NI Classification Training Interface

Use the NI Classification Training Interface to train and classify samples. The NI Classification Training Interface is designed for users who are new to classification as well as those who are experienced in using classification.

For more information about classification concepts, refer to the *NI Vision Concepts Manual*.

Accessing the Classification Training Interface

You can access the NI Classification Training Interface from the **Start** menu if the NI Vision Development Module is installed. You can also access the NI Classification Training interface from within NI Vision Assistant or NI Vision Builder for Automated Inspection (Vision Builder AI).

From the Start Menu

To launch the Classification Training Interface from the **Start** menu, select
Start»All Programs»National Instruments»Vision»Classification Trair

From Vision Assistant

The Classification Training Interface opens from Vision Assistant in a wizard to guide you through the creation of a new template. Complete the following steps to launch the Classification Training Interface wizard in Vision Assistant:

1. Acquire or open an image that contains a sample that you want to classify. Refer to the *NI Vision Assistant Help* for information about acquiring or opening images.
2. To access the Classification Setup panel, select **Identification»Classification** or click **Classification** on the **Identification** tab of the Processing Functions palette.
3. Click **New Classifier File** on the **Train** tab of the Classification Setup panel to open the Classification Training Interface.

From Vision Builder AI

The Classification Training Interface opens from Vision Builder AI in a wizard to guide you through the creation of a new template. Complete the following steps to launch the Classification Training Interface wizard in Vision Builder AI:

1. Acquire, or simulate the acquisition of, an image that contains a sample that you want to classify. Refer to the *Vision Builder for Automated Inspection: Configuration Help* for information about acquiring images or simulating acquisitions.
2. On the **Identify Parts** tab of the Inspection Steps palette, click **Classify Objects**.
3. Click **New Classifier File** on the Main tab of the Classification Setup panel to open the Classification Training Interface.

NI Classification Training Interface Tutorial

Through the Classification Training Interface you can train a classifier file by manually classifying sample images into new or existing classes. Based on those samples, the classifier file can then classify unknown samples into a known class. This tutorial explains how to train and test a classifier file using a set of example images.

This tutorial includes the following sections:

Opening the Example Images

Complete the following steps to open the set of example images in the NI Classification Training Interface:

1. Launch the Classification Training Interface.
2. Select **File»Open Images**.
3. Complete one of the following sets of steps to select the tutorial images:
    - **NI Vision** and **Vision Assistant**
        a. Navigate to <Vision>\Images\Classification Tutorial, where <Vision> is the location to which you installed the NI Vision Development Module.
        b. Select the following images:

        Tip You can select multiple image files by pressing the <Ctrl> key and clicking each file. Enable the **Select all files** checkbox to open all listed images in the directory you specified.

        - Parts00.png
        - Parts01.png
        - Bolt00.png
        - Bolt01.png
        - Motor00.png
        - Motor01.png

        c. Click **Open**.
    - **Vision Builder AI**
        a. Navigate to <Vision Builder AI>\DemoImg\Classification, where <Vision Builder AI> is the location to which you installed Vision Builder AI.
        b. Select the following images:

        Tip You can select multiple image files by pressing the <Ctrl> key and clicking each file. Enable the **Select all files** checkbox to open all listed images in the directory you

specified.

- Parts00.png
- Parts01.png
- Bolt00.png
- Bolt01.png
- Motor00.png
- Motor01.png

c. Click **Open**.

Creating the Bolt Class

Complete the following steps to create the bolt class and train the bolt classifier:

1. Use the navigation buttons to locate Parts00.png.
2. Set the correct options in the Preprocessing tab.
    a. For the **Method** of thresholding, select **Clustering**.
    b. Select **Dark Objects** from the **Look For** drop-down menu.
3. Draw an ROI around the bolt in the image.

    Tip It may be necessary to include parts of other objects in the ROI you draw around the bolt to successfully contain the entire bolt in the ROI. To configure the classification engine to classify the sample of the bolt correctly even though the ROI contains part of another object, enable the **Reject Objects Touching ROI** checkbox on the **Preprocessing** tab.

    

    The NI Classification Training Interface displays the objects in the ROI according to the preprocessing settings. When the preprocessing settings are configured to use a clustering method of thresholding and to look for dark objects, the objects in the ROI are blue.
4. Select **Add New Label** from the **Class Label** list. Enter Bolt for the **New Label**.
5. Click **OK**.
6. Navigate to the Parts01.png file.
7. Draw an ROI around a bolt in the image.

