Content

Simple Site Analysis - A simple site analysis tool for non-professionals

Simple Site Analysis intends to facilitate the selection of the best location for a certain purpose, e.g. the expansion of a branch network. It was born out of motivation to provide an initial visual overview for a decision on the basis of individually weighted location factors within a short period of time. Through easy handling and user-defined input, the algorithm can be applied to a variety of different issues and modified as needed, for example, to take more or different location factors into account, import or export other types of data, or perform other mathematical calculations relative or absolute. In the following, first the underlying mathematical principle is explained and then the actual application of the tool.

Scenario

A simple example is used to simplify the following explanations.

> *"A chain wants to open a new branch that, for marketing reasons, is aimed primarily at younger people (15-25). It therefore decides to open its snack bar as close as possible to many pupils and students. The company is considering that secondary schools (from 5th grade) and student halls of residence could be good criteria, whereby dormitories could also be an interesting target for discount campaigns."*

Open Data Bonn (https://opendata.bonn.de/) provides the locations of schools and dormitories as well as the districts of Bonn for download.

Districts: https://stadtplan.bonn.de/geojson?Thema=21247
Schools: http://stadtplan.bonn.de/geojson?Thema=18999
Homes: http://stadtplan.bonn.de/geojson?Thema=20916

The aim is now to get an idea of which district has the highest density of schools and dormitories and to consider the different relevance of the two criteria. The result should be a choropleth map, which can be used to plan the opening of a branch.

Mathematical Backgrounds

The general mathematical principle underlying the algorithm applied here is called the relative *scoring method*. The individual location factors are weighted differently, i.e. divided by the area ("target achievement points") and then cartographically represented on the basis of the final degree of target achievement. On the basis of the districts, a polygon layer in json format which forms the basis of the analysis, all points are first assigned to a district for the first point layer, the locations of the schools.

Only in the special case that all polygons have the same size, i.e. the spatial units have the same area, one of the following formulas can be used to create the choropleth map based on the degree of fulfillment E_i

$$\frac{s_i \cdot f_s + w_i \cdot f_w}{f_s \cdot max(s) + f_w \cdot max(w)} = E_i \quad \text{where} \quad s_i \cdot f_s + w_i \cdot f_w = Z_i$$

With s_i = schools in district i, w_i = dormitories in district i, f_s = weighting factor of schools, f_w = weighting factor of dormitories, E_i = degree of fulfilment for i and Z_i = target achievement value for i.

This formula weights E_i on a scale from 0 to max(Z).

Alternatively, the zero point can be shifted to min(Z), which better characterizes the ratio of the individual districts to each other (if min(Z) > 0). This results in

$$\frac{s_i \cdot f_s + w_i \cdot f_w}{f_s \cdot (max(s) - min(s)) + f_w \cdot (max(w) - min(w))} = E_i$$

On this basis, a map can be created by E_i , since always between 0 (worst expression) and 1 (best) by assigning a respective monochrome gray scale from 0 (white) to 1 (black) in both cases. The individual districts are colored in relation to the other districts, but their areas are ignored.

Normally, however, the target achievement values must be considered in relation to the area. The following formula is used to determine this for each district:

$$\frac{s_i \cdot f_s + w_i \cdot f_w}{A_i} = Z_i$$

where A_i = area of district i [m^2] and Z_i = target achievement value for district i [m^{-2}].

The absolute number of schools and dormitories weighted by the factors is divided by the area. In order to now design a choroplethic map using the Z_i values, the same procedure is used as in the case described above without the influence of the surface. In the simplest case the zero point of the scale corresponds to the value 0, then the formula for the relative achievement value is E_i:

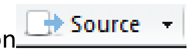
$$\frac{Z_i}{max(Z)} = E_i \quad \text{else} \quad \frac{Z_i - min(Z)}{max(Z) - min(Z)} = E_i$$

