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Tutorial 4: Moving window analysis

In this tutorial, you will quantify local landscape structure gradients via a moving window analysis on a single input grid. Briefly, a moving window analysis places a window (a local kernel of user-specified shape and size) over each focal cell and computes the selected metric and returns the metric value back to the focal cell. Thus, each window around a focal cell is treated like a sub-landscape. By repeating this process for every cell, the end result is a surface in which the height of the surface at each cell is equal to the value of the metric. The surface represents a gradient in local landscape structure, and there is a separate surface for each metric selected.

Note, this tutorial assumes that you now have a basic working understanding of FRAGSTATS from completing tutorials #1 and #2 and/or reading the detailed user guidelines that comes with the FRAGSTATS software.

1. Open FRAGSTATS

First, open FRAGSTATS from the start menu or by double clicking on the FRAGSTATS icon on the desktop.

2. Create a FRAGSTATS model

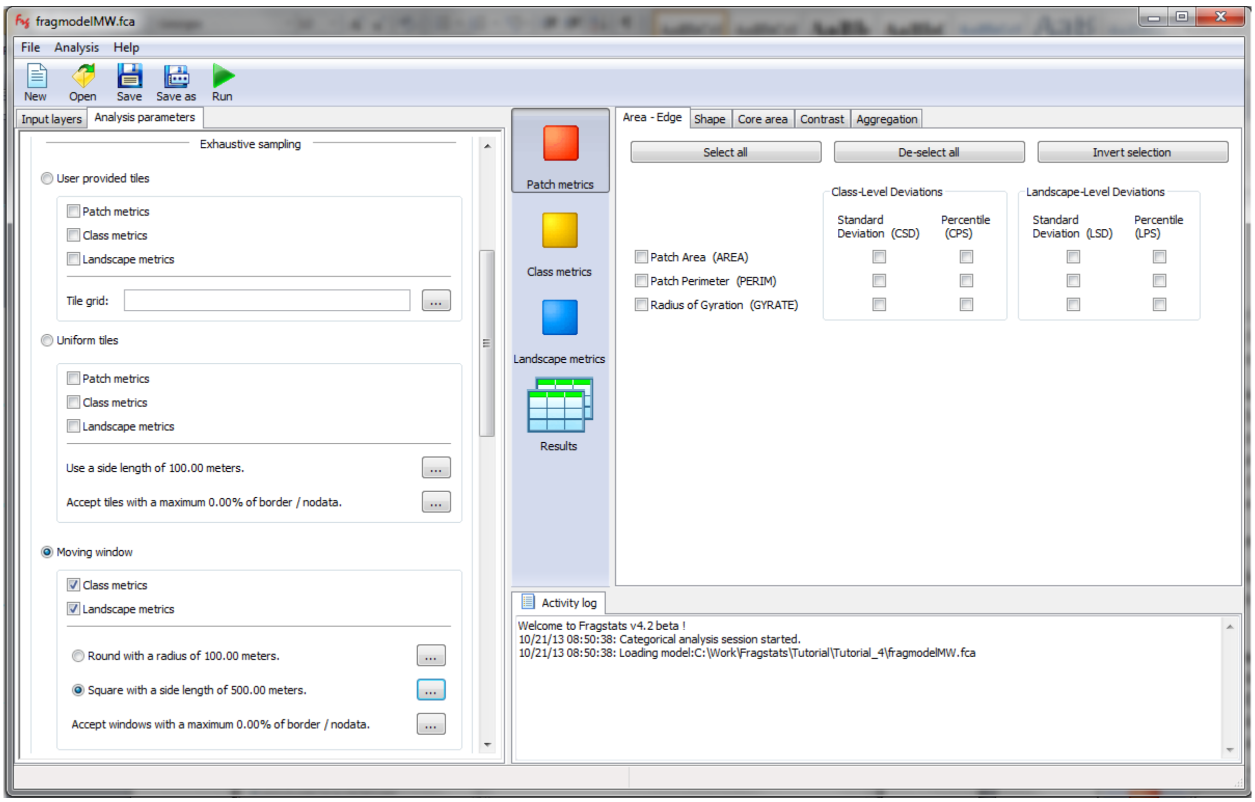
Next, create a New FRAGSTATS model, as before (see tutorial #2). Simply click on the **New** button on the tool bar or select **New** from the File drop-down menu. This creates a blank model for you to parameterize. Or, if you prefer, you can open the provided model (**fragmodelMw.fca**) -- but really you shouldn't, since this is a tutorial after all, and the best way of learning is by doing. Note, if you do open the provided model, you will likely need to modify the path to the tutorial grid and the corresponding class descriptors file (see tutorial #2 for instructions).

