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# **NiaAML**

***Release 1.1.7***

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**Feb 22, 2022**



# USER DOCUMENTATION

<b>1</b>	<b>Getting Started</b>	<b>3</b>
1.1	Basic example . . . . .	3
1.2	Components . . . . .	4
1.2.1	Classifiers . . . . .	4
1.2.2	Feature Selection Algorithms . . . . .	5
1.2.3	Feature Transformation Algorithms . . . . .	5
1.2.4	Fitness Functions based on . . . . .	5
1.2.5	Categorical Feature Encoders . . . . .	5
1.2.6	Feature Imputers . . . . .	5
1.2.7	Optimization Algorithms . . . . .	6
1.3	Optimization Process And Parameter Tuning . . . . .	6
<b>2</b>	<b>Changelog</b>	<b>7</b>
2.1	1.1.5 (2021-06-01) . . . . .	7
2.2	1.1.4 (2021-05-24) . . . . .	7
2.3	1.1.3 (2021-05-23) . . . . .	7
2.4	1.1.2 (2021-05-19) . . . . .	7
2.5	1.1.1 (2021-03-09) . . . . .	8
2.6	1.1.1rc2 (2020-12-22) . . . . .	8
2.7	1.1.1rc1 (2020-12-22) . . . . .	8
2.8	1.1.0 (2020-12-16) . . . . .	8
2.9	1.0.0rc7 (2020-12-14) . . . . .	8
2.10	1.0.0rc6 (2020-12-12) . . . . .	9
2.11	1.0.0rc5 (2020-12-11) . . . . .	9
2.12	1.0.0rc4 (2020-12-10) . . . . .	9
2.13	1.0.0rc3 (2020-12-10) . . . . .	9
2.14	1.0.0rc2 (2020-12-08) . . . . .	9
2.15	1.0.0rc1 (2020-12-06) . . . . .	10
2.16	0.1.4 (2020-12-05) . . . . .	10
2.17	0.1.3 (2020-12-04) . . . . .	10
2.18	0.1.3a1 (2020-12-01) . . . . .	10
2.19	0.1.2 (2020-11-30) . . . . .	10
2.20	0.1.2a1 (2020-11-29) . . . . .	11
2.21	0.1.1 (2020-11-28) . . . . .	11
2.22	0.1.0 (2020-11-27) . . . . .	11
<b>3</b>	<b>Installation</b>	<b>13</b>
3.1	Setup development environment . . . . .	13
3.1.1	Requirements . . . . .	13
3.1.2	Development dependencies . . . . .	13

<b>4</b>	<b>Testing</b>	<b>15</b>
<b>5</b>	<b>Documentation</b>	<b>17</b>
<b>6</b>	<b>API</b>	<b>19</b>
6.1	<code>niaaml</code> . . . . .	19
6.2	<code>niaaml.data</code> . . . . .	24
6.3	<code>niaaml.classifiers</code> . . . . .	25
6.4	<code>niaaml.preprocessing</code> . . . . .	33
6.4.1	<code>niaaml.preprocessing.feature_selection</code> . . . . .	33
6.4.2	<code>niaaml.preprocessing.feature_transform</code> . . . . .	39
6.4.3	<code>niaaml.preprocessing.encoding</code> . . . . .	42
6.4.4	<code>niaaml.preprocessing.imputation</code> . . . . .	44
6.5	<code>niaaml.fitness</code> . . . . .	45
<b>7</b>	<b>About</b>	<b>49</b>
7.1	Licence . . . . .	49
7.2	Disclaimer . . . . .	49
<b>8</b>	<b>Contributing to NiaAML</b>	<b>51</b>
8.1	Code of Conduct . . . . .	51
8.2	How Can I Contribute? . . . . .	51
8.2.1	Reporting Bugs . . . . .	51
8.2.2	Suggesting Enhancements . . . . .	51
8.2.3	Pull requests . . . . .	51
<b>9</b>	<b>Contributor Covenant Code of Conduct</b>	<b>53</b>
9.1	Our Pledge . . . . .	53
9.2	Our Standards . . . . .	53
9.3	Enforcement Responsibilities . . . . .	54
9.4	Scope . . . . .	54
9.5	Enforcement . . . . .	54
9.6	Enforcement Guidelines . . . . .	54
9.6.1	1. Correction . . . . .	54
9.6.2	2. Warning . . . . .	54
9.6.3	3. Temporary Ban . . . . .	55
9.6.4	4. Permanent Ban . . . . .	55
9.7	Attribution . . . . .	55
<b>10</b>	<b>References</b>	<b>57</b>
	<b>Python Module Index</b>	<b>59</b>
	<b>Index</b>	<b>61</b>

NiaAML is an automated machine learning Python framework based on nature-inspired algorithms for optimization. The name comes from the automated machine learning method of the same name [1]. Its goal is to efficiently compose the best possible classification pipeline for the given task using components on the input. The components are divided into three groups: feature selection algorithms, feature transformation algorithms and classifiers. The framework uses nature-inspired algorithms for optimization to choose the best set of components for the classification pipeline on the output and optimize their parameters. We use [NiaPy framework](#) for the optimization process which is a popular Python collection of nature-inspired algorithms. The NiaAML framework is easy to use and customize or expand to suit your needs.

- **Free software:** MIT license
- **Github repository:** <https://github.com/lukepecnik/NiaAML>
- **Python versions:** 3.6.x, 3.7.x, 3.8.x

The main documentation is organized into a couple of sections:

- *User Documentation*
- *Developer Documentation*
- *About*



## GETTING STARTED

This section is going to show you how to use the NiaAML framework. First install NiaAML package using the following command:

```
pip3 install niaaml
```

After the successful installation you are ready to run your first example.

### 1.1 Basic example

Create a new file, with name, for example *my\_first\_pipeline.py* and paste in the code below.

```
from niaaml import PipelineOptimizer, Pipeline
from niaaml.data import BasicDataReader
import numpy

# dummy random data
data_reader = BasicDataReader(
    x=numpy.random.uniform(low=0.0, high=15.0, size=(50, 3)),
    y=numpy.random.choice(['Class 1', 'Class 2'], size=50)
)

pipeline_optimizer = PipelineOptimizer(
    data=data_reader,
    classifiers=['AdaBoost', 'Bagging', 'MultiLayerPerceptron', 'RandomForest',
↪ 'ExtremelyRandomizedTrees', 'LinearSVC'],
    feature_selection_algorithms=['SelectKBest', 'SelectPercentile',
↪ 'ParticleSwarmOptimization', 'VarianceThreshold'],
    feature_transform_algorithms=['Normalizer', 'StandardScaler']
)
pipeline = pipeline_optimizer.run('Accuracy', 15, 15, 300, 300, 'ParticleSwarmAlgorithm',
↪ 'ParticleSwarmAlgorithm')
```

As you can see, pipeline components, fitness function and optimization algorithms are always passed into pipeline optimization using their class names. The example below uses the Particle Swarm Algorithm as the optimization algorithm. You can find a list of all available algorithms in the [NiaPy's documentation](#). Now you can run it using the command `python3 my_first_pipeline.py`. The code currently does not do much, but we can save our pipeline to a file so we can use it later or save a user-friendly representation of it to a text file. You can choose one or both of the scenarios by adding the code below.

```
pipeline.export('pipeline.ppln')
pipeline.export_text('pipeline.txt')
```

If you want to load and use the saved pipeline later, you can use the following code.

```
from niaaml import Pipeline
import pandas

loaded_pipeline = Pipeline.load('pipeline.ppln')

# some features (can be loaded using DataReader object instances)
x = pandas.DataFrame([[0.35, 0.46, 5.32], [0.16, 0.55, 12.5]])
y = loaded_pipeline.run(x)
```

The framework also supports the original version of optimization process where the components selection and hyperparameter optimization steps are combined into one. You can replace the ``run`` method with the following code.

```
pipeline = pipeline_optimizer.run_v1('Accuracy', 15, 400, 'ParticleSwarmAlgorithm')
```

This is a very simple example with dummy data. It is only intended to give you a basic idea on how to use the framework. **NiaAML supports numerical and categorical features.**

Find more examples [here](#)

## 1.2 Components

In the following sections you can see a list of currently implemented components divided into groups: classifiers, feature selection algorithms and feature transformation algorithms. At the end you can also see a list of currently implemented fitness functions for the optimization process. Values in parentheses are associated names.

### 1.2.1 Classifiers

- Adaptive Boosting (AdaBoost),
- Bagging (Bagging),
- Extremely Randomized Trees (ExtremelyRandomizedTrees),
- Linear SVC (LinearSVC),
- Multi Layer Perceptron (MultiLayerPerceptron),
- Random Forest Classifier (RandomForest),
- Decision Tree Classifier (DecisionTree),
- K-Neighbors Classifier (KNeighbors),
- Gaussian Process Classifier (GaussianProcess),
- Gaussian Naive Bayes (GaussianNB),
- Quadratic Discriminant Analysis (QuadraticDiscriminantAnalysis).



### 1.2.2 Feature Selection Algorithms

- Select K Best (SelectKBest),
- Select Percentile (SelectPercentile),
- Variance Threshold (VarianceThreshold).

#### Nature-Inspired

- Bat Algorithm (BatAlgorithm),
- Differential Evolution (DifferentialEvolution),
- Self-Adaptive Differential Evolution (jDEFSTH),
- Grey Wolf Optimizer (GreyWolfOptimizer),
- Particle Swarm Optimization (ParticleSwarmOptimization).

### 1.2.3 Feature Transformation Algorithms

- Normalizer (Normalizer),
- Standard Scaler (StandardScaler),
- Maximum Absolute Scaler (MaxAbsScaler),
- Quantile Transformer (QuantileTransformer),
- Robust Scaler (RobustScaler).

### 1.2.4 Fitness Functions based on

- Accuracy (Accuracy),
- Cohen's kappa (CohenKappa),
- F1-Score (F1),
- Precision (Precision).

### 1.2.5 Categorical Feature Encoders

- One-Hot Encoder (OneHotEncoder).

### 1.2.6 Feature Inputers

- Simple Imputer (SimpleImputer).

## 1.2.7 Optimization Algorithms

For the list of available optimization algorithms please see the [NiaPy's documentation](#).

## 1.3 Optimization Process And Parameter Tuning

In NiaAML there are two types of optimization. Goal of the first type is to find an optimal set of components (feature selection algorithm, feature transformation algorithm and classifier). The next step is to find optimal parameters for the selected set of components and that is a goal of the second type of optimization. Each component has an attribute `_params`, which is a dictionary of parameters and their possible values.

```
self._params = dict(  
    n_estimators = ParameterDefinition(MinMax(min=10, max=111), np.uint),  
    algorithm = ParameterDefinition(['SAMME', 'SAMME.R'])  
)
```

An individual in the second type of optimization is a real-valued vector that has a size equal to the sum of number of keys in all three dictionaries (classifier's `_params`, feature transformation algorithm's `_params` and feature selection algorithm's `_params`) and a value of each dimension is in range [0.0, 1.0]. The second type of optimization maps real values from the individual's vector to those parameter definitions in the dictionaries. Each parameter's value can be defined as a range or array of values. In the first case, a value from vector is mapped from one interval to another and in the second case, a value from vector falls into one of the bins that represent an index of the array that holds possible parameter's values.

