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Tutorial 2. Analyzing a Single Grid

In this tutorial, you will compute a suite of structural and functional patch, class and landscape metrics for a single input grid.

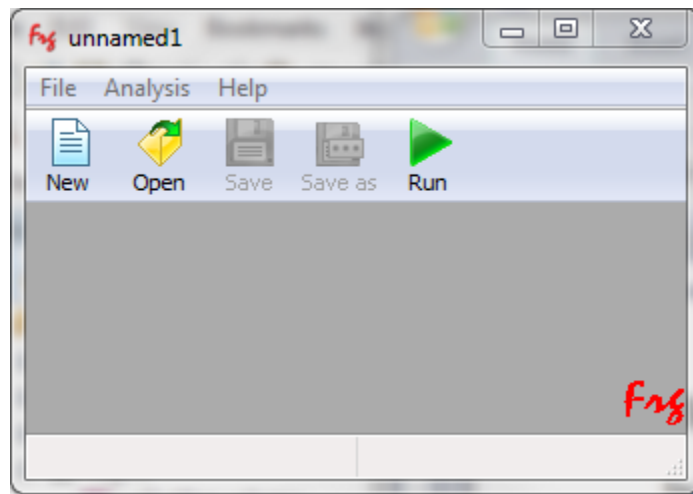
1. Open FRAGSTATS

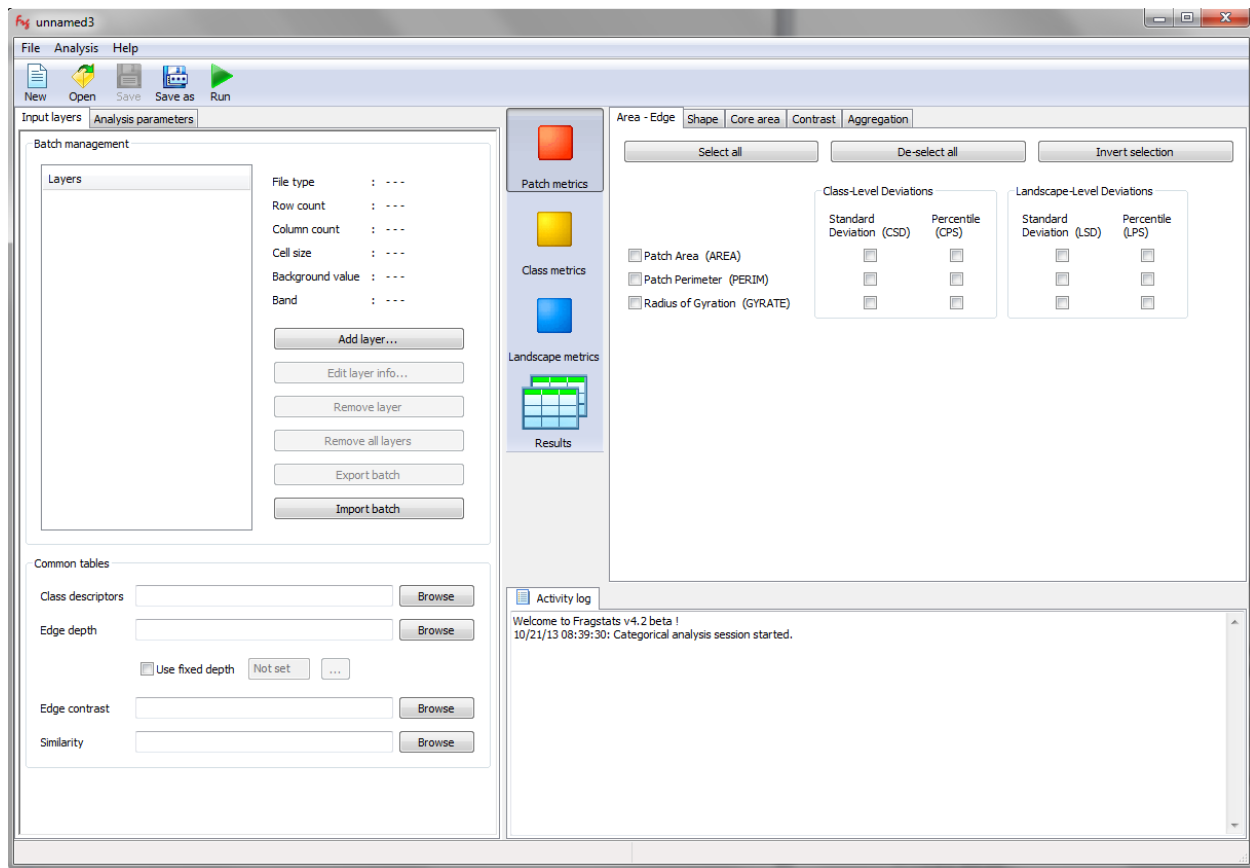
First, open FRAGSTATS from the start menu or by double clicking on the FRAGSTATS icon on the desktop.

