Package ‘prophet’

March 3, 2020

Title Automatic Forecasting Procedure

Version 0.6

Date 2020-02-10

Description Implements a procedure for forecasting time series data based on an additive model where non-linear trends are fit with yearly, weekly, and daily seasonality, plus holiday effects. It works best with time series that have strong seasonal effects and several seasons of historical data. Prophet is robust to missing data and shifts in the trend, and typically handles outliers well.

Depends R (>= 3.2.3), Rcpp (>= 0.12.0), rlang (>= 0.3.0.1)
Imports dplyr (>= 0.7.7), dygraphs (>= 1.1.1.4), extraDistr, ggplot2, grid, rstan (>= 2.14.0), scales, stats, tidyr (>= 0.6.1), xts
Suggests knitr, testthat, readr, rmarkdown
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URL https://github.com/facebook/prophet

BugReports https://github.com/facebook/prophet/issues

LazyData true

RoxygenNote 7.0.2

VignetteBuilder knitr

SystemRequirements C++11

Encoding UTF-8

NeedsCompilation no

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Repository CRAN

Date/Publication 2020-03-03 09:20:03 UTC
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add_changepoints_to_plot

Get layers to overlay significant changepoints on prophet forecast plot.

Description

Get layers to overlay significant changepoints on prophet forecast plot.

Usage

add_changepoints_to_plot(
  m,
  threshold = 0.01,
  cp_color = "red",
  cp_linetype = "dashed",
  trend = TRUE,
  ...
)

Arguments

- m: Prophet model object.
- threshold: Numeric, changepoints where abs(delta) >= threshold are significant. (Default 0.01)
- cp_color: Character, line color. (Default "red")
add_country_holidays

- cp_linetype: Character or integer, line type. (Default "dashed")
- trend: Logical, if FALSE, do not draw trend line. (Default TRUE)
- ... Other arguments passed on to layers.

Value

A list of ggplot2 layers.

Examples

```r
## Not run:
plot(m, fcst) + add_changepoints_to_plot(m)
## End(Not run)
```

add_country_holidays  Add in built-in holidays for the specified country.

Description

These holidays will be included in addition to any specified on model initialization.

Usage

```r
add_country_holidays(m, country_name)
```

Arguments

- m: Prophet object.
- country_name: Name of the country, like 'UnitedStates' or 'US'

Details

Holidays will be calculated for arbitrary date ranges in the history and future. See the online documentation for the list of countries with built-in holidays.

Built-in country holidays can only be set for a single country.

Value

The prophet model with the holidays country set.
add_regressor  Add an additional regressor to be used for fitting and predicting.

Description

The dataframe passed to ‘fit’ and ‘predict’ will have a column with the specified name to be used as a regressor. When standardize=’auto’, the regressor will be standardized unless it is binary. The regression coefficient is given a prior with the specified scale parameter. Decreasing the prior scale will add additional regularization. If no prior scale is provided, holidays.prior.scale will be used. Mode can be specified as either ‘additive’ or ‘multiplicative’. If not specified, m$seasonality.mode will be used. ’additive’ means the effect of the regressor will be added to the trend, ’multiplicative’ means it will multiply the trend.

Usage

add_regressor(m, name, prior.scale = NULL, standardize = "auto", mode = NULL)

Arguments

- m  Prophet object.
- name  String name of the regressor
- prior.scale  Float scale for the normal prior. If not provided, holidays.prior.scale will be used.
- standardize  Bool, specify whether this regressor will be standardized prior to fitting. Can be ’auto’ (standardize if not binary), True, or False.
- mode  Optional, ‘additive’ or ‘multiplicative’. Defaults to m$seasonality.mode.

Value

The prophet model with the regressor added.

add_seasonality  Add a seasonal component with specified period, number of Fourier components, and prior scale.

Description

Increasing the number of Fourier components allows the seasonality to change more quickly (at risk of overfitting). Default values for yearly and weekly seasonalities are 10 and 3 respectively.
Usage

```r
cross_validation

add_seasonality(  
m,  
name,  
period,  
fourier.order,  
prior.scale = NULL,  
mode = NULL,  
condition.name = NULL  
)
```

Arguments

- **m**: Prophet object.
- **name**: String name of the seasonality component.
- **period**: Float number of days in one period.
- **fourier.order**: Int number of Fourier components to use.
- **prior.scale**: Optional float prior scale for this component.
- **mode**: Optional 'additive' or 'multiplicative'.
- **condition.name**: String name of the seasonality condition.

Details

Increasing prior scale will allow this seasonality component more flexibility, decreasing will dampen it. If not provided, will use the seasonality.prior.scale provided on Prophet initialization (defaults to 10).