Let's say we have a classifier with 3 parameters, feature selection algorithm with 2 parameters and feature transformation algorithm with 4 parameters. Size of an individual in the second type of optimization is 9. Size of an individual in the first type of optimization is always 3 (1 classifier, 1 feature selection algorithm and 1 feature transform algorithm).

In some cases we may want to tune a parameter that needs additional information for setting its range of values, so we cannot set the range in the initialization method. In that case we should set its value in the dictionary to `None` and define it later in the process. The parameter will be a part of parameter tuning process as soon as we define its possible values. For example, see the implementation of [niaaml.preprocessing.feature\\_selection.SelectKBest](#) and its parameter `k`.

## CHANGELOG

### 2.1 1.1.5 (2021-06-01)

Full Changelog

**Merged pull requests:**

- Citation details #50 (firefly-cpp)

### 2.2 1.1.4 (2021-05-24)

Full Changelog

**Closed issues:**

- Unable to install with conda #47

### 2.3 1.1.3 (2021-05-23)

Full Changelog

### 2.4 1.1.2 (2021-05-19)

Full Changelog

**Merged pull requests:**

- Update niapy dependency #49 (lukapecnik)

## 2.5 1.1.1 (2021-03-09)

Full Changelog

### Merged pull requests:

- logo [ci skip] #48 (lukapecnik)
- Fedora package pushed to stable #46 (firefly-cpp)
- Restructuring of paper and editorial changes #45 (adi3)
- Corrections of paper #44 (firefly-cpp)

## 2.6 1.1.1rc2 (2020-12-22)

Full Changelog

## 2.7 1.1.1rc1 (2020-12-22)

Full Changelog

### Merged pull requests:

- Original NiaAML method support [ci skip] #43 (lukapecnik)

## 2.8 1.1.0 (2020-12-16)

Full Changelog

## 2.9 1.0.0rc7 (2020-12-14)

Full Changelog

### Closed issues:

- References #40

### Merged pull requests:

- Paper update #42 (firefly-cpp)
- minor corrections in examples #39 (firefly-cpp)

## 2.10 1.0.0rc6 (2020-12-12)

Full Changelog

### Closed issues:

- Conda package #34

### Merged pull requests:

- Additional features #38 (lukapecnik)
- Conda fix [ci skip] #37 (lukapecnik)
- Orcid identifiers added #36 (firefly-cpp)

## 2.11 1.0.0rc5 (2020-12-11)

Full Changelog

### Closed issues:

- Installation problems #31

### Merged pull requests:

- Conda support #35 (lukapecnik)

## 2.12 1.0.0rc4 (2020-12-10)

Full Changelog

### Merged pull requests:

- Python 3.6 support #33 (lukapecnik)
- First version of paper #32 (firefly-cpp)

## 2.13 1.0.0rc3 (2020-12-10)

Full Changelog

## 2.14 1.0.0rc2 (2020-12-08)

Full Changelog

### Merged pull requests:

- feature missing values imputation #30 (lukapecnik)
- README updated #29 (firefly-cpp)
- Readme update, encoder check for type int64 #28 (lukapecnik)
- Markdown and docs #27 (lukapecnik)

## 2.15 1.0.0rc1 (2020-12-06)

Full Changelog

### Merged pull requests:

- Added support for categorical features #26 (lukapecnik)
- badges and readme update #19 (lukapecnik)

## 2.16 0.1.4 (2020-12-05)

Full Changelog

### Merged pull requests:

- remove 10-fold cross validation from benchmark, critical bug fix #25 (lukapecnik)
- run all experiments at once #24 (firefly-cpp)

## 2.17 0.1.3 (2020-12-04)

Full Changelog

## 2.18 0.1.3a1 (2020-12-01)

Full Changelog

### Merged pull requests:

- 0.1.3a1 pre-release python 3.7 compatibility #23 (lukapecnik)
- Fixes and additions #22 (lukapecnik)

## 2.19 0.1.2 (2020-11-30)

Full Changelog

### Implemented enhancements:

- On the use of unittest #2

### Closed issues:

- Description of examples #16

### Merged pull requests:

- readme.rst fix, pipeline fix #21 (lukapecnik)
- Travis ci integration #20 (lukapecnik)

## 2.20 0.1.2a1 (2020-11-29)

Full Changelog

**Closed issues:**

- Information about hyperparameter tuning #15
- CHANGELOG #14
- Examples #13

**Merged pull requests:**

- Unittests, examples' description, references added to docs #17 (lukepecnik)

## 2.21 0.1.1 (2020-11-28)

Full Changelog

**Closed issues:**

- Installation instructions #11

**Merged pull requests:**

- Contributors table added #12 (lukepecnik)

## 2.22 0.1.0 (2020-11-27)

Full Changelog

**Implemented enhancements:**

- CSV Data Reader class #3

**Closed issues:**

- A non-functional demo could be written #4

**Merged pull requests:**

- Framework improvements, docs initialization and readme #10 (lukepecnik)
- Pipeline methods implementation #9 (lukepecnik)
- Pipeline optimizer progress #8 (lukepecnik)
- Implementation of jDEFSTH algorithm for feature selection #7 (firefly-cpp)
- refactoring and variance threshold feature selection implementation #6 (lukepecnik)
- NiaPy dependency added #5 (firefly-cpp)





## INSTALLATION

### 3.1 Setup development environment

#### 3.1.1 Requirements

- Poetry: <https://python-poetry.org/docs/>

After installing Poetry and cloning the project from GitHub, you should run the following command from the root of the cloned project:

```
$ poetry install
```

All of the project's dependencies should be installed and the project ready for further development. **Note that Poetry creates a separate virtual environment for your project.**

#### 3.1.2 Development dependencies

List of NiaAML's dependencies:

Package	Version	Platform
numpy	^1.19.1	All
scikit-learn	^0.23.2	All
NiaPy	^2.0.0rc11	All
pandas	^1.1.4	All

List of development dependencies:

Package	Version	Platform
sphinx	^3.3.1	Any
sphinx-rtd-theme	^0.5.0	Any
coveralls	^2.2.0	Any



## TESTING

Before making a pull request, if possible provide tests for added features or bug fixes.

We have an automated building system which also runs all of provided tests. In case any of the test cases fails, we are notified about failing tests. Those should be fixed before we merge your pull request to master branch.

For the purpose of checking if all test are passing locally you can run following command:

```
$ poetry run coverage run --source=niaaml -m unittest discover -b
```

If all tests passed running this command it is most likely that the tests would pass on our build system too.



## DOCUMENTATION

To locally generate and preview documentation run the following command in the project root folder:

```
$ poetry run sphinx-build ./docs ./docs/_build
```

If the build of the documentation is successful, you can preview the documentation in the docs/\_build folder by clicking the `index.html` file.



This is the NiaAML API documentation, auto generated from the source code.

## 6.1 niaaml

**class** niaaml.**Factory**(\*\*kwargs)

Bases: object

Base class with string mappings to entities.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** \_entities (Dict[str, any]): Dictionary to map from strings to an instance of anything.

**get\_name\_to\_classname\_mapping**()

Get dictionary of user-friendly name to class name mapping.

**Returns:** dict: Dictionary of user-friendly name to class name mapping.

**get\_result**(name)

Get the resulting entity.

**Arguments:** name (str): String that represents the entity.

**Returns:** any: Entity according to the given name.

**class** niaaml.**Logger**(verbose=False, output\_file=None, \*\*kwargs)

Bases: object

Class for logging throughout the framework.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**log\_optimization\_error**(text)

Log optimization error message.

**log\_pipeline**(text)

Log pipeline info message.

**log\_progress**(text)

Log progress message.

**class** niaaml.MinMax(*min, max*)

Bases: object

Class for ParameterDefinition's value property.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** min (float): Minimum number (inclusive). max (float): Maximum number (exclusive).

**See Also:**

- niaaml.utilities.ParameterDefinition

**class** niaaml.OptimizationStats(*predicted, expected, \*\*kwargs*)

Bases: object

Class that holds pipeline optimization result's statistics. Includes accuracy, precision, Cohen's kappa and F1-score.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** \_accuracy (float): Calculated accuracy. \_precision (float): Calculated precision. \_cohen\_kappa (float): Calculated Cohen's kappa. \_f1\_score (float): Calculated F1-score.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.ParameterDefinition(*value, param\_type=None*)

Bases: object

Class for PipelineComponent parameters definition.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** value (any): Array of possible parameter values or instance of MinMax class. param\_type (numpy.dtype): Selection output data type.

**See Also:**

- niaaml.pipeline\_component.PipelineComponent
- niaaml.utilities.MinMax

**class** niaaml.Pipeline(*\*\*kwargs*)

Bases: object

Classification pipeline defined by optional preprocessing steps and classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT



**Attributes:** `__feature_selection_algorithm` (Optional[FeatureSelectionAlgorithm]): Feature selection algorithm implementation. `__feature_transform_algorithm` (Optional[FeatureTransformAlgorithm]): Feature transform algorithm implementation. `__classifier` (Classifier): Classifier implementation. `__selected_features_mask` (Iterable[bool]): Mask of selected features during the feature selection process. `__best_stats` (OptimizationStats): Statistics of the most successful setup of parameters. `__categorical_features_encoders` (Dict[FeatureEncoder]): Instances of FeatureEncoder for all categorical features. `__imputers` (Dict[Imputer]): Dictionary of instances of Imputer for all columns that contained missing values during optimization process. `__logger` (Logger): Logger instance.

**export**(*file\_name*)

Exports Pipeline object to a file for later use. Extension is added if not present.

**Arguments:** *file\_name* (str): Output file name.

**export\_text**(*file\_name*)

Exports Pipeline object to a user-friendly text file. Extension is added if not present.

**Arguments:** *file\_name* (str): Output file name.

**get\_classifier**()

Get deep copy of the classifier.

**Returns:** Classifier: Instance of the Classifier object.

**get\_feature\_selection\_algorithm**()

Get deep copy of the feature selection algorithm.

**Returns:** FeatureSelectionAlgorithm: Instance of the FeatureSelectionAlgorithm object.

**get\_feature\_transform\_algorithm**()

Get deep copy of the feature transform algorithm.

**Returns:** FeatureTransformAlgorithm: Instance of the FeatureTransformAlgorithm object.

**get\_logger**()

Get logger.

**Returns:** Logger: Instance of the Logger object.

**get\_stats**()

Get optimization statistics.

**Returns:** OptimizationStats: Instance of the OptimizationStats object.

**static load**(*file\_name*)

Loads Pipeline object from a file.