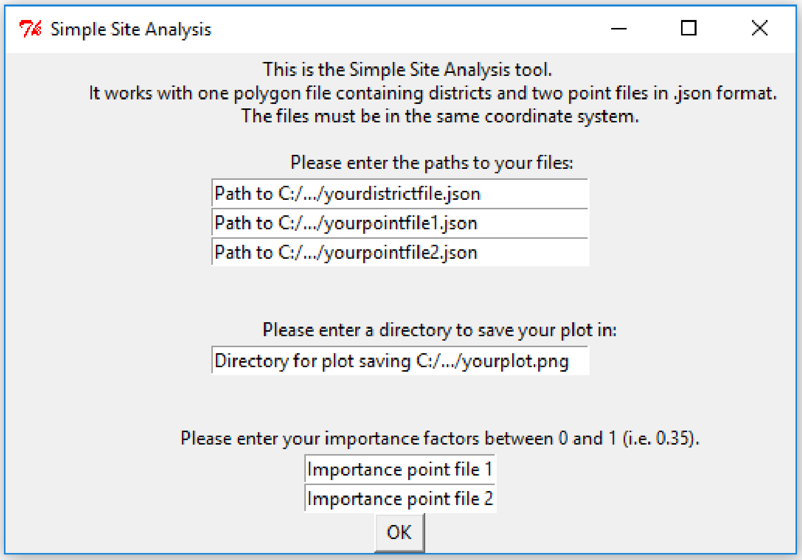
Simple Site Analysis is based on the latter formula, i.e. for the most complicated case described here, that the polygons *do not* have the same area and that the lowest value of Z *does not* correspond to 0. At this point it would also be possible to define a *userthreshold* that removes all values below (or above) a certain value from the calculation, since these are, for example, foreseeably too bad if there is only one school and one dormitory in one district. This function could easily be implemented, but is not further explained her

Execution of the tool

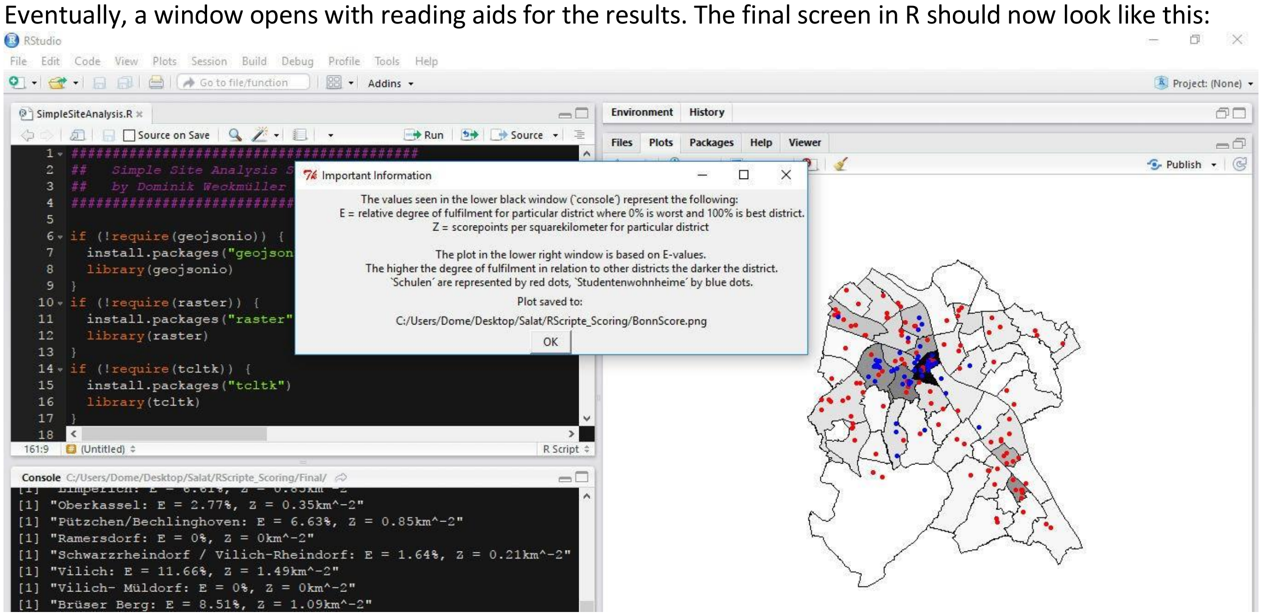
Simple Site Analysis should be a user-friendly tool and be characterized by its ease of use. To start, R-Studio must be installed, then it works as follows:

