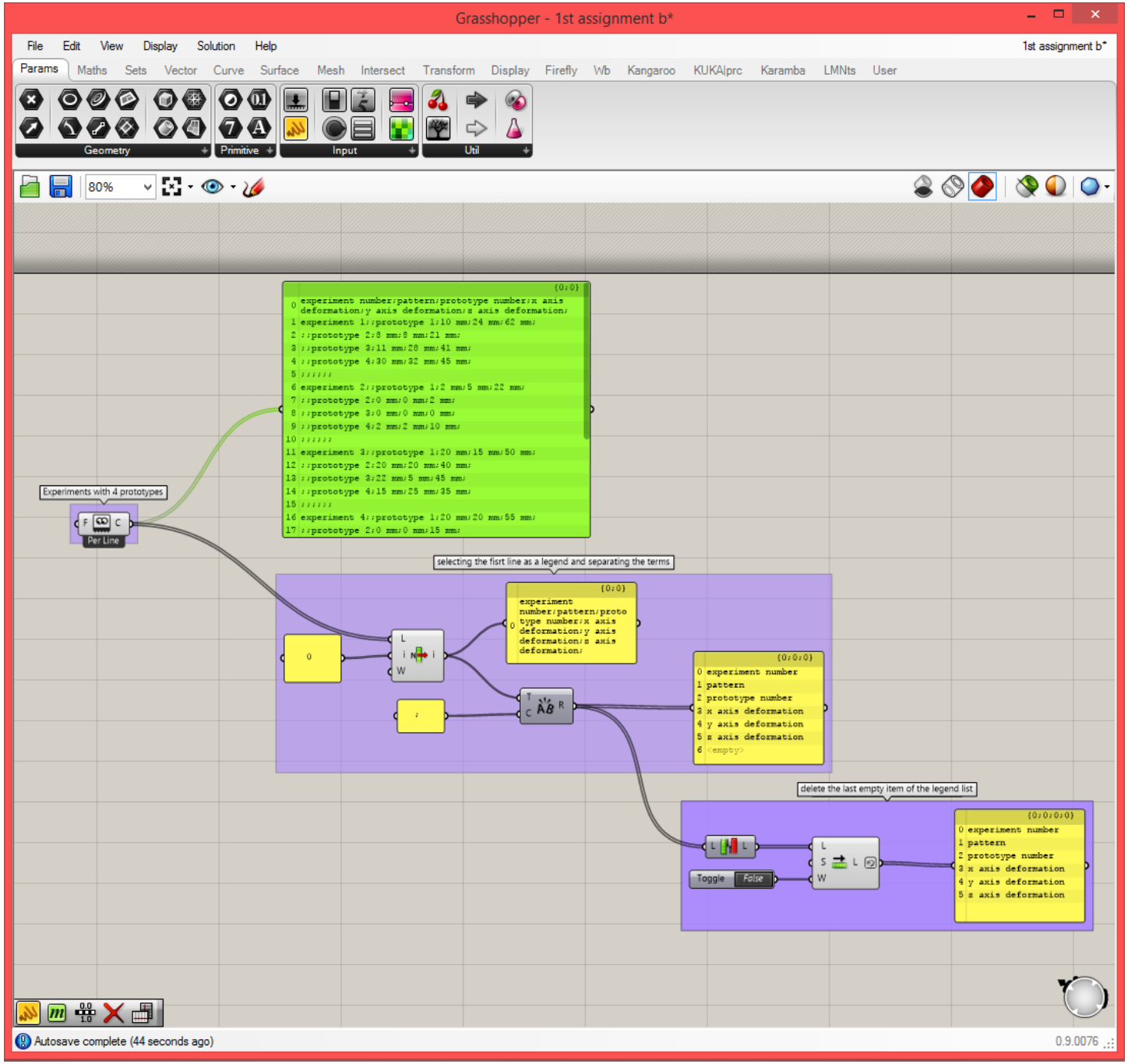
Drag and drop the first .csv file in Grasshopper and read its contents.



