

Package ‘SpectralMM’

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Type Package

Title Spectral Majorization for Statistical Estimation

Version 0.2.0

Description Fits generalized linear, asymmetric and robust regression models using spectral majorization and iterative quadratic subproblem solvers. A shared C++ computational core supports dense and sparse designs, automatic intercepts, optional Wald inference and detailed iteration diagnostics. Native code is compiled automatically during package installation.

License GPL-3

Encoding UTF-8

Depends R (>= 4.0.0)

Imports Rcpp, stats, utils

LinkingTo Rcpp, RcppEigen

Suggests Matrix

SystemRequirements C++17

NeedsCompilation yes

URL <https://github.com/Xunjian-Li/SpectralMM>

BugReports <https://github.com/Xunjian-Li/SpectralMM/issues>

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Contents

SpectralMM-package	2
spectralmm_family	2
spectralmm_fit	3
spectralmm_methods	5
Index	8

SpectralMM-package	<i>Spectral Majorization for Statistical Estimation</i>
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Description

A common C++ backend for generalized linear, asymmetric and robust regression, with iterative and Cholesky solvers, dense/sparse inputs, optional inference and iteration diagnostics.

Author(s)

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See Also

[spectralmm_fit](#)

spectralmm_family	<i>Non-GLM Loss Specifications</i>
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Description

Lightweight frontend specifications for the existing non-GLM fitting implementation. Use these constructors with `spectralmm_fit`, not `spectralmm_glm`.

Usage

```
pseudo_huber(delta = 1)
expectile(q = 0.5)
smooth_quantile(q = 0.5, epsilon = 0.1)
student_t(nu = 4)
```

Arguments

<code>delta</code>	Positive finite pseudo-Huber scale.
<code>q</code>	Finite asymmetry level strictly between zero and one.
<code>epsilon</code>	Positive finite smoothing parameter.
<code>nu</code>	Positive finite Student-t degrees of freedom. The residual scale retains its existing default of one.

Details

Matrix and formula fits normalize these objects to the existing string and `family_options` representation. The public `q` maps to the internal `tau`; `epsilon` maps to smoothing. Supplying `family_options` together with an object is an error, even for `NULL` or an empty list. Existing string specifications remain supported unchanged, including custom Student-t sigma. All interfaces use `delta=1` by default, including the legacy string path. To reproduce the earlier development default, explicitly set `delta=1.345`.

Value

A lightweight object of class `spectralmm_family`, containing a core family name and its options.

See Also

[spectralmm_fit](#)

Examples

```
set.seed(1)
dat <- data.frame(y=rnorm(100), x=rnorm(100))
m <- spectralmm_fit(y ~ x, data=dat, family=pseudo_huber(delta=1))
coef(m)
```

spectralmm_fit

Fit Statistical Models with SpectralMM

Description

Matrix and formula interfaces sharing the same numerical core. Use the GLM interface for conventional family/link specifications and the generic interface for residual losses or legacy family identifiers.

Usage

```
spectralmm_glm(X, y = NULL, data = NULL, family = stats::gaussian(),
  link = NULL, start = NULL, rank = NULL, solver = "pcg",
  control = spectralmm_control(), ...)
spectralmm_fit(X, y = NULL, family = "gaussian", data = NULL,
  start = NULL, beta0 = NULL, intercept = NULL, rank = NULL,
  solver = "pcg", control = spectralmm_control(),
  weights = NULL, offset = NULL, ...)
spectralmm_control(...)
spectralmm_diagnostics(object)
```

Arguments

<code>X</code>	A numeric feature matrix, a sparse dgCMatrix, or a formula.
<code>y</code>	Numeric response vector for matrix input.
<code>data</code>	A data frame for formula input. Missing values are rejected.
<code>family</code>	For GLMs, an R family object (gaussian, binomial, poisson or Gamma), or a supported family name. Negative binomial with fixed theta uses the name "negative_binomial". For generic fitting, a constructor such as <code>pseudo_huber(delta=1)</code> , or a legacy core family name or residual loss: <code>smooth_quantile</code> , <code>expectile</code> , <code>pseudo_huber</code> or <code>student_t</code> .