Mode can be specified as either 'additive' or 'multiplicative'. If not specified, m$seasonality.mode will be used (defaults to 'additive'). Additive means the seasonality will be added to the trend, multiplicative means it will multiply the trend.

If condition.name is provided, the dataframe passed to 'fit' and 'predict' should have a column with the specified condition.name containing booleans which decides when to apply seasonality.

Value

The prophet model with the seasonality added.

cross_validation  Cross-validation for time series.

description

Computes forecasts from historical cutoff points. Beginning from (end - horizon), works backwards making cutoffs with a spacing of period until initial is reached.
Usage

cross_validation(model, horizon, units, period = NULL, initial = NULL)

Arguments

model  Fitted Prophet model.
horizon  Integer size of the horizon
units  String unit of the horizon, e.g., "days", "secs".
period  Integer amount of time between cutoff dates. Same units as horizon. If not provided, 0.5 * horizon is used.
initial  Integer size of the first training period. If not provided, 3 * horizon is used. Same units as horizon.

Details

When period is equal to the time interval of the data, this is the technique described in https://robjhyndman.com/hyndsight/tscv/.

Value

A dataframe with the forecast, actual value, and cutoff date.

---

**dyplot.prophet**  
*Plot the prophet forecast.*

Description

Plot the prophet forecast.

Usage

dyplot.prophet(x, fcst, uncertainty = TRUE, ...)

Arguments

x  Prophet object.
fcest  Data frame returned by predict(m, df).
uncertainty  Optional boolean indicating if the uncertainty interval for yhat should be plotted, which will only be done if x$uncertainty.samples > 0. Must be present in fcst as yhat_lower and yhat_upper.
...  additional arguments passed to dygraph::dygraph

Value

A dygraph plot.
Examples

```r
## Not run: 
history <- data.frame(
  ds = seq(as.Date('2015-01-01'), as.Date('2016-01-01'), by = 'd'),
  y = sin(1:366/200) + rnorm(366)/10)
m <- prophet(history)
future <- make_future_data_frame(m, periods = 365)
forecast <- predict(m, future)
dyplot.prophet(m, forecast)
## End(Not run)
```

fit.prophet 

Fit the prophet model.

Description

This sets m$params to contain the fitted model parameters. It is a list with the following elements:

- **k** (M array): M posterior samples of the initial slope.
- **m** (M array): The initial intercept.
- **delta** (MxN matrix): The slope change at each of N changepoints.
- **beta** (MxK matrix): Coefficients for K seasonality features.
- **sigma_obs** (M array): Noise level. Note that M=1 if MAP estimation.

Usage

```r
fit.prophet(m, df, ...)
```

Arguments

- **m**: Prophet object.
- **df**: Data frame.
- **...**: Additional arguments passed to the optimizing or sampling functions in Stan.

generated_holidays 

holidays table

Description

holidays table

Usage

```r
generated_holidays
```

Format

A data frame with five variables: ds, holiday, country, year
Performance Metrics

Make dataframe with future dates for forecasting.

Description
Make dataframe with future dates for forecasting.

Usage
make_future_dataframe(m, periods, freq = "day", include_history = TRUE)

Arguments
m Prophet model object.
periods Int number of periods to forecast forward.
freq 'day', 'week', 'month', 'quarter', 'year', 1(1 sec), 60(1 minute) or 3600(1 hour).
include_history Boolean to include the historical dates in the data frame for predictions.

Value
Dataframe that extends forward from the end of m$history for the requested number of periods.

Performance Metrics

Compute performance metrics from cross-validation results.

Description
Computes a suite of performance metrics on the output of cross-validation. By default the following metrics are included: 'mse': mean squared error 'rmse': root mean squared error 'mae': mean absolute error 'mape': mean percent error 'coverage': coverage of the upper and lower intervals.

Usage
performance_metrics(df, metrics = NULL, rolling_window = 0.1)

Arguments
df The dataframe returned by cross_validation.
metrics An array of performance metrics to compute. If not provided, will use c('mse', 'rmse', 'mae', 'mape', 'coverage').
rolling_window Proportion of data to use in each rolling window for computing the metrics. Should be in [0, 1] to average.
Details

A subset of these can be specified by passing a list of names as the 'metrics' argument.

Metrics are calculated over a rolling window of cross validation predictions, after sorting by horizon. Averaging is first done within each value of the horizon, and then across horizons as needed to reach the window size. The size of that window (number of simulated forecast points) is determined by the rolling_window argument, which specifies a proportion of simulated forecast points to include in each window. rolling_window=0 will compute it separately for each horizon. The default of rolling_window=0.1 will use 10 rolling_window=1 will compute the metric across all simulated forecast points. The results are set to the right edge of the window.