3. Data Visualization

Step 3

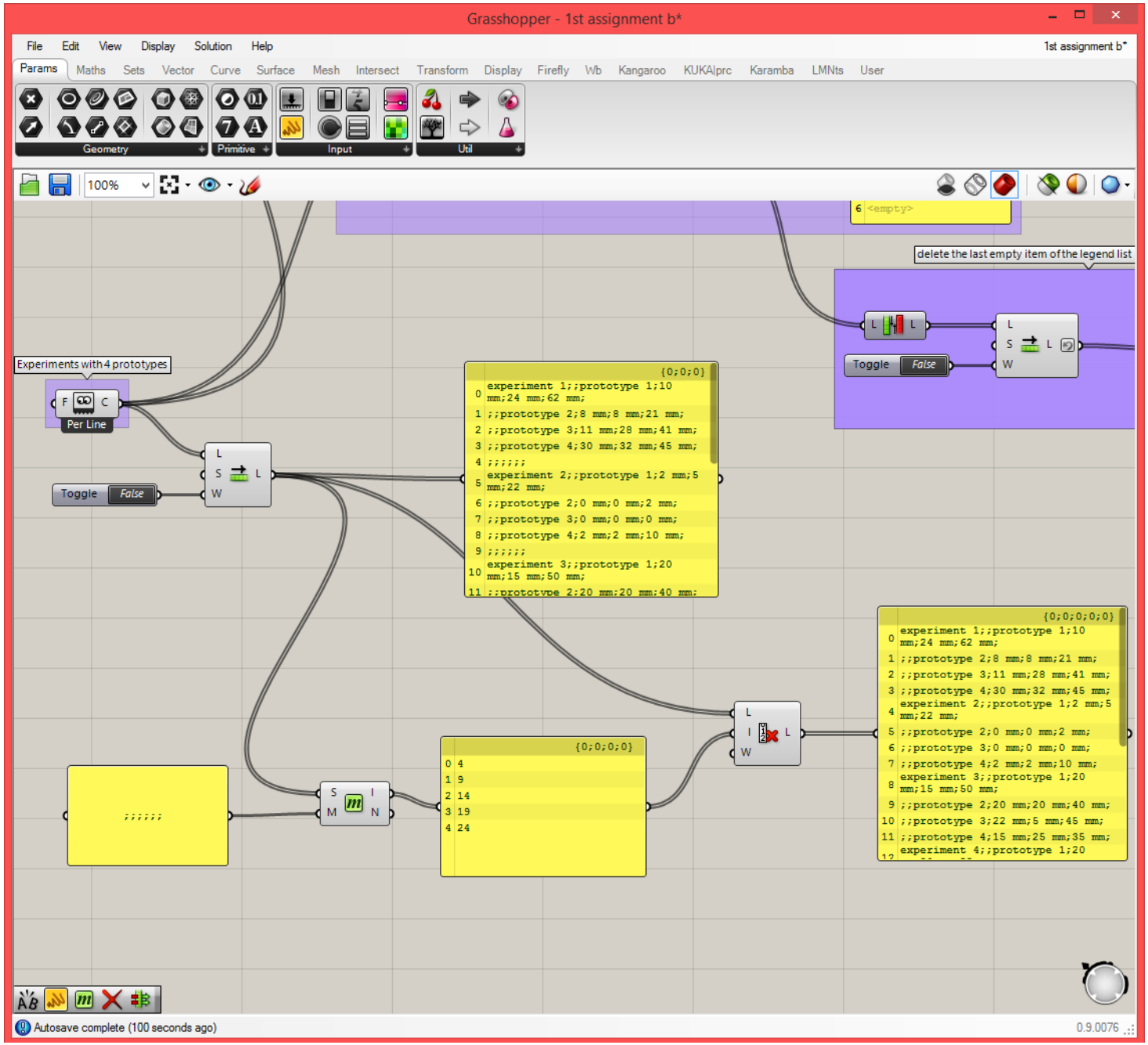
Separate the first line of the list as the legend of the charts to be created, and split the terms one by one.
The terms in the .csv file are separated by a ";". Since there is a ";" even after the last term the text split component creates one more empty list item. In order to delete this, we reverse the list, shift the list and then reverse it again.



3. Data Visualization

Step 4

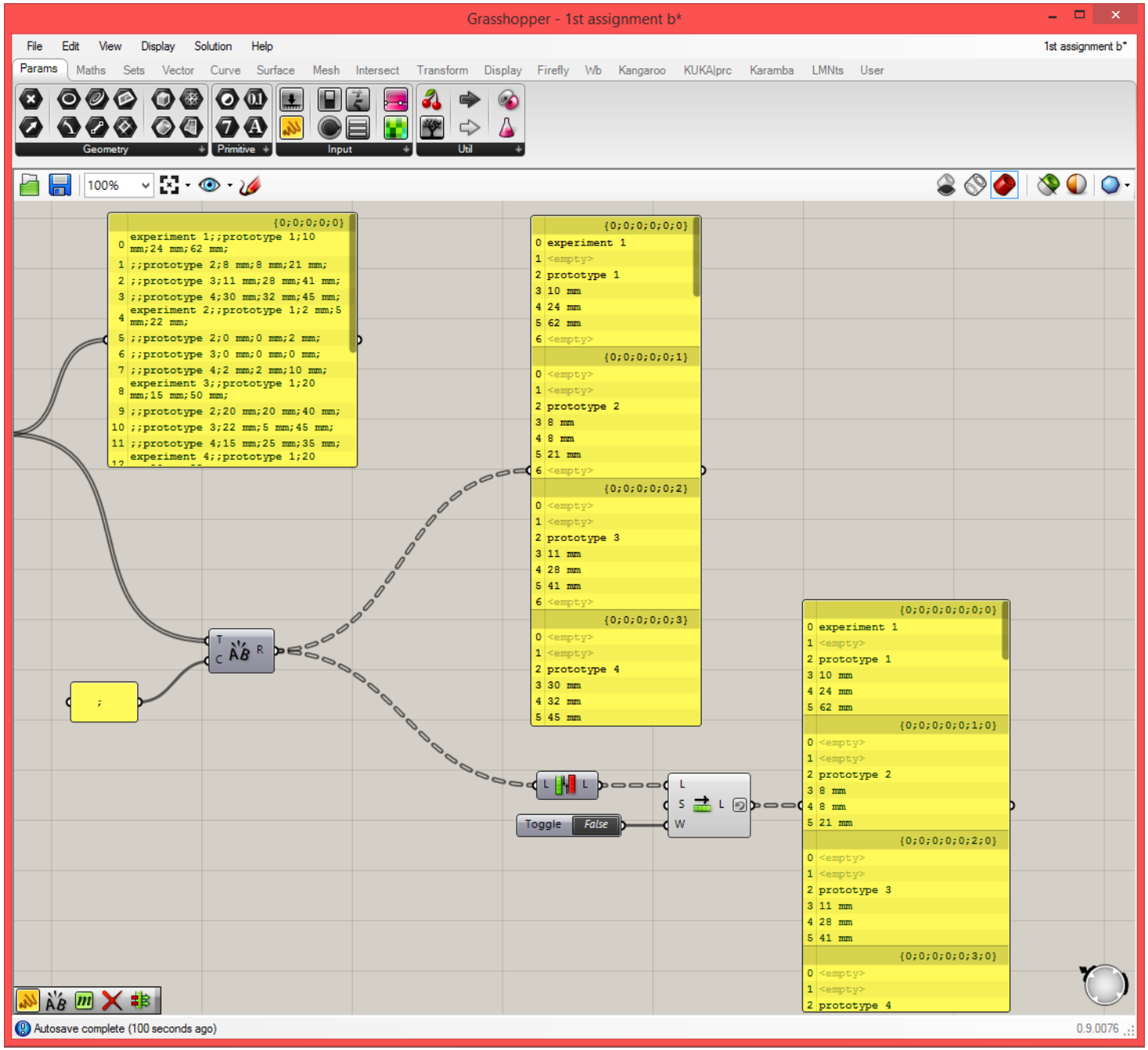
Next, we need to clear the data we get from the .csv file. First, we remove the first line of the list using the shift component.
When we saved the Excel file as .csv, the different experiments where separated by an empty line of cells. This results in in some items of the list being empty and being demonstrated as a series of ";". We use the member index and cull index components in order to find and eliminate all these items.



