

# Model Hyperspectral Information

The Model perspective of the Perception Studio program provides tools for the creation of models, which can be applied to hyperspectral information.

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## Motivation

A model is a simulation of a system to reproduce its behavior for a defined input range. Once a model is designed, it can be applied to new data (of same system). This results in a value used as scale of the behavior that was modeled.

*By applying a sugar-model onto one spectra, the sugar content represented by the spectra is measured - it results in 1 value, the sugar content"*  
*By applying a sugar-model to hyperspectral data, a monochrome image is obtained describing the sugar content by its pixel values (gray values).*

Please keep "qualitative" and "quantitative" investigation separated. Models for quantitative measurement are designed by means of a chemometric calibration routines while qualitative models are obtained e.g. by applying CCI-Methods described below.

*By applying a CCI-model to hyperspectral data, a perception of qualitative information is obtained. The information format is color. The color describes the behavior that was modeled.*

A model itself is a structure of values and is typically hard to interpret without specific spectroscopic knowledge.

## Layout of the Model Perspective

In the Model perspective of the Perception Studio program you can

- edit hyperspectral data,
- select spectra sets,
- preprocess the hyperspectral data,
- develop new models
- apply existing models to hyperspectral data
- edit existing models
- save a model for later use



The main panels of the *Model* perspective are

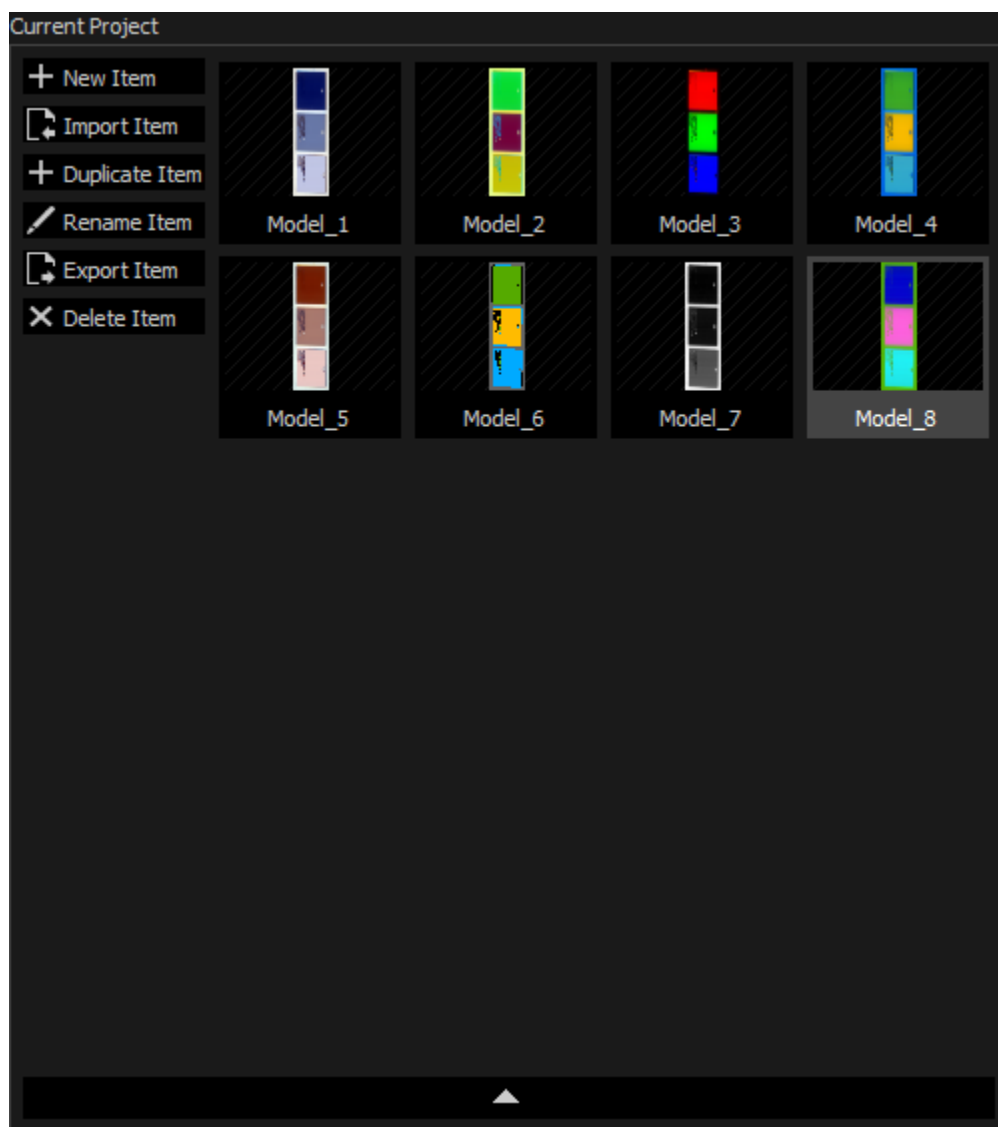
1. [Model Selection](#) (create, rename, delete, duplicate or select models)
2. [Method Selection](#) (select model type)
3. [Preprocessing Options](#) (set preprocessing for the current model)
4. [Training Data Panel](#) (select training data and edit it)
5. [Test Data Panel](#) (select data to test the model)
6. [Selected Spectra Plot](#) (display spectra sets of interest)
7. [Method Editor](#) (edit the selected model)
8. [Feature Model Graph](#) (see the current model curves)
9. [Info Panel](#) (shows information)

