

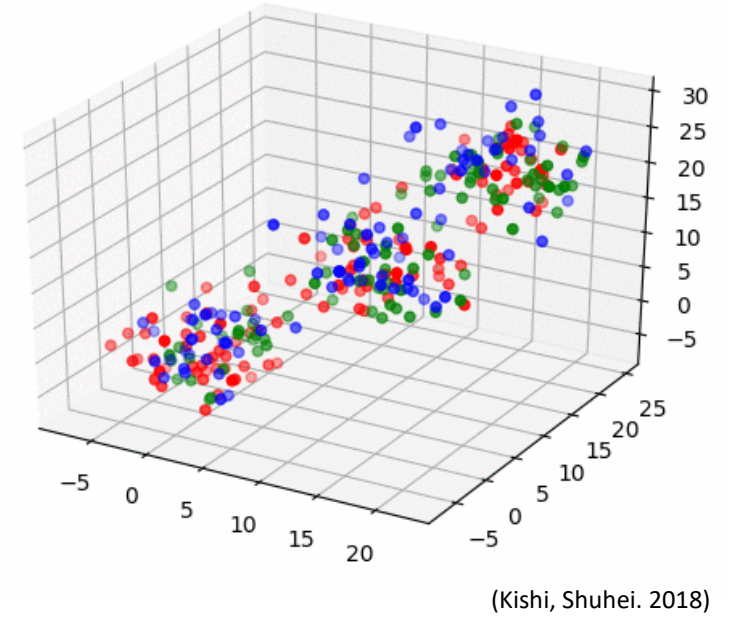
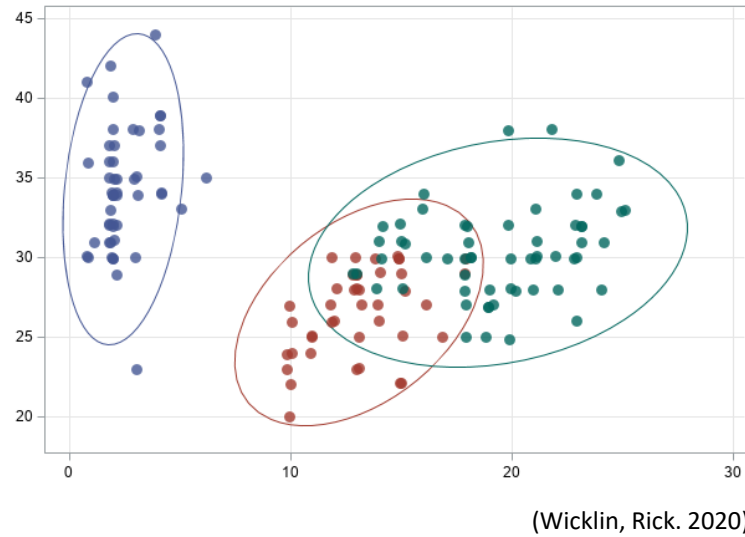
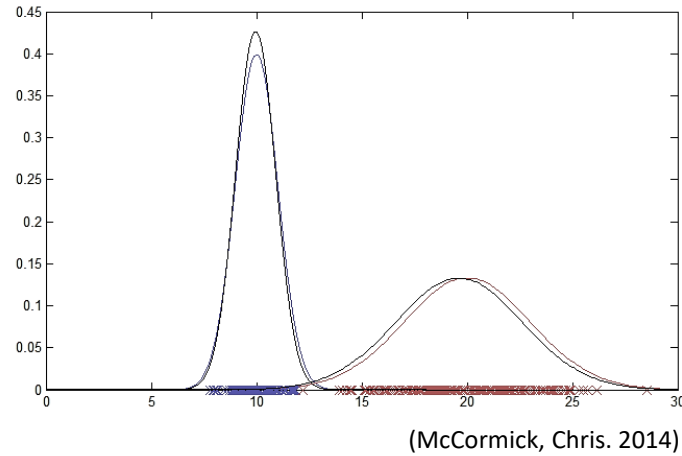


# Gaussian Mixture Model w/ SHapely Additive exPlanations

AASPI Unsupervised Machine Learning

Hilmi Putra 2026

# Unsupervised Clustering | GMM



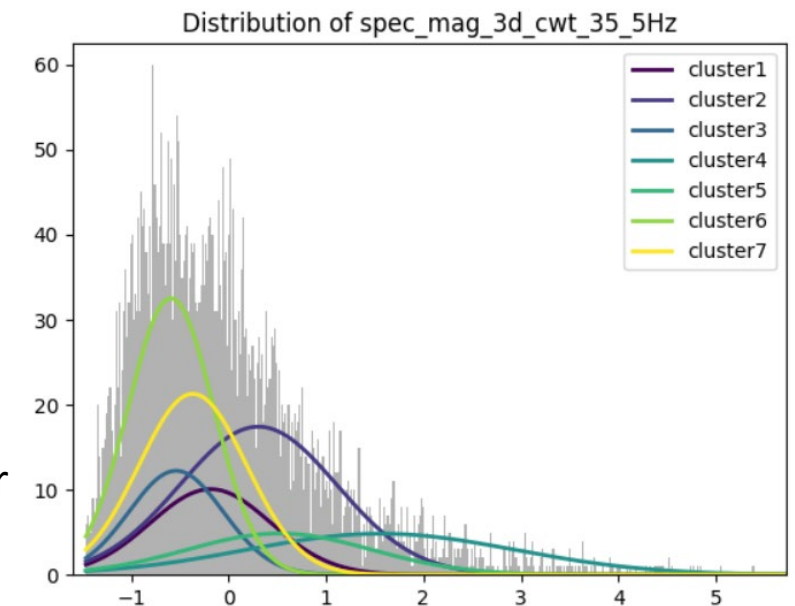
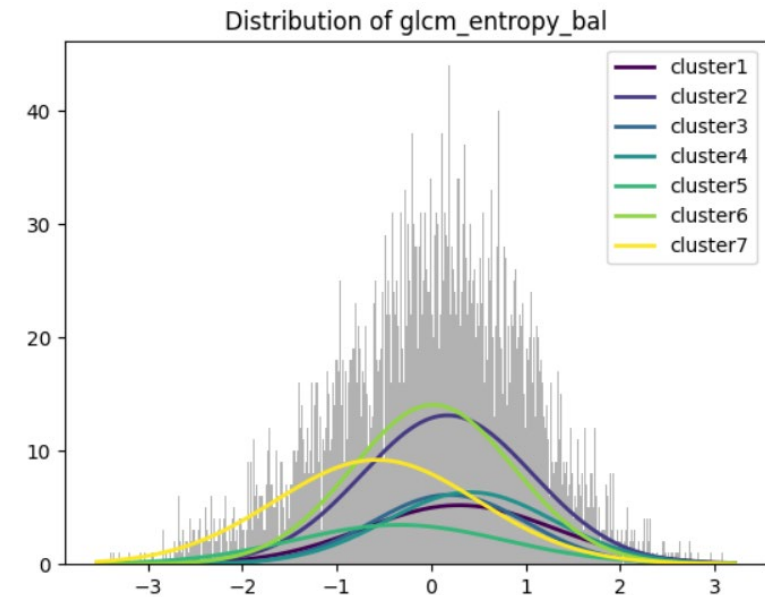
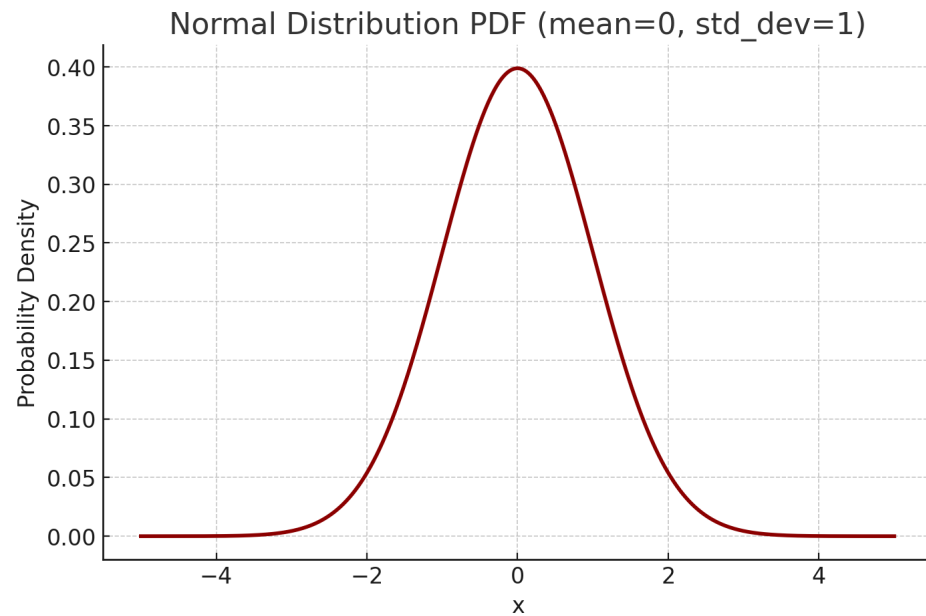
Assign datapoints to a determined number of groups based on a certain 'distance metric'

GMM: probability of membership

# Gaussian Mixture Model

Soft Clustering Method vs Hard Clustering -> i.e K-means

**Probability** density function: Gaussian curve/normal distribution

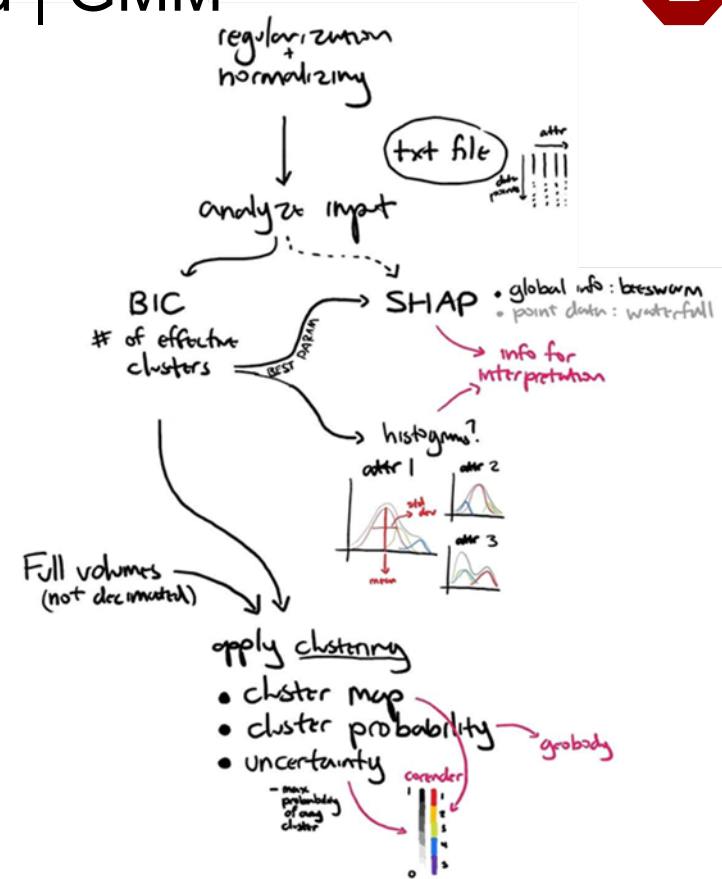


Outputs cluster designations & probability/degree of membership to that cluster  
this will be important

# AASPI Artificial Intelligence Toolbox: Unsupervised | GMM

As usual we'll...

1. Extract Training Data (we're NOT gonna run 5 million data points)
2. Analyze Input: **Parameterization**
  - Normalization
  - Bayesian Information Criterion
  - SHAP**
3. Create Model
4. Perform GMM Unsupervised Clustering



Import/Export | Seismic Attributes | Data Conditioning | **Artificial Intelligence Toolbox** | Attribute-to-Well Correlation Tools | Well Log Tools | Visualization | Utilities | Workflows | Help

AASPI QC Plotting | AASPI Prestack Utilities |

AASPI QC Plotting - A quick tool to display poststack AAS

AASPI format input file name (\*.H):  Browse

Colorbar file name:  Browse

Enter plot title:

**Artificial Intelligence Toolbox**

- Multiattribute Machine Learning
  - Unsupervised learning**
    - Step 1. Generate training data
    - Step 2. Analyze unsupervised ML models
    - Step 3. Create unsupervised model
    - Step 4. Perform unsupervised ML analysis
    - Step 5. Display unsupervised ML results
  - Deep learning
  - Volumetric Classification
  - Formation Analysis

**Unsupervised learning**

- Step 1. Plot and define polygons
- Step 2. Convert polygons to point sets (Alternative) Convert surfaces to point sets
- Step 3. Extract user-defined data**

Update: "for all options: extract attributes at point sets"

# Fire up AASPI!



The screenshots illustrate the initial setup steps:

- Locating the `AASPI_for_Annual_Meeting.bat` file in the `AASPI_demo` folder.
- Navigating to the `4-GMM_and_SHAP` sub-folder.
- Running the batch file, which sets the environment path and changes the working directory to `C:\Users\hilmi\Documents\AASPI_demo\Day1\4-GMM_and_SHAP`.

The software interface shows the following menu path for data extraction:

- Multiattribute Machine Learning > Unsupervised learning > Step 3. Extract user-defined data

Red arrows indicate the sequence of steps: 1 (to Unsupervised learning), 2 (to Step 3), 3 (to Step 3), and 4 (to Step 3). A callout box highlights Step 3 with the text: "Update: 'for all options extract attributes at point sets'".

# AASPI Artificial Intelligence Toolbox: Regularization

aaspi\_training\_data



The screenshot displays the AASPI software interface. On the left, a list of AASPI attribute files is shown, including files like 'envelope\_demo\_2026.H' and 'spec\_mag\_3d\_cwt\_13Hz\_demo\_2026.H'. Below this list are input fields for 'Time Interval (s): 0.016', 'CDP no. Start: 2555', 'CDP no. End: 3534', 'CDP no. Interval: 32', 'Line no. Start: 1430', 'Line no. End: 1680', and 'Line no. Interval: 32'. A blue arrow points to the 'Extract unsupervised training data' button. In the center, there are checkboxes for 'Take care of dead trace?' and 'Take care of mute?', a text field for 'Vertical unit factor: 8000', and a text field for 'Unique project name: demo'. A red arrow points to the 'Browse and add to current list' button. On the right, a file selection dialog box titled 'Please select AASPI files' is open, showing a directory view of 'GMM\_demo2026' with a list of files and folders. A red arrow points from the 'Browse and add to current list' button to this dialog. At the bottom, the text '(c) 2008-2026 AASPI for Windows - The University of Oklahoma' is visible.