3. Data Visualization

Step 5

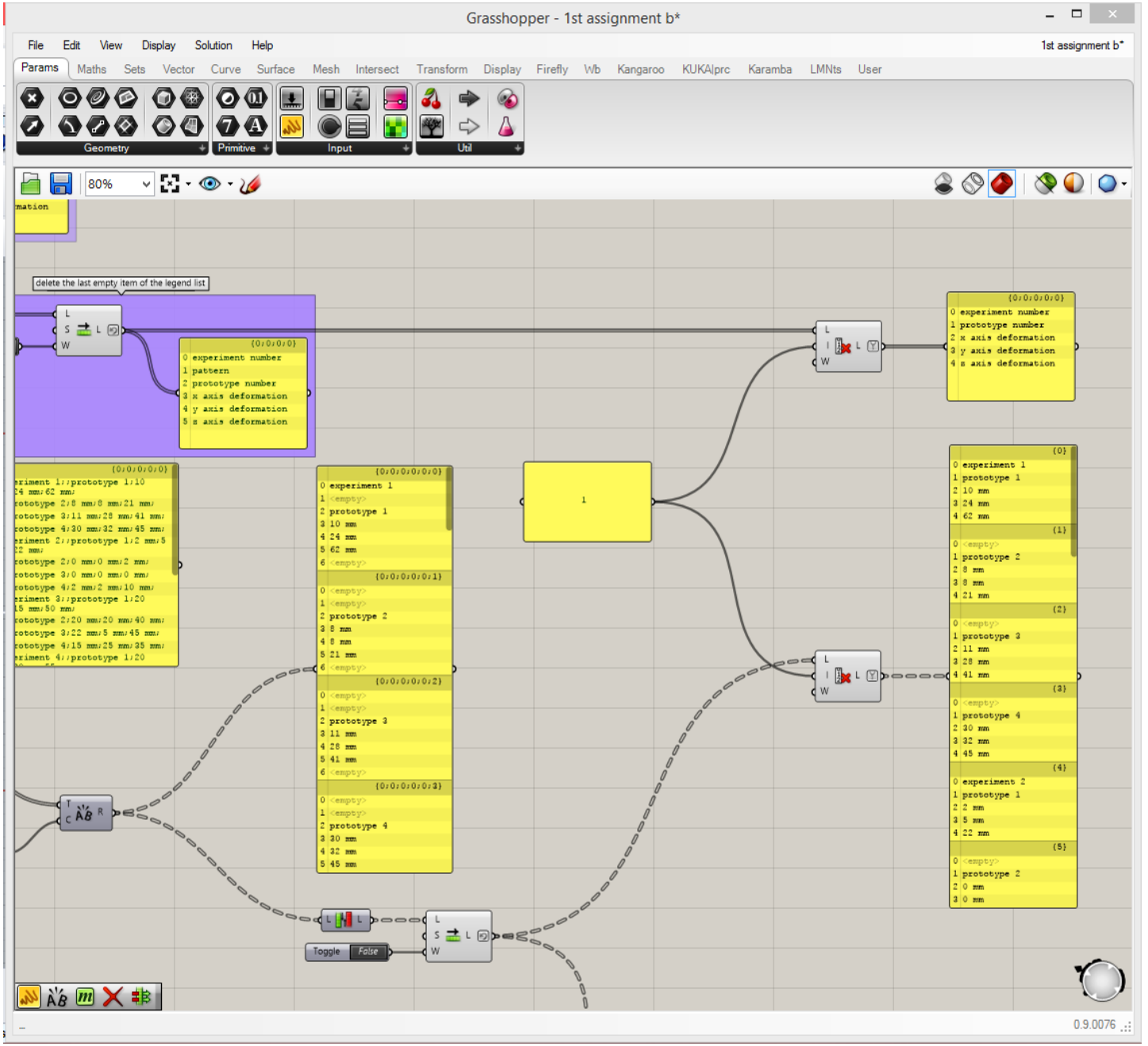
Then, we split the text contained in every list item, using the “;” character. Same as before, we need to reverse the lists twice and shift the lists in order to remove the last empty item of every list that is being created by the existence of the “;” character after every term.



