

Running ENVI Analytics in ArcGIS Pro Tutorial

In this tutorial you will learn how to create an ArcGIS® Python toolbox that contains ENVI geoprocessing tools. ENVI® Py for ArcGIS is required in order to create the toolbox. Each tool is based on an ENVITask in the ENVI application programming interface (API) that runs a specific analytic. You will view and run ENVI tools that are automatically installed and added to ArcGIS Pro. After configuring the ENVI environment in ArcGIS Pro, you will create a custom toolbox containing any number of ENVI analytic tools. You will also learn how to publish ENVI models as ArcGIS Pro tools.

This tutorial was tested with ENVI 5.5 and ArcGIS Pro 2.0.1 on a Windows 10 computer. You can use ENVI 5.4 or later, plus ArcGIS Pro 1.3 or later, or ArcMap™ 10.4 or later. The steps may be slightly different for ArcMap software. See the [ENVI Py for ArcGIS online documentation](#) for additional instructions with ArcMap.

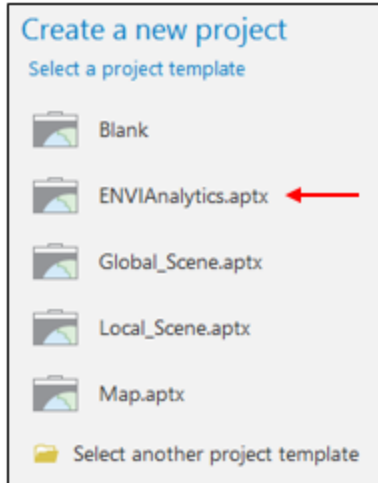
Before You Begin

1. Install ArcGIS Pro with administrator privileges. In the Installation Context screen of ArcGIS Pro setup, select the option **Anyone who uses this computer (all users)**.
2. Install ENVI 5.4 or later.
3. Install ENVI Py for ArcGIS Pro by running one of the following files with administrator privileges:
 - `envipyxx-arcgispro.exe`: Included with your web download of ENVI software
 - `setup-envipyxx-arcgispro.exe` : Located on the ENVI installation DVD in the ENVIPyxx folder
4. Follow the prompts in the ENVI Py for ArcGIS Pro installer.

View and Run Standard ENVI Tools

Once you install ENVI Py for ArcGIS Pro, an ENVI Analytics toolbox is automatically added to ArcGIS Pro. This toolbox contains several image-processing tools that are ready to use. Follow these steps to view the tools and to run an example.

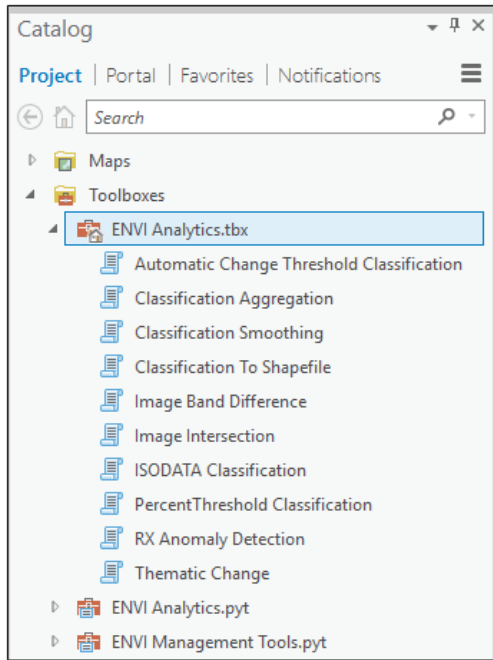
1. Start ArcGIS Pro.
2. In the project selection screen, select the **ENVIAnalytics.aptx** project template. This is located in the **Create a new project** section.



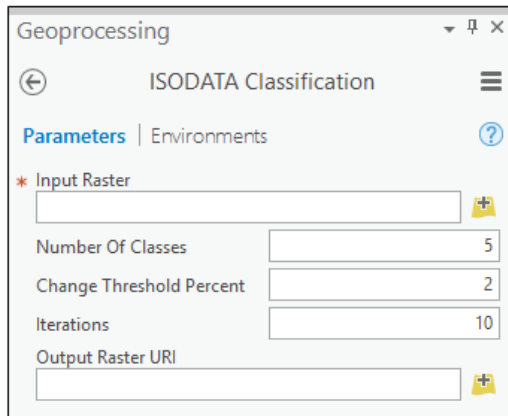
The Create a New Project dialog appears.

3. In the **Name** field, enter **ENVI Analytics**.
4. Select a location for the ENVI Analytics project. The default location is in your `ArcGIS\Projects` folder.
5. Keep the default selection of **Create a new folder for this project**.
6. Click **OK**. A topographic map is displayed.

Note: If you are using ArcGIS Pro version 1.3, it may display messages such as, "This document was created using a newer version of ArcGIS Pro. Unsupported features will be downgraded or dropped from the document" and "Saving the project with the current version may cause loss of data. Do you want to proceed?" You can safely click **Yes** in both messages; no data will be lost.
7. In the Catalog pane, click the **Toolboxes** folder to expand it.
8. Click **ENVI Analytics.tbx** to expand it. This toolbox contains several image-processing tools:

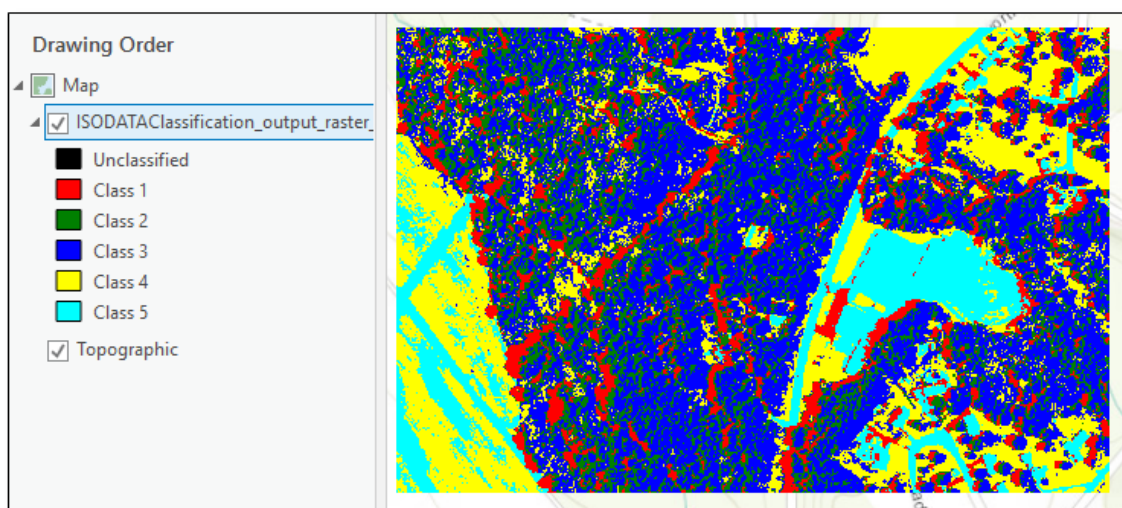


9. Double-click the **ISODATA Classification** tool. ISODATA is an unsupervised classification method. The parameters for ISODATA Classification are displayed in the Geoprocessing pane.



10. Click the **Browse** button next to **Input Raster**.
11. Navigate to the `\data` folder in your ENVI installation path; for example, `C:\Program Files\Harris\ENVIxx\data\`.

12. Select `Avon.dat` and click **OK**. This is a true-color orthophoto of an area near Avon, New York.
13. Keep the default values for **Number of Classes**, **Change Threshold Percent**, and **Iterations**.
Tip: To learn more about these parameters, click the blue help icon in the ISODATA Classification task.
14. To optionally specify a folder and filename for the output, type the path and filename directly in the **Output Raster URI** field. Be sure to include a `.dat` file extension with the filename.
15. Click the **Run** button at the bottom of the Geoprocessing pane.
16. When processing is complete, right-click on the new image (named `ISODATAClassification_output_raster_*.dat`) in the Contents pane and select **Zoom to Layer**. A classification image is displayed with five colors, each representing an unknown land-cover type.

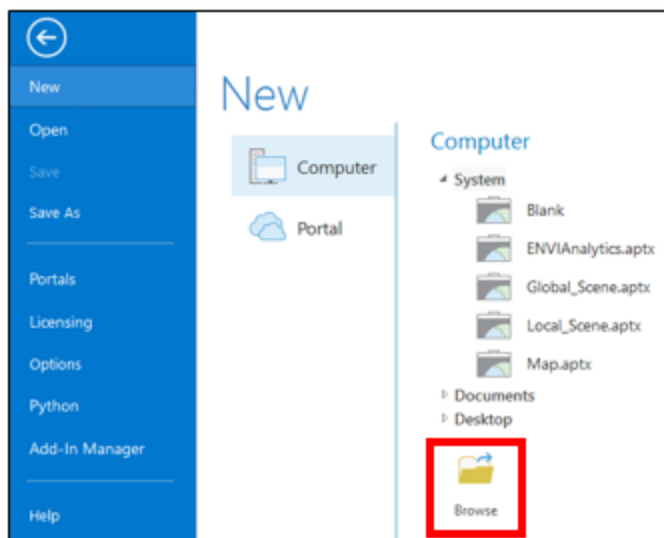


17. Remove the ISODATA classification layer from the display.
- Next you will create a custom toolbox that consists of ENVI geoprocessing tools.

Create an ENVI Toolbox

Before creating a custom toolbox, you need to create a new project called "TutorialProject." This project will be created from the "ENVI Py Management" project template. Follow these steps:

1. Click the **Project** tab in the ArcGIS Pro menu bar.
2. In the New screen, under Computer, click the **Browse** button.

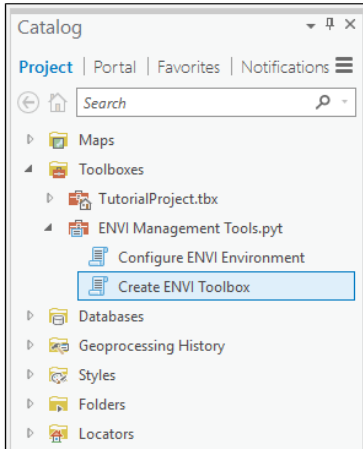


3. Navigate to `C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3\Lib\site-packages\envipyarc\esri\projecttemplates\`.
4. Select **ENVIPyManagement.aprx** and click **OK**. The Create a New Project dialog appears.
5. In the **Name** field, enter **TutorialProject**.
6. Select a location for the new project. The default location is in your `ArcGIS\Projects` folder.
7. Keep the default selection of **Create a new folder for this project**, then click **OK**.

Create a Custom Toolbox

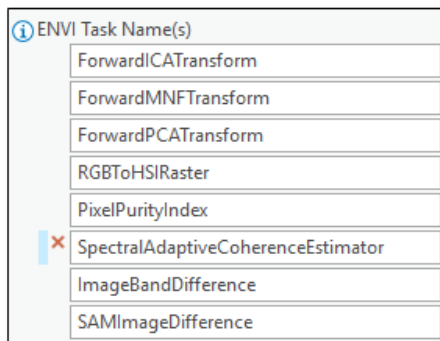
1. At the bottom of the Geoprocessing pane, click the **Catalog** tab to switch back to the Catalog pane.
2. Click **ENVI Management Tools.pyt** to expand it.