# AASPI GMM

## aaspi\_machine\_learning\_analyze\_input



The screenshot shows the 'Multiattribute Machine Learning' menu with 'Unsupervised learning' selected. A red arrow points to 'Step 2. Analyze unsupervised ML models'. Below, a file selection dialog is open for the directory 'GMM\_demo2026', showing a table of files. The file 'training\_data\_unsupervised\_ext... TXT File' is selected. A red arrow points from the 'Load and append list from a text file' button in the main window to this file in the dialog.

Name	Type	Size	Modified Date	User	Group	Attributes
..	File Folder	0	01/26/2026 15:07:43	0	0	drw-rw-rw-
segy	File Folder	0	01/15/2026 00:05:04	0	0	drw-rw-rw-
training_data_unsupervised_ext...	TXT File	449	01/26/2026 23:15:06	0	0	-rw-rw-rw-

load the training attribute volumes by choosing *load from text file*,

The screenshot shows the 'Attributes' tab with a list of detected attributes and their transformation types. The 'Runtime Parameters' tab is also visible, showing fields for 'Unique Project Name' (demo) and 'Suffix' (2026). A red box highlights the 'Runtime Parameters' tab, and a red arrow points to the 'Unique Project Name' field.

List of attributes detected from input training data:	Transformation Type:	Shift:	Scale:	Scale Logarithm:
1: envelope_demo_2026.H	Z-Score Normalization	0	1	1
2: glcm_entropy_bal_demo_2026.H	Z-Score Normalization	0	1	1
3: k1_demo_2026.H	Z-Score Normalization	0	1	1
4: k2_demo_2026.H	Z-Score Normalization	0	1	1
5: spec_mag_3d_cwt_13Hz_demo_2026.H	Z-Score Normalization	0	1	1
6: spec_mag_3d_cwt_20_5Hz_demo_2026.H	Z-Score Normalization	0	1	1
7: spec_mag_3d_cwt_35_5Hz_demo_2026.H	Z-Score Normalization	0	1	1

customize the session name (suffix, unique project name).

# AASPI GMM

aaspi\_machine\_learning\_analyze\_input



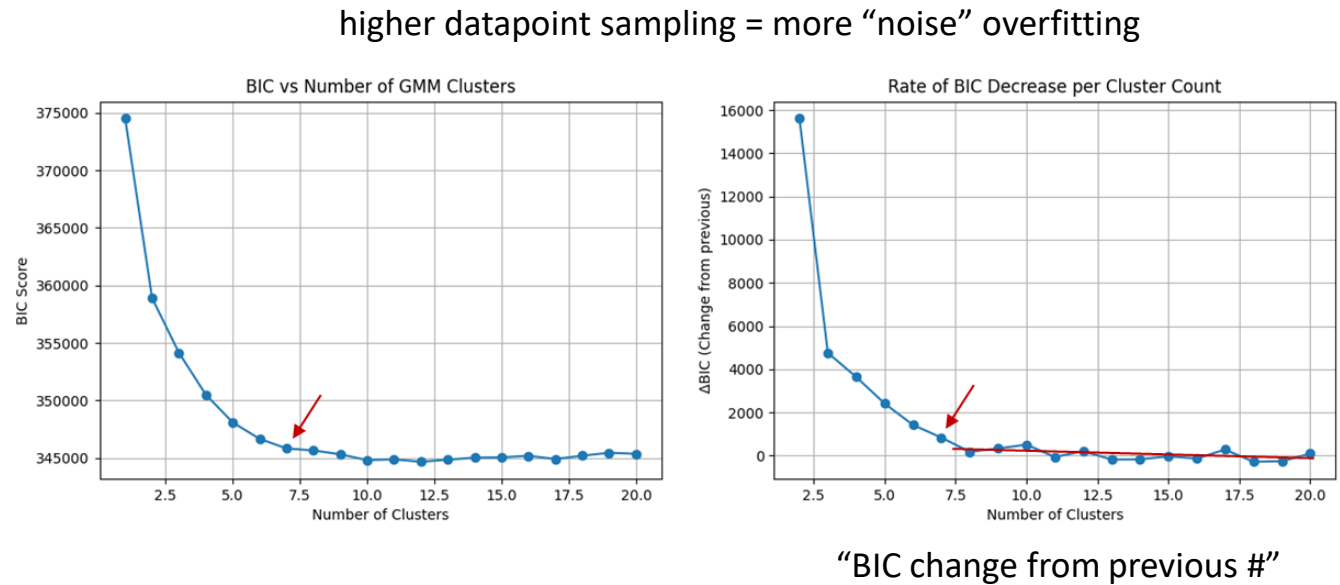
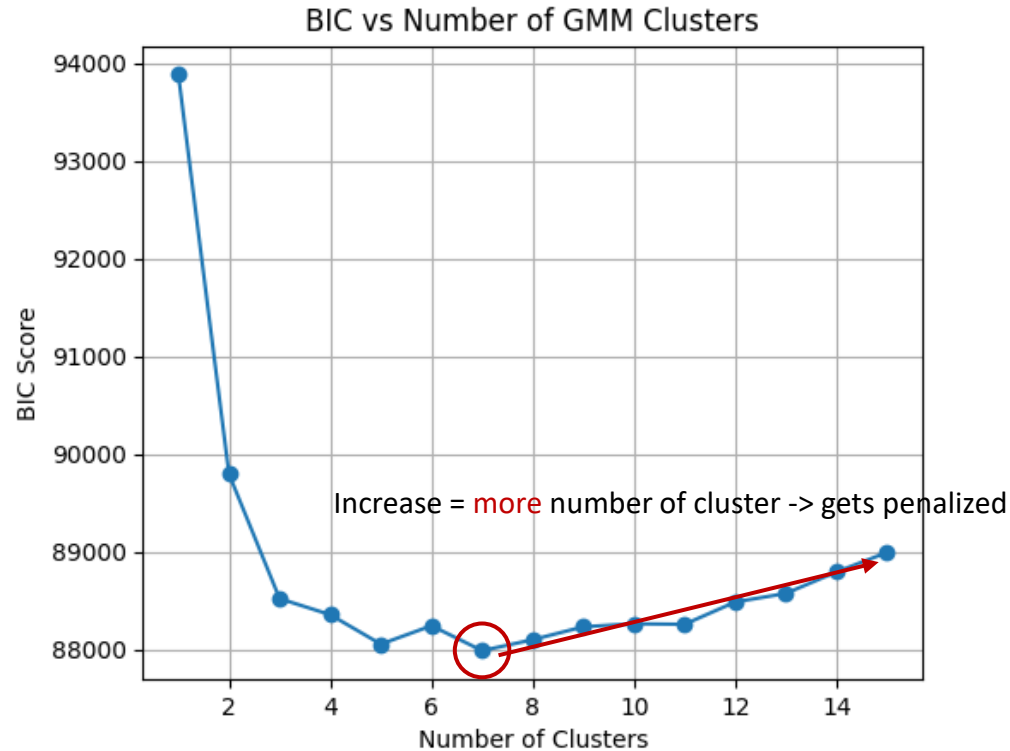
## Bayesian Information Criterion

Generally, you'd want to do **BIC analysis** (2) first to statistically inform **how many clusters is efficient for your specific training dataset**

It will scan up to the number of clusters (1) specified and we'll be able to observe where the BIC value converges/increases

# AASPI GMM | BIC

aaspi\_machine\_learning\_analyze\_input



note: BIC only shows what **statistically** makes sense. It does not have direct relationship with geophysical or geological meaning.

As with most unsupervised clustering methods, it picks up **multi-scale groupings** of data (facies, sub-facies, gradual changes)

# AASPI GMM

aaspi\_machine\_learning\_analyze\_input



File Help

Transformation Analysis | Data Analysis | Despike | PCA | ICA | K-means++ | GMM

Specify parameters for Gaussian Mixture Model (GMM) clustering analysis

GMM Analysis Documentation

Maximum number of clusters:  ← 1

Random seed:

Want Bayesian Information Criteria (BIC) analysis?

View Gaussian distributions?  ← 3

SHAP parameters

Do NOT perform SHAP analysis  Kernel SHAP analysis

Number of random samples per batch:

Number of batches:

Number of trees:

Depth of trees:

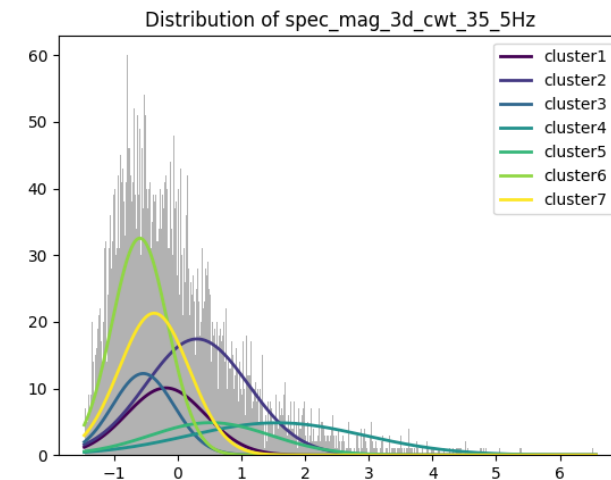
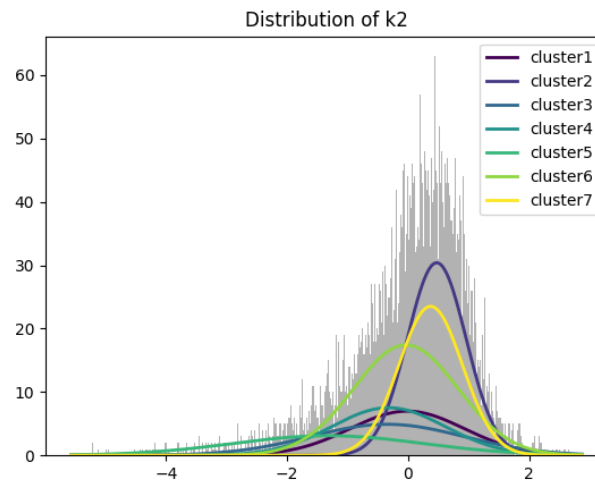
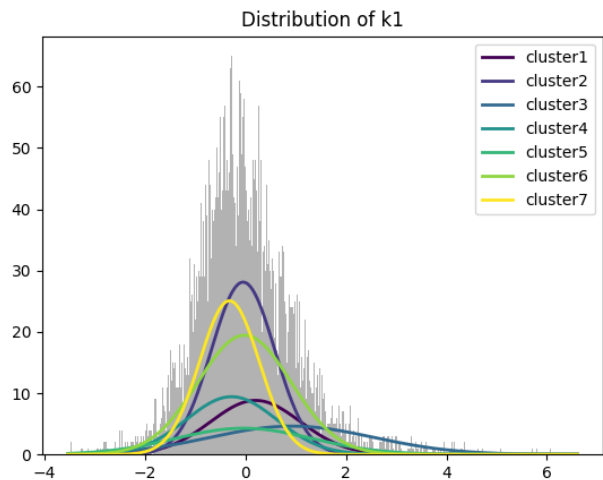
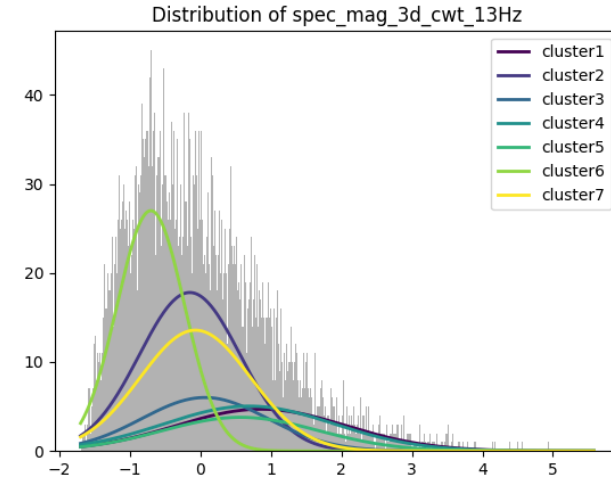
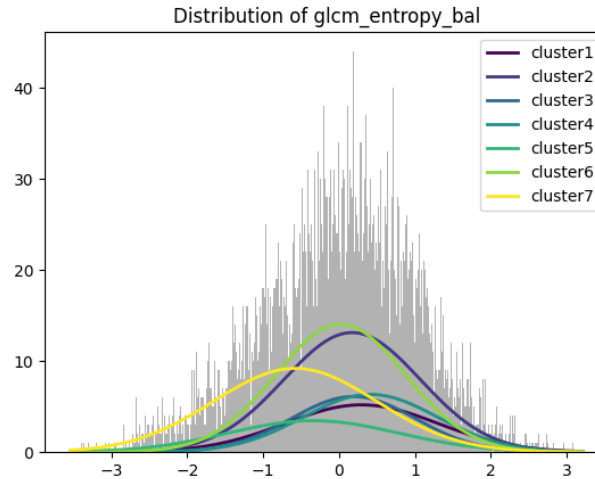
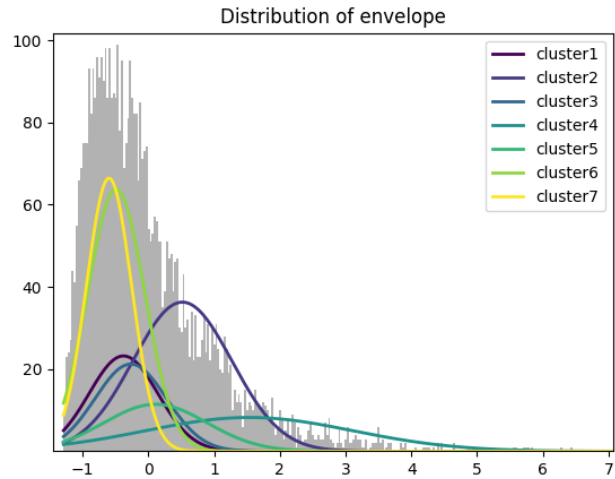
Execute GMM ←

(c) 2008-2026 AASPI for Windows - The University of Oklahoma

The **Gaussian distributions** option (3) will produce histograms of each feature inputs with the specified 'maximum number of Gaussians' fitted (1) overlaid.

# AASPI GMM | Histograms

aaspi\_machine\_learning\_analyze\_input



We can observe and QC how the gaussian distributions relate to the overall seismic attribute (feature input) histogram

# AASPI GMM

aaspi\_machine\_learning\_analyze\_input



File

Transformation Analysis | Data Analysis | Despike | PCA | ICA | K-means++ | GMM

Specify parameters for Gaussian Mixture Model (GMM) clustering analysis

Maximum number of clusters:  ← 1

Random seed:

Want Bayesian Information Criteria (BIC) analysis?

View Gaussian distributions?