3. Data Visualization

Step 6

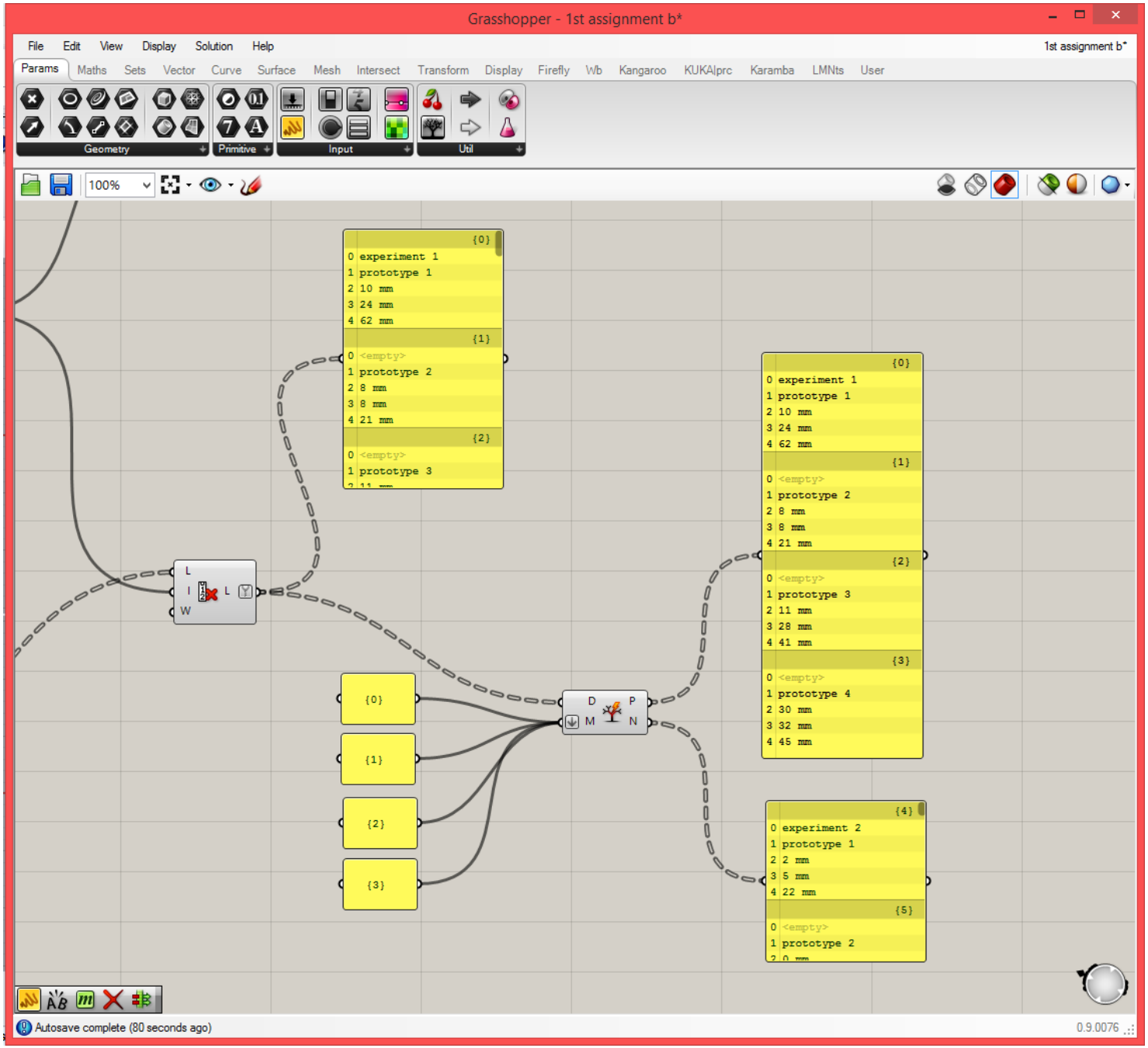
The item 1 of every data list is again empty, because in the original Excel file these cells contain photographs. In the legend list the “pattern” item refers to these items.
We apply the cull index component in both list in order to remove all the empty items as well as their relative legend term.