If FRAGSTATS does not open contact the development team at www.fragstats.org along with a detailed description of your setup.

2. Create a New model

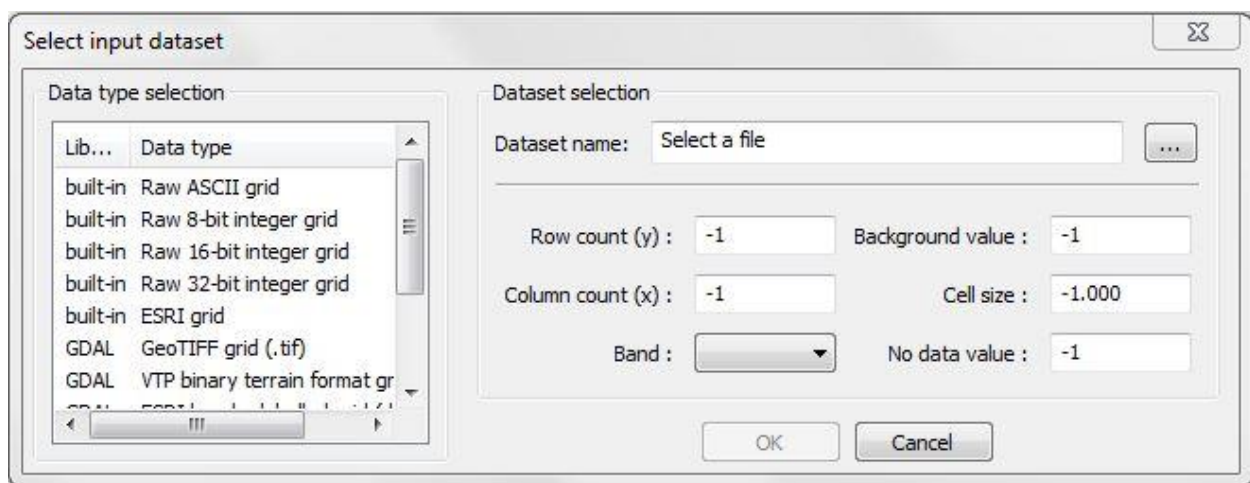
Next, you need to create a FRAGSTATS "model" for a categorical landscape representing the patch mosaic model of landscape structure. A FRAGSTATS model is simply a file containing a complete parameterization of FRAGSTATS; i.e., everything needed to conduct an analysis. Click on the **New** button on the tool bar or select **New** from the File drop-down menu. This creates a blank model for you to parameterize.