## 1 Model Selection

The model selection shows the currently selected model and its name. When clicked, a dropdown box appears, which shows all models that are contained in the currently loaded project as well as buttons to

- create a new model
- import a model from file
- duplicate the selected model
- rename the selected model
- export the selected model
- delete the selected model

Here is an example:



## 2 Method Selection

At the moment, there are 3 categories of modelling methods as described below. When a model is selected, The corresponding method button will be highlighted to identify the type of the model. The method of an existing model can be changed. This will relearn the model and is only possible if the model has valid Training Data.

### CCI (Model a colored perception)

The CCI (Chemical Colour Imaging) methods section in the ribbon menu enables you to select from following CCI methods:

- [CCI Preview Method](#): unsupervised method showing spectroscopic differences in different colors.
- [CCI Extract Method](#): extraction based on variance information.
- [CCI Correlate Method](#): correlation of pure substances
- [CCI Constrain Method](#): constraining colors
- [CCI Design Method](#): design of CCI-method model

Applying one of these methods results in a chemical color image which expresses chemical information of observed objects by color information. After a CCI-model is developed the model has to be saved for later usage.

### Classification

The classification methods section in the ribbon menu enables you to select from following classification methods:

- **Case Discrimination:** 1-Click classification method enabling the discrimination of different cases (e.g. objects).

Applying one of these methods results in a classification image which expresses a classification ID by a color information.

After a classification-model is developed the model has to be saved for later usage.

## Features

The feature methods section in the ribbon menu enables you to select from following feature methods:

- **TrueColor extraction:** Provides TrueColor measurements if the data covers the visual range.
- **Statistical Features:** The value per pixel is defined by a statistical function.

Applying one of these methods results in a gray value image which expresses a statistical property by its pixel values.

After a feature-model is developed the model has to be saved for later usage.

## 3 Preprocessing Options

Select from a list of preprocessing methods by clicking on the associated thumbnail in the ribbon menu and use the dropdown box to apply normalization.

Preprocessing is performed along the spectral domain.



In general preprocessing tends to reject unwanted influences (which are not associated to chemistry) from spectra - it transforms spectra e.g. in a form more suitable for modelling.

*By applying the 1st derivative to spectra, constant offset information is rejected (e.g. the influence of a varying light situation). The result helps when investigation into slope information is of importance (appropriate typically for polymers).*

You find guidelines to this topic in the document [Strategies on the Configuration of Hyperspectral Preprocessing](#).

## 4 Training Data Panel

The training data panel shows the current training data. In the top area, one can select a training data set from the data sets in the current project as well as import, export, rename and delete data sets in the project.



Note that changing the training data will force the model to recalculate with the new training data. Thus, if one wants to avoid a model of being overwritten it is recommended to create a duplicate of the model first by selecting "Duplicate Item" in the [Model Selection](#) or to create a new model.

In the top right of the training data panel there are several buttons to edit the current training data set as follows in the next subsections

### Crop a Hyperspectral Cube

See documentation: [Crop Hyperspectral Data](#)

Click on *Crop* button in the *Edit* section of the ribbon menu to crop selected hyperspectral cube data. When done, a new cube is generated and is available from the project browser.

### Select Spectra

See documentation: [Select Spectra](#)

Click on *Select Spectra* button in the *Edit* section of the ribbon menu to start the selection process. The modelling process is based on the selected spectra.

## Merge Hyperspectral Cubes

See documentation: [Merge Hyperspectral Data](#)

Click on *Merge* button in the *Edit* section of the ribbon menu to merge cubes (to get one over spanning cube of individual cubes). When done, a new cube is generated and is available from the project browser.

## 5 Test Data Panel

The test data panel allows the user to select a data set to test the current selected model. The drop down selection at the top allows the selection of a data set from the current project, as well as import, export and renaming of data sets. When the current model is applied to the test data set, the output image is displayed.