3. Data Visualization

Step 7

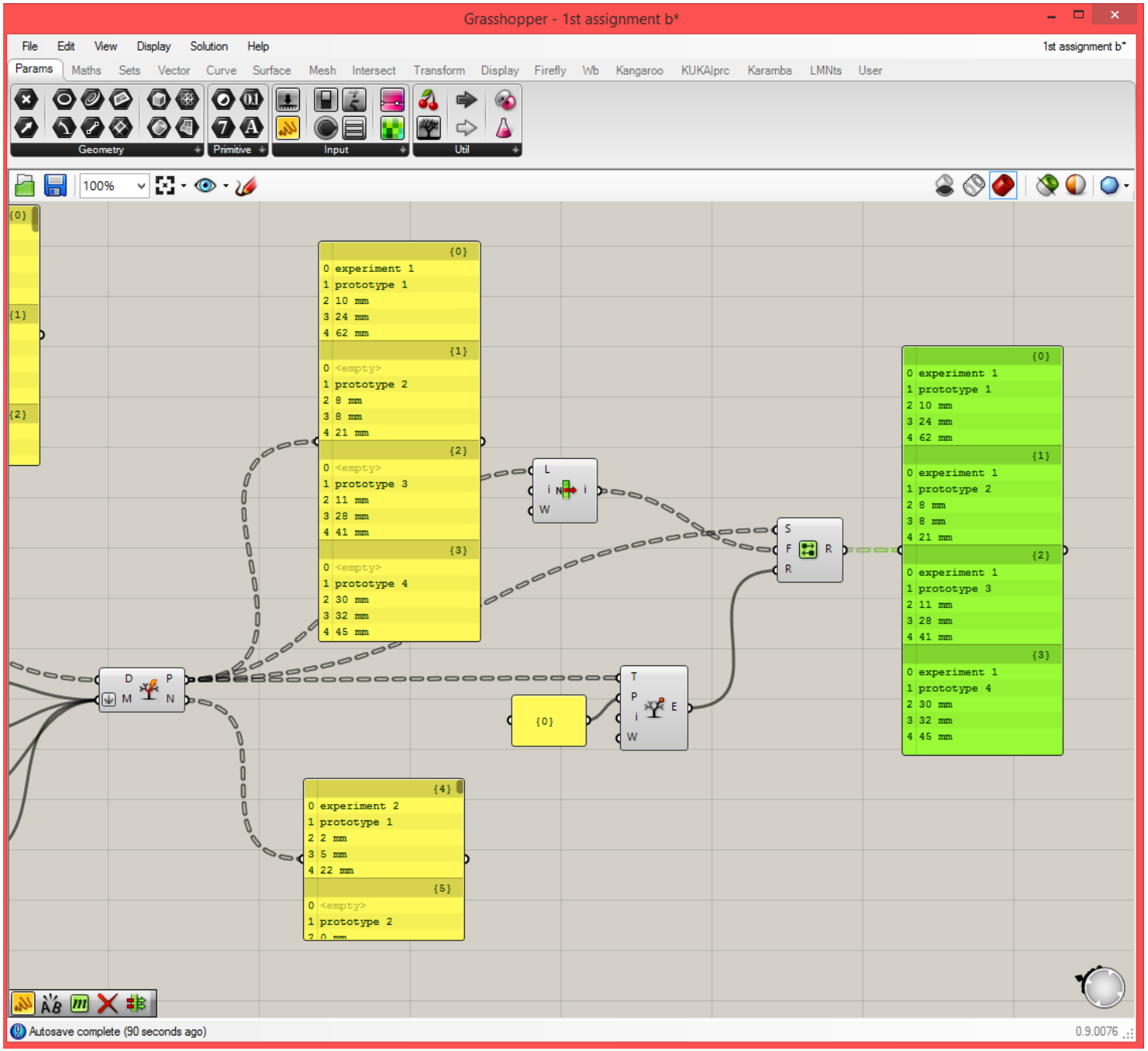
We know that every one from our experiments contains four prototypes to be compared between them.
In order to isolate the four prototypes of every prototype we use the split tree component for the four first branches of the tree.



3. Data Visualization

Step 8

In the Excel file, the title of each experiment (experiment 1,2,3) was mentioned in a merged cell in front of all the relative prototypes. In the .csv file the title goes only at the first line and the rest remain empty.
We use the replace member component to apply the experiment number in all the lists.

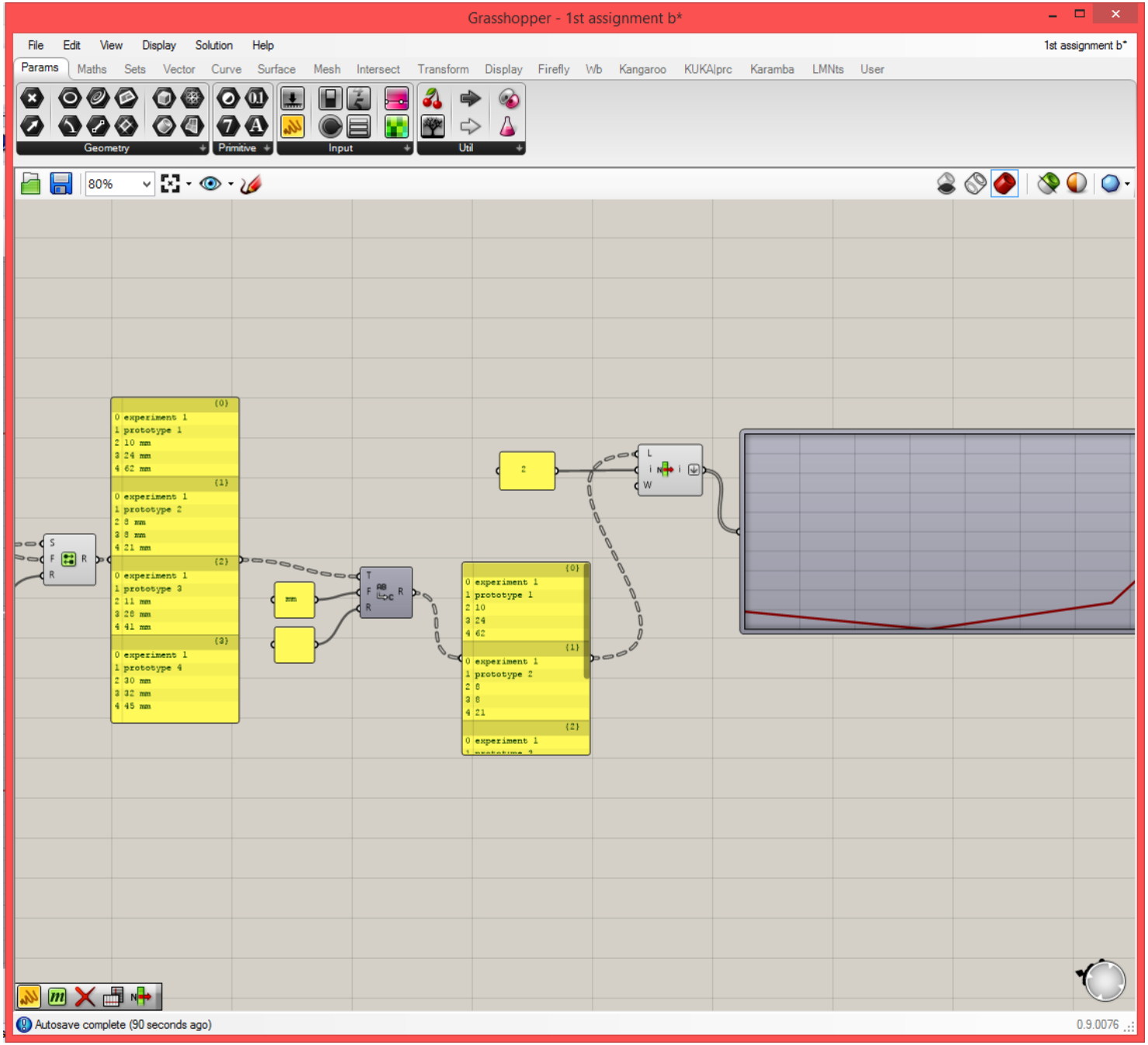


3. Data Visualization

Step 9

In order to create the graph, we need to remove all the letters that describe the units from the lists.