**Returns:** Pipeline: Loaded Pipeline instance.

**optimize**(*x*, *y*, *population\_size*, *number\_of\_evaluations*, *optimization\_algorithm*, *fitness\_function*)

Optimize pipeline's hyperparameters.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify. *y* (pandas.core.series.Series): *n* classes of the samples in the *x* array. *population\_size* (uint): Number of individuals in the optimization process. *number\_of\_evaluations* (uint): Number of maximum evaluations. *optimization\_algorithm* (str): Name of the optimization algorithm to use. *fitness\_function* (str): Name of the fitness function to use.

**Returns:** float: Best fitness value found in optimization process.

**run**(*x*)

Runs the pipeline.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: n predicted classes of the samples in the x array.

**set\_categorical\_features\_encoders**(*value*)

Set categorical features' encoders.

**set\_classifier**(*value*)

Set classifier.

**set\_feature\_selection\_algorithm**(*value*)

Set feature selection algorithm.

**set\_feature\_transform\_algorithm**(*value*)

Set feature transform algorithm.

**set\_imputers**(*value*)

Set imputers.

**set\_selected\_features\_mask**(*value*)

Set selected features mask.

**set\_stats**(*value*)

Set stats.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**to\_string\_slim**()

Slim user friendly representation of the object.

**Returns:** str: Slim user friendly representation of the object.

**class** niaaml.PipelineComponent(*\*\*kwargs*)

Bases: object

Class for implementing pipeline components.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** Name (str): Name of the pipeline component. \_params (Dict[str, ParameterDefinition]): Dictionary of components's parameters with possible values. Possible parameter values are given as an instance of the ParameterDefinition class.

**See Also:**

- niaaml.utilities.ParameterDefinition

**Name** = None

**get\_params\_dict**()

Return parameters definition dictionary.

**set\_parameters**(*\*\*kwargs*)

Set the parameters/arguments of the pipeline component.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

```
class niaaml.PipelineOptimizer(**kwargs)
```

Bases: object

Optimization task that finds the best classification pipeline according to the given input.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** `__data` (DataReader): Instance of any DataReader implementation. `__feature_selection_algorithms` (Optional[Iterable[str]]): Array of names of possible feature selection algorithms. `__feature_transform_algorithms` (Optional[Iterable[str]]): Array of names of possible feature transform algorithms. `__classifiers` (Iterable[Classifier]): Array of names of possible classifiers. `__categorical_features_encoder` (str): Name of the encoder used for categorical features. `__categorical_features_encoders` (Dict[FeatureEncoder]): Actual instances of FeatureEncoder for all categorical features. `__imputer` (str): Name of the imputer used for features that contain missing values. `__imputers` (Dict[Imputer]): Actual instances of Imputer for all features that contain missing values. `__logger` (Logger): Logger instance.

```
get_classifiers()
```

Get classifiers.

**Returns:** Iterable[str]: Classifier names.

```
get_data()
```

Get data.

**Returns:** DataReader: Instance of DataReader object.

```
get_feature_selection_algorithms()
```

Get feature selection algorithms.

**Returns:** Iterable[str]: Feature selection algorithm names or None.

```
get_feature_transform_algorithms()
```

Get feature transform algorithms.

**Returns:** Iterable[str]: Feature transform algorithm names or None.

```
get_logger()
```

Get logger.

**Returns:** Logger: Logger instance.

```
run(fitness_name, pipeline_population_size, inner_population_size, number_of_pipeline_evaluations,
    number_of_inner_evaluations, optimization_algorithm, inner_optimization_algorithm=None)
```

Run classification pipeline optimization process.

**Arguments:** `fitness_name` (str): Name of the fitness class to use as a function. `pipeline_population_size` (uint): Number of pipeline individuals in the optimization process. `inner_population_size` (uint): Number of individuals in the hiperparameter optimization process. `number_of_pipeline_evaluations` (uint): Number of maximum evaluations. `number_of_inner_evaluations` (uint): Number of maximum inner evaluations. `optimization_algorithm` (str): Name of the optimization algorithm to use. `inner_optimization_algorithm` (Optional[str]): Name of the inner optimization algorithm to use. Defaults to the `optimization_algorithm` argument.

**Returns:** Pipeline: Best pipeline found in the optimization process.

```
run_v1(fitness_name, population_size, number_of_evaluations, optimization_algorithm)
```

Run classification pipeline optimization process according to the original NiaAML paper.

**Reference:** Fister, Iztok, Milan Zorman, and Dušan Fister. “Continuous Optimizers for Automatic Design and Evaluation of Classification Pipelines.” *Frontier Applications of Nature Inspired Computation*. Springer, Singapore, 2020. 281-301.

**Arguments:** `fitness_name` (str): Name of the fitness class to use as a function. `population_size` (uint): Number of individuals in the optimization process. `number_of_evaluations` (uint): Number of maximum evaluations. `optimization_algorithm` (str): Name of the optimization algorithm to use.

**Returns:** Pipeline: Best pipeline found in the optimization process.

`niaaml.get_bin_index(value, number_of_bins)`

Gets index of value’s bin. Value must be between 0.0 and 1.0.

**Arguments:** `value` (float): Value to put into bin. `number_of_bins` (uint): Number of bins on the interval [0.0, 1.0].

**Returns:** uint: Calculated index.

## 6.2 niaaml.data

**class** `niaaml.data.BasicDataReader(**kwargs)`

Bases: `niaaml.data.data_reader.DataReader`

Implementation of basic data reader.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**See Also:**

- `niaaml.data.DataReader`

**class** `niaaml.data.CSVDataReader(**kwargs)`

Bases: `niaaml.data.data_reader.DataReader`

Implementation of CSV data reader.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** `__src` (string): Path to a CSV file. `__contains_classes` (bool): Tells if `src` contains expected classification results or only features. `__has_header` (bool): Tells if `src` contains header row.

**See Also:**

- `niaaml.data.DataReader`

**class** `niaaml.data.DataReader(**kwargs)`

Bases: `object`

Class for implementing data readers with different sources of data.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** `_x` (`pandas.core.frame.DataFrame`): Array of rows from dataset without expected classification results. `_y` (`Optional[pandas.core.series.Series]`): Array of encoded expected classification results.

**get\_x()**

Get value of `_x`.

**Returns:** `pandas.core.frame.DataFrame`: Array of rows from dataset without expected classification results.

**get\_y()**

Get value of `_y`.

**Returns:** `pandas.core.series.Series`: Array of encoded expected classification results.

**set\_x(value)**

Set the value of `_x`.

**set\_y(value)**

Set the value of `_y`.

## 6.3 niaaml.classifiers

**class** `niaaml.classifiers.AdaBoost(**kwargs)`

Bases: `niaaml.classifiers.classifier.Classifier`

Implementation of AdaBoost classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:**

Y. Freund, R. Schapire, “A Decision-Theoretic Generalization of on-Line Learning and an Application to Boosting”, 1995.

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.AdaBoostClassifier.html>

**See Also:**

- `niaaml.classifiers.Classifier`

**Name** = 'AdaBoost'

**fit**(`x`, `y`, **\*\*kwargs**)

Fit AdaBoost.

**Arguments:** `x` (`pandas.core.frame.DataFrame`): `n` samples to classify. `y` (`pandas.core.series.Series`): `n` classes of the samples in the `x` array.

**predict**(`x`, **\*\*kwargs**)

Predict class for each sample (row) in `x`.

**Arguments:** `x` (`pandas.core.frame.DataFrame`): `n` samples to classify.

**Returns:** `pandas.core.series.Series`: `n` predicted classes.

**set\_parameters(\*\*kwargs)**

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**Bagging**(\*\*kwargs)

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of bagging classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:**

L. Breiman, “Bagging predictors”, Machine Learning, 24(2), 123-140, 1996.

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.BaggingClassifier.html>

**See Also:**

- [niaaml.classifiers.Classifier](#)

**Name** = 'Bagging'

**fit**(x, y, \*\*kwargs)

Fit Bagging.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify. y (pandas.core.series.Series): n classes of the samples in the x array.

**Returns:** None

**predict**(x, \*\*kwargs)

Predict class for each sample (row) in x.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify.

**Returns:** pandas.core.series.Series: n predicted classes.

**set\_parameters**(\*\*kwargs)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**Classifier**(\*\*kwargs)

Bases: [niaaml.pipeline\\_component.PipelineComponent](#)

Class for implementing classifiers.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**See Also:**

- [niaaml.pipeline\\_component.PipelineComponent](#)

**fit**(x, y, \*\*kwargs)

Fit implemented classifier.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify. y (pandas.core.series.Series): n classes of the samples in the x array.

**predict**(*x*, *\*\*kwargs*)

Predict class for each sample (row) in *x*.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: *n* predicted classes.

**class** niaaml.classifiers.**ClassifierFactory**(*\*\*kwargs*)

Bases: niaaml.utilities.Factory

Class with string mappings to classifiers.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** *\_entities* (Dict[str, Classifier]): Mapping from strings to classifiers.

**See Also:**

- niaaml.utilities.Factory

**class** niaaml.classifiers.**DecisionTree**(*\*\*kwargs*)

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of decision tree classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:**

L. Breiman, J. Friedman, R. Olshen, and C. Stone, “Classification and Regression Trees”, Wadsworth, Belmont, CA, 1984.

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassifier.html#sklearn.tree.DecisionTreeClassifier>

**See Also:**

- [niaaml.classifiers.Classifier](#)

**Name** = 'Decision Tree Classifier'

**fit**(*x*, *y*, *\*\*kwargs*)

Fit DecisionTree.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify. *y* (pandas.core.series.Series): *n* classes of the samples in the *x* array.

**Returns:** None

**predict**(*x*, *\*\*kwargs*)

Predict class for each sample (row) in *x*.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: *n* predicted classes.

**set\_parameters**(*\*\*kwargs*)

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**ExtremelyRandomizedTrees**(\*\*kwargs)

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of extremely randomized trees classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:**

P. Geurts, D. Ernst., and L. Wehenkel, “Extremely randomized trees”, Machine Learning, 63(1), 3-42, 2006.

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.ExtraTreesClassifier.html>

**See Also:**

- [niaaml.classifiers.Classifier](#)

**Name = 'Extremely Randomized Trees'**

**fit**(x, y, \*\*kwargs)

Fit ExtremelyRandomizedTrees.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify. y (pandas.core.series.Series): n classes of the samples in the x array.

**Returns:** None

**predict**(x, \*\*kwargs)

Predict class for each sample (row) in x.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify.

**Returns:** pandas.core.series.Series: n predicted classes.

**set\_parameters**(\*\*kwargs)

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**GaussianNB**(\*\*kwargs)

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of gaussian Naive Bayes classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** Murphy, Kevin P. “Naive bayes classifiers.” University of British Columbia 18 (2006): 60.