    
8. Check that the **Class Label** control reads Bolt and click **Add Sample**.
9. Select the **Classify** tab, and click **Train Classifier**.

Testing the Bolt Classifier

Complete the following steps to verify that you have trained the bolt classifier:

1. Select the **Classify** tab.
2. Navigate to the Bolt00.png file.
3. Draw an ROI around the bolt in the image.

   

4. Verify that the object in the ROI is classified correctly by checking that the **Assigned Class Label** indicator reads Bolt. The **Classification Score** is 1000 because you have defined only one class.
5. Navigate to the Bolt01.png file.
6. Draw an ROI around the bolt in the image.

   

7. Verify that the sample in the ROI is classified correctly by checking that the **Assigned Class Label** indicator reads Bolt.

Creating the Motor Class

Complete the following steps to create the motor class and train the motor classifier:

1. Use the navigation buttons to locate Parts00.png.
2. Set the correct options in the Preprocessing tab.
    a. For the **Method** of thresholding, select **Clustering**.
    b. Select **Dark Objects** from the **Look For** drop-down menu.
3. Draw an ROI around a motor in the image.

    Tip It may be necessary to include parts of other objects in the ROI you draw around the motor to successfully contain the entire motor in the ROI. To configure the classification engine to classify the sample of the motor correctly even though the ROI contains part of another object, enable the **Reject Objects Touching ROI** checkbox on the **Preprocessing** tab.

    

    The NI Classification Training Interface displays the objects in the ROI according to the preprocessing settings. When the preprocessing settings are configured to use a clustering method of thresholding and to look for dark objects, the objects in the ROI are blue.
4. Select the **Add Samples** tab.
5. Select **Add New Label** from the **Class Label** list. Enter motor for the **New Label**.
6. Click **OK**.
7. Navigate to the Parts01.png file.
8. Draw an ROI around a motor in the image.

    
9. Check that the **Class Label** control reads motor and click **Add Sample**.
10. Select the **Classify** tab, and click **Train Classifier**.

Testing the Motor Classifier

Complete the following steps to verify that you have trained the motor classifier:

1. Select the **Classify** tab.
2. Navigate to the motor00.png file.
3. Draw an ROI around the motor in the image.

   

4. Verify that the object in the ROI is classified correctly by checking that the **Assigned Class Label** indicator reads motor.
5. Navigate to the motor01.png file.
6. Draw an ROI around the motor in the image.

   

7. Verify that the sample in the ROI is classified correctly by checking that the **Assigned Class Label** indicator reads motor.

Editing the Classifier File

Use the **Edit Classifier** tab to view the thumbnail images and descriptive information about the samples classified.

The following list describes the function of each control in the **Edit Classifier** tab:

- **Classifier File Description**—To add a description of the classifier file, select the **Classifier File Description** textbox and type the description.
- **Relabel**—To relabel a sample, select a sample in the browser and click **Relabel**. If you relabel a sample you must retrain the classifier.
- **Delete**—To delete a sample, select a sample in the browser and click **Delete**. If you delete a sample you must retrain the classifier.
- **Browser Display**—The browser can display either all samples or only samples of a specified class.
    - To display all samples, click the **All Trained Samples** option button.
    - To display samples of a certain class, click the **Samples of Class** option button and select the class you want to display from the list. The **Samples** indicator displays the number of samples from that class.
- The **Class Population** histogram displays existing classes and the number of samples for each class. The **Total # of Samples** indicator displays the number of samples you have identified for all classes.

Saving the Classifier File

Now that you have classified several objects, you are ready to save the classifier file. Each classifier file contains the current state of the classification engine options as well as the samples you have trained.

1. Use the navigation buttons to scroll through the images you classified in this tutorial. Review each image, and check that the class to which the image belongs is correct. When you hover your mouse over the thumbnail image in the **Edit Classifier** tab, the class name appears in the lower right corner below the image window.
2. Relabel any images that are not correctly labeled by selecting the image from the browser and clicking **Relabel**. The **Relabel Sample** dialog opens. Type the correct label for the image in the **New Label** control.
3. Delete any unwanted images by selecting the image in the browser and clicking **Delete**.
4. Select **File»Save Classifier File**.
5. Enter Tutorial.clf in **File Name** for the classifier file, and then click **Save**.

Training the Classifier

Complete the following steps to train a classifier file by manually classifying a sample image into a new or existing class.