SHAP parameters ← 3

Perform SHAP analysis ← 4

Kernel SHAP analysis ← 5

Number of random samples per batch:  ← 6

Number of batches:  ← 7

Number of trees:

Depth of trees:  500 x 10 = 5000

Execute GMM ← 4

History file/Parameter file: machine

```
item[want_bic_analysis]=y
item[view_gaussians]=n
item[perform_shap_analysis]=n
item[n_cluster]=12
item[random_seed]=1000
item[which_shap]=
item[shap_nsample]=500
item[shap_nbatch]=10
item[shap_ntrees]=100
item[shap_max_depth]=10
item[unique_project_name]=demo
item[surrogate]=2026
(4960, 7)
Calculating BIC for 1 clusters
Calculating BIC for 2 clusters
Calculating BIC for 3 clusters
Calculating BIC for 4 clusters
Calculating BIC for 5 clusters
Calculating BIC for 6 clusters
Calculating BIC for 7 clusters
Calculating BIC for 8 clusters
Calculating BIC for 9 clusters
Calculating BIC for 10 clusters
Calculating BIC for 11 clusters
Calculating BIC for 12 clusters
plotting...
displaying...
done
```

GMM Analysis Documentation

(c) 2008-2026 AASPI for Windows - The University of Oklahoma

We toggle the SHAP Analysis button (4) and determine the batch size (6) for sampling the dataset, and how many batches (7) you want to scan through.

Two options of SHAP calculation (5): **Kernel SHAP** traditionally calculates the values by testing out the model Input-Output. This will take exponentially longer the bigger the batch size.

**Surrogate Tree SHAP** uses a random forest model to fit the input-output set of the model, which will take significantly faster but requires parameterization of the surrogate tree model that properly simulates the GMM

Make sure the batch Kernel settings (6) (7) are not greyed out. This confirms we have Kernel SHAP selected.

# SHapley Additive exPlanations | Game Theory

Relay Win **Probability** = Hilmi's run + Aniq's run + Yasin's run + Jared's run

Cluster 1 **Probability** = Amplitude + Spectrum + Texture + Structural

	Coalition size 1		2		3	
Amplitude	Amplitude <b>Texture</b>	Amplitude	Amplitude Spectrum <b>Texture</b>	Amplitude Spectrum	Amplitude Spectrum Structural	Amplitude Spectrum Structural
Spectrum	Spectrum <b>Texture</b>	Spectrum	Amplitude Structural <b>Texture</b>	Amplitude Structural	<b>Texture</b>	
<b>Texture</b>	Structural <b>Texture</b>	Structural	Spectrum Structural <b>Texture</b>	Spectrum Structural		
Structural						
		3		3		1

Contribution =  $w/\text{Texture} - w/o \text{Texture}$

# SHapley Additive exPlanations | Kernel SHAP



Uses 'average world' to simulate not knowing a feature  
Representative values of the normal/background

sleep quality = duration + heart rate + breathing + movement

You can't just **NOT** breathe

So, what's the normal value? Then we test the other variables changes

it simulates **absence** then smartly samples the responses  
of the model to the input feature values

↓  
**probability** value

Vs

actual probability value of that **datapoint**

# AASPI GMM | SHAP

aaspi\_machine\_learning\_analyze\_input



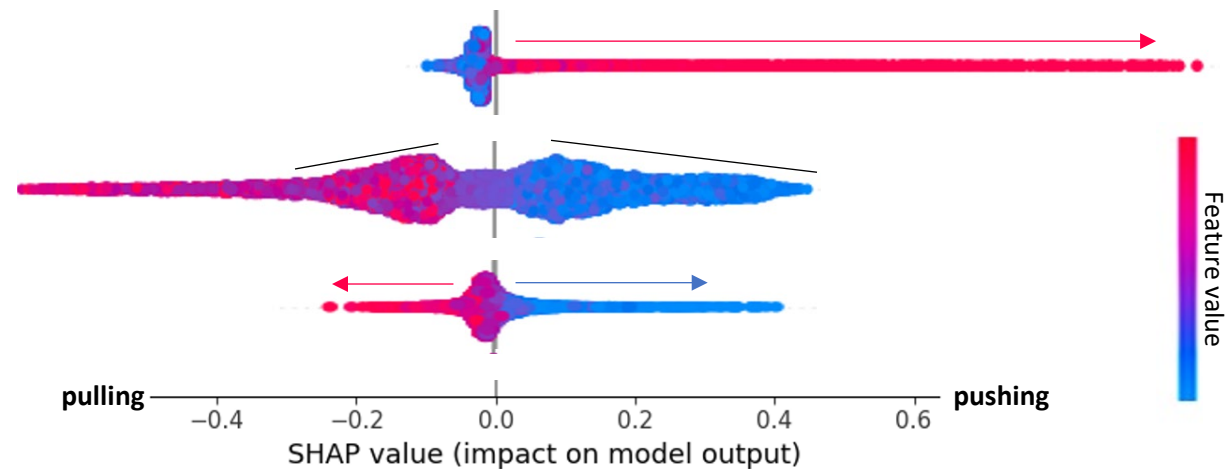
## Beeswarm plot

**X axis** is influence to output (SHAP values): **pushes** into or **pulls** from the cluster membership

**Color** is attribute value: **high/low** for characterization

**Thickness** is data point distribution (how many datapoint has that influence value for that attribute)

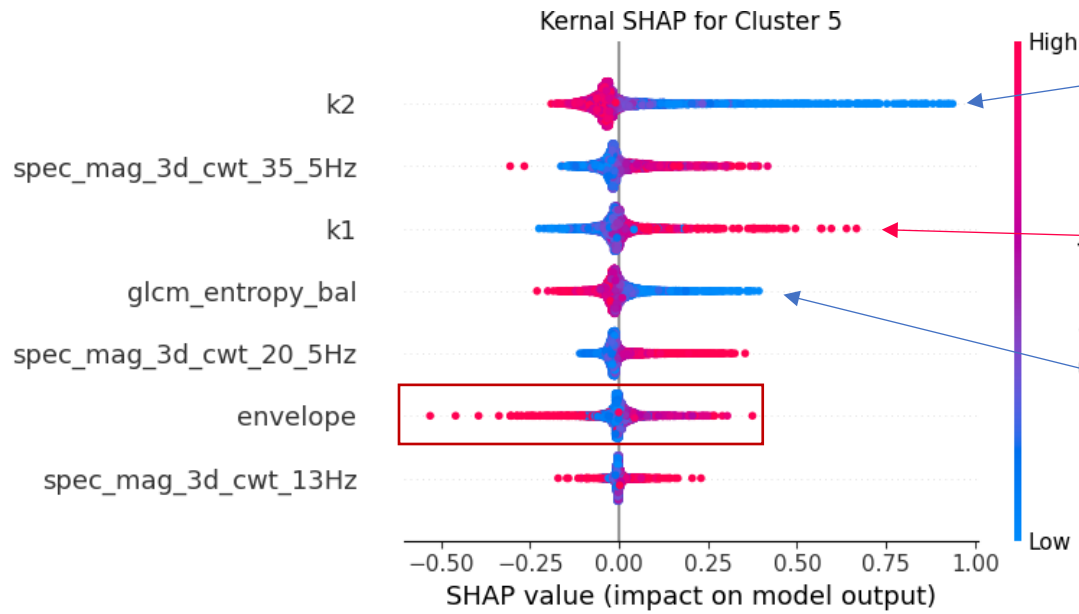
**Sort** is feature importance, typically wider *spread* of SHAP values



- **direction** of influence -> attribute indicator
- how **polarized** is the feature value distribution, one side? both side? gradual?
- **distribution** of the SHAP values of the dataset

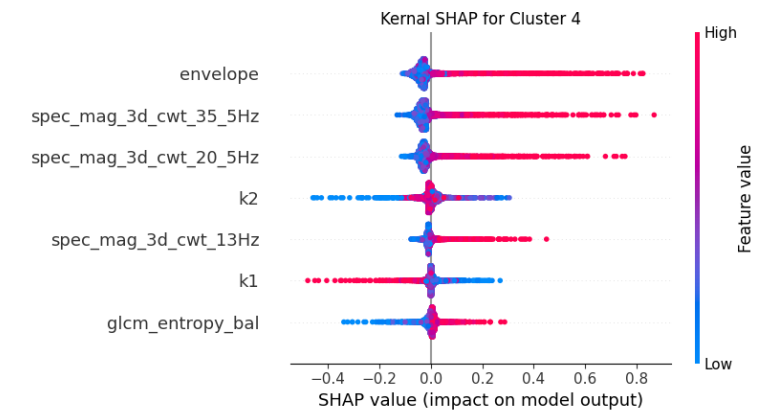
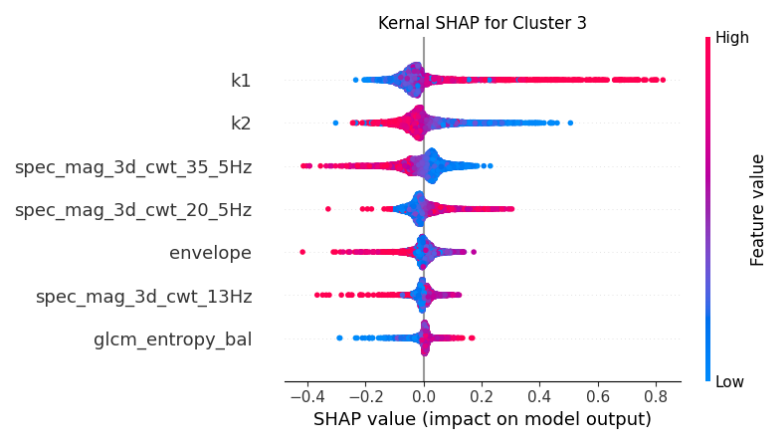
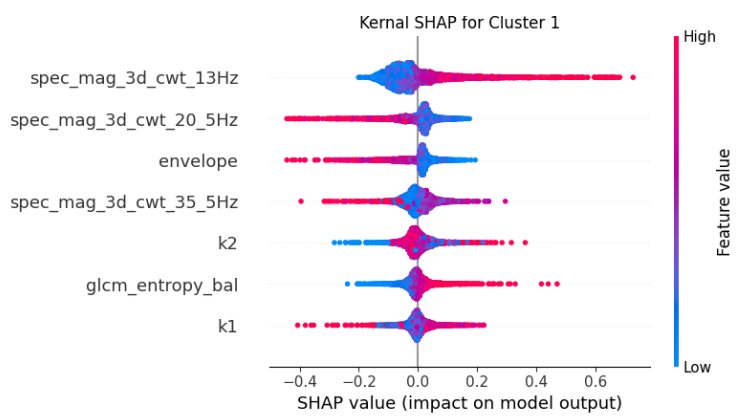
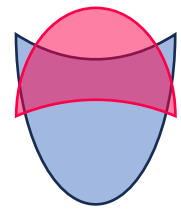
# AASPI GMM | SHAP

aaspi\_machine\_learning\_analyze\_input



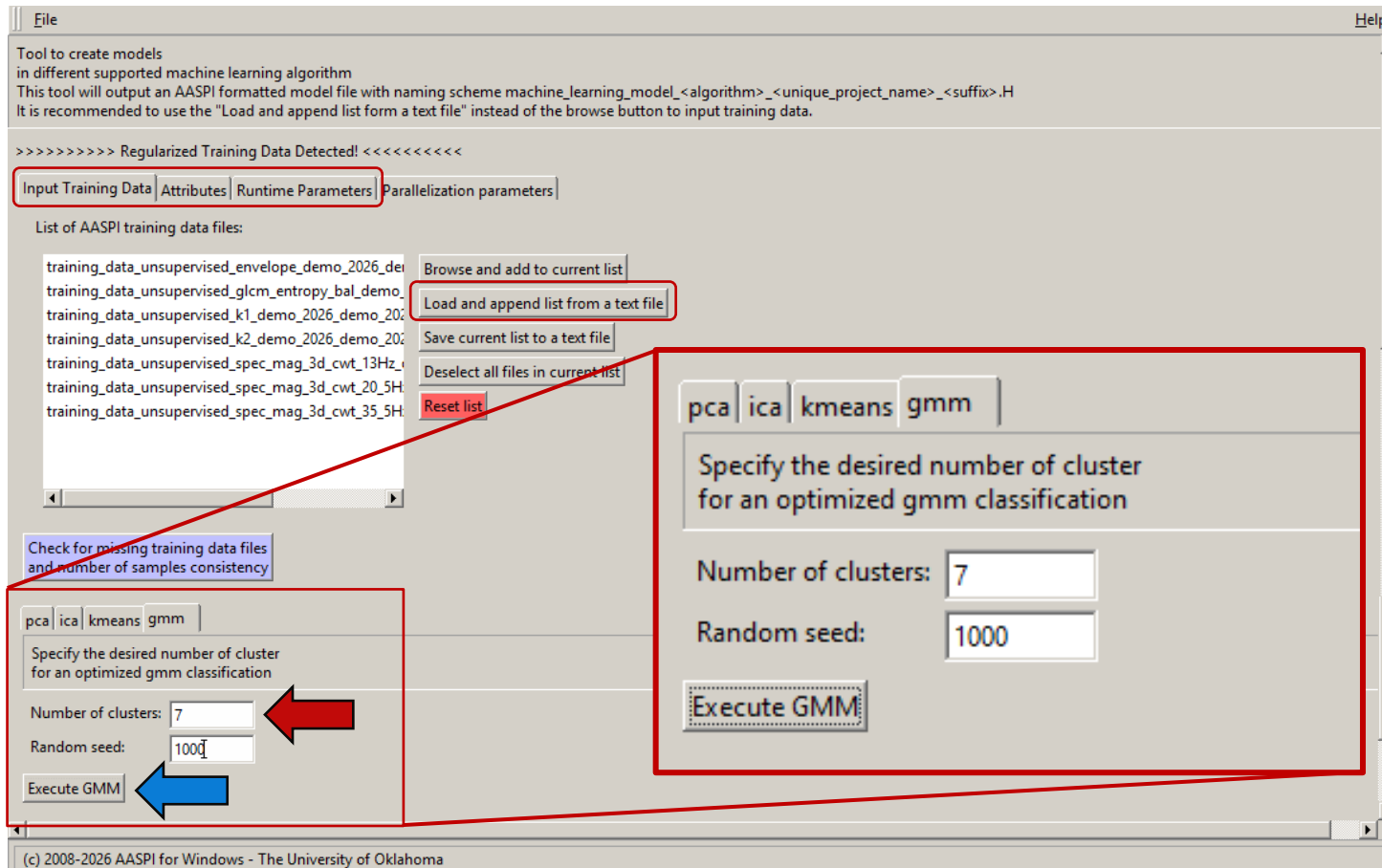
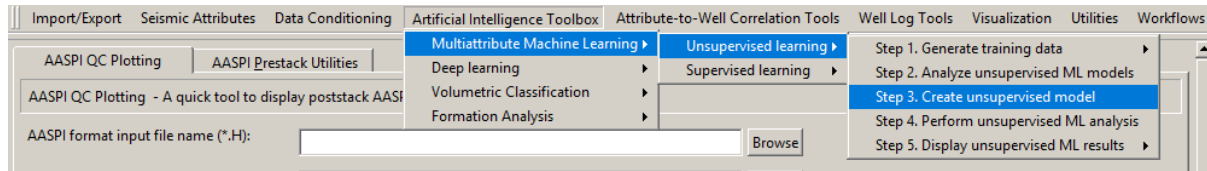
Cluster is characterized by **low** value **K2** (minimum negative curvature) and **high** value **K1** (max positive curvature)!