3. Double-click **Create ENVI Toolbox**.

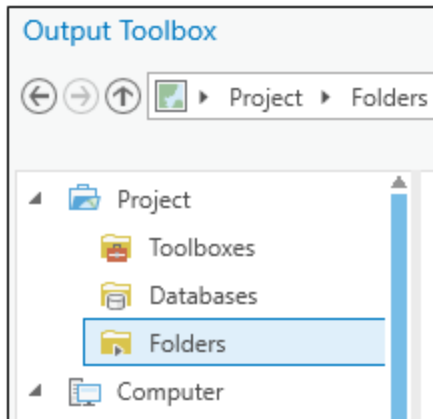


4. In the **ENVI Task Name(s)** field, you can add as many ENVITasks as you want. Here are some tips:

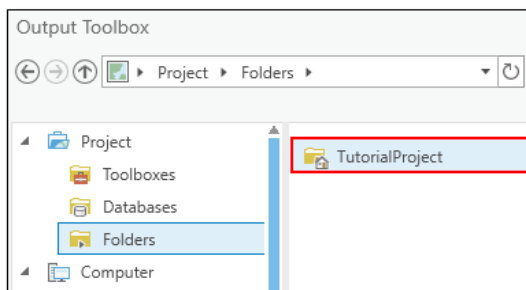
- Not all ENVITasks can be exposed as standalone tools because they require data types that are incompatible with ArcGIS Pro. See [Appendix: Supported ENVITasks](#) for a list of supported tasks.
- Omit the "ENVI" prefix and "Task" suffix when entering task names in the ENVI Task Name(s) field. For example, enter *ISODATAClassification* instead of *ENVIISODATAClassificationTask*.
- After entering a task name, press the **Enter** or **Tab** key on your keyboard to add a new task name.
- To remove a task, click inside of its field and click the **Remove** icon (the red X); for example:



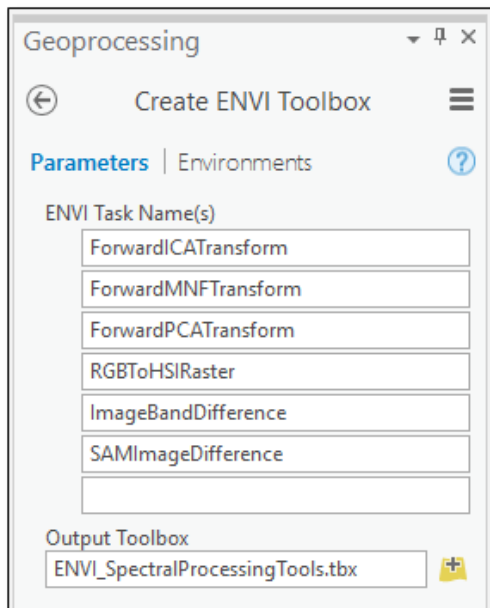
5. Click the **Browse** button to the right of the Output Toolbox folder. The Output Toolbox dialog appears.
6. Under **Project**, double-click **Folders**.



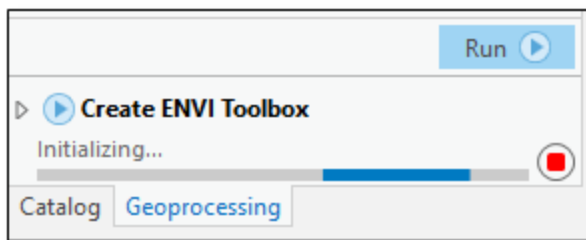
7. Double-click the **TutorialProject** folder.



8. In the **Name** field, enter a name for your toolbox; for example, `ENVI_SpectralProcessingTools.tbx`. The following figure shows an example of some tasks that comprise the new toolbox:



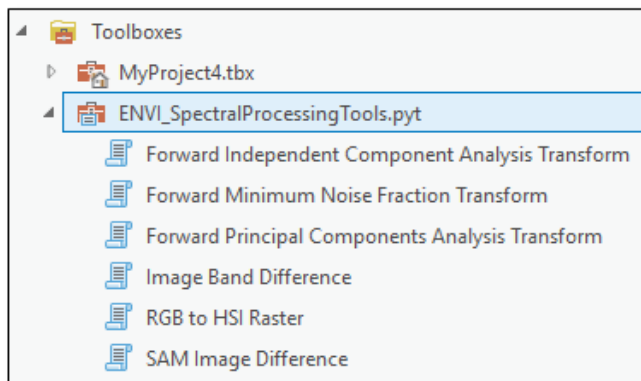
9. Click **Save**. The toolbox setup is ready.
10. Click the **Run** button at the bottom of the Geoprocessing pane.



When the toolbox is complete, a green check box indicates that the toolbox was successfully created.

11. Click the **Catalog** tab at the bottom of the Geoprocessing pane to switch to the Catalog pane.
12. Select the **Project** tab in the Catalog pane.
13. Right-click on **Toolboxes** and select **Add Toolbox**. The Add Toolbox dialog appears.
14. Navigate to the **TutorialProject** folder, and double-click it.

15. Select the Python toolbox you just created (for example, `ENVI_SpectralProcessingTools.pyt`), and click **OK**. The new toolbox appears under the Toolboxes list in the Catalog pane.
16. Double-click the new toolbox to see the tools within it; for example:



17. Click the **Project** tab in the ArcGIS Pro menu bar.
18. Click **Save** to save the current project.
19. Close ArcGIS Pro.