1. Select **File»Open Images**.
2. Navigate to the image that you want to use as a sample, then click **OK**.

   Tip You can select all of the files in a folder by enabling the **Select All Files** option, or you can select multiple files by holding the <Ctrl> key while clicking file names. When you select an image from the list, the **Preview Image** window displays the image, file type, image size, and image type. If you select a collection of images, the **Preview** window displays all images in a sequence. To view the sequence at a different rate, adjust the slide to the right of the **Preview Image** window.

3. If you open multiple images, use the navigation buttons to browse to a specific image.

Add Samples Tab

Use the **Add Samples** tab to apply a class label to an image or portion of an image. The image is then added to the classifier as a sample of the applied class.

1. If the image contains multiple objects, draw an ROI around the object you want to add as a sample.
2. Adjust the parameters on the Preprocessing, Engine Options, and Particle Classifier Options tabs, as necessary.
3. Assign a class label to the sample using one of the following methods:
    - To assign a new class label, select **Add New Label** from the **Class Label** list. The **Enter a new label** dialog box opens. Type the label name and click **OK**. The new class is assigned to the sample.
    - To assign an existing class label, select the label from the **Class Label** list. Click **Add Sample**. The class is assigned to the sample.

Classify Tab

Click **Train Classifier** to train the classifier engine.

Note If you add new samples, you must retrain the classifier.

Note The **Class Population** histogram displays existing classes and the number of samples for each class. The **Total # of Samples** indicator displays the number of samples you have identified for all classes.

Classifying Particles

To verify that the classifier engine has been trained correctly, complete the following steps:

1. Select **File»Open Images**.
2. Navigate to the image that you want to use as a sample and click **Open**.

   Tip You can select all of the files in a folder by enabling the **Select All Files** option, or you can select multiple files by holding the <Ctrl> key while clicking file names. When you select an image from the list, the **Preview Image** window displays the image, file type, image size, and image type. If you select a collection of images, the **Preview** window displays all images in a sequence. To view the sequence at a different rate, adjust the slide to the right of the **Preview Image** window.

3. If you open multiple images, use the navigation buttons to browse to a specific image.

Classify Tab

1. Draw an ROI around the object you want to classify.
2. Verify that the classifier engine produces the desired class label, classification score, and identification score.

   The assigned class label for the sample appears in the **Assigned Class Label** indicator. The **Classification Score** is the degree of certainty that a sample is assigned to one class instead of another class. The **Identification Score** is the degree of similarity between a sample and members of the class to which the sample is assigned. The **Distances** chart displays the distance between the classified sample and other classes.

Editing the Classifier

Use the **Edit Classifier** tab to edit the image samples you have classified in the NI Classification Training Interface.

Tip To edit multiple samples, select each sample that you want to modify by clicking on it. If you want to edit multiple samples individually, ensure that you deselect any samples that you do not want to modify by clicking them.

The following list describes the function of each control in the **Edit Classifier** tab:

- **Classifier File Description**—To add a description of the classifier file, select the **Classifier File Description** textbox and type the description.
- **Relabel**—To relabel a sample, select a sample in the browser and click **Relabel**. If you relabel a sample you must retrain the classifier.
- **Delete**—To delete a sample, select a sample in the browser and click **Delete**. If you delete a sample you must retrain the classifier.
- **Browser Display**—The browser can display either all samples or only samples of a specified class.
  - To display all samples, click the **All Trained Samples** option button.
  - To display samples of a certain class, click the **Samples of Class** option button and select the class you want to display from the list. The **Samples** indicator displays the number of samples from that class.
- The **Class Population** histogram displays existing classes and the number of samples for each class. The **Total # of Samples** indicator displays the number of samples you have identified for all classes.

Batch Training

Use **Tools»Batch Training** to train a folder of images. Complete the following steps to train a folder of images:

1. Select **Tools»Batch Training**.
2. Click **Browse** to open the Select a folder of images dialog box.
3. Locate the folder that contains the images which you want to batch process. Click **Open** to open the folder, then click **Current Folder** to set the folder as the image source.

   Note The Batch Training tool will only process the selected folder, and will ignore the contents of any subfolders.

4. Click **Draw ROI** and draw an ROI around the sample that you want to train. Ensure that the ROI will encompass the sample to train in all images in the folder and click **OK**.

   Note If you do not draw an ROI, the largest sample will be trained.

5. Choose one of the following methods to specify a label for each sample:
   - If all images in the folder are of the same class, enable the **Use the same label for all the samples** option and enter the label in the **Class Label** control.
   - If the images are not of the same class, you must use a labels file to specify individual labels for each image.
     a. Enable the **Use a file that specifies the labels of the samples** option.
     b. Click **Browse** to select a **Labels File Path**. Each line of a labels file lists an image name followed by the class name assigned to the image. A delimiter separates the image name from its label.