**GLCM entropy texture: concordant/not-chaotic/uniform**  
**Low** values >increase> towards membership  
**High** <decreases<



# AASPI GMM

## aaspi\_machine\_learning\_create model



Just like analyze\_input:

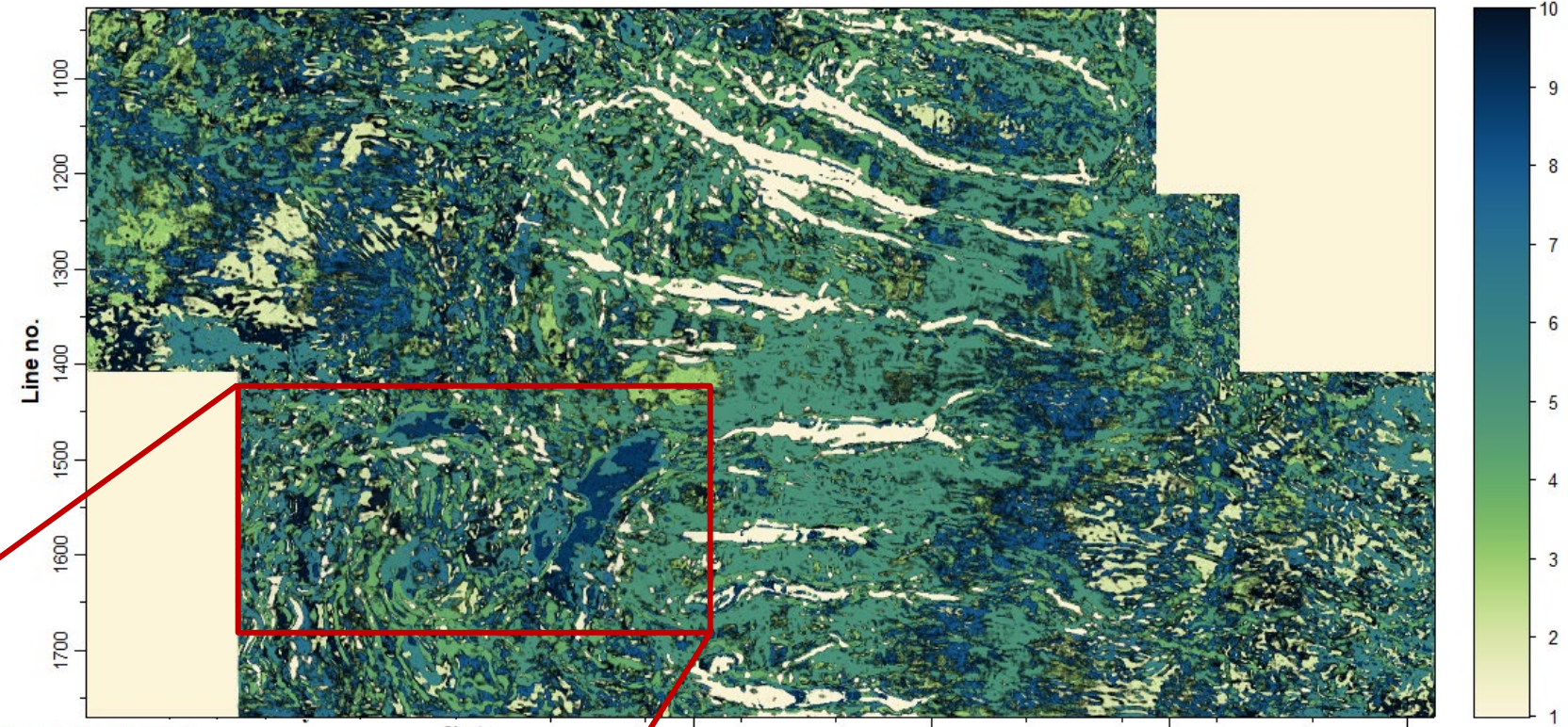
- load the attribute volumes from the text file,
- adjust the attribute normalization parameters, and
- customize the session name (suffix, unique project name).

Then input the optimum number of cluster that we have: 7 and **execute** to build the model.

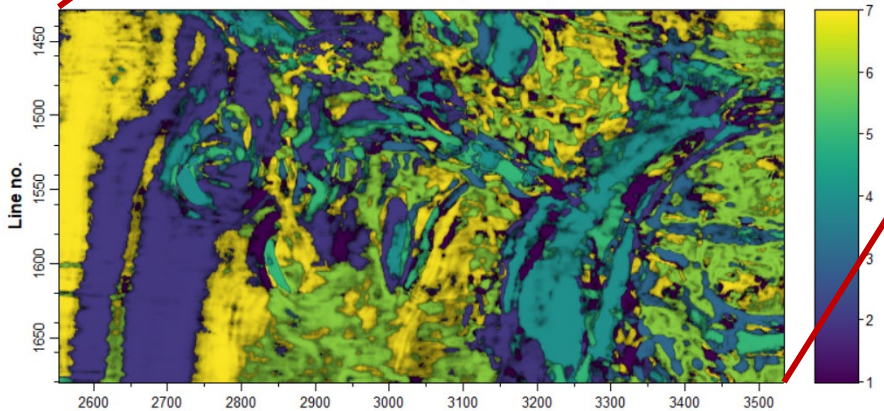


# GMM Output | `gmm_cluster_output_[project]_[suffix]`

Time about horizon=0.3 (Panel=51)



Time=1.456 (Panel=7)



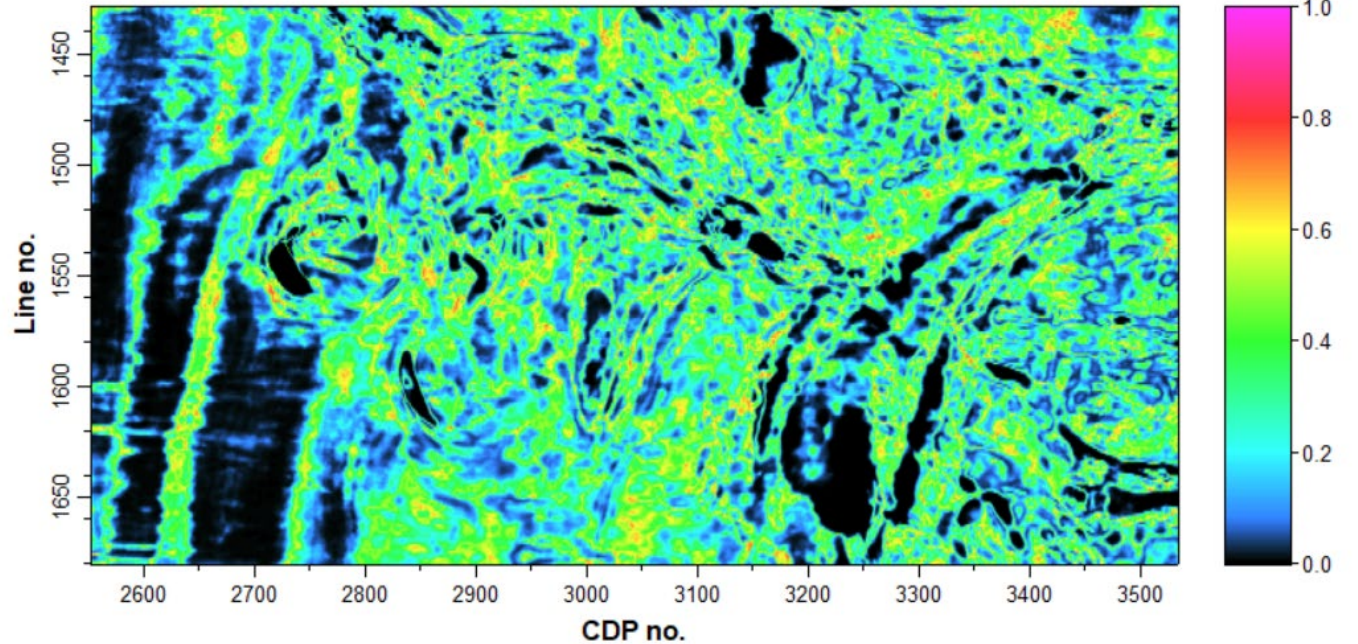
By looking at the Labels, we can intuitively select which Clusters represent our target objects of interest.

The smaller cropped volume was run separately to demonstrate the reliance of unsupervised methods to the provided training dataset-attribute quality

# GMM Output | `gmm_cluster_uncertainty_[project]_[suffix]`



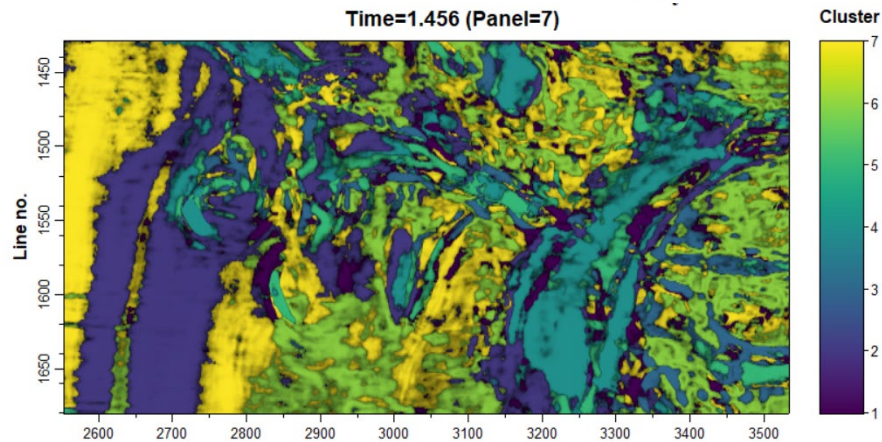
**GMM uncertainty**  
Time=1.456 (Panel=7)



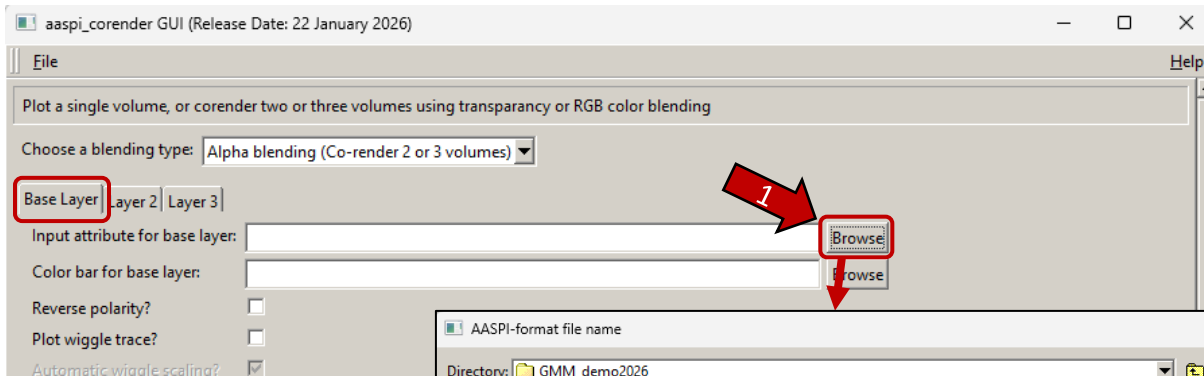
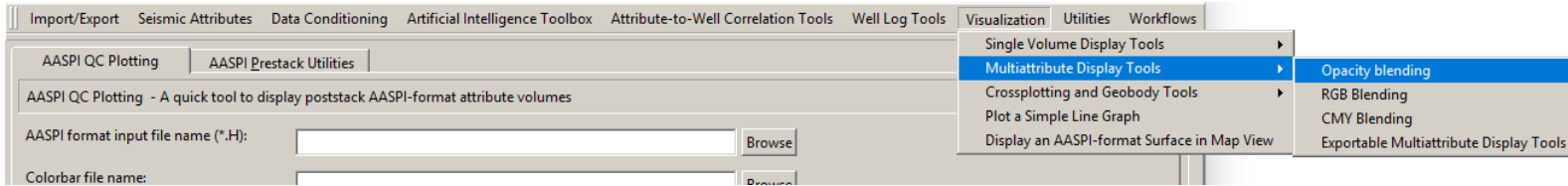
1 - [maximum probability across all clusters]

This volume is useful to see where the edges of our clusters are. It makes a good co-render with the main label output and **adds nuance of facies gradual changes**

Time=1.456 (Panel=7)



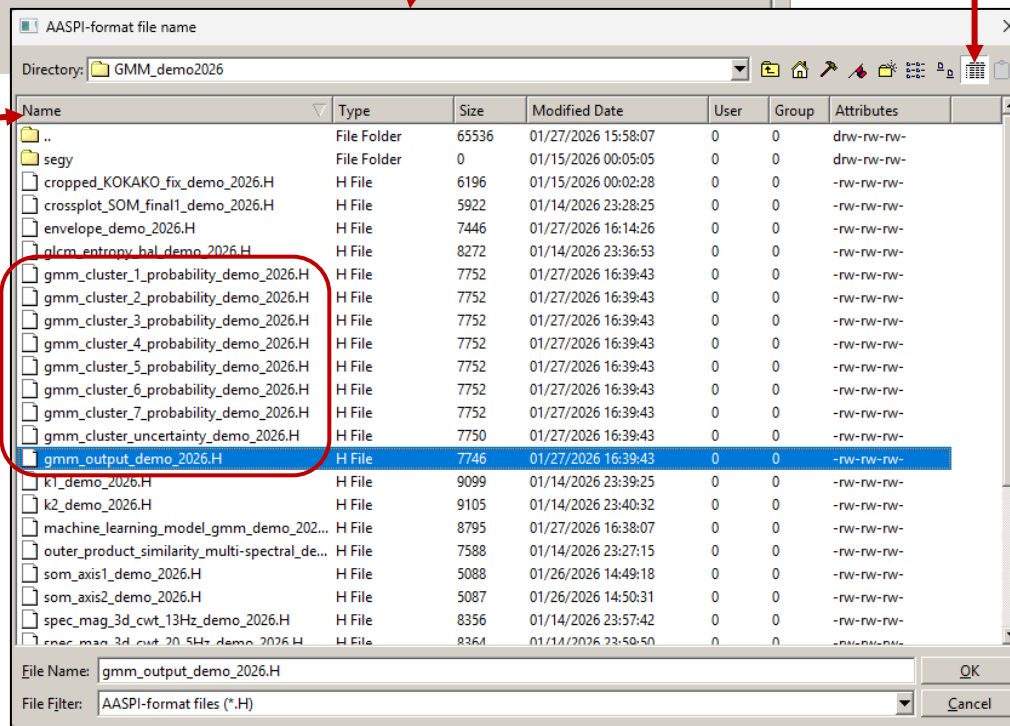
# Co-rendering gmm\_cluster\_output x gmm\_uncertainty



Pro tip: click [this](#) to change browser to detailed view

Pro tip: click [the column names](#) to sort by column

gmm products will have gmm prefix



# Co-rendering gmm\_cluster\_output x gmm\_uncertainty



**Base Layer** | Layer 2 | Layer 3

Input attribute for base layer: C:\Users\hilmi\Documents\GMM\_demo2026\gmm\_output\_demo\_2026.H

Color bar for base layer: rainbow\_viridis.alut

Reverse polarity?