Publish an ENVI Model as an ArcGIS Pro Tool

You can use the ENVI Modeler to create models with data-processing workflows that combine multiple tasks. Then you can save the entire model as a *metatask*, which is a single task that encompasses all of the tasks in the model. The metatask can be published as a standalone tool in ArcGIS Pro.

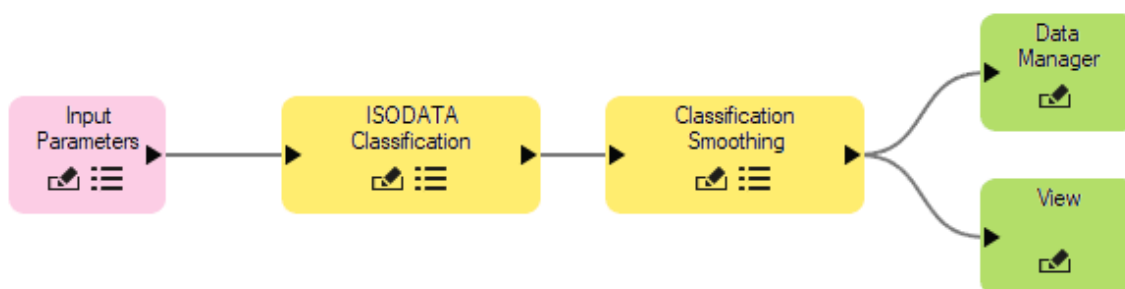
This section demonstrates how to do this using a simple pre-built model that performs ISODATA unsupervised classification and smooths the resulting classes.

Note: Before you begin, ensure that your ArcGIS Pro `\Toolboxes` folder has write permission. ENVI will attempt to publish the model/metatask in this example to the `\Toolboxes` folder. The default location is `C:\Program Files\ArcGIS\Pro\Resources\ArcToolBox\Toolboxes\`. If you do not have sufficient privileges to change the permission of this folder, you will need to [perform some extra steps to add the new tool to ArcGIS Pro](#).

Configure the Model

1. Start ENVI.
2. From the ENVI menu bar, select **Display > ENVI Modeler**.

3. From the ENVI Modeler menu bar, select **File > Open**.
4. Navigate to the `examples` folder of your ENVI installation path; for example, `C:\Program Files\Harris\ENVIxx\examples\`.
5. Select the file `Modeler_Tutorial.model` and click **Open**. The model elements are displayed:



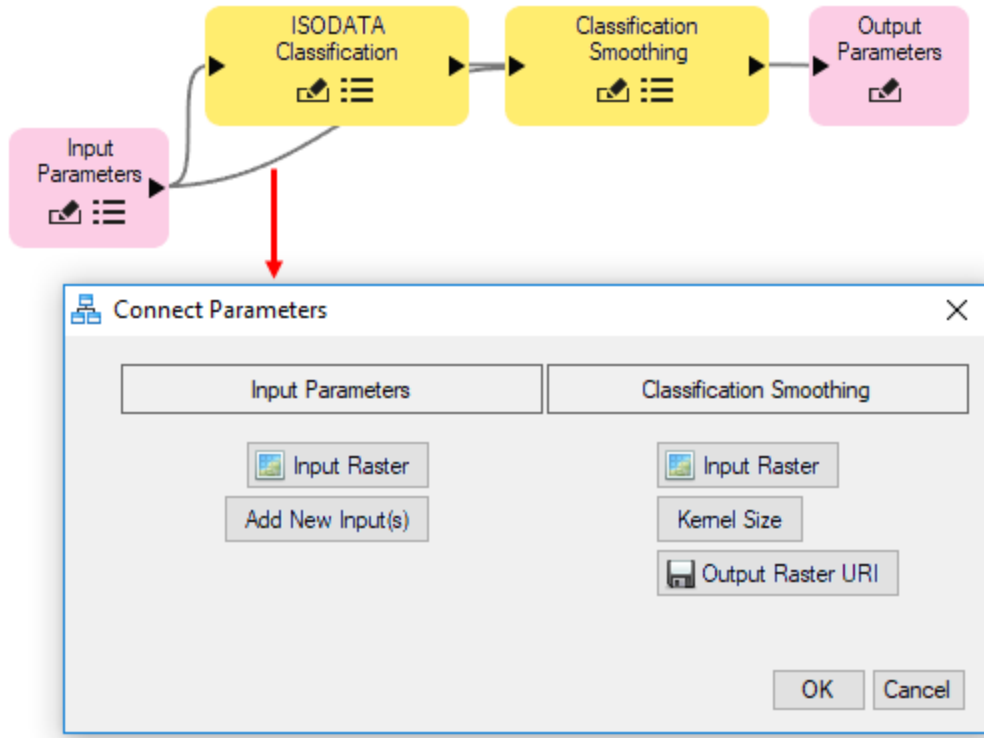
Before you can publish the model to ArcGIS Pro, you must make a few changes. You need to define input and output parameters so that all users can run the model using their own data and write the output to their own directory. Notice that the model already has an Input Parameters node. When the model is converted to a tool in ArcGIS Pro, an Input Parameters dialog will display so that you can select your own input file. Now you just need to add an Output Parameters node. Continue with these steps:

6. Select the **Data Manager** and **View** nodes, and press the **Delete** key to remove them. The grey connectors are also removed.
7. In the **Basic Nodes** list on the left side of the ENVI Modeler, double-click **Output Parameters**. A new Output Parameters node is added to the display.
8. Move the Output Parameters node to the end of the model, then draw a line to connect it with the Classification Smoothing node:

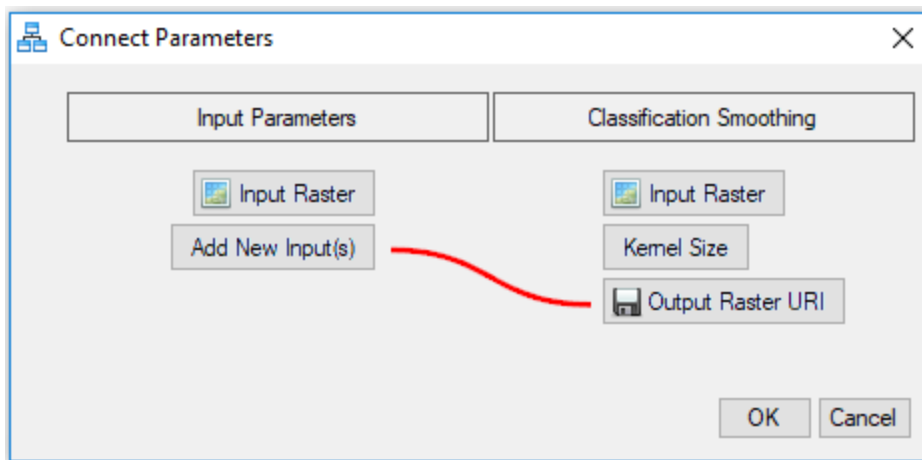


If you were to run the model now, the resulting image from Classification Smoothing would export to the ENVI temporary directory. Since you are creating a model to possibly share with others, you should display a dialog for users to choose the location of the output image. You will do this next.

9. Drag the Input Parameters node down, then add a connector between this node and the Classification Smoothing node (the last task in the processing chain). The Connect Parameters dialog appears:



10. Click the **Output Raster URI** button on the right. A red line is drawn between this and the **Add New Input(s)** button.



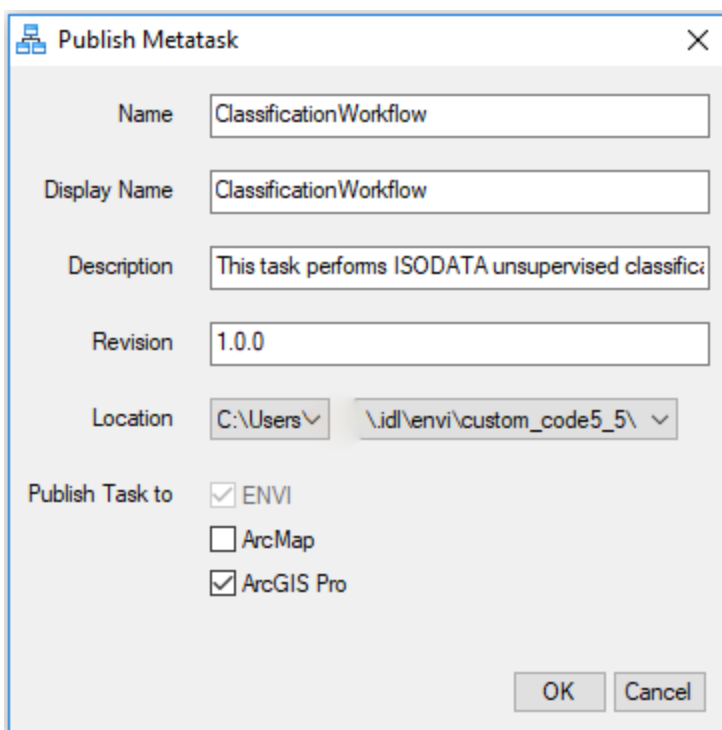
11. Click **OK** in the Connect Parameters dialog. Now is a good time to make sure the model runs successfully.

Run the Model

1. Click the **Run** button in the ENVI Modeler. After a few seconds, the Input Parameters dialog appears.
2. Click the **Browse** button next to the **Input Raster** field. The Data Selection dialog appears.
3. Click the **Open File** button in the Data Selection dialog.
4. Navigate to the `\data` folder in your ENVI installation path; for example, `C:\Program Files\Harris\ENVIXX\data\`. Select the file `Avon.dat` and click **Open**.
5. Click **OK** in the Data Selection dialog.
6. Click the **Browse** button next to the **Output Raster URI** field.
7. Select a folder and filename (with a `.dat` extension) for the output image.
8. Click **OK** in the Input Parameters dialog to run the model. The output image is created in the folder that you specified.
9. From the ENVI Modeler menu bar, select **File > Save As**. The Select Output Model File dialog appears.
10. Navigate to a folder that has write permission, and rename the model to `ClassificationWorkflow.model`. Click **Save**.

Generate a Metatask from the Model

1. From the ENVI Modeler menu bar, select **Code > Generate Metatask**. The Metatask dialog appears with JSON code for the metatask.
2. In the Metatask toolbar, click the **Publish Task** button. The Publish Metatask dialog appears.
3. In the **Name** field, enter **ClassificationWorkflow**.
4. In the **Display Name** field, enter **Classification Workflow**.
5. Enter an optional **Description**.
6. Click the **ArcGIS Pro** check box, then click **OK**.