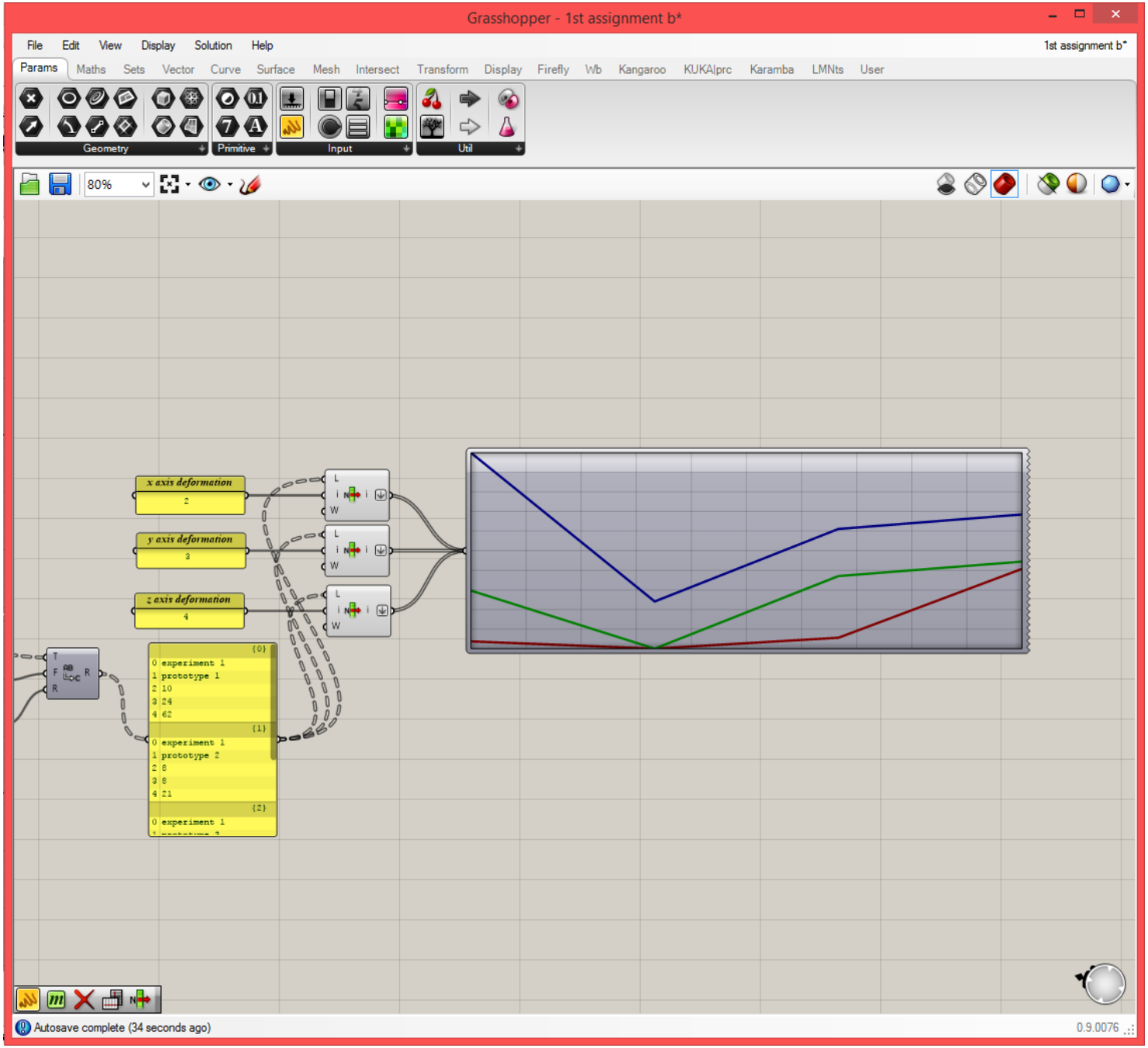
Then with the Quick Graph component we can create a graph that shows the differences between the parameter we choose.



