



EXERCISE 3

Smooth and Eliminate Segments

Introduction

The goal of this exercise is to provide you with an understanding of how to open previously created rule sets and changing parameters to run on your segmentation output.

Objectives

- Learn how to use a more complex rule set and ArcGIS to generate smoothed stand-level segments.

Required Data

- Developer project file: **mttaylor_stand_delin.dpr** (created in Exercise 1, built upon in Exercise 2 and should reference all of the data layers below)
- NAIP image file: **mttaylor_naip_10m.img** (3 bands, NIR, R, G, 10 m resolution)
- Derived vegetation index file: **mttaylor_ndvi_10m.img** (Normalized Difference Vegetation Index)
- Tri-shade image file: **mttaylor_trishade_10m.img** (fully-illuminated hillshade)

Prerequisites

- You have eCognition installed and licensed
- You have ArcGIS installed and licensed
- You have completed Exercises 1 and 2
- eCognition is open and the **mttaylor_stand_delin.dpr** project file is loaded

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Part 1: Load the Smooth Segments Rule Set

With your saved eCognition project from Exercise 1 & 2 open, you will load a rule set into the Process tree which when run will smooth the segments.

A. Open eCognition & Project

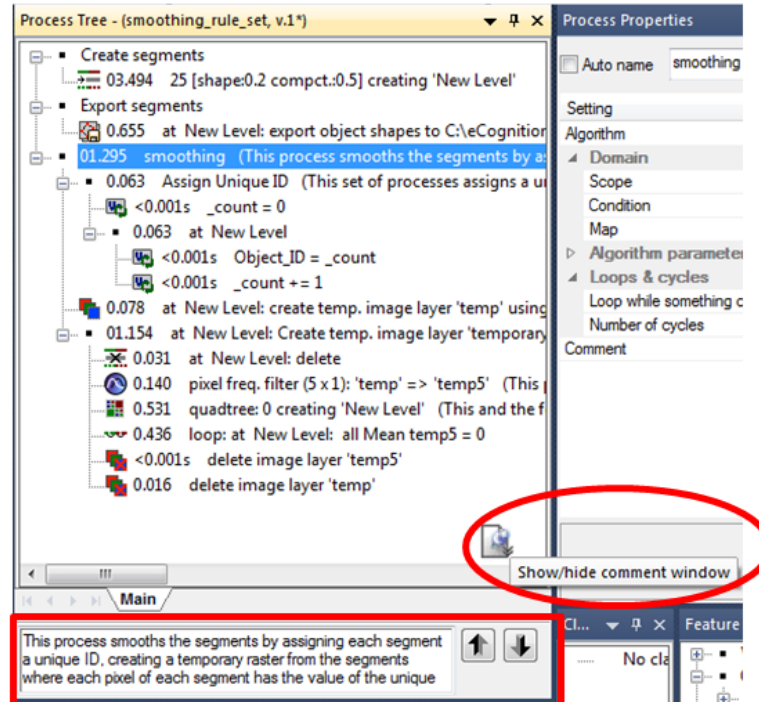
1. If necessary, **launch eCognition** and **Open** the project that you created in Exercise 1 and added to in Exercise 2—**mttaylor_stand_delin.dpr**
2. If you want, double check the Project information—the No Data values, the Subset and the Alias names. Make sure the No Data Values have been set to 0 (zero) for the NIR, Red and Green layers; the Subset area is correct; and that the Alias names have been set to “NIR”, “Red”, “Green”, “NDVI”, etc.

B. Add Smooth Segments Rule Set

1. To begin, **right click** inside the **Process Tree** window and select **Load Rule Set...** to load a saved rule set.
2. In the **Load Process** dialog that appears, navigate to your course data and in the **Rulesets** folder select the **smoothing_rule_set.dcp** file and click **OK**.
 - i. You may get an error mentioning that the ruleset uses legacy information, click **OK** and proceed.

Note: In eCognition, users can create and reuse rule sets. The **smoothing_rule_set** was created previously and is used to smooth the boundaries of the segments so they have more of a hand-drawn appearance. Although the smoothing process makes the segments more desirable in appearance, the process can compromise the spectral integrity of the segments and can sometimes reduce the accuracy of subsequent image classification. However, if classes are distinct, smoothing should have little impact.

