

# Package ‘trending’

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**Title** Model Temporal Trends

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**Description** Provides a coherent interface to multiple modelling tools for fitting trends along with a standardised approach for generating confidence and prediction intervals.

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accessors	<i>Accessors generics</i>
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---

## Description

Generics for accessing model information.

## Usage

```

get_result(x, ...)

## Default S3 method:
get_result(x, ...)

## S3 method for class 'trending_fit'
get_result(x, ...)

## S3 method for class 'trending_predict'
get_result(x, ...)

## S3 method for class 'trending_fit_tbl'
get_result(x, ...)

## S3 method for class 'trending_predict_tbl'
get_result(x, ...)

get_warnings(x, ...)

## Default S3 method:
get_warnings(x, ...)

## S3 method for class 'trending_fit'
get_warnings(x, ...)

## S3 method for class 'trending_predict'
get_warnings(x, ...)

## S3 method for class 'trending_fit_tbl'
get_warnings(x, ...)

## S3 method for class 'trending_predict_tbl'

```

```
get_warnings(x, ...)

get_errors(x, ...)

## Default S3 method:
get_errors(x, ...)

## S3 method for class 'trending_fit'
get_errors(x, ...)

## S3 method for class 'trending_predict'
get_errors(x, ...)

## S3 method for class 'trending_fit_tbl'
get_errors(x, ...)

## S3 method for class 'trending_predict_tbl'
get_errors(x, ...)

get_fitted_model(x, ...)

## Default S3 method:
get_fitted_model(x, ...)

## S3 method for class 'trending_fit'
get_fitted_model(x, ...)

## S3 method for class 'trending_fit_tbl'
get_fitted_model(x, ...)

get_fitted_data(x, ...)

## Default S3 method:
get_fitted_data(x, ...)

## S3 method for class 'trending_fit'
get_fitted_data(x, ...)

## S3 method for class 'trending_fit_tbl'
get_fitted_data(x, ...)

get_formula(x, ...)

## Default S3 method:
get_formula(x, ...)

## S3 method for class 'trending_model'
get_formula(x, ...)
```

```
## S3 method for class 'trending_fit'  
get_formula(x, ...)  
  
## S3 method for class 'trending_fit_tbl'  
get_formula(x, ...)  
  
get_response(x, ...)  
  
## Default S3 method:  
get_response(x, ...)  
  
## S3 method for class 'trending_model'  
get_response(x, ...)  
  
## S3 method for class 'trending_fit'  
get_response(x, ...)  
  
## S3 method for class 'trending_fit_tbl'  
get_response(x, ...)  
  
## S3 method for class 'trending_prediction'  
get_response(x, ...)  
  
## S3 method for class 'trending_predict'  
get_response(x, ...)  
  
## S3 method for class 'trending_predict_tbl'  
get_response(x, ...)  
  
get_predictors(x, ...)  
  
## Default S3 method:  
get_predictors(x, ...)  
  
## S3 method for class 'trending_model'  
get_predictors(x, ...)  
  
## S3 method for class 'trending_fit'  
get_predictors(x, ...)  
  
## S3 method for class 'trending_fit_tbl'  
get_predictors(x, ...)  
  
## S3 method for class 'trending_prediction'  
get_predictors(x, ...)  
  
## S3 method for class 'trending_predict'
```

```

get_predictors(x, ...)

## S3 method for class 'trending_predict_tbl'
get_predictors(x, ...)

get_estimate(x, ...)

## Default S3 method:
get_estimate(x, ...)

## S3 method for class 'trending_prediction'
get_estimate(x, ...)

## S3 method for class 'trending_predict'
get_estimate(x, ...)

## S3 method for class 'trending_predict_tbl'
get_estimate(x, ...)

```

### Arguments

x	An R object.
...	Not currently used by any methods.

### Details

Methods are provided for `trending_model`, `trending_fit`, `trending_fit_tbl`, `trending_predict`, and `trending_predict_tbl` objects.