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.naive\\_bayes.GaussianNB.html](https://scikit-learn.org/stable/modules/generated/sklearn.naive_bayes.GaussianNB.html)



**See Also:**

- [`niaaml.classifiers.Classifier`](#)

**Name** = 'Gaussian Naive Bayes'

**fit**(*x*, *y*, **\*\*kwargs**)

Fit GaussianNB.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify. *y* (pandas.core.series.Series): *n* classes of the samples in the *x* array.

**Returns:** None

**predict**(*x*, **\*\*kwargs**)

Predict class for each sample (row) in *x*.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: *n* predicted classes.

**set\_parameters**(**\*\*kwargs**)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.GaussianProcess(**\*\*kwargs**)

Bases: [`niaaml.classifiers.classifier.Classifier`](#)

Implementation of gaussian process classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** Rasmussen, Carl Edward, and Hannes Nickisch. "Gaussian processes for machine learning (GPML) toolbox." The Journal of Machine Learning Research 11 (2010): 3011-3015.

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.gaussian\\_process.GaussianProcessClassifier.html](https://scikit-learn.org/stable/modules/generated/sklearn.gaussian_process.GaussianProcessClassifier.html)

**See Also:**

- [`niaaml.classifiers.Classifier`](#)

**Name** = 'Gaussian Process Classifier'

**fit**(*x*, *y*, **\*\*kwargs**)

Fit GaussianProcess.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify. *y* (pandas.core.series.Series): *n* classes of the samples in the *x* array.

**Returns:** None

**predict**(*x*, **\*\*kwargs**)

Predict class for each sample (row) in *x*.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: *n* predicted classes.

**set\_parameters(\*\*kwargs)**

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**KNeighbors(\*\*kwargs)**

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of k neighbors classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** “Neighbourhood Components Analysis”, J. Goldberger, S. Roweis, G. Hinton, R. Salakhutdinov, Advances in Neural Information Processing Systems, Vol. 17, May 2005, pp. 513-520.

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.neighbors.KNeighborsClassifier.html>

**See Also:**

- [niaaml.classifiers.Classifier](#)

**Name = 'K Neighbors Classifier'**

**fit**(x, y, \*\*kwargs)

Fit KNeighbors.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify. y (pandas.core.series.Series): n classes of the samples in the x array.

**Returns:** None

**predict**(x, \*\*kwargs)

Predict class for each sample (row) in x.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify.

**Returns:** pandas.core.series.Series: n predicted classes.

**set\_parameters(\*\*kwargs)**

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**LinearSVC(\*\*kwargs)**

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of linear support vector classification.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** Fan, Rong-En, et al. “LIBLINEAR: A library for large linear classification.” Journal of machine learning research 9.Aug (2008): 1871-1874.

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.svm.LinearSVC.html>

**See Also:**

- [\*niaaml.classifiers.Classifier\*](#)

**Name = 'Linear Support Vector Classification'**

**fit**(*x*, *y*, *\*\*kwargs*)

Fit LinearSVCClassifier.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify. *y* (pandas.core.series.Series): *n* classes of the samples in the *x* array.

**Returns:** None

**predict**(*x*, *\*\*kwargs*)

Predict class for each sample (row) in *x*.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: *n* predicted classes.

**set\_parameters**(*\*\*kwargs*)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** *niaaml.classifiers.MultiLayerPerceptron*(*\*\*kwargs*)

Bases: [\*niaaml.classifiers.classifier.Classifier\*](#)

Implementation of multi-layer perceptron classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** Glorot, Xavier, and Yoshua Bengio. “Understanding the difficulty of training deep feedforward neural networks.” International Conference on Artificial Intelligence and Statistics. 2010.

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.neural\\_network.MLPClassifier.html](https://scikit-learn.org/stable/modules/generated/sklearn.neural_network.MLPClassifier.html)

**See Also:**

- [\*niaaml.classifiers.Classifier\*](#)

**Name = 'Multi Layer Perceptron'**

**fit**(*x*, *y*, *\*\*kwargs*)

Fit MultiLayerPerceptron.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify. *y* (pandas.core.series.Series): *n* classes of the samples in the *x* array.

**Returns:** None

**predict**(*x*, *\*\*kwargs*)

Predict class for each sample (row) in *x*.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: *n* predicted classes.

**set\_parameters(\*\*kwargs)**

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**QuadraticDiscriminantAnalysis**(\*\*kwargs)

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of quadratic discriminant analysis classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** “The Elements of Statistical Learning”, Hastie T., Tibshirani R., Friedman J., Section 4.3, p.106-119, 2008.

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.discriminant\\_analysis.QuadraticDiscriminantAnalysis.html#sklearn.discriminant\\_analysis.QuadraticDiscriminantAnalysis](https://scikit-learn.org/stable/modules/generated/sklearn.discriminant_analysis.QuadraticDiscriminantAnalysis.html#sklearn.discriminant_analysis.QuadraticDiscriminantAnalysis)

**See Also:**

- [niaaml.classifiers.Classifier](#)

**Name = 'Quadratic Discriminant Analysis'**

**fit**(x, y, \*\*kwargs)

Fit QuadraticDiscriminantAnalysis.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify. y (pandas.core.series.Series): n classes of the samples in the x array.

**Returns:** None

**predict**(x, \*\*kwargs)

Predict class for each sample (row) in x.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to classify.

**Returns:** pandas.core.series.Series: n predicted classes.

**set\_parameters(\*\*kwargs)**

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.classifiers.**RandomForest**(\*\*kwargs)

Bases: [niaaml.classifiers.classifier.Classifier](#)

Implementation of random forest classifier.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** Breiman, “Random Forests”, Machine Learning, 45(1), 5-32, 2001.

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.RandomForestClassifier.html>

**See Also:**

- *niaaml.classifiers.Classifier*

**Name** = 'Random Forest Classifier'

**fit**(*x*, *y*, *\*\*kwargs*)

Fit RandomForestClassifier.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify. *y* (pandas.core.series.Series): *n* classes of the samples in the *x* array.

**Returns:** None

**predict**(*x*, *\*\*kwargs*)

Predict class for each sample (row) in *x*.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to classify.

**Returns:** pandas.core.series.Series: *n* predicted classes.

**set\_parameters**(*\*\*kwargs*)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

## 6.4 niaaml.preprocessing

**class** niaaml.preprocessing.PreprocessingAlgorithm(*\*\*kwargs*)

Bases: niaaml.pipeline\_component.PipelineComponent

Class for implementing preprocessing algorithms.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**See Also:**

- niaaml.pipeline\_component.PipelineComponent

### 6.4.1 niaaml.preprocessing.feature\_selection

**class** niaaml.preprocessing.feature\_selection.BatAlgorithm(*\*\*kwargs*)

Bases: *niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.FeatureSelectionAlgorithm*

Implementation of feature selection using BA algorithm.

**Date:** 2020

**Author:** Luka Pečnik

**Reference:** The implementation is adapted according to the following article: D. Fister, I. Fister, T. Jagrič, I. Fister Jr., J. Brest. A novel self-adaptive differential evolution for feature selection using threshold mechanism . In: Proceedings of the 2018 IEEE Symposium on Computational Intelligence (SSCI 2018), pp. 17-24, 2018.

**Reference URL:** <http://iztok-jr-fister.eu/static/publications/236.pdf>

**License:** MIT

**See Also:**

- *niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.FeatureSelectionAlgorithm*

**Name = 'Bat Algorithm'**

**select\_features**(x, y, \*\*kwargs)

Perform the feature selection process.

**Arguments:** x (pandas.core.frame.DataFrame): Array of original features. y (pandas.core.series.Series) Expected classifier results.

**Returns:** pandas.core.frame.DataFrame: Mask of selected features.

**set\_parameters**(\*\*kwargs)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.preprocessing.feature\_selection.**DifferentialEvolution**(\*\*kwargs)

Bases: *niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.FeatureSelectionAlgorithm*

Implementation of feature selection using DE algorithm.

**Date:** 2020

**Author:** Luka Pečnik

**Reference:** The implementation is adapted according to the following article: D. Fister, I. Fister, T. Jagrič, I. Fister Jr., J. Brest. A novel self-adaptive differential evolution for feature selection using threshold mechanism . In: Proceedings of the 2018 IEEE Symposium on Computational Intelligence (SSCI 2018), pp. 17-24, 2018.

**Reference URL:** <http://iztok-jr-fister.eu/static/publications/236.pdf>

**License:** MIT

**See Also:**

- *niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.FeatureSelectionAlgorithm*

**Name = 'Differential Evolution'**

**select\_features**(x, y, \*\*kwargs)

Perform the feature selection process.

**Arguments:** x (pandas.core.frame.DataFrame): Array of original features. y (pandas.core.series.Series) Expected classifier results.

**Returns:** numpy.ndarray[bool]: Mask of selected features.

**set\_parameters(\*\*kwargs)**

Set the parameters/arguments of the algorithm.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.preprocessing.feature\_selection.**FeatureSelectionAlgorithm**(\*\*kwargs)

Bases: [niaaml.preprocessing.preprocessing\\_algorithm.PreprocessingAlgorithm](#)

Class for implementing feature selection algorithms.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**See Also:**

- [niaaml.preprocessing.preprocessing\\_algorithm.PreprocessingAlgorithm](#)

**select\_features**(x, y, \*\*kwargs)

Perform the feature selection process.

**Arguments:** x (pandas.core.frame.DataFrame): Array of original features. y (pandas.core.series.Series) Expected classifier results.

**Returns:** numpy.ndarray[bool]: Mask of selected features.

**class** niaaml.preprocessing.feature\_selection.**FeatureSelectionAlgorithmFactory**(\*\*kwargs)

Bases: [niaaml.utilities.Factory](#)

Class with string mappings to feature selection algorithms.

**Attributes:** \_entities (Dict[str, FeatureSelectionAlgorithm]): Mapping from strings to feature selection algorithms.

**See Also:**

- [niaaml.utilities.Factory](#)

**class** niaaml.preprocessing.feature\_selection.**GreyWolfOptimizer**(\*\*kwargs)

Bases: [niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm](#)

Implementation of feature selection using GWO algorithm.

**Date:** 2020

**Author:** Luka Pečnik

**Reference:** The implementation is adapted according to the following article: D. Fister, I. Fister, T. Jagrič, I. Fister Jr., J. Brest. A novel self-adaptive differential evolution for feature selection using threshold mechanism . In: Proceedings of the 2018 IEEE Symposium on Computational Intelligence (SSCI 2018), pp. 17-24, 2018.

**Reference URL:** <http://iztok-jr-fister.eu/static/publications/236.pdf>

**License:** MIT

**See Also:**

- [niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm](#)

**Name = 'Grey Wolf Optimizer'**

**select\_features**(x, y, *\*\*kwargs*)

Perform the feature selection process.

**Arguments:** x (pandas.core.frame.DataFrame): Array of original features. y (pandas.core.series.Series)  
Expected classifier results.

