pycast Documentation

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CONTENTS

CHAPTER

ONE

PYCAST.COMMON

class pycast.common.profileme.**_ProfileDecorator**(*filelocation*)
Bases: object

Decorator class that build a wrapper around any function.

Warning The decorator does not take recursive calls into account!

__call__(*func*)
Returns a wrapped version of the called function.

Parameters **func** (*Function*) – Function that should be wrapped.

Returns Returns a wrapped version of the called function.

Return type Function

__init__(*filelocation*)
Initializes the ProfileMe decorator.

Parameters

- **func** (*Function*) – Function that will be profiles.
- **filelocation** (*String*) – Location for the profiling results.

__weakref__
list of weak references to the object (if defined)

pycast.common.profileme.**profileMe**
alias of _ProfileDecorator

pycast.common.helper.**linear_interpolation**(*first*, *last*, *steps*)
Interpolates all missing values using linear interpolation.

Parameters

- **first** (*Numeric*) – Start value for the interpolation.
- **last** (*Numeric*) – End Value for the interpolation
- **steps** (*Integer*) – Number of missing values that have to be calculated.

Returns Returns a list of floats containing only the missing values.

Return type List

CHAPTER

TWO

TIMESERIES

class pycast.common.timeseries.**TimeSeries**(*isNormalized=False*, *isSorted=False*)

Bases: object

A TimeSeries instance stores all relevant data for a real world time series.

Warning TimeSeries instances are NOT threadsafe.

__add__(*otherTimeSeries*)

Creates a new TimeSeries instance containing the data of self and otherTimeSeries.

Parameters **otherTimeSeries** (*TimeSeries*) – TimeSeries instance that will be merged with self.

Returns Returns a new TimeSeries instance containing the data entries of self and otherTimeSeries.

Return type TimeSeries

__eq__(*otherTimeSeries*)

Returns if self and the other TimeSeries are equal.

TimeSeries are equal to each other if:

- they contain the same number of entries
- each data entry in one TimeSeries is also member of the other one.

Parameters **otherTimeSeries** (*TimeSeries*) – TimeSeries instance that is compared with self.

Returns True if the TimeSeries objects are equal, False otherwise.

Return type Boolean

__getitem__(*index*)

Returns the item stored at the TimeSeries index-th position.

Parameters **index** (*Integer*) – Position of the element that should be returned. Starts at 0

Returns Returns a list containing [timestamp, data] lists.

Return type List

Raise Raises an IndexError if the index is out of range.

__init__(*isNormalized=False*, *isSorted=False*)

Initializes the TimeSeries.

Parameters

- **isNormalized** (*Boolean*) – Within a normalized TimeSeries, all data points have the same temporal distance to each other. When this is `True`, the memory consumption of the TimeSeries might be reduced. Also algorithms will probably run faster on normalized TimeSeries. This should only be set to `True`, if the TimeSeries is realy normalized! TimeSeries normalization can be forced by executing `TimeSeries.normalize()`.
- **isSorted** (*Boolean*) – If all data points added to the time series are added in their ascending temporal order, this should set to `True`.

__iter__()
Returns an iterator that can be used to iterate over the data stored within the TimeSeries.

Returns Returns an iterator for the TimeSeries.

Return type Iterator

__len__()
Returns the number of data entries stored in the TimeSeries.

Returns Returns an Integer representing the number on data entries stored within the TimeSeries.

Return type Integer

__setitem__(*index*, *value*)
Sets the item at the index-th position of the TimeSeries.

Parameters

- **index** (*Integer*) – Index of the element that should be set.
- **value** (*List*) – A list of the form [timestamp, data]

Raise Raises an `IndexError` if the index is out of range.

__str__()
Returns a string representation of the TimeSeries.

Returns

Returns a string representing the TimeSeries in the format:

"TimeSeries([timestamp, data], [timestamp, data], [timestamp, data])".

Return type String

add_entry(*timestamp*, *data*, *format=None*)
Adds a new data entry to the TimeSeries.