3. A new set of processes will appear in the process tree below the last process that you had created, **Export segments** (see following figure).

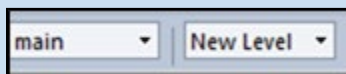


4. The order of parent processes in the example above is not ideal. It makes more sense to export segments after they have been smoothed. To move the processes around simply click and drag them to where you would like them to align in the Process Tree. Place the **Export segments** hierarchy title on top of the **smoothing** rule hierarchy title to move it below the rule set.

Note on Rule Set Organization: You can easily move processes around by clicking, dragging, and dropping. You might want to experiment and move some processes around to understand what happens. Left-clicking and dragging puts the process you drag at the same level as the process you drop it on. Right-clicking and dragging converts the process you drag to a child of the process you drop it on.

5. Below the Process Tree, you will see the **Comment Window** (see red box on the preceding figure). The comment window allows you to add descriptive comments about the various processes in a rule set. For the smoothing rule set, the comments were added previously.
 - i. If the Comment Window is not visible, hover your mouse near the lower-right corner of the Process Tree and the **Show/hide comment window** icon will appear (see red circle in preceding figure). Click the icon to show the comment window.
 - ii. If desired, highlight (click on) the various processes and read the comments to understand what they do.
6. **Right click** the **smoothing** process and select **Execute** to run the entire process. Watch the segments to see how they change when the process finishes.
7. **Pan** and **zoom** to examine the segments.
8. **Save** your project, but keep it open for the next part of this exercise.

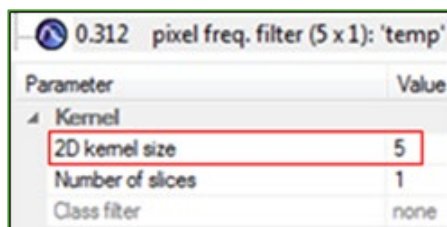
Important: The smoothing rule set assumes that the segments are named “New Level.” This is the default. You can find the name of the segments in the Navigation toolbar (see following graphic). If the segments are not named “New Level,” then open the Edit Process dialog for the multiresolution segmentation process that you created, change the **Level Name** to **New Level**, and execute the process to recreate the segments.



C. Optional, Adjust Kernel Size

The smoothing ruleset converts the segments to a temporary raster and then passes a focal majority filter over it. The software then segments the smoothed temporary raster to create the smoothed segments. You can increase or decrease the amount of smoothing by changing the size of the filter (known as a kernel or window) used to perform the smoothing. The steps are below.

1. Find the **pixel freq. filter** process in the Process Tree and **double click** to open the **Edit Process** dialog.
2. **Locate** the **2D kernel size** field. The value is currently set to 5 (see following graphic). In other words, the kernel is 5x5 pixels in size. You can adjust this number to 3 to reduce the amount of smoothing or increase it to a larger odd number to increase the amount of smoothing. Keep in mind, the larger the kernel, the greater the impact to the spectral integrity of the segments.



3. After you have made a change, click **OK** to close the dialog.
4. **Recreate** the **segments** (HINT: rerun the multiresolution segmentation process), then **rerun** the **smoothing** ruleset.

Part 2: Load the Eliminate Rule Set

In Part 1, you loaded and ran the smoothing rule set. In this part of the exercise you will again load a rule set and run it. The objective of the rule set you are about to load is to remove small segments (donuts) created from the smoothing process.

A. Load and Explore the Eliminate Rule Set

1. Collapse the **smoothing** rule set by clicking on the box with a minus sign to the left of the parent process titled **smoothing**.
2. In the **Process Tree**, **right-click** and select **Load Rule Set...** to load a saved rule set.

- i. You may get an error mentioning that the ruleset uses legacy information, click **OK** and proceed.
3. In the **Load Process** dialog that appears, navigate to the **Rule_sets** directory and select the **eliminate_rule_set.dcp** file (see following graphic) and click **OK**. A new set of processes will appear in the process tree below the smoothing process.