1. Double click on 

. It opens R-Studio.
2. The script is loaded and can be executed with a click on 

.
3. The menu opens 

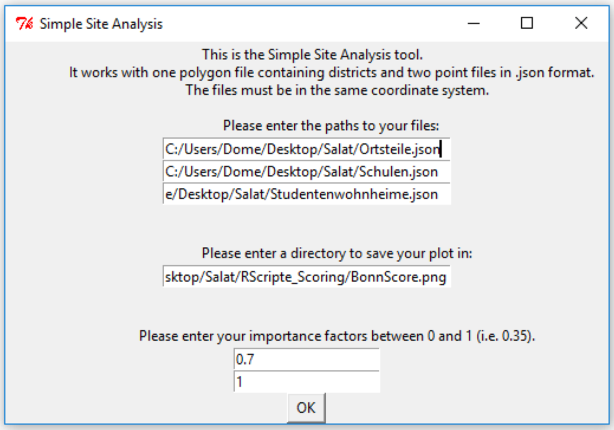
.
4. After entering the corresponding paths and factors, confirm with OK. There you go.
Eventually, a window opens with reading aids for the results. The final screen in R should now look like this:

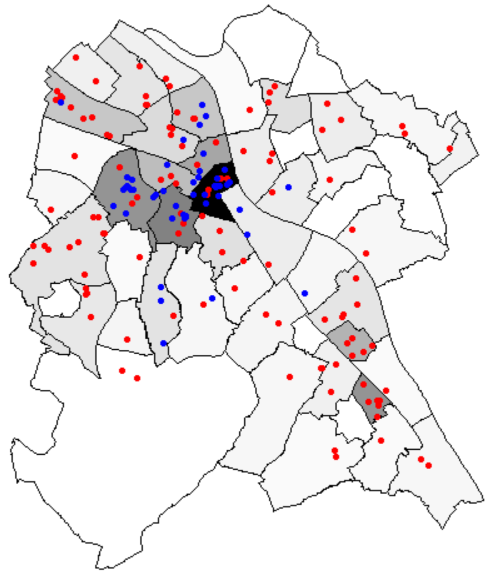


The information window explains the results table in the bottom left of the console, as well as the meaning of the colors and points in the plot window.

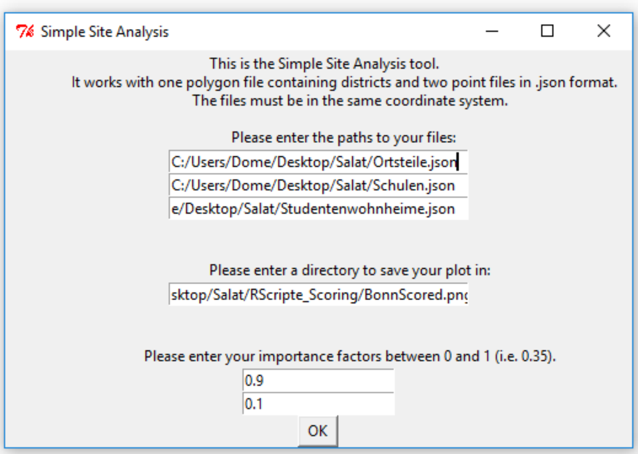
Application examples

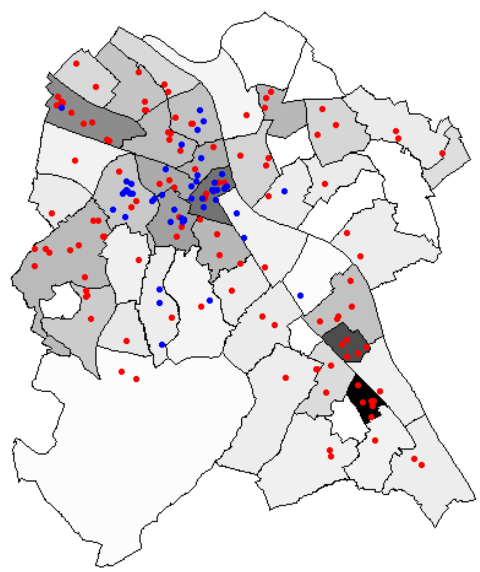
For the example given at the beginning, there are now different maps depending on the user factors. In the following two examples are explained. Since the dormitories have a slightly higher position in the example, this is taken into account when defining the factors. As can be seen in the input window, the school layer thus receives a value of 0.7 and the dormitory layer a higher value of 1, i.e. the dormitories are now weighted higher. The result is quite clear due to the black coloring. The value table in the console confirms the assumption that Südstadt has the best score: "Südstadt: E = 100%, Z = 12.78km^-2".





By way of comparison, if, on the other hand, schools are decisive and dormitories almost insignificant, the picture is different. This time another district is better, namely "Pennenfeld: E = 100%, Z = 6.94km^-2".





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