Parameters

- **timestamp** – Time stamp of the data. This has either to be a float representing the UNIX epochs or a string containing a timestamp in the given format.
- **data** (*Numeric*) – Actual data value.
- **format** (*String*) – Format of the given timestamp. This is used to convert the timestamp into UNIX epochs, if set. For valid examples take a look into the `time.strptime()` documentation.

apply(*method*)
Applies the given ForecastingAlgorithm or SmoothingMethod from the `pycast.methods` module to the TimeSeries.

Parameters **method** (*BaseMethod*) – Method that should be used with the TimeSeries. For more information about the methods take a look into their corresponding documentation.

classmethod **convert_epoch_to_timestamp** (*timestamp*, *format*)
Converts the given float representing UNIX-epochs into an actual timestamp.

Parameters

- **timestamp** (*Float*) – Timestamp as UNIX-epochs.
- **format** (*String*) – Format of the given timestamp. This is used to convert the timestamp from UNIX epochs. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns the timestamp as defined in format.

Return type String

classmethod **convert_timestamp_to_epoch** (*timestamp*, *format*)
Converts the given timestamp into a float representing UNIX-epochs.

Parameters

- **timestamp** (*String*) – Timestamp in the defined format.
- **format** (*String*) – Format of the given timestamp. This is used to convert the timestamp into UNIX epochs. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns an float, representing the UNIX-epochs for the given timestamp.

Return type Float

classmethod **from_json** (*json*, *format=None*)
Creates a new TimeSeries instance from the given json string.

Parameters

- **json** (*String*) – JSON string, containing the time series data. This should be a string created by `TimeSeries.to_json()`.
- **format** (*String*) – Format of the given timestamps. This is used to convert the timestamps into UNIX epochs, if set. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns a TimeSeries instance containing the data.

Return type TimeSeries

Warning This is probably an unsafe version! Only use it with JSON strings created by `TimeSeries.to_json()`. All assumtions regarding normalization and sort order will be ignored and set to default.

classmethod **from_twodim_list** (*datalist*, *format=None*)
Creates a new TimeSeries instance from the data stored inside a two dimensional list.

Parameters

- **datalist** (*List*) – List containing multiple iterables with at least two values. The first item will always be used as timestamp in the predefined format, the second represents the value. All other items in those sublists will be ignored.
- **format** (*String*) – Format of the given timestamp. This is used to convert the timestamp into UNIX epochs, if necessary. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns a TimeSeries instance containing the data from datalist.

Return type TimeSeries

initialize_from_sql_cursor(*sqlcursor*, *format=None*)
Initializes the TimeSeries's data from the given SQL cursor.

Parameters

- **sqlcursor** (*SQLCursor*) – Cursor that was holds the SQL result for any given "SELECT timestamp, value, ... FROM ..." SQL query. Only the first two attributes of the SQL result will be used.
- **format** (*String*) – Format of the given timestamp. This is used to convert the timestamp into UNIX epochs, if set. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns the number of entries added to the TimeSeries.

Return type Integer

is_normalized()
Returns if the TimeSeries is normalized.

Returns Returns `True` if the TimeSeries is normalized, `False` otherwise.

Return type Boolean

is_sorted()
Returns if the TimeSeries is sorted.

Returns Returns `True` if the TimeSeries is sorted ascending, `False` in all other cases.

Return type Boolean

normalize(*normalizationLevel='minute'*, *fusionMethod='average'*, *interpolationMethod='linear'*)
Normalizes the TimeSeries data points.

If this function is called, the TimeSeries gets ordered ascending automatically. The new timestamps will represent the center of each time bucket. Within a normalized TimeSeries, the temporal distance between two consecutive data points is constant.

Parameters

- **normalizationLevel** (*String*) – Level of normalization that has to be applied. The available normalization levels are defined in `timeseries.NormalizationLevels`.
- **fusionMethod** (*String*) – Normalization method that has to be used if multiple data entries exist within the same normalization bucket. The available methods are defined in `timeseries.FusionMethods`.
- **interpolationMethod** (*String*) – Interpolation method that is used if a data entry at a specific time is missing. The available interpolation methods are defined in `timeseries.InterpolationMethods`.