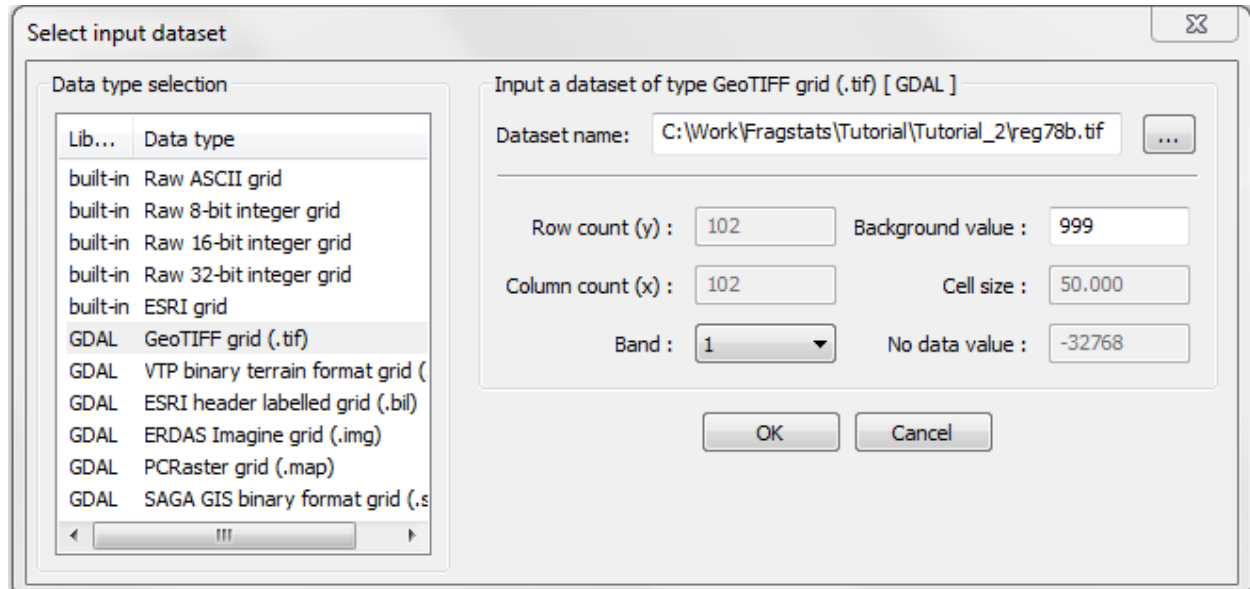
3. Import a grid

Next, import a grid to analyze. Specifically, you need to Add a layer to the batch manager on the Input layers tab. Click on the **Add layer** button to open the import data dialog.



Select **GeoTIFF** data type in the left pane and then navigate to the tutorial directory by clicking on the [...] button and selecting the **reg78b.tif** grid. Note, when you load a

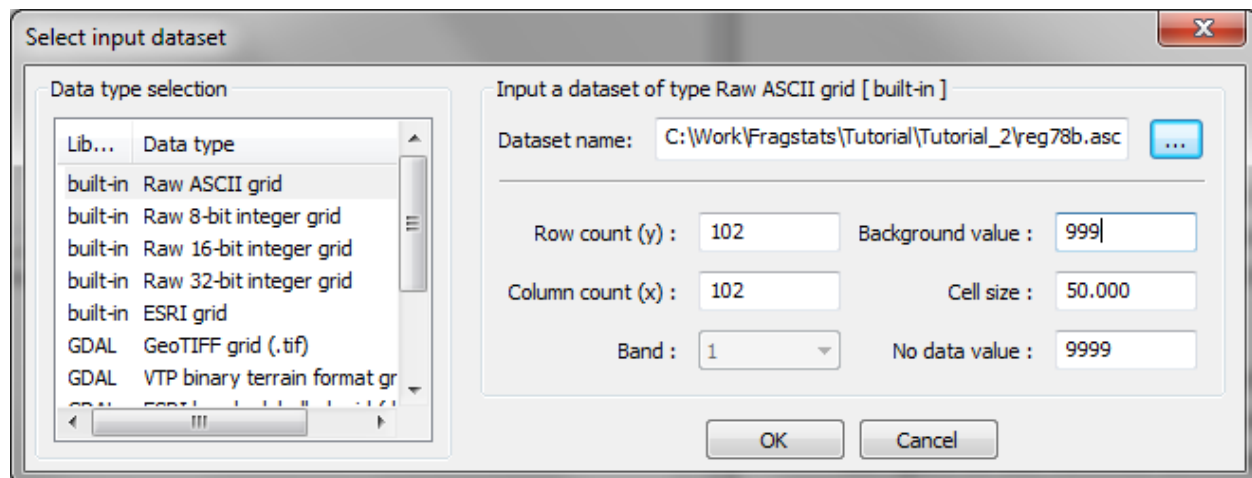
Geotiff, the grid attribute information pertaining to row count (y), column count (x), cell size, and nodata value are read from the grid header itself, and thus these fields are grayed out in the dialog. The only grid attribute item that you need worry about (and can modify) is the background value.



By default, the background class value is set to 999, but you can change it here to any class value that you want, so long as you understand the implications. Briefly, background is a class used to distinguish cells that you essentially want to ignore in the analysis; these can be cells that couldn't be classified to a real landcover class for lack of data, or cells that you simply want to treat as part of the background matrix in the landscape. Importantly, background cells can be considered 'internal' or 'inside' the landscape of interest (if assigned positive values) and/or 'external' or 'outside' the landscape of interest (if assigned negative values). Internal background is considered part of the landscape of interest and contributes to the total landscape area, and thus affects many metrics; external background is not considered to be part of the landscape of interest and only contributes to edge adjacency information for cells along the landscape boundary. To fully understand the implications of designating background, be sure to read the help files on nodata, backgrounds, borders, and boundaries in the section on User guidelines - Overview. Importantly, as a general rule, you should never set the background value equal to the nodata value. If you set the background value equal to the nodata value, and you have internal background, FRAGSTATS cannot distinguish between them and all background (internal and external) and nodata will be treated the same, as external background. For now, keep the background value set to **999**.