Plot wiggle trace?

Automatic wiggle scaling?

Fill positive parts of wiggles?

Manual wiggle scale: 50

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped): 5

Maximum percentage value (Higher values will be clipped): 95

All positive values?

Min-max data ranging

Minimum value: 1

Maximum value: 7

Plot Title: Corendered GMM

Axis 1 min Time: 1.36

Axis 1 max Time: 1.664

Axis 1 inc Time: 0.016

Axis 2 min CDP no.: 2555

Axis 2 max CDP no.: 3534

Axis 2 inc CDP no.: 1

Axis 3 min Line no.: 1430

Axis 3 max Line no.: 1680

Axis 3 inc Line no.: 1

Desired output axis 1: Line no.

Desired output axis 2: CDP no.

Desired output axis 3: Time

Reverse x-axis? n

Reverse y-axis? n

Want color bar? y

**Layer 2** | Layer 3

Input attribute for layer 2: C:\Users\hilmi\Documents\GMM\_demo2026\gmm\_cluster\_uncertainty\_demo\_2026.H

Color bar for layer 2: C:\AASPI\_for\_Demo\AASPI\_colors\monochrome\_black.alut

Reverse polarity?

Opacity curve type: For single-polarity attributes: set low values transparent, high values opaque

Plot wiggle trace? For single-polarity attributes: set low values transparent, high values opaque

Automatic wiggle scaling?

Fill positive parts of wiggles?

Manual wiggle scale:

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped):

Maximum percentage value (Higher values will be clipped):

All positive values?

Min-max data ranging

Minimum value: 0

Maximum value: 1

Plot Title: Corendered GMM GMM uncertainty

Axis 1 min Time: 1.36

Axis 1 max Time: 1.664

Axis 1 inc Time: 0.016

Axis 2 min CDP no.: 2555

Axis 2 max CDP no.: 3534

Axis 2 inc CDP no.: 1

Axis 3 min Line no.: 1430

Axis 3 max Line no.: 1680

Axis 3 inc Line no.: 1

Desired output axis 1: Line no.

Desired output axis 2: CDP no.

Desired output axis 3: Time

Reverse x-axis? n

Reverse y-axis? y

Want color bar? y

browse for layer 2:  
gmm\_cluster\_uncertainty  
then browse for colorbar (6)

choose *monochrome\_black*  
then select the first opacity  
curve (7)

Colorbar File

Directory: AASPI\_colors

Name	Type	Size	Modified Date	User	Group	Attributes
naime.alut	ALUT File	4069	12/12/2024 13:42:50	0	0	-rw-rw-rw-
hot.alut	ALUT File	3681	12/02/2021 14:24:52	0	0	-rw-rw-rw-
Isochron.alut	ALUT File	3545	01/21/2026 12:25:04	0	0	-rw-rw-rw-
lipari.alut	ALUT File	4046	12/12/2024 13:42:50	0	0	-rw-rw-rw-
magenta.alut	ALUT File	4242	12/02/2021 14:24:52	0	0	-rw-rw-rw-
magnitude_lajolla.alut	ALUT File	3922	02/17/2025 10:21:54	0	0	-rw-rw-rw-
managua_flip.alut	ALUT File	3998	12/12/2024 13:42:50	0	0	-rw-rw-rw-
monochrome_black.alut	ALUT File	2816	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_black_with_high...	ALUT File	2617	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_black_with_low...	ALUT File	2625	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_blue_oslo.alut	ALUT File	4003	01/26/2025 16:03:12	0	0	-rw-rw-rw-
monochrome_gray.alut	ALUT File	43452	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_white.alut	ALUT File	4352	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_yellow.alut	ALUT File	3840	12/02/2021 14:24:52	0	0	-rw-rw-rw-
navia.alut	ALUT File	4045	12/12/2024 13:42:50	0	0	-rw-rw-rw-
rainbow.alut	ALUT File	3731	12/02/2021 14:24:52	0	0	-rw-rw-rw-
rainbow_viridis.alut	ALUT File	3989	01/26/2025 16:03:12	0	0	-rw-rw-rw-
rainbow_w_black_white_extrem...	ALUT File	3730	12/02/2021 14:24:52	0	0	-rw-rw-rw-
rainbow_with_znull_gray_at_ne...	ALUT File	3852	12/02/2021 14:24:52	0	0	-rw-rw-rw-
red.alut	ALUT File	3218	12/02/2021 14:24:52	0	0	-rw-rw-rw-
red_white_blue.alut	ALUT File	4132	12/02/2021 14:24:52	0	0	-rw-rw-rw-
red_white_blue_balance.alut	ALUT File	4046	01/26/2025 16:03:12	0	0	-rw-rw-rw-
romaO.alut	ALUT File	4098	02/17/2025 10:21:54	0	0	-rw-rw-rw-

File Name: monochrome\_black.alut

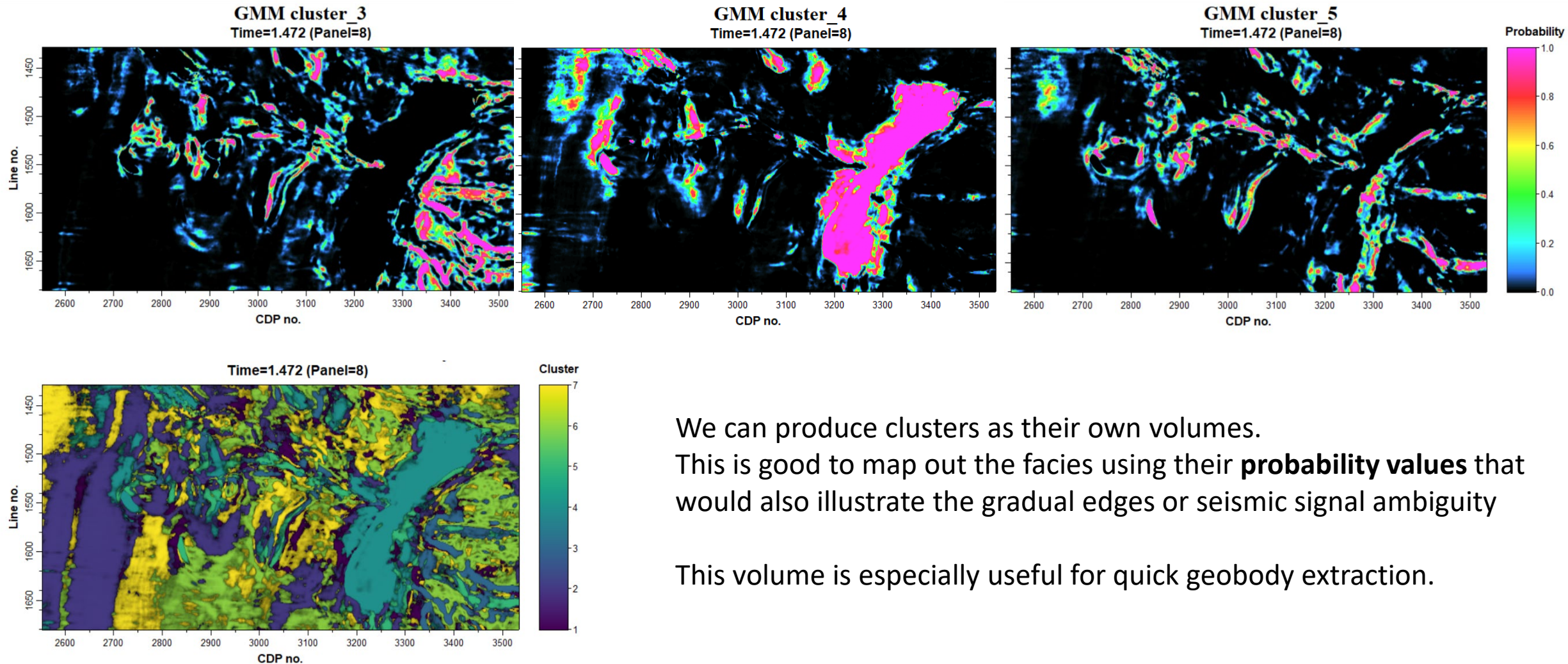
File Filter: Colorbar Files (\*.alut;\*.alut)



Change axis 3 (3) to "Time"  
then change increments (4)  
to 0.016s -> 16ms



# GMM Output | `gmm_cluster_[cluster number]_probability_[project]_[suffix]`



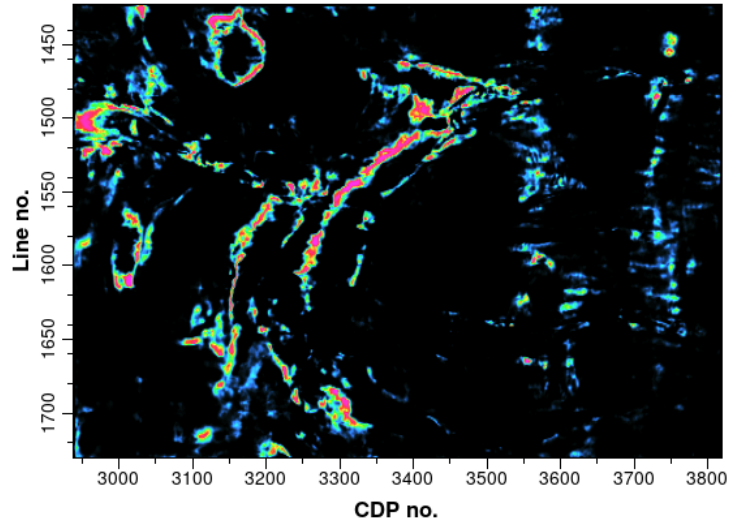
We can produce clusters as their own volumes.  
This is good to map out the facies using their **probability values** that would also illustrate the gradual edges or seismic signal ambiguity

This volume is especially useful for quick geobody extraction.

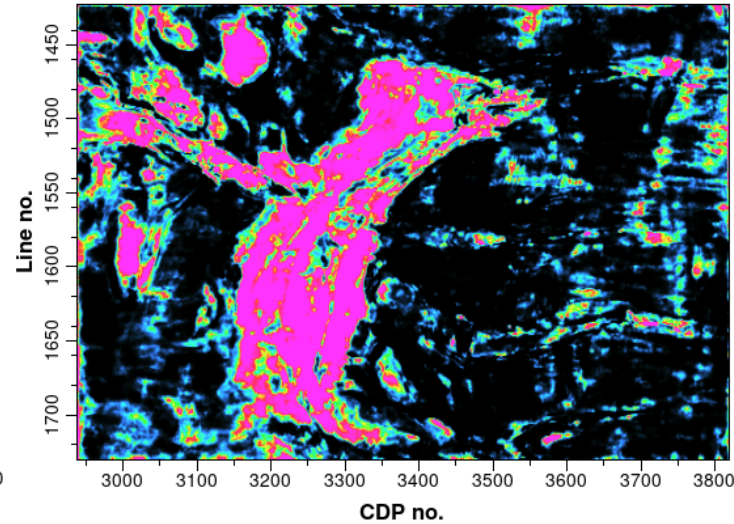
# GMM Output | `gmm_cluster_[cluster number]_probability_[project]_[suffix]`



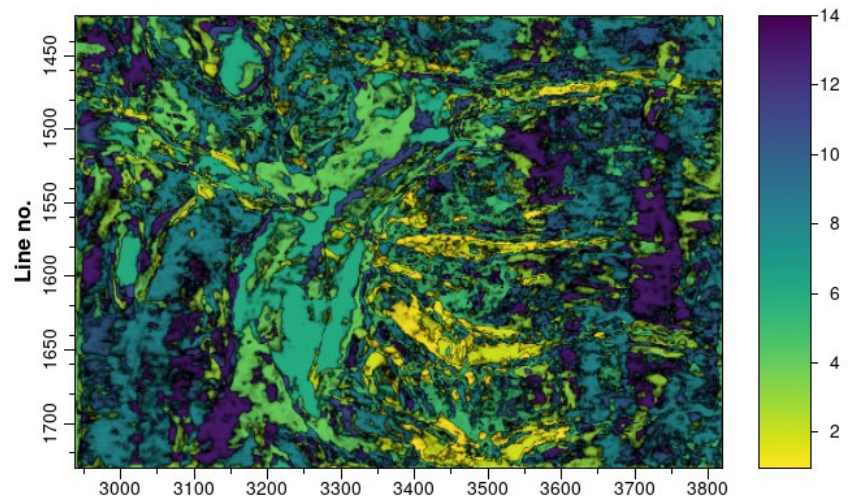
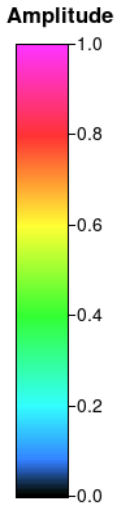
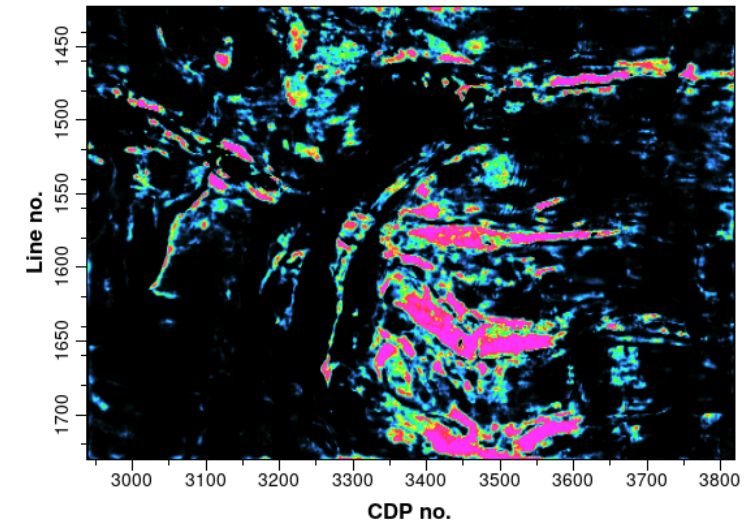
GMM cluster\_11  
Time=1.456 (Panel=14)



GMM cluster 4&6  
Time=1.456 (Panel=14)



GMM cluster 1&2  
Time=1.456 (Panel=14)



We can produce clusters as their own volumes.  
This is good to map out the facies using their **probability values** that would also illustrate the gradual edges or seismic signal ambiguity  
This volume is especially useful for quick geobody extraction.