Raise Raises a `ValueError` if a normalizationLevel, fusionMethod or interpolationMethod hanve an unknown value.

sort_timeseries(*ascending=True*)
Sorts the data points within the TimeSeries according to their occurence inline.

Parameters ascending (*Boolean*) – Determines if the TimeSeries will be ordered ascending or decending. If this is set to decending once, the ordered parameter defined in `TimeSeries.__init__()` will be set to False FOREVER.

Returns Returns `self` for convenience.

Return type TimeSeries

sorted_timeseries(*ascending=True*)
Returns a sorted copy of the TimeSeries, preserving the original one.

As an assumtion this new TimeSeries is not ordered anymore if a new value is added.

Parameters **ascending** (*Boolean*) – Determines if the TimeSeries will be ordered ascending or decending.

Returns Returns a new TimeSeries instance sorted in the requested order.

Return type TimeSeries

to_gnuplot_datafile(*datafilepath*, *format=None*)
Dumps the TimeSeries into a gnuplot compatible data file.

Parameters

- **datafilepath** (*String*) – Path used to create the file. If that file already exists, it will be overwritten!
- **format** (*String*) – Format of the timestamp. This is used to convert the timestamp from UNIX epochs, if set. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns `True` if the data could be written, `False` otherwise.

Return type Boolean

to_json(*format=None*)
Returns a JSON representation of the TimeSeries data.

Parameters **format** (*String*) – Format of the given timestamp. This is used to convert the timestamp into UNIX epochs, if set. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns a basestring, containing the JSON representation of the current data stored within the TimeSeries.

Return type String

to_twodim_list(*format=None*)
Serializes the TimeSeries data into a two dimensional list of [timestamp, value] pairs.

Parameters **format** (*String*) – Format of the timestamp. This is used to convert the timestamp from UNIX epochs, if set. For valid examples take a look into the `time.strptime()` documentation.

Returns Returns a two dimensional list containing [timestamp, value] pairs.

Return type List

__weakref__
list of weak references to the object (if defined)

CHAPTER

THREE

SMOOTHING METHODS

class pycast.methods.**SimpleMovingAverage**(*windowsize=5*)

Bases: pycast.methods.basemethod.BaseMethod

Implements the simple moving average.

The SMA algorithm will calculate the average value at time t based on the datapoints between [t - floor(windowsize / 2), t + floor(windowsize / 2)].

Explanation: http://en.wikipedia.org/wiki/Moving_average

__init__(*windowsize=5*)

Initializes the SimpleMovingAverage.

Parameters **windowsize** (*Integer*) – Size of the SimpleMovingAverages window.

Raise Raises a ValueError if windowsize is an even or not larger than zero.

execute(*timeSeries*)

Creates a new TimeSeries containing the SMA values for the predefined windowsize.

Parameters **timeSeries** (*TimeSeries*) – The TimeSeries used to calculate the simple moving average values.

Returns TimeSeries object containing the smooth moving average.

Return type TimeSeries

Note This implementation aims to support independent for loop execution.

CHAPTER

FOUR

FORECASTING METHODS

class pycast.methods.**ExponentialSmoothing**(*smoothingFactor=0.1*, *valuesToForecast=1*)

Bases: pycast.methods.basemethod.BaseForecastingMethod

Implements an exponential smoothing algorithm.

Explanation: http://www.youtube.com/watch?v=J4iODLa9hYw

__init__(*smoothingFactor=0.1*, *valuesToForecast=1*)

Initializes the ExponentialSmoothing.

Parameters

- **smoothingFactor** (*Float*) – Defines the alpha for the ExponentialSmoothing. Valid values are in (0.0, 1.0).
- **valuesToForecast** (*Integer*) – Number of values that should be forecasted.

Raise Raises a ValueError when smoothingFactor has an invalid value.

_get_parameter_intervals()

Returns the intervals for the methods parameter.

Only parameters with defined intervals can be used for optimization!