If you are using **ascii** or **binary** files, you can select the corresponding data type in the left pane and then navigate to the tutorial directory by clicking on the [...] button and

selecting the corresponding grid. For example, to use the provided ascii grid, select **reg78b.asc**. Note, when you try to load an ascii grid or binary grid, the grid attribute information must be entered manually. If you don't enter this information before selecting the grid, the software will complain that the layer attributes are invalid, so be sure to enter valid numbers for each of the attributes after selecting the grid. Specifically, for this grid, you need to enter row count (y) = **102**, column count (x) = **102**, cell size = **50**, and nodata value = **9999**. As before, you can also edit the background class value, but for now, keep the default value of **999**.



4. Optionally, input a class descriptors table

Next, you have the option of inputting a class descriptors table. The class descriptors table allows you to specify a character description (i.e., patch type) for each numeric class value, specify whether to compute statistics for each class, and whether to designate each class as background. The class descriptors table is optional. If you do not provide this table, then the numeric class values are used in the output, all classes are enabled and none are treated as background except any class with the assigned background value (999 in this case).

Open up the provided **descriptors.fcd** file in a text editor. Note, FRAGSTATS recognizes *.fcd as the extension for class descriptor files, but this is not a required extension. This file contains four fields. *ID* refers to the numeric class values; these are the unique cell values in the grid. These values derive from your landscape definition. *Name* is simply a description of each class and this will be output as TYPE in the FRAGSTATS output files. *Enabled* is a logical (true or false) and indicates whether to compute and output statistics for the corresponding class. Lastly, *IsBackground* is

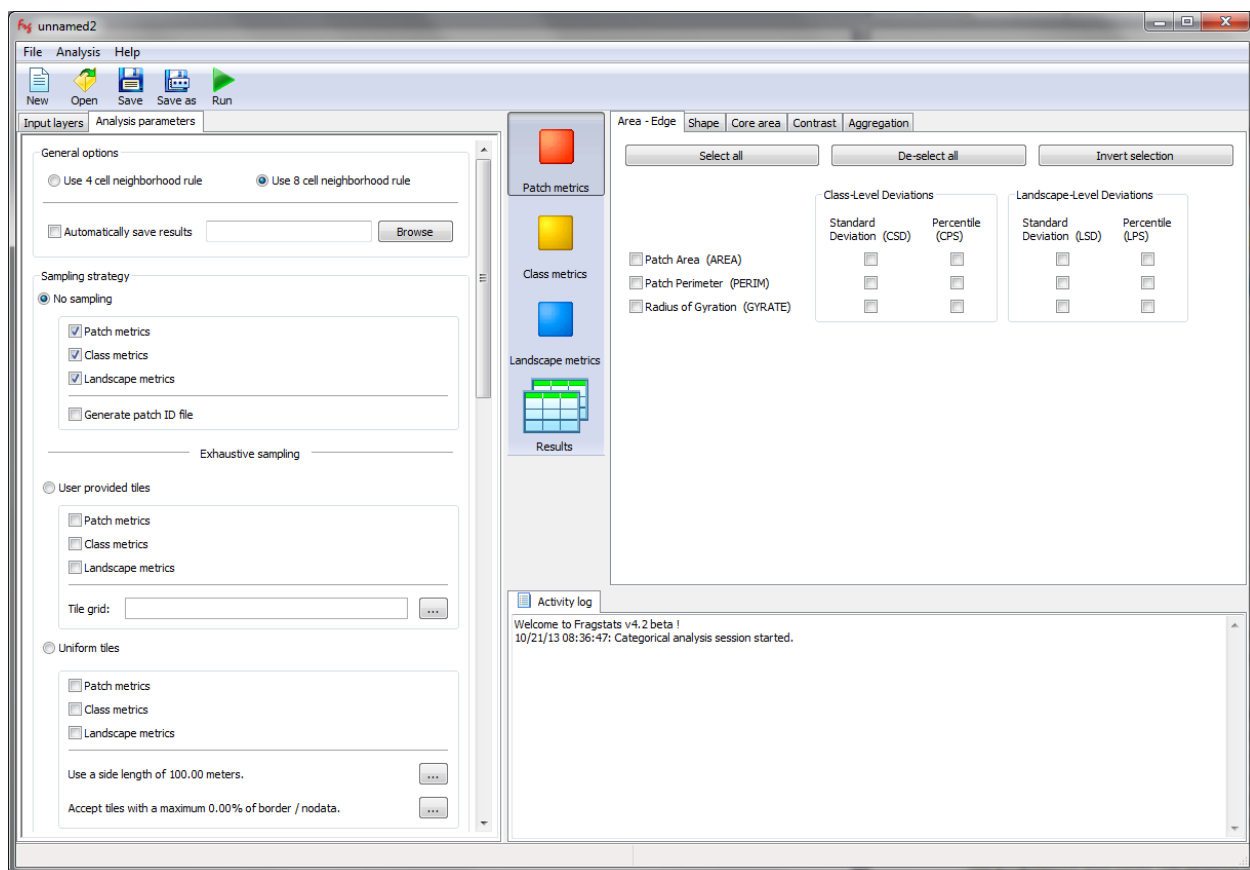
```
ID, Name, Enabled, IsBackground
100,open,true,false
300,resident,true,false
400,water,true,false
500,forest,true,false
600,wetland,true,false
700,urban,true,false
```

