Package 'aplime'

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Type Package

Title Adaptive Piecewise Local Model-Agnostic Explanations

Version 0.1.0

Description Implements Adaptive Piecewise Local Interpretable Model-Agnostic Explanations (AP-LIME) and its second-order interaction extension (AP2-LIME) for interpreting predictions from machine learning models. The methods replace the conventional locally weighted linear surrogate in LIME with Multivariate Adaptive Regression Splines (MARS). AP-LIME uses additive piecewise-linear hinge functions, whereas AP2-LIME allows pairwise interactions between hinge functions. The package generates proximity-weighted local explanations, estimates feature contributions, evaluates local surrogate fit, and assesses explanation stability across repeated runs. Stability is measured using the Variables Stability Index (VSI) and Coefficients Stability Index (CSI), including normal-theory and percentile bootstrap confidence intervals. MARS terms with the same predictors, hinge directions, and interaction structure are matched independently of knot locations. Coefficients within matched groups are summarized by their arithmetic mean, while the original knot thresholds remain available for inspection. The MARS-based local explanation approach is discussed by Somuncuoglu and Purutcuoglu (2027, ISBN:978-1-041-34431-5), ``Explainable AI Approaches in Biomedical Signals: A Case Study with Pima Indians Diabetes Dataset", in ``Biomedical Data Science: A Focus on Signaling", CRC Press.

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`aplime_bootstrap` *Bootstrap Intervals for Grouped MARS Coefficients*

Description

Fits the local MARS model on resampled neighborhood rows, averaging coefficients with the same variable, hinge direction, and interaction structure while ignoring knot values. A group absent from a refit remains missing rather than becoming zero.

Usage

```
aplime_bootstrap(explanation, n_boot = 100L, seed = NULL)
```

Arguments

`explanation`	Output from `aplime_explain()` with `keep_neighborhood = TRUE`.
`n_boot`	Number of bootstrap resamples (at least two).
`seed`	Optional random seed.

Value

A data frame of coefficient-group names, point estimates, and percentile confidence limits.

aplime_csi *Coefficient Stability Index*

Description

Computes pairwise interval overlaps among matching MARS coefficient groups. Knot positions are ignored when matching terms but hinge directions and interaction structure are retained. When multiple coefficients share a group in one fit, their arithmetic mean is used and the normal interval uses their joint covariance. Groups with fewer than two comparable intervals cannot contribute to the index.

Usage

```
aplime_csi(records, ci_method = c("normal", "bootstrap"))
```

Arguments

`records`	List of repeated explanations containing coefficient confidence interval tables.
`ci_method`	Confidence interval type: `"normal"` for normal-approximation intervals or `"bootstrap"` for percentile-bootstrap intervals.

Value

Percentage of overlap averaged across comparable groups, or `NA_real_` if none can be compared.

aplime_explain *Fit a Local Weighted MARS Explanation*

Description

Samples a Gaussian neighborhood, applies distance weights, and fits a weighted `earth` surrogate. The displayed variable contributions are prediction differences; CSI is calculated separately from grouped MARS coefficients.

Usage

```
aplime_explain(explainer, instance, degree = 1L, n_samples = 5000L,
  n_features = 6L, seed = NULL, keep_neighborhood = FALSE)
```

Arguments

explainer	An aplime_explainer object.
instance	One numeric observation in background column order.
degree	Interaction degree: 1 for additive hinge terms, 2 for two-way interactions.
n_samples	Number of Gaussian perturbations including the original observation.
n_features	Number of displayed variables, ranked by absolute prediction-difference contribution. Defaults to up to 6, capped at the number of available features.
seed	Optional random seed.
keep_neighborhood	Whether to retain samples and weights for coefficient interval estimation.

Value

An aplime_explanation object containing an earth fit, contribution table, selected feature indices, and weighted in-sample R-squared.

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aplime_explainer *Create an Adaptive Piecewise Explainer*

Description

Stores a reference distribution and a prediction interface for local perturbations.