Returns

Returns a dictionary containing the parameter intervals, using the parameter name as key, while the value hast the following format: [minValue, maxValue, minIntervalClosed, maxIntervalClosed]

minValue: Minimal value for the parameter maxValue: Maximal value for the parameter minIntervalClosed: True, if minValue represents a valid value for the parameter.

False otherwise.

maxIntervalClosed: True, if maxValue represents a valid value for the parameter.
False otherwise.

Return type Dictionary

execute(*timeSeries*)

Creates a new TimeSeries containing the smoothed and forcasted values.

Returns TimeSeries object containing the smoothed TimeSeries, including the forecasted values.

Return type TimeSeries

Note The first normalized value is chosen as the starting point.

class pycast.methods.**HoltMethod**(*smoothingFactor=0.1*, *trendSmoothingFactor=0.5*, *valuesToForecast=1*)

Bases: pycast.methods.basemethod.BaseForecastingMethod

Implements the Holt algorithm.

Explanation: http://en.wikipedia.org/wiki/Exponential_smoothing#Double_exponential_smoothing

__init__(*smoothingFactor=0.1*, *trendSmoothingFactor=0.5*, *valuesToForecast=1*)

Initializes the HoltMethod.

Parameters

- **smoothingFactor** (*Float*) – Defines the alpha for the ExponentialSmoothing. Valid values are in (0.0, 1.0).
- **trendSmoothingFactor** (*Float*) – Defines the beta for the HoltMethod. Valid values are in (0.0, 1.0).
- **valuesToForecast** (*Integer*) – Defines the number of forecasted values that will be part of the result.

Raise Raises a ValueError when smoothingFactor or trendSmoothingFactor has an invalid value.

_get_parameter_intervals()

Returns the intervals for the methods parameter.

Only parameters with defined intervals can be used for optimization!

Returns

Returns a dictionary containing the parameter intervals, using the parameter name as key, while the value hast the following format: [minValue, maxValue, minIntervalClosed, maxIntervalClosed]

minValue: Minimal value for the parameter maxValue: Maximal value for the parameter minIntervalClosed: True, if minValue represents a valid value for the parameter.

False otherwise.

maxIntervalClosed: True, if maxValue represents a valid value for the parameter.
False otherwise.

Return type Dictionary

execute(*timeSeries*)

Creates a new TimeSeries containing the smoothed values.

Returns TimeSeries object containing the smoothed TimeSeries, including the forecasted values.

Return type TimeSeries

Note The first normalized value is chosen as the starting point.

CHAPTER

FIVE

ERROR MEASURES

class pycast.errors.**BaseErrorMeasure**(*minimalErrorCalculationPercentage=60*)

Bases: object

Baseclass for all error measures.

__init__(*minimalErrorCalculationPercentage=60*)

Initializes the error measure.

Parameters **minimalErrorCalculationPercentage** (*Integer*) – The number of entries in an original TimeSeries that have to have corresponding partners in the calculated TimeSeries. Corresponding partners have the same time stamp. Valid values are in [0.0, 100.0].

Raise Raises a ValueError if minimalErrorCalculationPercentage is not in [0.0, 100.0].

_calculate(*startingPercentage*, *endPercentage*)

This is the error calculation function that gets called by BaseErrorMeasure.get_error().

Both parameters will be correct at this time.

Parameters

- **startingPercentage** (*Float*) – Defines the start of the interval. This has to be a value in [0.0, 100.0]. It represents the value, where the error calculation should be started. 25.0 for example means that the first 25% of all calculated errors will be ignored.
- **endPercentage** (*Float*) – Defines the end of the interval. This has to be a value in [0.0, 100.0]. It represents the vlaue, after which all error values will be ignored. 90.0 for example means that the last 10% of all local errors will be ignored.

Returns Returns a float representing the error.

Return type Float

Raise Raises a NotImplementedError if the child class does not overwrite this method.

_get_error_values(*startingPercentage*, *endPercentage*)

Gets the defined subset of self._errorValues.

Both parameters will be correct at this time.

Parameters

- **startingPercentage** (*Float*) – Defines the start of the interval. This has to be a value in [0.0, 100.0]. It represents the value, where the error calculation should be started. 25.0 for example means that the first 25% of all calculated errors will be ignored.