logical (true or false) and indicates whether to treat each class as background or not. Note, a "true" involves reclassifying the corresponding class to the background value specified earlier (999 in this case). If we had specified say, 400, as the background value earlier, then *Water* would be treated as background regardless of what is designated in this table.

To use the provided class descriptors file, 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 **descriptors.fcd** file.

5. 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 using one of the alternative sampling schemes (see tutorial #6).



For this tutorial, keep the default 8 cell neighbor rule and the **No sampling** strategy; the exhaustive moving window sampling strategy is covered in tutorial #4 and the rest of the sampling strategies in tutorial #6. In addition, check the boxes for **Patch**, **Class**

and **Landscape** metrics under the No sampling option. Note, you must have at least one of these boxes checked or you will get an error message later when trying to run the model. However, only check the level corresponding to the metrics you want to compute. Some applications will involve patch level metrics, for example when evaluating the spatial character and context of each habitat patch in a metapopulation context. Other applications will involve only the class level metrics, for example when evaluating the fragmentation of a focal class. And still other applications will involve only the landscape level metrics, for example when evaluating overall landscape heterogeneity. Of course, some applications will involve more than one level of metric.

There is an optional check box for generating a patch ID file. If checked, FRAGSTATS will generate a patch ID grid in the same format as the input layer, and each cell will be assigned a unique patch ID value. Thus, all the cells belonging to patch #1 will be assigned the value 1, all cells in patch #2 will be assigned the value 2, and so on. The unique patch ID values will correspond to the unique patch ID values in the PID field of the `basename.patch` output file. In this manner, the patch ID file can be used to connect the patch metric results to the corresponding patch in the landscape. In fact, the `basename.patch` outfile can be joined to the patch ID grid in the GIS if so desired, but we will not illustrate this here.

6. Select metrics

Next, you need to select some metrics to compute. Give that you selected patch, class and landscape metrics in step 5, you need to select individual metrics at each of these levels.

To begin, select Patch metrics in the top right pane of the user interface. Click on the **Patch metrics** button and then on each tabbed set of metrics. You can choose a subset of metrics or simply "Select all" -- your choice. Note, on the **Aggregation** tab, if you select either the *Proximity index* or the *Similarity index*, then you also need to specify a Search radius. These metrics are "functional" metrics and thus require additional parameterization. Both of these metrics require a search radius; the *Similarity index* also requires a similarity weights table (see below). To specify a search radius, click on the [...] button and enter the desired search radius in meters; e.g., 500.