3. Import a grid

Next, import a grid to analyze, as before (see tutorial #2). Note, if you are using the provided model (**fragmodelMw.fca**), you will probably have to change the path to the layer already loaded, since you are likely to have a different path to the tutorial on your machine. In this case, simply click on the **Edit layer** button in the Batch management section of the user interface on the Input layers tab and navigate to the **reg78b.tif** dataset on your machine. If you are starting from scratch, click on the **Add layer** button in the Batch management section of the user interface on the Input layers tab to open the import data dialog and add the provided **reg78b.tif** grid. Note, if you are working with ascii or binary grids, import the corresponding files.

4. Specify additional parameters for the analysis

Next, you need to specify some additional parameters for the analysis. Click on the **Analysis parameters** tab on the left pane of the user interface. Here, is where you chose the neighbor rule for delineating patches (4 cell rule or 8 cell rule) and specify whether you want to sample the landscape to analyze sub-landscapes and, if so, by which method.



For this tutorial, keep the default 8 cell neighbor rule and select the Exhaustive sampling **Moving window** option. In addition, check the boxes for **class** and **landscape metrics**, and choose between the **Round** or **Square** local kernel. Next, click on the **[...]** button associated with the chosen kernel and enter **500** (in meters) as either the radius of a circular kernel or the side of a square kernel. Lastly, leave the default maximum 0% of border/nodata to accept in the window. With this option set to 0%, any window containing any border (negative cell values) or nodata will be disregarded and the focal cell value set to nodata in the output grid. Note, this prevents partial windows from being analyzed. If you want to analyze every window, regardless of the percentage comprised of border/nodata, then click on the **[...]** button and change this threshold to 100%; but be aware of the implications for the computed metrics since the total landscape area (i.e., window area) will vary among windows.

5. Modify the class descriptors table and import

Because the moving window analysis is quite computationally intensive, it can take a very long time to complete on a large landscape. In addition, because each metric selected will produce a separate grid, it is prudent to be extremely selective in the choice of metrics (see below) and carefully consider which landcover class or classes to focus on (for class level metrics). For the purpose of this tutorial, we will focus solely on the *Forest* landcover class.

To restrict the moving window analysis to the *Forest* landcover class for the class level metrics you need to modify the class descriptors table. Open up the provided **descriptors.fcd** file in a text editor and change the Enabled argument to "false" for all the classes except *Forest*, as shown here. You can save this modified file to the same file or choose a different file name. If you choose a different file name be sure to import the correct file in the next step.