If rolling_window < 0, then metrics are computed at each datapoint with no averaging (i.e., 'mse' will actually be squared error with no mean).

The output is a dataframe containing column 'horizon' along with columns for each of the metrics computed.

Value

A dataframe with a column for each metric, and column 'horizon'.

---

plot.prophet

Plot the prophet forecast.

Description

Plot the prophet forecast.

Usage

```r
## S3 method for class 'prophet'
plot(
  x, fcst,
  uncertainty = TRUE,
  plot_cap = TRUE,
  xlabel = "ds",
  ylabel = "y",
  ...
)
```

Arguments

- `x`: Prophet object.
- `fcst`: Data frame returned by predict(m, df).
- `uncertainty` Optional boolean indicating if the uncertainty interval for yhat should be plotted, which will only be done if x$uncertainty.samples > 0. Must be present in fcst as yhat_lower and yhat_upper.
plot_cross_validation_metric

Plot a performance metric vs. forecast horizon from cross validation. Cross validation produces a collection of out-of-sample model predictions that can be compared to actual values, at a range of different horizons (distance from the cutoff). This computes a specified performance metric for each prediction, and aggregated over a rolling window with horizon.

Description

This uses fbprophet.diagnostics.performance_metrics to compute the metrics. Valid values of metric are 'mse', 'rmse', 'mae', 'mape', and 'coverage'.

Usage

plot_cross_validation_metric(df_cv, metric, rolling_window = 0.1)

Arguments

- df_cv: The output from fbprophet.diagnostics.cross_validation.
- metric: Metric name, one of 'mse', 'rmse', 'mae', 'mape', 'coverage'.
- rolling_window: Proportion of data to use for rolling average of metric. In [0, 1]. Defaults to 0.1.
Details

rolling_window is the proportion of data included in the rolling window of aggregation. The default value of 0.1 means 10 aggregation for computing the metric.

As a concrete example, if metric='mse', then this plot will show the squared error for each cross validation prediction, along with the MSE averaged over rolling windows of 10

Value

A ggplot2 plot.

plot_forecast_component

Plot a particular component of the forecast.

Description

Plot a particular component of the forecast.

Usage

plot_forecast_component(m, fcst, name, uncertainty = TRUE, plot_cap = FALSE)

Arguments

m
Prophet model

fcst
Dataframe output of ‘predict’.

name
String name of the component to plot (column of fcst).

uncertainty
Optional boolean to plot uncertainty intervals, which will only be done if m$uncertainty.samples > 0.

plot_cap
Boolean indicating if the capacity should be shown in the figure, if available.

Value

A ggplot2 plot.
predict.prophet  
Predict using the prophet model.

Description
Predict using the prophet model.

Usage

## S3 method for class 'prophet'
predict(object, df = NULL, ...)

Arguments

  object  Prophet object.
  df  Dataframe with dates for predictions (column ds), and capacity (column cap) if logistic growth. If not provided, predictions are made on the history.
  ...  additional arguments.

Value
A dataframe with the forecast components.

Examples

## Not run:
history <- data.frame(ds = seq(as.Date('2015-01-01'), as.Date('2016-01-01'), by = 'd'),
y = sin(1:366/200) + rnorm(366)/10)
m <- prophet(history)
future <- make_future_dataframe(m, periods = 365)
forecast <- predict(m, future)
plot(m, forecast)
## End(Not run)

predictive_samples  
Sample from the posterior predictive distribution.

Description
Sample from the posterior predictive distribution.

Usage

predictive_samples(m, df)
Arguments

- `m` Prophet object.
- `df` Dataframe with dates for predictions (column `ds`), and capacity (column `cap`) if logistic growth.

Value

A list with items "trend" and "yhat" containing posterior predictive samples for that component.

---

**prophet**

**Prophet forecaster.**

Description

Prophet forecaster.