Important: It is particularly important to read the comments associated with:

1. The first parent process of the **eliminate rule set** (named **eliminate**),
2. The parent process named **set variables**, and
3. The multiresolution segmentation region grow process, named **with Area <= MinSize at level...**

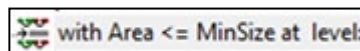
These comments provide instructions on how to set the parameters to ensure that this rule set works properly whenever you use it. For a detailed explanation please refer to Appendix 1 at the end of this Exercise.

B. Change Eliminate Parameters and Run

1. **Double-click** on the **min_scale** process to open the **Edit process dialog**. Find the **Value** field under **Algorithm** parameters. In the future, if you need to change the starting value for the scale parameter, just enter a new value here.
2. **Change** the value to **70**. Click **OK** to exit the dialog.

Note: None of the other variables need to be changed, but for future reference, they are changed in the same way. If you wish to increase the size of the segments to be eliminated (currently set at 2 hectares), make the change by changing the value for the **MinSize** variable.

3. **Double-click** the **multiresolution segmentation region merge** process (see following graphic) to open the **Edit process dialog**.



4. **Click** the arrow next to **Image Layer weights** to display the individual weights. **Enter the same weights** that you used to create the segments (see following graphic).

Algorithm parameters	
Parameter	Value
Image Layer weights	0, 1, 0, 2, 1, 1, 0, 0
blue	0
Green	1
green	0
NDVI	2
NIR	1
Red	1
red	0
temp	0
temp5	0
ts1	0.3
ts2	0.3
ts3	0.3

Why are there two green and two red image layers listed in the preceding graphic?

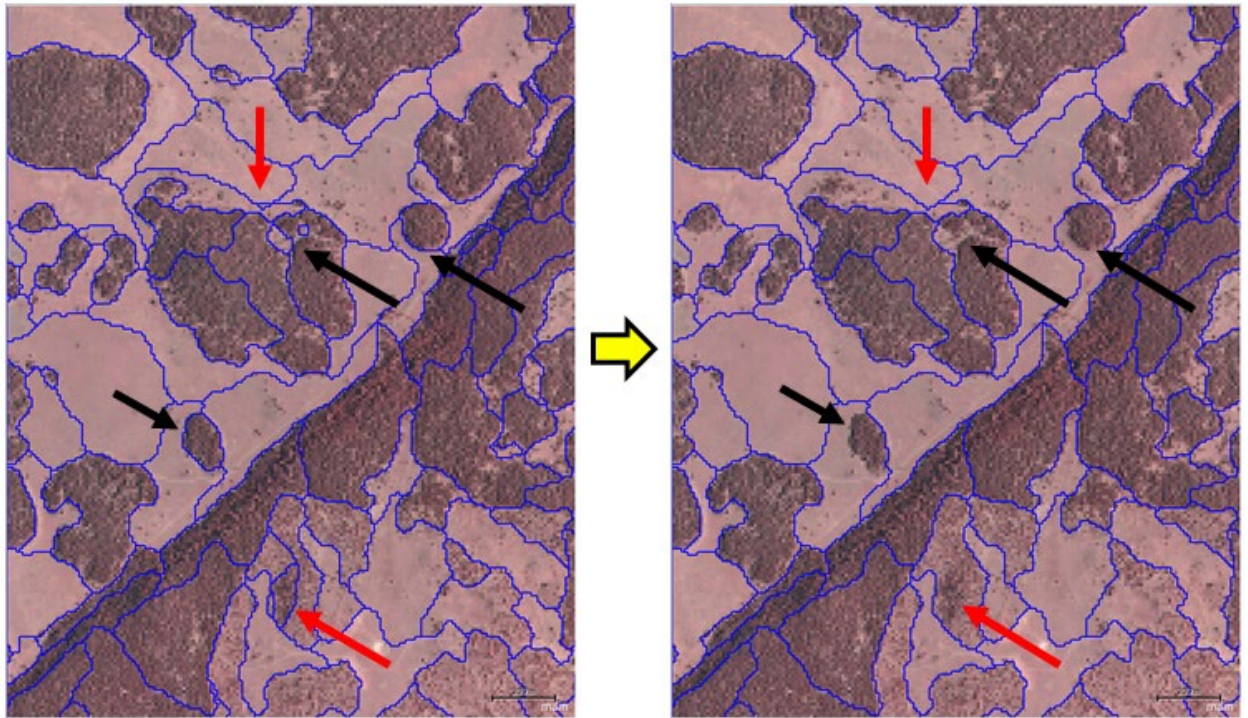
This is because the software is case sensitive in its image layer naming conventions. The rule set we loaded, eliminate, had the aliases set as lower case for red and green; however, in this tutorial series, we've been working with aliases that are all upper case. In this situation, both image layers are available – but make sure you know and select the layers which you have loaded in your project, not the empty ones.