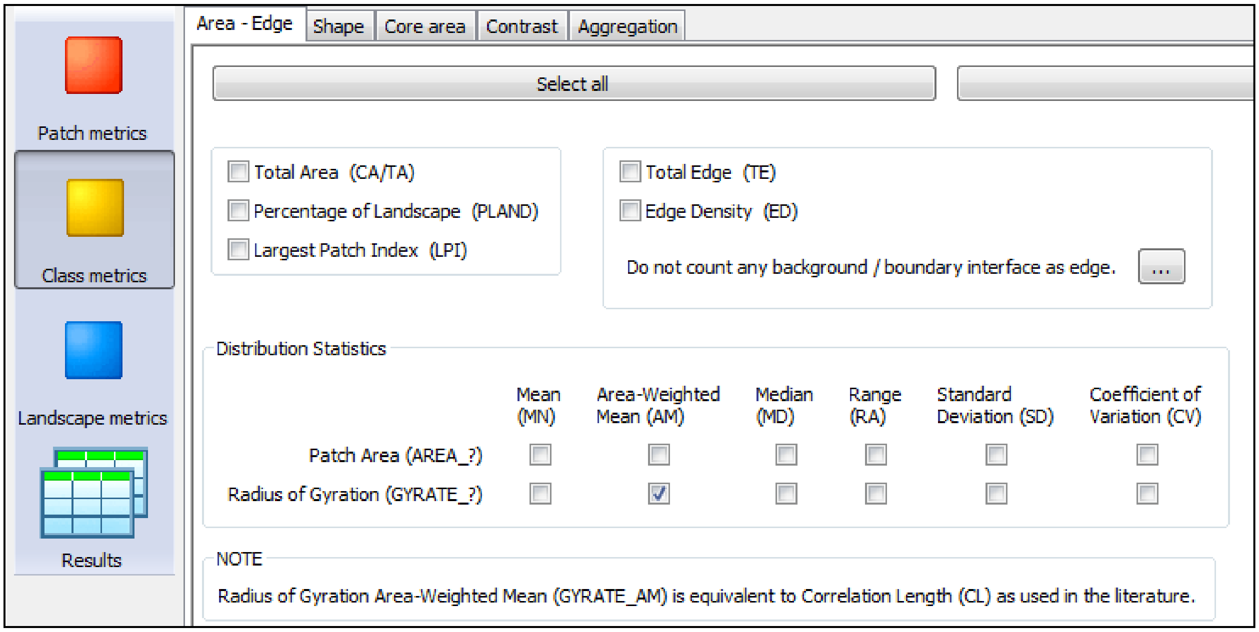
```
ID, Name, Enabled, IsBackground
100,open,false,false
300,resident,false,false
400,water,false,false
500,forest,true,false
600,wetland,false,false
700,urban,false,false
```

Next, click on the **Class descriptors Browse** button in the Common tables section of the user interface on the Input layers tab and navigate to the tutorial directory and select the modified **descriptors.fcd** file (be sure to select the modified file you saved, or use the one provided, **descriptors.modified.fcd**).

6. Select metrics

Next, you need to select some metrics to compute. Give that you selected Class and Landscape metrics in step 5, you need to select one or more metrics at each of these levels.

Click on the **Class metrics** button in the top right pane of the user interface and then on the **Area-Edge** tab (if it is not already the active tab). Check the box for the *Area-Weighted Mean (AM) Radius of Gyration* (also known as Correlation length). This is a measure of the physical continuity of the landscape and is often used in studies on habitat fragmentation.



Click on the **Landscape metrics** button in the top right pane of the user interface and then on the **Area-Edge** tab (if it is not already the active tab). Check the box for the *Area-Weighted Mean (AM) Radius of Gyration*.

Note, you have selected a single metric (Correlation length), but computed both at the class level for the *Forest* class only and at the landscape level for the entire patch mosaic. Select other metrics if you wish; each metric will produce an output grid.

