

Adaptive Conformal Predictions for Time Series

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Introduction

- Uncertainty quantification of predictive models is crucial in decision-making problems.
- Conformal prediction estimates a prediction interval in regression problems and a set of classes in classification problems.
- Aggregation of experts
- Generation of intervals along different horizons

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Methods

- Gaussian

$$C_{\alpha} := [\hat{y} \pm Q_{1-\alpha} * Std]$$

- CP

$$C_{\alpha} := [\hat{y} \pm Q_{1-\alpha}(|\hat{y} - y|)]$$

- ACP

$$\begin{cases} C_{\alpha t} := [\hat{y} \pm Q_{1-\alpha t}(|\hat{y} - y|)] \\ \alpha_{t+1} = \alpha_t + \gamma(\alpha - \mathbb{1}_{y_t \notin C_{\alpha t}}) \end{cases}$$

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Interval Class

- Class Interval in conf
 - This is the mother class for all intervals
 - Users are not expected to use this class as-is. Instead, user should use it in other modules like time series for example, but can be extended to other regression type problems
- We added an `__all__` list in the init files so that the classes added can be used everywhere

Conf

We added some methods to be able to generate some intervals

- Class Gaussian

- Function update

If the number of residuals is equal to the window size we calculate the interval

$$C_{\alpha} := [\hat{y} \pm Q_{1-\alpha} * Std]$$

- Function get

To return the current value of the interval

- CP

- Function update

If the number of residuals is equal to the window size we calculate the interval

$$C_{\alpha} := [\hat{y} \pm Q_{1-\alpha}(|\hat{y} - y|)]$$

- Function get

To return the current value of the interval

Conf

- ACP
 - Function update
update α_t *recursively*, If ACI does not cover at time t , then $\alpha_{t+1} \leq \alpha_t$, and the size of the predictive interval increases; conversely when it covers.

$$\begin{cases} C_{\alpha t} := [\hat{y} \pm Q_{1-\alpha t}(|\hat{y} - y|)] \\ \alpha_{t+1} = \alpha_t + \gamma(\alpha - \mathbb{1}_{y_t \notin C_{\alpha t}}) \end{cases}$$

- Function get
To return the current value of the interval

Time Series

The script `evaluates.py` has been modified and we added `intervals.py`

- `intervals.py`
 - Class `HorizonInterval`
It is the mother class for the below one
 - `ForecastingInterval`
It updates the prediction interval along the horizon : measures the prediction interval at each time step ahead
- `evaluates.py`
 - The parameter `interval` has been added in every function. For example `iter_evaluate` : Get first residuals series with the pre-trained model

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