# Co-rendering seismic x gmm\_cluster\_probability

Base layer:

Directory: GMM\_demo2026

Name	Type	Size	Modified Date	User	Group	Attributes
..	File Folder	65536	01/27/2026 15:58:07	0	0	drw-rw-rw-
segy	File Folder	0	01/15/2026 00:05:05	0	0	drw-rw-rw-
cropped_KOKAKO_fix_demo_2026.H	H File	6196	01/15/2026 00:02:28	0	0	-rw-rw-rw-
crossplot_SOM_final1_demo_2026.H	H File	5922	01/14/2026 23:28:25	0	0	-rw-rw-rw-
envelope_demo_2026.H	H File	7446	01/27/2026 16:14:26	0	0	-rw-rw-rw-
qlcm_entropy_bal_demo_2026.H	H File	8272	01/14/2026 23:36:53	0	0	-rw-rw-rw-

Base Layer Layer 2 Layer 3

Input attribute for base layer: \Users\hilm\Documents\GMM\_demo2026\cropped\_KOKAKO\_fix\_demo\_2026.H

Color bar for base layer: C:\AASPI\_for\_Demo\AASPI\_colors\red\_white\_blue\_balance.alut

Reverse polarity?

Plot wiggle trace?

Automatic wiggle scaling?

Fill positive parts of wiggles?

Manual wiggle scale: 50

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped): 5

Maximum percentage value (Higher values will be clipped): 95

All positive values?

browse (1) seismic data (*cropped\_KOKAKO\_fix\_demo\_2026*)  
 then browse for colorbar (2) *red\_white\_blue\_balance* or  
 whichever colorbar you like for looking at seismic

Layer 2:

Base Layer Layer 2 Layer 3

Input attribute for layer 2: \hilm\Documents\GMM\_demo2026\gmm\_cluster\_4\_probability\_demo\_2026.H

Color bar for layer 2: C:\AASPI\_for\_Demo\AASPI\_colors\monochrome\_black.alut

Reverse polarity?

Opacity curve type: For single-polarity attributes: set high values transparent, low values opaque

Plot wiggle trace: For single-polarity attributes: set low values transparent, high values opaque

Automatic wiggle scaling? For single-polarity attributes: set high values transparent, low values opaque

Fill positive parts of wiggles? For dual-polarity attributes: set extreme values transparent, zero values opaque

Manual wiggle scale: Custom settings read from the alpha channel on a \*.alut-format colorbar file

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped): 5

Maximum percentage value (Higher values will be clipped): 95

All positive values?

Min-max data ranging

Minimum value: 0

Maximum value: 1

Plot Title: Corendered crop Input Seismic Amplitude Data GMM cluster\_4

Axis 1 min Time: 1.36

Axis 1 max Time: 1.664

Axis 1 inc Time: 0.004

Axis 2 min CDP no.: 2555

Axis 2 max CDP no.: 3534

Axis 2 inc CDP no.: 10

Axis 3 min Line no.: 1430

Axis 3 max Line no.: 1680

Axis 3 inc Line no.: 1

Desired output axis 1: Time

Desired output axis 2: Line no.

Desired output axis 3: CDP no.

Reverse x-axis?

Reverse y-axis?

Want color bar?

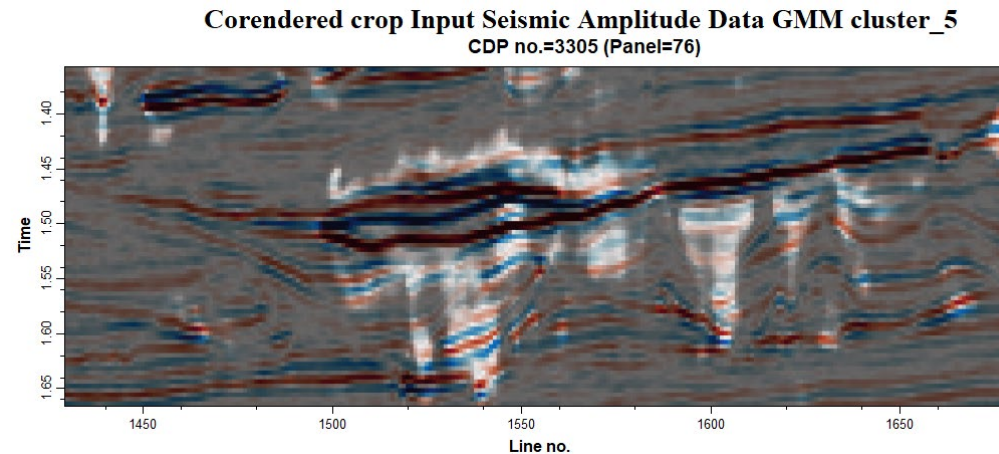
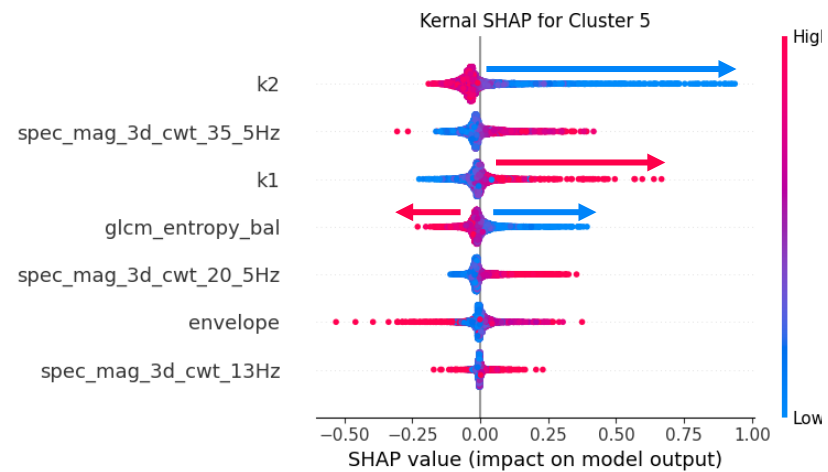
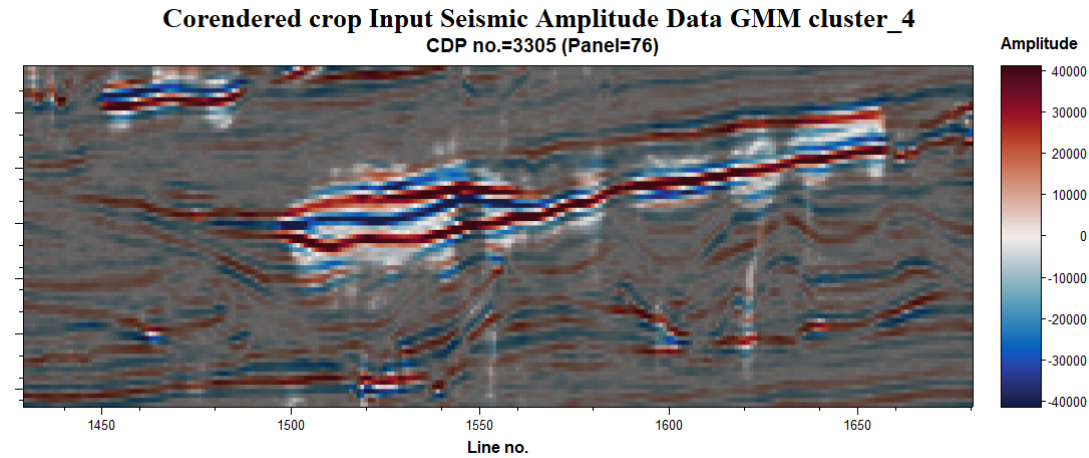
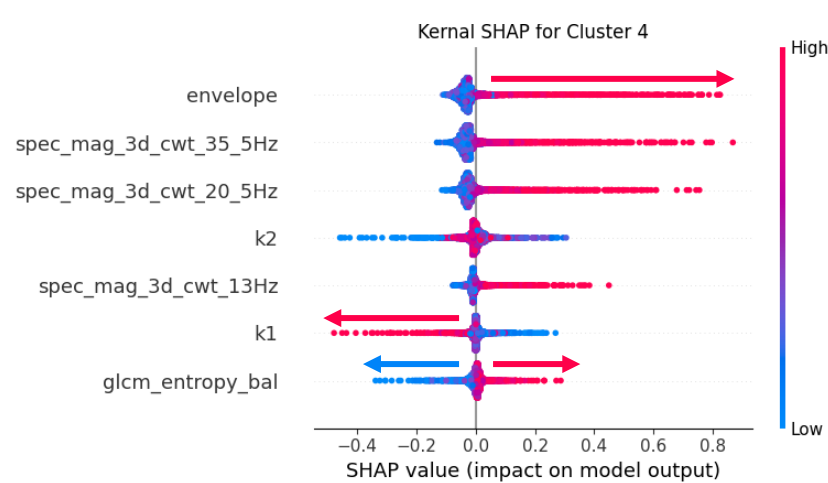
Execute corender

on layer 2

choose (3) *gmm\_cluster\_4\_probability*  
 set the colorbar (4) to *monochrome\_black*  
 then choose (5) the 2<sup>nd</sup> opacity curve

Change axis 2 (6) to Line if you  
 want to look at Xline section

# Co-rendering seismic x gmm\_cluster\_probability



Factors to consider:

- seismic attribute quality
- training data
- facies hierarchy



## +1 Machine Learning tool in your arsenal

With this not only are we utilizing machine learning to extract patterns, we're also getting meaning to the patterns

Gaussian Mixture Model may simulate how the real geological distribution works:

Shale | Sand

Shale >>>>> Sand (v/shale)

SHAP facies characterization adds QC to machine learning model AND could add interpretation value

# Acknowledgements



As always, thank you Dr Heather Bedle, Dr David Lubo-Robles, Dr Kurt Marfurt

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New Zealand Petroleum and Minerals the Kokako 3D dataset for our prototype testing



and to the AASPI sponsors:



# GMM Step0 Navigate to Multiattribute Machine Learning Toolbox



The screenshot shows the 'aaspi\_util GUI - Post Stack Utilities (Release Date: 22 January 2026)' window. The 'Artificial Intelligence Toolbox' menu is open, showing 'Multiattribute Machine Learning' selected. A sub-menu for 'Unsupervised learning' is also open, with 'Step 1. Generate training data' selected. A further sub-menu for 'Step 1. Generate training data' is open, showing the following steps:

- Step 1. Plot and define polygons
- Step 2. Convert polygons to point sets
- (Alternative) Convert surfaces to point sets
- Step 3. Extract user-defined data

The main window contains various input fields and options for configuring the tool. The 'AASPI format input file name (\*.H):' field is empty, with a 'Browse' button next to it. Other fields include 'Colorbar file name:', 'Enter plot title:', and three sets of 'Minimum label', 'Maximum label', and 'Increment label' for labels 1, 2, and 3. The 'Desired output axis' dropdowns are set to 'label1', 'label2', and 'label3'. There are also checkboxes for 'Reverse x-axis?', 'Reverse y-axis?', 'Display color bar?', 'Wiggle plot instead of color image?', 'Automatic wiggle scaling?', 'Fill positive parts of wiggles?', and 'Use statistical data scaling?'. The 'Manual wiggle scale' is set to 50. At the bottom, a status bar reads 'Construct training data by extracting attribute vectors from point sets'.

# Step1 aaspi\_training\_data



Tool to extract training data for either unsupervised (data decimation) or supervised classification (point sets and/or wells)  
The output will be multiple files corresponding to each attribute PER each point set/well and will be in the form of single trace (1D) data

List of AASPI attribute files:

- 2026\GMM\_demo2026\envelope\_demo\_2026.H
- 2026\GMM\_demo2026\glcm\_entropy\_bal\_demo\_2026.H
- 2026\GMM\_demo2026\k1\_demo\_2026.H
- 2026\GMM\_demo2026\k2\_demo\_2026.H
- 2026\GMM\_demo2026\spec\_mag\_3d\_cwt\_13Hz\_demo\_2026.H
- 2026\GMM\_demo2026\spec\_mag\_3d\_cwt\_20\_5Hz\_demo\_2026.H
- 2026\GMM\_demo2026\spec\_mag\_3d\_cwt\_35\_5Hz\_demo\_2026.H

Buttons: Browse and add to current list, Load and append list from a text file, Save current list to a text file, Deselect all files in current list, Remove selected files from current list, Reset list

Options:  
Take care of dead trace?   
Take care of mute?   
Extract coordinates (x,y,z) as attributes?   
Vertical unit factor: 8000  
Unique project name: demo  
Suffix: 2026  
Verbose output?