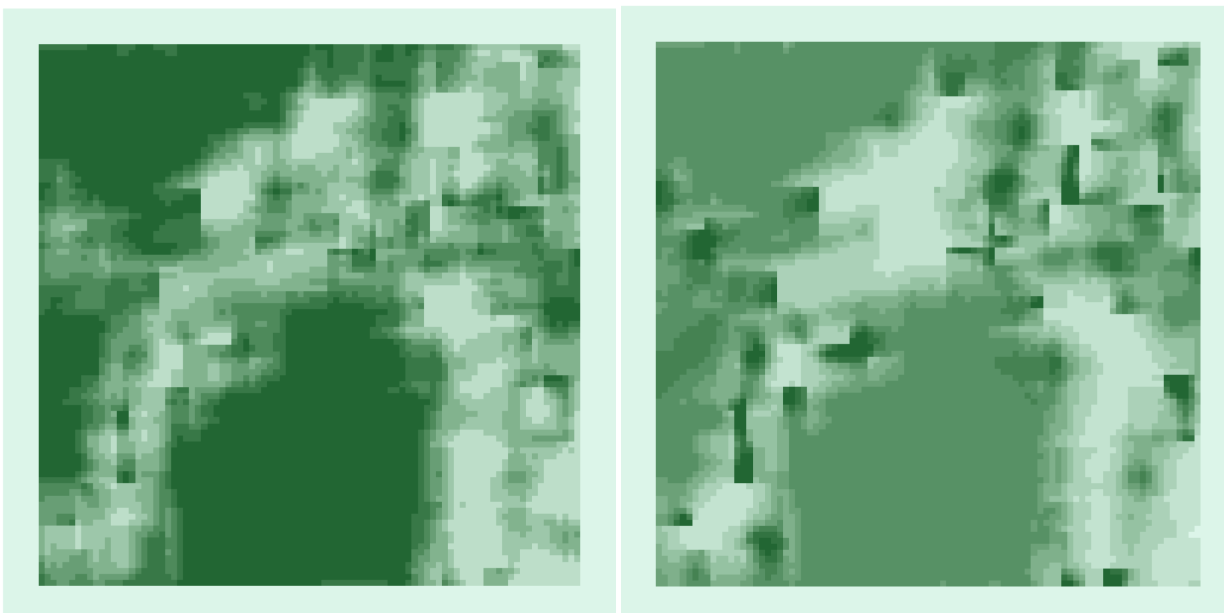
7. Run the model

Lastly, you are ready to **Run** the mode, as before (see tutorial #2). The major difference between this run and the runs from the previous tutorials is that the **Run list** in the top-right pane of the user interface is going to be empty after the run is complete because the moving window analysis produces grids as output instead of tables. The other notable difference is that the run takes much longer. Instead of computing the metrics for a single input grid, in this example, the metrics are computed for 6,561 separate windows (sub-landscapes), one for each cell in the landscape in which the specified window (500-m radius circle in this case) does not extend beyond the landscape boundary; i.e., the entire window contains positively-valued cells.

8. View the results

Lastly, once the run is complete, you can view the results. In this case, the results are grids in the same data format as the input grid.

***GeoTIFF grids*.**--If you analyzed a GeoTIFF grid, open up the provided **fragtutorial_4.mxd** project in ArcMap. The project contains the reg78b grid preloaded, as described in tutorial #1, along with the *Area-weighted mean radius of gyration* at the landscape level (**gyrate_am**) and at the class level for the forest class (**gyrate_am_500**). If you computed any other metrics, you can add them to the project now. Specifically, you should now have a folder named **reg78b_MW1** (first moving window analysis on reg78b) in the Tutorial_4 directory and inside this folder there should be grids for each of the metrics selected. Toggle the gyrate_am.tif and gyrate_am_500.tif layers on an off with the landcover grid in the background.



The first thing you should notice is that both grids contain a nodata border that is equal to the radius of the window used, which was 500 m in this case. FRAGSTATS does not compute focal cell values for cells within the specified window radius of the edge of the rectangular input grid, or within the specified window radius of the landscape boundary (i.e., border/nodata), because too many of the metrics are sensitive to landscape extent. If you want moving window results for the entire landscape, the only unbiased solution is to expand the landscape to include an appropriately sized buffer so that the end result is real values for all cells within the landscape of interest.

The second thing you should notice is that the window shape and size is evident in the results. This is not always so obvious and depends largely on the metric. In this case, the area-weighted mean radius of gyration is particularly sensitive to the exact pattern of what gets included in the window. Try running the analysis again but with a variety of other metrics to see how they vary.

The last thing you should notice is that the result differs, but only subtly, between the landscape (left figure above) and class (right figure above) grids. This is because the Forest class is dominant in this particular landscape, so the extensiveness of Forest (as measured by this metric) dominates the pattern at both the class and landscape level.

Ascii/binary grids.--If you analyzed ascii or binary grids, it is a bit more difficult to view the moving window results without importing them into your favorite GIS. However, if you are an R user, you can use the following script (or open the provided script, **tutorial_4.R**) to plot the grid in R. Note, there are several ways to plot the grids in R. Here, we will use the Raster package, which you will need to download and install if you don't already have it. Try the following script:

First, load the Raster library:

```
library(raster)
```

Next, set the working directory to wherever you have installed the tutorial; e.g.:

```
setwd('c:/work/fragstats/tutorial/tutorial_4/ reg78b.asc_mw1')
```