### Value

- `get_result()`: the captured output.
- `get_warnings()`: the captured warnings.
- `get_errors()`: the captured warnings.
- `get_fitted_data`: The underlying data used to fit the model.
- `get_fitted_model()`: The underlying fitted model.
- `get_formula()`: the formula used to model temporal trends.
- `get_response()`: the response variable of the underlying model.
- `get_predictors()`: the predictor variable(s) of the underlying model.

### Examples

```

x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)
poisson_model <- glm_model(y ~ x, family = "poisson")
fitted_poisson <- fit(poisson_model, dat)

```

```
get_fitted_model(fitted_poisson)
get_formula(fitted_poisson)
get_response(fitted_poisson)
get_predictors(fitted_poisson)
```

---

fit

*Fit generic*

---

## Description

`fit()` is a generic to fit a specified model.

## Usage

```
fit(x, data, ...)
```

```
## Default S3 method:
```

```
fit(x, data, ...)
```

## Arguments

<code>x</code>	An R object
<code>data</code>	A data frame containing the data to fit.
<code>...</code>	Arguments passed to underlying methods.

## Value

The value returned depends on the class of the input argument.

## Author(s)

Tim Taylor

## See Also

[fit.trending\\_model\(\)](#) and [fit.list\(\)](#)

## Examples

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)

poisson_model <- glm_model(y ~ x , family = poisson)
negbin_model <- glm_nb_model(y ~ x)
```

```
fit(poisson_model, dat)
fit(negbin_model, dat)
fit(list(poisson_model, negbin_model), dat)
fit(list(pm = poisson_model, nm = negbin_model), dat)
```

---

fit.list

*Fit method list object*

---

## Description

Fits a list of `trending_model` objects to the given input data.

## Usage

```
## S3 method for class 'list'
fit(x, data, ...)
```

## Arguments

x	A list of <code>trending_model</code> objects
data	A data frame containing the data to fit.
...	Not currently used.

## Value

A `trending_fit_tbl` object which is a [tibble](#) subclass with one row for each model and entries:

- `model_name` (optional): If the input is a named list then the name is extracted.
- `result`: the resulting fit from calling the underlying model directly, i.e.
  - `lm_model`: a fitted model object of class `lm`
  - `glm_model`: a fitted model object of class `glm`
  - `glm_nb_model`: a fitted model object of class `negbin`
  - `brm_model`: An object of class `brmsfit`

NULL if fitting fails.

- `warnings`: any warnings generated during fitting
- `errors`: any errors generated during fitting

## Author(s)

Tim Taylor

## See Also

[fit.trending\\_model\(\)](#)

**Examples**

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)
poisson_model <- glm_model(y ~ x , family = poisson)
negbin_model <- glm_nb_model(y ~ x)

fit(list(poisson_model, negbin_model), dat)
fit(list(pm = poisson_model, nm = negbin_model), dat)
```

---

fit.trending\_model      *Fit method for trending\_model objects*

---

**Description**

Fits the specified model to the input data

**Usage**

```
## S3 method for class 'trending_model'
fit(x, data, as_tibble = TRUE, ...)
```

**Arguments**

x	An R object
data	A data frame containing the data to fit.
as_tibble	Should the output be converted to a tibble subclass.
...	Not currently used.

**Value**

If `as_tibble = FALSE`, then a `trending_fit` object is returned. This is a list subclass with entries:

- `result`: the resulting fit from calling the underlying model directly, i.e.
  - `lm_model`: a fitted model object of class `lm`
  - `glm_model`: a fitted model object of class `glm`
  - `glm_nb_model`: a fitted model object of class `negbin`
  - `brm_model`: An object of class `brmsfit`

NULL if fitting fails.

- `warnings`: any warnings generated during fitting
- `errors`: any errors generated during fitting

If `as_tibble = TRUE`, a `trending_fit_tbl` object which is a `tibble` subclass with one row for each model and columns `'result'`, `'warnings'` and `'errors'` with contents as above.