Next, click on the **Class metrics** button and then on each tabbed set of metrics. Again, you can choose a subset of metrics or simply "Select all" -- your choice. Note, on the **Area-Edge** tab, if you select *Total Edge* or *Edge Density*, then you need to consider how you want to treat any background or boundary edge in the edge calculations. The default is to not consider any of it as true edge. However, you can choose to treat all of it as edge or any specified proportion as edge. To change the default, click on the [...] button and enter your choice. Note, since the input landscape contains a border and does not contain any designated background, the issue is mute since we know the true

status of every edge segment along the landscape boundary and there are no background edges to worry about. Similarly, on the **Aggregation** tab, if you select the *Connectance index*, then you also need to specify a threshold distance within which patches are deemed "connected". Simply click on the [...] button and enter the desired threshold distance in meters; e.g., 500.

Lastly, click on the **Landscape metrics** button and then on each tabbed set of metrics. Again, you can choose a subset of metrics or simply "Select all" -- your choice. Note, on the **Diversity** tab, if you select *Relative Patch Richness*, then you also need to specify the maximum number of classes (or patch types). Simply click on the [...] button and enter the value; 6 in this case.

7. Conditionally, input additional common tables

Next, if you selected any of the Core area metrics, Contrast metrics or Similarity index (on the Aggregation tab) at any level (patch, class or landscape), then you also need to create and input additional ancillary tables in order to parameterize these metrics. If you fail to input these tables or try to input improperly formatted tables, you will get an error message and the analysis will fail. Importantly, it is up to you to create these ancillary files to ensure that they are meaningful to your application. There are no meaningful default values for these tables; creating these tables is how you functionalize the corresponding metrics for your particular application.

Open up the provided **edgedepth.fsq** file in a text editor. Note, FRAGSTATS recognizes *.fsq as the extension for these common ancillary tables, but this is not a required extension. This comma-delimited ascii file contains the *depth-of-edge effect* distances (in meters) for each pairwise combination of classes (or patch types). The file must begin with the line: FSQ_TABLE. It can contain any number of comment lines beginning with the character symbol #. It must contain a class list of literal names (i.e., class descriptors) or numeric class values corresponding exactly to those in the class descriptors file. Note, only one of these lists is required and if both are provided, as in the example below, only the first one encountered is used. Note, the list should include a item for every class in the input grid. If the list contains additional classes not found in the input grid, they are simply ignored. Similarly, if the list omits a class found in the input grid, the edge depths are assumed to be zero by default.

The class list is followed by the edge depths for each pairwise combination of classes, given in the order they are provided in the list, and is read as follows. The row indicates the focal class and the column indicates the adjacent class. Thus, the fourth row is for *Forest* (fourth in the list) as the focal class, and each of the entries represents the depth-of-edge effect distance penetrating into *Forest* from an adjacent class. For example, in the table below, *Open* has an edge effect that penetrates 100 m into *Forest*, *Resident*

penetrates 50 m into *Forest*, and so on. Note, in this example, edge effects are specified only for the *Forest* class.

```
FSQ_TABLE
# comment lines start with # and are allowed anywhere in the table
# literal class names cannot contain spaces
# the order of rows and column is the one specified in the CLASS_LIST_???????
# two types of class lists are allowed CLASS_LIST_LITERAL() and CLASS_LIST_NUMERIC(),
# but only the first one encountered is considered
# class names or ids will be compared with the class descriptors in the model
# and only the matches will be imported
CLASS_LIST_LITERAL(open, resident, water, forest, wetland, urban)
CLASS_LIST_NUMERIC(100, 300, 400, 500, 600, 700)
0,0,0,0,0,0
0,0,0,0,0,0
0,0,0,0,0,0
0,0,0,0,0,0
100,50,50,0,50,200
0,0,0,0,0,0
0,0,0,0,0,0
```

To use the provided edgedepth file, click on the **Edge depth 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 **edgedepth.fsq** file.

Repeat the process above for the provided **contrast.fsq** and **similarity.fsq** tables; these tables provide the edge contrast weights and similarity coefficients for each pairwise combination of classes (patch types), respectively.