An Information dialog appears, indicating where the metatask file was written. The default path is the `custom_code` folder of your ENVI installation path; for example:

`C:\Program Files\Harris\ENVI55\custom_code`

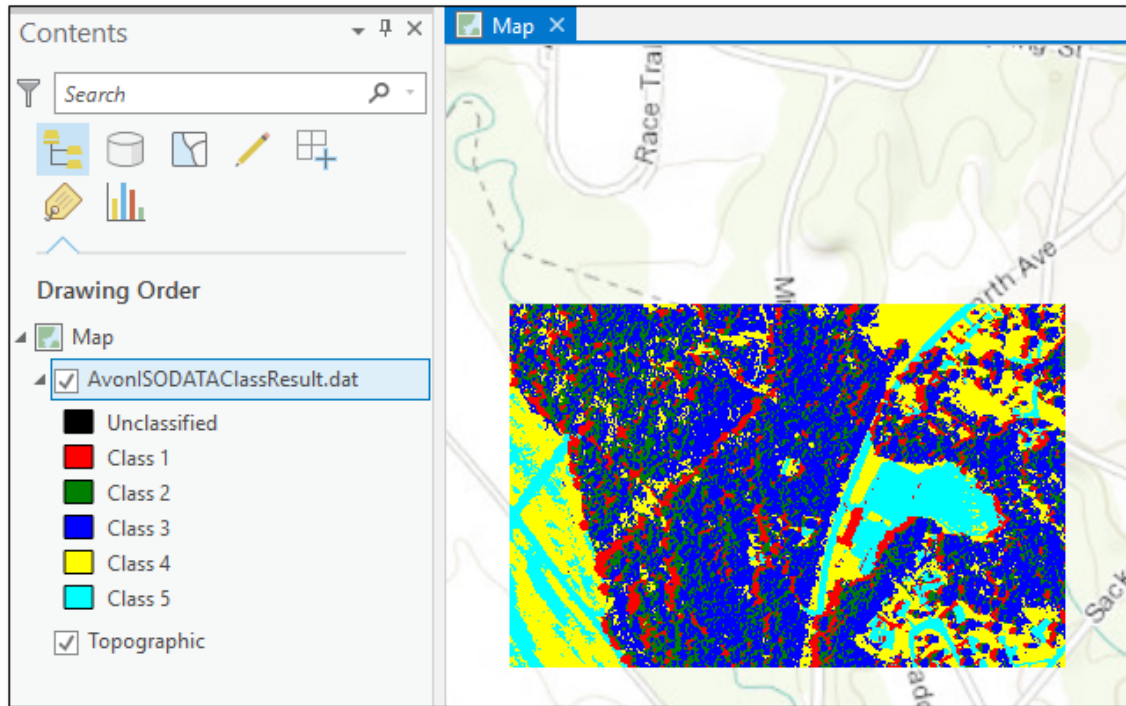
7. Click **OK** in the Information dialog.
8. If the above folder does not have write permission, then ENVI writes the metatask to `C:\Users\, where x_x is the ENVI version`

number. If this is the case, move the metatask file (`ClassificationWorkflow.task`) to the `custom_code` folder of your ENVI installation path, with administrator privileges.

9. Close the Metatask dialog and the ENVI Modeler, then exit ENVI.

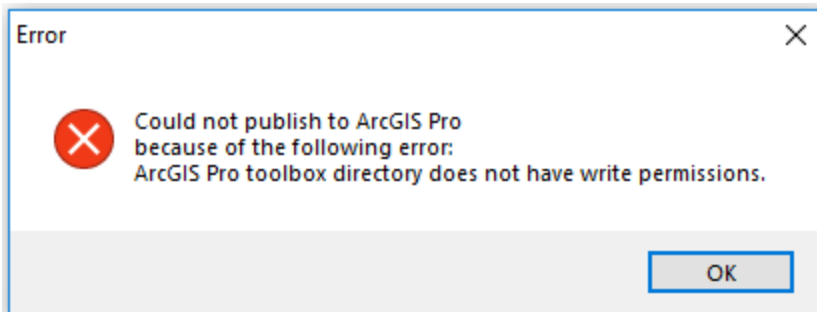
Run the ClassificationWorkflow Tool in ArcGIS Pro.

1. Restart ArcGIS Pro.
2. Select **TutorialProject**.
3. Now that the ClassificationWorkflow tool has been successfully created, it should be available under the Toolboxes folder of the Catalog pane. By default, ENVI adds the tool to the `Toolboxes` folder of your ArcGIS Pro installation path.
4. Double-click the **ClassificationWorkflow** tool.
5. Click the **Browse** button next to **Input Raster**.
6. Navigate to the `\data` folder in your ENVI installation path; for example, `C:\Program Files\Harris\ENVIXX\data\`. Select the file `Avon.dat` and click **OK**.
7. Optionally enter a full path and filename for the output image, in the **Output Raster URI** field. Be sure to include a `.dat` extension with the filename.
8. Click **Run**. When processing is complete, the resulting ISODATA (smoothed) classification image appears:



Additional Steps If You Receive a Permission Error

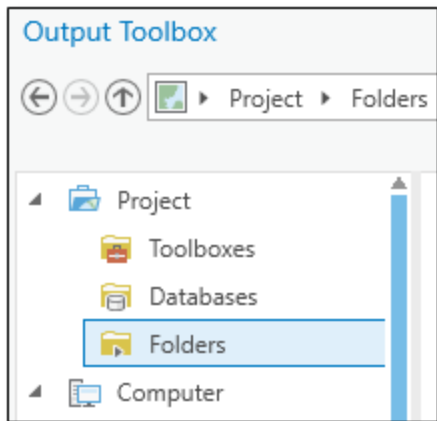
If you cannot provide write permission to the `\Toolboxes` folder (for example, if you do not have sufficient privileges; see the note [above](#)), you will receive an error message:



Perform the following steps to manually add the new tool:


1. Start ArcGIS Pro.
2. Select **TutorialProject**.

3. In the Geoprocessing pane, double-click **Create ENVI Toolbox** under the **Recent Tools** section.
4. In the **ENVI Task Name(s)** field, enter **ClassificationWorkflow** and press the **Enter** key.
5. Click the **Browse** button next to the **Output Toolbox** field. The Output Toolbox dialog appears.
6. Under **Project**, double-click **Folders**.