**Author(s)**

Tim Taylor

**See Also**[fit.list\(\)](#)**Examples**

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)

poisson_model <- glm_model(y ~ x , family = poisson)
negbin_model <- glm_nb_model(y ~ x)

fit(poisson_model, dat)
fit(negbin_model, dat)
fit(list(poisson_model, negbin_model), dat)
fit(list(pm = poisson_model, nm = negbin_model), dat)
```

---

predict.list

*Predict method for trending\_model objects*

---

**Description**

Adds estimated values and associated confidence and/or prediction intervals to data based on trending\_model fit.

**Usage**

```
## S3 method for class 'list'
predict(
  object,
  data,
  name = "estimate",
  alpha = 0.05,
  add_ci = TRUE,
  ci_names = c("lower_ci", "upper_ci"),
  add_pi = TRUE,
  pi_names = c("lower_pi", "upper_pi"),
  simulate_pi = FALSE,
  sims = 2000,
  uncertain = TRUE,
  ...
)
```

**Arguments**

object	A list of <code>trending_model</code> objects.
data	A <code>data.frame</code> containing data to which the model is to be fit and estimates derived.
name	Character vector of length one giving the name to use for the calculated estimate.
alpha	The alpha threshold to be used for prediction intervals, defaulting to 0.05, i.e. 95% prediction intervals are derived.
add_ci	Should a confidence interval be added to the output. Default TRUE.
ci_names	Names to use for the resulting confidence intervals.
add_pi	Should a prediction interval be added to the output. Default TRUE.
pi_names	Names to use for the resulting prediction intervals.
simulate_pi	Should the prediction intervals for glm models be simulated. If TRUE, default, <code>predict()</code> uses the <code>ciTools::add_pi()</code> function to generate the intervals.
sims	The number of simulations to run when simulating prediction intervals for a glm model.
uncertain	Only used for glm models and when <code>simulate_pi = FALSE</code> . Default TRUE. If FALSE uncertainty in the fitted parameters is ignored when generating the parametric prediction intervals.
...	Not currently used.

**Value**

A `trending_predict_tbl` object which is a `tibble` subclass with one row per model and columns:

- result: the input data frame with additional estimates and, optionally, confidence and or prediction intervals. NULL if the associated predict method fails.
- warnings: any warnings generated during prediction.
- errors: any errors generated during prediction.

**Author(s)**

Tim Taylor

**See Also**

`predict.trending_model()`, `predict.trending_fit()`, `predict.trending_fit_tbl()`,

**Examples**

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)
poisson_model <- glm_model(y ~ x, family = "poisson")
negbin_model <- glm_nb_model(y ~ x)
predict(list(poisson_model, negbin_model), dat)
predict(list(pm = poisson_model, nm = negbin_model), dat)
```

---

predict.trending\_fit *Predict method for trending\_fit object*

---

### Description

Adds estimated values and associated confidence and/or prediction intervals to trending\_fit objects.

### Usage

```
## S3 method for class 'trending_fit'
predict(
  object,
  new_data,
  name = "estimate",
  alpha = 0.05,
  add_ci = TRUE,
  ci_names = c("lower_ci", "upper_ci"),
  add_pi = TRUE,
  pi_names = c("lower_pi", "upper_pi"),
  simulate_pi = FALSE,
  sims = 2000,
  uncertain = TRUE,
  as_tibble = TRUE,
  ...
)
```

### Arguments

object	A <a href="#">trending_fit</a> object.
new_data	A data.frame containing data for which estimates are to be derived. If missing, the model frame from the fit data will be used.
name	Character vector of length one giving the name to use for the calculated estimate.
alpha	The alpha threshold to be used for prediction intervals, defaulting to 0.05, i.e. 95% prediction intervals are derived.
add_ci	Should a confidence interval be added to the output. Default TRUE.
ci_names	Names to use for the resulting confidence intervals.
add_pi	Should a prediction interval be added to the output. Default TRUE.
pi_names	Names to use for the resulting prediction intervals.
simulate_pi	Should the prediction intervals for glm models be simulated. If TRUE, default, predict() uses the <code>ciTools::add_pi()</code> function to generate the intervals.
sims	The number of simulations to run when simulating prediction intervals for a glm model.
uncertain	Only used for glm models and when simulate_pi = FALSE. Default TRUE. If FALSE uncertainty in the fitted parameters is ignored when generating the parametric prediction intervals.