        Note If an image is not listed in the labels file, it will not be processed.

     c. In the **Delimiter** list, choose the correct delimiter

for the labels file. If an appropriate delimiter is not listed, choose **User Specified** in the Delimiter list and type the appropriate delimiter into the **User Delimiter** field.

6. Click **Train** to process all of the images in the selected folder. The training process both trains and classifies the samples.

   Once processing is complete, the Batch Results dialog box will open.

Batch Classification

Use **Tools»Batch Classify** to classify a folder of images. You can verify the accuracy of the classification by providing a results file that lists the actual class of each image.

Note The classifier will classify images based on the classes that it has been trained to recognize. If the classifier has not been trained to recognize a class, it cannot correctly classify images of that class.

Complete the following steps to classify a folder of images:

1. Select **Tools»Batch Classify**.
2. Click **Browse** to open the Select a folder of images dialog box.
3. Locate the folder that contains the images which you want to batch process. Click **Open** to open the folder, then click **Current Folder** to set the folder as the image source.

   Note The Batch Classification tool will only process the selected folder, and will ignore the contents of any subfolders.

4. Click **Draw ROI** and draw an ROI around the sample that you want to classify. Ensure that the ROI will encompass the object to classify in all images in the folder and click **OK**.
5. If you want to check the accuracy of the classification against a results file, enable the **Verify Classification** option. Complete the following steps to specify a results file:
   a. Click **Browse** to select a **Results File Path**. Each line of a results file lists an image name followed by the class name assigned to the image. A delimiter separates the image name from its label.
   b. In the **Delimiter** list, choose the correct delimiter for the labels file. If an appropriate delimiter is not listed, choose **User Specified** in the Delimiter list and type the appropriate delimiter into the **User Delimiter** field.
6. Click **Classify** to classify the samples in all the images in the folder. Once processing is complete, the Batch Results dialog box will open.

Batch Results

After you train or classify a folder of images, the **Batch Results** dialog box displays the results of the batch training. The results are displayed on five tabs: **Classification Results**, **Scores Histogram**, **Class Information**, **Classification Distribution**, and **Distance Table**.

Classification Results Tab

The classification results are displayed in a chart that lists the following results for each file trained and classified:

- **Label**—If you trained samples without specifying a label file, this column lists the class you manually assigned to all images. If you classified samples without specifying a results file, this column lists the class assigned to each sample by the classifier.
- **Actual Label**—If you trained samples and specified a label file, or if you classified samples and specified a results file, this column lists the class assigned to each image in the label or results file.
- **Assigned Label**—If you trained samples and specified a label file, or if you classified samples and specified a results file, this column lists the label assigned to each image by the classifier.
- **Classification Score**—Degree of certainty that a sample is assigned to one class instead of other classes.
- **Identification Score**—Degree of similarity between a sample and members of the class to which the sample is assigned.
- **Classification**—The classification is **Good** if the sample label found during the classification process matches the label provided by the user. The classification is **Bad** if the sample label does not match.

Scores Histogram Tab

The scores histogram displays the number of each sample classified and trained for each score value.

The x-axis can represent either classification scores or identification scores. The Histogram Mode can be either linear or cumulative.

Class Information Tab

The accuracy and predictive value of the classification are displayed in a chart for each class.

- **Samples**—Number of samples belonging to the class.
- **Standard Deviation**—Standard deviation from the mean of all samples in the class.
- **Accuracy (sensitivity)**—Probability that a sample is classified into the class to which it belongs.
- **Predictive Value**—Probability that a sample classified into a given class belongs to that class.

Classification Distribution Tab

The classification distribution is displayed in a chart, and the classifier accuracy is calculated. The classification distribution is a matrix that gives the probability that a sample belonging to a specific class will be classified in another class.

Distance Table Tab

The distance table displays the mean distance from each class to each other class.

Tip You can also display this dialog by choosing **Tools»Training Summary**. Only the **Class Information**, **Classification Distribution**, and **Distance Table** tabs are available.

Export to Excel and Save Results

The **Export to Excel** and **Save Results** buttons appear on all tabs.

- Click  **Export to Excel** to export the contents of the current tab to a Microsoft Excel spreadsheet.
- Click  **Save Results** to save the contents of the current tab to a tab-delimited text file.