3. Data Visualization

Step 10

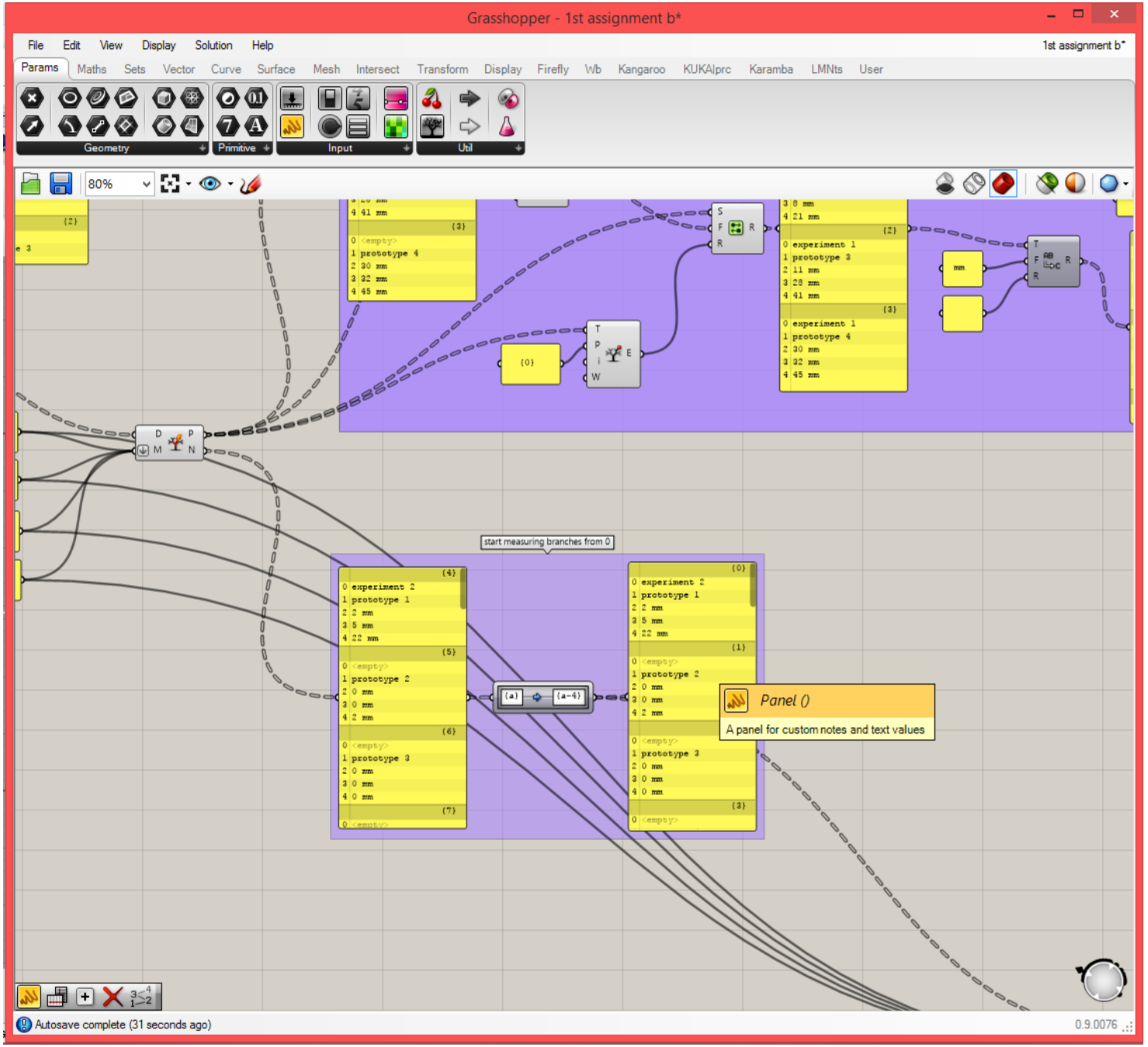
Showing all the graphs at the same time.



3. Data Visualization

Step 11

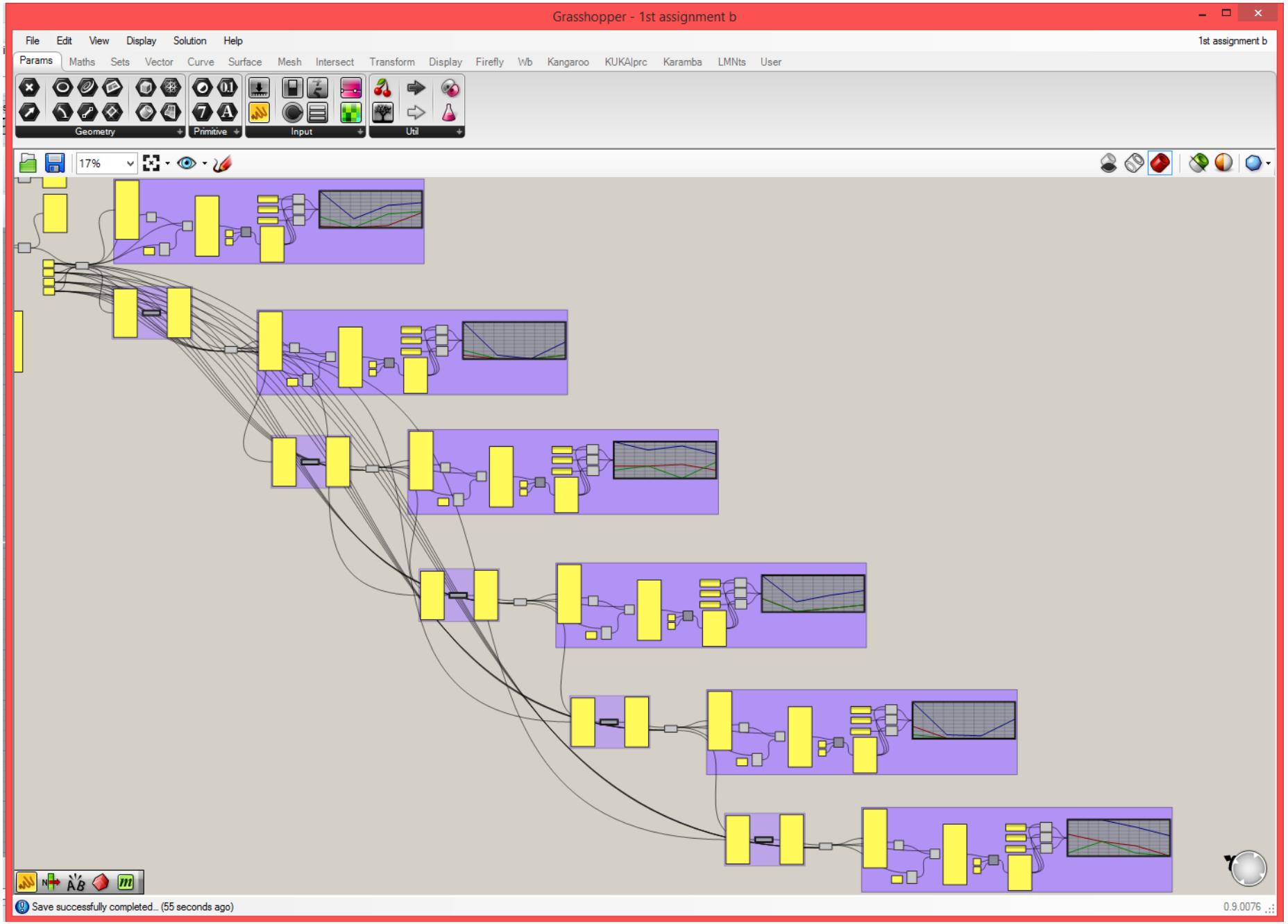
In order to create the graphs for the rest of the experiments, we need to copy and paste the whole procedure for the remaining list.
However, the split list component creates a tree with the remaining branches using their old branch names. In order to reset the branch names, we use the path mapper and offset all the names 4 numbers back.