`as_tibble`      Should the output be converted to a tibble subclass.  
 ...              Not currently used.

**Value**

If `as_tibble = FALSE`, a `trending_predict` object, which is a list subclass, with entries:

- `result`: the input data frame with additional estimates and, optionally, confidence and or prediction intervals. NULL if the associated predict method fails.
- `warnings`: any warnings generated during prediction.
- `errors`: any errors generated during prediction.

If `as_tibble = TRUE`, a `trending_predict_tbl` object which is a `tibble` subclass with one row per model and columns 'result', 'warnings' and 'errors' with contents as above.

**Author(s)**

Tim Taylor

**See Also**

[predict.trending\\_fit\\_tbl\(\)](#) and [predict.trending\\_model\(\)](#)

**Examples**

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)
poisson_model <- glm_model(y ~ x , family = "poisson")
fitted_poisson <- fit(poisson_model, dat)
predict(fitted_poisson)
predict(fitted_poisson, as_tibble = FALSE)
```

---

`predict.trending_fit_tbl`

*Predict method for trending\_fit\_tbl object*

---

**Description**

Adds estimated values and associated confidence and/or prediction intervals to `trending_fit_tbl` objects.

**Usage**

```
## S3 method for class 'trending_fit_tbl'
predict(
  object,
  new_data,
  name = "estimate",
  alpha = 0.05,
  add_ci = TRUE,
  ci_names = c("lower_ci", "upper_ci"),
  add_pi = TRUE,
  pi_names = c("lower_pi", "upper_pi"),
  simulate_pi = FALSE,
  sims = 2000,
  uncertain = TRUE,
  ...
)
```

**Arguments**

object	A <a href="#">trending_fit_tbl</a> object.
new_data	A <code>data.frame</code> containing data for which estimates are to be derived. If missing, the model frame from the fit data will be used.
name	Character vector of length one giving the name to use for the calculated estimate.
alpha	The alpha threshold to be used for prediction intervals, defaulting to 0.05, i.e. 95% prediction intervals are derived.
add_ci	Should a confidence interval be added to the output. Default TRUE.
ci_names	Names to use for the resulting confidence intervals.
add_pi	Should a prediction interval be added to the output. Default TRUE.
pi_names	Names to use for the resulting prediction intervals.
simulate_pi	Should the prediction intervals for glm models be simulated. If TRUE, default, <code>predict()</code> uses the <code>ciTools::add_pi()</code> function to generate the intervals.
sims	The number of simulations to run when simulating prediction intervals for a glm model.
uncertain	Only used for glm models and when <code>simulate_pi = FALSE</code> . Default TRUE. If FALSE uncertainty in the fitted parameters is ignored when generating the parametric prediction intervals.
...	Not currently used.

**Value**

a `trending_predict_tbl` object which is a [tibble](#) subclass with one row per model and columns 'result', 'warnings' and 'errors' with contents as above.:

- result: the input data frame with additional estimates and, optionally, confidence and or prediction intervals. NULL if the associated predict method fails.
- warnings: any warnings generated during prediction.
- errors: any errors generated during prediction.

**Author(s)**

Tim Taylor

**See Also**[predict.trending\\_fit\(\)](#), [predict.trending\\_fit\\_tbl\(\)](#) and [predict.trending\\_model\(\)](#)**Examples**

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)
poisson_model <- glm_model(y ~ x , family = "poisson")
negbin_model <- glm_nb_model(y ~ x)
fitted_tbl <- fit(list(poisson_model, negbin_model), dat)

predict(fitted_tbl)
```

---

`predict.trending_model`*Predict method for trending\_model objects*

---

**Description**

Adds estimated values and associated confidence and/or prediction intervals to data based on trending\_model fit.