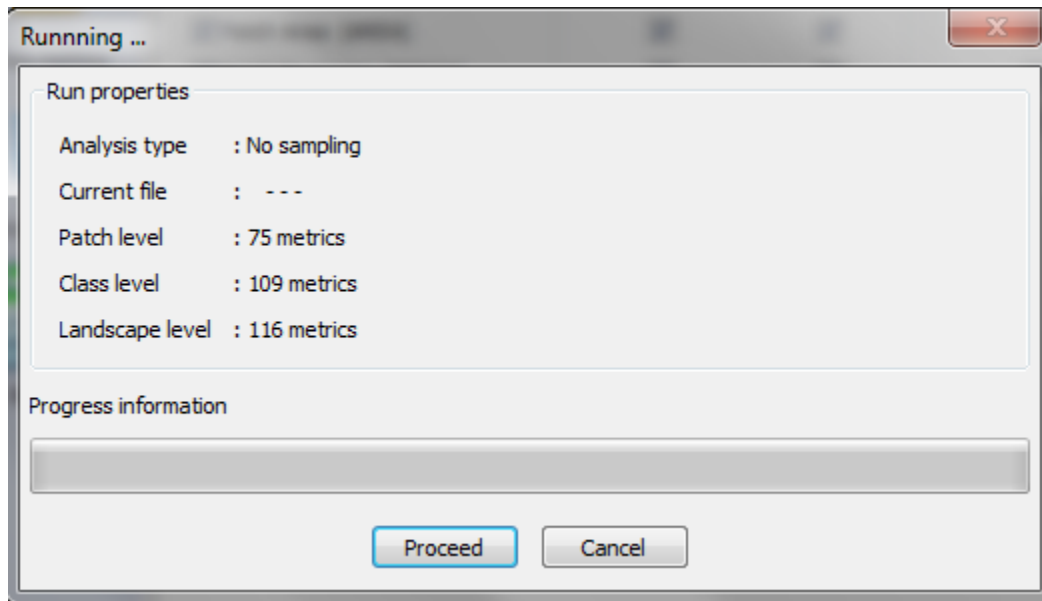
8. Optionally, save the model

Next, you might want to save the model for future use. Often times it is easier to open a saved model and modify it than to create a new model from scratch. At any point in the process of parameterizing the model, simply click on the **Save** or **Save as** buttons on the toolbar or select these options from the File drop-down menu to save the model. Simply navigate to the desired directory and enter a file name for the model. Note, FRAGSTATS will automatically assign the extension *.fca to the file, which identifies the file as a model for a categorical landscape.

9. Run the model

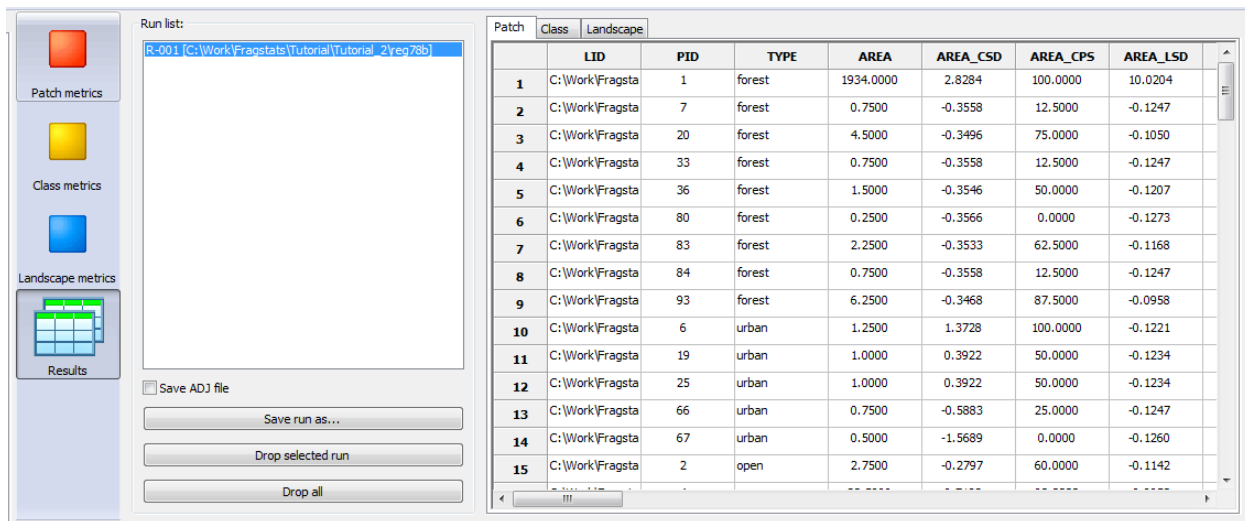
Next, you are ready to run the model. Simply click on the **Run** button on the toolbar or select this option from the Analysis drop-down menu. This will open the Run dialog that lists the analysis type (no sampling in this case), the current file (which gets listed after clicking on the Proceed button, below), and the number of metrics selected at each level (patch, class and landscape). If you like what you see, click on the **Proceed** button, otherwise click on **Cancel** and make the needed modifications to the model. In the

example shown here, the run includes 75 patch metrics, 109 class metrics and 116 landscape metrics because I selected All the available metrics at each level.