**Returns:** numpy.ndarray[bool]: Mask of selected features.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.preprocessing.feature\_selection.**ParticleSwarmOptimization**(*\*\*kwargs*)

Bases: [niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm](#)

Implementation of feature selection using PSO algorithm.

**Date:** 2020

**Author:** Luka Pečnik

**Reference:** The implementation is adapted according to the following article: D. Fister, I. Fister, T. Jagrič, I. Fister Jr., J. Brest. A novel self-adaptive differential evolution for feature selection using threshold mechanism . In: Proceedings of the 2018 IEEE Symposium on Computational Intelligence (SSCI 2018), pp. 17-24, 2018.

**Reference URL:** <http://iztok-jr-fister.eu/static/publications/236.pdf>

**License:** MIT

**See Also:**

- [niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm](#)

**Name = 'Particle Swarm Optimization'**

**select\_features**(x, y, *\*\*kwargs*)

Perform the feature selection process.

**Arguments:** x (pandas.core.frame.DataFrame): Array of original features. y (pandas.core.series.Series)  
Expected classifier results.

**Returns:** numpy.ndarray[bool]: Mask of selected features.

**set\_parameters**(*\*\*kwargs*)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.preprocessing.feature\_selection.**SelectKBest**(*\*\*kwargs*)

Bases: [niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm](#)

Implementation of feature selection using selection of k best features according to used score function.

**Date:** 2020

**Author:** Luka Pečnik



**License:** MIT

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.feature\\_selection.SelectKBest.html](https://scikit-learn.org/stable/modules/generated/sklearn.feature_selection.SelectKBest.html)

**See Also:**

- [\*niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm\*](#)

**Name = 'Select K Best'**

**select\_features**(*x*, *y*, *\*\*kwargs*)

Perform the feature selection process.

**Arguments:** *x* (pandas.core.frame.DataFrame): Array of original features. *y* (pandas.core.series.Series) Expected classifier results.

**Returns:** numpy.ndarray[bool]: Mask of selected features.

**set\_parameters**(*\*\*kwargs*)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**class** niaaml.preprocessing.feature\_selection.**SelectPercentile**(*\*\*kwargs*)

Bases: [\*niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm\*](#)

Implementation of feature selection using percentile selection of best features according to used score function.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.feature\\_selection.SelectPercentile.html](https://scikit-learn.org/stable/modules/generated/sklearn.feature_selection.SelectPercentile.html)

**See Also:**

- [\*niaaml.preprocessing.feature\\_selection.feature\\_selection\\_algorithm.FeatureSelectionAlgorithm\*](#)

**Name = 'Select Percentile'**

**select\_features**(*x*, *y*, *\*\*kwargs*)

Perform the feature selection process.

**Arguments:** *x* (pandas.core.frame.DataFrame): Array of original features. *y* (pandas.core.series.Series) Expected classifier results.

**Returns:** numpy.ndarray[bool]: Mask of selected features.

**set\_parameters**(*\*\*kwargs*)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

```
class niaaml.preprocessing.feature_selection.VarianceThreshold(**kwargs)
    Bases: niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.
            FeatureSelectionAlgorithm

    Implementation of feature selection using variance threshold.

    Date: 2020

    Author: Luka Pečnik

    License: MIT

    Documentation: https://scikit-learn.org/stable/modules/generated/sklearn.feature\_selection.
                        VarianceThreshold.html

    See Also:

        • niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.
          FeatureSelectionAlgorithm

    Name = 'Variance Threshold'

    select_features(x, y, **kwargs)
        Perform the feature selection process.

        Arguments: x (pandas.core.frame.DataFrame): Array of original features. y (pandas.core.series.Series)
            Expected classifier results.

        Returns: numpy.ndarray[bool]: Mask of selected features.

    set_parameters(**kwargs)
        Set the parameters/arguments of the algorithm.

    to_string()
        User friendly representation of the object.

        Returns: str: User friendly representation of the object.

class niaaml.preprocessing.feature_selection.jDEFSTH(**kwargs)
    Bases: niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.
            FeatureSelectionAlgorithm

    Implementation of self-adaptive differential evolution for feature selection using threshold mechanism.

    Date: 2020

    Author: Iztok Fister Jr.

    Reference:

        D. Fister, I. Fister, T. Jagrič, I. Fister Jr., J. Brest. A novel self-adaptive differential evolution for feature selection using threshold mechanism . In: Proceedings of the 2018 IEEE Symposium on Computational Intelligence (SSCI 2018), pp. 17-24, 2018.

    Reference URL: http://iztok-jr-fister.eu/static/publications/236.pdf

    License: MIT

    See Also:

        • niaaml.preprocessing.feature\_selection.feature\_selection\_algorithm.
          FeatureSelectionAlgorithm

    Name = 'Self-Adaptive Differential Evolution'

    select_features(x, y, **kwargs)
        Perform the feature selection process.
```

**Arguments:** x (pandas.core.frame.DataFrame): Array of original features. y (pandas.core.series.Series) Expected classifier results.

**Returns:** numpy.ndarray[bool]: Mask of selected features.

**to\_string()**

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

## 6.4.2 niaaml.preprocessing.feature\_transform

**class** niaaml.preprocessing.feature\_transform.**FeatureTransformAlgorithm**(\*\*kwargs)

Bases: [niaaml.preprocessing.preprocessing\\_algorithm.PreprocessingAlgorithm](#)

Class for implementing feature transform algorithms.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**See Also:**

- [niaaml.preprocessing.preprocessing\\_algorithm.PreprocessingAlgorithm](#)

**fit**(x, \*\*kwargs)

Fit implemented feature transform algorithm.

**Arguments:** x (pandas.core.frame.DataFrame): n samples to fit transformation algorithm.

**transform**(x, \*\*kwargs)

Transforms the given x data.

**Arguments:** x (pandas.core.frame.DataFrame): Data to transform.

**Returns:** pandas.core.frame.DataFrame: Transformed data.

**class** niaaml.preprocessing.feature\_transform.**FeatureTransformAlgorithmFactory**(\*\*kwargs)

Bases: [niaaml.utilities.Factory](#)

Class with string mappings to feature transform algorithms.

**Attributes:** \_entities (Dict[str, FeatureTransformAlgorithm]): Mapping from strings to feature transform algorithms.

**class** niaaml.preprocessing.feature\_transform.**MaxAbsScaler**(\*\*kwargs)

Bases: [niaaml.preprocessing.feature\\_transform.feature\\_transform\\_algorithm.FeatureTransformAlgorithm](#)

Implementation of feature scaling by its maximum absolute value.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.MaxAbsScaler.html#sklearn.preprocessing.MaxAbsScaler>

**See Also:**

- [niaaml.preprocessing.feature\\_transform.FeatureTransformAlgorithm](#)

**Name** = 'Maximum Absolute Scaler'

**fit**(*x*, **\*\*kwargs**)

Fit implemented transformation algorithm.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to fit transformation algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**transform**(*x*, **\*\*kwargs**)

Transforms the given *x* data.

**Arguments:** *x* (pandas.core.frame.DataFrame): Data to transform.

**Returns:** pandas.core.frame.DataFrame: Transformed data.

**class** niaaml.preprocessing.feature\_transform.**Normalizer**(**\*\*kwargs**)

Bases: [niaaml.preprocessing.feature\\_transform.feature\\_transform\\_algorithm.FeatureTransformAlgorithm](#)

Implementation of feature normalization algorithm.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.Normalizer>

**See Also:**

- [niaaml.preprocessing.feature\\_transform.FeatureTransformAlgorithm](#)

**Name** = 'Normalizer'

**fit**(*x*, **\*\*kwargs**)

Fit implemented transformation algorithm.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to fit transformation algorithm.

**set\_parameters**(**\*\*kwargs**)

Set the parameters/arguments of the algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**transform**(*x*, **\*\*kwargs**)

Transforms the given *x* data.

**Arguments:** *x* (pandas.core.frame.DataFrame): Data to transform.

**Returns:** pandas.core.frame.DataFrame: Transformed data.

**class** niaaml.preprocessing.feature\_transform.**QuantileTransformer**(**\*\*kwargs**)

Bases: [niaaml.preprocessing.feature\\_transform.feature\\_transform\\_algorithm.FeatureTransformAlgorithm](#)

Implementation of quantile transformer.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.QuantileTransformer.html#sklearn.preprocessing.QuantileTransformer>

**See Also:**

- *niaaml.preprocessing.feature\_transform.FeatureTransformAlgorithm*

**Name = 'Quantile Transformer'**

**fit**(*x*, **\*\*kwargs**)

Fit implemented transformation algorithm.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to fit transformation algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**transform**(*x*, **\*\*kwargs**)

Transforms the given *x* data.

**Arguments:** *x* (pandas.core.frame.DataFrame): Data to transform.

**Returns:** pandas.core.frame.DataFrame: Transformed data.

**class** niaaml.preprocessing.feature\_transform.**RobustScaler**(**\*\*kwargs**)

Bases: *niaaml.preprocessing.feature\_transform.feature\_transform\_algorithm.FeatureTransformAlgorithm*

Implementation of the robust scaler.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.RobustScaler.html#sklearn.preprocessing.RobustScaler>

**See Also:**

- *niaaml.preprocessing.feature\_transform.FeatureTransformAlgorithm*

**Name = 'Robust Scaler'**

**fit**(*x*, **\*\*kwargs**)

Fit implemented transformation algorithm.

**Arguments:** *x* (pandas.core.frame.DataFrame): *n* samples to fit transformation algorithm.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**transform**(*x*, **\*\*kwargs**)

Transforms the given *x* data.

**Arguments:** *x* (pandas.core.frame.DataFrame): Data to transform.

**Returns:** pandas.core.frame.DataFrame: Transformed data.

```
class niaaml.preprocessing.feature_transform.StandardScaler(**kwargs)
    Bases: niaaml.preprocessing.feature\_transform.feature\_transform\_algorithm.FeatureTransformAlgorithm
    Implementation of feature standard scaling algorithm.
    Date: 2020
    Author: Luka Pečnik
    License: MIT
    Documentation: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
    See Also:
        • niaaml.preprocessing.feature\_transform.FeatureTransformAlgorithm
    Name = 'Standard Scaler'
    fit(x, **kwargs)
        Fit implemented transformation algorithm.
        Arguments: x (pandas.core.frame.DataFrame): n samples to fit transformation algorithm.
    to_string()
        User friendly representation of the object.
        Returns: str: User friendly representation of the object.
    transform(x, **kwargs)
        Transforms the given x data.
        Arguments: x (pandas.core.frame.DataFrame): Data to transform.
        Returns: pandas.core.frame.DataFrame: Transformed data.
```

### 6.4.3 `niaaml.preprocessing.encoding`

```
class niaaml.preprocessing.encoding.EncoderFactory(**kwargs)
    Bases: niaaml.utilities.Factory
    Class with string mappings to encoders.
    Attributes: _entities (Dict[str, FeatureEncoder]): Mapping from strings to encoders.
    See Also:
        • niaaml.utilities.Factory
class niaaml.preprocessing.encoding.FeatureEncoder(**kwargs)
    Bases: object
    Class for implementing feature encoders.
    Date: 2020
    Author: Luka Pečnik
    License: MIT
    Attributes: Name (str): Name of the feature encoder.
    Name = None
```

**fit**(*feature*)

Fit feature encoder.