- **endPercentage** (*Float*) – Defines the end of the interval. This has to be a value in [0.0, 100.0]. It represents the vlaue, after which all error values will be ignored. 90.0 for example means that the last 10% of all local errors will be ignored.

Returns Returns a list with the defined error values.

Return type List

get_error(*startingPercentage=0.0*, *endPercentage=100.0*)

Calculates the error for the given interval (startingPercentage, endPercentage) between the TimeSeries given during `BaseErrorMeasure.initialize()`.

Parameters

- **startingPercentage** (*Float*) – Defines the start of the interval. This has to be a value in [0.0, 100.0]. It represents the value, where the error calculation should be started. 25.0 for example means that the first 25% of all calculated errors will be ignored.
- **endPercentage** (*Float*) – Defines the end of the interval. This has to be a value in [0.0, 100.0]. It represents the vlaue, after which all error values will be ignored. 90.0 for example means that the last 10% of all local errors will be ignored.

Returns Returns a float representing the error.

Return type Float

Raise Raises a `ValueError` in one of the following cases:

- startingPercentage not in [0.0, 100.0]
- endPercentage not in [0.0, 100.0]
- endPercentage < startingPercentage

Raise Raises a `StandardError` if `BaseErrorMeasure.initialize()` was not successfull before.

initialize(*originalTimeSeries*, *calculatedTimeSeries*)

Initializes the ErrorMeasure.

During initialization, all `BaseErrorMeasure.local_errors()` are calculated.

Parameters

- **originalTimeSeries** (*TimeSeries*) – TimeSeries containing the original data.
- **calculatedTimeSeries** (*TimeSeries*) – TimeSeries containing calculated data. Calculated data is smoothed or forecasted data.

Returns Return `True` if the error could be calculated, `False` otherwise based on the minimalErrorCalculationPercentage.

Return type Boolean

local_error(*originalValue*, *calculatedValue*)

Calculates the error between the two given values.

Parameters

- **originalValue** (*Numeric*) – Value of the original data.
- **calculatedValue** (*Numeric*) – Value of the calculated TimeSeries that corresponds to originalValue.

Returns Returns the error measure of the two given values.

Return type Numeric

Raise Raises a `NotImplementedError` if the child class does not overwrite this method.

__weakref__
list of weak references to the object (if defined)

class `pycast.errors.`**MeanSquaredError**(*minimalErrorCalculationPercentage=60*)
Bases: `pycast.errors.baseerrormeasure.BaseErrorMeasure`

Implements the mean squared error measure.

Explanation: http://en.wikipedia.org/wiki/Mean_squared_error

_calculate(*startingPercentage*, *endPercentage*)
This is the error calculation function that gets called by `BaseErrorMeasure.get_error()`.

Both parameters will be correct at this time.

Parameters

- **startingPercentage** (*Float*) – Defines the start of the interval. This has to be a value in [0.0, 100.0]. It represents the value, where the error calculation should be started. 25.0 for example means that the first 25% of all calculated errors will be ignored.
- **endPercentage** (*Float*) – Defines the end of the interval. This has to be a value in [0.0, 100.0]. It represents the vlaue, after which all error values will be ignored. 90.0 for example means that the last 10% of all local errors will be ignored.

Returns Returns a float representing the error.

Return type Float

Raise Raises a `NotImplementedError` if the child class does not overwrite this method.

local_error(*originalValue*, *calculatedValue*)
Calculates the error between the two given values.

Parameters

- **originalValue** (*Numeric*) – Value of the original data.
- **calculatedValue** (*Numeric*) – Value of the calculated TimeSeries that corresponds to originalValue.

Returns Returns the error measure of the two given values.

Return type Numeric

class `pycast.errors.`**SymmetricMeanAbsolutePercentageError**(*minimalErrorCalculationPercentage=60*)
Bases: `pycast.errors.baseerrormeasure.BaseErrorMeasure`

Implements the symmetric mean absolute percentage error with a boarder of 200%.