link	Link name for a named family; specify it within an R family object instead when using one. Supported pairs are Gaussian identity/log, binomial logit/probit, Poisson log, Gamma log/inverse and negative binomial log.
start, beta0	Initial coefficients including an intercept when present. beta0 is a compatibility alias; do not supply both.
intercept	NULL adds an intercept for matrix input. FALSE means a complete design matrix. Formula input controls its own intercept and rejects this argument.
rank	Retained spectral rank; NULL retains the existing numerical default.
solver	pcg, mm, cg, cho, cgls, crls, lsqr or lsqr. Legacy aliases spectral and cholesky remain accepted.
control	Advanced numerical settings from spectralmm_control. Omitted settings retain existing defaults. Duplicate direct and control options are rejected.
weights, offset	Not implemented by the numerical core. Non-NULL values are rejected, including formula offsets.
object	A fitted SpectralMM model.
...	Numerical settings (maxiter, inner_maxiter, krylovdim, ridge, floor, gtol, relgtol, eta_max, correction_tol, resid_tol, nesterov, preconditioner, krylov_rtol, krylov_atol, accept_negligible, accept_stalled, negligible_step_tol, step_reltol, stalled_reltol); or fit arguments family_options, inference, inference_max_p, cov_type, level, use_t, dispersion, verbose, trace, penalize_intercept. Control accepts only numerical settings.

Details

The GLM binomial interface currently accepts binary zero/one responses, not proportions or two-column success/failure responses. Generic binomial fitting retains success counts with `family_options=list(trials=...)`. Probit is a binomial link; the old probit core identifier remains a generic compatibility alias. Fixed negative binomial shape uses `family_options=list(theta=...)`.

Formula fits preserve terms, factor levels, contrasts and coefficient names for new-data prediction. Both input routes call the same solver. Matrix input defaults to automatically adding one intercept. Starting vectors follow the resulting coefficient order.

Inference defaults to automatic only for at most 50 coefficients including the intercept. It also requires an unpenalized gradient-converged identifiable model with n greater than p . Setting `inference=TRUE` bypasses only the size cutoff. No covariance matrix is allocated merely for summary or diagnostics.

Deviance is unscaled. Gaussian log likelihood uses the maximum-likelihood scale RSS/n unless dispersion is supplied. Gamma log likelihood is evaluated at the supplied dispersion or Pearson dispersion with $n-p$ denominator; this is not a profiled Gamma likelihood. The covariance dispersion policy is unchanged. Shape parameters remain fixed. Student-t offers a normalized location-scale log likelihood with fixed ν and σ , but no deviance. Normalized likelihood is unavailable for the other residual losses and Tweedie. Verbose output displays LogLik where available, otherwise Objective (summed loss plus ridge). Gradient columns always refer to the optimization objective.

Value

A spectralmm object retaining the spectralmm_native compatibility class. It contains coefficients, family/link, formula metadata, cached linear predictors, fitted values, response residuals, inference and separate numerical diagnostics. The control constructor returns a validated options list; the diagnostics accessor returns a list.

See Also

[spectralmm_methods](#)

Examples

```
set.seed(1)
dat <- data.frame(x1=rnorm(100), x2=rnorm(100), y=rbinom(100,1,.5))
m <- spectralmm_glm(as.matrix(dat[c("x1","x2")] ), dat$y,
                    family=binomial("logit"))
f <- spectralmm_glm(y ~ x1 + x2, data=dat, family=binomial("logit"))
coef(f)
summary(f)
head(predict(f, dat, type="response"))
spectralmm_diagnostics(f)$termination_reason
```

spectralmm_methods	<i>Extract Results from a SpectralMM Fit</i>
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Description

Coefficient, prediction, covariance, confidence interval and summary methods for fitted SpectralMM models.