**Arguments:** *feature* (pandas.core.frame.DataFrame): A column (categorical) from DataFrame of features.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**transform**(*feature*)

Transform feature's values.

**Arguments:** *feature* (pandas.core.frame.DataFrame): A column (categorical) from DataFrame of features.

**Returns:** pandas.core.frame.DataFrame: A transformed column.

**class** niaaml.preprocessing.encoding.**OneHotEncoder**(\*\*kwargs)

Bases: [niaaml.preprocessing.encoding.feature\\_encoder.FeatureEncoder](#)

Implementation of one-hot encoder.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Reference:** Seger, Cedric. "An investigation of categorical variable encoding techniques in machine learning: binary versus one-hot and feature hashing." (2018).

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.OneHotEncoder.html>

**See Also:**

- [niaaml.preprocessing.encoding.FeatureEncoder](#)

**Name = 'One-Hot Encoder'**

**fit**(*feature*)

Fit feature encoder.

**Arguments:** *feature* (pandas.core.frame.DataFrame): A column (categorical) from DataFrame of features.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**transform**(*feature*)

Transform feature's values.

**Arguments:** *feature* (pandas.core.frame.DataFrame): A column (categorical) from DataFrame of features.

**Returns:** pandas.core.frame.DataFrame: A transformed column.

**niaaml.preprocessing.encoding.encode\_categorical\_features**(*features*, *encoder*)

Encode categorical features.

**Arguments:** *features* (pandas.core.frame.DataFrame): DataFrame of features. *encoder* (str): Name of the encoder to use.

**Returns:**

**Tuple**[pandas.core.frame.DataFrame, Iterable[FeatureEncoder]]:

1. Converted dataframe.

2. Dictionary of encoders for all categorical features.

#### 6.4.4 `niaaml.preprocessing.imputation`

**class** `niaaml.preprocessing.imputation.Imputer(**kwargs)`

Bases: `object`

Class for implementing imputers.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** `Name (str)`: Name of the imputer.

**Name = None**

**fit**(*feature*)

Fit imputer.

**Arguments:** `feature (pandas.core.frame.DataFrame)`: A column from DataFrame of features.

**to\_string**()

User friendly representation of the object.

**Returns:** `str`: User friendly representation of the object.

**transform**(*feature*)

Transform feature's values.

**Arguments:** `feature (pandas.core.frame.DataFrame)`: A column from DataFrame of features.

**Returns:** `pandas.core.frame.DataFrame`: A transformed column.

**class** `niaaml.preprocessing.imputation.ImputerFactory(**kwargs)`

Bases: `niaaml.utilities.Factory`

Class with string mappings to imputers.

**Attributes:** `_entities (Dict[str, Imputer])`: Mapping from strings to imputers.

**See Also:**

- `niaaml.utilities.Factory`

**class** `niaaml.preprocessing.imputation.SimpleImputer(**kwargs)`

Bases: `niaaml.preprocessing.imputation.imputer.Imputer`

Implementation of simple imputer.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** <https://scikit-learn.org/stable/modules/generated/sklearn.impute.SimpleImputer.html>

**See Also:**

- `niaaml.preprocessing.imputation.Imputer`

**Name = 'Simple Imputer'**



**fit**(*feature*)

Fit imputer.

**Arguments:** *feature* (pandas.core.frame.DataFrame): A column from DataFrame of features.

**to\_string**()

User friendly representation of the object.

**Returns:** str: User friendly representation of the object.

**transform**(*feature*)

Transform feature's values.

**Arguments:** *feature* (pandas.core.frame.DataFrame): A column from DataFrame of features.

**Returns:** pandas.core.frame.DataFrame: A transformed column.

**niaaml.preprocessing.imputation.impute\_features**(*features, imputer*)

Impute features with missing data.

**Arguments:** *features* (pandas.core.frame.DataFrame): DataFrame of features. *imputer* (str): Name of the imputer to use.

**Returns:**

**Tuple[pandas.core.frame.DataFrame, Dict[Imputer]]:**

1. Converted dataframe.
2. Dictionary of imputers for all features with missing data.

## 6.5 niaaml.fitness

**class** niaaml.fitness.**Accuracy**(\*\**kwargs*)

Bases: [niaaml.fitness.fitness\\_function.FitnessFunction](#)

Class representing the accuracy as a fitness function.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.metrics.accuracy\\_score.html](https://scikit-learn.org/stable/modules/generated/sklearn.metrics.accuracy_score.html)

**See Also:**

- [niaaml.fitness.FitnessFunction](#)

**Name** = 'Accuracy'

**get\_fitness**(*predicted, expected*)

Return fitness value. The larger return value should represent a better fitness for the framework to work properly.

**Arguments:** *predicted* (pandas.core.series.Series): Predicted values. *expected* (pandas.core.series.Series): Expected values.

**Returns:** float: Calculated fitness value.

**class** niaaml.fitness.**CohenKappa**(\*\**kwargs*)

Bases: [niaaml.fitness.fitness\\_function.FitnessFunction](#)

Class representing the cohen's kappa as a fitness function.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.metrics.cohen\\_kappa\\_score.html](https://scikit-learn.org/stable/modules/generated/sklearn.metrics.cohen_kappa_score.html)

**See Also:**

- [\*niaaml.fitness.FitnessFunction\*](#)

**Name** = "Cohen's Kappa"

**get\_fitness**(*predicted, expected*)

Return fitness value. The larger return value should represent a better fitness for the framework to work properly.

**Arguments:** *predicted* (pandas.core.series.Series): Predicted values. *expected* (pandas.core.series.Series): Expected values.

**Returns:** float: Calculated fitness value.

**class** `niaaml.fitness.F1`(\*\**kwargs*)

Bases: [\*niaaml.fitness.fitness\\_function.FitnessFunction\*](#)

Class representing the F1-score as a fitness function.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.metrics.f1\\_score.html](https://scikit-learn.org/stable/modules/generated/sklearn.metrics.f1_score.html)

**See Also:**

- [\*niaaml.fitness.FitnessFunction\*](#)

**Name** = 'F-score'

**get\_fitness**(*predicted, expected*)

Return fitness value. The larger return value should represent a better fitness for the framework to work properly.

**Arguments:** *predicted* (pandas.core.series.Series): Predicted values. *expected* (pandas.core.series.Series): Expected values.

**Returns:** float: Calculated fitness value.

**class** `niaaml.fitness.FitnessFactory`(\*\**kwargs*)

Bases: `niaaml.utilities.Factory`

Class with string mappings to fitness class.

**Attributes:** `_entities` (Dict[str, Fitness]): Mapping from strings to fitness classes.

**See Also:**

- `niaaml.utilities.Factory`

**class** `niaaml.fitness.FitnessFunction`(\*\**kwargs*)

Bases: `object`

Class for implementing fitness functions.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Attributes:** Name (str): Name of the fitness function.

**Name = None**

**get\_fitness**(*predicted, expected*)

Return fitness value. The larger return value should represent a better fitness for the framework to work properly.

**Arguments:** *predicted* (pandas.core.series.Series): Predicted values. *expected* (pandas.core.series.Series): Expected values.

**Returns:** float: Calculated fitness value.

**set\_parameters**(\*\**kwargs*)

Set the parameters/arguments of the pipeline component.

**class** niaaml.fitness.**Precision**(\*\**kwargs*)

Bases: [niaaml.fitness.fitness\\_function.FitnessFunction](#)

Class representing the precision as a fitness function.

**Date:** 2020

**Author:** Luka Pečnik

**License:** MIT

**Documentation:** [https://scikit-learn.org/stable/modules/generated/sklearn.metrics.precision\\_score.html](https://scikit-learn.org/stable/modules/generated/sklearn.metrics.precision_score.html)

**See Also:**

- [niaaml.fitness.FitnessFunction](#)

**Name = 'Precision'**

**get\_fitness**(*predicted, expected*)

Return fitness value. The larger return value should represent a better fitness for the framework to work properly.

**Arguments:** *predicted* (pandas.core.series.Series): Predicted values. *expected* (pandas.core.series.Series): Expected values.

**Returns:** float: Calculated fitness value.



## ABOUT

NiaAML is an automated machine learning Python framework based on nature-inspired algorithms for optimization. The name comes from the [automated machine learning method of the same name](#). Its goal is to efficiently compose the best possible classification pipeline for the given task using components on the input. The components are divided into three groups: feature selection algorithms, feature transformation algorithms and classifiers. The framework uses nature-inspired algorithms for optimization to choose the best set of components for the classification pipeline on the output and optimize their parameters. We use NiaPy framework for the optimization process which is a popular Python collection of nature-inspired algorithms. The NiaAML framework is easy to use and customize or expand to suit your needs.

The NiaAML framework allows you not only to run full pipeline optimization, but also separate implemented components such as classifiers, feature selection algorithms, etc. It supports numerical and categorical features.

### 7.1 Licence

This package is distributed under the [MIT License](#).

### 7.2 Disclaimer

This framework is provided as-is, and there are no guarantees that it fits your purposes or that it is bug-free. Use it at your own risk!



## CONTRIBUTING TO NIAAML

First off, thanks for taking the time to contribute!

### 8.1 Code of Conduct

This project and everyone participating in it is governed by the *Contributor Covenant Code of Conduct*. By participating, you are expected to uphold this code. Please report unacceptable behavior to [lukepecnik96@gmail.com](mailto:lukepecnik96@gmail.com).

### 8.2 How Can I Contribute?

#### 8.2.1 Reporting Bugs

Before creating bug reports, please check existing issues list as you might find out that you don't need to create one. When you are creating a bug report, please include as many details as possible in the issue template.

#### 8.2.2 Suggesting Enhancements

Open new issue using the feature request template.

#### 8.2.3 Pull requests

Fill in the pull request template and make sure your code is documented.





## CONTRIBUTOR COVENANT CODE OF CONDUCT

### 9.1 Our Pledge

We as members, contributors, and leaders pledge to make participation in our community a harassment-free experience for everyone, regardless of age, body size, visible or invisible disability, ethnicity, sex characteristics, gender identity and expression, level of experience, education, socio-economic status, nationality, personal appearance, race, religion, or sexual identity and orientation.

We pledge to act and interact in ways that contribute to an open, welcoming, diverse, inclusive, and healthy community.