Usage

```
aplime_explainer(background, predict_function, kernel_width = NULL)
```

Arguments

background	Numeric data frame or matrix with finite values.
predict_function	Function returning one finite prediction for each numeric matrix row.
kernel_width	Positive Gaussian kernel width; default is 0.75 times the square root of the predictor count.

Value

An object of class aplime_explainer.

Examples

```
set.seed(1)
x <- data.frame(a = rnorm(30), b = rnorm(30))
f <- function(z) 2 * z[, 1] + z[, 2]
explainer <- aplime_explainer(x, f)
```

aplime_knot_report *Report Original MARS Hinge Knots*

Description

Lists each original hinge basis term and its coefficient, with a knot-insensitive group key and a logical flag indicating whether different original terms were matched in the group. The report retains all original thresholds even though CSI uses grouped coefficient means.

Usage

```
aplime_knot_report(records)
```

Arguments

records	List of repeated aplime_explanation objects.

Value

Data frame with repetition, term_group, original_term, hinges, coefficient, and different_knots.

aplime_predict_xgboost *Adapt XGBoost Predictions for AP-LIME*

Description

Creates a prediction function suitable for aplime_explainer(). The optional xgboost package must be installed.

Usage

```
aplime_predict_xgboost(model)
```

Arguments

model	An XGBoost Booster object or a model file path recognized by xgboost::xgb.load().

Value

A function taking a numeric matrix and returning numeric predictions.

aplime_repeat *Repeat Local Explanations and Evaluate Stability*

Description

Generates repeated weighted MARS explanations and computes normal CSI, optional percentile-bootstrap CSI, variable stability, and rank-position frequencies. Terms are matched ignoring knot values; within-group coefficients are averaged. The `knot_report` output retains original terms, thresholds, and coefficients; `different_knot_groups` lists only matched groups containing different original terms. A warning identifies such groups.

Usage

```
aplime_repeat(explainer, instance, degree = 1L, n_repeats = 100L,
  n_samples = 5000L, n_features = 6L, n_boot = 0L, seed = NULL)
```

Arguments

`explainer`	An `aplime_explainer` object.
`instance`	Observation to explain.
`degree`	MARS interaction degree: 1 or 2.
`n_repeats`	Number of explanation repetitions (at least two).
`n_samples`	Number of perturbations per repetition.
`n_features`	Number of displayed features and top coefficient groups.
`n_boot`	Number of bootstrap resamples, or zero to skip bootstrap CSI.
`seed`	Optional random seed.

Value

A list with `runs`, `vsi_percent`, `csi_normal_percent`, `csi_bootstrap_percent`, `rank_frequency`, `knot_report`, and `different_knot_groups`.

Examples

```
## Lightweight example; increase repetitions for a stability study.

set.seed(1)
x <- data.frame(a = rnorm(60), b = rnorm(60), c = rnorm(60))
f <- function(z) 1 + pmax(0, z[, 1] - 0.2) + z[, 2] * z[, 3]
e <- aplime_explainer(x, f)
out <- aplime_repeat(e, as.numeric(x[1, ]), n_repeats = 3,
                     n_samples = 80, n_features = 2, n_boot = 3)
out$csi_normal_percent
out$different_knot_groups
```

aplime_vsi *Variable Stability Index*

Description

Measures mean pairwise overlap of selected top-feature sets, normalized by the requested feature count.

Usage

```
aplime_vsi(records, n_features = NULL)
```

Arguments

records	List of repeated explanations.
n_features	Number of top features in each explanation; inferred from the first record if omitted.

Value

VSI on a 0 to 100 scale, or NA_real_ for fewer than two runs.

print.aplime_explanation *Print an AP-LIME Explanation*

Description

Print the local surrogate type, weighted R-squared and ranked feature contributions.

Usage

```
## S3 method for class 'aplime_explanation'
print(x, ...)
```

Arguments

x	An aplime_explanation object.
...	Unused optional arguments.

Value

Returns x invisibly.

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