Also notice that completely new image layers have been loaded too (blue), and some of our temporary layers (temp and temp5). As you work with eCognition, you may also find that there are many more aliases than you expected. eCognition stores aliases in memory until you delete them. Sometimes these aliases are from projects you are not even working in but remain in the software memory. Just leave these all set to a weight value of 0.

You can delete aliases you are no longer working with (e.g., temporary layers or aliases from different projects) by selecting **Process**, then **Edit Aliases**, then **Image Layer Aliases**. A table will open in a new window that lists all the image layer aliases in your project and indicates what data they're referring to or if they are not (yet) assigned. Here you can highlight and delete aliases.

5. Before leaving the Edit Process dialog, also notice that the **Scale parameter** is set to the variable "current_scale", rather than to a number.
6. You can either leave the **Shape** and **Compactness** values at their default values or you can change them to those you used to create the segments.
7. Under the **Domain** section (left side), you will find the **Condition** field is set to **Area<=MinSize**. Click in this field. Then click the box with three dots that appears to open the **Edit condition** box. This is where you can change the units for the variable **MinSize**.
 - i. It is currently set to hectares. To change the units, just click on Hectares and other options will appear. For now, keep the units set to hectares and click **OK** to close the dialog.
8. Click **OK** to close the **Edit Process** dialog.

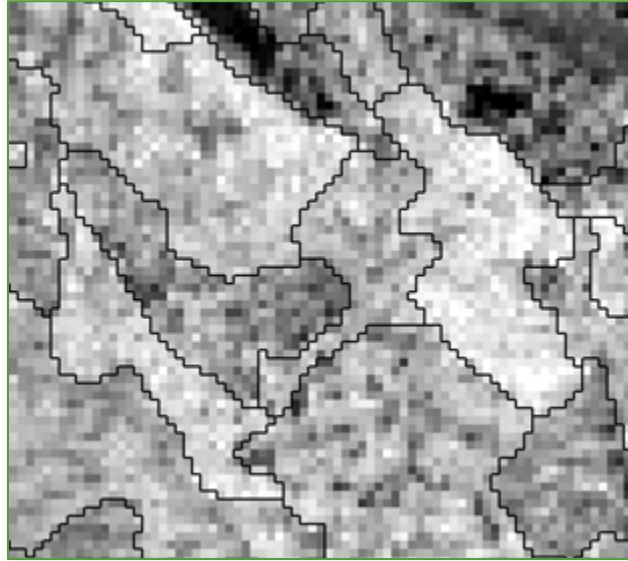
9. **Zoom** in and **pan** around to find some very small segments. Watch what happens to them when you execute the rule set (see following graphic).



10. **Execute** the **eliminate** parent process.
11. Investigate the results. In the illustration above, there are fewer small segments. Some merges look good (red arrows). However, it is important to thoroughly review your work. You will find in some other areas, the sections that were merged due to size thresholds might be better represented as small areas given their very different spectral signatures (black arrows). You could investigate improving the results by adjusting the image layer weights (review Step B, 4).
12. **Save** your project when done.

Part 3: Use ArcGIS to Smooth Segments Further

The “stair step” boundaries of the segments exported from eCognition (see following graphic) can be smoothed even more using post-processing steps performed in ArcGIS. This creates polygons with a more hand-drawn appearance, which is appealing to some people. Be aware that these processes can be time-intensive and may take a long time to complete for large sets of polygons.