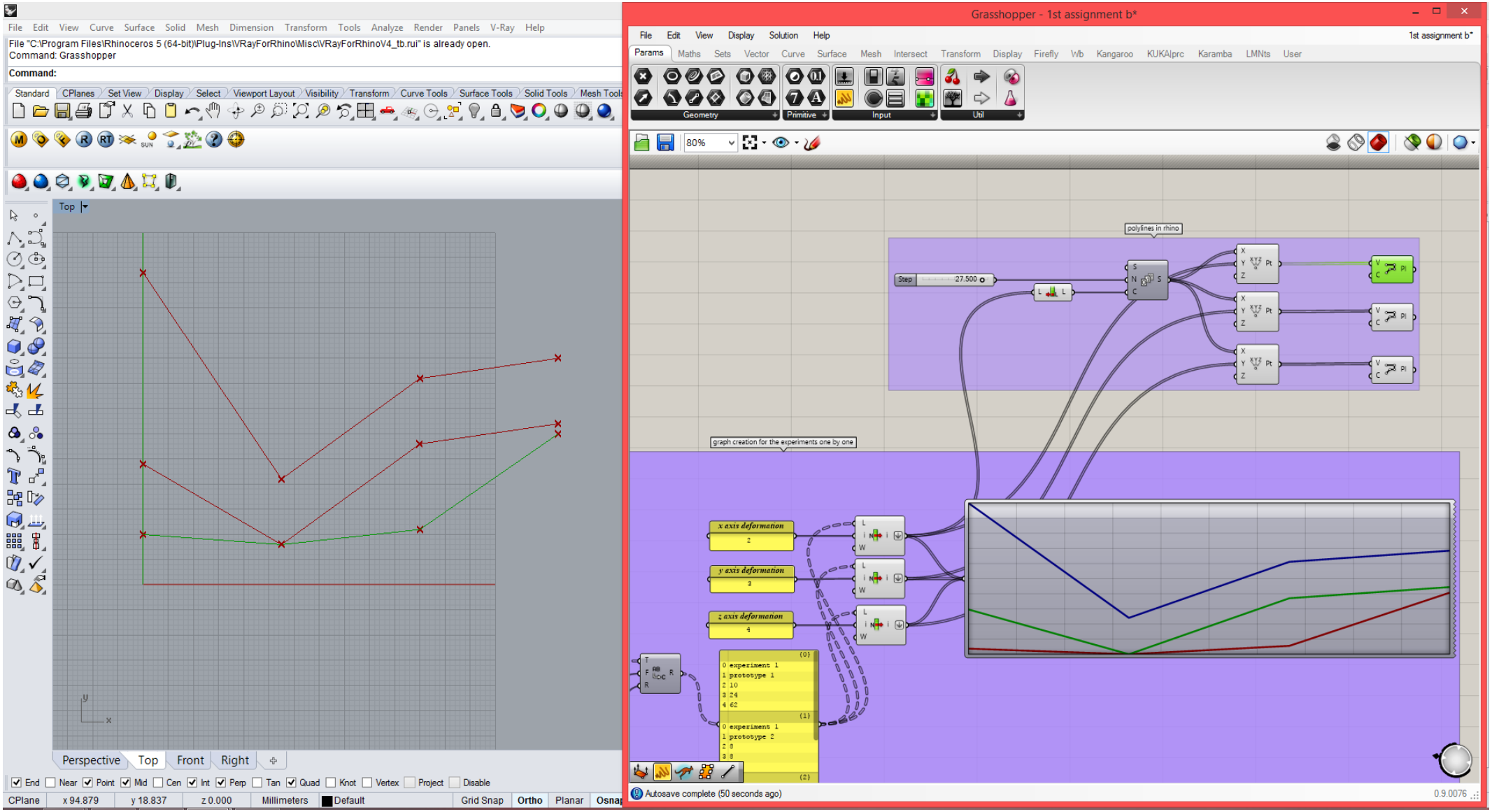
3. Data Visualization

Step 12

Get all the graphs.



3. Data Visualization

Step 13

Get the graphs as lines in Rhino.
(Rhino file: assignment 1 b)