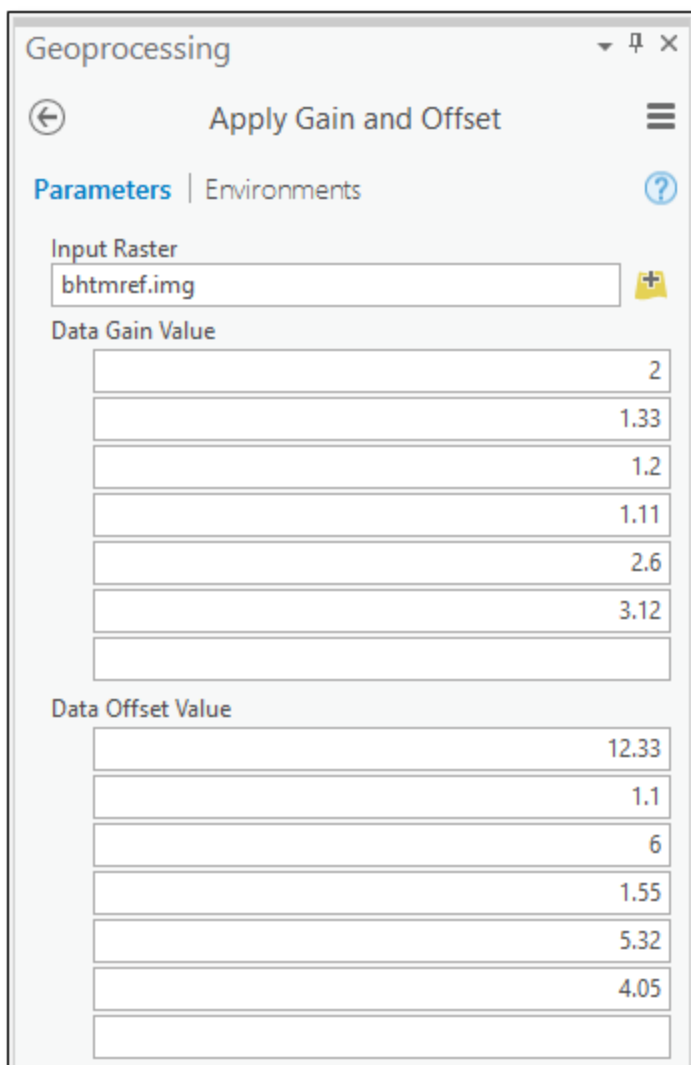


7. Double-click the **TutorialProject** folder.
8. In the **Name** Field, enter **ClassificationWorkflow.tbx** and click **Save**.
9. Click the **Run** button in the Geoprocessing pane. When the toolbox is complete, a green check box indicates that the toolbox was successfully created.
10. Click the **Catalog** tab at the bottom of the Geoprocessing pane to switch to the Catalog pane.
11. Select the **Project** tab in the Catalog pane.
12. Right-click on **Toolboxes** and select **Add Toolbox**. The Add Toolbox dialog appears.
13. Navigate to the **TutorialProject** folder.
14. Select **ClassificationWorkflow.pyt** and click **OK**. The ClassificationWorkflow tool is now available for you to use in ArcGIS Pro.

Tips for Using ENVI Tools

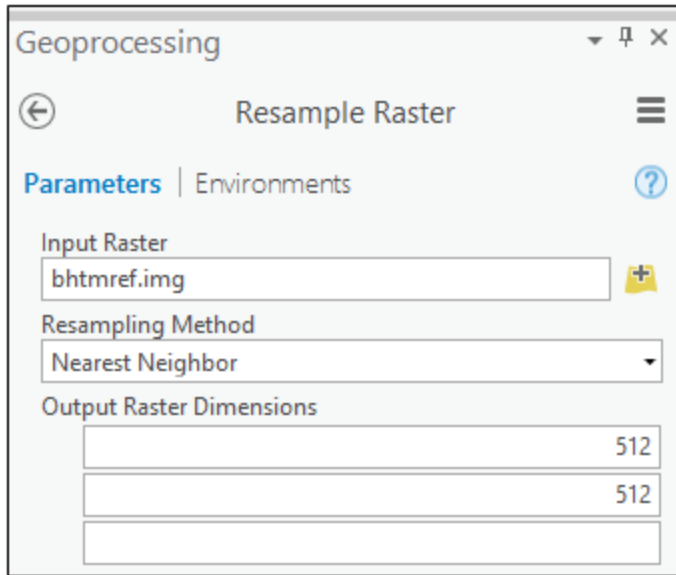
ENVI tools have specific requirements for input parameters. Click the  tooltip next to a parameter to learn more about it. Since each tool is based on an ENVITask, you can also refer to the ENVI Help topic for that task to see an example of how it is used.

Some tools such as ApplyGainOffset and GaussianStretchRaster have input parameters that accept multiple values. Since you cannot enter an array of values in ArcGIS Pro (as you can with an ENVITask in the ENVI API), you must enter the values line-by-line. For example, the ApplyGainOffset tool requires a gain and offset value for each band of an image. If an image has six bands, you must enter each gain and offset value separately:



In this example, the **Data Gain Value** of 2 and the **Data Offset Value** of 12.33 pertain to the first band in the image.