Explanation: http://monashforecasting.com/index.php?title=SMAPE (Formula (3))

If the calculated value and the original value are equal, the error is 0.

_calculate(*startingPercentage*, *endPercentage*)
This is the error calculation function that gets called by `BaseErrorMeasure.get_error()`.

Both parameters will be correct at this time.

Parameters

- **startingPercentage** (*Float*) – Defines the start of the interval. This has to be a value in [0.0, 100.0]. It represents the value, where the error calculation should be started. 25.0 for example means that the first 25% of all calculated errors will be ignored.

- **endPercentage** (*Float*) – Defines the end of the interval. This has to be a value in [0.0, 100.0]. It represents the vlaue, after which all error values will be ignored. 90.0 for example means that the last 10% of all local errors will be ignored.

Returns Returns a float representing the error.

Return type Float

`local_error`(*originalValue*, *calculatedValue*)

Calculates the error between the two given values.

Parameters

- **originalValue** (*Numeric*) – Value of the original data.
- **calculatedValue** (*Numeric*) – Value of the calculated TimeSeries that corresponds to originalValue.

Returns Returns the error measure of the two given values.

Return type Numeric

CHAPTER

SIX

OPTIMIZATION METHODS

class pycast.optimization.**BaseOptimizationMethod**(*errorMeasureClass*, *precision=-1*)
Bases: object

Baseclass for all optimization methods.

__init__(*errorMeasureClass*, *precision=-1*)
Initializes the optimization method.

Parameters

- **errorMeasureClass** (*BaseErrorMeasure*) – Error measure class from pycast.errors
- **precision** (*Integer*) – Defines the accuracy for parameter tuning in 10^precision. This parameter has to be an integer in [-10, 0].

Raise Raises a TypeError if errorMeasureClass is not a valid class. Valid classes are derived from pycast.errors.BaseErrorMeasure.

Raise Raises a ValueError if precision is not in [-10, 0].

optimize(*timeSeries*, *forecastingMethods=[]*)
Runs the optimization on the given TimeSeries.

Parameters

- **timeSeries** (*TimeSeries*) – TimeSeries instance that requires an optimized forecast.
- **forecastingMethods** (*List*) – List of forecastingMethods that will be used for optimization.

Returns Returns the optimzed forecasting method with the smallest error.

Return type (BaseForecastingMethod, Dictionary)

Raise Raises a ValueError ValueError if no forecastingMethods is empty.

__weakref__
list of weak references to the object (if defined)

class pycast.optimization.**GridSearch**(*errorMeasureClass*, *precision=-1*)
Bases: pycast.optimization.baseoptimizationmethod.BaseOptimizationMethod

Implements the grid search method for parameter optimization.

GridSearch is the brute force method.

_generate_next_parameter_value(*parameter*, *forecastingMethod*)
Generator for a specific parameter of the given forecasting method.

Parameters

- **parameter** (*String*) – Name of the parameter the generator is used for.
- **forecastingMethod** (*BaseForecastingMethod*) – Instance of a ForecastingMethod.

Returns Creates a generator used to iterate over possible parameters.

Return type Generator Function

optimize(*timeSeries*, *forecastingMethods*=[ ])
Runs the optimization of the given TimeSeries.

Parameters

- **timeSeries** (*TimeSeries*) – TimeSeries instance that requires an optimized forecast.
- **forecastingMethods** (*List*) – List of forecastingMethods that will be used for optimization.

Returns Returns the optimzed forecasting method with the smallest error.

Return type BaseForecastingMethod, Dictionary

Raise Raises a `ValueError` ValueError if no forecastingMethods is empty.

optimize_forecasting_method(*timeSeries*, *forecastingMethod*)
Optimizes the parameters for the given timeSeries and forecastingMethod.

Parameters

- **timeSeries** (*TimeSeries*) – TimeSeries instance, containing hte original data.
- **forecastingMethod** (*BaseForecastingMethod*) – ForecastingMethod that is used to optimize the parameters.

Todo Errorclass for calculation

Todo percentage for start_error_measure, end_error_measure

Todo Definition of the result that will be returned.

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SEVEN

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