### 9.2 Our Standards

Examples of behavior that contributes to a positive environment for our community include:

- Demonstrating empathy and kindness toward other people
- Being respectful of differing opinions, viewpoints, and experiences
- Giving and gracefully accepting constructive feedback
- Accepting responsibility and apologizing to those affected by our mistakes, and learning from the experience
- Focusing on what is best not just for us as individuals, but for the overall community

Examples of unacceptable behavior include:

- The use of sexualized language or imagery, and sexual attention or advances of any kind
- Trolling, insulting or derogatory comments, and personal or political attacks
- Public or private harassment
- Publishing others' private information, such as a physical or email address, without their explicit permission
- Other conduct which could reasonably be considered inappropriate in a professional setting

## 9.3 Enforcement Responsibilities

Community leaders are responsible for clarifying and enforcing our standards of acceptable behavior and will take appropriate and fair corrective action in response to any behavior that they deem inappropriate, threatening, offensive, or harmful.

Community leaders have the right and responsibility to remove, edit, or reject comments, commits, code, wiki edits, issues, and other contributions that are not aligned to this Code of Conduct, and will communicate reasons for moderation decisions when appropriate.

## 9.4 Scope

This Code of Conduct applies within all community spaces, and also applies when an individual is officially representing the community in public spaces. Examples of representing our community include using an official e-mail address, posting via an official social media account, or acting as an appointed representative at an online or offline event.

## 9.5 Enforcement

Instances of abusive, harassing, or otherwise unacceptable behavior may be reported to the community leaders responsible for enforcement at [lukepecnik96@gmail.com](mailto:lukepecnik96@gmail.com). All complaints will be reviewed and investigated promptly and fairly.

All community leaders are obligated to respect the privacy and security of the reporter of any incident.

## 9.6 Enforcement Guidelines

Community leaders will follow these Community Impact Guidelines in determining the consequences for any action they deem in violation of this Code of Conduct:

### 9.6.1 1. Correction

**Community Impact:** Use of inappropriate language or other behavior deemed unprofessional or unwelcome in the community.

**Consequence:** A private, written warning from community leaders, providing clarity around the nature of the violation and an explanation of why the behavior was inappropriate. A public apology may be requested.

### 9.6.2 2. Warning

**Community Impact:** A violation through a single incident or series of actions.

**Consequence:** A warning with consequences for continued behavior. No interaction with the people involved, including unsolicited interaction with those enforcing the Code of Conduct, for a specified period of time. This includes avoiding interactions in community spaces as well as external channels like social media. Violating these terms may lead to a temporary or permanent ban.

### 9.6.3 3. Temporary Ban

**Community Impact:** A serious violation of community standards, including sustained inappropriate behavior.

**Consequence:** A temporary ban from any sort of interaction or public communication with the community for a specified period of time. No public or private interaction with the people involved, including unsolicited interaction with those enforcing the Code of Conduct, is allowed during this period. Violating these terms may lead to a permanent ban.

### 9.6.4 4. Permanent Ban

**Community Impact:** Demonstrating a pattern of violation of community standards, including sustained inappropriate behavior, harassment of an individual, or aggression toward or disparagement of classes of individuals.

**Consequence:** A permanent ban from any sort of public interaction within the community.

## 9.7 Attribution

This Code of Conduct is adapted from the Contributor Covenant, version 2.0, available at [https://www.contributor-covenant.org/version/2/0/code\\_of\\_conduct.html](https://www.contributor-covenant.org/version/2/0/code_of_conduct.html).

Community Impact Guidelines were inspired by Mozilla's code of conduct enforcement ladder.

For answers to common questions about this code of conduct, see the FAQ at <https://www.contributor-covenant.org/faq>. Translations are available at <https://www.contributor-covenant.org/translations>.



## **REFERENCES**

[1] Iztok Fister Jr., Milan Zorman, Dušan Fister, Iztok Fister. Continuous optimizers for automatic design and evaluation of classification pipelines. In: Frontier applications of nature inspired computation. Springer tracts in nature-inspired computing, pp.281-301, 2020.



## PYTHON MODULE INDEX

### n

- `niaaml, ??`
- `niaaml.classifiers, 25`
- `niaaml.data, 24`
- `niaaml.fitness, 45`
- `niaaml.preprocessing, 33`
- `niaaml.preprocessing.encoding, 42`
- `niaaml.preprocessing.feature_selection, 33`
- `niaaml.preprocessing.feature_transform, 39`
- `niaaml.preprocessing.imputation, 44`





## A

Accuracy (class in *niaaml.fitness*), 45  
 AdaBoost (class in *niaaml.classifiers*), 25

## B

Bagging (class in *niaaml.classifiers*), 26  
 BasicDataReader (class in *niaaml.data*), 24  
 BatAlgorithm (class in *niaaml.preprocessing.feature\_selection*), 33

## C

Classifier (class in *niaaml.classifiers*), 26  
 ClassifierFactory (class in *niaaml.classifiers*), 27  
 CohenKappa (class in *niaaml.fitness*), 45  
 CSVDataReader (class in *niaaml.data*), 24

## D

DataReader (class in *niaaml.data*), 24  
 DecisionTree (class in *niaaml.classifiers*), 27  
 DifferentialEvolution (class in *niaaml.preprocessing.feature\_selection*), 34

## E

encode\_categorical\_features() (in module *niaaml.preprocessing.encoding*), 43  
 EncoderFactory (class in *niaaml.preprocessing.encoding*), 42  
 ExtremelyRandomizedTrees (class in *niaaml.classifiers*), 28

## F

F1 (class in *niaaml.fitness*), 46  
 FeatureEncoder (class in *niaaml.preprocessing.encoding*), 42  
 FeatureSelectionAlgorithm (class in *niaaml.preprocessing.feature\_selection*), 35  
 FeatureSelectionAlgorithmFactory (class in *niaaml.preprocessing.feature\_selection*), 35  
 FeatureTransformAlgorithm (class in *niaaml.preprocessing.feature\_transform*), 39

FeatureTransformAlgorithmFactory (class in *niaaml.preprocessing.feature\_transform*), 39  
 fit() (*niaaml.classifiers.AdaBoost* method), 25  
 fit() (*niaaml.classifiers.Bagging* method), 26  
 fit() (*niaaml.classifiers.Classifier* method), 26  
 fit() (*niaaml.classifiers.DecisionTree* method), 27  
 fit() (*niaaml.classifiers.ExtremelyRandomizedTrees* method), 28  
 fit() (*niaaml.classifiers.GaussianNB* method), 29  
 fit() (*niaaml.classifiers.GaussianProcess* method), 29  
 fit() (*niaaml.classifiers.KNeighbors* method), 30  
 fit() (*niaaml.classifiers.LinearSVC* method), 31  
 fit() (*niaaml.classifiers.MultiLayerPerceptron* method), 31  
 fit() (*niaaml.classifiers.QuadraticDiscriminantAnalysis* method), 32  
 fit() (*niaaml.classifiers.RandomForest* method), 33  
 fit() (*niaaml.preprocessing.encoding.FeatureEncoder* method), 42  
 fit() (*niaaml.preprocessing.encoding.OneHotEncoder* method), 43  
 fit() (*niaaml.preprocessing.feature\_transform.FeatureTransformAlgorithm* method), 39  
 fit() (*niaaml.preprocessing.feature\_transform.MaxAbsScaler* method), 40  
 fit() (*niaaml.preprocessing.feature\_transform.Normalizer* method), 40  
 fit() (*niaaml.preprocessing.feature\_transform.QuantileTransformer* method), 41  
 fit() (*niaaml.preprocessing.feature\_transform.RobustScaler* method), 41  
 fit() (*niaaml.preprocessing.feature\_transform.StandardScaler* method), 42  
 fit() (*niaaml.preprocessing.imputation.Imputer* method), 44  
 fit() (*niaaml.preprocessing.imputation.SimpleImputer* method), 44  
 FitnessFactory (class in *niaaml.fitness*), 46  
 FitnessFunction (class in *niaaml.fitness*), 46

## G

GaussianNB (class in *niaaml.classifiers*), 28

GaussianProcess (*class in niaaml.classifiers*), 29  
 get\_fitness() (*niaaml.fitness.Accuracy method*), 45  
 get\_fitness() (*niaaml.fitness.CohenKappa method*), 46  
 get\_fitness() (*niaaml.fitness.F1 method*), 46  
 get\_fitness() (*niaaml.fitness.FitnessFunction method*), 47  
 get\_fitness() (*niaaml.fitness.Precision method*), 47  
 get\_x() (*niaaml.data.DataReader method*), 25  
 get\_y() (*niaaml.data.DataReader method*), 25  
 GreyWolfOptimizer (*class in niaaml.preprocessing.feature\_selection*), 35

**I**

impute\_features() (*in module niaaml.preprocessing.imputation*), 45  
 Imputer (*class in niaaml.preprocessing.imputation*), 44  
 ImputerFactory (*class in niaaml.preprocessing.imputation*), 44

**J**

jDEFSTH (*class in niaaml.preprocessing.feature\_selection*), 38

**K**

KNeighbors (*class in niaaml.classifiers*), 30

**L**

LinearSVC (*class in niaaml.classifiers*), 30

**M**

MaxAbsScaler (*class in niaaml.preprocessing.feature\_transform*), 39  
 module  
   niaaml, 1  
   niaaml.classifiers, 25  
   niaaml.data, 24  
   niaaml.fitness, 45  
   niaaml.preprocessing, 33  
   niaaml.preprocessing.encoding, 42  
   niaaml.preprocessing.feature\_selection, 33  
   niaaml.preprocessing.feature\_transform, 39  
   niaaml.preprocessing.imputation, 44  
 MultiLayerPerceptron (*class in niaaml.classifiers*), 31