**Usage**

```
## S3 method for class 'trending_model'
predict(
  object,
  data,
  name = "estimate",
  alpha = 0.05,
  add_ci = TRUE,
  ci_names = c("lower_ci", "upper_ci"),
  add_pi = TRUE,
  pi_names = c("lower_pi", "upper_pi"),
  simulate_pi = FALSE,
  sims = 2000,
  uncertain = TRUE,
  as_tibble = TRUE,
  ...
)
```

**Arguments**

object	A <a href="#">trending_model</a> object.
data	A <code>data.frame</code> containing data to which the model is to be fit and estimates derived.
name	Character vector of length one giving the name to use for the calculated estimate.
alpha	The alpha threshold to be used for prediction intervals, defaulting to 0.05, i.e. 95% prediction intervals are derived.
add_ci	Should a confidence interval be added to the output. Default TRUE.
ci_names	Names to use for the resulting confidence intervals.
add_pi	Should a prediction interval be added to the output. Default TRUE.
pi_names	Names to use for the resulting prediction intervals.
simulate_pi	Should the prediction intervals for glm models be simulated. If TRUE, default, <code>predict()</code> uses the <code>ciTools::add_pi()</code> function to generate the intervals.
sims	The number of simulations to run when simulating prediction intervals for a glm model.
uncertain	Only used for glm models and when <code>simulate_pi = FALSE</code> . Default TRUE. If FALSE uncertainty in the fitted parameters is ignored when generating the parametric prediction intervals.
as_tibble	Should the output be converted to a tibble subclass.
...	Not currently used.

**Value**

If `as_tibble = FALSE`, a `trending_predict` object, which is a list subclass, with entries:

- `result`: the input data frame with additional estimates and, optionally, confidence and or prediction intervals. NULL if the associated predict method fails.
- `warnings`: any warnings generated during prediction.
- `errors`: any errors generated during prediction.

If `as_tibble = TRUE`, a `trending_predict_tbl` object which is a [tibble](#) subclass with one row per model and columns 'result', 'warnings' and 'errors' with contents as above.

**Author(s)**

Tim Taylor

**See Also**

[predict.trending\\_fit\(\)](#) and [predict.trending\\_fit\\_tbl\(\)](#)

**Examples**

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))
dat <- data.frame(x = x, y = y)
poisson_model <- glm_model(y ~ x , family = "poisson")
predict(poisson_model, dat)
predict(poisson_model, dat, as_tibble = FALSE)
```

---

trending_model	<i>Modeling interface</i>
----------------	---------------------------

---

**Description**

These functions wrap various modelling tools to ensure a consistent input for *trending* functions. They work by capturing the underlying model call and decoupling it from the data specification. This makes it easy to use the same underlying model specification and fitting procedure across different data sets. See details for available model interfaces.

**Usage**

```
lm_model(formula, ...)

glm_model(formula, family = gaussian, ...)

glm_nb_model(formula, ...)

brm_model(formula, ...)
```

**Arguments**

formula	The formula of the model, with the response variable on the left of a tilde symbol, and predictors on the right hand-side; variable names used in the formula will need to be matched by columns in the data input to other functions.
...	Further arguments passed to the underlying models with the exception of data.
family	Link function to be used for the glm model.

**Details**

The following interfaces are available:

- `lm_model`: interface for linear models implemented in `stats::lm()`.
- `glm_model`: interface for generalised linear models (GLMs) implemented in `stats::glm()`.
- `glm_nb_model`: interface for negative binomial generalised linear models implemented in `MASS::glm.nb()`.
- `brm_model`: interface for Bayesian regression models implemented in `brms::brm()`.



These interfaces will accept the same inputs as the underlying model functions but do not require, nor will they accept, a data argument. Fitting is handled instead by the `fit()` generic and associated methods.

**Value**

A `trending_model` object.

**Author(s)**

Tim Taylor

**Examples**

```
x = rnorm(100, mean = 0)
y = rpois(n = 100, lambda = exp(1.5 + 0.5*x))

poisson_model <- glm_model(y ~ x , family = "poisson")
negbin_model <- glm_nb_model(y ~ x)
```

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