Configuring the Preprocessing Settings

Use the settings on the **Preprocessing** tab to determine how you want the classification engine to calculate the threshold value it uses to segment particles in each image.

Complete the following steps to configure the preprocessing settings:

1. Select a **Method** for thresholding.
    - **Manual Threshold**—Manually determine the threshold range for the ROI.
    - **Clustering**—The classification engine sorts the histogram of the image within a discrete number of classes corresponding to the number of phases perceived in an image. Clustering is the most frequently used automatic thresholding method.
    - **Entropy**—The classification engine detects samples that are present in minuscule proportions on the image.
    - **Metric**—The classification engine calculates a value for each threshold that is determined by the surfaces representing the initial gray scale.
    - **Moments**—A method of thresholding used for images that have poor contrast.
    - **Inter Variance**—A method of thresholding used for images in which classes are not too disproportionate. For satisfactory results, the smallest class must be at least 5% of the largest one.
2. If you selected **Manual Threshold** in **Method**, use the **Min** and **Max** controls or the slider at the bottom of the histogram to set the threshold value. If you select an automatic threshold method, the algorithm calculates the threshold value and updates the **Threshold Range**. You can specify a **Lower Limit** and an **Upper Limit** for the threshold computed by the automatic method.
3. Select a type of object to search for from the **Look For** drop-down menu. The NI Classifier will look for **Bright Objects**, **Dark Objects**, or **Gray Objects**.
4. Click **Reject Objects Touching ROI** to ignore objects that are touching the border of the ROI you drew.

5. Use the **Remove Small Objects (# of Erosions)** box to select the number of erosions you want the classification engine to perform to remove small objects from the ROI.

   As you manipulate settings on the **Preprocessing** tab, the NI Classification Training Interface displays thresholded objects in blue.

Tip If the samples in the ROI are not classified as you expect them to be, experiment with settings on the Engine Options and Particle Classifier Options tabs to improve the classification.

Configuring the Engine Options

Use the **Engine Options** tab to indicate the Method and Metric values required for sample classification.

Select a **Method** on the **Engine Options** tab to configure the method of classification.

- **Nearest Neighbor**Most direct approach to classification. In nearest neighbor classification, the distance of an input feature vector of unknown class to another class is defined as the distance to the closest samples that are used to represent that class.
- **K-Nearest Neighbor**More tolerant of noise compared with nearest neighbor classification. In K-nearest neighbor classification, an input feature vector is classified into a class based on a voting mechanism. The NI Classifier finds *K* nearest samples from all the classes. The input feature vector of unknown class is assigned to the class with majority of the votes in the *K* nearest samples.
- **Minimum Mean Distance**Most effective in applications that have little or no feature pattern variability or other corruptive influences. In minimum mean distance classification, an input feature vector of unknown class is classified based on its distance to each class center.

Select a **Metric** on the **Engine Options** tab to configure the metric used in the classification algorithm.

- **Maximum**Most sensitive to small variations between samples. Use **Maximum** when you need to classify samples with very small differences into different classes.
- **Sum**Metric used in most classification applications. **Sum** is also known as the Manhattan metric or Taxicab metric. This is the default **Metric** value.
- **Euclidean**Least sensitive to small variations between samples. Use **Euclidean** when you need to classify samples with small differences into the same class.

Tip If the samples in the ROI are not classified as you expect them to be, experiment with settings on the Preprocessing and

Particle Classifier Options tabs to improve the classification.

Configuring the Particle Classifier Options

Use the **Particle Classifier Options** tab to indicate whether the classification is **Scale Dependent** or **Mirror Dependent**.

1. Enable the **Scale Dependent** option if you want to distinguish samples of different sizes.
2. Enter the numeric scale factor value (between 0 and 1000) in the **Scale Factor** control. If the scale factor value is 0, the samples are classified independent of scale.
3. Enable the **Mirror Dependent** option if you want to classify mirrored objects in separate classes.
4. Enter the numeric mirror factor value (between 0 and 1000) in the **Mirror Factor** control. If the mirror factor value is 0, the samples are classified independent of mirror symmetry.

Tip If the samples in the ROI are not classified as you expect them to be, experiment with settings on the Preprocessing and Engine Options tabs to improve the classification.

Navigating Images

If you open multiple images for training, you can use the toolbar buttons to navigate through the images. Refer to the following button descriptions for information about how to view images.

- Navigates to the first image in the list of open images.
- Navigates to the previous image.
- Navigates to the next image.
- Navigates to the last image in the list of open images.