10. Browse the results

Pay attention to the Activity log in the bottom right pane of the user interface. If all went well, you will learn that the run ended and how long it took. Assuming that the run was successful, you are now ready to browse the results. Click on the **Results** button in the top-right pane of the user interface and then on each tabbed set of results. The results are displayed in a table for each level of metrics selected. So, if you computed patch, class and landscape metrics, as was done here, there will be results in each of the corresponding tabs. Otherwise, only the tab corresponding to the level of metrics computed will contain data; the others will be empty. The **Patch** tab will contain a row for each patch in the input landscape and a column for each patch metric selected. The **Class** tab will contain a row for each (non-background) class in the input landscape and a column for each class metric selected. The **Landscape** tab will contain a single row for the entire input landscape mosaic and a column for each landscape metric selected.



The screenshot shows the Fragstats software interface. On the left is a vertical toolbar with icons for Patch metrics (red square), Class metrics (yellow square), Landscape metrics (blue square), and Results (green grid icon). The 'Run list' pane shows a single run: 'R-001 [C:\Work\Fragstats\Tutorial\Tutorial_2\eq78b]'. Below this are buttons for 'Save ADJ file' (checked), 'Save run as...', 'Drop selected run', and 'Drop all'. The main 'Results' table has tabs for 'Patch', 'Class', and 'Landscape'. The 'Landscape' tab is active, displaying a table with 8 columns: LID, PID, TYPE, AREA, AREA_CSD, AREA_CPS, and AREA_LSD. The table contains 15 rows of data for various land use types including forest, urban, and open.

	LID	PID	TYPE	AREA	AREA_CSD	AREA_CPS	AREA_LSD
1	C:\Work\Fragsta	1	forest	1934.0000	2.8284	100.0000	10.0204
2	C:\Work\Fragsta	7	forest	0.7500	-0.3558	12.5000	-0.1247
3	C:\Work\Fragsta	20	forest	4.5000	-0.3496	75.0000	-0.1050
4	C:\Work\Fragsta	33	forest	0.7500	-0.3558	12.5000	-0.1247
5	C:\Work\Fragsta	36	forest	1.5000	-0.3546	50.0000	-0.1207
6	C:\Work\Fragsta	80	forest	0.2500	-0.3566	0.0000	-0.1273
7	C:\Work\Fragsta	83	forest	2.2500	-0.3533	62.5000	-0.1168
8	C:\Work\Fragsta	84	forest	0.7500	-0.3558	12.5000	-0.1247
9	C:\Work\Fragsta	93	forest	6.2500	-0.3468	87.5000	-0.0958
10	C:\Work\Fragsta	6	urban	1.2500	1.3728	100.0000	-0.1221
11	C:\Work\Fragsta	19	urban	1.0000	0.3922	50.0000	-0.1234
12	C:\Work\Fragsta	25	urban	1.0000	0.3922	50.0000	-0.1234
13	C:\Work\Fragsta	66	urban	0.7500	-0.5883	25.0000	-0.1247
14	C:\Work\Fragsta	67	urban	0.5000	-1.5689	0.0000	-0.1260
15	C:\Work\Fragsta	2	open	2.7500	-0.2797	60.0000	-0.1142

Once you have verified that the tables contain results, the next step is probably to export the tables so that you can use them in subsequent analyses. To export the results, simply click on the desired run in the Run list (note, at this point you should have only one run listed), and then click on **Save run as...** and navigate to the desired folder and enter a **basename** for the output files. The basename will be given an extension corresponding to each level of metrics computed (basename.patch, basename.class, and basename.land). Thus, in this example, three files will be created corresponding to the three levels of metrics computed. Note, a fourth output file containing the cell adjacency information can be created by checking the **Save ADJ file** check box (basename.adj). Each of these output files is a comma-delimited ascii file and can easily imported into other software such as R and Excel for further analysis and summary.

Note that is also possible to automatically save the results with the execution by checking the **Automatically save results** option on the Analysis parameters tab in the left pane of the user interface. Simply check this box and then click on the **Browse** button to navigate to a desired output directory and enter a basename for the output file(s).