A. Run the Smooth Polygon Tool

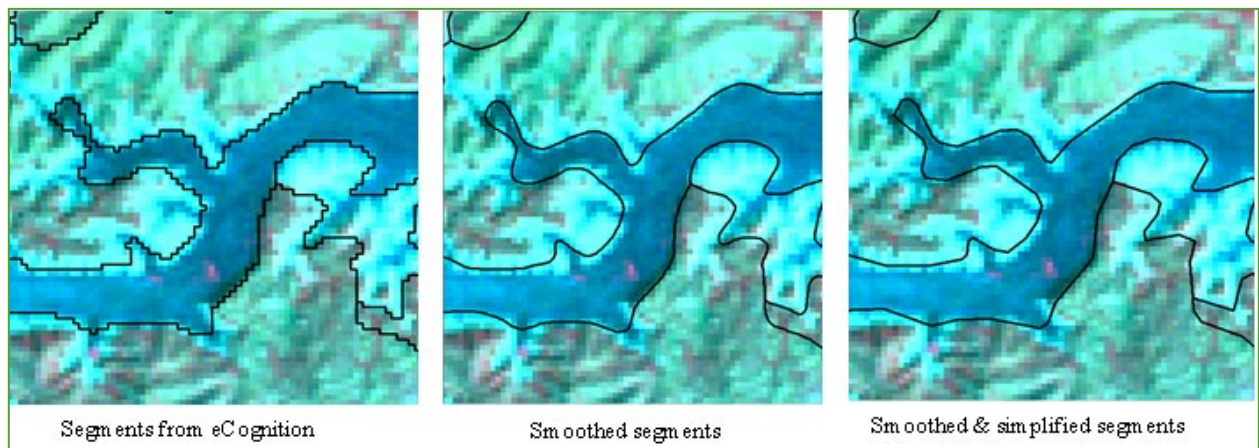
1. **Load** your segment **shapefile** from **eCognition** into **ArcMap**.
2. **Open** the **Smooth Polygon** tool from ArcToolbox (**Cartography Tools, Generalization, and then Smooth Polygon**).
3. In the **Smooth Polygon** dialog,
 - i. **Select** the shapefile containing the segments exported from eCognition in **Input Features** field
 - ii. **Navigate** to an **output directory** and name the output file in the **Output Feature Class** field.
 - iii. **Select PAEK** for the **Smoothing Algorithm**.
 - iv. **Enter** a value for the **Smoothing Tolerance** and ensure that the proper units are set (usually meters). For segments derived from 10 m imagery, a value around 70 meters works well. As you increase the value, a greater amount of smoothing (and a greater amount of boundary shift) will occur. **If segments are derived from finer resolution imagery, the value set for the smoothing tolerance should be smaller.**
 - v. **Select FLAG_ERRORS** for the **Handling Topological Errors** field.
 - vi. Click **OK** to run the tool.
 - vii. **Examine** the results in the output shapefile (see graphic below).

B. Optional, Run the Simplify Polygon Tool

The **Smooth Polygon** tool does a nice job of smoothing the boundaries; however, it creates a lot of vertices, which significantly increases the file size. If file size is an issue, then it may be necessary to run the **Simplify Polygon** tool to remove some of the vertices to reduce the file size.

1. **Launch** the **Simplify Polygon** tool from ArcToolbox (**Cartography Tools, Generalization, Simplify Polygon**).
2. In the **Simplify Polygon** dialog,
 - i. **Select** the smoothed shapefile from step A in the **Input Features** field

- ii. **Navigate** to an output directory and name the output file in the **Output Feature Class** field
 - iii. Select **POINT_REMOVE** for the Simplification Algorithm.
 - iv. **Enter 15 meters** (if the segments were derived from 30m imagery; otherwise set this value to about half the resolution of the imagery that the segments were derived from) in the **Maximum Allowable Offset** field. Ensure that the units are set to Meters.
 - v. If you desire to eliminate small polygons, enter a minimum area in the **Minimum Area** field (e.g., 2 ha). The software will eliminate polygons smaller than this value. Note, however, in ArcMap 10.0, this functionality does not always work.
 - vi. Select **RESOLVE_ERRORS** for the Handling Topological Errors field.
 - vii. Click **OK** to run the tool.
3. **Examine** the results (see following graphic).