**N**

Name (*niaaml.classifiers.AdaBoost attribute*), 25  
 Name (*niaaml.classifiers.Bagging attribute*), 26  
 Name (*niaaml.classifiers.DecisionTree attribute*), 27  
 Name (*niaaml.classifiers.ExtremelyRandomizedTrees attribute*), 28  
 Name (*niaaml.classifiers.GaussianNB attribute*), 29  
 Name (*niaaml.classifiers.GaussianProcess attribute*), 29  
 Name (*niaaml.classifiers.KNeighbors attribute*), 30  
 Name (*niaaml.classifiers.LinearSVC attribute*), 31  
 Name (*niaaml.classifiers.MultiLayerPerceptron attribute*), 31  
 Name (*niaaml.classifiers.QuadraticDiscriminantAnalysis attribute*), 32  
 Name (*niaaml.classifiers.RandomForest attribute*), 33  
 Name (*niaaml.fitness.Accuracy attribute*), 45  
 Name (*niaaml.fitness.CohenKappa attribute*), 46  
 Name (*niaaml.fitness.F1 attribute*), 46  
 Name (*niaaml.fitness.FitnessFunction attribute*), 47  
 Name (*niaaml.fitness.Precision attribute*), 47  
 Name (*niaaml.preprocessing.encoding.FeatureEncoder attribute*), 42  
 Name (*niaaml.preprocessing.encoding.OneHotEncoder attribute*), 43  
 Name (*niaaml.preprocessing.feature\_selection.BatAlgorithm attribute*), 34  
 Name (*niaaml.preprocessing.feature\_selection.DifferentialEvolution attribute*), 34  
 Name (*niaaml.preprocessing.feature\_selection.GreyWolfOptimizer attribute*), 35  
 Name (*niaaml.preprocessing.feature\_selection.jDEFSTH attribute*), 38  
 Name (*niaaml.preprocessing.feature\_selection.ParticleSwarmOptimization attribute*), 36  
 Name (*niaaml.preprocessing.feature\_selection.SelectKBest attribute*), 37  
 Name (*niaaml.preprocessing.feature\_selection.SelectPercentile attribute*), 37  
 Name (*niaaml.preprocessing.feature\_selection.VarianceThreshold attribute*), 38  
 Name (*niaaml.preprocessing.feature\_transform.MaxAbsScaler attribute*), 39  
 Name (*niaaml.preprocessing.feature\_transform.Normalizer attribute*), 40  
 Name (*niaaml.preprocessing.feature\_transform.QuantileTransformer attribute*), 41  
 Name (*niaaml.preprocessing.feature\_transform.RobustScaler attribute*), 41  
 Name (*niaaml.preprocessing.feature\_transform.StandardScaler attribute*), 42  
 Name (*niaaml.preprocessing.imputation.Imputer attribute*), 44  
 Name (*niaaml.preprocessing.imputation.SimpleImputer attribute*), 44  
 niaaml  
   module, 1  
   niaaml.classifiers  
     module, 25  
   niaaml.data  
     module, 24

niaaml.fitness  
 module, 45  
 niaaml.preprocessing  
 module, 33  
 niaaml.preprocessing.encoding  
 module, 42  
 niaaml.preprocessing.feature\_selection  
 module, 33  
 niaaml.preprocessing.feature\_transform  
 module, 39  
 niaaml.preprocessing.imputation  
 module, 44  
 Normalizer (class in ni-  
 aaml.preprocessing.feature\_transform), 40

## O

OneHotEncoder (class in ni-  
 aaml.preprocessing.encoding), 43

## P

ParticleSwarmOptimization (class in ni-  
 aaml.preprocessing.feature\_selection), 36  
 Precision (class in niaaml.fitness), 47  
 predict() (niaaml.classifiers.AdaBoost method), 25  
 predict() (niaaml.classifiers.Bagging method), 26  
 predict() (niaaml.classifiers.Classifier method), 26  
 predict() (niaaml.classifiers.DecisionTree method), 27  
 predict() (niaaml.classifiers.ExtremelyRandomizedTrees  
 method), 28  
 predict() (niaaml.classifiers.GaussianNB method), 29  
 predict() (niaaml.classifiers.GaussianProcess  
 method), 29  
 predict() (niaaml.classifiers.KNeighbors method), 30  
 predict() (niaaml.classifiers.LinearSVC method), 31  
 predict() (niaaml.classifiers.MultiLayerPerceptron  
 method), 31  
 predict() (niaaml.classifiers.QuadraticDiscriminantAnalysis  
 method), 32  
 predict() (niaaml.classifiers.RandomForest method),  
 33  
 PreprocessingAlgorithm (class in ni-  
 aaml.preprocessing), 33

## Q

QuadraticDiscriminantAnalysis (class in ni-  
 aaml.classifiers), 32  
 QuantileTransformer (class in ni-  
 aaml.preprocessing.feature\_transform), 40

## R

RandomForest (class in niaaml.classifiers), 32  
 RobustScaler (class in ni-  
 aaml.preprocessing.feature\_transform), 41

## S

select\_features() (ni-  
 aaml.preprocessing.feature\_selection.BatAlgorithm  
 method), 34  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.DifferentialEvolution  
 method), 34  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.FeatureSelectionAlgorithm  
 method), 35  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.GreyWolfOptimizer  
 method), 36  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.jDEFSTH  
 method), 38  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.ParticleSwarmOptimization  
 method), 36  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.SelectKBest  
 method), 37  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.SelectPercentile  
 method), 37  
 select\_features() (ni-  
 aaml.preprocessing.feature\_selection.VarianceThreshold  
 method), 38  
 SelectKBest (class in ni-  
 aaml.preprocessing.feature\_selection), 36  
 SelectPercentile (class in ni-  
 aaml.preprocessing.feature\_selection), 37  
 set\_parameters() (niaaml.classifiers.AdaBoost  
 method), 25  
 set\_parameters() (niaaml.classifiers.Bagging  
 method), 26  
 set\_parameters() (niaaml.classifiers.DecisionTree  
 method), 27  
 set\_parameters() (ni-  
 aaml.classifiers.ExtremelyRandomizedTrees  
 method), 28  
 set\_parameters() (niaaml.classifiers.GaussianNB  
 method), 29  
 set\_parameters() (ni-  
 aaml.classifiers.GaussianProcess method),  
 29  
 set\_parameters() (niaaml.classifiers.KNeighbors  
 method), 30  
 set\_parameters() (niaaml.classifiers.LinearSVC  
 method), 31  
 set\_parameters() (ni-  
 aaml.classifiers.MultiLayerPerceptron  
 method), 31  
 set\_parameters() (ni-

<code>aaml.classifiers.QuadraticDiscriminantAnalysis</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.encoding.FeatureEncoder</code>
<code>method</code> ), 32	<code>method</code> ), 43
<code>set_parameters()</code> ( <code>niaaml.classifiers.RandomForest</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.encoding.OneHotEncoder</code>
<code>method</code> ), 33	<code>method</code> ), 43
<code>set_parameters()</code> ( <code>niaaml.fitness.FitnessFunction</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.BatAlgorithm</code>
<code>method</code> ), 47	<code>method</code> ), 34
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_selection.BatAlgorithm</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.DifferentialEvolution</code>
<code>method</code> ), 34	<code>method</code> ), 35
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_selection.DifferentialEvolution</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.GreyWolfOptimizer</code>
<code>method</code> ), 34	<code>method</code> ), 36
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_selection.jDEFSH</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.jDEFSH</code>
<code>method</code> ), 34	<code>method</code> ), 39
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_selection.ParticleSwarmOptimization</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.ParticleSwarmOptimization</code>
<code>method</code> ), 36	<code>method</code> ), 36
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_selection.SelectKBest</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.SelectKBest</code>
<code>method</code> ), 37	<code>method</code> ), 37
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_selection.SelectPercentile</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.SelectPercentile</code>
<code>method</code> ), 37	<code>method</code> ), 37
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_selection.VarianceThreshold</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_selection.VarianceThreshold</code>
<code>method</code> ), 37	<code>method</code> ), 38
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_transform.MaxAbsScaler</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_transform.MaxAbsScaler</code>
<code>method</code> ), 38	<code>method</code> ), 40
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_transform.Normalizer</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_transform.Normalizer</code>
<code>method</code> ), 38	<code>method</code> ), 40
<code>set_parameters()</code> ( <code>niaaml.preprocessing.feature_transform.QuantileTransformer</code>	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_transform.QuantileTransformer</code>
<code>method</code> ), 40	<code>method</code> ), 41
<code>set_x()</code> ( <code>niaaml.data.DataReader</code> <code>method</code> ), 25	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_transform.RobustScaler</code>
<code>set_y()</code> ( <code>niaaml.data.DataReader</code> <code>method</code> ), 25	<code>method</code> ), 41
<code>SimpleImputer</code> ( <code>class</code> <code>in</code> <code>niaaml.preprocessing.imputation</code> ), 44	<code>to_string()</code> ( <code>niaaml.preprocessing.feature_transform.StandardScaler</code>
<code>StandardScaler</code> ( <code>class</code> <code>in</code> <code>niaaml.preprocessing.feature_transform</code> ), 41	<code>method</code> ), 42
	<code>to_string()</code> ( <code>niaaml.preprocessing.imputation.Imputer</code>
	<code>method</code> ), 44
	<code>to_string()</code> ( <code>niaaml.preprocessing.imputation.SimpleImputer</code>
	<code>method</code> ), 45
<b>T</b>	<code>transform()</code> ( <code>niaaml.preprocessing.encoding.FeatureEncoder</code>
<code>to_string()</code> ( <code>niaaml.classifiers.AdaBoost</code> <code>method</code> ), 25	<code>method</code> ), 43
<code>to_string()</code> ( <code>niaaml.classifiers.Bagging</code> <code>method</code> ), 26	<code>transform()</code> ( <code>niaaml.preprocessing.encoding.OneHotEncoder</code>
<code>to_string()</code> ( <code>niaaml.classifiers.DecisionTree</code> <code>method</code> ), 27	<code>method</code> ), 43
<code>to_string()</code> ( <code>niaaml.classifiers.ExtremelyRandomizedTrees</code> <code>method</code> ), 28	<code>transform()</code> ( <code>niaaml.preprocessing.feature_transform.FeatureTransformer</code>
<code>to_string()</code> ( <code>niaaml.classifiers.GaussianNB</code> <code>method</code> ), 29	<code>method</code> ), 39
<code>to_string()</code> ( <code>niaaml.classifiers.GaussianProcess</code> <code>method</code> ), 30	<code>transform()</code> ( <code>niaaml.preprocessing.feature_transform.MaxAbsScaler</code>
<code>to_string()</code> ( <code>niaaml.classifiers.KNeighbors</code> <code>method</code> ), 30	<code>method</code> ), 40
<code>to_string()</code> ( <code>niaaml.classifiers.LinearSVC</code> <code>method</code> ), 31	<code>transform()</code> ( <code>niaaml.preprocessing.feature_transform.Normalizer</code>
<code>to_string()</code> ( <code>niaaml.classifiers.MultiLayerPerceptron</code> <code>method</code> ), 32	<code>method</code> ), 40
<code>to_string()</code> ( <code>niaaml.classifiers.QuadraticDiscriminantAnalysis</code> <code>method</code> ), 32	<code>transform()</code> ( <code>niaaml.preprocessing.feature_transform.QuantileTransformer</code>
<code>to_string()</code> ( <code>niaaml.classifiers.RandomForest</code> <code>method</code> ), 33	<code>method</code> ), 41
	<code>transform()</code> ( <code>niaaml.preprocessing.feature_transform.RobustScaler</code>
	<code>method</code> ), 41
	<code>transform()</code> ( <code>niaaml.preprocessing.feature_transform.StandardScaler</code>
	<code>method</code> ), 42
	<code>transform()</code> ( <code>niaaml.preprocessing.imputation.Imputer</code>
	<code>method</code> ), 44
	<code>transform()</code> ( <code>niaaml.preprocessing.imputation.SimpleImputer</code>
	<code>method</code> ), 45

## V

VarianceThreshold (class in ni-  
aaml.preprocessing.feature\_selection), [37](#)