Usage

```r
prophet(
  df = NULL,
  growth = "linear",
  changepoints = NULL,
  n.changepoints = 25,
  changepoint.range = 0.8,
  yearly.seasonality = "auto",
  weekly.seasonality = "auto",
  daily.seasonality = "auto",
  holidays = NULL,
  seasonality.mode = "additive",
  seasonality.prior.scale = 10,
  holidays.prior.scale = 10,
  changepoint.prior.scale = 0.05,
  mcmc.samples = 0,
  interval.width = 0.8,
  uncertainty.samples = 1000,
  fit = TRUE,
  ...
)
```

Arguments

- `df` (optional) Dataframe containing the history. Must have columns `ds` (date type) and `y`, the time series. If growth is logistic, then `df` must also have a column `cap` that specifies the capacity at each `ds`. If not provided, then the model object will be instantiated but not fit; use `fit.prophet(m, df)` to fit the model.
- `growth` String 'linear' or 'logistic' to specify a linear or logistic trend.
changepoints - Vector of dates at which to include potential changepoints. If not specified, potential changepoints are selected automatically.

n.changepoints - Number of potential changepoints to include. Not used if input 'changepoints' is supplied. If 'changepoints' is not supplied, then n.changepoints potential changepoints are selected uniformly from the first 'changepoint.range' proportion of df$ds.

changepoint.range - Proportion of history in which trend changepoints will be estimated. Defaults to 0.8 for the first 80 'changepoints' is specified.

yearly.seasonality - Fit yearly seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.

weekly.seasonality - Fit weekly seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.

daily.seasonality - Fit daily seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.

holidays - data frame with columns holiday (character) and ds (date type) and optionally columns lower_window and upper_window which specify a range of days around the date to be included as holidays. lower_window=-2 will include 2 days prior to the date as holidays. Also optionally can have a column prior_scale specifying the prior scale for each holiday.

seasonality.mode - 'additive' (default) or 'multiplicative'.

seasonality.prior.scale - Parameter modulating the strength of the seasonality model. Larger values allow the model to fit larger seasonal fluctuations, smaller values dampen the seasonality. Can be specified for individual seasonalities using add_seasonality.

holidays.prior.scale - Parameter modulating the strength of the holiday components model, unless overridden in the holidays input.

changepoint.prior.scale - Parameter modulating the flexibility of the automatic changepoint selection. Large values will allow many changepoints, small values will allow few changepoints.

mcmc.samples - Integer, if greater than 0, will do full Bayesian inference with the specified number of MCMC samples. If 0, will do MAP estimation.

interval.width - Numeric, width of the uncertainty intervals provided for the forecast. If mcmc.samples=0, this will be only the uncertainty in the trend using the MAP estimate of the extrapolated generative model. If mcmc.samples>0, this will be integrated over all model parameters, which will include uncertainty in seasonality.

uncertainty.samples - Number of simulated draws used to estimate uncertainty intervals. Settings this value to 0 or False will disable uncertainty estimation and speed up the calculation.
prophet_plot_components

fit  Boolean, if FALSE the model is initialized but not fit.
...  Additional arguments, passed to fit.prophet

Value

A prophet model.

Examples

## Not run:
history <- data.frame(ds = seq(as.Date('2015-01-01'), as.Date('2016-01-01'), by = 'd'),
y = sin(1:366/200) + rnorm(366)/10)
m <- prophet(history)
## End(Not run)

---

prophet_plot_components

*Plot the components of a prophet forecast. Prints a ggplot2 with whichever are available of: trend, holidays, weekly seasonality, yearly seasonality, and additive and multiplicative extra regressors.*

---

Description

Plot the components of a prophet forecast. Prints a ggplot2 with whichever are available of: trend, holidays, weekly seasonality, yearly seasonality, and additive and multiplicative extra regressors.

Usage

```r
prophet_plot_components(  
m,  
fcst,  
uncertainty = TRUE,  
plot_cap = TRUE,  
weekly_start = 0,  
yearly_start = 0,  
render_plot = TRUE  
)
```

Arguments

- **m**: Prophet object.
- **fcst**: Data frame returned by predict(m, df).
- **uncertainty**: Optional boolean indicating if the uncertainty interval should be plotted for the trend, from fcst columns trend_lower and trend_upper. This will only be done if m$uncertainty.samples > 0.
### prophet_plot_components

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>plot_cap</td>
<td>Boolean indicating if the capacity should be shown in the figure, if available.</td>
</tr>
<tr>
<td>weekly_start</td>
<td>Integer specifying the start day of the weekly seasonality plot. 0 (default) starts the week on Sunday. 1 shifts by 1 day to Monday, and so on.</td>
</tr>
<tr>
<td>yearly_start</td>
<td>Integer specifying the start day of the yearly seasonality plot. 0 (default) starts the year on Jan 1. 1 shifts by 1 day to Jan 2, and so on.</td>
</tr>
<tr>
<td>render_plot</td>
<td>Boolean indicating if the plots should be rendered. Set to FALSE if you want the function to only return the list of panels.</td>
</tr>
</tbody>
</table>

**Value**

Invisibly return a list containing the plotted ggplot objects.
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