Other tools accept a two-element array of values for kernels and X/Y dimensions. Again, enter each value in a separate line. For example, the `DimensionsResampleRaster` tool accepts two values for the **Output Raster Dimensions** parameter: the number of pixels in the X direction and the number of pixels in the Y direction. To resample an image to a new raster with 512 rows and 512 columns, enter the values as follows:



Finally, most tools have an output parameter such as **Output Raster** or **Output Raster URI**. These are optional, and you can still run the tool without specifying an output file. However, output parameters are actually treated as inputs in ENVITasks. If you click the **Browse** button next to an output parameter field, and you specify a filename and location, you will receive an error that the output file does not exist. Instead, type the full path and name for the output file in the field provided; for example:



When the tool runs, the output will be written to that location.

With raster output, you can also omit the **Output Raster** or **Output Raster URI** field and display the resulting image in ArcGIS Pro. Then right-click on the layer name in the Contents window and select **Data > Export** to export the image to one of several common image formats.

Appendix: Supported ENVITasks

Some data types that are used in ENVI are not supported in ArcGIS Pro. These include regions of interest (ROIs), point clouds, ground control points (GCPs), tie points, multi-dimensional arrays of data, and others. If an ENVI tool exposes an input or output parameter that includes any of these data types, the tool will not run and an error message will appear in the progress bar.

Tip: If you want to use ENVITasks that operate on these data types (for example, ROIs or multi-dimensional arrays), you can create a model that includes these tasks as long they do not expose input/output parameters for unsupported data types to the end user. Use the ENVI Modeler to create a new metatask from the model. Then publish the metatask to ArcGIS Pro.

The ENVITasks listed below have been successfully tested and verified to work with ArcMap and ArcGIS Pro. Refer to the ENVI Help for more information about these tasks. Items marked with an asterisk (*) are meant to be used within a processing chain (such as an ENVI or ArcGIS model) and will not display any results.

- AdditiveLeeAdaptiveFilter
- AdditiveMultiplicativeLeeAdaptiveFilter
- ApplyGainOffset
- AutoChangeThresholdClassification
- BinaryGTThresholdRaster
- BinaryLTThresholdRaster
- BitErrorAdaptiveFilter
- CalculateQUACGainOffset*
- CastRaster
- ChangeThresholdClassification
- ClassificationAggregation
- ClassificationSieving
- ClassificationSmoothing
- ClassificationToShapefile
- DarkSubtractionCorrection
- DimensionsResampleRaster
- DirectionalFilter

- EnhancedFrostAdaptiveFilter
- EnhancedLeeAdaptiveFilter
- EqualizationStretchRaster
- ExportRasterToENVI
- ExportRasterToNITF20 (Requires a NITF/NSIF license.)
- ExportRasterToNITF21 (Requires a NITF/NSIF license.)
- ExportRasterToNSIF10 (Requires a NITF/NSIF license.)
- ExportRasterToPNG
- ExportRasterToTIFF
- ExtractRasterFromFile* (Use this task to extract band groups from Landsat and Sentinel-2 images.)
- FirstOrderEntropyTexture
- ForwardICATransform
- ForwardMNFTransform
- ForwardPCATransform
- FrostAdaptiveFilter
- FXSegmentation
- GammaAdaptiveFilter
- GaussianHighPassFilter
- GaussianLowPassFilter
- GaussianStretchRaster
- GramSchmidtPanSharpening
- HighClipRaster
- HighPassFilter
- ImageBandDifference
- ImageIntersection
- ISODATAClassification
- KuanAdaptiveFilter
- LabelEntropyTexture

- LabelRegions
- LaplacianFilter
- LinearPercentStretchRaster
- LinearRangeStretchRaster
- LocalSigmaAdaptiveFilter
- LogStretchRaster
- LowClipRaster
- LowPassFilter
- MaskRaster
- MedianFilter
- MirrorRaster
- MultiplicativeLeeAdaptiveFilter
- NNDiffusePanSharpening
- OptimizedLinearStretchRaster
- PCPanSharpening
- PercentThresholdClassification
- PixelPurityIndex
- PixelScaleResampleRaster
- PixelwiseBandMathRaster
- QUAC (Requires an ENVI Atmospheric Correction Module license.)
- QuerySpectralIndices*
- RGBtoHSIRaster
- RXAnomalyDetection
- RadiometricCalibration
- RadiometricNormalization
- RankStrengthTexture
- ReprojectGLT
- RobertsFilter
- RootStretchRaster

- SAMImageDifference
- SobelFilter
- SpectralIndex
- SpectralIndices* (You must first run QuerySpectralIndices inside of a model before running this tool.)
- SubsetRaster
- ThematicChange
- VectorMaskRaster
- VegetationSuppression

The following ENVI Crop Science tasks are supported in ArcGIS Pro. ENVI Crop Science must be licensed and installed on your system. Refer to the ENVI Crop Science Help for more information about these tasks.

- AgCalculateAndRasterizeCropMetrics
- AgCalculateAndRasterizeCropMetricsWithSpectralIndex
- AgCalculateCropMetrics*
- AgCalculateGetisOrd*
- AgCountAndRasterizeCrops
- AgCropCount*
- AgCropsToShapefile
- AgDevelopingHotspotColorSlice
- AgEnhanceCrops
- AgFindAndRasterizeCropGaps
- AgFindDevelopingHotspots
- AgFindDevelopingHotspotsWithSpectralIndex
- AgHotspotAnalysis
- AgHotspotColorSlice
- AgRasterizeCrops
- AgSpectralHotspotAnalysis