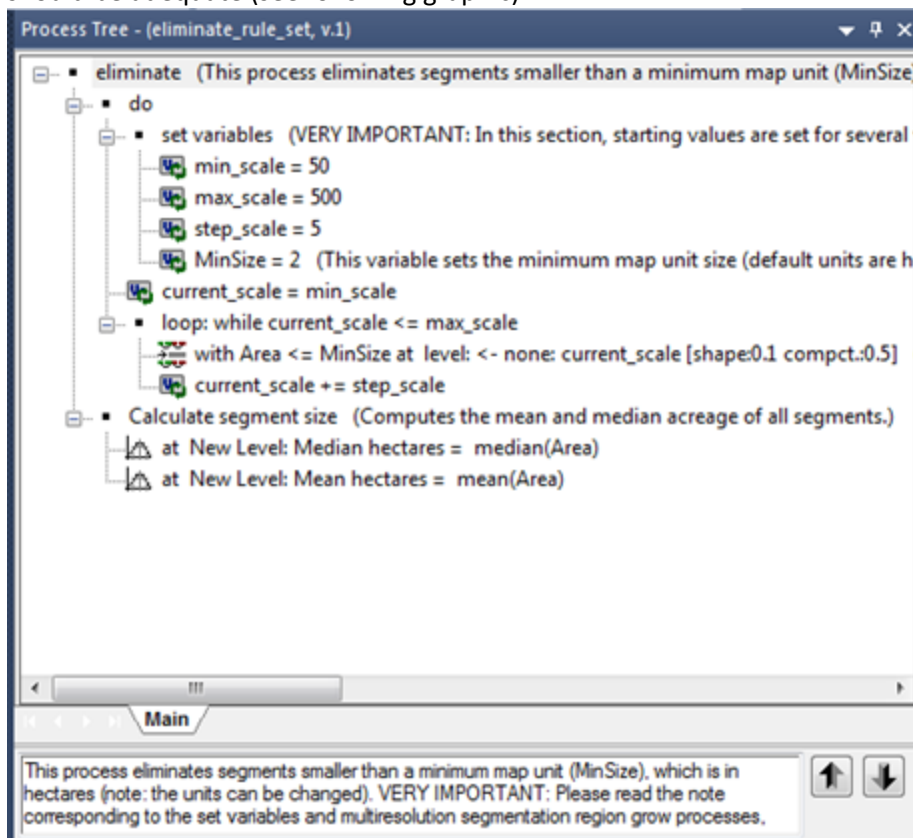
Congratulations! You have successfully learned how to smooth segments both in eCognition and ArcGIS. In the next exercise, you will use what you have learned in Exercise 1 and 2 to create a new project and then you will learn how to classify an image to Tree, Non-Tree and Single Tree.

Appendix 1: Setting the Eliminate Ruleset Parameters

The eliminate rule set uses the multiresolution segmentation region grow process to grow the excessively small segments into spectrally similar larger ones. Like the standard multiresolution segmentation process, this one requires the user to set layer weights and a scale parameter. In this case, the user must edit the process to set the layer weights. The scale parameter is set by a variable that gradually grows from one smaller than the original scale parameter used to create the segments to one considerably larger.

A total of 5 variables are used to control the rule set.

- **min_scale** sets the starting scale parameter. This variable should be set just smaller than the scale parameter used to create the original segments (in our case a scale of 25 was used to create the segments so a value of 20 would be fine for this variable).
- **max_scale** sets the ending scale parameter. This variable should be set considerably larger than the original scale parameter. If this variable is not large enough, some of the more spectrally distinct small segments will not merge with their neighbors. For this exercise, a value of 500 should be adequate (see following graphic).





- The **step_scale** variable controls how large the step increments are as the software increases the scale parameter from **min_scale** to **max_scale**. The default value is set to 5. So, the **multiresolution segmentation region merge** process will run repeatedly with scale parameters of 20, 25, 30, 35, etc. up to 500. This iterative processing is necessary to ensure that groups of small segments merge properly with their most spectrally similar neighbors rather than just merging into one large, less homogeneous segment (just trust us that it is necessary!).
- **MinSize** sets the size of segments that will be merged. The default is 2 hectares. In other words, segments 2 hectares or smaller will be merged with their neighbors.
- The last variable, **current_scale** keeps track of the current value for the scale parameter. The last important thing you need to know is that you can change the units of **MinSize**.