Usage

```
## S3 method for class 'spectralmm'
predict(object, newdata = NULL, type = NULL,
        trials = NULL, offset = NULL, ...)
## S3 method for class 'spectralmm'
fitted(object, ...)
## S3 method for class 'spectralmm'
residuals(object, type = "response", ...)
## S3 method for class 'spectralmm'
nobs(object, ...)
## S3 method for class 'spectralmm'
deviance(object, ...)
## S3 method for class 'spectralmm'
logLik(object, ...)
## S3 method for class 'spectralmm'
summary(object, ...)
## S3 method for class 'spectralmm'
```

```

print(x, ...)
## S3 method for class 'summary.spectralmm'
print(x, digits = 6, max_rows = 20L, ...)

## S3 method for class 'spectralmm_native'
coef(object, ...)
## S3 method for class 'spectralmm_native'
predict(object, newdata, trials = NULL, ...)
## S3 method for class 'spectralmm_native'
vcov(object, ...)
## S3 method for class 'spectralmm_native'
confint(object, parm, level = .95, ...)
## S3 method for class 'spectralmm_native'
summary(object, ...)
## S3 method for class 'spectralmm_native'
print(x, ...)
## S3 method for class 'summary.spectralmm_native'
print(x, digits = 5, max_rows = 20L, ...)

```

Arguments

object	A fitted model.
x	A fitted model or summary, as appropriate.
type	Prediction: link or response; NULL defaults to link for <code>spectralmm_glm</code> and response for legacy <code>spectralmm_fit</code> . Residuals: only response is supported.
newdata	NULL for training predictions, a data frame for formula fits, or a numeric or sparse matrix with the same feature columns and ordering as training data, without an automatically fitted intercept column.
trials	Grouped binomial prediction trial counts, a positive scalar or vector. Defaults to the fitting value. Supply new counts for new rows when needed.
offset	Not implemented; a non-NULL value raises an error.
parm	Optional coefficient indices or names.
level	Confidence level between zero and one.
digits	Number of significant digits to print.
max_rows	Maximum coefficient rows to print. Full results remain in the summary.
...	Further arguments; the fitted-model print method forwards them to the summary print method.

Details

Coefficient tables use a t or z reference. Separate `wald_chisq` and `wald_p_value` components use an asymptotic chi-square reference; their p-values can differ from t-reference p-values.

Value

Coefficients (intercept first), response predictions, a covariance matrix, a confidence-interval matrix, or a summary list, depending on the method. Binomial predictions are expected counts. Non-GLM predictions are fitted locations: conditional expectiles for expectile loss, smoothed quantiles for smoothed quantile loss, and robust locations for Pseudo-Huber and Student-t. These are point predictions, not prediction intervals. Print methods return their input invisibly. Covariance and confidence interval methods signal an error when inference is unavailable.

See Also

[spectralmm_fit](#)

Index

`coef.spectralmm_native`
 (`spectralmm_methods`), 5
`confint.spectralmm_native`
 (`spectralmm_methods`), 5
`deviance.spectralmm`
 (`spectralmm_methods`), 5
`expectile(spectralmm_family)`, 2
`fitted.spectralmm(spectralmm_methods)`,
 5
`logLik.spectralmm(spectralmm_methods)`,
 5
`nobs.spectralmm(spectralmm_methods)`, 5
`predict.spectralmm`
 (`spectralmm_methods`), 5
`predict.spectralmm_native`
 (`spectralmm_methods`), 5
`print.spectralmm(spectralmm_methods)`, 5
`print.spectralmm_native`
 (`spectralmm_methods`), 5
`print.summary.spectralmm`
 (`spectralmm_methods`), 5
`print.summary.spectralmm_native`
 (`spectralmm_methods`), 5
`pseudo_huber(spectralmm_family)`, 2
`residuals.spectralmm`
 (`spectralmm_methods`), 5
`smooth_quantile(spectralmm_family)`, 2
`SpectralMM(SpectralMM-package)`, 2
`SpectralMM-package`, 2
`spectralmm_control(spectralmm_fit)`, 3
`spectralmm_diagnostics`
 (`spectralmm_fit`), 3
`spectralmm_family`, 2
`spectralmm_fit`, 2, 3, 3, 7
`spectralmm_glm(spectralmm_fit)`, 3
`spectralmm_methods`, 5, 5
`student_t(spectralmm_family)`, 2
`summary.spectralmm`
 (`spectralmm_methods`), 5
`summary.spectralmm_native`
 (`spectralmm_methods`), 5
`vcov.spectralmm_native`
 (`spectralmm_methods`), 5