Don't forget to customize the session name (suffix, unique project name)

Time Interval (s): 0.016 (1)  
CDP no. Start: 2555  
CDP no. End: 3534  
CDP no. Interval: 32 (2)  
Line no. Start: 1430  
Line no. End: 1680  
Line no. Interval: 32 (3)

Extract unsupervised training data

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Please select AASPI files

Directory: GMM\_demo2026

Name	Type	Size	Modified Date	User	Group	Attr
..	File Folder	0	01/26/2026 15:07:43	0	0	drw-r
segy	File Folder	0	01/15/2026 00:05:04	0	0	drw-r
cropped_KOKAKO_fix_demo_2026.H	H File	6196	01/15/2026 00:02:28	0	0	-rw-r
crossplot_SOM_final1_demo_2026.H	H File	5922	01/14/2026 23:28:24	0	0	-rw-r
envelope_demo_2026.H	H File	7462	01/14/2026 23:34:12	0	0	-rw-r
glcm_entropy_bal_demo_2026.H	H File	8272	01/14/2026 23:36:52	0	0	-rw-r
k1_demo_2026.H	H File	9099	01/14/2026 23:39:24	0	0	-rw-r
k2_demo_2026.H	H File	9105	01/14/2026 23:40:32	0	0	-rw-r
outer_product_similarity_multi-spectral_demo_2026.H	H File	7588	01/14/2026 23:27:14	0	0	-rw-r
som_axis1_demo_2026.H	H File	5088	01/26/2026 14:49:18	0	0	-rw-r
som_axis2_demo_2026.H	H File	5087	01/26/2026 14:50:30	0	0	-rw-r
spec_mag_3d_cwt_13Hz_demo_2026.H	H File	8356	01/14/2026 23:57:42	0	0	-rw-r
spec_mag_3d_cwt_20_5Hz_demo_2026.H	H File	8364	01/14/2026 23:59:50	0	0	-rw-r
spec_mag_3d_cwt_35_5Hz_demo_2026.H	H File	8364	01/15/2026 00:01:04	0	0	-rw-r

File Name: "spec\_mag\_3d\_cwt\_13Hz\_demo\_2026.H" "spec\_mag\_3d\_cwt\_20\_5Hz\_demo\_2026.H" "spec\_mag\_3d\_cwt\_35\_5Hz\_demo\_2026.H" OK

File Filter: AASPI files (\*.H) Cancel

Pro tip: hold down "ctrl" to multi select

Select:  
- envelope  
- glcm\_entropy  
- K1 & K2  
- 3 CWT spectral magnitudes

Scroll down, set time interval sampling (1) to 0.016s -> 16ms  
set the CDP (2) and Line (3) sampling to 32

# Step2 aaspi\_machine\_learning\_analyze\_input



The screenshot displays the AASPI software interface. The top menu bar includes 'Import/Export', 'Seismic Attributes', 'Data Conditioning', 'Artificial Intelligence Toolbox', 'Attribute-to-Well Correlation Tools', 'Well Log Tools', 'Visualization', 'Utilities', and 'Workflows'. The 'Artificial Intelligence Toolbox' is expanded to show 'Multiattribute Machine Learning', which is further expanded to 'Unsupervised learning'. A sub-menu is open, showing 'Step 1. Generate training data', 'Step 2. Analyze unsupervised ML models', 'Step 3. Create unsupervised model', 'Step 4. ...', and 'Step 5. D...'. The 'Load list from a text file' dialog box is open, showing the directory 'GMM\_demo2026' with a table of files:

Name	Type	Size	Modified Date	User	Group	Attributes
..	File Folder	0	01/26/2026 15:07:43	0	0	drw-rw-rw-
segy	File Folder	0	01/15/2026 00:05:04	0	0	drw-rw-rw-
training_data_unsupervised_ext...	TXT File	449	01/26/2026 23:15:06	0	0	-rw-rw-rw-

The 'aaspi\_machine\_learning\_analyze\_input' tool window is shown with the 'Input Training Data' tab selected. A red box highlights the 'Input Training Data' tab, and a red arrow points to the 'Load and append list from a text file' button. Below the list of training data files, there are buttons for 'Browse and add to current list', 'Load and append list from a text file', 'Save current list to a text file', 'Deselect all files in current list', and 'Reset list'. The 'Attributes' tab is also shown, with a red box highlighting the 'Attributes' tab. The 'List of attributes detected from input training data:' section lists seven attributes. The 'Transformation Type' section shows a table of normalization parameters:

Transformation Type	Shift	Scale	Scale Logarithm
Z-Score Normalization	0	1	1
Z-Score Normalization	0	1	1
Z-Score Normalization	0	1	1
Z-Score Normalization	0	1	1
Z-Score Normalization	0	1	1
Z-Score Normalization	0	1	1
Z-Score Normalization	0	1	1

The 'Runtime Parameters' tab is also shown, with a red box highlighting the 'Runtime Parameters' tab. The 'Unique Project Name' is 'demo', the 'Suffix' is '2026', and 'Verbose output?' is unchecked. The 'File Name' field is 'training\_data\_unsupervised\_extracted\_list\_demo\_2026.txt' and the 'File Filter' is 'AASPI training data list file (training\_data\*\_extracted\*.txt, despiked\_training\_data\*.txt, transformed\_data\_list\*.txt)'. The 'Parallelization parameters' tab is also visible.

load the training attribute volumes by choosing *load from text file*,

customize the session name (suffix, unique project name).

adjust the attribute normalization parameters

# Step2 aaspi\_machine\_learning\_analyze\_input



File

Transformation Analysis | Data Analysis | Despike | PCA | ICA | K-means+ | **GMM**

Specify parameters for Gaussian Mixture Model (GMM) clustering analysis

Maximum number of clusters:  ← 1

Random seed:

Want Bayesian Information Criteria (BIC) analysis?  ← 2

View Gaussian distributions?  ← 3

SHAP parameters ← 4

Perform SHAP analysis | Kernel SHAP analysis ← 5

Number of random samples per batch:  ← 6

Number of batches:  ← 7

Number of trees:

Depth of trees:

Execute GMM ←

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Scroll down and select the GMM tab

## BIC analysis:

Typically, we want to analyze BIC first to see the optimum number of cluster for our dataset. Set number of cluster **(1)** to a reasonable number you want to test out. Make sure BIC analysis is active **(2)**, [execute](#). The algorithm will scan to show how the unsupervised ML performs up to the specified number of cluster.

## Display Histograms and Gaussians:

Now we can set the optimum number of cluster **(1)**. *Put in 7 as that's what we observe with this demo dataset.* Then activate the *view gaussian* **(3)** option, [execute](#).

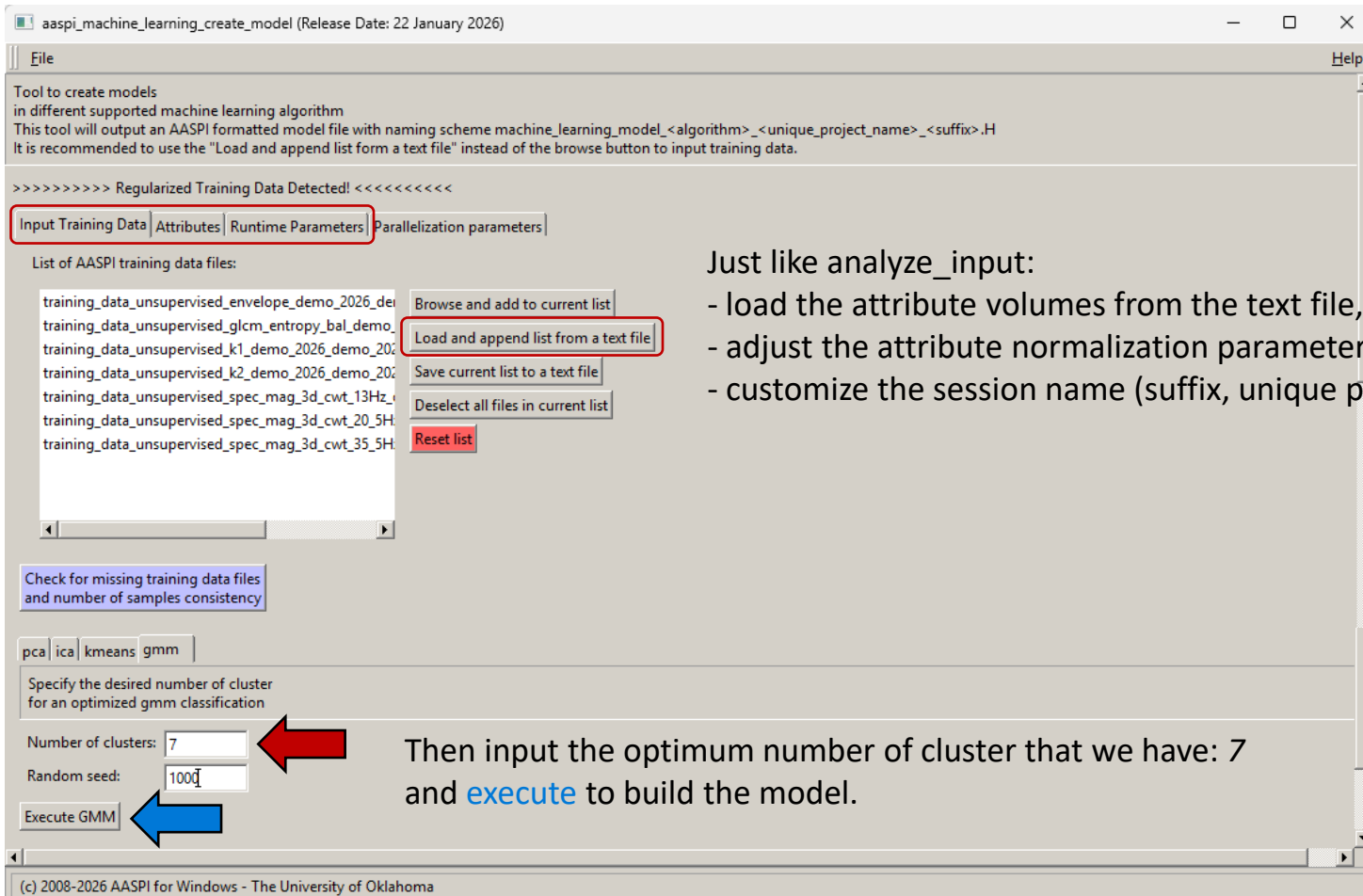
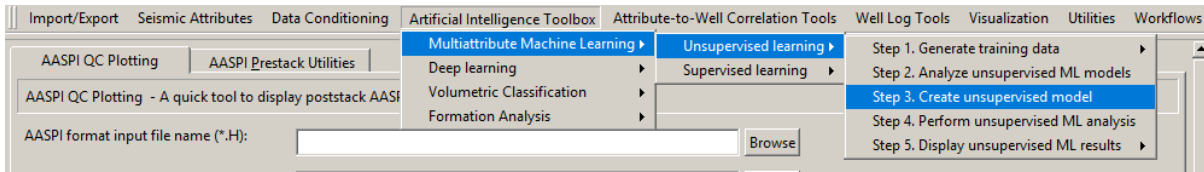
## Kernal SHAP analysis:

Still with the optimum number of cluster **(1)**, toggle the SHAP Analysis button **(4)** and determine the batch size **(6)** for sampling the dataset, and how many batches **(7)** to scan through. *We have 4960 datapoints so setting it to 10 batches of 500 datapoints makes sure we use all of the available data to obtain the most representative SHAP plot.* [execute](#)

## BONUS: Surrogate SHAP analysis

Kernal SHAP takes time, a potentially faster way is to let a simple random forest model simulate the GMM then analyze the decision tree SHAP instead. To do this click the toggle button **(5)**.

# Step3 aaspi\_machine\_learning\_create\_model

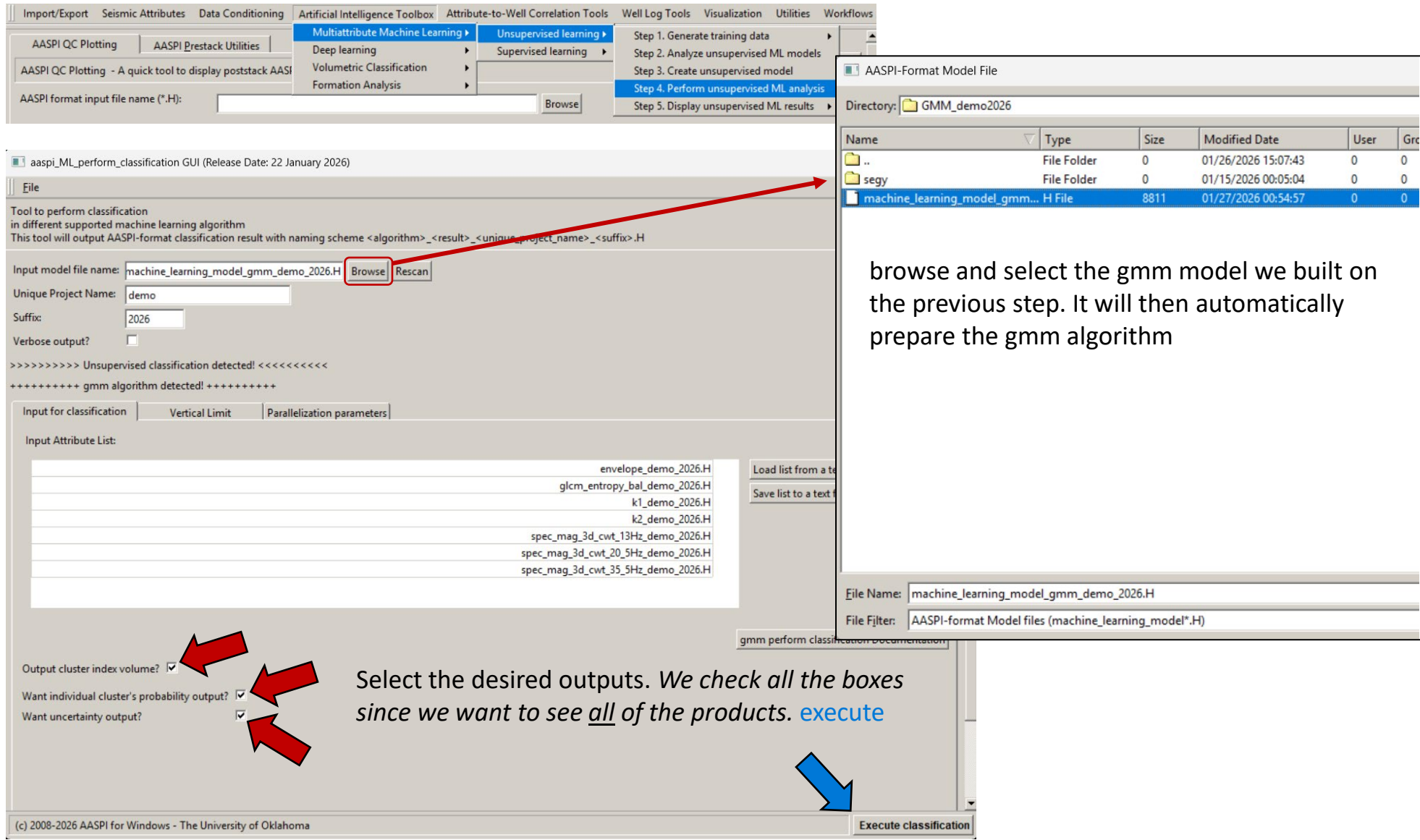


Just like analyze\_input:

- load the attribute volumes from the text file,
- adjust the attribute normalization parameters, and
- customize the session name (suffix, unique project name).

Then input the optimum number of cluster that we have: 7 and **execute** to build the model.

# Step4 aaspi\_machine\_learning\_perform\_classification



Import/Export Seismic Attributes Data Conditioning Artificial Intelligence Toolbox Attribute-to-Well Correlation Tools Well Log Tools Visualization Utilities Workflows

Multiattribute Machine Learning > Unsupervised learning > Step 4. Perform unsupervised ML analysis

AASPI-Format Model File


Directory: GMM\_demo2026


Name	Type	Size	Modified Date	User	Grp
..	File Folder	0	01/26/2026 15:07:43	0	0
segy	File Folder	0	01/15/2026 00:05:04	0	0
machine_learning_model_gmm...	H File	8811	01/27/2026 00:54:57	0	0


File Name: machine\_learning\_model\_gmm\_demo\_2026.H

File Filter: AASPI-format Model files (machine\_learning\_model\*.H)


gmm perform classification documentation

Output cluster index volume?  

Want individual cluster's probability output?  

Want uncertainty output?  