Next, read in the ascii grid, as a matrix, into an object (m), but also specify the negative background value (-999 by default) to treat as nodata so that the border that was created from the moving window analysis is not read in as real data:

```
m<-as.matrix(read.table('gyrate_am.asc',na.strings='-999'))
```

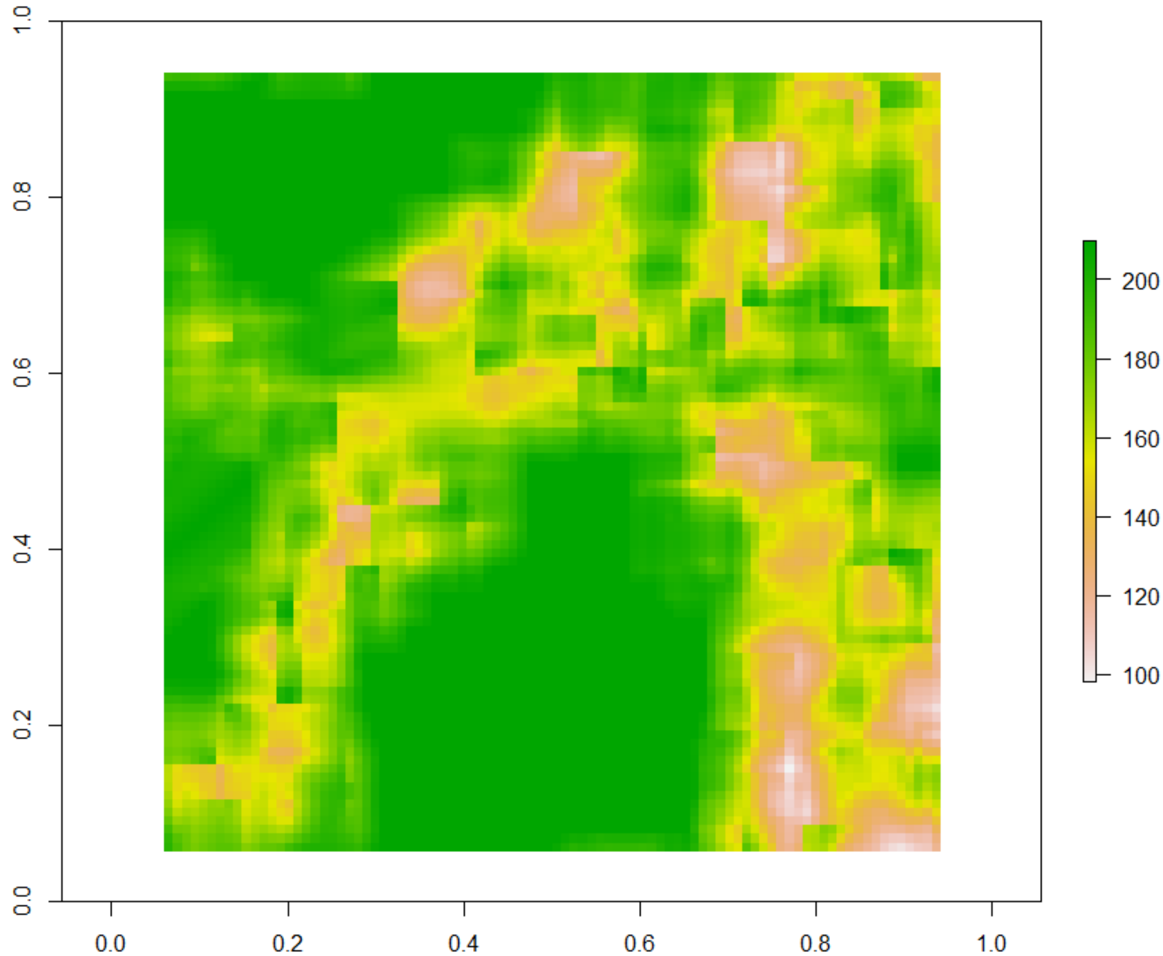
Next, convert the matrix object (m) into a Raster object (also assigned to m):

```
m<-raster(m)
```

Finally, plot the image:

```
plot(m)
```

If you want, plot the class level metric using the previous script, but substituting the grid name: gyrate_am_500.asc.


1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
200
180
160
140
120
100