Errors are shown in this panel if

- the spectral resolution of the model and the test data set do not match
- there is no model selected
- the selected model is invalid because it failed to calculate from the given test data

## 6 Selected Spectra Plot

The selected spectra plot shows the selected spectra of the training data set and thus may help to identify differences in materials. If the mouse is hovered above the training data image above, the spectra plot also displays the spectrum under the cursor.

For information on how to select spectra, see documentation: [Select Spectra](#)

## 7 Method Editor

The method editor shows all parameters of the currently selected model. Here, the model can be changed and fine tuned. The UI elements, shown in the model editor vary, depending on the selected method type (top bar). An existing model can only be edited, if a valid Training Data is available for the model. If this is not the case, an information will be shown, which tells the user, which data set is expected. when loading this exact data set into the project, the model will be editable again.

For information on the different editors for all available methods, see [Method Selection](#)

## 8 Feature Model Graph

The *Feature Model* graph shows information about the model itself, such as the wavelength range, the model can be used for. Note, that this is not available for all method types.


## 9 Info Panel


The info panel shows information about the selected data set or the selected model. When moving the mouse over other panels, such as the input view, output view, selected spectra or feature model, information about the shown image/plot is displayed. This information includes information like feature values, color values (per pixel), wavelength, etc.

# Development of a model

To develop a model used to extract an application relevant information (such as a molecular information resolved by pixels) be sure to have a hyperspectral cube available within the project browser.

E.g. acquire a hyperspectral cube by means of a hyperspectral camera interface to the *Perception Studio* program or e.g. load an example data available from the *Perception Wiki*.

 Please refer to [Acquire Hyperspectral Data](#) documentation for further information on how to acquire data.

 Example data from *Perception Wiki*:

Open *Perception Wiki* within your web browser

- by clicking on the *Perception Wiki* icon in the Start perspective.
- by the following internet address: [wiki.perception-park.com](http://wiki.perception-park.com)

If you like to work with the data set shown on this page, download the [Three Polymer Samples](#) example data set.

## Step-by-step guide:

1. Switch to the Model perspective to start your development.
2. Select a hyperspectral cube from the [Training Data Panel](#).
3. In the [Training Data Panel](#) you should see the *Preview* of the selected hyperspectral data

 Please refer to the [Preview Method](#) documentation for further information.


4. Consider to crop the data to get a reasonable data size.  
E.g. concentrate only on objects of interest, reject environment information which does not carry valuable information. By this, you can greatly speed up the processing.

 Please refer to the [Crop Hyperspectral Data](#) documentation for further information.

5. Select objects of interest.  
Dependent on your strategy select pixels from objects in the scene which seem to be important to you. E.g. give a meaningful name and color.

 Please refer to the [Select Spectra](#) documentation for further information.

6. Create a new model by either
  - a. Selecting a model method from the top ribbon bar. E.g. select the CCI-Extract method shown in various images on this page.
  - b. Press "New Item" in the [Model Selection](#) dropdown
  - c. Press "Create new model" in the [Test Data Panel](#) if this hint is shown
7. Parametrize the method from the control panel located bottom right in the model perspective.


 Please refer to the model methods documentation for further information

- [CCI Preview Method](#)
- [CCI Extract Method](#)
- [CCI Correlate Method](#)
- [CCI Constrain Method](#)
- [CCI Design Method](#)
- [Case Discrimination Method](#)
- [Statistical Features Method](#)
- [True Color Method](#)


8. Study the result in the [Test Data Panel](#).  
To improve the quality of the result vary your spectra selection, adapt the parametrization of the model method, try an other model method and/or apply preprocessing to the hyperspectral data.

 Please refer to the [Strategies on the Configuration of Hyperspectral Preprocessing](#) documentation for further information.

9. Apply the model to new hyperspectral data.  
E.g. setup a new run-job - so the developed model is applied live to new camera data.

 For further information please refer to the [Setup a Hardware Device](#) documentation.

Or e.g. apply the developed model onto new hyperspectral data.

 For further information please refer to the next section in this documentation.


## Applying an existent model on new hyperspectral data

Especially when offline work has to be performed, often a model (developed in past) has to be applied on new hyperspectral data (e.g. acquired a moment ago).

To do so take care the model and the hyperspectral data are accessible from the project browser (e.g. import the data from file).

- Switch to the model perspective.
- Select the hyperspectral cube in the [Test Data Panel](#).

Now, the [Test Data Panel](#) in the model perspective will show the result of the selected model applied to the selected hyperspectral data or it will display a info message if the model can not be applied to the selected data set

 For further information please refer to the previous section in this documentation.

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