Select the desired outputs. We check all the boxes since we want to see all of the products. **execute**

Execute classification 

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# Co-rendering 1 gmm\_cluster\_output x gmm\_uncertainty



Import/Export Seismic Attributes Data Conditioning Artificial Intelligence Toolbox Attribute-to-Well Correlation Tools Well Log Tools Visualization Utilities Workflows

AASPI QC Plotting AASPI Prestack Utilities

AASPI QC Plotting - A quick tool to display poststack AASPI-format attribute volumes

AASPI format input file name (\*.H):  Browse

Colorbar file name:  Browse

aaspi\_corender GUI (Release Date: 22 January 2026)

File Help

Plot a single volume, or corender two or three volumes using transparency or RGB color blending

Choose a blending type: Alpha blending (Co-render 2 or 3 volumes)

Base Layer Layer 2 Layer 3

Input attribute for base layer:  Browse

Color bar for base layer:  Browse

Reverse polarity?

Plot wiggle trace?

Automatic wiggle scaling?

Pro tip: click this to change browser to detailed view

Pro tip: click the column names to sort by column

gmm products will have gmm prefix

AASPI-format file name

Directory: GMM\_demo2026

Name	Type	Size	Modified Date	User	Group	Attributes
..	File Folder	65536	01/27/2026 15:58:07	0	0	drw-rw-rw-
segy	File Folder	0	01/15/2026 00:05:05	0	0	drw-rw-rw-
cropped_KOKAKO_fix_demo_2026.H	H File	6196	01/15/2026 00:02:28	0	0	-rw-rw-rw-
crossplot_SOM_final1_demo_2026.H	H File	5922	01/14/2026 23:28:25	0	0	-rw-rw-rw-
envelope_demo_2026.H	H File	7446	01/27/2026 16:14:26	0	0	-rw-rw-rw-
glcm_entropy_bal_demo_2026.H	H File	8272	01/14/2026 23:36:53	0	0	-rw-rw-rw-
gmm_cluster_1_probability_demo_2026.H	H File	7752	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_cluster_2_probability_demo_2026.H	H File	7752	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_cluster_3_probability_demo_2026.H	H File	7752	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_cluster_4_probability_demo_2026.H	H File	7752	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_cluster_5_probability_demo_2026.H	H File	7752	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_cluster_6_probability_demo_2026.H	H File	7752	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_cluster_7_probability_demo_2026.H	H File	7752	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_cluster_uncertainty_demo_2026.H	H File	7750	01/27/2026 16:39:43	0	0	-rw-rw-rw-
gmm_output_demo_2026.H	H File	7746	01/27/2026 16:39:43	0	0	-rw-rw-rw-
k1_demo_2026.H	H File	9099	01/14/2026 23:39:25	0	0	-rw-rw-rw-
k2_demo_2026.H	H File	9105	01/14/2026 23:40:32	0	0	-rw-rw-rw-
machine_learning_model_gmm_demo_202...	H File	8795	01/27/2026 16:38:07	0	0	-rw-rw-rw-
outer_product_similarity_multi-spectral_de...	H File	7588	01/14/2026 23:27:15	0	0	-rw-rw-rw-
som_axis1_demo_2026.H	H File	5088	01/26/2026 14:49:18	0	0	-rw-rw-rw-
som_axis2_demo_2026.H	H File	5087	01/26/2026 14:50:31	0	0	-rw-rw-rw-
spec_mag_3d_cwt_13Hz_demo_2026.H	H File	8356	01/14/2026 23:57:42	0	0	-rw-rw-rw-
spec_mag_3d_cwt_20.5Hz_demo_2026.H	H File	8364	01/14/2026 23:58:50	0	0	-rw-rw-rw-

File Name: gmm\_output\_demo\_2026.H

File Filter: AASPI-format files (\*.H)

# Co-rendering 1 gmm\_cluster\_output x gmm\_uncertainty



**Base Layer** | Layer 2 | Layer 3

Input attribute for base layer: C:\Users\hilm\Documents\GMM\_demo2026\gmm\_output\_demo\_2026.H

Color bar for base layer: rainbow\_viridis.alut

Reverse polarity?

Plot wiggle trace?

Automatic wiggle scaling?

Fill positive parts of wiggles?

Manual wiggle scale: 50

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped): 5

Maximum percentage value (Higher values will be clipped): 95

All positive values?

Min-max data ranging

Minimum value: 1

Maximum value: 7

Plot Title: Corendered GMM

Axis 1 min Time: 1.36

Axis 1 max Time: 1.664

Axis 1 inc Time: 0.016

Axis 2 min CDP no.: 2555

Axis 2 max CDP no.: 3534

Axis 2 inc CDP no.: 1

Axis 3 min Line no.: 1430

Axis 3 max Line no.: 1680

Axis 3 inc Line no.: 1

Desired output axis 1: Line no.

Desired output axis 2: CDP no.

Desired output axis 3: Time

Reverse x-axis? n

Reverse y-axis? n

Want color bar? y

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**Layer 2** | Layer 3

Input attribute for layer 2: C:\Users\hilm\Documents\GMM\_demo2026\gmm\_cluster\_uncertainty\_demo\_2026.H

Color bar for layer 2: C:\AASPI\_for\_Demo\AASPI\_colors\monochrome\_black.alut

Reverse polarity?

Opacity curve type: For single-polarity attributes: set low values transparent, high values opaque

Plot wiggle trace: For single-polarity attributes: set low values transparent, high values opaque

Automatic wiggle scaling? For single-polarity attributes: set high values transparent, low values opaque

Fill positive parts of wiggles? For dual-polarity attributes: set extreme values transparent, zero values opaque

Manual wiggle scale: For dual-polarity attributes, set zero values transparent, extreme values opaque

Custom settings read from the alpha channel on a \*.alut-format colorbar file

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped):

Maximum percentage value (Higher values will be clipped):

All positive values?

Min-max data ranging

Minimum value: 0

Maximum value: 1

Plot Title: Corendered GMM GMM uncertainty

Axis 1 min Time: 1.36

Axis 1 max Time: 1.664

Axis 1 inc Time: 0.016

Axis 2 min CDP no.: 2555

Axis 2 max CDP no.: 3534

Axis 2 inc CDP no.: 1

Axis 3 min Line no.: 1430

Axis 3 max Line no.: 1680

Axis 3 inc Line no.: 1

Desired output axis 1: Line no.

Desired output axis 2: CDP no.

Desired output axis 3: Time

Reverse x-axis? n

Reverse y-axis? y

Want color bar? y

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browse (5) for layer 2:  
*gmm\_cluster\_uncertainty*  
 then browse for colorbar (6)  
 choose *monochrome\_black*  
 then select the first opacity  
 curve (7)

Colorbar File

Directory: \AASPI\_colors

Name	Type	Size	Modified Date	User	Group	Attributes
name.alut	ALUT File	4009	12/12/2024 13:42:50	0	0	-rw-rw-rw-
hot.alut	ALUT File	3681	12/02/2021 14:24:52	0	0	-rw-rw-rw-
Isochron.alut	ALUT File	3545	01/21/2026 12:25:04	0	0	-rw-rw-rw-
lipari.alut	ALUT File	4046	12/12/2024 13:42:50	0	0	-rw-rw-rw-
magenta.alut	ALUT File	4242	12/02/2021 14:24:52	0	0	-rw-rw-rw-
magnitude_lajolla.alut	ALUT File	3922	02/17/2025 10:21:54	0	0	-rw-rw-rw-
managua_flip.alut	ALUT File	3998	12/12/2024 13:42:50	0	0	-rw-rw-rw-
monochrome_black.alut	ALUT File	2816	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_black_with_high...	ALUT File	2617	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_black_with_low...	ALUT File	2625	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_blue_oslo.alut	ALUT File	4003	01/26/2025 16:03:12	0	0	-rw-rw-rw-
monochrome_gray.alut	ALUT File	43452	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_white.alut	ALUT File	4352	12/02/2021 14:24:52	0	0	-rw-rw-rw-
monochrome_yellow.alut	ALUT File	3840	12/02/2021 14:24:52	0	0	-rw-rw-rw-
navia.alut	ALUT File	4045	12/12/2024 13:42:50	0	0	-rw-rw-rw-
rainbow.alut	ALUT File	3731	12/02/2021 14:24:52	0	0	-rw-rw-rw-
rainbow_viridis.alut	ALUT File	3989	01/26/2025 16:03:12	0	0	-rw-rw-rw-
rainbow_w_black_white_extrem...	ALUT File	3730	12/02/2021 14:24:52	0	0	-rw-rw-rw-
rainbow_with_null_gray_at_ne...	ALUT File	3852	12/02/2021 14:24:52	0	0	-rw-rw-rw-
red.alut	ALUT File	3218	12/02/2021 14:24:52	0	0	-rw-rw-rw-
red_white_blue.alut	ALUT File	4132	12/02/2021 14:24:52	0	0	-rw-rw-rw-
red_white_blue_balance.alut	ALUT File	4046	01/26/2025 16:03:12	0	0	-rw-rw-rw-
roma0.alut	ALUT File	4098	02/17/2025 10:21:54	0	0	-rw-rw-rw-

File Name: monochrome\_black.alut

File Filter: Colorbar Files (\*.alut;\*.ALUT)



Change axis 3 (3) to "Time"  
 then change increments (4)  
 to 0.016s -> 16ms



# Co-rendering2 seismic x gmm\_cluster\_probability

Base layer:

Directory: GMM\_demo2026

Name	Type	Size	Modified Date	User	Group	Attributes
..	File Folder	65536	01/27/2026 15:58:07	0	0	drw-rw-rw-
segy	File Folder	0	01/15/2026 00:05:05	0	0	drw-rw-rw-
cropped_KOKAKO_fix_demo_2026.H	H File	6196	01/15/2026 00:02:28	0	0	-rw-rw-rw-
crossplot_SOM_final1_demo_2026.H	H File	5922	01/14/2026 23:28:25	0	0	-rw-rw-rw-
envelope_demo_2026.H	H File	7446	01/27/2026 16:14:26	0	0	-rw-rw-rw-
qlcm_entropy_bal_demo_2026.H	H File	8272	01/14/2026 23:36:53	0	0	-rw-rw-rw-

Base Layer Layer 2 Layer 3

Input attribute for base layer: \Users\hilm\Documents\GMM\_demo2026\cropped\_KOKAKO\_fix\_demo\_2026.H

Color bar for base layer: C:\AASPI\_for\_Demo\AASPI\_colors\red\_white\_blue\_balance.alut

Reverse polarity?

Plot wiggle trace?

Automatic wiggle scaling?

Fill positive parts of wiggles?

Manual wiggle scale: 50

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped): 5

Maximum percentage value (Higher values will be clipped): 95

All positive values?

browse (1) seismic data (*cropped\_KOKAKO\_fix\_demo\_2026*)  
 then browse for colorbar (2) *red\_white\_blue\_balance* or  
 whichever colorbar you like for looking at seismic

Layer 2:

Base Layer Layer 2 Layer 3

Input attribute for layer 2: \hilm\Documents\GMM\_demo2026\gmm\_cluster\_4\_probability\_demo\_2026.H

Color bar for layer 2: C:\AASPI\_for\_Demo\AASPI\_colors\monochrome\_black.alut

Reverse polarity?

Opacity curve type: For single-polarity attributes: set high values transparent, low values opaque

Plot wiggle trace: For single-polarity attributes: set low values transparent, high values opaque

Automatic wiggle scaling? For single-polarity attributes: set high values transparent, low values opaque

Fill positive parts of wiggles? For dual-polarity attributes: set extreme values transparent, zero values opaque

Manual wiggle scale: For dual-polarity attributes, set zero values transparent, extreme values opaque

Use statistical data scaling?

Statistical data scaling

Minimum percentage value (Lower values will be clipped): 5

Maximum percentage value (Higher values will be clipped): 95

All positive values?

Min-max data ranging

Minimum value: 0

Maximum value: 1

Plot Title: Corendered crop Input Seismic Amplitude Data GMM cluster\_4

Axis 1 min Time: 1.36

Axis 1 max Time: 1.664

Axis 1 inc Time: 0.004

Axis 2 min CDP no.: 2555

Axis 2 max CDP no.: 3534

Axis 2 inc CDP no.: 10

Axis 3 min Line no.: 1430

Axis 3 max Line no.: 1680

Axis 3 inc Line no.: 1

Desired output axis 1: Time

Desired output axis 2: Line no.

Desired output axis 3: CDP no.

Reverse x-axis?

Reverse y-axis?

Want color bar?

Execute corender

on layer 2  
 choose (3) *gmm\_cluster\_4\_probability*  
 set the colorbar (4) to *monochrome\_black*  
 then choose (5) the 2<sup>nd</sup> opacity curve

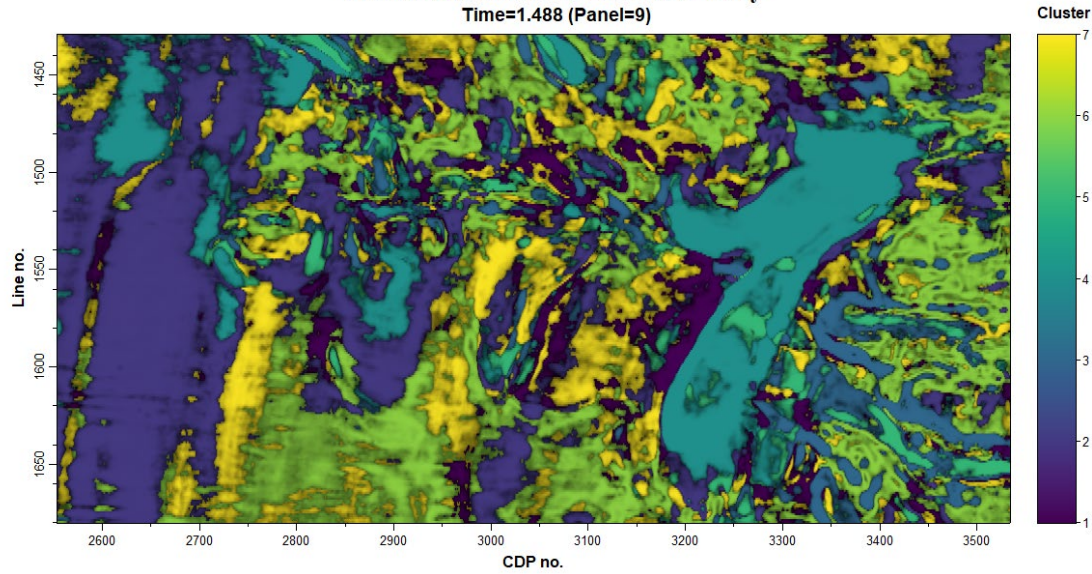
Change axis 2 (6) to *Line* if you  
 want to look at Xline section

# Co-rendering



1

Corendered GMM GMM uncertainty  
Time=1.488 (Panel=9)



2

Corendered crop Input Seismic Amplitude Data GMM cluster\_4  
CDP no.=3355 (Panel=81)

